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Sabine Ladstätter
Walter Prochaska
Vasiliki Anevlavi (eds.)



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PREFACE OF THE EDITORS

The ASMOSIA XIII International Conference took place from 19th to 24th September 2022. The hosting organizations were the Austrian Archaeological Institute (OeAI) of the Austrian Academy of Sciences (OeAW) and the Kunsthistorisches Museum in Vienna (KHM).

ASMOSIA (Association for the Study of Marble and Other Stones in Antiquity) is an international organization aiming to establish and strengthen the communication between scientists and archaeologists thus uniting archaeometry with archaeology in the field of scientific investigation of marble and geomaterials in general and the application of scientific results in archaeology and art-history. Experts addressed are physical scientists working in archaeometry, archaeologists, art historians, and conservators. To promote these connections the activities of ASMOSIA are aimed at releasing irregular newsletters and communications, however, of pivotal importance is its commitment to hold a triennial conference, which is regular tradition now since 1988 (Ciocco, Luca/Italy). These conferences are the central means for some 300 members worldwide to communicate with each other, to meet in person and to disseminate their scientific results.

The conference in Vienna was hosted by the Kunsthistorisches Museum (KHM), which provided its excellent premises for the conference and gave a magnificent infrastructure for the event. For the one-week conference and the framework programmes some 150 participants were welcomed in the »Bassanosaal« of the museum. According to the time-schedule of the ASMOSIA conferences 70 contributions were selected for oral presentations, and directly adjacent to the lecture room a continuous poster session with some 70 posters took place during the whole week of the meeting.

In line with the tradition of the ASMOSIA conferences the presentations were structured in eight different sessions: Session 1 – »Applications to Specific Archaeological Questions: Use of Marble«; Session 2 – »Provenance Identification I: Marble«; Session 3 – »Provenance Identification II: Other Stones«; Session 4 – »Advances in Provenance Techniques, Methodologies and Databases«; Session 5 – »Quarries and Geology: Quarrying Techniques, Organization, Transport of Stones, New Quarries, Stone Carving and Dressing, Hazards to and Preservation of Quarries«; Session 6 – »Stone Properties, Weathering Effects and Restoration«; Session 7 – »Pigments and Paintings on Marble«; Session 8 – »Production and Trade of Marble and Other Stones in the Alpine and Danube Provinces: Regional Resources and Mediterranean Imports«.

For many years now it is accepted habit that one session and the choice of the themes is reserved to the organizers. Session 8 of this conference thus was devoted to the production, trade and use of marble in the Alpine region and in the Danube provinces. Presented here were inter alia the results of the »Marble Group« of the OeAI and also the outcomes of a recently finished project from the Austrian Science Fund (FWF) about the marbles of Roman Thrace.

Very special thanks for the perfect organization and the success of the conference are going to Georg Plattner (KHM) and to Astrid Pircher, Thomas Schwarnthorer, Ebru Garip, Niki Gail and Judith Wurzer (all OeAI). We are very grateful to Viktoria Schwammerl and Jennifer Steiner for their assistance. We would like to thank our volunteers Petya Andreeva, Fragkiskos Anevlavis, Manos Anevlavis, Thorsten Jakobitsch, Murat Dirican, Benjamin Frerix, Barbara Umfahrer and Wioletta Tenczar for their efforts and personal commitment before and during the conference. Finally, our gratitude goes to our sponsors of the conference for their valued support: Stadt Wien, Omya GmbH, Gesellschaft der Freunde von Ephesos, Federal Government of Lower Austria, Karpontini Bros – Naxian Marbles, Sölker Marmor GmbH and Dombau Wien.

It is thanks to the contributions of so many colleagues who sent the results of their valuable research in time that we were capable of producing this very complete compendium of the relevant

recent scientific research on the wide topic of ancient marble. Several colleagues were involved in the arduous and complex task of realising and preparing this volume, first of all the proven and experienced team of the coordinator Barbara Beck-Brandt with the assistance of Jörg Weilhartner and Angela Schwab for layout (all OeAI). Nicola Wood was responsible for the careful English proofreading. The financial support by the Austrian Science Fund (FWF) as well as the Hlauschek-Legat of the Austiran Academy of Sciences made the production of this volume possible. The printing of the volume was performed by the Holzhausen publishing house in the tried and trusted quality.

This volume we give an extensive overview of the recent activities of the ASMOSIA matters and will provide and present a substantial vade mecum at the next conference in Ljubljana/Slovenia in 2025.

Sabine Ladstätter – Walter Prochaska – Vasiliki Anevlavi
Vienna, April 2024

IN MEMORIAM SABINE LADSTÄTTER

We deeply mourn the loss of Sabine Ladstätter, who passed away in June 2024 after a long illness. When we confronted her in the summer of 2019 with the idea to organise the ASMOSIA XIII conference in Vienna as a joint project between the Austrian Archaeological Institute (OeAI) and the Kunsthistorisches Museum (KHM) in Vienna she, as the then managing director of the OeAI, was immediately a passionate advocate in this endeavour. The organisation and the success of the conference were made possible largely by her commitment and in consequence by the essential support of the OeAI.

For several years Sabine Ladstätter was determined to initiate and strengthen all branches of archaeometry and natural sciences in archaeology at her institute. In consequence, an impressive installation of laboratory facilities during the relocation of the institute took place, and marble provenance investigation now has perfect conditions in the OeAI. Moreover, she was a strong advocate for the availability and sustainability of archaeometric data and actively supported the development of the online open-access database, oeai.METRIX, which hosts extensive marble data and numerous related projects.

As a result of her activities in supporting and organising the Vienna ASMOSIA conference and ›marble activities‹ in general, Sabine Ladstätter developed a deep interest and contribution in the scientific work in this field. We gratefully remember magnificent fieldtrips, sampling campaigns and stimulating discussions with her at the occasion of projects in Bulgaria, Greece, Italy, Türkiye, etc. One of her last papers is on marble in Roman Noricum and is included in this volume.

To continue her efforts and achievements in the science of marble investigations is both commitment and challenge to us to continue the way.

We will always preserve a grateful memory.

Walter Prochaska – Vasiliki Anevlavi
Vienna, December 2024

ASMOSIA PROCEEDINGS I–XIII

ASMOSIA I N. Herz – M. Waelkens (eds.), Classical Marble. Geochemistry, Technology, Trade. Proceedings of the NATO Advanced Research Workshop on Marble in Ancient Greece and Rome, Geology, Quarries, Commerce, Artifacts, Il Ciocco, Lucca, Italy, May 9–13, 1988 (Dordrecht 1988).

ASMOSIA II M. Waelkens – N. Herz – L. Moens (eds.), Ancient Stones. Quarrying, Trade and Provenance. Interdisciplinary Studies on Stones and Stone Technology in Europe and Near East from the Prehistoric to the Early Christian Period, ActaALovMono 4 (Leuven 1992).

ASMOSIA III Y. Maniatis – N. Herz – Y. Basiakos (eds.), The Study of Marble and other Stones Used in Antiquity. Asmosia III Athens. Transactions of the 3rd International Symposium of the Association for the Study of Marble and Other Stones Used in Antiquity (London 1995).

ASMOSIA IV M. Schvoerer (ed.), Archéomatériaux. Marbres et autres roches. Asmosia IV. Actes de la IVème conférence internationale de l'association pour l'étude des marbres et autres roches utilisés dans le passé, Bordeaux-Talence, 9–13 octobre 1995 (Bordeaux 1999).

ASMOSIA V J. J. Herrmann, Jr. – N. Herz – R. Newman (eds.), ASMOSIA 5. Interdisciplinary Studies on Ancient Stone. Proceedings of the Fifth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Museum of Fine Arts, Boston, 11–15 June 1998 (London 2002).

ASMOSIA VI L. Lazzarini (ed.), Interdisciplinary Studies on Ancient Stone. ASMOSIA VI. Proceedings of the Sixth International Conference of the Association for the Study of Marble and Other Stones in Antiquity, Venice, June 15–18, 2000 (Padua 2002).

ASMOSIA VII Y. Maniatis (ed.), Actes du VIIe colloque international de l'ASMOSIA organisé par l'École française d'Athènes, le National Center for Scientific Research »DIMOKRITOS«, la 18e éphorie des antiquités préhistoriques et classiques (Kavala) et l'Institute of Geology and Mineral Exploration, Thasos, 15–20 septembre 2003 / Proceedings of the 7th International Conference of Association for the Study of Marble and Other Stones in Antiquity organized by the French School of Athens, the National Center for Scientific Research »DIMOKRITOS«, the 18th Ephoreia of Prehistoric and Classical Antiquities (Kavala) and the Institute of Geology and Mineral Exploration, Thassos, September 15–20, 2003, BCH Suppl. 51 (Athens 2009).

ASMOSIA VIII P. Jockey (ed.), Λευκός λίθος. Marbres et autres roches de la Méditerranée antique. Études interdisciplinaires. Actes du VIIIe Colloque International de l'Association for the Study of Marble and Other Stones Used in Antiquity (ASMOSIA) / Λευκός λίθος. Interdisciplinary Studies on Mediterranean Ancient Marble and Stones. Proceedings of the VIIIth International Conference of the Association for the Study of Marble and Other Stones Used in Antiquity (ASMOSIA), Aix-en-Provence, 12–18 juin 2006 (Paris 2009).

ASMOSIA IX A. Gutiérrez Garcia-Moreno – M. P. Lapuente Mercadal – I. Rodà de Llanza (eds.), Interdisciplinary Studies on Ancient Stone. Proceedings of the IX Association for the Study of Marbles and Other Stones in Antiquity (ASMOSIA) Conference, Tarragona 2009, Documenta 23 (Tarragona 2012).

ASMOSIA X P. Pensabene – E. Gasperini (eds.), Interdisciplinary Studies on Ancient Stone. ASMOSIA X. Proceedings of the Tenth International Conference of ASMOSIA, Association for the Study of Marble & Other Stones in Antiquity, Rome, 21–26 May 2012 (Rome 2015).

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APPLICATIONS TO SPECIFIC ARCHAEOLOGICAL QUESTIONS: USE OF MARBLE

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Vasiliki Anevlavi

KOURO-STORIES

AN EDUCATIONAL PROGRAMME ABOUT THE MARBLE KOUROI OF NAXOS ISLAND, GREECE

Abstract
By treating education as the mechanism which communicates with the past and at the same time connects with the daily reality of students, we designed an educational programme focused on the local history of Naxos Island, Greece. The design of a learning process, in an interdisciplinary context with the use of play, aims at fostering the active involvement of children, the development of their way of thinking and acting, and the development of skills. This work is based on the view that knowledge and learning are the results of a collaborative process and the interaction of participants. Through a game that oscillates between reality and fantasy, students explore the marble past of Naxos and meet the kouroi of the Archaic era. The interdisciplinary approach of the educational programme invites and encourages the children to engage with the island's history, art, geography, mathematics, and archaeology in a positive way.

INTRODUCTION

This paper presents an educational programme that concerns the Archaic kouroi of Naxos. This programme is aimed at preschool children, but with appropriate adaptation, it can be presented to primary school classes as well. The programme's themes and the choice of the kouroi are based on the uniqueness of these sights of Naxos. These statues are semi-worked masterpieces of the Archaic period, made of white marble, and are considered among the most important findings of this period in Greece. Their importance is not only archaeological and historical but also geological, as marble is at the forefront of the mineral wealth of Naxos. These cases of statues also attract interest in terms of their surroundings as they have remained *in situ* since antiquity. By contrast, the ancient marble quarries give us complete information about daily life and trade at that time. In recent years, particular sites have been highlighted, specifically in the area of Melanes, as excavations have brought to light a complex of antiquities such as the Sanctuary of the Springs, the aqueduct, etc.[1].

A combination of different characters, designed for each day of the school week, will help the students to travel through history and learning. Mysterious letters arrive in the classroom, guiding them to become researchers by discovering the past. The programme will focus on marble as a raw material, and other parameters such as trade, tool marks, tools, workshops, sculptures, preservation, and conservation of marble and heritage. The programme, with proper adjustments, can be presented to various school levels as well as to adults.

THEORETICAL BACKGROUND

Museum education is the educational science with the museum as the place of action. It helps in the operation of the museum as well as in the achievement of the educational goals for society which the museum has set. The science of museum education has drawn influences from the educational

[1] Lambrinoudakis – Sfyroera – Bilis 2010, 11–15.

sciences as well as from the development of the role of museums. In particular, with the help of museum collections, educational techniques, communication science and informal education, an environment is created in the museum space that is suitable for the extraction of information and knowledge in a creative way[2], while the active participation of visitors provides a more creative museum experience. As educational institutions, museums address not just young people but the whole of society. They are responsive to all audience groups, regardless of age and social status[3]. However, educational programmes can also be implemented in the school setting, and often in a combined manner (a combination of classroom programmes and museum visits)[4]. Educational programmes constitute active learning, academic knowledge that the school provides, a connection of knowledge with reality, learning challenges, moments of exploration, moments of activation of the students' imagination, and moments of entertainment. Of course, in every programme, the primary role and objective is the proper design and the overall mission of the museum/theme/classroom in question. In addition, the characteristics of non-formal education, which are offered in the context of a museum education programme, also offer help to groups of people with special educational needs in terms of gaining self-confidence and, as a result, broadening their horizons, thus complementing the role of the school[5]. The objectives of educational programmes consist of cognitive objectives (knowledge of terminology, understanding, analysis, synthesis, etc.), the development of critical thinking and skills (critical objectives) and the development of social-emotional objectives (such as the development of memory and imagination)[6]. To achieve these objectives, a wide range and a combination of methods are used. The aim and purpose are the presentation of a particular experience with a balance of knowledge and entertainment[7].

A project is, in theory, successful when:

- its main objective, which for all primary school programmes should be the development of a positive attitude towards museums and the perception of the visit as a pleasant and entertaining experience, has been achieved;
- the individual objectives set during its design (aesthetic enjoyment, observation, knowledge, development of skills, socialisation, etc.) have been achieved;
- the objectives of the programme have met the expectations of the teacher and the children;
- children respond enthusiastically[8].

In the present educational programme, we suggest that experiential learning is particularly important. The term experiential learning refers to learning that takes place through or because of an experience or the relationship between learning and doing (learning by doing)[9]. The basic theory around experiential learning is represented by a four-core circle that captures the cyclical process of learning[10], while at the same time synthesising an active way of understanding experience. According to D. Kolb[11], the learning cycle involves four stages that the learner goes through in the process of seeking knowledge. These are listed and described, briefly, as follows:

1. Experience: It concerns a new empirical situation or the redefinition of an existing one. Those involved in the educational process discover what they have observed, how they feel, what they think and what the meaning is for them.

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2 Oikonomou 2003.
3 Nikonanou 2010, 15–53.
4 Hooper-Greenhill 1998.
5 Nikonanou 2002.
6 Kasvikis – Nikonanou – Fourligka 2002.
7 Nikonanou et al. 2015.
8 Nikonanou 2010, 15–118.
9 Zarifis 2003.
10 McLeod 2010/2024.
11 Kolb 1984.

2. Reflective observation: In this stage they go through a process and try to understand what they have experienced, using interpretation and reflection as tools.
3. Cognitive processing: In trying to make sense of the experiences, the people involved make connections with previous experiences lived by themselves, they look for similarities, i.e. a kind of comparison is made, and finally they generalise and judge.
4. Active experimentation[12].

HISTORICAL BACKGROUND

The Archaic period (700–480 BC) is characterised by the development of the arts, especially architecture, and sculpture. Naxos became a leading power in the central Aegean, exerting the greatest influence on the Ionian religious centre of Delos[13]. Due to the richness of minerals, particularly marble and emeralds, it offered important works of architecture and sculpture[14]. Evidence is observed not only on the island of Naxos, but also in central buildings of this period on the sacred island of Delos dedicated by the Naxians, such as the »House of the Naxians«, which was probably the first Temple of Apollo, and the Lodge of the Naxians[15]. Key features of the period are the ancient marble quarries in the area of Melanes, in central Naxos, and Apollonas, in the northern part of the island, where the pioneering steps for the development of the great art in marble begin[16]. It should be noted that after the initial volume was extracted, ancient sculptors removed successive mantles of material, working with progressively finer tools, to impart more detail before the final shaping[17]. Often, the workers in the quarry would stop at the rough shaping stage of the form, leaving the final stage to be executed at the site where the work was to be placed. This resulted in possible knocks during the initial work and an incomplete project[18].

The Kouros in Fleurio (Melanes Area)

The kouros at the Fleurio site was found *in situ* within a narrow private orchard. The kouros is 5.5 m in size and its right leg is broken (fig. 1). This break was created during transportation. The statue of Fleurio was made at the same time, in the first half of the 6th century BC[19].

The Kouros in the Faraggi (Melanes Area)

The second statue, the kouros in the Faraggi, is located south of Fleurio at a higher altitude, accessible by rough paths. The statue has been left on the ground since its construction (1st half of the 6th cent. BC) and depicts a naked man (fig. 2). The statue survives from head to knee on the right side, while the left leg is missing. The hair, falling to the right and left from the head to the chest, has been completely removed from the face[20]. Although the statue is unfinished, the creator has already given it the general characteristics of Naxian taste, pleasing proportions, flowing contours, and lack of a sense of flesh. The surviving length of the kouros is 3.83 m, and its overall height would have been 5.5 m[21]. The most probable reason why the statues were abandoned in the quarries is presumed to be accidents that occurred either during the quarrying process or during

12 Triliva – Anastasopoulou 2008.
13 Sondgrass 1980, 143–151.
14 Tambakopoulos – Maniatis 2012, 291.
15 Richter 1949, 26–29.
16 Ridgway 1993.
17 Kokkorou-Alevras – Poupaki – Eustathopoulos 2010.
18 Lambrinoudakis 2019, 26 f.
19 Lambrinoudakis – Sfyroera – Bilis 2010, 11–15.
20 Lambrinoudakis – Sfyroera – Bilis 2010, 11–15.
21 Lambrinoudakis – Sfyroera – Bilis 2010, 11–15.



1 Kouros in Fleurio (photo: E. Anevlavis)



2 Kouros in the Faraggi (photo: E. Anevlavis)



3 The Kouros of Apollonas (photo: E. Anevlavis)

the movement of the statues for delivery[22]. Large volumes of marble, semi-worked marble, and traces of ancient tools are also observed in the quarries.

The Kouros of Apollonas (Apollonas Area)

The second large quarry is located at the northeastern end of the island, in the village of Apollonas. The quarry is thought to have operated alongside the ancient quarry around Melanes. Traces of ancient quarrying and mining are observed on the hill of the quarry[23]. A semi-worked kouros was preserved, with little extraction from the parent rock, and is the largest known sculptural work of antiquity[24].

The sculpture is thought to represent the god Dionysus, dressed in a tunic and long robe, and probably held a kantharos in its slightly extended right hand (fig. 3). The work is 10.2 m high and is believed to have been carved in the 540s–530s BC[25]. Its date and size match the date and height of the Fourth Temple of Uriah, and researchers speculate that this was probably the intended location

22 Lambrinoudakis – Sfyroera – Bilis 2010, 11–15.

23 The quarrymen carved grooves around the perimeter of the tumour, on the surface of the rock and along the horizontal plane of the base of the tumour, either exploiting the cleavage of the deposit or opening slots for metal or wooden wedges, see Lambrinoudakis 2019, 17 f.

24 Richter 1960, 11.

25 Richter 1960, 11.

for the statue[26]. On the beach of Apollonas, where the road of the *lithagogia* from the quarry ended, huge boulders from the ancient pier where the ships received their cargo are still preserved[27].

Archaic Architecture and the Temple of Apollo

On the island of Palatia, around 530 BC, building of a marble temple by the tyrant Lygdami (545–524 BC) in honour of the god Apollo began. The temple was oriented towards Delos[28]. The temple was designed as a peristyle Ionic temple with six columns at the front and twelve at the sides. On the front and back sides, however, the temple was designed as a dipterous, i.e. the plan provided for a second row of columns through the first row of the circumference and before the front and back columns of the temple[29]. The tyranny of Lygdami ended in 524 BC, and the work remained unfinished. Part of the cella and part of the entrance were completed. The entrance to the cella was formed into a monumental thyrsus with a monolithic threshold, lintel, and pilaster stones, each weighing about 20 tonnes. The monumental doorway was the main monumental element in the architecture, with a width of 6.2 m, and a height of 9 m[30].

DESCRIPTION OF THE EDUCATIONAL PROGRAMME

The programme is addressed to kindergarten classes and has a minimum duration of five days. Based on a letter that arrives in the classroom, the children are invited to become researchers and search for information about the kouroi of Naxos. An archaeologist sends a letter to the class, asking for information concerning the Kouros of Naxos. The letter asks the children for help in finding out more about the statue. Every day new clues come to the classroom that challenge the children to process them through hands-on activities, games, and art activities. The children, with the support of the teacher, collect information, and at the end, they are asked to synthesize their findings as a response to the archaeologist. The structure of the project is described in more detail below.

Day One

On the first day, the teacher displays a letter received by the school administration addressed to the children in the class. Children and teachers process the envelope of the letter before opening it and observe what is written on the outside, then express thoughts and speculate. They open the letter and decide together how to read it (for example, whether it will be read by the teacher or by some children with a more advanced level of literacy). The letter has been sent by an archaeologist, who asks the children for help in getting to know the Kouros better. In the envelope, she has included a photo of the Kouros to explain better the statue to which she is referring. After reading the letter, the aim is to bring out possible prior knowledge that the children have about the Kouros of Naxos. Whether the children know about the subject or not, observing the photograph is very useful as an educational process, as the children, with the support of the teacher, observe and identify features of the statue, describe the surrounding area, and make assumptions about the material, its age, the reason for its existence, etc. The teacher then encourages the children to think together about ways to find more information. It is very useful for them to agree on a way of recording their ideas, and this will help to organize their thinking and coordinate the information that they collect daily. The day ends with an agreement to try to learn more about the Kouros (with their families) and return to class the next day with their discoveries.

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26 Lambrinoudakis 2019, 26 f.
27 Lambrinoudakis 2019, 17 f.
28 Lambrinoudakis 2019, 17 f.
29 Gruben 2000, 376–380.
30 Gruben 2000, 376–380.

Day Two

The next day starts with a review of the previous day and continues with the children's discoveries. In case the children have not brought any new information, they move on to the next phase, where the teacher informs them that they have received a second letter. After reading the letter, they discover that the sender is a swallow, a migratory bird that comes from Africa and uses the Kouros as a signpost on its journey. It describes the size of the Kouros and how it looks from above. Through suggested activities and games, the children are engaged in the process of working through the concept of size, and with the support of the teacher, they look for different ways to understand and visualise the length of 10 m (e.g. measuring in steps).

Day Three

The next day another letter awaits the children in the classroom. This time it is from a tiny spider that lives in the cracks of the marble Kouros. There is a report on the current state of the Kouros, the reasons why it was left unfinished and the ancient marble quarries and tool marks. The daily life of the ancient quarrymen is briefly described, and the letter includes photographs of ancient tools. Activities are then proposed to familiarise children with ancient tools and modern methods of quarrying and processing marble.

Day Four

Day four begins with a new letter, this time from a flying resident of the island, a seagull. Intent on shedding additional light on the children's research, its letter mentions the existence of two more large kouroi in the Melanes area. In addition, it mentions the characteristics and typology of the statues. The letter includes photographs of the kouroi as well as a map of Naxos, which the children are asked to work on to identify the signs showing all the relevant locations. We then suggest kinetic play aimed at familiarising the children with the characteristics of the positions of the koroi and visual arts activities. The day ends with the children sharing their creations along with their thoughts about the kouroi.

Day Five

Day five begins, and one last letter arrives in class. The letter is from the Kouros. He writes about how the marble statues speak to people through their features. In addition, he encourages them to visit all three kouroi, as he passes on a message of heritage conservation. The children, with the support of the teacher, are then tasked with revising all the evidence they have discovered during the week and composing their responses to the archaeologist. The format of the answer is agreed upon together in class (photos, drawings, letters, etc.). After sending their answer, they receive a thank-you note from the archaeologist. Finally, in the event the class is able to go on an excursion to a relevant archaeological site, the teacher is given supporting notes.

EPILOGUE

As soon as the economic and social conditions allowed it, the craftsmen of Naxos, with centuries of experience in the processing of this noble material, which was available to them on a daily basis, created with knowledge and daring monumental architectural and sculptural figurative forms which sealed the evolution of Classical Greek architecture and plastic art.

Through the educational programme, we hope to link education and culture and develop curiosity and exploration of various other elements of our culture. In the coming years, we plan to pilot this educational programme in the kindergartens of Naxos. With appropriate future adaptation, this programme can be implemented in kindergartens in the rest of the country, as well as in primary school classes. The results of the educational programme will be presented at a future conference.

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TYPOLOGICAL STUDY OF THE MOULDED MARBLE SLABS AS PART OF THE WALL DECORATION OF THE FRIGIDARIUM IN THE MONUMENTAL THERMAL COMPLEX OF VALERIA (CUENCA, SPAIN)

Abstract
The successive archaeological interventions carried out in the frigidarium of the Valeria public thermal complex have made it possible to recover an important set of marble pieces belonging to the decorative programme of its different rooms. A notable part of this set belongs to parietal covering slabs in which, in numerous cases, a moulded decoration has been carved into their surface. The present work aims to establish a proposed classification for the moulding seen in marble pieces, from the simplest models to those that present greater compositional complexity, in order to systematise their study and be able to establish comparisons with other moulded carved plates present elsewhere in the Roman Empire.

INTRODUCTION

Since 2014, archaeological excavations in an unexplored area of the Hispano-Roman city of Valeria (Cuenca)[1] have focused on the remains of a monumental thermal bath complex, which is the only example of this type of building within the city. So far, only the rooms belonging to the frigidarium have been completely excavated[2].

The building, which continued to serve the community as a thermal bath for almost 400 years (1st–4th cent. AD), was richly decorated with wall and floor mosaics, as well as an elaborate decorative programme that included varieties of marble from across the empire[3].

After its final abandonment, the building was not subjected to any significant looting of its construction materials. In fact, only sporadic acts of theft have been identified, which were mainly targeted at recovering the metal clamps that fixed the marble revetment to the walls.

The archaeological excavations of the frigidarium have recovered a total of 7,058 pieces belonging to the marble decoration of the building, all of which were detached from their supports. This collection includes cornices, fluted pilasters, floor tiles, and, above all, wall cladding slabs[4]. Although most of the marble cladding slabs have a smooth surface, others have carved decorations on their surface consisting of simple mouldings with straight, convex, or concave profiles, which in some cases combine to form complex designs[5].

This work presents the preliminary results of the study being conducted on these elements, a study that seeks to establish an initial classification of both the types of marble the elements are made of and the typologies of their surface decoration.

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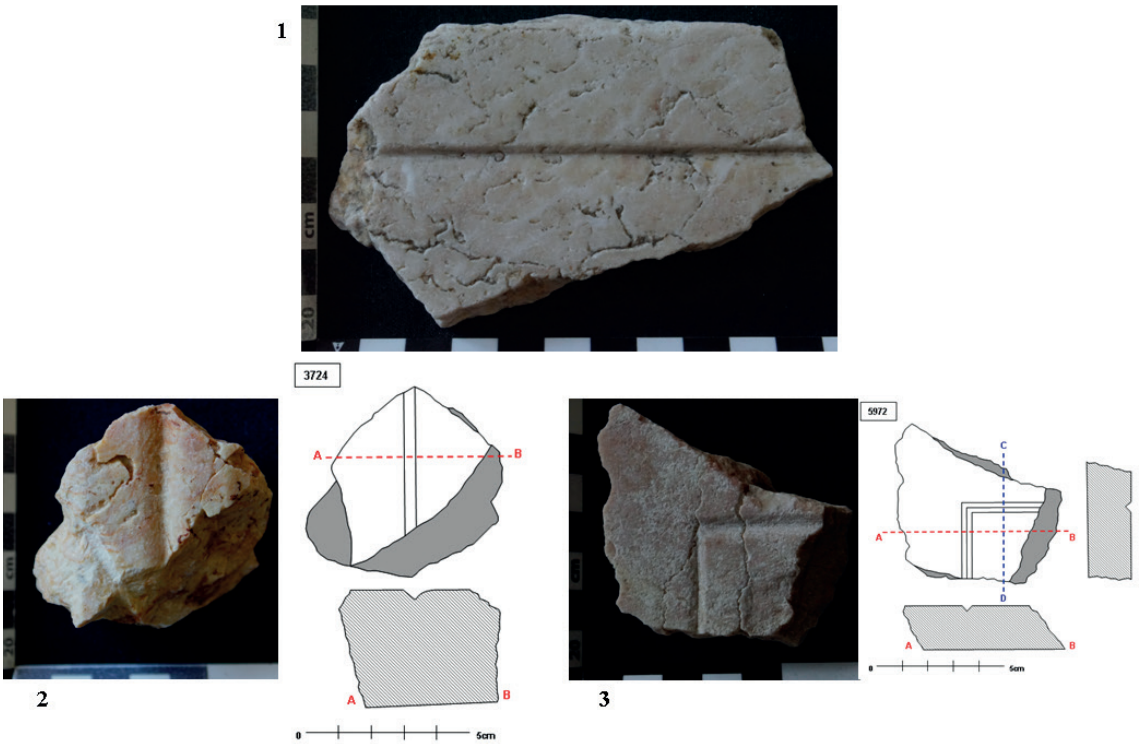
1 The archaeological site of Valeria has been the subject of systematic excavations for decades. However, relatively few scientific articles with the results of these excavations have been published. For a general overview of the history of Valeria, see Osuna et al. 1978; Fuentes 2006, 97–210; Gozalbes 2009, 13–37.

2 Domínguez – Atienza – Bruno 2020, 54–56.

3 Atienza 2019a, 117–124.

4 Atienza 2019a, 124 f.

5 Atienza 2019b, 63 f.; Atienza 2021, 743 f.



1 Examples of marble fragments from the decorative slabs used for wall cladding that were carved with mouldings of type A (photos and graphics: J. A. Fuente)

It is possible that the study of these decorated plaques found in Valeria may help to establish parallels with other identical or similar examples found at other archaeological sites, as well as in other periods of Roman history[6].

METHODOLOGY

In total, the fragments of marble slabs from the original wall cladding that had moulded decorations on their surface amount to 1,873 pieces. They have all been classified into six different categories based on the shape, arrangement, and design of their decoration. Each of these fragments has undergone a visual inspection which includes a review of their specific marble typology and the types of moulding observed on the surface. Similarly, investigation was undertaken to establish whether any breaks in the fragments could form joins with other analysed marble elements. The presence or absence of perimeter faces on the piece, as well as the technical quality of the preserved decorative motifs was also examined. For the classification of the mouldings, a general criterion has been followed, ranging from the simplest to the most complex moulded pieces. Furthermore, different groups have been formed within each category based on the degree of complexity exhibited by the moulded motifs.

6 M. L. Bruto and C. Vannicola have made a remarkable effort to compile the most commonly used compositional schemes in marble wall decorative programmes, based on slabs and panels, during the Roman era. They also discuss the elements that constituted each of these schemes, their articulation in the overall design and the proportions that needed to be maintained between their different elements to achieve a clear aesthetic balance, see Bruto – Vannicola 1990.

MOULDINGS OF TYPE A

This is the simplest model amongst the analysed fragments. It consists of a groove or channel formed by two oblique flat faces that converge inward. All of the cases studied have a triangular profile in a V-shape. The grooves can appear in isolation or accompanied by other types of moulding. This type of moulding creates a chiaroscuro effect on the marble slabs in the form of a thin line of shadow when light is reflected on the surface. This effect contrasts with the rest of the piece, which remains evenly illuminated.

Out of the total set of analysed marble pieces, a total of 18 have this type of decoration.

Variant A1

The pieces that fall under this variant have an isolated groove on their surface that follows a straight line (fig. 1, 1–2). This moulding has a very narrow width, ranging from 0.4–0.7 cm, while its depth varies between 0.3 and 0.6 cm. In those cases where the marble fragments have preserved part of their perimeter faces, the moulding can be seen to run parallel to it, leaving a smooth space between the edge of the slab and the beginning of the moulding which ranges from 2–5 cm.

A total of 13 pieces with this decorative variant on their surface have been documented. Out of these, four pieces are made of Marmor Saetabitanum[7] with a cream or ivory tone, two are made of a lithotype that matches the macroscopic characteristics of Marmor Lunensis[8], while the rest are made of white marble of the Greco scritto type[9].

Variant A2

The grooves found in the variant A1 also appear in this variant but this time they are found in pairs running parallel to each other and following a straight line. The space separating the two grooves varies in each piece, ranging from 2.5–3.5 cm. When any part of the perimeter face of a given piece has been preserved, it is evident that the grooves are parallel to it.

Only three fragments of slabs that preserve this variant of moulded decoration have been documented, and they are all white marble of the Greco scritto type.

Variant A3

Only in two specimens do the grooves follow a converging pattern, which forms a design at a right angle (fig. 1, 3). The surface of the marble slab is completely smooth on both sides of the grooves.

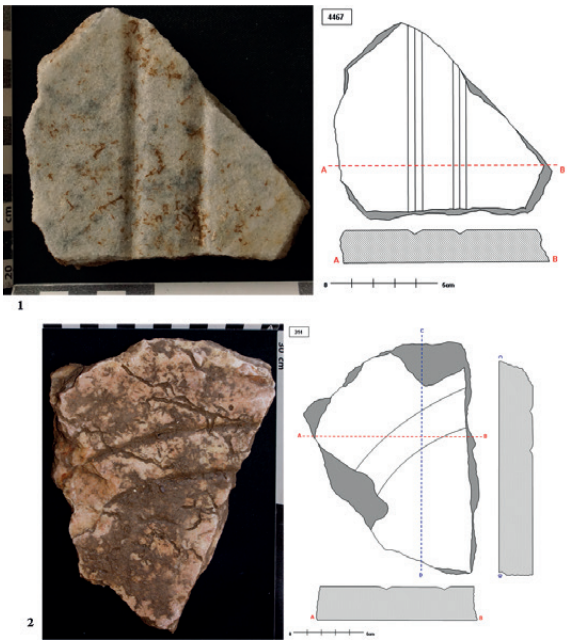
All the pieces of this variant were carved in Marmor Saetabitanum.

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7 M. Mayer provides a general description of this type of rock and its use as a construction and decorative material, see Mayer 1998. The use and exploitation of this lithotype during the Roman period is extensively discussed by R. Cebrián, see Cebrián 2008; Cebrián 2012.

8 The typological definition and use of Luni marble in the province of Hispania are addressed by P. Pensabene, see Pensabene 2004.

9 On the petrographic characterisation of this marble and its North African origin, see Antonelli et al. 2009. Recent discoveries indicate the existence of extraction points for a variety of rock with similar, if not identical, characteristics in the vicinity of Ephesos, in present-day Türkiye, see Yavuz – Bruno – Attanasio 2011; Attanasio et al. 2012; Perna – Antonelli – Lazzarini 2022; Perna – Scognamiglio 2023. Currently the author is collaborating with other researchers from the Catalan Institute of Classical Archaeology (ICAC), under the direction of S. Perna, in the review of the use of this type of marble in Roman Hispania.



2 Examples of marble fragments from the decorative slabs used for wall cladding that were carved with mouldings of type B (photos and graphics: J. A. Fuente)

MOULDINGS OF TYPE B

This is a flat and smooth moulding, shaped like a rectangular section band with a variable width that is delimited on the longitudinal sides by bevelled grooves that converge inward. This moulding appears isolated in most of the examples examined during the analysis process, although in some pieces this type of moulding is associated with other mouldings, thereby creating a design of greater compositional complexity. The reflection of light on the marble elements decorated with this type of moulding creates a chiaroscuro effect, forming narrow bands of light delimited in their contour by fine shadow lines.

A total of 56 pieces with this type of moulding have been identified among the analysed elements.

Variant B1

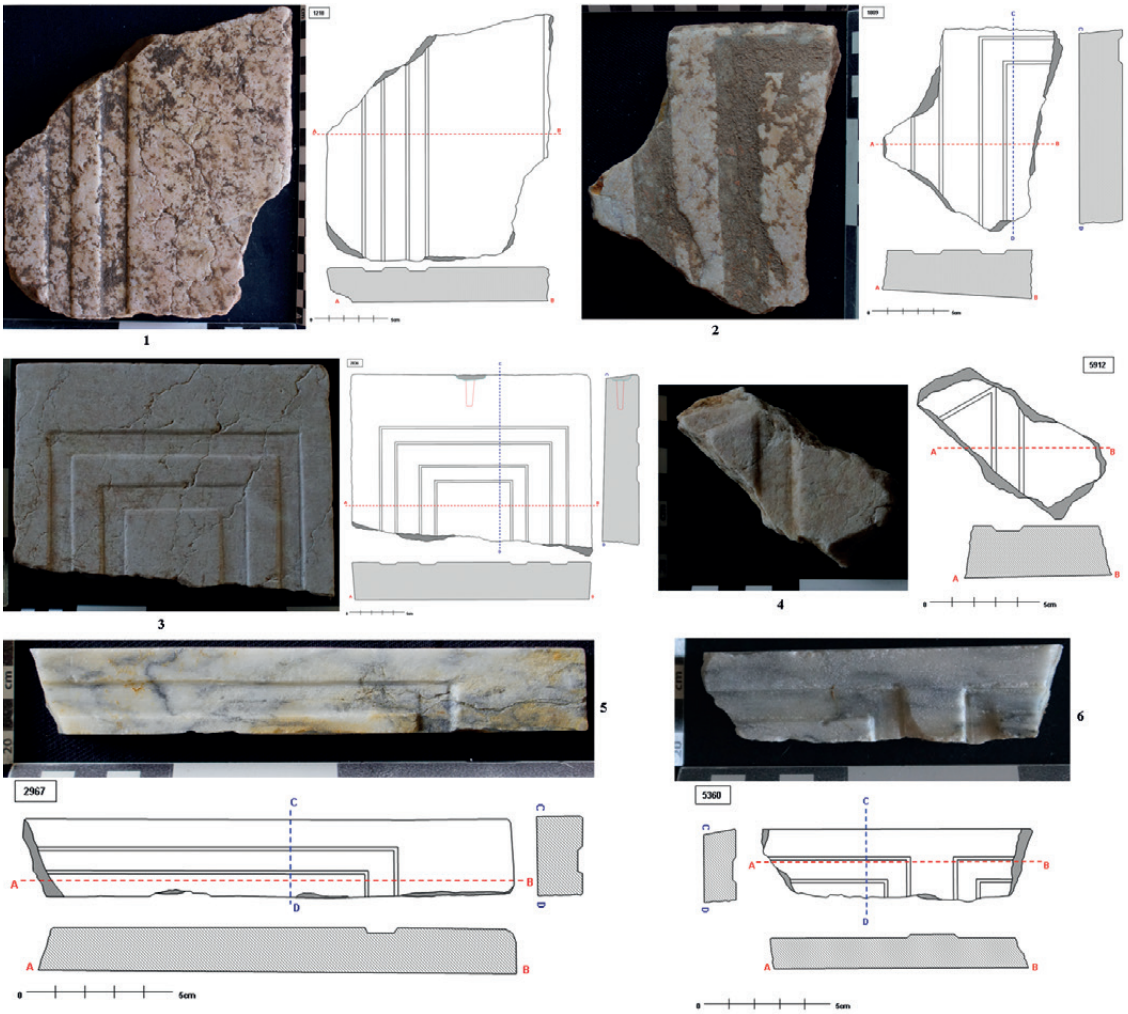
The band or fillet found in most of the examples that can be classed under variant B1 runs along the surface of the piece in a straight line (fig. 2, 1). The most common width of this band varies between 2.5 and 3 cm, although in some pieces the fillets may have a width that exceeds 5 cm.

All the pieces with this variant of moulding are white marble of the Greco scritto type.

Variant B2

Some of the analysed pieces of this variant have bands that follow a curvilinear path (fig. 2, 2). They therefore maintain the same characteristics as those described for the pieces in the previous variant. All the elements identified with this variant of decoration have bands with a width of 2–2.5 cm. In most cases, the curvilinear bands are the only decorative feature of the piece. However, in a couple of fragments, this moulding appears to be associated with other convex-shaped decorative forms, creating a plastic design of a certain compositional complexity.

Almost all the studied pieces containing this variant of moulding are white marble of the Greco scritto type, except for a couple of fragments that were carved in Marmor Saetabitanum.



3 Examples of marble fragments from the decorative slabs used for wall cladding that were carved with mouldings of type C (photos and graphics: J. A. Fuente)

MOULDINGS OF TYPE C

Fragments with mouldings in the form of narrow flat-bottomed grooves or channels that alternate consecutively with straight and smooth listels comprise type C. In this type of moulding, the lateral faces are bevelled slightly outward.

The depth is very uniform in all the elements with this type of moulding, ranging between 0.4 and 0.5 cm. However, regarding the width of the grooves, pieces have been identified with a uniform width of 1.2 cm and others of 0.9 cm[10]. The elements with wider grooves are all made of Marmor Saetabitanum, while those with narrower grooves are carved from white marble of the Greco scritto type. In the pieces made of Marmor Saetabitanum, the channels are usually paired, positioned parallel to each other, and separated by smooth listels with a width of 2.2 cm. In contrast, in the elements made of white marble, the separating listels can be wider or even absent.

10 A set of elements made of white limestone and superficially polychromed, with a moulding in the form of narrow flat-bottomed grooves, was recovered during the excavation of the frigidarium of the balneum in Herrera (Seville). These pieces show a high level of similarity and coincidence with some of the pieces that have been recovered in Valeria, especially in terms of their measurements and the morphology of the marble slabs chosen, see Buzón – Carrasco 2013/2014, 192–194 fig. 5.

A total of 157 pieces have been identified within the sample of elements that present this type of decoration on the surface.

The chromatic effect on the surface of each piece when light is reflected on it is very striking, as there is a contrast between the interior of the grooves, which remains in shadow, and the separating listels, which remain illuminated, thus creating parallel bands of different reflective intensity. However, it is not the size of the shape but its arrangement on the surface of the slab that allows the different variants of this type of moulding to be distinguished.

Variant C1

The grooves or channels of this variant follow a straight path along the entire piece (fig. 3, 1). With a total of 84 elements, this is the most common type found on this variant of moulding. Examples of this variant of moulding have been identified in both Marmor Saetabitanum and white marble of the Greco scritto type.

Variant C2

In this case, the grooves or channels are arranged at a right angle, with the use of a straight listel to maintain the same separation distance between them (fig. 3, 2–3. 5–6). Such a technique is fairly common, especially in marble fragments that have preserved a whole corner or part of it. In one case where the distal end of a rectangular-shaped slab is fully preserved, the grooves run parallel to the edges of the piece (fig. 3, 3).

A total of 69 elements with this variant of moulded decoration on the surface have been counted. Almost all of the pieces that make up this variant are made of Marmor Saetabitanum, except for two white marble pieces of the Greco scritto type.

Variant C3

Despite maintaining the same characteristics as described for the channels of the previous variants, a total of four fragments within this variant are arranged in a pattern that links several acute angles, giving it a broken appearance (fig. 3, 4). All these elements are made of Marmor Saetabitanum.

MOULDINGS OF TYPE D

This group includes fragments of plaques that have a moulding consisting of concave grooves. A total of 237 elements with this type of carved decoration on their surface have been identified.

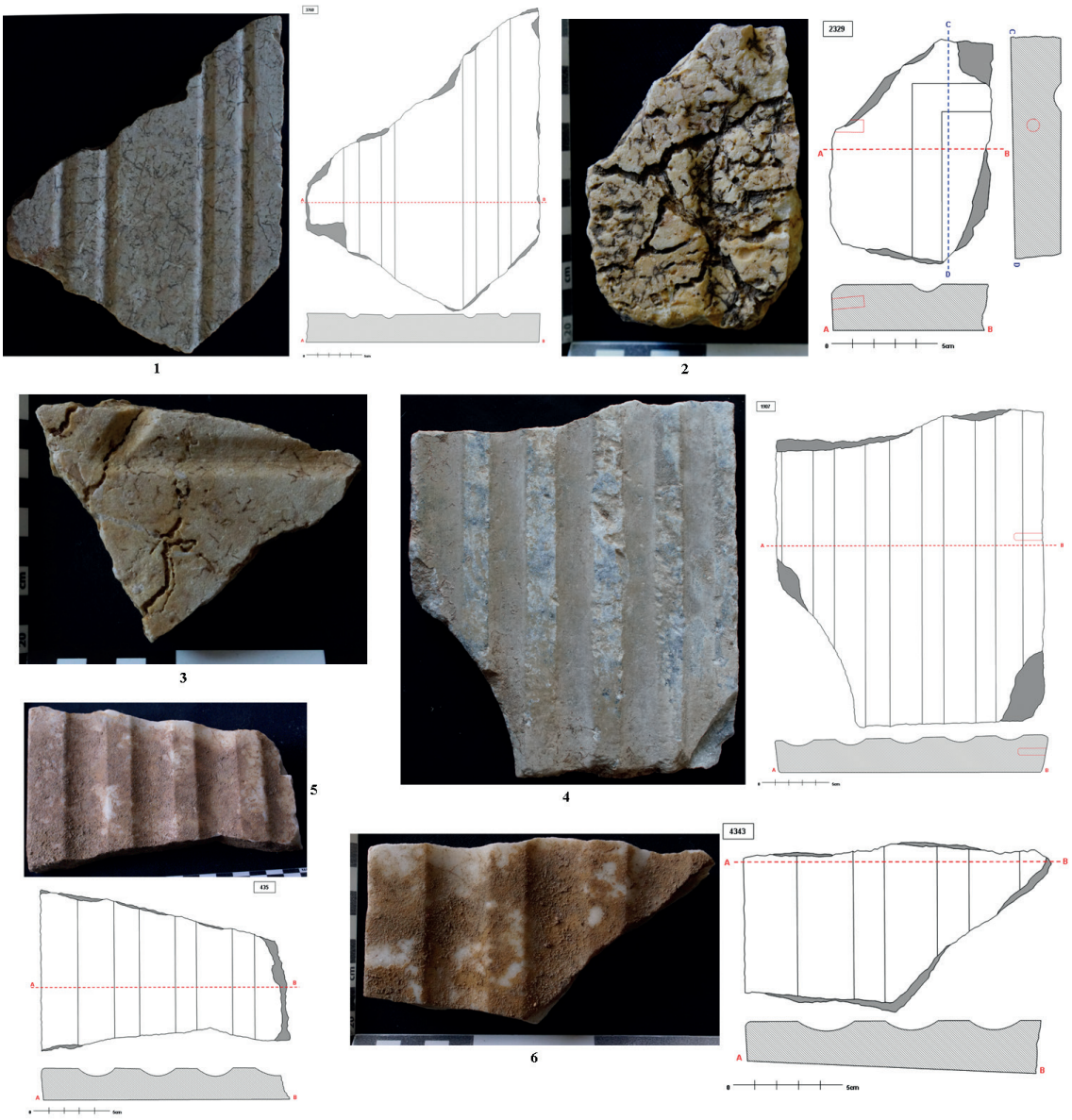
Although the depth of the grooves usually remains uniform in all the fragments (around 0.7–0.9 cm), the width varies significantly between each type of piece.

With regard to the reflection of light on these pieces, a notable chiaroscuro effect is created with well-lit areas on the polished surface and shadowed lines in the area occupied by the grooves. Unlike in the previous type, in this case the grooves have a concave bottom and the shading inside them is a gradient that gradually increases from the outer edges to the bottom.

Variant D1

The grooves in this variant of element have a depth of 0.9 cm and a width of between 1 and 1.2 cm, following a straight pattern. In the better-preserved pieces, which are those that retain the full width of the plaque[11], the grooves are arranged in pairs, running parallel to each other and to

[11] Pieces with the same morphology as those recovered in Valeria have been found at La Alcudia de Elche, see Muñoz – Sarabia 2000, 181.



4 Examples of decorative marble plaque fragments for wall cladding carved with mouldings of type D (photos and graphics: J. A. Fuente)

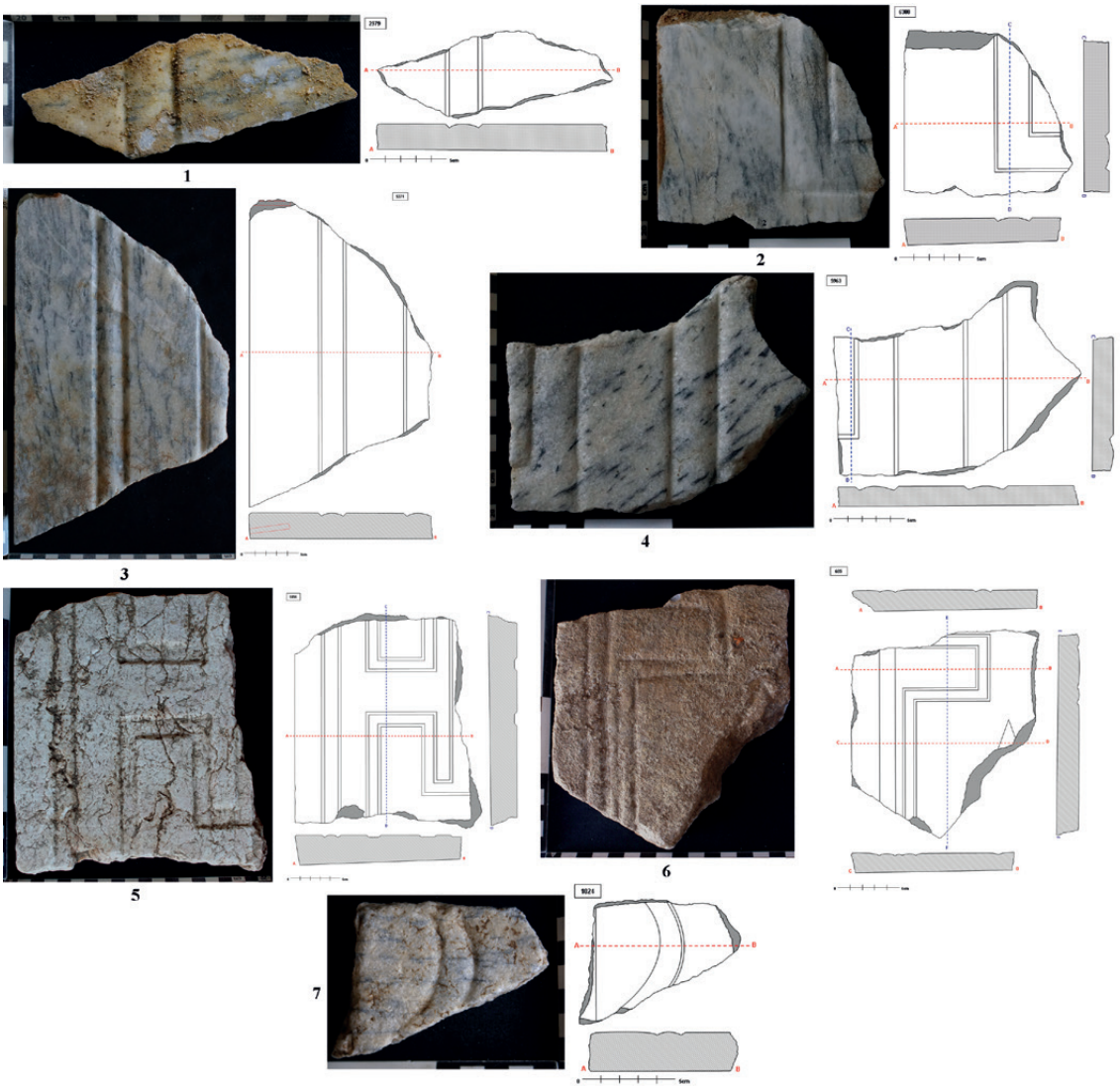
the longitudinal edges of the plaque (fig. 4, 1). The smooth space between the plaque edge and the first groove is 3.5 cm. The paired grooves are separated by a smooth listel with a width of 3 cm, leaving the central part of the plaque free of decoration with a smooth and polished finish.

A total of 32 pieces with this variant of carved ornamentation on their surface have been counted, all of which are made of Marmor Saetabitanum.

Variant D2

While maintaining the same characteristics as described in the previous variant, the grooves on some pieces are arranged at a right angle and appear to be isolated (fig. 4, 2); no other similar or different mouldings associated with this ornamentation have been observed.

The group comprising this variant is composed of five fragments, all made of cream/ivory-coloured Marmor Saetabitanum.



5 Examples of decorative marble plaque fragments for wall cladding carved with moulding of type E (photos and graphics: J. A. Fuente)

Variant D3

The grooves in this variant have the same characteristics as described in the previous variant, but a small group of eleven fragments are arranged in a broken or zigzag pattern, forming a complex decorative scheme (fig. 4, 3). In this group, the grooves do not appear to be paired but rather isolated. However, the fragmented state of the pieces with this moulding means it is not possible to determine their exact form with certainty.

All the pieces of this variant that have been studied were made of Marmor Saetabitanum.

Variant D4

A specific example of pieces with decoration using smooth grooves is found in the shafts of the lesenes (fig. 4, 4–6), of which 189 fragments have been recovered. All the examples of this type of element recovered from the different rooms of the frigidarium of Valeria have grooves with a width between 2.1 and 2.3 cm and a depth between 0.7 and 0.9 cm. The grooves are separated by smooth listels with a width of 1.5 cm.

Some of the grooved shaft fragments retain the total width defined by the lateral faces[12]. The original width of other shafts has therefore been reconstructed from different but matching fragments[13]. The grooved lesene shafts documented in the frigidarium of the thermal complex of Valeria are made of two different marble varieties: one of these is a homogeneous white marble without any noticeable stains or veins on the surface, which matches the macroscopic characteristics of Marmor Lunensis; the other is a marble with a dark appearance in which irregular white stains and veins are randomly distributed on the surface, giving it a brecciated appearance.

MOULDINGS OF TYPE E

With a total of 863 fragments, this is the largest set of moulded elements among the total analysed. They have a convex moulding on their surface in the form of smooth fillets or shafts. This type of moulding does not protrude from the surface of the plaque and is usually delimited by straight incisions with bevelled edges towards the outside which define the total width of the shape. This width varies between 1.2 and 2.2 cm depending on each piece.

When light is reflected on a surface carved with this type of moulding, it creates some striking chiaroscuro effects, creating fine lines of pronounced shadow in the side incisions that delimit the fillets. From there, the shading gradually decreases from the edges towards the central part, which is the most prominent part of the moulding and therefore offers the greatest gradient of light reflection.

Variant E1

This is the most numerous decorative variant that has been documented in the total set of studied fragments, with 319 elements. All of them have the fillet or shaft running along the surface of the piece individually and following a straight trajectory[14] (fig. 5, 1).

The vast majority of fragments with this variant of carved surface decoration are in white marble of the Greco scritto type. However, this variant of moulding has been detected in some fragments of plaques made of Marmor Saetabitanum.

Variant E2

The fillets in this variant are often associated with an identical moulding, running parallel to each other in a straight line and leaving a space between them in the form of a smooth fillet with a variable width ranging from 4–6.5 cm (fig. 5, 3).

Some fragments preserve parts of their original perimeter faces and also preserve moulding. In the case of these fragments, the outermost fillets also run parallel to the moulding, leaving a free space from the edge of the piece to the border of the incision that delimits the fillet, ranging from 2–7 cm.

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12 The fluted shafts of the frigidarium, regardless of the marble variety in which they were carved, have a total width of 22.5 cm. On the front face of the shafts there are five smooth flutes, separated by four smooth fillets.

13 Fluted lesene shafts, carved in a material macroscopically similar to those recovered in Valeria and of practically identical dimensions, have been found in numerous sites from the early Imperial period to the Late Empire. To mention some of the most representative ones, it is worth noting those belonging to the 2nd-cent. AD phase of the Villa of Els Munts, see Domingo 2022, 397 fig. 5, 19; Gutiérrez-Galán 2022, 517 f. Due to their proximity to the Valeria site, we mention here the fragments of fluted lesene shafts recovered in the excavation of the forum of Segobriga with a compositional scheme and materials that are practically identical to those found in the thermal complex of Valeria, see Cebrián 2004, 348 fig. 6.

14 Plaques with a carved decoration that is identical to the pieces from Valeria and have a very similar design have been found in excavations in the southern sector of the Palace of Diocletian in Split, see Marasovic – Marinkovic 2018, 844 f. fig. 10.

A total of 274 elements make up this variant, all of which are carved in white marble of the Greco scritto type.

Variant E3

There are also numerous instances in this variant where the moulded decoration has been carved following a right-angle pattern (fig. 5, 2), often following the arrangement of the perimeter faces of the plaques when they have been preserved. When two paired fillets have been preserved, the most common option is for both of them to follow the angular trajectory in parallel, thus maintaining the straight fillet of separation between them.

The set of analysed marble elements presenting this variant of decoration amounts to 102 units. Most of them are made of white marble of the Greco scritto type, although around a dozen of these fragments were made using Marmor Saetabitanum.

Variant E4

An observable feature in some pieces is that one of the fillets maintains a straight trajectory while the other follows an angular path (fig. 5, 4). When this circumstance occurs in any of the fragments that preserve some of the original perimeter faces, it is the fillet running along the outer part of the moulded surface that maintains a straight trajectory, while the inner fillet turns at a right angle.

The fragments that exhibit these decorative characteristics total 134, all of which were made of white marble of the Greco scritto type.

Variant E5

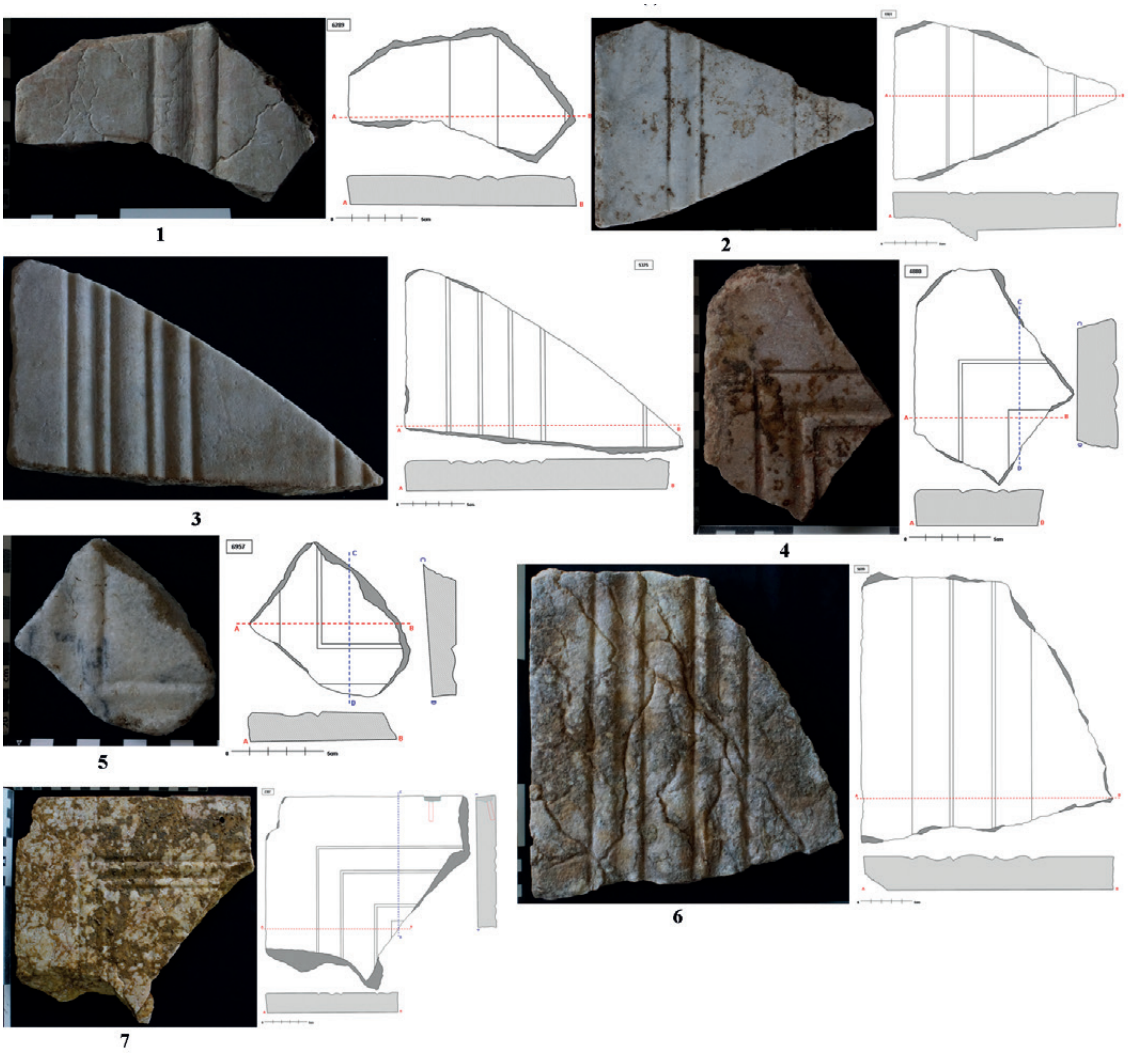
The partial reconstruction of some of the marble plaques decorated with this variant of moulding has revealed that the straight convex moulding is occasionally combined with convex mouldings that connect various right angles, thus forming a dentil pattern (fig. 5, 6). In these cases, the fillet is notably narrower than in the variants described previously for the other mouldings of type E, with a uniform measurement of 1.2 cm. However, the flanking incisions are maintained for both the straight fillets and the dentil ones. In the case of those plaque fragments where the original perimeter faces have been preserved, it has been noted that the fillet runs parallel to it, leaving a smooth space of 2.5 cm.

A total of 27 fragments presenting this combined variant of decoration have been recorded.

Variant E6

Some of the fragments of this variant present breaks that coincide with each other and thus have allowed some joins to be made. These joins have allowed us to reconstruct, at least partially, the total width of a pair of moulded plaques that feature a fillet associated with smooth grooves with the characteristics described for decorative pieces of type C (fig. 5, 5). In both of the plaques, the convex-section fillet runs parallel to the original edges of the perimeter faces, leaving a smooth space with a width of 3 cm until the beginning of the moulding. This creates a kind of perimeter frame within which a more complex decoration develops. On one of the plaques, the smooth grooves occupying the central part form a meander or labyrinth design, while in the other plaque, the grooves consist of straight sections combined with curvilinear ones.

A total of seven pieces with this variant of decoration have been counted, all made of Marmor Saetabitanum.



6 Examples of decorative marble plaque fragments for wall cladding carved with mouldings of type F (photos and graphics: J. A. Fuente)

MOULDINGS OF TYPE F

This type of moulding is characterised by the presence of one or several convex-concave mouldings, known as *cyma reversa*, whose profile is formed by two arcs of a consecutively linked circumference, where the convex arc is the most prominent and precedes the concave, which constitutes the deepest part of the moulding. The reflection of light on the surface of this moulding creates vivid contrasts of light and shadow in the concave part and a more gradual gradient in the convex part. Additionally, the fact that this moulding is often accompanied by other mouldings in the same element only serves to further accentuate the effects of light and shadow that are distributed across the surface.

This group comprises a total of 542 elements carved in various types of marble, such as Marmor Saetabitanum, white marble of the Greco scritto type, or Marmor Lunensis. The latter variety exhibits a higher technical quality in the execution of the carved decoration.

Variant F1

In its simplest form, this variant of moulding appears as an isolated feature between smooth spaces, following a straight line on the surface of the plaque (fig. 6, 1). In all the cases with this variant

of moulding documented during the analysis process, the *cyma reversa* was flanked by straight incisions with bevelled inward edges.

This variant of decoration numbers a total of 101 pieces, which are carved in white Greco scritto-type marble, Marmor Lunensis, and Marmor Saetabitanum. Some of the pieces have preserved fine incised strokes made during the design process of the decoration[15].

Variant F2

The most common way in which these complex straight mouldings appear is in pairs. This sees them associated with mouldings of the same variant and characteristics, arranged in parallel, leaving a free space between them of variable width. This central space can be in the form of a smooth band or occupied by other simple mouldings, both convex in shape and having flat-bottomed grooves[16] (fig. 6, 2–3. 6). Although these complex mouldings can have the same orientation when appearing in pairs, it is more common to find them arranged with the concave parts facing each other in both cases.

The group of pieces with this variant of decoration amounts to 265 examples, which are mostly carved in Marmor Saetabitanum, although some specimens have also been identified in white Greco scritto-type marble and Marmor Lunensis.

Variant F3

It is rare for complex straight mouldings to be arranged with a converging trajectory between them (fig. 7, 1). Only three pieces among the studied elements have this compositional scheme, and all of them are made of Marmor Saetabitanum.

Variant F4

In some cases where the decorated plaques have preserved part of their orthogonal perimeter edges, the complex mouldings are also arranged at a right angle, leaving a free and smooth space from the edge of the edge to the beginning of the moulding, ranging from 1.2–6 cm (fig. 6, 4–5. 7).

Almost all the examples of this variant that have been recovered in the frigidarium of Valeria are carved in Marmor Saetabitanum.

Variant F5

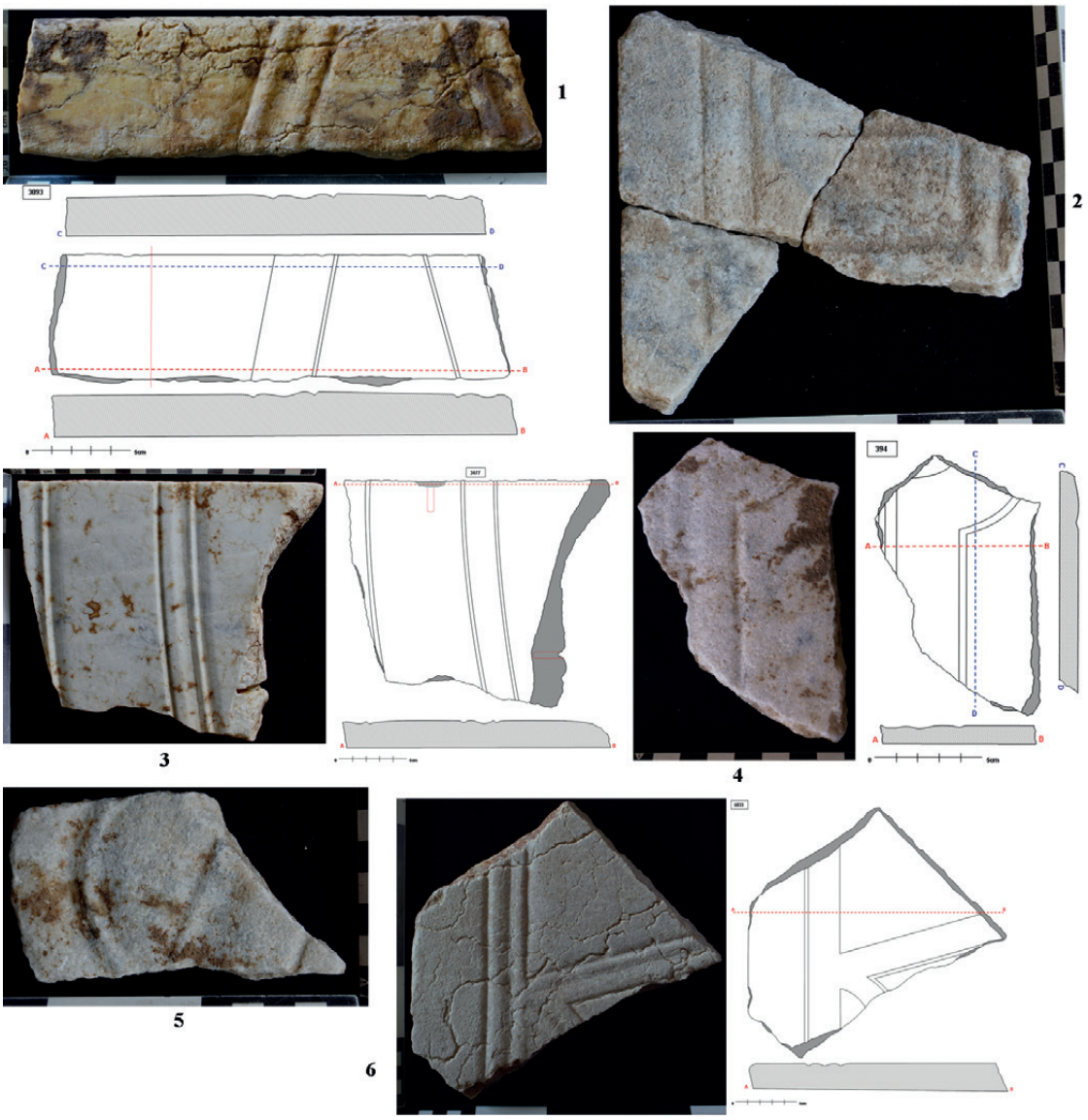
In the case of this variant, complex convex-concave mouldings are arranged on the surface of the piece, linking several right angles and forming a dentil design with a smooth space inside the dentils.

Three fragments with this decoration have been recovered. Because their breaks match, it is fair to assume that they belonged to the same wall cladding plaque (fig. 7, 2). They are all white marble of the Greco scritto type.

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15 Some examples of incised strokes on marble plaques from the thermal complex at Valeria can be found in Atienza 2019b, 64 f. figs. 1–3. 15; Atienza 2021, 747 fig. 16.

16 Due to the preserved size of some fragments and the technical quality of their execution, it is worth mentioning that the moulded *crustae* made of Marmor Saetabitanum from the area of the forum at Libisosa present a plastic finishing on their surface that is identical to some variants found at Valeria, see Muñoz 2004, 553–555 fig. 3. Some fragments of wall cladding plaques that have been documented in the baths of La Alcudia de Elche have the same finishing and are also in Marmor Saetabitanum, see Muñoz – Sarabia 2000, 176–178 figs. 6–7.



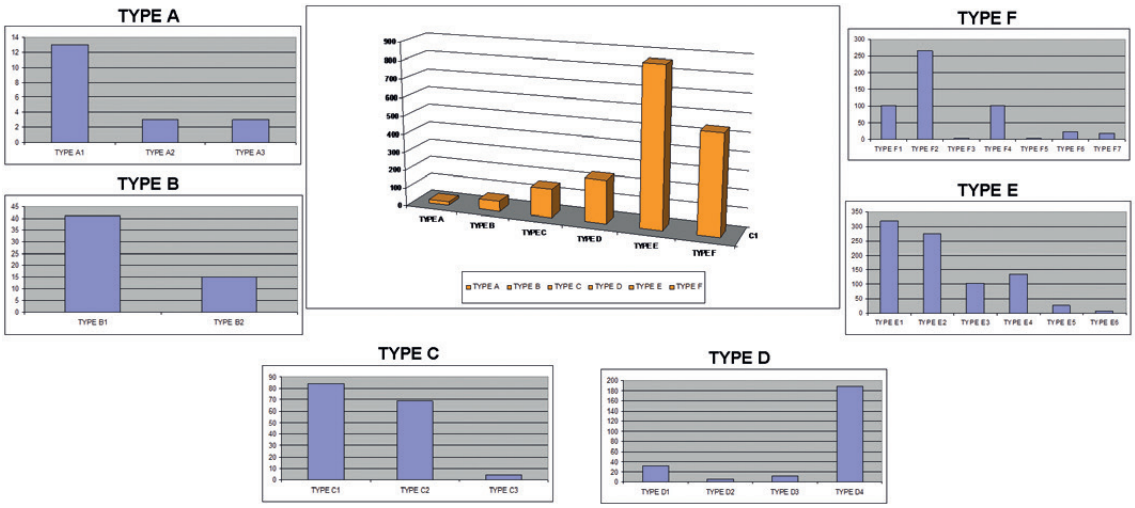
7 Examples of decorative marble plaque fragments for wall cladding carved with complex curvilinear mouldings of type F (photos and graphics: J. A. Fuente)

Variant F6

In some cases, the moulding in the form of a *cyma reversa* follows a curved path on the surface of the plaque (fig. 7, 3). This is especially evident in the pieces that formed the cladding of the arched opening of one of the entrance doors from the palaestra to the vestibulum. Here the carved decoration adopts a concentric curvature to follow the intrados of the voussoirs recovered during the excavation of that area. The cladding elements of this arch were entirely made of Marmor Lunensis[17].

Also associated with the voussoirs of another arched opening are the fragments of marble plaques with complex curvilinear mouldings that have been recovered from the site. However, in

17 Atienza 2019a, 122 fig. 16.



8 Quantitative data of the moulded pieces studied here. In the centre, the total data by type of moulding, and around it, the units belonging to each of the variants (graphics: J. A. Fuente)

this case these fragments are from the entrance that provides access to the tepidarium from the vestibulum. All the fragments associated with this opening were made of Marmor Saetabitanum.

Variant F7

Less numerous are the pieces of variant 7. These combine moulded sections with rectilinear *cyma reversa* and curved sections carved with the same moulding, which form a single decorative design (fig. 7, 4–6). The fragmentary state of the pieces has prevented an in-depth analysis of this variant of complex composition; however, some schemes may be reconstructed as consisting of a series of consecutive arches and elongated rhombuses with truncated vertices and curvilinear sections[18].

This variant of pieces have been found carved in both Marmor Saetabitanum and white Greco scritto-type marble.

STATISTICAL DATA

The marble fragments recovered during the excavation of the rooms comprising the frigidarium of the Valerian thermal complex correspond to a wide variety of lithotypes, whose extraction quarries were scattered throughout the Mediterranean region[19]. Out of all of these marble typologies, only a few received moulded decoration on their surface.

Regarding the types of mouldings, simple convex shapes and reverse crest mouldings are predominant. These mouldings are frequently combined with each other or with other types of shapes to create designs of a certain compositional complexity (fig. 8).

18 Designs with a lozenge-like pattern that are very similar to the one proposed for Valeria have been proposed for some of the plaques from the wall cladding of the villa of La Majona (Soler – Antolinos 2020, 348 f.), but the design also appears in other geographical areas such as the northwest of Gaul (Langouet et al. 2000, 218–220 fig. 4).

19 In addition to the aforementioned Marmor Saetabitanum, Greco scritto marble, and Marmor Lunensis, which are the typologies that contain the moulded decoration, the excavation of the thermal complex has yielded other marble varieties such as Marmor Taenarium, Marmor Thessalicum, and Marmor Sagarium, whose extraction quarries were located on the North African coast, Greece, and present-day Türkiye, respectively, see Pensabene 2013, 292–294. 364.

CONCLUSIONS

The large number of marble elements that were part of the wall decorations of the frigidaria of the thermal complex in the city of Valeria and that have been recovered in the course of successive archaeological excavation campaigns have made it possible to learn a great deal about the marble decorative programme employed in this part of the building.

The detailed study of each individual piece is still in progress, but it has been possible to identify decorative motifs on those elements that present moulded decoration on their surface. Specifically, these decorative motifs range from the simplest linear models to designs that combine different mouldings to create complex decorative patterns.

Moulded marble slabs with a decoration similar and even identical to that of the Valeria elements have been identified in other places in Hispania, Lusitania, and in Gaul.

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Fede Berti – Diego Peirano

IASOS RED CIPOLLINO SLABS

FROM USE IN CLADDING TO THEIR PICTORIAL IMITATION

Abstract
Recent research on Iasian marble has focused on its use in sculptures and on its aesthetics, with special reference to association with other marbles. The latter research is still ongoing. In order to understand better the workmanship of the red Cipollino slabs, we began to compare the 108 blocks abandoned in the workshop built in the tomb named »Balık Pazarı« with slabs conserved *in situ* in 6th-century monuments. In its floruit era, and in times of difficult supply, it seems that the wavy veins of red Cipollino began to be imitated through painting on walls or mosaic in flooring. We found painted imitations in Iasos, in the Tripartite Building; in Ravenna in the Arian Baptistery; in residences in Hadrianopolis, in Paphlagonia and in Sardeis; and in a later period, in the church of St. Pantalemon in Nerezi. An example of marble imitated in flooring and by mosaic can be found in the Theodorician Villa at Galeata, where red Cipollino appears in a threshold.

INTRODUCTION

Research on Marmor Iassense has in the past focused on its presence in the quarries, in the city or in places where it was imported[1]. The quarries undoubtedly represent the most impressive testimony of the past marble processing in Iasos and in the territory. In order to understand more about the quarries, it is necessary to await the data to be published by the »*chora* Survey Mission« led



1 Iasos, Agora Basilica. The large slab of red Cipollino marking the doorway leading from the narthex to the nave (photo: D. Peirano)

[1] Andreoli et al. 2002, 13 f.; Lazzarini 2004, 110; Pierobon Benoit 2005, 232 f.; Lazzarini – Cancelliere – Pierobon Benoit 2005; Berti – Peirano 2016, 178–183; Peirano 2018, 102–104; Berti – Peirano 2023, 3–6.

by Raffaella Pierobon Benoit that, until now, has mainly presented results concerning the topography of places[2]. Not far from Iasos, marble outcrops with quarrying traces abound in gorges and on plateaus. From the quarries to the city there was an effective road system for the handling of blocks. In one instance, the blocks were moved toward the basin of the »little sea« along a sledge route[3]; having arrived there they were loaded onto boats bound for the city. Three main quarries are known; these provided as many marble types[4]: the monochrome, the brecciated – both also used in sculpture[5] – and the Cipollino.

The westernmost quarry is characterised by the simultaneous presence of the two main qualities: Cipollino and brecciated, and – a very interesting aspect – the ruins of a number of buildings, scattered evidence of different marble-processing phases[6]. Urban excavations – very rich in written documents – have not revealed any inscription that would be helpful in providing information on the ownership of the quarries, their management or the marble trade[7].

Otherwise, research into the city shows the day-to-day use of the marble, starting from small artefacts from the Middle and Late Bronze Age[8]. A fragmentary Doric capital (inv. 7045) was found during excavations in a building of probable cultic function overlooking the terrace on the Karaoğlan Dağ, a place where the outcrops of Cipollino are very extensive. A second item, a parallelepiped block (inv. 7158), came from the same edifice; the local quarries were probably active in the late Hellenistic period, as the building dates back to that period[9].

In the Augustan age, the brecciated marble appears in the *opus sectile* of the eastern stoa of the agora, later in the bouleuterion floor[10]. Here also, blocks of monochrome are evident, used in the door jamb baseboards, but not only this. Again, during this period, a different marble (of a uniform rosé) was used in sculpture[11]. In the late empire, the Cipollino was preferred over brecciated marble, the latter reserved for tables, basins and for a number of columns[12].

The primary use seems to relate to its heyday – as is known from the first work dedicated to the subject by Matthias Bruno[13] – with the sawmill built in the imperial tomb named »Balık Pazarı« flanking the aqueduct using saw slabs, this workshop being active between the Justinian era and within the mid-7th century[14].

In Iasos however, there is scant evidence of the local marble, probably because it was more profitable to sell it compared to using it here, but there are signs of it in the Agora Basilica, dated to the Justinian era[15]; here a small column made of Iasian brecciated marble is found in the mid-Byzantine chapel built within the nave, as well as some red Cipollino wall cladding slabs, the latter with a thickness of 2.2 cm. Monochrome tiles were alternated with white marble in the nave and in the north room facing the narthex[16], while the aisles were paved with mosaics. Here, the use of red marble was probably a sign of the importance of the annex, linking the outside with the

2 Lazzarini – Cancelliere – Pierobon Benoit 2005.
3 Pierobon Benoit 2011, 411. 414.
4 Lazzarini 2004, 87.
5 Berti – Peirano 2023, 3–6; Attanasio et al. 2021, 25.
6 Andreoli et al. 2002, 14; Pierobon Benoit 2005, 232 f.; Berti – Peirano 2016, 180.
7 On these problems, see Berti – Peirano 2016, 183 f. However, one inscription is conserved in the Karaoğlan Deresi quarry; its publication is still awaited, see Andreoli et al. 2002, fig. 6.
8 Momigliano 2012, 107. 151. 158. 162 fig. 168.
9 Berti 2001, 121 f.; Andreoli et al. 2002, 14 fig. 8; Lazzarini – Cancelliere – Pierobon Benoit 2005, 324 f.
10 Berti – Peirano 2016, 179 n. 2; 180 fig. 3. The same type of marble was used in the mosaics of the 2nd cent. AD in the House of Mosaics and the »Balık Pazarı«.
11 Attanasio et al. 2021, 25; Berti – Peirano 2023, 3–6.
12 Berti – Peirano 2014, 47–54; Berti – Peirano 2016, 179. 184; Berti – Peirano 2023, 3.
13 Bruno 2012, 706–713. On some of the acronyms and marks used on these blocks, see Marsili 2023, 126–138.
14 One of the latest references to primary use of Iasian marble seems to be the church of Hagios Demetrios in Thessaloniki, built between 629 and 634, see Berti – Peirano 2023, 10.
15 Serin 2004, 99.
16 Berti – Peirano 2016, 185; Peirano 2023, 111 fig. 4 b.

narthex to the east; the latter was mainly paved with reused marble slabs, while the room facing it had no flooring at all. In addition to that, a large slab of red Cipollino marked the entrance leading to the nave from the narthex[17] (fig. 1). At the same time, the marble was used in the most up-to-date buildings in the Eastern Mediterranean[18] while from the mid-7th century, its use seems to have decreased[19], although periods during which it apparently experienced a revival are known through reuse in the middle to late Byzantine period[20]. The end of the Iasos marble era is represented by the use/reuse in much later ages, for example the Firuz Bey Mosque in Mylasa dating back to 1394[21]. The research concerning the diffusion of the marble – the map of which has improved in accuracy compared to the beginning of our studies –, is still ongoing.

F. Berti

USE AND AESTHETIC OF IASOS MARBLE

Research about the aesthetic of Iasian marble mainly refers to the association with other stones[22], these used items still *in situ*. Of these, thanks to the cooperation of the Archaiologiki Etaireia and the Ephorate of Antiquities of Magnesia[23], it was possible to examine the red Cipollino slabs used in the Nea Anchialos Basilica C, in all probability the city's cathedral. The presbytery is connected to the second enlargement of the church, dating back to Justinian times[24].

The sanctuary was of the monumental π-shaped type (fig. 2), preceded by a short *solea* (*prostoon*) and raised one step with respect to the nave, and it was divided by two corridors from the north and south stylobates; these were accessible from the nave by means of two thresholds. The sanctuary prolonged the nave axis with a lane that began from the *prostoon*, was flanked (it seems) by large marble slabs, passed through an *opus sectile* panel also made of Iasos marbles, while another lost panel introducing the ciborium; beneath it was the altar with cruciform *enkainon*. Finally, other large slabs, of which only the imprints were discovered in the excavations, connected the presbytery with the *synthronon*. The presbytery was probably enclosed by means of high barriers made of slabs alternating with chancel pillars that carried an entablature, perhaps made of wood[25]. The columns at the four corners of the *prostoon* were probably of another type, with capitals and bases, one of which is still conserved. It is clear how the presbytery arrangements constituted the climax of the basilica's interior.

The *prostoon* pavement was made up of a radial motif made of Iasos marble hexagons, alternating with square tiles made of white veined marble and small triangles of a green-grey marble (sometimes veined), all framed by the above-mentioned white stone. In its entirety, the panel was preceded and followed by two large slabs 143 × 58–62 cm made of Verde antico (fig. 3). The second conserved panel was composed of poised square and triangular tiles made of white veined and red Iasos marbles with a central tondo (now lost); it is possible that the tondo marked a pause, in front of the altar, in approaching it. At the end of this lane, it must be noted how the *synthronon*

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17 The slab measures 57 × 114 cm with a H of 10.9 cm. On the building, see Serin 2004, 38–85 and related bibliography; in particular, on the area in front of the church, see p. 38.

18 Peirano 2018, 102 f.; Peirano 2023, 108–118.

19 See n. 14 and related text.

20 Apart from *opus sectile* tiles, larger slabs used on walls or in flooring are known in the Kainourgion of Basil I (867–886); in the Comnenian age in the church of Pammakaristos and in the church of St. Savior in Chora. On these, see Mango 1986, 192 f.; Guiglia Guidobaldi 1999, 325.

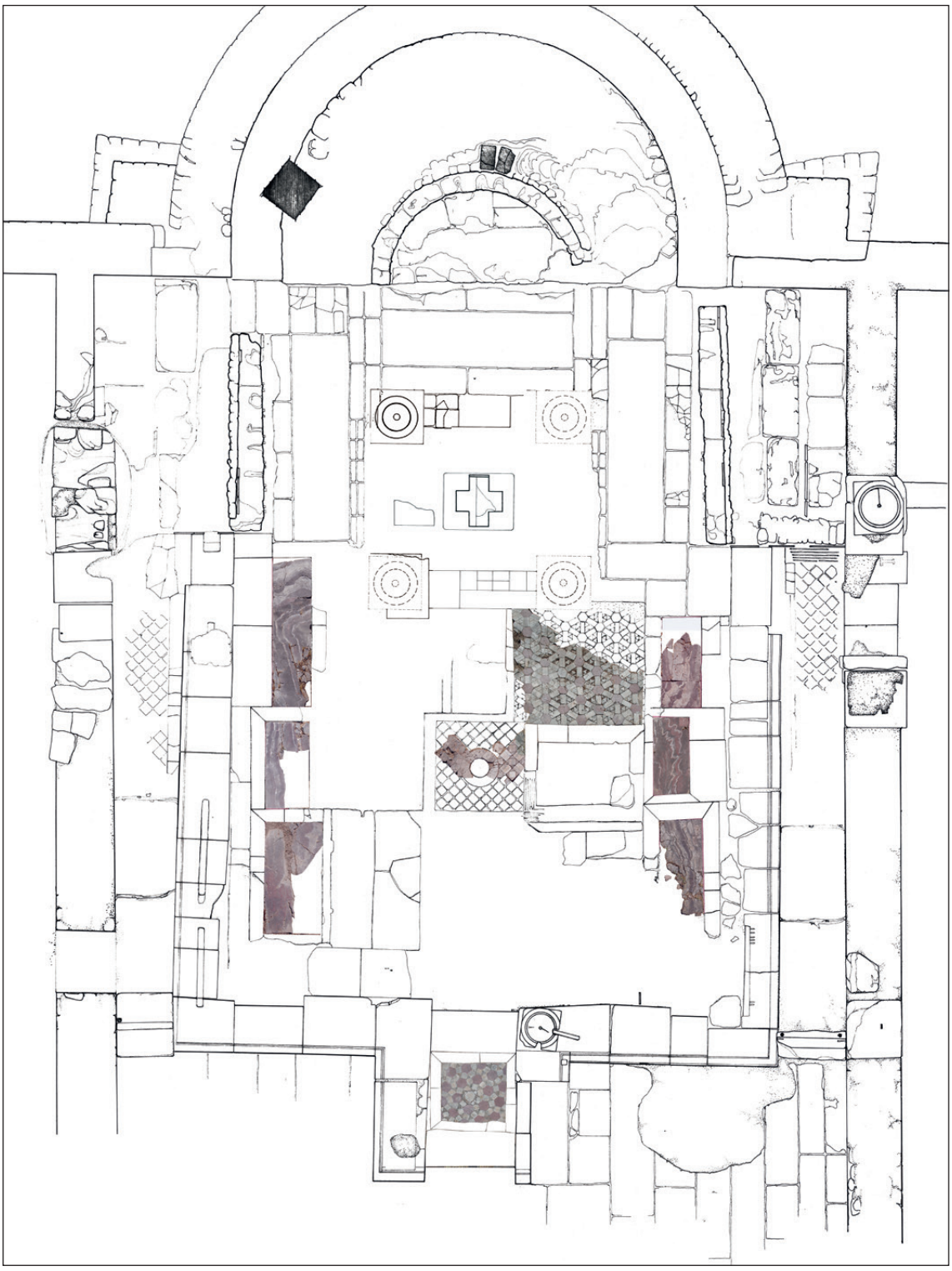
21 Akarca – Akarca 1954, 99–102; Berti – Peirano 2023, 6.

22 Berti – Peirano 2023, 7–9; Peirano 2023, 108–117.

23 In addition to the aforementioned authorities, we would like to thank the direction of the Italian Archaeological School of Athens for their help and Paschalis Stantzouris of the Ephorate of Antiquities of Magnesia, who personally oversaw the survey.

24 Lazaridis 1988, 93.

25 In general, on the loss of *templon epistyles*, see Niewöhner 2021, 160.



2 Plan of the presbytery of Basilica C in Nea Anchialos with the position of Iasos marbles (graphics: P. Lazaridis, photos: D. Peirano)

conserves traces of its original two-colour layout, created, it seems, by the alternation of white veined and red Iasos marbles.

The short sides of the presbytery were framed with medium-large slabs made of red Cipollino with different lengths and widths. These are very variable, with their width spanning from 58–92 cm and their length from 43–179 cm, with two panels composed of two slabs. However,



3 The *prostoon* of the Nea Anchialos Basilica C (photo: D. Peirano)

such differences were scarcely noticeable because, as stated, the conserved *opus sectile* panels showed intricate motifs made of radial and poised motifs using grey, white veined and red Iasos marbles, and those lost probably had the same character. The presence of a ciborium and of high barriers probably also concealed these differences, from within and from outside, respectively. With regard to marble association, a number of chancel barriers were made of Proconnesian marble, while a precinct colonnette came from Cape Fanari, Thasos, all linked to the 6th century[26]. But why were slabs with different lengths and widths used? Comparing the information from large slabs preserved *in situ* outside Nea Anchialos, marbles used mainly on walls[27], it is noticeable how these are arranged in book-matched or open-vein arrangements, rarely in single panels[28]. So, in the sawing workshop located within the »Balık Pazarı«, saw frames with two or four blades were probably preferred. Of the blocks unloaded in front of the sawmill, three stones conserved two saw marks and only one could be related to an open-stain arrangement. Block no. 74 has five cut marks that may be explained by an attempt to reposition the blade frame. Generally, only large blocks show signs of sawing, and these marks were at an average distance of approx. 2.5 cm, which suggests that only wall revetments were sawn by machine. Typical pavement slabs have thicknesses greater than 4 cm, like the erratic fragmentary slab of the Acropolis Basilica in Iasos, 4.2 cm high and with only the low side being roughened, up to the slab conserved in front of the main entrance of the Agora Basilica with its thickness of 10.9 cm. The smaller stones conserved in the »Balık Pazarı« only bear signs of roughing or

26 Barbin et al. 2018, 313. 316.

27 The flooring conserved two book-matched slabs made of red Cipollino in the Hagia Sophia presbytery, in a row of panels once placed in front of the altar. A second book-matched panel has probably been obliterated by the building of the Turkish mihrab platform.

28 However, there is a reference to this kind of use in the church of Hagios Demetrios in Thessaloniki, where a single slab framed by a white veined marble is conserved on the wall dividing the nave and the north aisle.



4 The Mascoli Chapel in St. Mark's Basilica in Venice (photo: D. Peirano)

squaring with a point chisel. Thus, floor slabs had to be laid with significantly greater thickness and after being split using the traditional tools of carvers, probably wedges, and refined only on the visible sides.

The thickness of the Nea Anchialos slabs, where verifiable, is 2.7 cm. Consequently, the slabs of Basilica C seem in all probability to be unpaired stock slabs initially intended for use in wall revetments and to be arranged in a paired layout, but whose vein is suddenly interrupted, so these were used as single slabs and in flooring. Their reduced thickness resulted in the need for a series of repairs.

As stated, it seems that only large blocks were sawn by the hydraulic sawmill; this led us to try to compare the dimensions of the abandoned blocks in »Balık Pazarı« with the larger slabs still in place in the wall cladding of monuments from the 5th–6th centuries. The bigger known slabs are the well-known ones of the Hagia Sophia narthex, the biggest being 238 × 93 cm. The two slabs flanking the main access to the church of Hagios Demetrios in Thessaloniki have a height of 213 and a width of 94.3 cm. Even larger are the slabs originating from an unknown Constantinopolitan building and now in Venice, cladding the wall behind the altar of the Mascoli Chapel in St. Mark's Basilica, with a width of 112 cm and a height of 214 cm (fig. 4). The height of these examples

does not find any immediate correspondence in the blocks conserved around »Balık Pazarı«[29]. The only block longer than the slabs in St. Mark's Basilica is the Hagios Demetrios' block no. 108 with its length of 219 cm[30], but its width is only slightly more than half that of the Venetian slabs: even if it is not possible to relate the slabs with certainty to the Iasian workshop, their measurements confirm the exceptionality of the marbles in question.

However, block no. 108 has four holes to insert wedges in it; so, it was probably intended to be used to obtain floor slabs. These were probably destined to embellish a church, a fact possibly confirmed by the presence of a mark, a cross with enlarged termini[31]. Other blocks show signs of roughing made with a point chisel, meant to take full advantage of the irregularities of the stone: see example no. 73, prepared to obtain two blocks rotated together by sawing or splitting. On some block surfaces, signs of blade bending due to imperfect blade tensioning are recognisable.

In general the movement of the blades caused a relatively large quantity of waste material: the width of cuts is approx. 1 cm.

D. Peirano

IASOS MARBLE AND ITS IMITATIONS

Another field of research is that of the substitutive use of Iasos marble by means of painted or mosaic imitation. It seems that this use began in its *floruit* era and when supply was difficult; thus, the wavy veins of red Cipollino began to be imitated through other mediums. We find evidence of this in Iasos, where – as stated – the marble is rarely documented in wall cladding[32]. In the north room of the Tripartite Building, an edifice dated to the end of the 2nd century AD[33], a plaster fragment measuring 64 × 10 cm is conserved, painted *a secco*, showing the Cipollino veins running horizontally. A second – very small – piece is located 33 cm above and shifted toward the wall dividing the room from the central one (fig. 5). Together they imitate the large slabs used from the early 6th century onward to clad the most prestigious buildings of the Mediterranean. The horizontal development of the veins suggests imitation of a cornice or of a single panel of »faux marble«, not of the better-known book-matched slabs. The larger fragment is located just above the benches leaning against the room walls, so it is not certain that this décor relates to the first construction phase. Moreover, painted imitation of slabs whose first appearance is dated to the 6th century in the 2nd century AD is implausible. These considerations seem to link the paintings to a restoration of the room, perhaps contemporary to the time during which the central room (or part of it) was used as a chapel, as attested by the presence of two Christian inscriptions[34].

This first – but not necessarily more remote – attestation of a painted imitation of red Cipollino, as stated, is linked to a ›substitution‹ use: where marble was produced, the preference was for exporting it, using only a small quantity of it in Iasos and imitating it with painting. A similar use appears in Ravenna, in the Arian Baptistery, where the imitation of red Cipollino painted *a secco* is evident in three window arches. Here the painted marbles alternated with a bright stone, perhaps alabaster, following Constantinopolitan usage[35], always attested in the windows' intradoses. Some scarce traces were also conserved in two low apse walls: in the east and in the

29 Block no. 75 has a length of 189 cm, a width of 99 cm and a height of 25 cm with saw marks; block no. 102 – without saw marks – exceeds 2 m in length but is not comparable in width (204 × 70 cm, H 60 cm).

30 W 59 cm, H 51 cm.

31 The cross was already noted by Matthias Bruno, see Bruno 2012, 710 fig. 10, 3.

32 On this, recently, Marsili 2023, 30.

33 On this building, see Baldoni 2008; Baldoni 2014.

34 Baldoni 2014, 383.

35 For example, the intradoses of window galleries in the Hagia Sophia, where the bright stone is, however, a Pavonazzetto in which the cream cement prevails over the purple clasts.



5 The painted plaster fragments in the Tripartite Building in Iasos (photo: D. Peirano)

north[36]. The decoration of the baptistery is dated within the first half of the 6th century and related to Constantinopolitan models, even if marbles were not used on the walls[37]. Instead, marble slabs were evident in the flooring[38].

The imitation, now using mosaic, of book-matched slabs is evident in the threshold leading to an octagonal room, also paved with mosaics, now geometric, relating to the representative area of Theoderic's Villa in Galeata[39] (fig. 6). Here, the decoration was probably completed by marble plinths on the walls and with mosaics, including gold tesserae[40].

Therefore, in two important Ravenna monuments from the Theodoric period, we know of the imitation of red Cipollino via different media (painting, mosaic). This undoubtedly implies knowledge of contemporary oriental/Constantinopolitan decorative trends. However, this willingness to adopt the most updated marble décors ran into difficulties in finding certain materials[41], forcing the baptistery builders into the prevalent choice of painted marble (not only Iasian), while in plinths of the octagonal hall of Theoderic's Villa by contrast, white marble was present. Both of the buildings – related to Theodoric – seem to have been completed within the Gothic domination in Ravenna that ended in 540. Before that, the regular import of red Cipollino, as well as other stones, was established in the city with its entry into the Byzantine orbit. This ›substitutive use‹ can be explained by

36 Gerola 1923, 123.

37 Carile – Cirelli 2015, 109. Gerola (1923, 123), observing the absence of metal clamps to fix the slabs, assumed that the marble imitation made by painting was part of the original project. On this, see also Deichmann 1974, 253.

38 Gerola 1923, 113.

39 It cannot be excluded that the mosaic imitates an onyx slab, but there is little evidence of the latter in book-matched slabs. In other instances, red Cipollino was linked to mosaics imitating marbles, but – also intriguing – the examples proposed by Michaelidis (in Djemila's »Maison aux murs de brique«, and in the circus mosaic of the Piazza Armerina villa) are unsatisfactory due to the choice of colours in the Djemila house (beige used instead of grey, orange-ochre unknown in red Cipollino) and for the absence of wavy veins in the latter example, see Michaelidis 1985, 159. 161 tabs. 5, 1; 6, 3.

40 Morigi – Villitich 2020, 12.

41 These problems would appear to be more contingent than structural. Some hints as to the difficulties are contained in two letters sent by the Ostrogothic administration to Justinian I and contained in the »Variae« of Cassiodorus (10, 8–9). In these, the Byzantine administration was asked to follow up on previous agreements in sending marble supplies to Ravenna, an accord disregarded due to the death of an intermediary named Calogenitus. On the basis of these letters, Kapitän (1980, 129) speculated a Byzantine embargo against the Ostrogoths, not, however, supported by sources. The hypothesis has been excluded by the most recent studies, see e.g. Marano 2008, 60.



6 The threshold leading to the octagonal room in Theoderic's Villa in Galeata (after Morigi 2018, 6)

the difficulty in importing marbles, but not only this fact; in some cases such use of »faux marbles« could also have taken place due to unsustainable procurement costs. Therefore it is not surprising to find the representation of red Cipollino in centres of western Asia Minor, in private buildings, where the pictorial imitation of precious marbles enjoyed a long tradition.

In a room of a luxury house in Sardeis excavated in 2005, the plaster in the south wall painted with »faux marbles« to a height of 1.75 m[42] is exceptionally well conserved (fig. 7). Above a fascia, a fluted column on a plinth protruding in an illusionistic way toward the viewer is recognisable. On the sides, two marble wainscots correspond to the plinth, and above them, two cornices framing two panels, one rendering an *opus sectile* composition, the second a red Cipollino slab. The house is dated by the excavators to the 5th–6th century[43]. The illusionistic rendering seems to imply knowledge of a contemporary use of real marble; thus, the representation of a single slab instead of book-matched ones might suggest some precocity of the pictorial reproduction with respect to the heyday of red Cipollino claddings, which however, do not date back to before the 6th century. The single painted slabs in Sardeis and Iasos could indirectly testify to a similar contemporary use in real marble decoration, which was later replaced in the Justinian I period by book-matched or open-vein slabs.

The alternation of wavy veins of red, white and grey seems to be the way in which the painters of the 6th century imitated red Cipollino, sometimes distorting their mutual relationship or proportions. This seems to be the case in a domus dated to the beginning of the 6th century in Hadrianopolis in Paphlagonia where, in Room 3, a painted panel imitates book-matched slabs[44]. However, the relationships are reversed: in fact the white vein prevails.

From the 7th century onward, evidence of use of Marmor Iassense becomes sporadic, as if to indicate interruption of the quarrying activity. The use, limited to spolia, and the consequent reduced visibility also affected the painted reproduction, of which traces from this time are lost. The imitation of red Cipollino on the wall reappears with the Constantinopolitan revival of marble style, realised through reuse and starting from the Comnenian age[45].

42 Rautmann 2008, 155.
43 Rautmann 2008, 155.
44 Laflı – Pataci 2019, 225 figs. 297–298.
45 See n. 20.



7 The wall in a luxury house in Sardeis painted with »faux marbles« (after Rautmann 2008, pl. 19 a)

The paintings in the church of St. Pantalemon in Gorno Nerezi, works of a Constantinopolitan atelier promoted by Alexios Angelos Komnenos, are dated to approx. 1164[46]. In a multitude of painted marble imitations, red Cipollino appears in the four pillars at the corners of the *diaconicon*, perhaps at the two ends of the marble plinth of the Lamentation wall[47], and schematically in the archivolts of the windows under the dome. Finally, the marble returns to the scene of the Presentation in the Temple where, behind a ciborium and the figure of Simeon, two pairs of mirrored slabs appear, one certainly of Marmor Iassense, the other of grey-blue Cipollino (fig. 8).

D. Peirano

46 Sinkević 2000, 80.

47 It cannot be excluded that these panels show alabaster slabs.



8 A detail of the scene of the Presentation in the Temple in the church of St. Pantalemon in Gorno Nerezi (after Sinkević 2000, 141 fig. 39, detail)

CONCLUSION

We should remember, summing up, how recent research on Marmor Iassense developed in two directions: the comparison between *in situ* slabs and the blocks unloaded at »Balık Pazarı« allowed us to improve our understanding of their workmanship, the different processing between wall and floor coatings and the exceptional nature of a number of conserved slabs; conversely, since the appearance of red Cipollino slabs, their rarity or supply difficulties led to them being imitated through painting on the wall and mosaic in flooring. This imitation seemed to follow a path of growth, then of decline, following the use of real marble, until the revivals in the Comnenian age, promoted through reuse of real marble, which were accompanied by the rediscovery of painted imitation.

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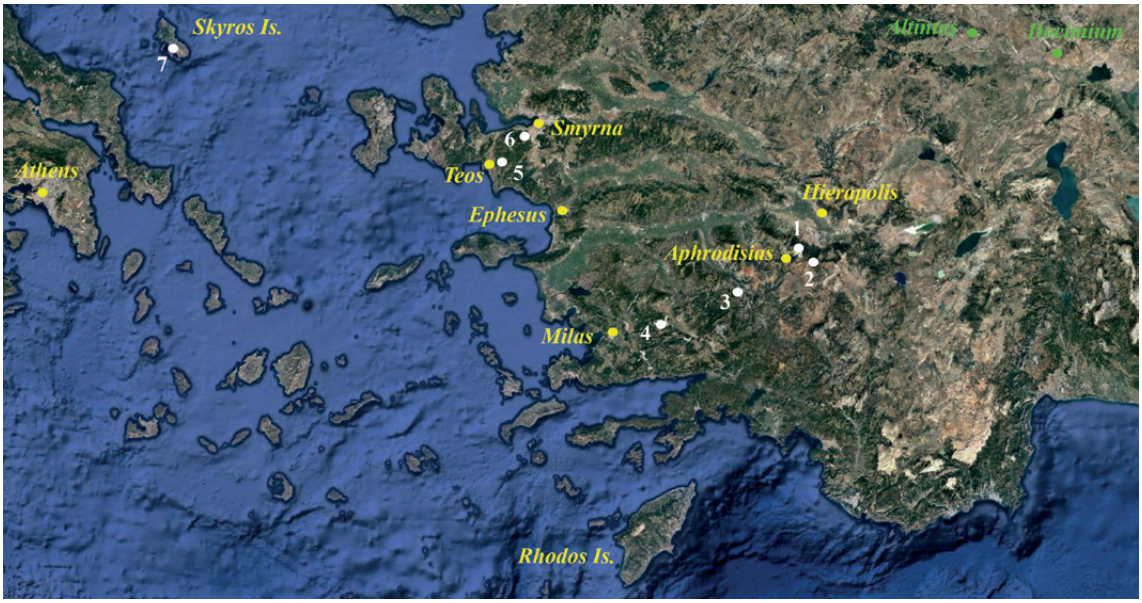
Matthias Bruno – Eleonora Ferrazza

THE PAVONAZZETTO-LIKE MARBLES AND THE IMAGES OF BARBARIANS

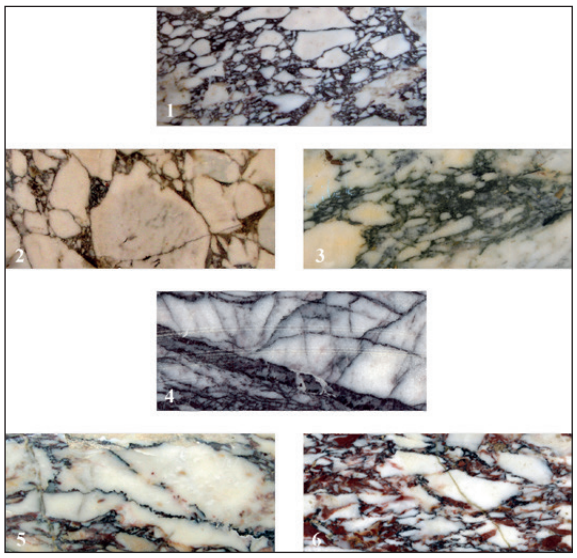
A STATUE OF AN EASTERNER IN BEYLER BRECCIA FROM ROME

Abstract
A large group of coloured marble from Asia Minor resembles, in macroscopic appearance, the renowned Pavonazzetto from Phrygian quarries. With regard to these marbles and whether they can be considered as substitute stones for the imperial Phrygian marble, and therefore named as Pavonazzetto-like marbles, there is very rare evidence of figurative use so far. Thus, an imposing pillar statue of an Easterner in the Vatican Museums, archaeometrically identified as Beyler breccia, offers the opportunity to investigate the use of Pavonazzetto-like marbles in Imperial Rome. Specifically, the Vatican pillar statue can probably be attributed to a funerary monument, so it would attest to the assimilation in the private sphere of figurative language transmitted by the imperial authority through the Phrygian marble statues, like the ones in the Basilica Aemilia or the Kneeling Barbarians in Naples and Copenhagen. Therefore, we may affirm that in antiquity, Pavonazzetto-like marbles made it possible to preserve the iconographic value linked to the use of Phrygian marble, and today they make it possible to distinguish different types of patronage linked precisely to the specific and non-random use of coloured marbles.

During the surveys of Roman quarries conducted by D. Attanasio, M. Bruno and A. B. Yavuz since 2006 in Asia Minor, a considerable number of sites were discovered that produced marble varieties very similar to the famous Pavonazzetto or Phrygian marble, one of the most renowned and representative Roman imperial marbles. This was extracted in Central Anatolia in the districts



1 Location map of Pavonazzetto-like marble quarries. 1: Aphrodisias, Babadağ. 2: Aphrodisias, Karahisar. 3: Muğla, Kavaklıdere. 4: Milas, Kozağaç. 5: Teos, Beyler. 6: Smyrna, Tirazlı. 7: Greece, Skyros Island (graphics: Google Earth, edited by M. Bruno)



2 Pavonazzetto and Pavonazzetto-like marbles. 1: Dokimeion, Iscehisar. 2: Aphrodisias, Karahisar. 3: Milas, Kozağaç. 4: Muğla, Kavaklıdere. 5: Teos, Beyler. 6: Greece, Skyros Island (photos: M. Bruno)

of Afyon İscehisar and Altıntaş and exported from the last decades of the 1st century BC onwards, as Strabo reminds us in his »Geographica«[1]. Several of the newly identified sources of similar marble are in Caria[2]. Two distinct quarries are close to Aphrodisias, one on the slopes of the Babadağ (fig. 1, 1), the other not far from the town of Karahisar (fig. 1, 2), while others are near Kavaklıdere (fig. 1, 3) and near the village of Kozağaç near Milas (fig. 1, 4). Two other quarries of Pavonazzetto-like marble are located in Ionia, the first near the village of Beyler (fig. 1, 5) not far from Teos, the second one a few kilometres west of Izmir near the village of Tirazlı (fig. 1, 6). In addition to these sources in Asia Minor, another Pavonazzetto-like marble is quarried in several districts of the Greek island of Skyros in the southern Sporades (fig. 1, 7).

Generally speaking, the marbles quarried in all these places are breccias with more or less white or slightly yellowish clasts in a bluish-black or purplish matrix. Even if some simple macroscopic distinctions can be made between them, they can all be grouped together as marbles similar to Pavonazzetto or better still, as Pavonazzetto-like marbles. In fact, while the marbles quarried near Aphrodisias, on the slopes of the Babadağ and near Karahisar (fig. 2, 2), and in the Milas-Kozağaç district (fig. 2, 3), show a very strong resemblance to the Phrygian Pavonazzetto (fig. 2, 1), the other varieties have peculiarities that are essential for identification and distinction on a simple macroscopic basis. In fact, broad violet veins of varying degrees of fineness characterise the marble quarried at Kavaklıdere, nowadays sold as Milas lilac (fig. 2, 4). The breccia from Beyler (fig. 2, 5) and that from Skyros Island (fig. 2, 6) are more similar to each other and can be distinguished from the previous ones – and especially from the Pavonazzetto – by a pronounced iso-orientation of the clasts and by a more intense red colouring of the background cement. Finally, Beyler breccia has a distinctive feature that allows it to be easily and safely recognised and distinguished from all the others on a macroscopic basis alone. This characteristic is the frequent presence of very compact and dark red clasts of varying size within the breccia (fig. 3).

BEYLER BRECCIA: QUARRIES, USE AND DISTRIBUTION

The Beyler quarries are located in the hinterland of Teos, about 15 km to the east of the town, near which was the mining district of Kara Gölu, where the renowned Africano marble, known in Roman antiquity as Marmor Luculleum, was exploited. The Beyler quarries are to the east of the small homonymous village and were open on the flank of a rocky peak on which extensive traces of the ancient quarry faces are still preserved, as well as deep and wide galleries used for underground marble extraction[3]. The considerable volume of extraction is also evidenced by huge debris piles along the slopes of the mountain and a large amount of abandoned quarry artefacts,

1 Strab. 12, 8, 14. See also Bruno – Attanasio – Prochaska 2015, 381–383.
2 Bruno et al. 2012; Attanasio – Bruno – Yavuz 2015.
3 Bruno et al. 2012, 567 f.

such as column shafts or parallelepiped blocks, in the area around and along the ancient transport route leading towards the sea-coast following the nearby valley of the small river Kayadere.

Beyler breccia was mainly used for column shafts not only in Asia Minor, as attested for instance by many examples in Teos, Ephesos, Smyrna and Sardeis, but also in Italy, in Rome and Ostia[4]. The marble was also used for cladding and revetment slabs, as demonstrated by several finds again in Rome and Ostia, and also at Lucus Feroniae[5]. Its use in sculpture was, however, completely unknown and unexpected, initially evidenced only by the imposing statue of an Easterner, identifiable by his costume of short tunic, trousers (*bracae*) and floppy cap, displayed in the Chiaramonti Gallery of the Vatican Museums[6] (fig. 4). The marble of this statue, the subject of the present study, has in the past always been identified as the famous Pavonazzetto from Phrygia. Nevertheless, the peculiar presence of dark red clasts within the strong iso-orientated breccia (figs. 3–4) first allowed us to identify the stone macroscopically as Beyler breccia (and not



3 Standing Easterner, Vatican Museums inv. MV. 1308, detail. The dark-red clasts of the Beyler breccia are highlighted with red circles (photo: © Governorate of the Vatican City State – Directorate of the Vatican Museums, edited by M. Bruno)



4 Standing Easterner (Beyler breccia), Vatican Museums, inv. MV. 1308 (photo: © Governorate of the Vatican City State – Directorate of the Vatican Museums)

4 Bruno et al. 2012, 568.
5 Attanasio – Bruno – Yavuz 2015, 759. 762.
6 Chiaramonti Gallery, section VIII, inv. MV. 1308.

the Phrygian marble), an identification which was later corroborated by archaeometric data[7].

This large statue in the Vatican can confidently be flanked by another smaller one, now in the Museum of Fine Arts in Boston[8], whose marble had been identified as Skyros breccia, but which again, due to the iso-orientation of the white clasts and the frequent presence of dark red clasts of various sizes, can be identified with relative certainty (on a macroscopic basis) as Beyler breccia (fig. 5).



5 Captive Barbarian (Beyler breccia), Boston, Museum of Fine Arts, inv. 2000-1053 (photo: © Museum of Fine Arts Boston)

Unfortunately, until now too little has been known about Beyler breccia. There is little data and evidence on its distribution in Roman times, and it may have often been confused with Skyros breccia. We have no epigraphic evidence to define a diachronic panorama of its exploitation, and the artefacts found in Asia Minor and Italy are unfortunately mostly out of context, except in the case of the large Theatre Gymnasium of Ephesos, dated back to AD 125[9], where large Beyler column shafts are part of the architectural decoration. The quarries themselves did not provide any engraved inscriptions, nor did the artefacts found there offer any other dating elements. The parallelepiped blocks and column shafts abandoned in the quarry district are identical to the broader quarry production of generic Imperial age. However, it is perhaps the proximity of the Teos quarries of Kara Gölu, where the famous Lucullean or Africano marble was extracted since the 1st century BC[10] that can perhaps offer us some chronological clues and explanations for the distribution of the Beyler Pavonazzetto-like marble. In fact, it is very likely that the Beyler breccia became part of the wider marble trade of Roman times thanks to its proximity to the Africano marble quarries of Kara Gölu. It could use the same harbours to export its artefacts, destined not only for the regional and coastal areas of Asia Minor, but also dispatched overseas to the Italian Peninsula, more precisely to Rome and Ostia. In fact, we assume that the use of Beyler breccia for sculptural purposes may have begun, at least sporadically, at the same time, or rather, a little later than the first exploitation of Africano marble, which was exported in large quantities to Rome and other cities of the Roman Empire and whose distribution may also have facilitated that of Beyler breccia.

7 Attanasio – Bruno – Yavuz 2015, 759 tab. 2 no. 21; 760–763.

8 For this statuette, see the online collection catalogue of the Museum of Fine Arts in Boston, <https://collections.mfa.org/objects/314531/captive-barbarian> (21.03.2025). The sculpture of unknown provenance, inv. 2000.1053, is quite small (H 52 cm; W 24.5 cm; D 15.9 cm) and is indicated as »Captive Barbarian«.

9 Akurgal 1985, 157; Scherrer 2000, 162. The complex is generally dated to the 2nd cent. AD.

10 Gnoli 1988, 174–180; Fant 1989; Pensabene – Lazzarini 1998; Lazzarini 2002, 250 f.; Adak – Kadioğlu 2017.

USE OF PAVONAZZETTO-LIKE MARBLES

In a broad sense, we can say that in the panorama of polychrome marbles used in Roman times, the characteristically imperial ones, whose use represented an immediate and clear reference to the emperor and his power, must have been relatively few. As F. Guidobaldi has already pointed out for marble pavements, polychrome marbles that identify imperial patronage in an urban context are those of the so-called Neronian quadrichromy (*quadricromia neroniana*), the four-colour pattern of Neronian age[11]: Egyptian red porphyry, green Laconian porphyry (Serpentino), Numidian Giallo antico and Phrygian Pavonazzetto. Some others can certainly be added to this list, such as Africano from Teos, Verde antico from Thessaly, Mons Claudianus and Aswan granite from Egypt, Cipollino from Euboea and Portasanta from Chios. Almost all the other coloured marbles can be considered substitutes to imitate and emulate the imperial marbles that were not accessible to others, even high ranking patrons. By way of example, we may mention Troad granite, which was among the most widespread stone types used throughout the Roman Empire and was employed in place of the imperial Egyptian granites, as well as the various yellow breccias that replaced the ›unattainable‹ Numidian Giallo antico. Perhaps all the Pavonazzetto-like marbles should be considered in this light, as marbles intended for non-imperial clients in imitation of the renowned Phrygian marbles, which we believe were not accessible even to a large part of the Roman elite.

From the very early Augustan age onwards, the Pavonazzetto (as well as Giallo antico), used mainly for column shafts and floor and wall revetments, was also intended for statuary, especially for defeated Easterners/barbarians such as the standing figures in the Basilica Aemilia or the kneeling ones now in Naples and Copenhagen. Thus, the pillar statue of the Vatican Museums in Beyler breccia is a case study on the use of the Pavonazzetto-like marbles by a non-imperial patron.

AN IMPOSING PILLAR STATUE OF A STANDING EASTERNER

The imposing pillar statue in the Chiaramonti Gallery (inv. MV. 1308)[12] was sold by the antiquarian, sculptor and restorer Francesco Antonio Franzoni to the pontifical collections in the late 18th century[13]. At the moment it is not possible to connect the sculpture with an excavation site or an antiquarian collection that could have come into Franzoni's possession. The vendor, known to have worked on most of the coloured marble sculptures of animals in the Vatican, was well established in the Roman antique market, in partnership with other antiquarians and excavators active in the surroundings of Rome[14]; it is therefore highly probable that the provenance of our find is Rome, or rather its suburban area.

The statue depicts a ›non-Roman‹ person, in a standing pose, wearing a Phrygian cap and breeches, elements that identify him as an Easterner (fig. 6 a–c). The folds of the robe below the belt have preserved the original modelling; above the belt, the folds on the chest have been highlighted with a pointed chisel by the modern restorer, as have the contours of the face, the curls, and the edges of the Phrygian cap[15]. The definition »pillar statue« seems the most appropriate for the imposing figure carved from a single marble block with the base below the feet and the pillar on the back[16]. The figure is sculpted in high relief; it stands frontally, with the left arm raised as if supporting a load placed above the pillar on which the remains of the fingers of the left hand are

11 Guidobaldi 2003, 29–31.
12 Amelung 1903, 883 n. 220; Liverani 1989, 26.
13 Carloni (forthcoming).
14 Bignamini – Hornsby 2010, 268 f.
15 Schneider 1986, 202 f.
16 Dimensions: H 204 cm; W 67 cm; D 62 cm.



a b



c

6 a–c Standing Easterner (Beyler breccia), Vatican Museums, inv. MV. 1308, details (photos: © Governorate of the Vatican City State – Directorate of the Vatican Museums)

resting. The right arm, not preserved, was supported at the hip, as can be seen from the remains of the fingers of the right hand, of which the thumb is clearly visible.

There are numerous iconographic parallels (i.e. in subject, posture, clothing), and the parallels extend to the size, the format as a pillar statue, and to the mottled effect of the stone.

STATUES OF EASTERNERS FROM IMPERIAL MONUMENTS

There are also examples of official, imperial patronage for such figures, first of all the series of pillar statues in the Basilica Aemilia in the Roman Forum[17]. A study day was dedicated to this very important series of sculptures in 2019, providing an update on research and new information on the subject[18]. There are at least 18 statues in both Pavonazzetto and Giallo antico, which sumptuously adorned the Basilica Aemilia. The basilica was so sumptuous, in fact, that Pliny mentioned it among the three wonders of Rome precisely because of its marble decor (*columnis et Phrygibus*). It has already been shown how this series of sculptures, dating back to the reconstruction of the building after the fire in 14 BC, served as a model for at least three other statues of Easterners in Pavonazzetto and Giallo antico, two of them from official monuments: the Easterner from the forum of Cherchell, ancient Caesarea Mauretaniae[19], and the Easterner from the theatre of Terracina, an ancient Roman colony on the Mediterranean coast about 100 km southwest of Rome[20]; the third is the so-called Mattei Dacian from an old collection in Rome[21].

These standing Easterners with heights of around 2 m, are pillar statues with a raised arm. Except for the statues from the Basilica Aemilia, the original faces in a different marble are not preserved; the bearded face of the Mattei Dacian in black marble was added in the likeness of the famous Dacians of Trajan's Forum by a modern restorer. Modern additions are also the bearded faces of the well-known Kneeling Barbarians



7 Kneeling Easterner (Pavonazzetto), Naples, Museo Archeologico Nazionale, inv. 6115 (photo: M. Bruno)

17 Bitterer 2007; Schneider 2016; Consoli et al. 2023.

18 The conference »Statue di barbari in marmi colorati. Novità dal Foro Romano e Terracina« was held in Rome, Curia Iulia, by the Parco Archeologico del Colosseo on June 6th, 2019 (proceedings forthcoming).

19 Landwehr 2000, 74–83.

20 Cassieri 2023.

21 De Angelis 2011, 78 f.

in Pavonazzetto now in Naples[22] and Copenhagen[23] (fig. 7). Whether these kneeling Easterners belonged to a colossal tripod, as suggested by R. M. Schneider[24], or to an elaborate façade of an imperial building, as supposed by J. Lipps[25], they pertained, in any case, to an official imperial monument commissioned by Augustus or the Julio-Claudian family. The affinities between the Pavonazzetto kneeling Easterners and the standing Easterners in terms of subject, clothing, and size, are very evident. The posture is different, but the angle of the raised arm is identical to that of the Vatican statue in Beyler breccia and the Mattei Dacian. This set of kneeling figures, about 170 cm high, and thus the same scale as the standing Easterners, inspired numerous replicas in a smaller format, for furniture, in Pavonazzetto, in Giallo antico, and even in white marble, a kind of neutral colour. Apart from the two positions, standing and kneeling, the main difference between these Eastern figures is that those from official monuments in prestige marbles – Pavonazzetto and Giallo antico – used a different marble for the clothing and the skin, but most of the smaller artefacts from the private sphere do not make this distinction.

STATUES OF EASTERNERS IN FUNERARY CONTEXTS

Another kneeling Easterner, who is also beardless and wearing a Phrygian cap, comes from a tomb at Isernia in Molise, dated to the late 1st century BC (fig. 8)[26]. The figure has dimensions very close to those of the Naples-Copenhagen group. So, in a municipium, a provincial town, 200 km southeast of Rome, an official model was chosen for a tomb, the most important monument that a private citizen could aspire to, but in spite of this ambition, the stone was a local limestone. With an architectural function, albeit an ideal one, standing Easterners recur in other private funerary monuments: in a tomb in Cologne, an Easterner, placed on a high base, serves as a statuary decoration next to a pillar[27]; in the funerary stele from Osimo, the standing Easterner is at the centre of the depiction[28]; in the tomb of Virtius Ceraunus, the two opposing figures support the table with the *cursus honorum* of the deceased[29]. Because of its characteristics, the Vatican pillar statue could relate to a tomb of the so-called multi-storey aedicule type, consisting of one or more aediculae on a podium or on several plinths. This architectural typology is very loose because of the numerous possible combinations of individual architectural elements; it is attested in Italy between the 1st century BC and the middle of the 1st century AD[30]. The Vatican pillar statue can be imagined as positioned at some distance from the ground, high enough so that the unfinished part between the legs is not visible. The over-life-size scale makes the figure compatible with a tomb in the suburban area of Rome. This was a favoured area of antiquarian excavations in the second half of the 18th century with numerous ruins of tombs of the ›multi-storey aedicule‹ type. If it were part of a pair placed on either side of an entrance, it would be the left element in relation to an observer, since it has its left arm raised. The posture also corresponds to that of the Caryatids in a funerary monument in Ephesos[31]. This is probably a cenotaph dedicated to Memmius, grandson of Sulla; in the hypothesis of U. Outschar, it corresponds to the multi-storey aedicule type[32].

22 Prisco 2007, 95; Dodero 2010, 137–144 n. 54–55, with extensive previous bibliography.
23 Moltesen 2002, 310–313.
24 Schneider 1986, 18–97. See also Cohon 1990.
25 Lipps 2016.
26 Diebner 1979, 113–115.
27 arachne.dainst.org/entity/1112069 (21.03.2025).
28 arachne.dainst.org/entity/1083582 (21.03.2025).
29 arachne.dainst.org/entity/1063984 (21.03.2025).
30 von Hesberg 1992, 144–185.
31 Bammer 2007; Spanu 2010, 55–58.
32 Outschar 1990; von Hesberg 1992, 156.



8 Kneeling Easterner (limestone), Isernia, Museo Archeologico, inv. 35105 (photo: M. Bruno)

To sum up, the Vatican's pillar statue in Beyler breccia echoes the monuments in prestigious marbles funded at the highest levels of Roman society, but its private patron made use of a lesser stone to present the triumphal image. The macroscopic effect of the Beyler breccia, however, was similar to that of the mottled marble of the imperially controlled quarry of Dokimeion, especially if the statue was displayed at a certain distance or height, as a tomb of this type presupposes.

CONCLUSIONS

We have seen how, from the Augustan age onwards, the Easterner subject, in its two versions standing and kneeling, became linked with the most prized mottled marbles, Phrygian Pavonazzetto and Giallo antico. As soon as this tradition was established, substitute marbles also began to be used; it was therefore a usage linked to the model set by authority, as the private citizen adopted the figurative language of official art. The Vatican statue and the Captive Barbarian in Boston, both sculpted in Beyler breccia, and a small statue of a barbarian from Aphrodisias, made in Pavonazzetto-like marble from the nearby quarries of Karahisar[33], together demonstrate how Pavonazzetto-like marbles were used for various iconographies of barbarians or Easterners, which in the case of the Vatican statue clearly derives from an imperial model. In general terms, in antiquity, Pavonazzetto-like marbles made it possible to preserve the iconographic value linked to the use of Phrygian marble, and today they make it possible to distinguish different types of patronage linked precisely to the specific and non-random use of coloured marbles.

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Roberto Bugini – Luisa Folli

LATE USE OF COLOURED MARBLES IN ITALY (1860–1915)

Abstract
The use of ancient coloured marbles in the architecture of the late 19th to early 20th centuries was mainly developed in Rome and in a few Italian cities. Plenty of edifices were renovated or specifically planned and built by architects assisted by craftsmen from marble workshops, called *marmorari* and established for centuries in Rome. The works of two architects (Virginio Vespignani and Guiseppe Sacconi) are examined in detail together with other particular cases (Pompeii, Ravenna, Venice).

INTRODUCTION

The term »ancient coloured marbles« includes different lithologies capable of taking a polish to bring out the full colour and the character of the stone. They are igneous rocks such as granite or porphyry, sedimentary rocks such as breccia or bioclastic limestone, metamorphic rocks such as marble or ophicalcite, and non-clastic deposits such as travertine or alabaster. Ancient authors described porphyries and granites but used indeterminate terms (»mischio« or »misto«) to indicate breccia or marble with streaks, bands and mottling. The current terms to identify each marble were stipulated in the first half of 19th century: Faustino Corsi, author of the treatise »Delle pietre antiche«[1], was the first to match the terms used by Latin authors with the terms used by craftsmen of Rome.

MARBLES AND QUARRIES

A list of coloured marbles used in the late 19th century includes: alabaster, Granito rosso, Porfido rosso antico (Egypt); Africano, alabaster, Pavonazzetto (Türkiye); Cipollino, Fior di pesco, Porfido serpentino verde, Semesanto, Settebasi, Verde antico (Greece); Giallo antico (Tunisia); Broccatello (Spain), etc.; these marbles were always combined with white ones (Apuanian, Proconnesian, etc.)[2].

The original quarries from which the marbles came were scattered across the Eastern Mediterranean Basin (Continental Greece, Aegean Islands, Aegean Türkiye, Western Anatolia) and also in Egypt (Eastern Desert), in Tunisia (Chemtou, Gendūbah), in Spain (Tortosa, Catalonia), in Italy (Apuanian Alps, Tuscany; Venetian Prealps), etc. The quarry sites were almost always unknown or unreachable in the late 19th century, so the marbles were mainly available in Rome from the stores established by the Romans along the Tiber (e.g. Portus Romae [Fiumicino or Ostia]; La Marmorata [Aventino or Testaccio]; containing both roughly squared blocks suitable for carved pieces or sawed slabs) or the dismantling of older buildings (e.g. San Paolo *extra muros*, after the fire of 1823) or new excavations in town[3].

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1 Corsi 1828; Corsi 1833; Corsi 1845.
2 Belli 1842; Corsi 1845; Mielsch 1985; Gnoli 1988; Borghini 1998; Lazzarini 2007.
3 Maischberger 1997.

USE OF COLOURED MARBLES: CHRONOLOGY

Coloured marbles were used in Rome starting from Augustus (columns, slabs for pavements or to clothe concrete structures), and then they reached even the most remote areas of the empire[4]. Centuries later, the use started again in the cities with significant Roman remains. Particularly, the works made of reused materials attained extraordinary standards of skill in the Byzantine period (churches of Ravenna)[5]; in the Middle Ages of Rome and its surroundings (Cosmati and Vassalletto; pavements, pulpits, ciboria)[6], Venice (San Marco) and Torcello (cathedral), with pavements recalling Roman patterns[7]. There are a few examples outside Italy: the Palatine Chapel (Aachen, marbles brought from Rome and Ravenna, since the 9th cent.)[8]; the high altar pavements of Canterbury Cathedral[9] and of Westminster Abbey (Cosmati work, 13th cent.)[10]; the Chapel of St. Wenceslas, Prague Cathedral (Parler, 1358); and the chapels of St. Catherine and Holy Cross (Karlštejn Castle, Bohemia, 14th cent.)[11].

The reuse was significant in the Byzantine architecture of Istanbul (St. Sergios and St. Bakchos, Küçük Ayasofya, 6th cent.[12]; Kyriotissa, Kalenderhane, late 12th cent.)[13] and Muslim architecture of Cairo (Sultan Hassan Mosque-Madrasa, mid-14th cent.)[14]. Byzantine influences were still present in Venice (early Renaissance): inlays of coloured marbles on façades of several palazzos (e.g. Ca' Dario, late 15th cent.)[15].

Raphael, the most influential artist of the Renaissance, used coloured marbles (e.g. the columns of the Palazzo Branconio, Rome 1518, demolished 1667)[16]. Later on, Mannerism and Baroque embraced them: Fontana and craftsmen of Lake Lugano in Rome, Naples, Salerno, Amalfi (pavements, veneering)[17]; Opificio Pietre Dure in Florence (»commesso alla Fiorentina« for tabletops and other furniture; Cappella dei Principi, the Medici's mausoleum)[18]; Maderno and Dosio in Rome (tombs, altar frontals)[19]; Fanzago and Lazzari in Naples (altars, balustrades, pavements)[20]; Amato and *lapidum incisores* in Palermo[21].

The use of modern coloured marbles (e.g. Rosso Francia) prevailed in other state capitals such as Genoa (Cappella Ducale, mid-17th cent.) or Turin (Cappella Sindone; San Lorenzo, late 17th cent.). Some cases from abroad were (17th cent.): workshops in Prague (Castrucci), Paris (Gobelins)[22], Amsterdam (Van Rijswijck, mother-of-pearl inlays on black stone) or Augsburg (Spitzmacher or Boscher, wood cabinets veneered with ivory, ebony, etc. and panels of »commesso« made by the Florentine Opificio)[23] or even in India (Agra, Taj Mahal)[24]. The Lombard workshops of the

4 Ward Perkins 1981, 273–306.
5 Krautheimer 1965, 181–186.
6 Claussen 1998.
7 Howard 2002, 7–28.
8 Conant 1959, 46–51.
9 Neal 2022.
10 Grant – Mortimer 2002.
11 Coldstream 2002, 196–201.
12 Krautheimer 1965, 205–232.
13 Krautheimer 1965, 292–295.
14 Harrell – Lazzarini – Bruno 2002.
15 Howard 2002, 123.
16 Beltramini – Burns – Nesselrath 2023, 168–189.
17 Navone – Tedeschi – Tosini 2022.
18 Giusti 1988, 62–73.
19 Tuena 1998.
20 Cantone 1992, 59–107.
21 Biagi 1939.
22 Giusti 1992.
23 Baarsen 2000.
24 Asher 1992, 211–215.

18th century (Fantoni, Bergamo; Carra or Corbarelli, Brescia; Buzzi, Viggiù; Sacchi, Pavia)[25] or the Real Laboratorio Pietre Dure (Naples, then Madrid, Buen Retiro, late 18th cent.)[26] were mainly dedicated to altars or the decoration of furniture. Coloured marbles were also imitated (18th cent.) with coloured or painted stucco to coat architectural elements (e.g. Bavarian Rococo)[27] or with »scagliola« (a mix of gypsum, glue and pigments) to make altar frontals (Barberini or valle Intelvi workshops, Como)[28]. The skill of cutting, carving and shaping marbles and porphyries persisted in Rome (Casino Borghese, late 18th cent.; centrepiece of Eugène de Beauharnais' coronation, craftsman G. Raffaelli, Milan 1804) and in Florence (Opificio, e.g. the library of the poet Leopardi – Recanati, early 19th cent. – holds four Florentine tabletops, inlaid with geometrical slabs of coloured marbles) even when Neo-classicism moved the emphasis to white plasters, gilded stuccoes and »faux marbres«.

Finally, at the dawn of the Italian Unification (last decades of the 19th cent.), the leading Neo-Renaissance style marked a revival of coloured marbles. These works followed tried-and-tested schemes: slabs of various shapes and sizes for veneering; slabs of veined materials properly cut and arranged to enhance the streaks of contrasting colour for ›open-book‹-style panels; veined fragments combined for bending motifs; small pieces of geometric shape together with discs and white slabs for pavements; thick slabs for bas-reliefs and decorative cornices; more or less carved massive elements for column shafts, balustrades, sculptures and vases. The accuracy of the joints must be underlined, together with the laboriousness of carving pieces of hard stones.

ARCHITECTS AND CRAFTSMEN

Rome was the centre of the manipulation of ancient coloured marbles, operated by the *marmorari* workshops. These workshops were passed from father to son by some families such as the Fedeli, Fortini, Martinori, and Sibilio families; a Università dei Marmorari was also active in 1852–1868, under the papacy of Pio IX[29]. Skilful craftsmen, led by architects, produced hundreds of ornaments for churches, cloisters, pulpits, thrones, altars, chancels and other artefacts in Rome and its surroundings. Architects and craftsmen were also involved, since 1871, in the construction and decoration of buildings to house ministries and public authorities for the new Italian capital.

VIRGINIO VESPIGNANI AND GIUSEPPE SACCONI

Virginio Vespignani and Giuseppe Sacconi were the crucial figures in the field of coloured marbles, as evidenced by their buildings in Rome and in Italy. Nevertheless, some edifices built by famed architects should be investigated in Rome: Ministero Finanze (R. Canevari, 1871); Palazzo Esposizioni (P. Piacentini, 1883); Banca Italia (G. Koch, 1886); Palazzo Giustizia (R. Calderini, 1888), etc.

Vespignani: List of Works and Materials

Virginio Vespignani (Rome, 1808–1882) was involved in dozens of constructions in Rome and in central Italy; these works were encouraged and developed during the papacy of Pius IX (1846–1878). Some notable buildings are: the eastern front of the Porta Pia (Elba granites); the cemetery of Verano; the theatres of Viterbo and Orvieto. Nevertheless, a substantial part of his work concerned the erection and adornment of religious buildings, involving the ›restoration of

25 Giordano 2000.
26 Gonzalez Palacios 2001, 129–189.
27 Summerson 1969, 41–54.
28 Hoffman 1928.
29 Ciranna 2007.



1 Rome, Santa Maria Maggiore. Confession (architect V. Vespignani). Veneering: Africano, alabaster, Bianco e Nero antico, Cipollino, Occhio di pavone, Portasanta, Settebasi, Verde antico, etc. (photo: R. Bugini, L. Folli)

the original aspect‹ and the rearrangement of the interiors, together with new ornaments in place of Baroque ones. The architect was often assisted by his son Francesco (Rome, 1842–1899)[30].

Rome: Madonna Archetto (Via di San Marcello) Neo-Renaissance Interior (1850–1851)

Veneering: different white or coloured marbles and Lumachellone Savorelli (from Vigna Savorelli, Aventino).

Rome: San Marcello Corso, High Altar (1861–1867)

Balustrade: alabaster (baluster), Giallo antico, Verde antico, Apuanian white (handrail). Altar: Africano, alabaster, Breccia di Seravezza, Fior di pesco, Lumachella rossa, porphyries, Apuanian white. Roman urn: basanite.

Rome: Santa Maria Maggiore, Confessio (1861–1864)

Columns: alabaster. Panels: alabasters, Bianco e Nero antico, Cipollino mandolato, Fior di pesco, Giallo antico, Settebasi, Semesanto Verde antico. Cornice: Africano. Staircase panels: Alabastro a pecorella, Breccia dorata, Fior di pesco, Giallo antico, Occhio di pavone, Pavonazzetto, Portasanta, Verde antico. Staircase base: Africano. Balusters: Bigio antico. Handrail: Proconnesian. Pavement: Africano, Giallo antico, Granito rosso, Occhio di pavone, Pavonazzetto, Portasanta, Rosso antico, Apuanian white (fig. 1).

30 Barucci 2006.



2 Rome, Santa Maria Trastevere. Pavement (architect V. Vespignani). *opus sectile*: Porfido rosso antico, Porfido serpentino verde, Palombino, white veined marble (photo: R. Bugini, L. Folli)

Rome: San Lorenzo Extra Muros, Interior (1862–1865, Craftsman S. Cianfarani)

Aerial bombings (1943) severely damaged the church and Vespignani's decorative works.

Gospel ambo: Porfido rosso, Porfido serpentino, Pavonazzetto. Epistle ambo: Porfido rosso, Pavonazzetto, Proconnesian. Presbytery pavement: Porfido rosso, Porfido serpentino, Giallo antico, granites, white marble, etc. Episcopal throne: Granito verde della sedia, Porfido rosso, Porfido serpentino, Apuanian white (structure). Ciborium: Porfido rosso (columns).

Rome: In Front of the Church of San Lorenzo (1865)

Column of Pio IX: Granito rosso (shaft).

Rome: Santa Maria Trastevere, Pavement, Ciborium (1864–1874; Craftsman P. Martinori)

Pavement: Giallo antico, Porfido rosso, Porfido serpentino, Palombino, Bardiglio, Apuanian white (fig. 2). Ciborium: Porfido rosso (column shaft).

Rome: San Pietro Vincoli, Confessio, Ciborium (1876–1877)

Balustrade: Africano, Apuanian white. Panels: Giallo antico, Fior di pesco, Porfido rosso, Porfido serpentino, Verde antico. Staircase: Bianco e Nero antico. Confession panels: alabasters, Pavonazzetto, Portasanta, Rosso antico, Verde antico. Confession pavement: Cipollino mandolato, Giallo antico, Portasanta, Verde antico, Apuanian white. Ciborium: Granito violetto (column shaft).



3 Rome, San Giovanni Laterano. Presbytery (architect V. Vespignani). Veneering: Africano, alabaster, Breccia corallina, Giallo antico, Verde antico, etc. (photo: R. Bugini, L. Folli)



4 Rome, Sacro Cuore (architect V. Vespignani), St. Giuseppe altar: Cipollino, Giallo antico, Pavonazzetto, Portasanta, Verde antico (column pedestal) (photo: R. Bugini, L. Folli)

Rome: San Giovanni Battista Laterano, Presbytery, Apse (1879–1886)

Presbytery: Africano, alabaster, Breccia corallina, Giallo antico, Verde antico, etc. (fig. 3). Apse: Porfido rosso, Porfido serpentino, Apuanian white (panel), Verde antico (base, cornice).

Rome: San Tommaso Canterbury (Via di Monserrato), Portal (ca. 1880)

Threshold: Africano (three thick slabs, from excavations of Roman emporium).

Rome: Sacro Cuore Gesù (Via Marsala), Altars, Pavement (1879–1887)

The first parish church built after Rome became the Italian capital was completed by F. Vespignani.

High altar: alabasters, Giallo antico, Pavonazzetto, Portasanta, Rosso antico, Verde antico. Side altars: alabaster, Broccatello, Cipollino, Giallo antico, Giallo Siena, Libeccio, Occhiadino, Pavonazzetto, Portasanta, Rosso Francia, Rosso Levanto, stalattite, Verde Alpi, Verde antico (fig. 4). Pavement: Apuanian white, Bardiglio, Rosso Levanto.

Sacconi: List of Works and Materials

Giuseppe Sacconi (Montalto Marche, 1854–1905) is known for the Vittoriano in Rome, a memorial of King Vittorio Emanuele Secondo (died in 1878) and also the most disputed post-Unification building[31]. Another memorial was the Cappella Espiatoria in Monza (King Umberto Primo, died in 1900)[32]. Buildings planned by Sacconi are also present in The Marks: Loreto (Santuario Santa Casa) and Ascoli Piceno (Duomo)[33]. Guido Cirilli (Ancona, 1871–1954) was involved in many works as a disciple of Sacconi.

Rome: Vittoriano, Interior, Upper Portico (1885–1905)

Sacconi attended to this memorial between 1885 and 1905. After Sacconi's death, the construction was led, until the inauguration (1911), by G. Koch (1849–1910), M. Manfredi (1859–1927) and P. Piacentini (1846–1928). *Marmorari* were led by O. Fedeli and C. Tronfietti. Coloured marbles were chosen by Sacconi, but the installation was carried out after his death and some differences were introduced to the original plan. A Roman pavement with coloured marbles was found in the site (1903) and then arranged in the new building.

Pavements, stairways: Africano, Bardiglio, Botticino, Granito del goro, Giallo Siena, Granito rosso, Porfido rosso, Libeccio, Portasanta Caldana, Rosso Collemandina, Verde antico, etc. (fig. 5) and a few modern breccias (discs). Upper portico pavement: Africano, Cipollino, Giallo antico, Pavonazzetto, Verde antico, etc.

Monza: Cappella Espiatoria, Sacellum, Crypt (1901–1910)

The upper part (sacellum) of this memorial, featuring a tall cross, reflects Sacconi's project; the lower part (crypt) reflects Cirilli's modifications to the original plan. Craftsmen: O. Fedeli, Rome (veneering, pavement); E. Retrosi (mosaic); Ars Veneta (mosaic workshop).

Sacellum: Africano, Proconnesian (veneering); Algerian alabaster (window); Botticino (bases, spandrels); Cipollino, Giallo antico, Greco scritto, Pavonazzetto, Porfido rosso, Porfido serpentino, etc. (pavement) (fig. 6); mosaic (niche, arches, vault – glass tesserae).

31 Acciaresi 1911; Coppola – Morabito – Placidi 2005.
32 Nardini 1910.
33 Morosini 1921.





6 Monza, Cappella Espiatoria Sacellum (architect G. Sacconi). Pavement: Giallo antico, Porfido rosso antico, Porfido serpentino verde, Proconnesian marble (photo: R. Bugini, L. Folli)

5 Rome, Vittoriano (architect G. Sacconi). Pavement: Giallo Siena, Pavonazzetto, Porfido rosso antico, Portasanta Caldana, Rosso Collemandina, Verde antico (photo: R. Bugini, L. Folli)

Crypt: Nembro Giallo Verona limestone, Verde Polcevera ophicalcite (veneering); Broccatello Verona limestone (arches); Algerian alabaster (windows); modern coloured marbles (pavement); mosaic (vault).

Rome: Pantheon, Tomb of Umberto Primo (1901)

A cubic urn placed on a double base, in the east chapel (facing the tomb of Vittorio Emanuele). Urn and upper base: Porfido rosso; lower base: Africano.

Loreto: Sanctuary Santa Casa, Chapels of Transepts and Choir (Early 20th Cent.)

Different modern coloured marbles were employed (altar, balustrade, pavement, veneering) to arrange some of the chapels. Right transept: Swiss chapel (Gabria, Repen); Spanish chapel (Ammonitico rosso). Choir: German chapel (Paonazzo Carrara). Left transept: Slavic chapel with A. Biondelli (Paonazzo Carrara, Ammonitico rosso); French chapel with G. Cirilli (Cipollino apuano). The incrustations of Santa Casa (begun 1509 by Bramante and others), by contrast, include Porfido rosso, Porfido verde, Africano, alabaster, Greek Cipollino, etc., set in a structure of Apuanian white.

Ascoli Piceno: Duomo (S. Emidio), Ciborium (1893–1895 with G. Cirilli)

Ciborium: Bianco e Nero antico (column shaft).

PARTICULAR CASES (19TH AND 20TH CENT.)

Three specific cases are investigated: Santa Maria del Rosario (Pompeii); San Vitale (Ravenna); Ca' d'Oro (Venice).

Santa Maria del Rosario

The Sanctuary of Pompeii was founded by B. Longo to honour an image of Our Lady of the Rosary. The construction includes the first church (A. Cua, 1891), the colonnaded façade (G. Rispoli, 1901) and the bell-tower (A. and P. Leonori, 1925). The decoration of the interior was planned by G. Rispoli in the late 19th century and carried out by *marmorari*. Finally, the church was enlarged in 1933–1939 (papacy of Pius XI) with a wide dome and two aisles added (S. M. Chiappetta, 1868–1948); the decorations of the enlarged church followed the previous patterns: veneering of piers (›open-book‹ style and cornices) (fig. 7); column shafts (monolithic pieces); *opus sectile* pavements (slabs of different shape), etc.[34].



7 Pompeii, Santa Maria del Rosario (architect G. Rispoli). Pilaster veneering: Cipollino (›open-book style‹), Griotte (cornice) (photo: R. Bugini, L. Folli)

The stone materials of the building came from northern Italy: pink and white granites (Baveno and Montorfano; Piedmont). Coloured marbles for the decorations came from Rome (reuse – alabaster, Bianco e Nero antico, Breccia Quintilina, Broccatello Spagna, Greek Cipollino, Pavonazzetto, etc.), Italy (alabaster, Portasanta Caldana, etc.), France-Pyrénées (Cipollino mandolato, Griotte, Portor, Rouge Languedoc, Serrancolin) and France-Provence (Brèche d'Alet). Rouge Languedoc or Rosso Francia was quarried in Caunes en Minervois (Aude, Occitanie) starting from the 1650s, but it was ignored by the Italian authors like F. Belli and F. Corsi. The French authors called it »marbre rouge de Languedoc«[35] or »marbre incarnat et blanc«[36]. This marble matches the colour and the texture of Cipollino rosso and Rosso brecciato from Iasos (Muğla province, Türkiye, ancient Caria), mainly used in the late Roman and Byzantine periods (Istanbul, Ayasofya; veneering, pavement)[37]. Rouge Languedoc was widespread in France (e.g. Grand Trianon, Versailles; Arc du Carrousel, Paris) and also in the Italian Baroque since the early 18th century: monolithic column shafts for altars or wide slabs for pavements.

San Vitale

The Basilica of Ravenna, completed in 546–548, has often been judged a sister building of Küçük Ayasofya (Istanbul). The interior was richly adorned: tapestries of mosaic with figures; veined marble revetments on the piers (Proconnesian, Cipollino rosso); *opus sectile* pavements (Cipollino rosso, Proconnesian, Giallo antico, Porfido rosso, Porfido serpentino, etc.)[38]. The entire arrangement of marble and mosaic was repaired, retouched and renewed over the centuries. In

34 Tamburro 1990.
35 D'Aviler 1691; Quatremère de Quincy 1788; Rondelet 1802.
36 Félibien 1676; Rondelet 1802.
37 Gnoli 1988, 243–245.
38 Krautheimer 1965, 232–237.



8 Venice, Ca' d'Oro (architect G. Franchetti). Court pavement: Lumachella San Vitale, Porfido rosso antico, Porfido serpentino verde, Proconnesian marble, Verde antico (photo: R. Bugini, L. Folli)

particular, the marbles of the original veneering of the lower part of the apse were removed in the middle of the 16th century to set up a wooden choir; the choir was in turn removed and replaced by white marble slabs. A significant restoration of the apse was planned (1900–1904) by C. Ricci (art historian and archaeologist, 1858–1934), together with I. Bocci (architect) and the Opificio Pietre Dure (director E. Marchionni, craftsmen E. Renai, I. Bichi). Ricci's controversial restoration, albeit based on historical references (e.g. Euphrasius Basilica, Poreč, Croatia; panels of porphyry and mother-of-pearl)[39], arranged six square panels (Fior di pesco) with central discs (Porfido rosso) and cornices (Porfido serpentino, Porfido rosso, Giallo antico, mother-of-pearl, etc.); the panels are separated by twelve engaged columns (Porfido serpentino); a frieze with Red porphyry rhombs was set on the top together with stucco mouldings; a marble episcopal throne was located in the centre. The raw material came from some original remains of the church and from the marbles stored at the Opificio in Florence[40]. Interestingly, the Opificio was reformed a few years earlier (September 1895) to be effective in the field of the conservation of works of art, especially marble inlays and similar artifacts[41].

Ca' d'Oro

The former Contarini Palace (15th cent.), facing the Grand Canal of Venice, was transformed by G. B. Meduna 1850s) and then by the owner G. Franchetti (musician, 1865–1922). Franchetti reshaped the palace (early 20th cent.) to house a painting gallery, and he added a new pavement in the courtyard using ancient materials (Cipollino, Giallo antico, Lumachella, Occhio di pavone, Pavonazzetto, Porfido rosso, Porfido serpentino, etc.) (fig. 8). The work was directed by Franchetti

39 Krautheimer 1965, 278–281.
40 Bertelli 1992.
41 Giusti 2011, 24–38.

himself, following tried-and-tested patterns (San Marco or Torcello) and listening to the opinion of archaeologists[42].

USE OF MODERN COLOURED STONES

The architects who worked in Milan at end of the 19th century mainly chose modern coloured stones, already used in Milanese buildings. The most significant use is flooring, but some architectural elements of façades are also noticeable.

Galleria Vittorio Emanuele Secondo

Giuseppe Mengoni (1829–1877) planned this cruciform complex (four eclectic palaces including two streets, with glass and iron vaults), that has become a landmark of Milan. The construction started in 1865 and it was completed in 1878; the aerial bombings (August 1943) caused serious harm and a complete repair took place in 1946–1950. Coloured stones were used for pavements: Verona red limestone, Apuanian white and Bardiglio marbles (slabs); Viggiù grey, Varenna black and Verona red limestones; Candoglia pink marble and the not better identified ›color caffè di Brianza‹, together with coloured enamels (mosaic, craftsmen Candiani, 1867). This original pavement was replaced (craftsmen Campanati and Aquino, 1967) using slabs of Verona red limestone, Apuanian white and Bardiglio marbles; mosaic of Mori yellow, Botticino creamy white, Varenna black, Verona and Assisi red limestones[43].

Cimitero Monumentale

Carlo Maciachini (1818–1899) built the front buildings of this Neo-Romanesque cemetery (1865) using granites (pink Baveno, white Montorfano), Balma violet syenite, Oira deep green peridotite, Simona purple sandstone, coloured limestones (Verona red or white, Saltrio light-brown), and dolostone (Angera pink or white)[44].

Case Bagatti Valsecchi

The brothers Bagatti Valsecchi (Fausto 1843–1914, Giuseppe 1845–1934) built their own Neo-Renaissance palaces (1878–1895) to house an art collection. The buildings suffered from aerial bombings, like many others in Milan, and they were restored in 1945–1954. The pavements show Arzo, Verona, Varenna and Botticino coloured limestones, Apuanian marble, etc. Column shafts are made of Macchia vecchia; tondi of Porfido rosso are inserted in doorway and window frames[45].

Tomba Giuseppe Verdi

Camillo Boito (1836–1914) built the Neo-Romanesque Casa di Riposo per Musicisti, named after Giuseppe Verdi (1899), embracing the crypt where the composer is buried (1901). Three arches (Bardiglio) of the crypt façade include rectangular slabs of Fior di pesco, Porfido rosso, and Verde antico on the entablature; the interior shows Rosso Levanto ophicalcite (pavement, veneering of the lower part of the walls) and multicoloured mosaics by L. Pogliaghi (upper part of the walls). A Verdi's bronze portrait is surrounded by eight small slabs of Porfido rosso[46].

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42 Howard 2002, 103–106.
43 Rondello 1967; Gioeni 1995.
44 Selvafolta – Ginex 1999.
45 Pavoni 1997.
46 Formenti 1899, 48 f.

Banca Commerciale Italiana

Luca Beltrami (1854–1933) built, on the same square, two opposite edifices of the Banca Commerciale (1905 and 1913). Marbles were used for veneering and flooring (workshop F. Pelitti): coloured Breccia aurora and Macchia vecchia; Rosso Levanto and Verde Alpi ophicalcites; Giallo Siena yellow and Uliano venato grey marbles; Arabescato orobico, Botticino, Varenna, Verona and Rosso Francia coloured limestones, etc.[47].

MUSEUMS AND GALLERIES

The use of ancient coloured marbles in museums has never been investigated. Coloured pieces were variously employed: columns to support busts and statues, small cubes or prisms to support objects, slabs to coat the bases of sculptural groups. The first example was the Sala Ottagonale: a wooden pavilion, built by V. Vespignani in a courtyard of the Palazzo dei Conservatori (Rome, 1876; demolished in 1903) to house Roman statues and artefacts coming from contemporaneous urban excavations. This particular use of coloured marbles is now evident in the Museo Romano, the Capitolino, the Pio Clementino, the Borghese (Rome), the Museo Archeologico (Naples), the Louvre, the Hermitage, etc. Coloured marbles were also present in some architectural parts of the museums themselves as pavements, thresholds, doorways or window frames, etc. The Pinacoteca di Brera (Milan) was completely refurbished by E. Modigliani (1925) using Africano or Cipollino (supplied by the Florentine Opificio) for the doorways of the exhibition rooms[48].

A LOOK ABROAD

The use of coloured marbles in the late 19th century is not a prerogative of Italian architects; three examples are significant: the Opéra (Paris), Westminster Cathedral (London) and the Morgan Library (New York). The Opera House was built in the Beaux-Arts style by C. Garnier (Paris, 1825–1898) in 1875; the interior, among gilding, mosaics and ornaments, shows Breccia di Seravezza, onyx, Rouge antique (Hérault), and Swedish green on the great staircase[49]. The Roman Catholic cathedral was built in the Neo-Byzantine style by J. F. Bentley (Doncaster, 1839–1902) in 1903; the interior contains marble columns of various colours brought from abroad (i.e. Verona rosso and Giallo limestones) and veneering made of coloured marbles as Bianco e Nero antico, Breccia di Seravezza, Cipollino, Verde antico, Apuanian white, Belgian black, etc.[50]. The Morgan Library was built in the Renaissance style by C. F. McKim (Chester, 1847–1909) in 1906; three main rooms and the rotunda contain columns of different sizes made of Africano, Cipollino, lapis lazuli, etc.[51].

COLOURED MARBLES IN THE 1930S

The use of coloured marbles was again noticeable in the 1930s. Marbles did not come from the Roman remains nor from the ancient quarries, but they came from numerous sites scattered throughout the Italian territory: these quarries, in most cases, were operated as a result of specific surveys and the marbles were used for the first time; in fact, the exploitation of national resources was strongly promoted by the Fascist dictatorship (›autarky‹ or economic self-sufficiency). Remarkable stones were: Rosso Pantheon (Biella, Piedmont); green ophicalcites (Val d'Aosta); Arabescato orobico (Val Brembana, Lombardy); Verde Polcevera (Genoa, Liguria); Chiampo

47 Bellini 1997.
48 Bassanini 2021.
49 Mead 1991.
50 Clifton Taylor 1967, 249 f.
51 Le Blanc 1996, 13.

(Veneto); Fior di pesco carnico (Forni Avoltri) and Rosso porfirico (Verzegnis, Friuli); Arabescato, Calacata, Cipollino zebrino (Carrara) and Portasanta (Caldana, Tuscany), etc. The use in Milan includes apartment buildings (pavements) and public buildings such as the Stazione Centrale (U. Stacchini, 1931) or Palazzo di Giustizia (M. Piacentini, 1932). In particular, these last two buildings must be considered as an exhibition of the contemporaneous Italian marbles. However, a complete overview of coloured marbles in 1930s Italian architecture should include public buildings such as ministries, city halls, universities, post offices, railway stations, churches, etc.

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COLOURED MARBLES OF THE IMPERIAL PALACE ON THE PALATINE HILL

RESEARCH INSIGHTS

Abstract
This paper is focused on the study of the distribution of white and coloured marbles within the main sections of the Imperial Palace of the Flavian dynasty on the Palatine Hill (Domus Flavia and Domus Augustana), widely employed both for architectural elements and for floor and wall revetments. Their pervasiveness is testified to by the numerous *disiecta membra* as well as the remains of the veneers in different sectors of the complex; the holes for the clamps in the masonry and the imprints of the slabs on mortar beds are also noteworthy. The architecture, dimensions and function of each room played a fundamental role in the selection of the different qualities of marble. An outstanding context is represented by the so-called lower peristyle of the Domus Augustana, which provides a vivid picture of the polychromy of the Imperial Palace. Based on the use of the different varieties of marble within the Domitian residence, two important features emerge: a continuous dialogue between their colours and the light and also a sort of ›specialisation‹ for some types.

INTRODUCTION

Since 2012 the Department of Archaeology of Sapienza Università di Roma has been conducting an extensive study on the architecture and architectural decoration of the Imperial Palace on the Palatine Hill, in cooperation with the Parco Archeologico del Colosseo. In particular, the research focused on the systematic analysis of the main sections of the complex (the Domus Flavia and the Domus Augustana) and the numerous marble architectural fragments scattered throughout the area as *disiecta membra*[1].

Primarily built by Domitian, the palace stands as his most significant building venture, both architecturally and ideologically[2]. Spanning across three main levels, it occupies nearly the entire Palatine (fig. 1). The central block lies on the top of the hill and it consists of the Domus Flavia and the Domus Augustana, usually referred to as the »public« and the »private« sections of the palace[3]. The Domus Flavia is characterised by large ceremonial halls (501, 530–532) and a peristyle (515) surrounded by smaller rooms along its western and eastern branches. The Domus Augustana is built on two different levels: the upper one presents a central peristyle (583), along whose northern and southern sides lie respectively the vestibule (599) – probably the

1 A monograph on the architecture and architectural decoration of the Flavian Palace is in preparation, see Pensabene – Caprioli (forthcoming). For preliminary considerations, see Coticelli et al. 2017; Caprioli 2021.

2 For a summary of the construction phases, see Bukowiecki – Wulf-Rheidt 2015; Pflug 2022, 174–186. On the architecture of the palace and its reception in contemporary written sources, see Wataghin Cantino 1966; MacDonald 1982, 47–74; Darwall-Smith 1996, 179–215; Mar 2005, 161–217; Bruno 2012, 240–264; Coarelli 2012, 450–474. 491–532; Sojc 2012; Bruno 2017, 241–264; Citroni 2019, 133–135; Sojc 2021; Raimondi Cominesi 2022, 102–112.

3 Recently, Coarelli 2012, 494. Although epigraphic evidence shows that the whole complex was known as the Domus Augustana or Augustiana (see Panciera 2007), in this paper the names by which the different sectors of the palace are traditionally identified in the literature are used. For the numbering of the rooms, see Bukowiecki – Wulf-Rheidt 2015, pls. 1–12.



1 Rome, Palatine Hill. The Imperial Palace (graphics: A. Mortera after Google Maps)

main entrance of the whole complex – and a group of small rooms; the lower level consists of an open court surrounded by a portico (327) and numerous rooms along its northern and eastern wings. On the southeastern edge of the hill is the Domus Severiana, separated from the rest of the palace by the stadium, a wide garden. The northeastern extremity of the Palatine is occupied by the Vigna Barberini, a vast garden where in the 3rd century AD the Temple of Elagabalus would be built. The lowest level of the palace is represented by a remote pavilion positioned between the Circus Maximus and the southern slopes of the Palatine, the Paedagogium. Finally, on the northwestern side of the hill, the Domus Tiberiana can be considered as another section of the imperial residence.

Among the notable features of the Imperial Palace is the extensive use of coloured marble, which played a crucial role in enhancing its magnificence. Therefore, this paper focuses on the use and distribution of polychrome and white marbles within this complex, particularly in the areas of the Domus Flavia and Domus Augustana. Emphasis will be given to their combination in chromatic agreement or contrast, as well as their aesthetics, according to the different contexts of the palace itself. The context, indeed, identified by architecture and function, as well as natural light, was expected to play a crucial role in the selection and arrangement of marbles. In this way, along with architectural decoration, the colour of marbles contributed to the creation of different ›atmospheres‹ within the palace[4].

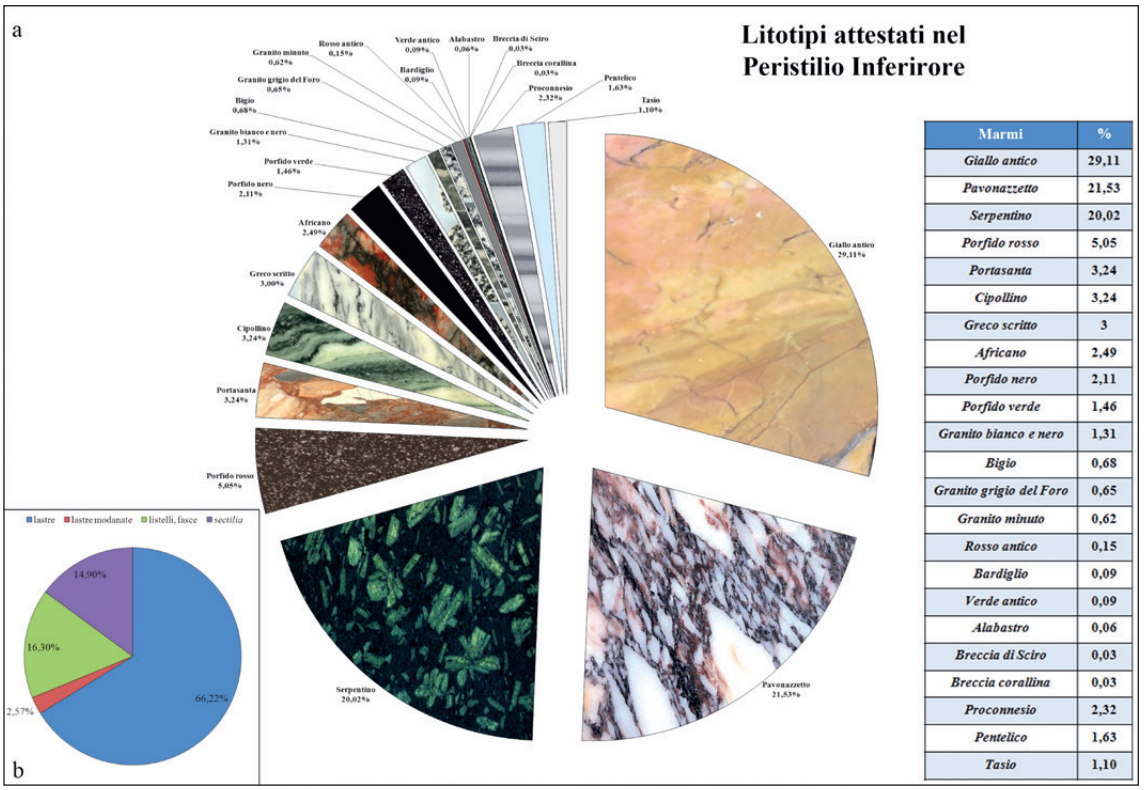
F. Caprioli – P. Pensabene

THE COLOURED MARBLES OF THE IMPERIAL PALACE

Only scanty remains of the luxurious marble revetments of the palace are still preserved *in situ*. However, their pervasiveness is revealed by the numerous holes for the clamps in the masonry as well as the imprints left by the slabs on the mortar beds, both on floors and walls.

The opulence of the Domitian complex and the qualities of marbles from the most important quarries that were used in the imperial residence are attested by a well-known paragraph

4 On this aspect, see Haug 2014, 219 f.



Marmi	%
Giallo antico	29,11
Pavonazzetto	21,53
Serpentino	20,02
Porfido rosso	5,05
Portasanta	3,24
Cipollino	3,24
Greco scritto	3
Africano	2,49
Porfido nero	2,11
Porfido verde	1,46
Granito bianco e nero	1,31
Bigio	0,68
Granito grigio del Foro	0,65
Granito minuto	0,62
Rosso antico	0,15
Bardiglio	0,09
Verde antico	0,09
Alabastro	0,06
Breccia di Sciro	0,03
Breccia corallina	0,03
Proconnesio	2,32
Pentelico	1,63
Tasio	1,10

2 Imperial Palace, Domus Augustana. Coloured and white marble slabs from the area of the lower peristyle (graphics: A. Mortera)

of Statius' »Silvae«: *Aemulus illic / mons Libys Iliacusque nitet, [///] multa Syene / et Chios et glaucae certantia Doridi saxa; / Lunaque portandis tantum suffecta columnis*[5]. In this passage, Sienite (*multa Syene*), Portasanta (*Chios*), Serpentino (*Doridi saxa*) and Luna marble are listed. Albeit its vague nature and despite the generally admiring tone of the poem, these few verses are of utmost importance. In fact, they are the sole source of information shedding light on the use of multiple marbles in the decoration of the Imperial Palace, thus offering a rare glimpse into the polychromatic nature of this complex[6].

In this regard, the lower peristyle of the Domus Augustana represents a very significant context. The examination of a sample composed of 3,367 fragments of both white and polychrome marble slabs (fig. 2) has returned a rather vivid picture of the wide range of colours that must have distinguished the veneers of the lower peristyle and, more generally, of the entire palace itself[7]. Given the nature of this context, the presence of large amounts of Giallo antico (ca. 29 %), Pavonazzetto (ca. 21.5 %) and Serpentino (ca. 20 %) is not surprising; other marbles such as Red porphyry (ca. 5 %), Portasanta (ca. 3 %), Cipollino (ca. 3 %) and Africano (ca. 2.5 %) show significantly lower percentages. Among the white marbles, Proconnesian (ca. 2 %), Pentelic (ca. 1.5 %) and Thasian (1 %) are attested[8].

5 Stat. silv. 4, 2, 26–29.

6 The same marbles are mentioned in two other paragraphs by Statius (silv. 1, 5, 34–43; 2, 2, 85–94), thus identifying a literary topos, see Darwall Smith 1996, 196. See also Campana 2004, 331–335, where later texts with stereotyped lists of marbles are recorded, and recently Papini 2021, 516 f.

7 Caprioli 2021, 87 pl. 6 fig. 2; Caprioli et al. 2023, 304 f. fig. 10. The sample is composed by floor and wall slabs and also *sectilia*.

8 At the moment, white marbles have been identified only through macroscopic evidence.

Although these data must be considered in light of the centuries-long removal activities that affected the whole palace, the limited correspondence with the paragraph from Statius is evident. The presence of Sienite seems rather intriguing, possibly associated with small or medium-sized column shafts[9]. Yet to be investigated is the relevance of the presence of the Greco scritto (3 %), generally connected with private architecture. Its presence within the Flavian complex, however, may indicate that such a variety – perhaps the one quarried in nearby Ephesos – might have also been used in imperial residences as well[10]. However, its low percentage compared to the ›imperial marbles‹ confirms its limited relevance for the revetments.

Although common, the predominance of Giallo antico and Pavonazzetto revealed by the sample from the lower peristyle finds, on the other hand, an interesting correspondence with the description of the baths of Claudius Etruscus by Statius[11]. In this account, moreover, other marbles such as Thasian, Cipollino, Serpentino and onyx are noted as absent.

The sample from the lower peristyle provides evidence of a continuous exploitation of the same coloured marbles that had been used since Augustus[12]. The introduction of other qualities that became prominent in the Neronian age also emerged: an »imperial heptachromy« is thus outlined, meaning by this the combination of seven coloured marbles used for public architecture and imperial residences[13]. Such heptachromy, inherited by the Flavians, includes Africano, Cipollino, Giallo antico, Pavonazzetto, Portasanta, Red and Green porphyry (Serpentino) and it is largely attested in the revetments of the Domus Transitoria and the Domus Aurea, such as in the Baths of Livia and the Basilica[14]. The presence of small slabs of Granito del foro, which would become especially widespread from the Domitian era onwards, is also noteworthy.

In order to investigate the aesthetic choices and the selection of the coloured marbles for the Flavian palace, a brief reference to the Augustan Palatine complex is necessary. When it was abandoned, the marbles of the *sectilia pavimenta* were dismantled, carefully recovering the tiny slabs. During this process, small fragments of these *sectilia* remained in the mortar of the preparation layers, proving that marbles such as Giallo antico and Pavonazzetto were already used in the House of Octavian (the one dating before 36 BC) along with local stones[15]. Additionally, the peristyle of this building combined different elements of the architectural order (bases, shafts and capitals) made of alabaster, Giallo antico, Pavonazzetto and Portasanta[16].

It is possible that a similar scenario also occurred during the dismantlement of the Domus Aurea. The marbles used in this huge construction – including the column shafts – could have been recovered in order to be reused in the Flavian buildings, such as the Baths of Titus or the Imperial Palace itself[17]. The latter, in fact, was built over the Palatine pavilions of the Domus Aurea, some

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9 Monolithic unfluted columns shafts of Sienite were used in the Stadium (Iara 2015, 46 f.), although these may belong to the Severan restoration of the building.

10 On the debate about the provenance of Greco scritto, see recently Pensabene 2016, 678 f. Although widely attested in the 2nd and 3rd cent. AD, as in the wall revetments of the Villa dei Quintili, the introduction of Greco scritto at the end of the 1st cent. AD is testified to by the excavation of the complex of the Terme del Nuotatore in Ostia: Carandini et al. 1973, 638; Pensabene 1973, 179–190; Pensabene 1974/1975, 179 n. 2.

11 Stat. silv. 1, 5, 34–41: *non huc admissae Thasos aut undosa Carystos; / maeret onyx longe, queriturque exclusus ophites: / sola nitet flavis Nomadum decisa metallis / purpura, sola cavo Phrygiae quam Synnados antro / ipse cruentavit maculis lucentibus Attis / quaeque Tyri niveas secat et Sidonia rupes. / vix locus Eurotae, viridis cum regula longo / Synnada distinctu variat*. See also Campana 2004.

12 Pensabene 2013, 30–56.

13 See Guidobaldi 2003, 30 f., where a »Neronian quadricromy« is identified (Giallo antico, Pavonazzetto, Red and Green porphyry). See also Pensabene – Caprioli 2020, 185.

14 Morricone Matini 1967, 63–70 figs. 24. 26 pls. 29–30; Guidobaldi 1999, 643 f.; Guidobaldi 2003, 30 f.; Lugari – Guidobaldi 2013, 613–618.

15 Gallocchio – Musco – Pensabene 2017; Pensabene 2021, 37–42 fig. I, 20–22. By contrast, see Guidobaldi 1999, 639–641; Guidobaldi 2018, 708–711. See also Quaranta – Violante 2023.

16 Pensabene 2021, 31 f. fig. I, 13–14.

17 von Hesberg 2004, 72; Pensabene – Caprioli 2020, 185.

fragments of the revetments of which are still preserved *in situ* under the structures of the Domitian palace (Baths of Livia, Basilica).

The systematic analysis of the marbles preserved in the archaeological area of the palace and the warehouses of the Palatine has also revealed the presence of some ›rare marbles‹ used for column and pilaster shafts and for floor or wall revetments. These include, for example, the green breccia of Egypt (Hecatontalithon) and other Egyptian granites, such as the Granito della sedia di San Lorenzo. The definition of »rare« for these marbles is due to the quantities that were quarried and the fact that they were used almost exclusively for public architecture, not because of their cost[18]. Some quartzites and certain types of alabasters can also be referred to as rare, including the phengite mentioned by Suetonius: afraid of being the victim of some kind of conspiracy, in order to always be able to look over his shoulders, Domitian is said to have had the walls of the porticoes of the palace under which he used to walk covered with a particularly shiny marble – phengite, in fact –, possibly a variety of quartzite quarried from Cappodocia[19].

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THE COLOURED MARBLES OF THE IMPERIAL PALACE: *SECTILIA PAVIMENTA*

As usual, the use of coloured marbles is mainly reserved for the floor and wall revetments, which were widespread throughout the palace. For the largest halls, the Aula Regia and the Triclinium of the Domus Flavia, big slabs of the most expensive and prestigious coloured marbles were employed, including *rotae* of considerable size.

The floor of the Aula Regia (531) has been completely dismantled and its reconstruction can only be based on the records of the excavations of the Farnese family. Referring to the floor of the Pantheon, the only comparable *sectile* known at that time, Francesco Bianchini mentions the existence of »dischi larghi piedi 7«[20]. Comparing it with other similar floors (Forum of Trajan, Pantheon, Temple of Venus and Roma, Templum Pacis, Porticus Octaviae), it is possible to assume the existence of a grid consisting of rectangular Pavonazzetto slabs and large squares of Giallo antico, within which discs of Red porphyry, Granito grigio del foro and Pavonazzetto were likely placed (fig. 3)[21].

A similar scheme, albeit on a smaller scale, was used for the central part of the adjacent hall, the Basilica (530), where a disc made of Granito grigio del foro within a square of Giallo antico framed by a band of Africano were seen. The side aisles, on the other hand, were paved with rectangular slabs of white marble[22].

In the Triclinium (501) two distinct pavements are preserved. The one located in the apse (fig. 4 a) is much more elaborate, consisting of rectangular and square panels of different sizes, within which we find complex motifs. These elements are composed of listels, bands, discs and *sectilia* of different shapes made of Giallo antico, Pavonazzetto, Red porphyry and Serpentino[23]. The more extensive one (fig. 4 b) lies above a hypocaust system built at the time of Hadrian[24]. For this *sectile*, marbles of various size and nature were used: slabs of Africano, alabaster and

18 In fact, they do not appear in the Diocletian Edict of prices, see Pensabene 2013, 603.

19 Suet. Dom. 14: *Tempore vero suspecti periculi appropinquante sollicitior in dies porticuum, in quibus spatiari consuerat, parietes phengite lapide distinxit, e cuius splendore per imagines quidquid a tergo fieret provideret*. The phengite also appears in Plin. nat. 36, 163, where it is said that it was discovered during the reign of Nero.

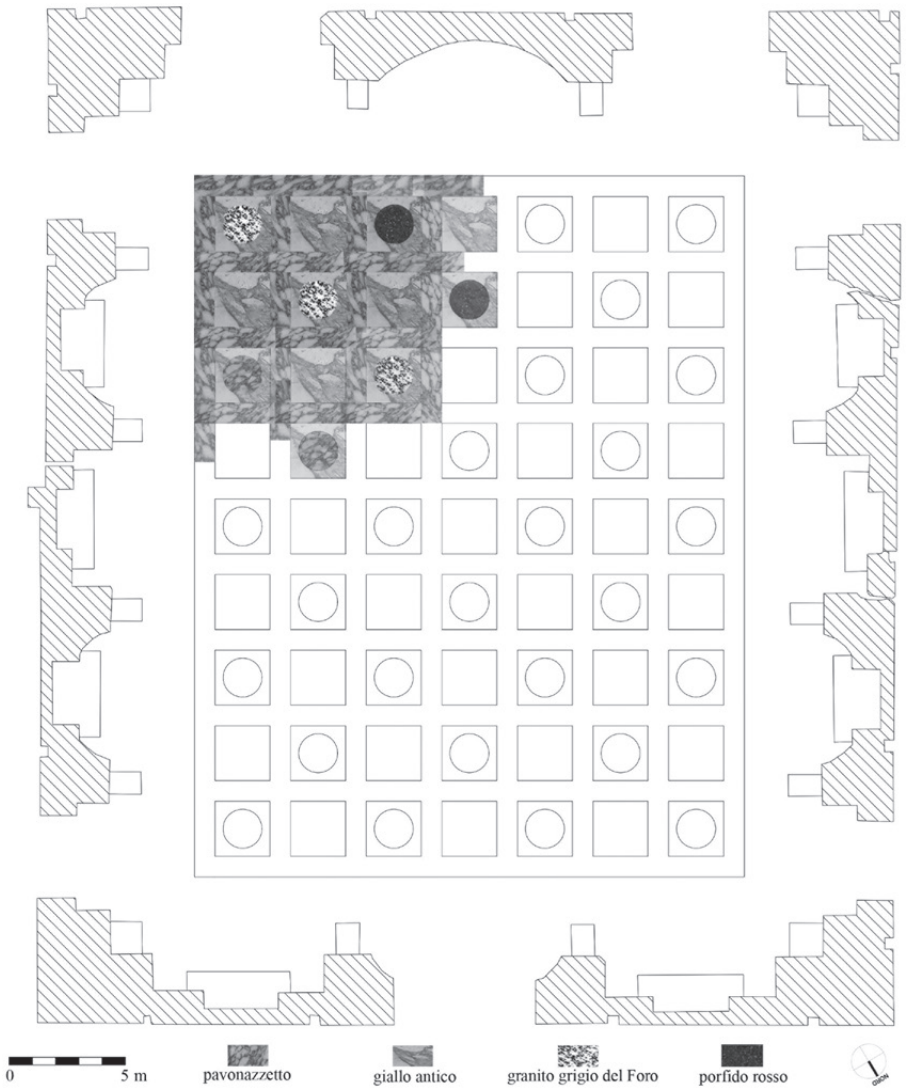
20 Bianchini 1738, 44.

21 Mortera 2020.

22 Lange 1885, 375 pl. 6, 2; Mortera 2020, 215 n. 37.

23 For a comprehensive description, see Morricone Matini 1967, 83 n. 78 pl. 31, 78. For the classification of this floor, see Guidobaldi 1985, 178. 180.

24 Bloch 1947, 210 f. 216; Gibson – DeLaine – Claridge 1994, 73; Bukowiecki – Wulf-Rheidt 2015, 388.



3 Imperial Palace, Aula Regia. Reconstruction of the *opus sectile* (graphics: A. Mortera after Mortera 2020, 224 fig. 6 a)



4 Imperial Palace, Triclinium of the Domus Flavia, *sectilia pavimenta*. 4 a: *Opus sectile* of the apse. 4 b: *Opus sectile* along the western wall (photos: A. Mortera, published with the permission of the Ministero della Cultura – Parco archeologico del Colosseo)

Cipollino compose the outer frame, while the central area presents a complex motif with big squares of Giallo antico and Portasanta divided by small panels of Granito grigio del foro; small panels in Africano isolate squares of Giallo antico with discs of Granito grigio of different diameters within them alternating with rectangular panels of Pavonazzetto[25].

Establishing the chronology of these *sectilia pavimenta* is quite complex. The presence of Domitian brickstamp on two *bipedales* of the preparation layer of the floor of the Basilica – seen by Bianchini, but no longer *in situ*[26] – seems to suggest a date at the end of the 1st century AD. Based on this evidence, the floor of the Aula Regia should be considered – at least based on the current state of knowledge – as the earliest example of this kind of *sectilia pavimenta*[27].

For the floors of the Triclinium, the issue is more problematic. According to their formal and quality features, the two floors may in fact belong to two different building phases. The *sectile* of the apse, which shows a scheme and a polychromy similar to a floor from Trajan's Villa in Arcinazzo, may date back to the original phase of the Triclinium[28]. By contrast, the heterogeneity of the design and polychromy of the *sectile* that is located along the eastern wall of the hall – which employs reused slabs, while the granite *rotae* were likely obtained from one or more sawn column shafts – suggests a later date for this floor, between the 4th and 5th centuries AD[29].

Rich *sectilia pavimenta* also characterised the area of the Domus Augustana. In a small room of a still partially unknown section of the palace behind the Triclinium, which has recently been excavated, the mortar bed of an elaborated *sectile* emerged. A big disc composed of small triangular slabs arranged in multiple lines, which have been completely removed, occupied the centre of the room. Rectangular slabs of Giallo antico were used to cover the space between the central motif and the walls, while the entrance was paved with rectangular slabs of Pavonazzetto[30].

Floor revetments with a Q3-motif in which Giallo antico, Pavonazzetto, Cipollino, Portasanta, Africano, Granito grigio and Thasian marble are used can be observed in Room 565 and Room 568 of the upper level of the Domus Augustana[31]. A similar floor made of Giallo antico, Serpentino and white marble was documented by Giuseppe Antonio Guattani in Room 305 of the lower peristyle[32]. While the latter probably belongs to the time of Domitian, the two floors of the upper level of the Domus Augustana have been considered a late restoration due to the chromatic alteration caused by the use of different marbles[33].

New floors with elaborate Q-motifs have recently been uncovered in the area of the lower peristyle (rooms 316–318. 322)[34].

In both the Domus Flavia and the Domus Augustana, simpler *sectilia pavimenta* are present. These pavements consist of rectangular slabs arranged in multiple parallel rows with staggered joints, mostly with monochromatic compositions[35].

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25 For a comprehensive description, see Morricone Matini 1967, 82 n. 77 pl. 31, 77. For the classification of this floor, see Guidobaldi 1985, 178.

26 Bloch 1947, 27; Morricone Matini 1967, 83; Bukowiecki – Wulf-Rheidt 2015, 383.

27 See Guidobaldi 1999, 644 n. 36; Mortera 2020, 215 f.

28 Guidobaldi 1999, 644 n. 36; Guidobaldi 2005, 806. Cf. Morricone Matini 1967, 84. For the *opus sectile* of the Villa of Trajan in Arcinazzo, see Fiore – Mari 2005, 634–636 figs. 6–7.

29 Cf. Morricone Matini 1967, 80. 82; Guidobaldi – Guiglia Guidobaldi 1983, 31–37; Guidobaldi 1985, 178. 180.

30 Santoro – Tomei 2015, 14 (»pavimento A«) figs. 2 a; 3; Nazzaro – Santoro 2019, 208 f. fig. 21. This room does not appear in Bukowiecki – Wulf-Rheidt 2015, pl. 12.

31 Morricone Matini 1967, 78 f. n. 76–77 pl. 31. For the motif, see Guidobaldi 1985, 186 fig. 4. It is possible that the same scheme was also used for Room 581 and Room 582.

32 Guattani 1785, 86: »[...] restava per anco il suo pavimento intatto buona parte [...] diviso in triangoli, alternativamente variati di giallo bianco, e serpentino.«

33 Morricone Matini 1967, 78 f. n. 76–77; Fogagnolo 2009b, 280 f. In particular, the pattern of the sectile of Room 568 appears to be more irregular.

34 Quaranta 2021, 20–22; Quaranta – Violante – Pintucci 2024.

35 On this type of floor, see Olevano 2001.



5 Imperial Palace, remains of simple *sectilia pavimenta*. a: Ambulatory of the upper peristyle of the Domus Augustana (583). b–c: Ambulatory and fountain basin of the peristyle of the Domus Flavia (515) (photos: A. Mortera, published with the permission of the Ministero della Cultura – Parco archeologico del Colosseo)

The ambulatory of the peristyle of the upper level of the Domus Augustana (583) was paved with rectangular slabs of Pavonazzetto of different sizes (fig. 5 a)[36]. By contrast, in the peristyle of the Domus Flavia (515) few portions of the floor are preserved, for which various marbles are employed. Along the back wall of its western wing, heterogeneous rectangular slabs of Africano, Pavonazzetto, Portasanta and Bigio are present (fig. 5 b), while along the northern branch, rectangular slabs of white marble, alabaster and Cipollino are attested.

For fountain basins and nymphaea, an almost exclusive use of white marble – likely Thasian – seems to emerge[37]. This is the case of the three nymphaea of the lower peristyle (326. 337. 339) and the peristyle of the Domus Augustana (516. 584); for the peristyle of the Domus Flavia big rectangular slabs of Proconnesian marble were used (fig. 5 c). In all these cases, some remains of the marble revetments are still *in situ*.

There are also two examples of floor revetments with an isodomic pattern with a combination of two colours, both in the Domus Augustana. The first is a minor peristyle that has recently been identified in a small room between the Triclinium and one of the libraries of the House of Augustus, where rectangular slabs of Giallo antico and Pavonazzetto are used[38]. The other one is the T-shaped corridor (310. 312) from the area of the lower peristyle, which was paved with rectangular slabs of white marble and of Portasanta[39].

Most of these floors could be dated to the time of Domitian, with the exception of the ones in the peristyle of the Domus Flavia, which probably belong to a later phase. In the first case, the variation in the dimensions of the slabs was likely not perceptible, as the colour scheme was uniform; moreover, the attention of the ancient visitor might have been captivated by the large water basin at the centre of the peristyle[40]. For the peristyle of the Domus Flavia, a later dating

36 Morricone Matini 1967, 77; Olevano 2001, 552. Dimensions of the slabs: 60/85 × 37 cm, 60/65 × 37 cm. Few fragments of white marble are present.

37 Fogagnolo 2009a, 491 n. 13. Nymphaeum 339 also testifies to a recurring use of Cipollino in water-related contexts, see below n. 48.

38 Fogagnolo 2009b, 281 fig. 5; Santoro – Tomei 2015, 14 (»pavimento B«) figs. 2 b; 4; Nazzaro – Santoro 2019, 192 f. figs. 3–4; Santoro 2020, 165 fig. 2 a. Dimensions of the slabs: 60 × 30 cm. This room does not appear in Bukowiecki – Wulf-Rheidt 2015, pl. 12.

39 Fogagnolo 2009a, 493; Fogagnolo 2009b, 280. Dimensions of the slabs: 50/75 × 45 cm.

40 Fogagnolo 2009b, 281. See also Quaranta 2021, 19 f., where a stratigraphic proof for a Domitianic date of the floors



6 Imperial Palace, Domus Augustana, *sectilia pavimenta*. a: Room 567. b: Room 501 (photos: A. Mortera, published with the permission of the Ministero della Cultura – Parco archeologico del Colosseo)

is suggested by the fact that a portion of its floor lies above the southern edge of the basin. Other remains of the same floor occupy a significant portion of the central basin, leaving only the octagonal fountain uncovered. For the ambulatory of the peristyle, the use of different marbles provides further evidence for the late dating.

From the scenario outlined so far, two rooms of the Domus Augustana can be clearly distinguished. Both rooms must have overlooked – probably via large windows – the Stadium, and they were at least partially characterised by the dark veneers.

The hall with two apses (567) is paved with rectangular Africano slabs of heterogeneous dimensions (fig. 6 a)[41]. The same marble was used at least for the baseboard of the walls, as evidenced by a few remains *in situ*, along with Cipollino. Thus, a partial continuity between the floor and the walls had to be created. Africano was also employed for the unfluted column shafts corresponding with the passage between the peristyle and the hall itself[42].

The decision to use a dark marble for both floor and wall veneers could be attributed to the availability of abundant natural light. The presence of chambers distinguished by a predominant colour, after all, is testified to by the palace in Constantinople, where a room whose walls were entirely covered in Porfido rosso – known as »porphyra« – is mentioned in ancient sources[43]. Moreover, according to Cassius Dio, Domitian once held a banquet in a room which was completely dark[44].

In the other room of the Domus Augustana (501) only a portion of the floor made of thick slabs of Serpentino is preserved (fig. 6 b), in which the porphyritic *plateae* mentioned by the »Historia Augusta« in the lives of Heliogabalus and Severus Alexander have tentatively been recognised[45].

A. Mortera

of the biapsidal room (567) and the ambulatory of the peristyle of the Domus Augustana (583) is now provided. By contrast, Alfonso Bartoli referred to the Pavonazzetto floor of the peristyle of the Domus Augustana (583) as »opera tarda«, see Bartoli 1929, 20.

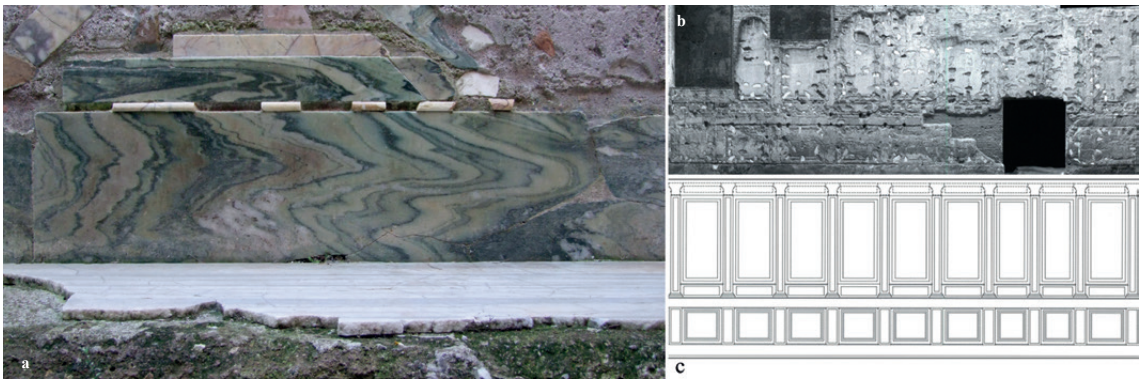
41 Cf. Morricone Matini 1967, 78 (»aula ellittica«); Quaranta 2021, 19 f. Dimensions of the slabs: 67 × 38 cm, 90 × 30 cm.

42 Bartoli 1929, 21.

43 An. Comn. 2, 90, 3–19. The emperors who were born inside this room were named »porphyrogenitus«.

44 Cass. Dio 67, 9, 1–5.

45 Guidobaldi 2002. On the contrary, Lazzarini 2007, 56 fig. 26. There are also two fragments of thick white marble slabs; however, they do not seem to be *in situ*. The adjacent room (502) is paved with large slabs of Luna and Proconnesian marble.



7 Imperial Palace, Nymphaeum 339 of the lower peristyle of the Domus Augustana. a: Remains of the wall veneer (photo: A. Mortera, published with the permission of the Ministero della Cultura – Parco archeologico del Colosseo). b–c: Northwestern wall with mortar bedding layer and reconstruction of the decorative pattern (graphics: S. Andrizzi after Fogagnolo 2009a, 497 fig. 9)

THE COLOURED MARBLES OF THE IMPERIAL PALACE: *OPERA SECTILIA*

As far as wall veneers are concerned, evidence is even scarcer. The lack of extensive remains of the revetments, systematically stripped, was already raised by Guattani for the area of the lower peristyle[46].

In most cases, the only indication of the existence of these veneers is provided by the holes for the clamps or the imprints of the slabs in the mortar bedding. Although useful for reconstructing the decorative schemes, generally consisting of larger panels framed by narrow bands or fillets in chromatic contrast between them – as has been reconstructed for the area of the lower peristyle[47] –, they do not provide any information on the nature of the marbles used.

There are, however, some exceptions, among which the most impressive are located in the lower level of the Domus Augustana. Along the walls of Nymphaeum 339, the baseboard of rectangular slabs of Cipollino (fig. 7 a) with a disposition »a macchia aperta« is well preserved, as well as the revetments of the basin made of Thasian marble[48].

Stairway 328 has a baseboard of Portasanta with a *cyma reversa* moulding of the same kind of marble; rectangular panels of Pavonazzetto and Portasanta frame larger panels of Portasanta[49].

In both cases, extensive brains of the mortar bed with the imprints of the slabs also remain. The case of the Nymphaeum 339 is particularly outstanding (fig. 7 b). The mortar preparation layer shows that the middle zone of the walls was meant to have larger and smaller alternating rectangular panels, while the upper part likely had elongated rectangular panels alternating with pilasters.

A few remains of wall revetments are also found in the Domus Flavia. Along the back wall of the northern and western wings of the peristyle (515), two segments of the baseboard in Giallo antico with a *cyma recta* moulding of the same marble are still preserved. Nothing is left of the upper zone, except for a portion of the bedding layer. However, the arrangement of the clamp holes suggests the alternation of wide and narrow rectangular panels[50].

46 Guattani 1785, 86: »[...] Non si può accertare cosa stesse ne' fondi de' molti riquadri che vi sono; [...] se quando infiniti pezzi, e frantumi delle cornici si rinvennero qua, e là caduti, ed altri attaccati al loro sito ancora, neppur uno vi fu trovato de' suddetti specchi, o riquadri [...].«

47 Fogagnolo 2009a; Fogagnolo 2009b, 280; Bitterer 2012.

48 Fogagnolo 2009a, 491–493 figs. 8–10; Fogagnolo 2009b, fig. 3.

49 Fogagnolo 2009a, 491 fig. 6; Fogagnolo 2009b, 280. A similar pattern is used for Stairway 338 of the lower peristyle, see Fogagnolo 2009a, 491 figs. 3–5; Fogagnolo 2009b, fig. 4.

50 Bruto – Vannicola 1990, 343 figs. 15–17.

In the Triclinium, the baseboard consisting of rectangular slabs of Giallo antico and some fragments of the upper *cyma recta* moulding made of Pavonazzetto are still preserved along the apse and the western wall[51].

It is also expected that a baseboard made of Pavonazzetto was present inside the Aula Regia, as indicated by few fragments of slabs.

F. Caprioli – A. Mortera

THE COLOURED MARBLES OF THE IMPERIAL PALACE: ARCHITECTURAL ELEMENTS

Coloured marbles were also employed for various architectural elements, particularly column and pilaster shafts, bases, capitals and entablatures.

Specimens in Africano, Giallo antico, Pavonazzetto and Rosso antico are known: these are not only smooth architectural elements, mostly architraves and tiny cornices; some of them are characterised by decorated mouldings. Among these, it is worth mentioning a fine cornice in Africano and an architrave in Giallo antico, in which the chiselled decorative details fit well with the colour and nuances of the marble[52].

The use of polychrome marbles for architectural members was already noticed during the excavations of the 18th century, for example in rooms 304–306 of the lower peristyle. As noted by Guattani, Pavonazzetto was predominantly used for the architectural order, while capitals and the friezes were carved in Giallo antico; for architraves and cornices Rosso antico was used[53].

Some of these architectural elements are still preserved in the area, including a large fragment of a cornice in Rosso antico. Other specimens are part of the permanent exhibition of the Palatine Museum (capitals, pilaster shafts) or are stored within the warehouses of the Parco Archeologico del Colosseo[54].

Another significant aspect regarding the polychromy of the Domitian palace is represented by the use of coloured stones for column and pilaster shafts[55], the number of which, according to Statius, was remarkable[56]. As a matter of fact, façades, pathways and also interior spaces were meant to be monumentalised by colonnades, many of which featured coloured shafts.

A prime example is provided by the three peristyles of the palace, which usually had two superimposed architectural orders whose fluted column shafts combined several colours, as in the *scaenae frons* of the theatres. In the peristyle of the Domus Flavia Pavonazzetto and Portasanta were employed[57], while the open court of the upper level of the Domus Augustana was characterised by a combination of Pavonazzetto and Giallo antico[58]. The travertine pillars with attached semicolumns of the first architectural order of the lower peristyle had a white marble cladding, while the second order likely had alternating column shafts of Cipollino and Portasanta[59].

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51 Gibson – DeLaine – Claridge 1994, 72. 93 (skirtings) figs. 1–3.

52 The Africano cornice was shown for the first time in the exhibition »Domiziano imperatore: odio e amore«, at Musei Capitolini (2022–2023), see Alteri 2023, 33 fig. 4.

53 Guattani 1785, 86: »Tutto il composto quindi dell'ordine era lavorato in marmo paonazzetto, esclusi i capitelli di giallo, la cornice, ed architrave di rosso, ed il fregio parimente di giallo […].«

54 von Hesberg 2004, 69–72; Coarelli 2009, 498. 500–503 (K. Iara). 112 (S. Fogagnolo); Fogagnolo 2009b, 281; Gasparri – Tomei 2014, 218–221 (K. Iara).

55 Pensabene – Caprioli 2020, 185–193.

56 Stat. silv. 4, 2, 18–20: *Tectum augustum, ingens, non centum insigne columnis, / sed quantae superos caelumque Atlante remisso / sustentare queant*.

57 Gibson – DeLaine – Claridge 1994, 87–90. 94 (frg. IV–IX); Pensabene – Caprioli 2020, 186 f. fig. 24.

58 Bartoli 1929, 19.

59 Caprioli et al. 2023, 301–303 figs. 6. 9.

The Triclinium of the Domus Flavia provides another very interesting case. While the entrance was probably monumentalised by six column shafts of Pavonazzetto[60], for the first inner architectural order, since the time of Domitian, 16 unfluted monolithic shafts made of Granito grigio del foro were used (fig. 8)[61]. This therefore represents the earliest extensive use for large column shafts of this particular type of granite, which would later become widely used during the reigns of Trajan and Hadrian (such as in the Forum of Trajan, the Pantheon, the Temple of Venus and Roma). Indeed, it would be problematic to consider the introduction of these shafts at a later stage – for example during the restoration of this hall by Hadrian –, especially due to the difficulties involved in their passage and handling inside the palace[62], which was completely built at that time.

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8 Imperial Palace, Triclinium of the Domus Flavia. Fragment of a smooth column shaft of Granito grigio del foro (photo: A. Mortera, published with the permission of the Ministero della Cultura – Parco archeologico del Colosseo)

CONCLUSIONS

Given the nature of the context, the abundance of white and coloured marbles used for the revetments and the architectural elements of the Imperial Palace is not surprising. Such polychromy, in fact, represents a fundamental aspect of the ›architectural language‹ of the Domitian complex.

The case study of the lower peristyle, the scarce remains of the veneers and the architectural elements reveal how the colour combinations used in the Palatine residence are quite common, with a prevalence of Giallo antico and Pavonazzetto. A colour scheme mostly inherited from the Domus Transitoria and the Domus Aurea also emerges, with the addition of some new types, also including some ›rare‹ marbles such as some qualities of alabaster, granite and quartzite.

Along with the architecture and its decorative elements, the colour of marbles serves as a valid instrument to outline the nature of the various spaces within the palace. In this sense, it can be argued that the function of individual spaces played a significant role in the selection of marbles during the design phases, thus outlining a sort of ›specialisation‹. Both spaces characterised by being more frequented (peristyles, corridors) and rooms of secondary importance mostly had simple pavements consisting of rectangular slabs, where aesthetics relied solely on the qualities of the marbles used (one or at least two). A notable exception has been identified in a small room next to the Palatine Museum, with a disc made of triangular *sectilia* at its centre. By contrast, the wide reception halls of the Domus Flavia associated with important ceremonial functions (Aula Regia,

60 Gibson – DeLaine – Claridge 1994, 86. 94 (frg. VI); Pensabene – Caprioli 2020, 187.
61 Gibson – DeLaine – Claridge 1994, 81. 83. 94 (frg. I); Pensabene – Caprioli 2020, 187.
62 On the itinerary that such shafts have to follow inside Rome, see Pensabene – Domingo 2016.

Basilica, Triclinium) were embellished with *sectilia pavimenta* made from large slabs arranged in elaborated designs, which were combined with a rather exuberant architectural decoration.

A continuous dialogue between the colour of marbles and natural light also emerges, a concept with which ancient architects and painters were familiar[63]. Recent studies have highlighted the significant role played by the light in the selection and combination of various marbles in Roman architecture[64]. With the help of light, marble veneers contributed to creating a sense of expanded space, almost transcending the physical boundaries imposed by solid walls. White and lighter marbles, such as Giallo antico and Pavonazzetto, were commonly employed in the courtyards of the peristyles. White marble, especially Thasian, and Cipollino, were often associated with water, as in the fountain basins and nymphaea of the palace. In this case, the light colours of the marbles, along with the sunlight reflecting on the water, must have contributed to illuminating the numerous rooms overlooking the peristyles. Otherwise, marbles could also be used in contrast with light, as in the case of Room 501 and Room 567 of the Domus Augustana, both characterised by the use of dark marbles. This specific choice can only be explained by the presence of large amounts of direct light, ensured by the presence of large windows overlooking the stadium.

Around the 3rd–4th centuries AD, some late restorations partially altered the chromatic appearance given to the palace at the time of Domitian. This is evident in the case of the Triclinium and the peristyle of the Domus Flavia, where new floors made of reused slabs of different marbles were prepared. By contrast, in other sections of the palace such as the area of the vestibulum and the lower peristyle[65], large portions of the wall revetments were replaced with paintings.

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63 Plin. nat. 35, 29: *Tandem se ars ipsa distinxit et invenit lumen atque umbras, differentia colorum alterna vice sese excitante. Postea deinde adiectus est splendor, alius hic quam lumen. Quod inter haec et umbras esset, appellarunt tonon, commissuras vero colorum et transitus harmogen*.

64 Grüner 2017.

65 Cf. Fogagnolo 2009a, 490 n. 11; Fogagnolo 2009b, 281; Caprioli et al. 2023, 306.

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FOSSILIFEROUS STONES AND FOSSILS AND THEIR GLASS SKEUOMORPHS IN ANTIQUITY

Abstract
This work looks into the imitation of fossiliferous ornamental rocks and fossils in bicolour and polychrome glass. This depositional group makes up one of the most solid sets, with unique features and characteristics, which enabled the widespread artistic production of glass, especially during the reigns of emperors from Tiberius through to Nero (ca. AD 20–68). The underlying message conveyed by many of these objects is the search for protection, a permanent and deep-rooted need in the ancient world. This message usually derives from the nature of the precious stones and other organic matter considered as precious stones. Glass was considered a similar substance to these and served a comparable purpose due to its particular properties. At the foundation of this belief was the assumption that the intrinsic characteristics of the aforementioned materials (colour, pattern, shape) helped parasympathetic magic, as archaeology has revealed and antique literary sources have confirmed. This article explores this multifarious phenomenon and examines the chromatic variations and imitated forms, paying special attention to the cases of Hispania in the context of imitations of ornamental rocks.

INTRODUCTION

This paper is the result of a long and comprehensive analysis of glass skeuomorphs of ornamental and precious stones in antiquity, examining their background and duration. The group of fossiliferous ornamental rocks constitutes one of the most solid groups, with peculiar traits and characteristics which fostered widespread artistic glass production. Fossils that were traditionally compared with counterparts in this type of material were limited to monochrome varieties, such as amber and jet, which were worked on like gems. The decorative genesis of the bichrome/polychrome varieties appears as a relevant contribution to the typology and to the understanding of designs that are constructed from the archaeological findings and the analysis of fossils which are documented in ancient literary sources.

Cryptopalaeontology, which is a complementary contribution to palaeontology, tries to identify the possible known fossils from ancient times, their origin and their interpretation as elements integrated in nature[1]. In this regard, the contributions of E. Liñán are of a great documentary and scientific value, and they are a reliable bibliographical basis for this archaeological study, still in its beginnings, which delves into their use and social application. Here we will try to provide a general presentation, with a significant sample of fossiliferous rocks and fossils and their skeuomorphs in glass, that goes beyond the corresponding and previous identification and classification methodology. We shall adhere to other parallel overviews, such as those developed for clay and faience in funerary contexts, something that exposes the permeability of ›nature‹ in ›culture‹ and its imitation in a wide range of materials[2].

1 Liñán 2004, 183.
2 Bruck – Jones 2018, 253.

ROCKS – FOSSILS/SKEUOMORPHIC GLASSES

We will distinguish, on the one hand, chemical fossils or degraded organic matter products, that come from past living beings preserved as organic rocks by their fossilisation, and on the other hand, mineralised skeletons that were a portion of the body of the living organism which they came from (body fossils)[3]. In turn, among the archaeological findings, it is possible to differentiate between individual fossils and fossiliferous rocks, both of which may be modified. It is also necessary to consider that the presence of unaltered fossils in archaeological contexts is not always accidental. The reasons behind them are manifold, just as for architectural creations or monuments: the composition of funerary deposits[4], the use for personal adornment[5], the desire to collect, etc. Knowledge of their existence and artificial transformations of specimens have been well documented since Palaeolithic times[6], entering into an ever more complex dialogue with man. The mere gathering (ecofacts) was followed, in certain cases, by a functional use without the need to apply invasive actions (anthropocrinus stone)[7]. More frequently, there were simple interventions such as perforations or different degrees of elaboration to form objects (artefacts) and even manipulation to turn them into active ingredients of preparations or pseudo medicines. Pliny wrote about stones that surely refer to fossils, a list that has been compiled and identified by Liñán[8]. They were marketed by the Romans, and there is no doubt about the use of some specimens during the reign of Augustus. They received many varied names, some of them depending on the dominant colour, which could be that of the background or that of the fossils themselves, such as Lumachella nera or Occhio di pavone bianco[9].

In ancient times, glass was ideal for making precious and ornamental stone *similes*. Although it was a substance made by man, its components connected it with the natural environment, and in many respects, it behaved like rocks, together with economic and artisanal factors that made it especially suitable.

Combinations of designs are present in the fossil stones and glass, in the former structurally and in the latter prioritising decoration. Various decorations lead us to these patterns in the technological approach to glass. Skeuomorphism can be fully developed, with an irrefutable degree of accuracy, or it can be partially developed. Sometimes, the imitations in this group do not refer to any specific model, but rather to a generic one, which allows for an extremely varied background colour and the presence of fossils or shells, giving rise to numerous interpretations of segments and elongated or rounded elements which can be closed or open, depending on the creative freedom of the craftsman. The combined compositions, from a selection of fossil forms, is another argument that would support these identifications. A similar process can be seen in some imitations of ornamental rocks in wall paintings, in which rocks which are locally or regionally known are represented, but in a very free manner[10]. Considering the chromatic variety, it is possible to distinguish two large groups in relation to stones and glass.

Monochrome Patterns

Although the focus is not placed on these now, deserving monographic investigations, it is appropriate to mention them from a methodological point of view. The optimal glass manufacturing methods applied to match the colours and qualities that define them have made their

3 Carrasco et al. 2013, 116.
4 Bruck – Jones 2018, 255.
5 Liñán 2005a, 124.
6 Liñán 2004, 184.
7 Liñán 2005a, 124.
8 Liñán 2005b.
9 Gnoli 1988, 200–214; Di Leo 1989, 82–84.
10 Cisneros – Ortiz – Paz 2013, 287.

visual cataloguing easier. Among the group of mineraloids, it is possible to highlight two representative classes:

Amber/Skeuomorphs in Glass

Pliny dedicates an extensive space to amber in his »Natural History«[11]. The disparity of beliefs about its origin stands out, having checked numerous sources, and it being mistaken for different current tree resins when extracted and hardened. Its use in objects for personal adornment was dominant (fig. 1, 1), although small containers and objects were also made, such as those retrieved from the Sarcophagus of the Grottarossa mummy, kept in the Palazzo Massimo alle Terme (Rome) or the Aquileia complex[12]. The identification of ochre-yellow-toned glass with amber may be chronologically incorrect (fig. 1, 2), as it is known that in Roman times the preferred colour was red[13]; chromatic tastes varied according to the periods, and there were procedures used to correct the colour[14]. Perhaps for the ›amber‹ tones, the similarities could be found in gold, although the image we have of this is not exactly the same as the original.

Jet/Skeuomorphs in Glass

Jet (or Gagates' stone)[15] was cut as a gem. Some models intensify the connection with fossils and they establish direct and unchallengeable links with these. We refer to trilobites (*trilobita* = three lobes), extinct arthropods that inhabited marine rocks during the Palaeozoic era[16] (fig. 1, 3). The Lapis Cantharias[17], cantharus, derives from the Greek κάνθαρος, beetle, and may correspond to trilobites. Fossil beetles are rare and delicate as they are preserved as thin carbon films[18]. They are usually found in deposits formed in old lakes (»Konservatlagerstätten«). Some pelagic trilobites such as the agnostoids (exclusive to the Cambrian and Ordovician periods), which are very common in the Mediterranean, are very similar to beetles[19].

The verification of the record of beads known as »Trilobitenperlen«[20] is very revealing and of key importance in the research on fossils versus jet and glass. The parallel ribs are similar in the jet and glass beads (fig. 1, 5), and markers have been defined to discriminate between them without having to resort to analytical systems[21]. In jet they were carved, while in glass they were obtained using moulds or stamping and were rarely engraved. Lignite, obsidian, and black jade were also passed off as jet. The association of the raw material with the carving of trilobites would strengthen the apotropaic belief in the mineraloid. A bead from Tarazona (Zaragoza, Spain), recorded as jet[22] (fig. 1, 4), could really be moulded glass, based on a visual observation in the photograph.

Furthermore, opaque black glass is compared to obsidian, which on first impression does not differ from jet[23]. This results in a functional differentiation that, broadly speaking, chronologically

11 Plin. nat. 37, 30–51.
12 Calvi 2005.
13 Plin. nat. 37, 47.
14 Isid. orig. 16, 8–9.
15 Liñán 2005a, 125.
16 Liñán 2005a, 122 f.
17 Plin. nat. 37, 187.
18 Fernández Fernández et al. (in print) compile the examples of trilobites documented in the archaeological record to contextualise the finding of a trilobite at the Armea site (Allariz, Orense, Spain). The specimen was possibly worn as part of a necklace or bracelet. It is dated to between the 1st and 3rd cent. AD. Researchers consider it plausible that this trilobite was perceived as possessing magical and protective powers by its owner.
19 Liñán 2005b, 224.
20 Haevernick 1974; Cosyns 2012, 28–30.
21 Cosyns 2012, tab. 8.
22 García 2003, 186 f.
23 Cosyns 2012, XV.



1 1: Necklace. Glass and amber, 6th century AD. Museo Arqueológico Nacional, inv. 1955/51/1369 (photo: P. E. Suárez). 2: ›Amber‹ glass, handle support fragment. Probably of an Isings 15. AD 68–70. Museo de Zaragoza, inv. 58261 (photo: J. Garrido). 3: Fossil, trilobite. 6 × 9.5 × 4.5 cm. Morocco. Devonian. Museo Ciencias Naturales, University of Zaragoza, MPZ 2014/393 (after <https://patrimoniocultural.unizar.es/node/3384> [16.03.2016]). 4: »Trilobitenperle«, bead. Jet/black glass. 1.8 cm (from García 2003, 187, photo: J. Garrido). 5: »Trilobitenperle«, bead. Black glass (after Dévai 2015, 110 fig. 8 [detail], photo: D. Bartus)

leans towards the Julio-Claudian period for the first and towards the advanced 4th century for the second. The small and simple design of the objects, the findings of black glass lumps and their historical contexts point to the standardisation of local productions in secondary workshops[24]. By preference, the obsidian manufactures were used for tableware and the jet ones for ornaments[25].

24 Ortiz 2001, 267. 400 f. figs. 120, 3; 121.
25 Cisneros – Ortiz – Paz 2023, 23.

Bichrome/Polychrome Patterns

The common feature of this set is the two-dimensional and/or three-dimensional ornamentation. For glass, we will present three groups with differentiated manufacturing techniques.

Mosaic Glass

This is a defined group with a great creative diversity. The manufacturing technique is simultaneously formative and decorative[26]. Within this group, one of the classes would be marbled glass, to which different types would correspond, mainly types such as fossiliferous limestones (*lumachelles*) or »turkey eyes«, »partridge eyes« (the »œil-de-perdrix« has also been a ceramic specialty from Sèvres since 1740), spirals and corals.

Eyed

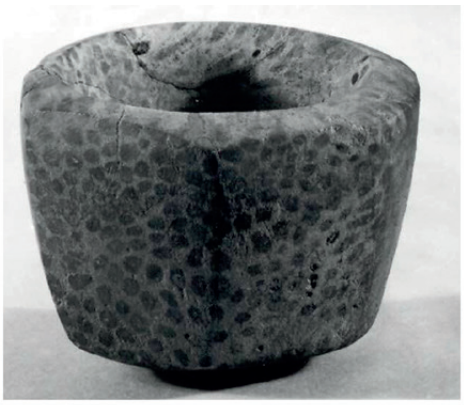
In some stones the ›eyes‹ appear isolated in their gangue and in others, in a massive rock, being frequent shapes in nature. The most well-known ones, the porphyroids, have a glandular structure. There are sedimentary ones called bird eyes. Curly limestone also has a glandular structure when, during diagenesis, the thin carbonate bodies are strangled and form eye-shaped cavities as they weather[27]. The motive lying behind the choice of stones »that contained eyes« would probably be to protect against the evil eye, in which the multiplication of the patterns would be a factor which was considered to increase effectiveness[28].

One of the first decorations created by glassmakers, it originated in Mesopotamia and Egypt. The structure and technique of the beads have been modified since Egyptian times[29]. The oldest examples of containers can be found in Assur, dating from the 13th century BC[30]. It was rapidly assimilated by the Phoenician and Greek cultures, with the findings of the Antikythera wreck[31] being very representative. Tableware is well represented between the late Hellenistic period and the first half of the 1st century AD. Its relevance during the reigns of emperors from Tiberius to Nero (ca. AD 20–68) is demonstrated by a compact hereditary evidence along with continuity over time due to the apotropaic symbolism attributed to it, which has survived with very little interruption to the present day, albeit with varying prevailing popular connotations. Transfer of this decoration from beads to containers[32] relates to the ornamental value of these motifs. Their passage to containers must have seemed a logical transition, using schematic designs similar to those of votive offerings[33].

A prominent subtype has to do with coralline structure. The best example is a small container (5.41 cm) made of fossil coral, ca. 9th century BC, which comes from Hasanlu (Iran) (The Metropolitan Museum of Art, New York) (fig. 2, 1) and evidences the knowledge and craftsmanship man has had of this rock since archaic times, with a functional use which went beyond the decorative one.

Mythology links Medusa and corals due to their alleged petrifying capacities[34]: »[...] in corals the same nature remained [...].«[35]; although for Pliny, coral »[...] was called like that because it is

26 Grose 1989.
27 Liñán 2005b, 230 f.
28 Ortiz – Paz 2020, 226.
29 Eisen 1916.
30 Sternini 1995, 14. 17 fig. 8.
31 Weinberg et al. 1965.
32 Typological compendium in Ruano 1996, 40.
33 Ortiz – Paz 2020, 222–226.
34 Liñán – Liñán 2006, 14 f. fig. 15.
35 Ov. met. 4, 732–752.



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2 1: Bowl. Fossil coral. 5.6 × 7.7 × 7.7 cm. The Metropolitan Museum, inv. 60.20.55 (Creative Commons Zero license, CC0. 1.0). 2: Roman mosaic with detail of Medusa in emblem. Museo Arqueológico Nacional, inv. 3618 (photo: J. Barea). 3: Coral skeuomorph. Glass, fragment, dish, Isings 18. Exterior. Trajanic period. Museo de Zaragoza, inv. 65933 (photo: J. Garrido). 4: Fossil, *Mollusca, Ammonoidea*. 7.5 × 15.5 × 4.5 cm. Aragón. Upper Jurassic. Museo de Ciencias Naturales, University of Zaragoza, MPZ 2771 (after <https://patrimoniocultural.unizar.es/node/3329> [16.03.2016]). 5: Head of Zeus Amon. Marble. 49.8 × 34 × 29.8 cm. The Metropolitan Museum of Art, inv. 2012.22 (Metropolitan Museum of Art, CC0 1.0 Universal [CC0 1.0] Public Domain Dedication). 6: Hemispherical bowl of ›network‹ mosaic glass. Hellenistic, ca. 150 BC. The British Museum, inv. 1896,0630.2 (The Trustees of the British Museum)

soft in the sea, and when touching air, it takes the hardness of the stone [...].«[36] The leitmotif in the iconography of Medusa falls on the perimetral hair/tentacles and the power of the eyes, although

[36] Plin. nat. 37, 164.



3 1: Lumacchellone antico. Corsi 231, Oxford University Museum of Natural History (after <http://www.oum.ox.ac.uk/corsi/stones/view/231/classi/corsi_231> [16.06.2022]). 2: Skeuomorph in glass. Bottom of a bowl. Isings 17. Museo de Zaragoza, inv. 45613 (photo: J. Garrido)

it underwent aesthetic modifications over time (fig. 2, 2). In glass, it leads us to an unprecedented classification of one of the most recognisable types in mosaic glass, which was mistakenly assimilated under »millefiori« (fig. 2, 3)[37].

Spirals

Ammonites[38] are among the most common fossils known, with numerous variants and sizes (fig. 2, 4). Pliny[39] connected the spiral fossil shells with the deity of Amun – referring to his horns as *ammonis cornua* – a divinity that would give them their name (fig. 2, 5). Some cast vessels known as so-called network-type glasses have a zenithal view that shows the same helicoidal development, with consecutive and sinuous ›septa‹, obtained thanks to the chromatic alternation and manufacturing process (fig. 2, 6). The predominant profiles (Isings 1) that favoured this decorative/formative adaptation were hemispherical[40].

Applied Glass

In this group, the unique spirals, wound around the piece itself, stand out. As its name implies, the intervention takes place at a later time in the formative phase, on top of any previous conformation process. The Lumacchellone antico type[41] (fig. 3, 1) presents obvious analogies with the Isings 17 blown ribbed vessels, which can generate unique spirals on the outer base (fig. 3, 2). The ductile glass threads were coiled around the object at intervals, leaving them in relief or crushed and embedded in it. This process, known as marbling (›marvering‹), was carried out while hot on a flat surface or ›marble‹, rolling the piece with the help of the rod or the pontil. Behind this choice is the relationship with the hypnotic wefts and drawings that redirect the observer's gaze (labyrinths, chequered shapes, moiré effects creating visual distortions, etc.) which are frequent in mosaics and usually reinforce the emblems of Medusa[42]. An ontological approach which analyses the cause-effect aspects leads to a coincidence of their aesthetic and prophylactic dimension.

37 Ortiz – Paz 2020, 226.
38 Historiographical summary in Sequeiros et al. 1998.
39 Plin. nat. 37, 167.
40 Technological description in Grose 1989, 35.
41 Cisneros – Ortiz – Paz 2013, 285–287 fig. 2 g–j; Cisneros – Revilla – Suau 2021, 217–221 figs. 12, 7, 18; 12, 11, 1.
42 Ortiz – Paz 2020, 227.

Moulded Glass

This production adds relief or three-dimensionality. It can appear in monochrome or bichrome/polychrome glass.

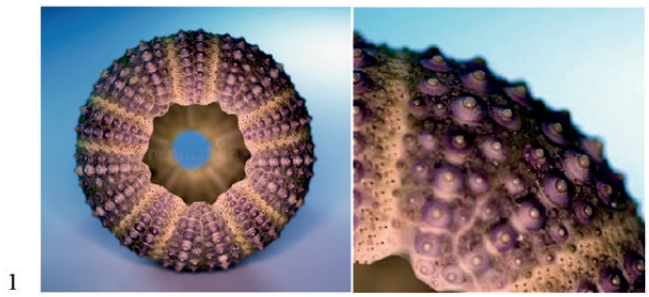
Ribs

The structure of the sea urchin exoskeleton (fig. 4, 1) defines a decorative pattern of radius in relief and bulges, with a spiral-shaped cross-section, which is reproduced in some ribbed glasses, to which chromatic similarities should be added. Echinoid fossils are the most common in archaeological sites in many parts of Europe and the Near East[43]. From Pliny's account, it can be concluded that the druids believed fossil sea urchins to be snake eggs and held them in high esteem; »[...] as large as an apple of moderate size; the shell [...] surrounded by numerous domes resembling the arms of the polyp [...].«[44] It was said that owning one ensured success in court or in battle and a favourable reception with princes, something which was denied by the Romans. This author mentions up to eleven remedies[45] and therapeutic uses of the sea urchin which were perpetuated through literary sources, highlighting the healing and antiseptic properties[46]. When describing them, he establishes a connection through similarity with glass: »[...]. They are not all the same vitreous colour; near Torone they are born white [...].«[47] Probably he was referring to the clear colour of Roman glass. It is significant that there are glasses that combine the ›pillar-moulded‹ or ›ribbed‹ profiles, echinoid *similes*, with white spirals on a purple base (fig. 4, 2–3) which were morphologically similar to the profile, the section of the bulges and the colour of certain sea urchins, resulting in an unknown classification. However, they may also be similar to fossiliferous rocks[48].

Marine fauna was a decorative niche and a reference source in the craft of glass-making, judging from the archaeological findings[49]. The distinctive exoskeleton or shell of sea urchins has radial thickenings similar to those of the shells of some molluscs and to that of pods that protect the seeds in certain plants, such as the opium poppy, which was widely present in the ancient world and the image of which was transferred to the ›melon‹ beads made in various materials[50]. The decorative transfer from the beads to the containers would have at the top of the hierarchy, indistinctly, poppy seeds in some cases[51] and sea urchin fossils and pecten in others, depending on the morphology, decorative design and different colours used.

In glass, the ribbed bowls (Isings 3a and Stern 1995, no. 14), deep bowls (Isings 3b and Stern 1995, no. 13) and beakers (Isings 17) can be obtained through different procedures[52]. The three main techniques were mould-pressing (Isings 3a and 3b), the blowing into the inside of a molten glass pellet[53] and the pinching of the glass in a ductile state with the use of tools (Isings 17). The name of the sea urchin was also the source for the place name of the city of Cimolus or Echinussa (from Echinus, now Kimolos) in the Greek islands, and it was the Hellenistic culture which produced the first glass ribbed vessels. That is to say, the animal world and nature in general offered solutions and lessons that were taken into consideration.

43 McNamara 2007, 292.
44 Plin. nat. 29, 12.
45 Plin. nat. 32, 20.
46 Carrasco 2013, 47–49.
47 Plin. nat. 9, 31, 100.
48 Cisneros – Ortiz – Paz 2013, 285 fig. 2 f.
49 Ortiz – Paz 2009, 195–198 fig. 12.
50 Ortiz – Paz 2020, 220 fig. 3.
51 Ortiz – Paz 2020, 219–221.
52 A general overview is provided in Paz 1998, 502 f.
53 Stern 1995, 111–113 nos. 13–14.



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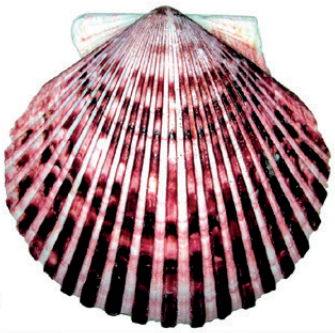
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4 1: Sea urchin exoskeleton, and detail (after <https://es.dreamstime.com/imagenes-de-archivo-simetr%C3%ADa-del-erizo-de-mar-image4549994> [19.09.2017]). 2: Fragment, deep bowl. Glass, Isings 3b. Neronian Period. Museo de Zaragoza, inv. 47622 (photo: J. Garrido). 3: Shallow bowl. Glass, Isings 3a. Dm 16.8 cm. Dorsal zenithal view (after <https://uk.linkedin.com/in/dr-chrissy-partheni-37909937> [08.03.2023]). 4: Fossil. Pecten (after <https://www.tesorosnaturales.com/en/fossils/other-fossils/ostraea-crassissima-288-457-detail> [12.02.2023]). 5: Polychrome glass. Ornament in the form of a shell, solid block. H 4.4 cm. 1st century AD. The Metropolitan Museum of Art, inv. 91.1.1512 (Metropolitan Museum of Art, CC0 1.0 Universal [CC0 1.0] Public Domain Dedication). 6: *Argopecten purpuratus*. Attribution (Creative Commons by 2.0, after <https://gl.wikipedia.org/wiki/Argopecten_purpuratus#/media/Ficheiro:Argopecten_purpuratus_(purple_scallop)_1.jpg> [10.02.2023]). 7: Fragment, shallow bowl. Glass, Isings 3a. Neronian Period. Museo de Zaragoza, inv. 58336 (photo: J. Garrido)

This morphology also directs us to ancient shields[54], for which the layout, arrangement and number of projections, which covered the entire convex surface, offered greater strength, resistance and functionality against blows from offensive weapons. The concept, on a smaller scale, has survived in the ribbed bowls made of various materials[55]. The original shape is found in Hallstatic types (Hallstatt Tomb 502) or in metal vessels from Hallstatt C. Other metal models, such as a bowl from Gordion and the Assyrian »Zungenphialen« from the 9th–8th centuries BC date at the beginning of this profile[56].

Grooves

The shells of various aquatic species are frequent in archaeological contexts, indicating a complete use. Their recycling as containers to hold and mix medicine, and in particular some cosmetics, is well documented[57], with mother-of-pearl lining being the main point of interest. Ostrites[58] refers to petrified oyster and by extension to fossil shells with which this stone was related. »Ostracites have the appearance of baked clay [...].«[59] Both names could refer to the same stone, but come from different sources[60]. The valves have constituted prototypes for some counterpoints, simultaneous works executed in different materials, including glass, a faithful copy only in the profile and not in the structural attributes of the original material[61]. However, there are also skeuomorphs such as a polychrome glass shell[62], dating from the 1st century AD, with the particularity that it is of solid glass (fig. 4, 5), an appearance which is very consistent with the fossilised ones (fig. 4, 4). There are also glass vessels (fig. 4, 7) which reproduce different types of valves (fig. 4, 6). In prehistoric and ancient times there was some confusion over living species that coexisted with their fossils, such as shells, corals, etc.

THE APOTROPAIC SYMBOLISM OF SOME FOSSIL DECORATIONS

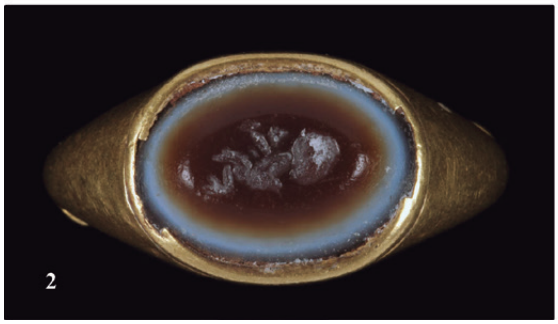
A common denominator in these findings is their apotropaic background, rooted in an environment in which man interacted with other humans, atmospheric elements and living organisms. Different types of stones and glass (fig. 5, 3) share a similarity with the ›eye‹ (fig. 5, 1), *similes* to agates, (fig. 5, 2) animal eyes or ocelli. Their shape and frequency reveal intentionality and they have been present in societies since olden times to protect against the evil eye. The assimilation of the prophylaxis against the evil eye between the 1st centuries BC and the 2nd century AD had a lot to do with the wealth generated by an expanding empire, which grew not only economically but also in customs, fashions, works of art, etc., broadening the social spectrum that made up the elite. This preventive attitude took root in a new scenario of conflicts between the *mos maiorum* and the prevailing social *luxus*, which extended throughout all the strata of the population, since the feeling of insecurity against envy was omnipresent[63].

Plates and drinking vessels decorated with ›eyes‹ and ocelli were used in their usual spatial environment, which was the triclinium, employed as a means to exercise what they believed to

54 Ortiz – Paz 2009, 204 f. fig. 17.
55 Luschey 1939, figs. 19–35.
56 Paz 1998, 503.
57 Pérez – Paz – Ortiz 1996, 653 f.
58 Ostrita, »Lapidario órfico«, v. 344–346.
59 Plin. nat. 36, 139.
60 Liñán 2005a, 121 f.
61 Beltrán – Ortiz – Paz 2007.
62 The Metropolitan Museum of Art, Accession no. 91.1.1512.
63 Alvar 2010, 263 f. 270 f.



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5 1: Mosaic. House of the Evil Eye. Antioch on the Orontes (Syria) (photo: W. Rieger, after <https://commons.wikimedia.org/wiki/File:Antiochia_-_House_of_the_Evil_Eye.jpg> [08.03.2023]). 2: Agate and gold. Ring. Dm 1.9 cm. 2nd century. Museo Arqueológico Nacional, inv. 52518 (photo: G. Cases Ortega). 3: Glass and bronze. Ring. Courtesy of National Museums Liverpool, World Museum, inv. 1973.4.192 (after <https://www.liverpoolmuseums.org.uk/artifact/finger-ring-80> [15.12.2023])

be the protection and efficacy of apotropaic symbols (with various sets, such as Isings 1 and 18; Isings 2 and 5; Isings 3a, 3b and 17)[64].

The process of transposition of magic and properties given to the stones passed on to their imitations in glass, as happens, for example, with amethyst or olivine[65]. Due to its peculiar properties, glass was considered a similar substance and served a comparable purpose. The intrinsic features of these materials (colour, pattern, shape) were considered to act in coexistence with parasympathetic magic, as archaeology reveals and ancient literary sources reflect. This feature in fossils with eyed designs reinforced the standard belief in the intrinsic power of stones as natural talismans.

64 Cisneros – Ortiz – Paz 2013, 285–287.

65 Price 2007, 239; Mastrocinque 2011, 64 f.

CONCLUSIONS

The interpretive sequence of these findings starts from the overview of stones that simulated animals and plants that must have awoken curiosity since ancient times. Exoticism also meant the objects belonged to the group of prestigious goods, articles of power and wealth[66]. Over time, supposed apotropaic properties would be added when they were used as ornaments, until they came to be seen as protective amulets and propitiatory talismans; it is even probable that some became cult objects. They are present in funerary environments and among the tools of shamans and sorcerers. A sample of their category is observed in their transmission as family heirlooms. None of the above excludes other added uses, such as construction materials, etc. The fact that one material takes the form of another is very similar to what happens with the formation of fossils, as moulds of beings that once were alive[67]. This fact affects their value as models, in existing pieces or in those transmitted through drawings in iconographic repertoires, etc., which the artisans would work with, in this case the glassmakers.

The original lack of information about the origin and formative processes of the fossils could explain why they came to be seen as creations of previous human communities and why attempts were made to replicate their characteristics. Cultural anthropology rescues practices which have been transmitted down generations, with the participation of temporal and spatial synergies. In this way, the fossil sea urchins were ›baptized‹ with the expression »stones of Catherine of Alexandria«[68], a port in which the pilgrimage routes began or ended.

Scientific ›breakthroughs‹ between additional areas of knowledge not only add to, but also give rise to new, emerging content. Undoubtedly, other decorations will be incorporated into the typographic catalogue that advance along this path of redirected research.

ACKNOWLEDGEMENTS

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66 Liñán 2004, 184.
67 Bruck – Jones 2018, 238. 253.
68 Tamayo 1659, 264.

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EUROMOS MARBLE (GRECO DISLOCATO)

CONSPICUOUS AND INCONSPICUOUS: COLUMN SHAFTS IN ITALY, CROATIA, CYPRUS, AND TYRE

Abstract
Marble with grey and white veins broken by ›steps‹, known in Rome as Greco dislocato, has recently been traced to its source at Euromos in Türkiye, and examples have been identified in some coastal cities of the Eastern Mediterranean, and central Italy. We have macroscopically identified additional column shafts at new sites in Cyprus, Lebanon, Croatia, Italy, and Sicily and have verified the provenance of several through laboratory analysis of stable isotopes of carbon and oxygen. These new identifications make it clear that Euromos marble/Greco dislocato had a significant presence throughout the Eastern Mediterranean and Italy, including the northern Adriatic Basin and Sicily, and that, perhaps because of its often unobtrusively stepped veins, it has often gone unrecognised in assemblages of grey-veined marbles.

SOURCE IDENTIFICATION, ANALYSIS, AND DIFFUSION OF GRECO DISLOCATO

Marble with grey and white veins broken by ›steps‹ has long been known in Rome as Greco dislocato, and it can often be identified confidently by eye[1]. Recently M. Bruno, D. Attanasio, W. Prochaska, and A. B. Yavuz have identified the source of the marble at Euromos near Iasos in Caria[2], and they have characterised it isotopically, in terms of maximum grain size, and electron paramagnetic resonance (EPR) characteristics. Marble from Euromos was previously not thought to have had a wide diffusion[3], but Bruno and colleagues have now identified it in coastal cities of southern Asia Minor, Palestine, Libya, Croatia and central Italy[4]. In our recent travels we have macroscopically identified additional examples at new sites in Cyprus, Lebanon, Italy, Sicily, and Croatia. In several of these cases, we have been able to take small samples and verify the provenance through laboratory analysis of stable isotopes of carbon and oxygen and by comparison with the database of Bruno and colleagues[5]. Our new identifications of Euromos marble make it clear that this material had a significant presence throughout the Eastern Mediterranean, Italy, and the northern Adriatic Basin. It should be noted that isotopically these column shafts could also be Greco scritto from Hasançavuslar, near Ephesos, but the stepped veins make the identification of Euromos marble unambiguous.

1 Pullen 1894, 46; Croscenzi 2015, 90. 195 fig. 78.
2 Croscenzi 2015; Bianchi – Attanasio – Prochaska 2018; Bruno et al. 2018.
3 Cramer 2004, 142–144.
4 Bianchi – Attanasio – Prochaska 2018; Bruno et al. 2018.
5 Bruno et al. 2018.

MACROSCOPICALLY CONSPICUOUS EXAMPLES

At times the ›stepping‹ of the veins of Euromos marble is very conspicuous. Even without laboratory analysis, it seems highly probable that a sculpture pedestal in the Palazzo Altemps in Rome is Greco dislocato (fig. 1). The parallel bands of sharply contrasting grey and white veins make the steps stand out clearly. There are so many steps that at first glance the cylindrical shaft, which is probably a repolished section of a column shaft, appears to be covered with small plaques of marble. The multitude of steps is comparable to that of a spectacular column shaft in Ss. Giovanni e Paolo in Rome[6] or another at the excavation office of Ostia[7]. Isotopic analysis of a tiny flake furthermore confirmed the origin of the marble as from Euromos (tab. 1; fig. 6). On the basis of the isotopes alone the pedestal could also be from Hasançavuslar, but the macroscopic evidence makes Euromos the obvious choice.

Another previously unnoticed example of Greco dislocato with conspicuously stepped banding is a fragmentary shaft in the semicircular entry courtyard of the Villa del Casale at Piazza Armerina (fig. 2 a)[8]. The dark veins on the grey and white bands make the breaks very evident, and the macroscopic identification is clear. Isotopic analysis of a tiny flake again supported the Euromos source, while the macroscopic evidence eliminates the Hasançavuslar option (tab. 1; fig. 6). On an optical basis, all the columns in the entry courtyard have been considered Bigio venato and attributed to Hippo Regius in Algeria[9], but this shaft makes it evident that the Bigio venato columns in the courtyard came from a variety of quarries. All the columns in the early 4th-century villa seem to have been taken from earlier structures and grouped according to their visual characteristics.



1 Pedestal for bust of Germanicus. Collezione Lazzarini, Palazzo Altemps, Rome. Euromos marble (tested) (photo: J. Herrmann)

MACROSCOPICALLY INCONSPICUOUS EXAMPLES OF EUROMOS MARBLE

Many striated column shafts have much less conspicuous stepping, but it is very likely that most, if not all come from Euromos. One shaft in the large peristyle at Piazza Armerina has parallel

6 Croscenzi 2015, 90. 195 fig. 78.
7 Bruno et al. 2018, 646 fig. 17.
8 Cf. a similar shaft of Euromos marble at Ephesos: Bruno et al. 2018, fig. 12.
9 Atienza Fuente – Gonzáles de Andrés 2019, 119–123.

Lab ID	Sample ID	$\delta^{13}C$ (VPDB)	$\delta^{18}O$ (VPDB)	Possible quarries (in order of preference
C2102065	Kourion Apollo	1.23	–5.97	Euromos, Hasançavuslar
C2102071	Kourion Apollo	1.18	–6.00	Euromos, Hasançavuslar
C210206	Minturno, Republican forum	1.33	–7.64	Euromos, Hasançavuslar
C2102070	Minturno, Republican forum	1.36	–7.66	Euromos, Hasançavuslar
230301 (JHGB030623)	Piazza Armerina, entry court, first column at left	1.96	–5.13	Euromos, Hasançavuslar
JHGB062023	Rome, Palazzo Altemps, Germanicus pedestal	1.05	–5.39	Euromos, Hasançavuslar

Table 1 Analysis of striated column shafts with stepping (Greco striato/Greco dislocato) by J. Cox



2 a: Piazza Armerina, Sicily, Villa del Casale, semicircular entrance. Greco dislocato from Euromos (tested). b: Piazza Armerina, Sicily, Villa del Casale, peristyle, north colonnade, 2nd shaft from the west. Greco dislocato from Euromos (macroscopic) (photos: J. Herrmann). c: Siracusa, Museo Regionale di Palazzo Bellomo. Greco dislocato from Euromos (macroscopic) (photo: A. van den Hoek)

striations with only a single conspicuous break[10], but this is probably enough to identify the shaft as the Carian marble (fig. 2 b)[11]. The upper half of another very inconspicuous example of stepped veining appears in the Palazzo Bellomo in Siracusa, where it supports a capital from S. Agata (fig. 2 c).

Isotopic analyses confirm that several other shafts with inconspicuous stepping are from Euromos. Many fragmentary column shafts of grey spotted and veined marble lie in the column deposit in the Republican forum of Minturnae, on the border between central and southern Italy. The shafts are thought to have largely come from the stage of the nearby theatre in its various phases. The shafts are in a variety of marbles, including Aswan granite, Portasanta and Cipollino, but most are classified under the heading »grey marble« (»marmo bigio«) with a few subvarieties (Bigio venato, Cipollino grigio)[12]. Some also seemed to be Bigio antico from Lesbos. One of the shafts at Minturnae, however, is an unobtrusive example of stepped veins; a single ›seam‹ cuts

10 It was not possible to approach the columns of the peristyle because of the system of elevated walkways.

11 Because of the elevated walkways through much of the villa, the columns of the peristyle could not be approached for close examination.

12 Mesolella 2012, 196. 526–534 fig. 77 pl. 22.



3 Minturno, Republican forum, column shaft of Greco dislocato. Marble from Euromos (tested) (photo: J. Herrmann)



a b

4 a: Kourion, Cyprus, Sanctuary of Apollo Hylates, column shaft of Euromos marble (tested). b: Kourion, Cyprus, agora, column shaft of Euromos marble (macroscopic) (photos: J. Herrmann)

across several grey and white parallel striated bands, and a sample proved it to be isotopically compatible with Euromos (fig. 3; tab. 1)[13].

A few column shafts with relatively unobtrusive stepped veins in the Eastern Mediterranean can be added to those identified by Bruno and colleagues[14]. Several shafts were seen in Cyprus. One was in the Sanctuary of Apollo Hylates near Kourion, which was renovated under Nero and/or Trajan (AD 98–117)[15] and isotopic testing confirms the identification as marble from Euromos (figs. 4 a; 6; tab. 1). Another example, which was not sampled, appears in the Roman agora of Kourion (fig. 4 b). It has very small steps, evident particularly at the lower end of the shaft. Its

13 Probably Mesolella 2012, 533 (M377) pl. 22 (Cipollino grigio).
14 Bruno et al. 2018.
15 Scranton 1967, 74; Karageorghis 2009, 39. 42.



a b

5 a: Tyre, Lebanon, hippodrome, column shaft of Euromos marble (macroscopic). b: Poreç, church, atrium, column shaft of Euromos marble (macroscopic) (photos: J. Herrmann)

veins also undulate in a way often seen in Euromos marble and that evokes Cipollino. The agora has a variety of different shafts, including Proconnesian marble and Cipollino and Cipollino grigio. The Corinthian capitals present a variety of Proconnesian typologies, but all seem to be more or less Severan. By analogy with the capitals, all the various columns in the agora could also be early 3rd-century work. In Paphos, several Euromos column shafts were reused in the church of the Chrysopolitissa.

Several more shafts with stepped veins were seen further east at Tyre in Lebanon, where they appeared in the hippodrome (fig. 5 a) and in the basilica.

Shafts with stepped veins appear in the atrium of the church at Poreç, Croatia (fig. 5 b). In this case, the shafts are a relatively uniform grey tone, and the steps are almost bends or undulations, but similar shafts in Türkiye have been proven to come from Euromos[16]. The Poreç shafts have an extra interest in that they are still in their original location in the mid-6th-century construction[17], and they carry impost capitals of mid-6th-century type. Their upper mouldings, moreover, are flat bands, an Early Byzantine type, rather than the torus and fillet typical of the 2nd and 3rd centuries. The shafts are apparently not reused older material but were quarried in the 6th century.

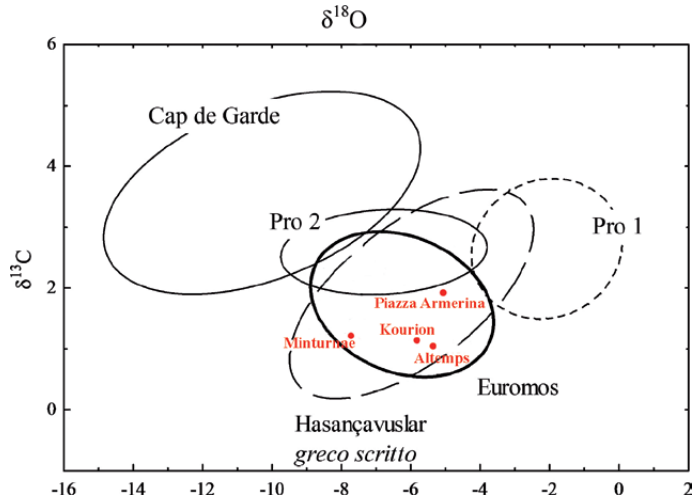
The church of Monte Sorbo near Rimini in northeastern Italy seems to present column shafts from Euromos mixed with very similar Greco scritto shafts. At least one column shaft with undulating, stepped veins was reused in the nave (fig. 7). Several short interruptions appear near the neck of the column in the published illustration by F. Antonelli and colleagues[18]. The authors have analysed all eight of the shafts in the nave of the church and tentatively identified them as Greco scritto from Hasançavuslar near Ephesos. The isotopic data they provide for this particular shaft (MS6) is compatible with Euromos as well as Hasançavuslar (fig. 8; tab. 2), but the stepping of the veins indicates that it is from Euromos. The other seven columns of the nave have similar veining, and slight stepping is visible in some photographs[19]. Two of the shafts, however, have

16 Bruno et al. 2018, 643 figs. 10. 15; tab. 1.

17 Prelog 1986, 10 pls. 3–5.

18 Antonelli et al. 2016, 14 fig. 3 f; tab. 2.

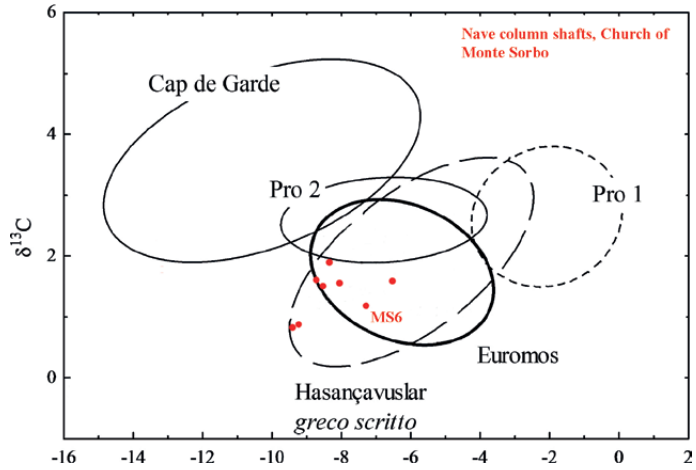
19 For additional illustrations of the shafts, see <https://www.tripadvisor.com/Attraction_Review-g1180040-d10768854-Reviews-Pieve_di_Monte_Sorbo-Mercato_Saraceno_Province_of_Forli_Cesena_Emilia_Romagna.html> and <https://www.flickr.com/photos/lorenz2007/3496992634> (02.04.2025).



6 Column shafts with ›stepped‹ veins: our isotopic data (after Bruno et al. 2018, fig. 8, graphics: J. Herrmann)



7 Monte Sorbo, church, column shaft MS6, nearest apse at left. Greco dislocato from Euromos (tested) (from Antonelli et al. 2015, fig. 3 f, photo: M. Mengozzi, Stilgraf of Cesena)



8 Isotopic ratios of Greco scritto/Cipollino grigio column shafts from the nave of the church of Monte Sorbo. Column shaft MS6 is marble from Euromos (isotopic data after Antonelli et al. 2015, diagram after Bruno et al. 2018, fig. 8, graphics: J. Herrmann)

Numbers after Antonelli et al. 2015	$\delta^{13}C$ (VPDB)	$\delta^{18}O$ (VPDB)
MS3	1.62	–6.42
MS4	0.90	–9.06
MS5	1.54	–8.06
*MS6	1.23	–7.32
MS7	0.85	–9.31
MS8	1.58	–8.87
MS9	1.53	–8.56
MS10	1.93	–8.43

Table 2 Monte Sorbo, church, streaked Roman column shafts reused in nave (data after Antonelli et al. 2015)

isotopic signatures compatible only with Hasançavuslar and not with Euromos (fig. 8; tab. 2). Apparently there is a mixture of Greco scritto/Cipollino grigio shafts from Hasançavuslar and Euromos in the Monte Sorbo church. These shafts were apparently chosen for their similar dark tones and interesting markings. Shaft MS6 and another shaft across the nave from it (MS10 [?]) are smaller than the other six shafts[20] and could be a separate group from Euromos. Hasançavuslar shafts are usually lighter and have dotted markings, but some quarry samples from Hasançavuslar have darker tones and densely convoluted patterns[21].

EXPORTATION OF BLOCKS?

Blocks intended to be cut up into plaques for paving and incrustation may also have been a minor export product from Euromos. Plaques of stepped marble are not common[22], but they were seen in the episcopal basilica at Kourion and in the early 6th-century archiepiscopal chapel in Ravenna.

CONCLUSIONS

This study adds new locations for Euromos marble in the northern Adriatic, Sicily, Cyprus and Tyre, and it makes clear that there were numerous markets for Euromos marble throughout the Mediterranean as far west as Rome. Macroscopic evidence (the stepped veins of the marble) makes identifications clear, even though its isotopic ratios usually coincide with those of Greco scritto from Hasançavuslar, Ephesos. The column shafts of Monte Sorbo, where both marbles seem to have been used, also indicate that the general appearance of the two marbles can be very similar. Previous study has shown the main period of production and distribution of Euromos marble seems to have been the 2nd century[23], but the example in the agora of Kourion is probably datable in the early 3rd century. Many Greco dislocato shafts, of course, were reused in later constructions. The shafts in the church at Poreç, with their late antique upper mouldings, however, show that the quarries were still in use – or else were revived – in the mid-6th century.

ACKNOWLEDGEMENTS

We are indebted to Matthias Bruno for introducing us to the Greco dislocato column shafts of Rome, and to Chiara Giobbe and the Museo Nazionale Romano, Palazzo Altemps.

20 Porta 2012, 193.
21 Attanasio et al. 2012, figs. 3 a (darker); 3 b; 8.
22 Bruno et al. 2018, 648.
23 Bruno et al. 2018, 643–645. 648.

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Agneta Freccero

REFLECTIONS ON WHITE MARBLES AT LABRAUNDA

CONSERVATION AND RESEARCH

Abstract
The marble conservation project initiated at the sanctuary at Labraunda in 2010 soon developed into a broader marble study. The main principles in conservation were to focus on inscriptions and architectural elements with delicate carving, and to avoid substances harmful for nature and human beings. The buildings at the site belong to three main phases; the 4th-century BC Hekatomnid period, the Roman period, and Late Antiquity. Different kinds of white marble were identified in the survey and conservation, which led to questions such as the marble's provenance and whether different qualities could be linked to epochs or to types of objects. Ancient written sources and research reports regarding marble identification, quarrying and trade were studied to identify quarry areas in the region that were known and approachable in the periods investigated, and excursions were made to ancient quarries in the area. A set of scientific methods were applied to a large number of samples at the Consiglio Nazionale delle Ricerche/Istituto di Scienze del Patrimonio Culturale (CNR/ISPC) in Florence. One result showed that different choices of marble were related to the period rather than to the type of object. Some questions, however, remain unsolved. The focus in this paper is on the Hekatomnid period.

INTRODUCTION: THE SITE

There is a modern road, narrow and zigzagging along the edges of the steep mountainside, which, in spite of the many scary turns, takes you to Labraunda. The sanctuary, with remnants of an old temple dedicated to Zeus with the double axe, is situated at almost 700 m asl, overlooking the valley of Milas, ancient Mylasa (fig. 1). Labraunda was known in antiquity as a sacred place for people in the region[1]. »Why is it that the statue of the Labrandean Zeus in Caria is fashioned holding an axe, but not a sceptre or a thunderbolt?« asks Plutarch, and explains how the mythic axe became connected with Labraunda[2]. But the site was holy long before that, with a sacred well below a split rock and a sanctuary to Kybele[3]. The site and its atmosphere are quite special.

Most of the standing structures visible today, including the broad staircases and huge terraces, were constructed in the 4th century BC as part of the extensive Hekatomnid building programme[4]. Hekatomnos, a local dynast appointed satrap of Caria by the Persian king in the

1 Herodotus (5, 119) speaks of the precinct of Zeus of the armies at Labraunda with a great and holy grove of plane trees; Strabo (14, 2, 23) mentions Labraunda as the place where Zeus was worshipped by people in the region; and Aelian (12, 30) speaks about the shrine of Zeus and the spring with transparent water.

2 Plut. mor. 45: »Because when Herakles had slain Hippolyte, together with her other arms he took her axe and gave it as a present to Omphale. The Lydian kings who succeeded Omphale used to carry it as part of the sacred regalia, handling it down one to the other until it came to Candaules. He deemed it of little worth and gave it to one of his companions to carry. But when Gyges revolted and was at war with Candaules, Arselis came from Mylasa with an army as an ally for Gyges and slew both Candaules and his companion and brought the axe to Caria together with the other spoils. He therefore constructed a statue of Zeus and placed the axe in his hand, and called the god Labrandeus; for the Lydians call the axe ›labrys‹.«

3 Baran 2011. On the Sanctuary of Kybele, see Karlsson 2013a, 298–300.

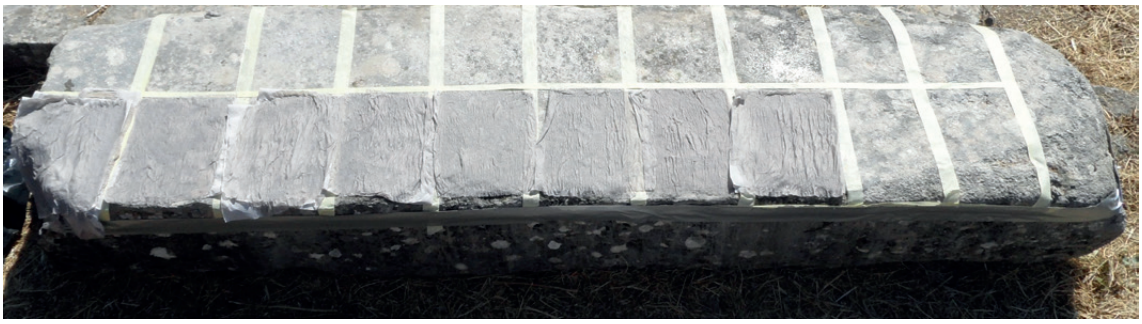
4 On the buildings at Labraunda, see e.g. Hellström – Thieme 1981; Hellström – Thieme 1982; Karlsson 2013b; Hellström – Blid 2019. On the monumental tomb, see Henry 2011; Henry 2014. For the inscriptions, see Crampa 1969; Crampa 1972.



1 The sanctuary seen from the split rock. View overlooking the valley (photo: A. Freccero)

early 4th century BC, may have initiated this architectural project, but the dedications were made by his sons and successors Maussollos and Idrieus. Recent research indicates that all Hekatomnid buildings were constructed as part of one extensive dynastic project and completed before the death of Artemisia, the wife and successor of Maussollos, maybe already by 353 BC[5]. A new style, in which ancient Anatolian, Persian and Hellenic ideology and power structures were combined, was created to manifest Hekatomnid royal power and legacy[6]. The style, which is attested in cities and sanctuaries in Western Anatolia and beyond, has been recognised as the Ionian renaissance[7]. Alexander's conquest of the region was the end of Hekatomnid supremacy, although he reinstated the last member of the family, Ada, to the throne[8]. In the Hellenistic period there was again some building activity, including the semicircular exedra consisting of a curved back wall and a low bench. Cuts in the stone on the top of the wall indicate where a series of bronze statues were placed. Among the edifices constructed or rebuilt in the Roman period (30 BC – AD 400) are two bath complexes[9]. Finally, in the Byzantine period, old edifices were reused and transformed into Christian churches[10].

5 Hellström 2011, 154 f.
6 Henry 2017, 22.
7 Waywell 1994; Carstens 2009, 22; Pedersen 2013. On Mylasa, see Rumscheid 2010, who suggests Uzun Yuva at Milas might have been intended as the rulers' tomb, the unfinished »proto-Mausolleion«.
8 Strab. 14, 2, 17.
9 On the Roman stoa, see Liljenstolpe – von Schmalensee 1996.
10 Blid 2012; Blid 2016.



2 Marble slab used for consolidation tests during the applications (photo: A. Freccero)



3 The result after four years (photo: A. Freccero)

THE CONSERVATION PROJECT

In 2009 I was asked by the former director of the excavation, Lars Karlsson, to suggest a conservation plan for the large quantity of architectural marbles brought to light during the excavations and now spread across the site. An overview in 2010 led to the conservation of the Ionic capital in Andron A and the selection of 33 items that were in great need of conservation. Conservation began in 2011 in collaboration with the Institute of Conservation at the University of Gothenburg[11].

All items are an integral part of the environment, standing in nature, in a climate changing from extreme heat in the summer to cold temperatures in winter. Even in the summer, there is a great difference between the heat at midday, which gradually becomes bearable by the afternoon with the breeze rising from the sea, followed by the freshness of the night. As nature and the climate cannot be controlled, the basic principle was to focus on cleaning, consolidation and maintenance, and to use substances that would not cause harm to the students' health or kill off the surrounding vegetation. Series of tests were undertaken to find suitable substances for cleaning and consolidation. Occasionally some stabilising interventions, such as the reattachment of broken pieces, were carried out as part of the conservation too.

Biological growth on the marbles was the most imminent problem. Analyses of the biodiversity were made, and various types of lichens, one type of moss and phototrophic microorganisms such as cyanobacteria and green algae were identified[12]. Therefore, a biocide was applied on selected objects the year before conservation interventions and each season began with a light cleaning[13].

11 Freccero 2013; Freccero 2014a; Freccero 2014b. All annual conservation reports are available in the archives at Labraunda.

12 Analyses carried out by Oana A. Cuzman, CNR/ISPC in Florence.

13 A Quats product, Grönfri, was used. Cleaning was undertaken with pine soap, Grönsåpa, in spring water.



4 Selection of marble samples, showing variations in grain sizes and hues (photo: A. Freccero)

Consolidation tests were carried out on a large slab. Five different products were tested, each of them in two concentrations and in two different modes – with or without wet tissue paper covered with a large plastic sheet to prolong the drying process[14]. The most efficient variant was diammonium phosphate covered with wet tissue paper[15]. This product had good cleaning properties as well. The long-term result was quite satisfactory (figs. 2–3).

RESEARCH

The determination of marbles used in Classical Greek, Hellenistic, and Roman sculpture has been part of many international projects aiming at identifying ancient quarries. As pointed out by Donato Attanasio, the identification of quarries is essential if we want to understand important issues such as the range of commercial relationships and the trade routes pursued in antiquity and to recognise technological distinctions and changing taste[16].

On my first visit to Labraunda, I took a few marble samples, which were analysed at CNR in Florence[17]. The results showed considerable differences, which prompted a proper sampling plan (fig. 4). Archaeologists at the site were asked to suggest architectural elements of importance for their studies, which led to the selection of fragments dated to the pre-Hekatomnid, Hekatomnid, Hellenistic, Roman and Byzantine periods[18]. The analytical methods *in situ* were

[14] The commercial products Bindzil CC301 and Bindzil CC401, a mixture of casein/lime, diammonium phosphate and calcium oxalate were tested.

[15] The product was equally efficient in both solutions, 25 g in 1 l or in 2 l water.

[16] Attanasio – Brilli – Ogle 2006, 13. On analytical methods on marble, including stable isotope analysis, see e.g. Walker – Matthews 1988; Attanasio 2003; Attanasio – Bruno – Prochaska 2011; Prochaska – Attanasio 2012.

[17] The samples were analysed in 2010 by Fabio Fratini.

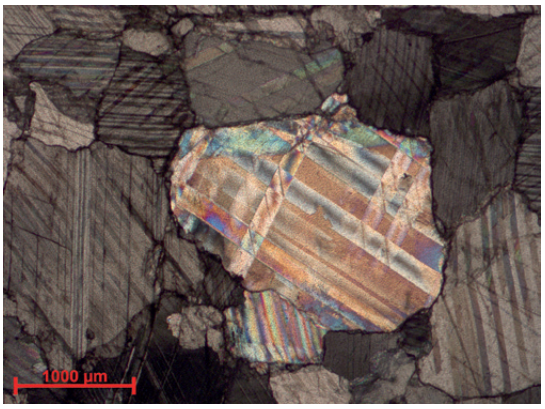
[18] Three samples from elements dated to the Pre-Hekatomnid period, 21 to the Hekatomnid, four to the Hellenistic, nine to the Roman and one object dated to the Byzantine period.

Period	Building	Architectural element	Sample	P/M group	Isotopic ID	Isotopic group
Pre-Hekatomnid	Built Tomb	Slab 3Y 13	LabBTomb	3	AF4	1 (Milas)
	Old Temple	Ovolo	LabTov	3	AF19	1 (Milas)
	Statue base	Inscribed base	LabHek	6		
Hekatomnid ca. 392–330 BC	Andron B	Architrave block	Lab C42	2		
	Andron A	Architrave block	LabA3	1		
	Andron A	Architrave block	LabA5	1		
	Andron A	Frieze	LabAF	1		
	First terrace	Unfluted column	LabCol	1		Herakleia (Herz)
	Doric house	Architrave block	LabDH	1	–	Herakleia (Herz)
	Oikoi	Architrave block	LabOikoi	1	–	2 (Herakleia)
	East Propylon	Architrave block	LabEProp	1	AF1	2 (Herakleia)
	South Propylon	Architrave block	LabSProp	1	AF2	–
	Temple of Zeus	Architrave block	LabTZeus	1	–	2 (Herakleia)
	Andron B	Anta block	LabBanta	1	AF6	2 (Herakleia)
	Andron A	Ionic capital	LabACap	1	AF9	2 (Herakleia)
	Doric house	Architrave block	LabDH2	1	AF17	2 (Herakleia)
	East Propylon	Tympanon	LabEProptym	1	AF18	2 (Herakleia)
	East Propylon	Anta block	LabEPropanta	1	AF11	2 (Herakleia)
	South Propylon	Architrave block	LabSProp2	1		
	Temple of Zeus	Architrave block	LabTZ1	1		
	Temple of Zeus	Architrave block	LabTZ2	1		
	Temple of Zeus	Architrave block	LabTZ3	1		
	North Stoa	Anta block	LabMau	1		
	Oikoi	Architrave block	LabOikoi2	1		
Hellenistic 330–27 BC	Exedra	Central block	LabEx	6		
	Propylon Y	Anta block	LabYanta	6	AF7	1 (Milas)
	Exedra	Base block	LabExbas	6	AF13	1 (Milas)
	Statue base	Inscribed base	LabAria	6		
Roman 30 BC – AD 400	North Stoa	Frieze/architrave	LabNstoa	5	AF8	1 (Milas)
	North Stoa	Corinthian capital 1	CorCap1	4	–	–
	North Stoa	Corinthian capital 2	CorCap2	4	–	–
	North Stoa	Corinthian capital 5	CorCap5	4	AF5	1 (Milas)
	Temple terrace	Column	LabTTCol	5	AF10	4 (Ephesos?)
	Temple terrace	Architrave	LabTTArch	4	AF15	3 (unknown)
	Temple terrace	Sima	LabTTSima	4	AF12	3 (unknown)
	Temple terrace	Architrave/frieze	LabTTC	5	AF16	1 (Milas)
	Propylon Y	Architrave	LabYarch	5	AF14	3 (unknown)
Byzantine	West Church	Ambo	LabAmbo	5	AF3	1 (Milas)
Undated	Temple terrace	Fragment	Labraunda white	1		
	Andron A terrace	Fragment	Labraunda grey	7		

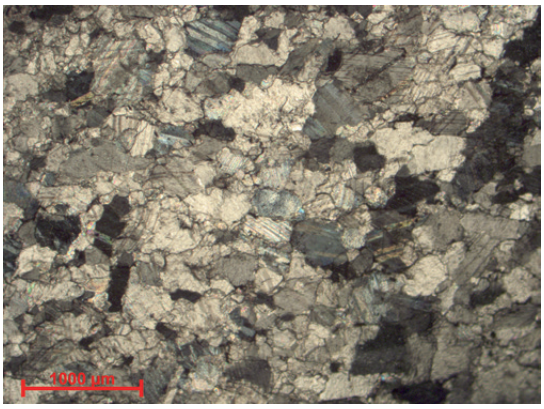
Table 1 P/M analyses undertaken by Emma Cantisani serve as the basis for the present marble groups. Isotopic analyses were carried out by Donato Attanasio, CNR-ISM, Rome. The two samples investigated by Norman Herz, University of Georgia, in 2006 are included in the table too

ocular examination and description of the object, followed by sampling, scrutiny under a magnifying glass, and later under a stereomicroscope. Photographic documentation of the object and the sampling area was next, and close-up photos of the samples were taken. Analyses of the first 38 samples were undertaken by Emma Cantisani in 2012, the results discussed and eight preliminary groups created, seven of marbles and one containing other stone types such as quartz and metabauxite (tab. 1).

Another 14 samples were selected for scrutiny in the following phase and the same set of analytical laboratory methods was used by Emma Cantisani and Silvia Vettori in 2016



5 Thin section of Sample EProp, in polarised optical microscopy. The coarse-grained marble is from East Propylon, dated to the Hekatomnid period (photo: E. Cantisani)



6 Thin section of Sample LabNStoa, in polarised optical microscopy. The fine-grained marble is from the North Stoa of the Roman period (photo: E. Cantisani)

(figs. 5–6)[19]. Isotopic analyses on a few important samples were carried out by Donato Attanasio at the Institute of Structure of Matter (ISM/CNR) in Rome[20]. The investigations led to the identification of some marbles, but in a few cases, the marble's origin still remains unknown.

MARBLE AND TRADE

It had been taken for granted that the Labraunda marbles were quarried on Sodradağ in the plain of Mylasa[21]. There were four main reasons for this hypothesis: the proximity of the site to Mylasa, Strabo's account on Mylasa and its white marble, the presence of a processional road from Mylasa to Labraunda, and the fact that ancient quarries on the mountain slope can still be seen from Milas[22].

Accepting that Milas marble was used at Labraunda is understandable. However, mountain routes had been laid out in Anatolia already in the middle of the 3rd millennium BC[23]. By the rise of the Hittite Kingdom in the 16th century BC, there were fortified administrative centres and

19 Cantisani's and Vettori's description of the preparation of the sample and methodologies applied at CNR/ISPC: »The samples received were all observed and photographed under a stereomicroscope. From all the samples were obtained powders for mineralogical analysis by X-ray diffraction and small fragments for the realization of thin sections for petrographic analysis by optical microscope polarizer. Thin sections of samples were documented and analyzed by optical microscopy in transmitted light. A polarized light microscope (Zeiss Axioscope A1) equipped with a camera (resolution 5 Megapixel) and dedicated image software (Axiovision) for evaluating the microstructural parameters (i.e. minimum and maximum diameter) was used. Powders obtained from each sample were analysed with a PANalytical diffractometer X'Pert PRO with radiation CuKα1 = 1,545Å, operating at 40 KV, 30 mA, investigated range 2θ 3-70°, equipped with X' Celerator multidetector and High Score data acquisition and interpretation software for determining the mineralogical composition.«

20 Pontus Hellström informed me in 2012 that isotopic analyses of one sample each from Andron A and Andron B had been carried out by Norman Herz in 2006. Herz considered the two slightly different marbles to be from Herakleia at Latmos, Bafa Gölu, which was considered unlikely. Herz's results were confirmed by Attanasio, who identified marble from Hekatomnid buildings as from Herakleia.

21 There is no marble quarry close to Labraunda. The local stone is gneiss.

22 Strab. 14, 2, 23. Strabo explains that Mylasa »has a most excellent quarry of white marble. Now this quarry is of no small advantage since it has stone in abundance and close at hand for building purposes and in particular for the building of temples and other public works. Accordingly, this city, as much as any other, is in every way beautifully adorned with porticoes and temples.«

23 On procession and transport routes in antiquity in the Near East/Asia Minor see e.g. Andrae 1941; Archibald 2016. On the Great Caravan Route between Cilicia and Troy, established in the early Bronze Age, see Efe 2007.

storehouses at regular distances[24]. A consistent traffic policy was developed by the Persian king in order to control the empire. This kind of interconnecting work continued as the Sacred Way, which started at the door of Mylasa, was paved with stone by the Hekatomnids. The road passing through Labraunda continued further to Alabanda and Alinda, while another road, passing by Euromos led directly from Mylasa to Herakleia[25]. Recent studies show that these roads are similar and therefore may have been constructed at the same time[26]. As the Hekatomnids had control over the territory on both sides of the mountain and there was a functional road system, the marble might have been transported from Herakleia, as well as from Mylasa, Euromos, Stratonikeia or from quarries even further away.

QUARRIES AND MARBLES

The marble at Labraunda was constantly described as coarse-grained, friable, weathered and white in excavation papers and literature[27]. It is a correct description of the marble type connected to buildings of the Hekatomnid period[28]. But there are other types of marble too, and these seemed to be related to later structures, which gave rise to questions such as whether a single quarry area could provide different qualities, or if marble came from other quarries too, and whether differences in marble quality could be related to the period in time. Another question regarded the transportation of large quantities of marble blocks. There were existing roads for transportation, and the Hekatomnids had the means and power to choose whatever they preferred, but it would still have been convenient to bring heavy goods from nearby quarries. Reports on the subject were studied and a proper plan for visiting quarries was laid out, followed by excursions, documentation of quarries and sampling spots. A short description and summary of the outcome of the studies is provided below, beginning with Milas.

Dario Monna and Patrizio Pensabene visited quarries in Asia Minor and analysed the marbles. At Milas they found two quarry areas on Sodradağ. The quarries were at a high level (565 m) on the northeast slope of the mountain and another area was south of the city along the road to Bodrum (ancient Halikarnassos). The marbles were, in brief, defined as fine-grained grey-black, grey, grey-veined or grey-white, and two samples from the south area were white (»chiaro«) with larger grains. Quarries at Milas situated at a high level above the city and difficult to reach are mentioned by Thomas Cramer, too[29]. He conclusively defined Milas marble as fine-grained, although occasionally some rocks had larger grains.

The marble I studied in the quarries at Sodradağ could be defined as fine-grained and in nuances from pale to dark grey, and there was no large-grained white marble. But on the other hand, a long time has passed since Strabo described the white marble close at hand. Milas is a rapidly growing city, and houses have been constructed at high levels on the mountain slope facing central Milas: if there once were quarries providing white marble at lower levels, those are no longer visible. The south quarry area mentioned by Monna and Pensabene can only be imagined through scattered marbles and a few remnants of lime kilns among waste materials and modern multi-storey buildings along the former road to Bodrum. But on the western slope of the mountain, there is an almost unexploited area with ancient quarries. Marble in the four old quarries I visited was

[24] Ökse 2007, 41.

[25] Westholm 1963, 10; Peschlow-Bindokat 1996, 43. Hellström mentions the paved road »on the other side of the mountain«, from Alinda to Alabanda, see Hellström 2009, 270.

[26] Baran 2011, 53.

[27] See e.g. Jeppesen 1955, 6; Westholm 1963, 11; Hellström – Thieme 1982, 17; Hornblower 1982, 7; Hellström 2007, 25; Hellström 2009, 270; Baran 2011, 52.

[28] Freccero 2015; Freccero 2016.

[29] Cramer 2004, 184. Cramer used a wide set of analytical methods to determine the petrographic, isotopic and geochemical properties of marbles in the Menderes massif.



7 Column of coarse-grained marble with a cluster of large crystals. The marble is from Herakleia at Latmos (photo: A. Freccero)

fine-grained and pure white; a beautiful marble but not of the same kind as used for the Hekatomnid buildings at Labraunda.

Monna and Pensabene mentioned quarries situated along the road from Milas to Bafa Gölu, before reaching the ancient site of Euromos[30]. These quarries, on the west side of the mountain, are visible from the road at approx. 12 km northwest of Milas[31]. Anneliese Peschlow-Bindokat found quarries east of the Temple of Zeus Lepsynos too, which presumably provided marble for the temple itself and for other monuments of Euromos[32]. The quarry area above the temple was explored by Cramer too, described as fine-grained and appearing in nuances from white to grey[33]. I found that the marble close to the road is mainly in nuances from pale to dark grey, but quarries on the slope east of the temple have white marble too.

Quarries at Stratonikeia were known to have provided marble for the Temple of Hecate at Lagina[34]. Cramer visited two areas in the district. One of these areas contains several old quarries with white marble and partially worked architectural elements. Some of them are at the level of the dirt road and others at higher levels[35]. When arriving at the top, you look down on a large modern quarry with white marble. Marble in these quarries is pure white, fine- to medium-grained.

Near Herakleia at Latmos, along the south shore of Lake Bafa, there are two quarry areas where marble has been extracted since at least the 6th century BC[36]. Peschlow-Bindokat studied this extensive area, which can be divided into two major districts: the eastern, which belonged to the ancient city of Latmos, and the western, that belonged to Miletos. These are now recognised as the Herakleia quarries and the Miletos quarries respectively[37]. The Herakleia quarries have a coarse-grained white stone, while Miletos marbles have finer grains and are rarely pure

30 Monna – Pensabene 1977, 117–124. On the northeast slope of Sodradağ, at 565 m (»Milas N«) and south of the city along the road to Bodrum (»Milas S«).
31 Monna – Pensabene 1977, 117.
32 Peschlow-Bindokat 1981, 211 f.
33 Cramer 2004, 142. In spite of these similarities, the Euromos marbles form a group of their own.
34 Strab. 14, 2, 25.
35 Cramer 2004, 152.
36 On the Miletos and Herakleia quarries, see Monna – Pensabene 1977, 124; Peschlow-Bindokat 1981.
37 Peschlow-Bindokat 1989, 69 f.

white[38]. Between them is an area where the marble is slightly finer than in the eastern quarries. In spite of petrological differences, the marbles have proved to be isotopically and spectroscopically quite similar, and can therefore be collectively identified as Herakleian marble[39]. These marbles have the same characteristics as the most common type at Labraunda: splendid white and coarse-grained with clusters of large crystals (fig. 7).

MARBLE: DECORATION AND STATUARY

Statues were found during the early Swedish excavations at Labraunda, among these some notable sculptures recorded in reports and on photos[40]. One of these is an almost complete male sphinx crowned by a polos which is now on display on a high pillar at the Archaeological Museum in Bodrum, the marble of which, at a distance, looks quite similar to the marble used in Hekatomnid buildings. The head of a second sphinx and fragments recorded as wings that were parts of a sphinx were found in the same context in 1960[41]. The two sphinxes have been interpreted as corner acroteria crowning Andron B, a building for ritual banquets dedicated by Maussollos[42]. Fragments of larger-than-life-sized statues of marble and bronze that were found inside the building, placed in niches in the rear wall, have been interpreted as parts of a statue of Zeus and figures representing members of the Hekatomnid family. It has been suggested that at least one monumental statue was placed in the large niche in the back wall, as on the Tegea relief, where Zeus with the double axe and pectoral decoration stands between Idrieus and Ada[43]. Among other finds was a male marble foot wearing a sandal and three fragments of animals, possibly lions and the head of an eagle[44].

Other fragmentary statues were found in connection with Andron A, a building constructed on a terrace at an even higher level, facing the Temple of Zeus[45]. Among the fragments were pieces of four apparently freestanding male and female life-sized marble figures, one of which had a general resemblance to a female at the mausoleum[46].

No statues remain at the site. The sculpture fragments excavated in 1948–1953 are scattered between the archaeological museums in Bodrum, Izmir and Milas. Only a limited number of fragments, most of which are architectural elements, are kept in the local storage, but there are cuts on the top side of many blocks which indicate where statues' feet were anchored, and that makes it possible to imagine how the site may have appeared.

Ann C. Gunter describes the eastern part of the temple terrace as a showplace for sculptures. The remaining statue bases have dateable inscriptions spanning from the early 4th century BC to the 2nd century AD[47]. Most statues were rather small, as the majority of the fragments belonged to less-than-life-sized parts of male and female statues in the round. Among the larger pieces was a statue, »Girl holding a goose«, now in the Archaeological Museum of Bodrum[48]. Cuts on the

38 Pensabene 2002, 214 f.

39 Attanasio – Brilli – Ogle 2006, 190.

40 Swedish excavations at Labraunda began in 1948 and were concluded in 1960. Fieldwork at the site started again in 1979, followed by new excavations. Since 2013, excavations and research have continued as an international project directed by Olivier Henry.

41 The sphinxes presumably fell from the roof of Andron B into the adjacent Andron C, a building dated to the Hellenistic period, which is situated on a lower terrace.

42 J. Blid in: Hellström – Blid 2019, 223. 232.

43 Waywell 1993.

44 Gunter 1995, 19. Only one of these, the head of an eagle, could be found for re-examination. Another object which could not be located was a fragment of a draped female torso, cat. 7.

45 Gunter 1995, cat. 4. 6. 9: fragments of marble sculptures from 18 separate monuments were found between 1948 and 1960.

46 Gunter 1995, 31 cat. 4.

47 Gunter 1989, 91.

48 Gunter 1995, cat. 5, »Girl with a goose«.

large base that remains at the site show that there was at least one more marble statue, of which no traces have been found.

Another large base with a decoration in relief shows a chariot and a figure interpreted as Nike[49]. Other particular finds were made in the *oikoi*, close to Andron A, where at least forty double meander frieze fragments with enclosed elements in relief such as ears, double axes and a shield were found. In her study of sculpted marbles, Gunter was able to distinguish between three types of marble differing in hardness, colour and grain size[50]. She dated most fragments of coarse-grained marble to the middle of the 4th century BC, one to the middle or late 4th century, and the fine-grained marble of the meander frieze was considered as Roman. However, due to inconsistencies in the documentation at early excavations, it has not been possible to find some objects registered at the time of excavation at a later date, as evidenced in the material study described below[51].

As mentioned above, there are stylistic and conceptual links between the decorations in Halikarnassos and the sanctuary at Labraunda; symbols such as sphinxes, lions, eagles, and chariots appear in both contexts.

NEW FINDS AND EARLY FRAGMENTS IN THE DEPOT

I wanted to understand whether or not the same kind of marble was used for architectural elements and for statuary in each specific period of time. As several sculpted fragments were found during the excavations of Andron A in 2015, such a study could indeed be undertaken, and four fragments were selected for study[52]. Two of these were tentatively interpreted as parts of a large palmetto leaf, possibly the crowning acroteria of the building; one was a fragment of a draped large-sized figure; and the fourth, a large-sized part of a meander frieze. While these were being studied, scheduled and sampled, I was informed that there were smaller sculpture fragments in the storage depot. In a box labelled »Mermer D48« there were many fragments of small-sized sculptures, and six of these were selected for study too. The ten fragments were chosen according to the principle that they, hypothetically, should represent the principal construction periods at the site, be of different types and belong to objects of various sizes. The intention was to have the samples sent to Florence for petrographic and mineralogical (P/M) analyses, but due to new regulations in 2017, the samples were instead taken to Istanbul[53].

After having studied, measured, photographed, sampled and scheduled the fragments at the site, I was informed that the provenance of the fragments in Box D48 was uncertain[54]. As the early

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49 The base is now in the Archaeological Museum in Milas. See also Gunter 1995, cat. 12.

50 Gunter 1995, 18.

51 Hellström 2019, 61 f. Hellström explains that early excavations were not published and that due to inadequate recording, the find spots remain unknown. When excavations were concluded in 1960, the stratigraphic material was transferred to the Archaeological Museum in Izmir, and only the notebooks with insufficient information remain. Inconsistences in registration during early excavations have been noted by Blid: »Most finds from early excavations can only reveal an indication of activity at certain periods, but not a precise and accurate date«, see Blid 2016, 133. 21 fragments are described in the catalogue. For eight of these, the present location was unknown. Gunter states that »[f]or fragments that could not be located for re-examination information has been supplied from descriptions or sketches preserved in notebooks.« And she informs us that fragments that were »too small to catalogue were not reported in the notebooks«, see Gunter 1995, 44.

52 On recent excavations and work at Andron A, see Henry 2015.

53 Requests were also sent to the museum in Bodrum for permission to study and take photos of some objects in Gunter's catalogue and if possible, to take some samples. Olivier Henry was allowed to look at and take photos of two objects, the statuette of a »Girl holding a goose« mentioned above and a meander frieze fragment. Samples were taken by a museum employee. The statue base on which the girl previously stood was kept in the depot at Labraunda and sampled by Henry. These samples are among those sent to Istanbul.

54 The box was one of 20 boxes with small archaeological finds received from the Archaeological Museum in Izmir in 2007.

documentation is not quite reliable, it is, at present, impossible to say anything more regarding the fragments' provenances[55]. The question was whether to forget about the fragments or to incorporate them into the study. Having studied the pieces and made schedules, my choice was to use them as examples of small-sized statues and see whether finer-grained marble had been used[56]. As scientific analyses of the samples could not be undertaken due to new regulations, this part of the study is based only on ocular examinations[57].

The fragments of palmetto leaf and the fragment of a draped figure found in Andron A were made of a frail, coarse-grained, white marble of the same kind as used for the architectural elements related to the buildings of the Hekatomnid period. That corresponds with Gunter's description of the fragments of four free-standing large-sized statues found in front of Andron A, made of coarse-grained marble[58]. Most probably, the new fragments belong to at least one of these figures. They have been sampled, and the material can be compared to the previously analysed marble.

The meander frieze fragment had a different kind of marble, white and fine-grained, reminiscent of marble from Sodradağ and similar to the marble of the Corinthian capitals that belonged to the North Stoa, a building that was originally erected by Maussollos and rebuilt in the Roman period[59]. Gunter described the frieze marbles as hard and fine-crystalled, which is compatible with my observations of the new frieze fragment.

The six fragments from the D48 marble box were studied, sampled and scheduled. Some have marks on the back which might be helpful for future identification. The fragments will only be used as examples with regard to the relationship between the marble's grain size and the size of a sculpture. All details are, however, recorded in schedules kept in the excavation archive.

The first fragment in this group is a fragmentary head of a female, made of coarse-grained and rather frail stone, which shows that a smaller-sized object could be made of coarse-grained marble too. The same goes for another fragment, part of an arm consisting of two pieces glued together, a fragmentary draped forearm of a male, the right arm of a male, and a fragment of a lion's paw. All were made of white, medium- to coarse-grained marble similar to marble from Herakleia. The fragmentary leg of a Roman male was made of hard white marble with medium-fine grains, very similar to marble from Sodradağ. To sum up, five of the samples were considered as presumably Herakleian marble, and one sample was different, possibly marble from Mylasa.

CONCLUSION

The main questions in this study regarded the provenance of the Labraunda marbles and whether the choice of marble type was related to the period in time or to the type of object. After studies in quarry areas, scrutiny of marble, reading ancient texts and recent research, and using different analytical methods at CNR/ISPC plus isotopic analysis at ISM/CNR on a selected number of samples, there are some solid results. There is no doubt that the coarse-grained marble used in the Hekatomnid period, described by all archaeologists as coarse-grained and frail, was quarried at Herakleia. There is a possibility that stone from the area between the Miletos and Herakleia districts, with grains slightly finer than in the Herakleia quarries, was used for the architrave with dedication of Andron B. Also the sphinxes, sandaled foot and the eagle head found in Andron B, might be from the same quarry area, linked to the construction period of Maussollos. Even though

[55] Some might be missing pieces reported in earlier documentation.

[56] The samples in this study were labelled MS (Marble Sample) and a consecutive number. The palmetto leaves were labelled MS 1 and MS 2, the frieze fragment MS 3, and the part of a draped figure MS 4. Fragments from the marble box were labelled MS 5–10. Fragments MS 11–13, »Girl holding a goose«, a meander frieze in the museum at Bodrum, and the base in the depot at Labraunda are excluded because I neither saw nor sampled them.

[57] The 13 samples can be used for comparative studies with the previous marbles investigated at Labraunda. All information is available in the schedules in the Labraunda archives.

[58] Gunter 1995, cat. 4. 6. 9; appendix 1.

[59] See Liljenstolpe – von Schmalensee 1996.

the crystals are slightly finer, the marbles in this extensive area have the same properties and go under the collective name Herakleian marble. I must add that the frailty noted by the archaeologists and during conservation is often superficial and due to weathering. Where the fresh marble is observable, it is hard, lustrous and warm white, often with clusters of large crystals.

Three items dated to the pre-Hekatomnid period were sampled and scientific analyses show that the fine-grained marble of those objects was brought from quarries at Milas. Marble in the Hellenistic and Roman periods was mostly fine-grained and principally likewise brought from quarries in Milas. In Strabo's day, Sodradağ provided fine white marble for the city and Labraunda. At present, the white marble close at hand can be found on the east side of the mountain. The provenance of a few elements dated to the Roman period remains unknown, which is no great surprise, as the Roman marble trade was highly developed and intense. The Byzantine ambo was made of marble from Milas.

One question regarded whether there was a relationship between the marble type and the object, i.e. whether coarse-grained marble was used for large objects and fine-grained marble was chosen for small objects. Gunter defined the marble of all sculpted items from the 4th century BC as coarse-crystalline. My own observations of the new finds in Andron A show that they are made of coarse-grained marble, indicating they were part of the same decoration. Ocular observations of the sphinx in Bodrum and the chariot in Milas suggest this kind of marble was used for those too. Fine-grained marble was preferred for building and sculpture in the Roman era, as shown in previous investigations and confirmed by the piece of meander frieze decoration. Most of the small fragments in box D48 were made of large-grained marble, while only the fragment of a Roman male had marble with finer grains. Therefore, the marble type seems to be linked to the period rather than the object's size, at least at Labraunda.

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EXPORTATION OF PREFABRICATED STATUES FROM THASOS

Abstract
Thasian dolomitic marble has been identified combining macroscopic examination and scientific techniques (XRD, EPR, XRF). Groups of statuary replicas in Thasian dolomitic marble make it clear that Roman copies of statues were produced on the island and exported regionally and to Italy. A dolomitic marble statue from a shipwreck off the coast of Sicily provides further evidence for production and exportation of almost-finished statues in or near the Thasian quarries.

METHODOLOGY AND THE PROBLEM

The Greek island of Thasos was apparently the only source of white, medium-to-coarse-grained, dolomitic marble widely used in antiquity. This is not only a widely accepted proposition but also a very useful one, since dolomitic marble can be scientifically identified via several methods requiring very small samples. Until about 2006, our marble samples were usually analysed at the Museum of Fine Arts, Boston with X-ray diffraction (XRD). Since then, samples have been analysed by Donato Attanasio with electron paramagnetic resonance (EPR) spectrography and Robert Tykot with X-ray fluorescence (XRF). Using these methods, we have tracked Thasian marble around the Mediterranean and in museums on both sides of the Atlantic[1].

It is clear that Thasian dolomitic marble was primarily used for figure sculpture rather than architecture. In Roman times there was a production of statuettes, usually intended for cheerful decoration[2], but it is difficult to determine if Thasian marble was exported for fully shaped figures in large scale. Several recent tests, however, help to shed light on this issue.

NEGATIVE EVIDENCE

In many cases, to be sure, it is clear that marble from Thasos was turned into figural sculpture at the marble's destination. Matthias Bruno has shown that marble for sculpture could be exported from Thasos as shapeless masses: merely as a raw material[3]. Thasian marble was also exported as rough rectilinear blocks[4], which could also be turned into revetment or pavement slabs or, as is relevant here, statues. A Hercules in Utica, Tunisia, is a clear example[5]. The smooth, saw-cut surface of the block is conspicuously preserved on the side as well as the rectangular base (fig. 1). The Torre Sgaratta shipwreck of Thasian marble indicates that blocks were usually exported from

1 Herrmann 1990; Herrmann 1992; Herrmann – Newman 1995; Herrmann 1999; Herrmann – Newman 1999; Herrmann – Newman 2002a; Herrmann – Newman 2002b; Tykot et al. 2018; Herrmann 2023.
2 Herrmann – Attanasio – van den Hoek 2015.
3 Bruno et al. 2002, 351.
4 Gabellone – Giannotta – Alessio 2009, 325–327; Antonelli et al. 2020.
5 Herrmann – Newman 2002b, 359 f. fig. 3.



1 Hercules, Utica Museum. Thasian marble (XRD) (photo: A. van den Hoek)

Thasos roughly shaped with picks and chisels[6]. The Utica block was evidently squared with a saw after it arrived in Africa. The trimmings would have been used for veneering or pavements, while the core of the block became the Hercules.

Life-size statues, especially Roman copies of Greek masterpieces (Roman Imperial replicas of statues of Classical Greek times) are not common on Thasos itself. The usual types familiar from Rome are rare on Thasos, and at least one was imported, possibly from Athens. A Lycian Apollo, now in Istanbul, was excavated on Thasos, but XRD has shown that it is not dolomite but a fine-grained calcite that could well be Pentelic[7]. Replicas of the Lycian Apollo type were often sculpted in Thasian marble, but none of them seem to have been found on Thasos[8]. A few familiar types have been found on the island: a torso of the common Meleager type is in the Thasos Museum[9], as is a rare Hermes of the Atalante type[10]. Both are apparently in Thasian marble.

In spite of the relative scarcity of normal Roman copies on the island, a few cases make it clear that life-size replicas of Classical and Hellenistic masterpieces in dolomitic marble were, indeed, exported in an almost finished state from Thasos. The cases where this appears clearly are when almost all replicas of the types are made of Thasian dolomitic marble and one of the examples is on Thasos itself. The example on Thasos made of Thasian marble was in all probability made on Thasos, and it seems legitimate to presume that the other examples in Thasian marble were exported almost fully shaped from Thasos.

A prime example is a statue of a woman tightly wrapped in her himation excavated at Stratoni on the Chalkidiki peninsula near Thasos (fig. 2 a)[11]. The statue has another replica in Brindisi, Italy[12], and a third (unpublished [?]) replica is in the Thasos Museum (fig. 2 b–c). All have similar workmanship, and two of them have been proven to be dolomitic marble, and the third, in the Thasos Museum, also appears to be Thasian marble. It seems highly probable that all three statues were carved on Thasos. The original design of the female statue, it should be noted, was not created on Thasos: it replicates a figure from a 4th-century BC tomb monument in the Kerameikos cemetery in Athens[13]. Presumably there was a plaster cast of the Athenian original in the sculpture workshops on Thasos. Another example, in fine-grained marble, is in Antalya[14].

6 Gabellone – Giannotta – Alessio 2009, 325.
7 Mendel cat. 602, see Herrmann – Newman 2002a, 216.
8 Milleker 1986, 196–318 n. 2 (Louvre MA928). n. 8 (Berlin, Staatliche Museen SK44). n. 17 (New York, Metropolitan Museum of Art 03.12.15). n. 23 (Rome, Museo Nazionale Romano, 115255). The Louvre statue was analysed by Philippe Blanc (pers. comm. 12.04.2013). Another head of the Lycian Apollo in the Louvre may also be Thasian, see Laugier 2021, cat. 95. 250. For the New York and Roman pieces, see Herrmann 1992, 86; Herrmann – Newmann 1995, 82. A fragment not in Milleker's catalogue is in Bologna, see Herrmann – Newman 1995, 82.
9 Unpublished?
10 Unpublished?
11 Linfert 1976, 129; Herrmann – Newman 1995, 76 fig. 1.
12 Linfert 1976.
13 Athens National Museum inv. 1005, from the Kerameikos, see Higgins 1986, 125 fig. 152.
14 Probably Docimeian marble; unpublished?



2 a: Female statue from Stratoni, Poligiros Museum. Thasian marble (XRD) (photo: E. Triolo, Flicker); b: Female statue, Museo Archeologico Provinciale Ribezzo, Brindisi, inv. 141. Thasian marble (XRD); c: Fragmentary female statue, Archaeological Museum Thasos. Thasian marble (macroscopic identification) (photos b. c: A. van den Hoek)

Another example of a prefabricated large-scale masterpiece exported from Thasos is a statue in the garden of the Palazzo Colonna in Rome (fig. 3 a)[15]. Robert H. Tykot has established with portable (p)XRF and isotopic analysis that the statue is dolomitic marble from Thasos (tab. 1). In a general sense, the figure, who is again tightly wrapped in her himation, is a common type representing a woman exemplifying the virtue of modesty (*pudicitia*). This particular variant, wearing a long himation with a twisted upper border and with the weight on the left leg, however, is a relatively rare type in marble sculpture, and the only exact replicas we have found are three fragmentary pieces in northern Greece. One is at Philippi on the Thracian mainland just north of Thasos (fig. 3 b)[16]. Two more replicas are in the Thasos Museum itself. One comes from the harbour excavations[17], and the other seems to be unpublished (fig. 3 c). None of these pieces on or near Thasos have been sampled, but macroscopic examination strongly suggests that they are made of the dolomitic marble of Thasos. In all probability, all four of these statues were produced on the island. On the basis of current evidence, the type seems to be a Thasian specialty.

These statues seem to reproduce a prototype that is known from the late 3rd century BC, since the composition of the statues can be paralleled in Hellenistic terracotta statuettes from ca. 200 BC from Tanagra, north of Athens[18], and from Myrina on the coast of Asia Minor[19]. The

15 Rosetti 2018.
16 Unpublished?
17 Kozelj 1990, 548. 552 fig. 4; Empereur 1991, 719 fig. 11.
18 Higgins 1986, 132 fig. 161: end of the 3rd cent.
19 E.g. Myrina 212; Myrina 235: <https://collections.louvre.fr/ark:/53355/cl010282102> (19.03.2025).



3 a: »Pudicitia« with modern head of Venus, Palazzo Colonna, Rome, garden. Thasian marble (EPR) (photo: A. van den Hoek); b: »Pudicitia« Philippi, Museum. Thasian marble (macroscopic identification) (photo: J. Herrmann); c: »Pudicitia«, Thasos, Museum. Storage. Thasian marble (macroscopic identification) (photo: A. van den Hoek)

USF no.	Site	$\delta^{13}C$	$\delta^{18}O$	Comment
37732	Palazzo Colonna, Garden, Venus	3.7	–3.7	Pa-1, Pr-1 (?), Th-CV. pXRF analysis confirms dolomitic, and is thus Th-CV

Table 1 Isotopic and pXRF analysis at the University of South Florida by Robert H. Tykot of a marble statue of Venus (»Pudicitia«), Palazzo Colonna, Rome

marble replica in the Palazzo Colonna, Rome, however, is not likely to date before the 1st century BC, when Greek sculptures began to be transported to Italy.

There is yet another group of Thasian marble statues with a replica on Thasos. Four life-size fighters in the Albertinum Museum in Dresden were found together on the Via Appia near Rome (figs. 4 a–b; 6 a)[20], and macroscopic examination has long suggested that they were all made of the same marble. It has been suggested that the medium-grained marble might be Parian[21]. On our behalf, the conservation staff of the Albertinum took samples of all four, and Donato Attanasio has

20 Daehner 2008.
21 Daehner 2008.



4 a: Warrior found near Rome, Albertinum, Dresden, Hm 235. Thasian marble (Cape Vathy) (EPR, MGS) (photo: J. Herrmann); b: Wrestler found near Rome, Albertinum, Dresden, Hm 234. Thasian marble (Saliara area) (EPR, MGS) (photo: J. Karpinski, after Daehner 2008, pl. 34)

Sample or quarry	MGS mm	EPR intensity %	EPR linewidth %	EPR dolomite %
DR 1, Hm 234	2.0	355	87.8	ca. 100
DR 2, Hm 235	1.5	54.3	77.9	ca. 100
DR 3, Hm 236	1.5	74.2	76.2	ca. 100
DR 4, Hm 233	1.7	57.1	79.7	ca. 100
Thasos Vathy	2.0 0.9–3.0	235 33–634	85.4 72–107	ca. 100
Thasos Saliara	1.8 1.0–3.2	60 19–130	72.1 62–104	ca. 100
Thasos all	1.85 0.9–3.2	105 19–633	75.8 62–107	ca. 100

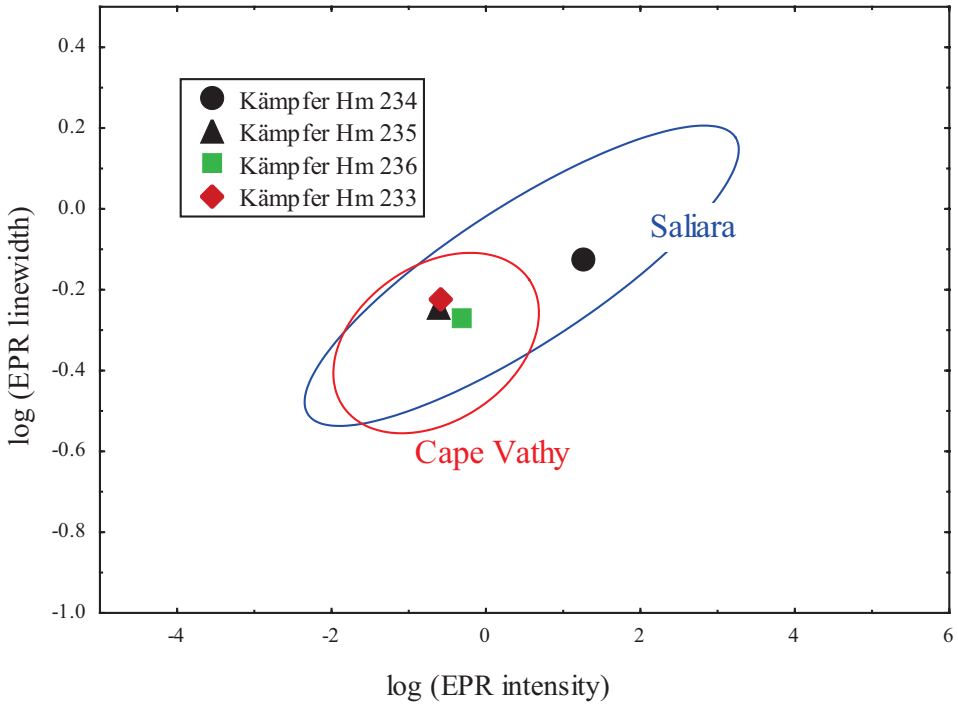
Table 2 Analysis with EPR at the Consiglio Nazionale delle Ricerche (CNR) by Donato Attanasio of four statues of fighters (»Kämpfer«) at the Albertinum Museum, Staatliche Kunstsammlungen Dresden

determined with EPR that all four are, in fact, dolomitic marble and that three come from Cape Vathy and one from the nearby Saliara area on Thasos (tab. 2; fig. 5).

The fighters are pairs of warriors and wrestlers in identical striding and twisting poses. While the poses are the same, the figures are different in detail. Two are youthful and beardless, while the other two are mature and bearded. One of the figures survives only as a torso.

A fragmentary statue of a highly similar warrior can be found in the storage depot of the Thasos Museum (fig. 6 b)[22]; only the legs survive, but the stance is the same as that of the Dresden

[22] Unpublished?



5 EPR data for the Dresden fighters: quarry origins on Thasos (graphics: D. Attanasio)



6 a: Wrestler and warrior found near Rome, Albertinum, Dresden, Hm 233. 236. Thasian marble (Cape Vathy) (EPR, MGS) (photo: J. Herrmann); b: Legs of a warrior, museum storage, Thasos. Thasian marble (macroscopic identification) (photo: A. van den Hoek)



7 a: Warrior found near Rome, Albertinum, Dresden, Hm 236. Thasian marble (Cape Vathy) (photo: J. Herrmann); b: Legs of a warrior, museum storage, Thasos. Thasian marble (macroscopic identification) (photo: A. van den Hoek)

fighters. Macroscopically the marble also appears to be Thasian. It is clear that the Thasian legs are the same type as the Dresden bearded warriors, since a cuirass or body armour is used as a reinforcement for the left leg, just as in the left leg of one of the Dresden warriors (fig. 7 a–b). The figure in Thasos was apparently unfinished; its surface is still rough, its pubic hair is undetailed, and its foot does not yet have toes. This indicates that this kind of detail was meant to be finished at its destination. A marble brace or strut for support stretches between the sculpture's knees. Presumably the strut would have been removed and the surface would have been finished if the statue had been moved to its final destination. No other replicas of these fighters are known. It therefore seems highly likely that all five fighters were given their basic shape on Thasos. Four of the figures were shipped to Rome, while the fifth stayed on the island for unknown reasons. The rectangular bases indicate that the fighters, including the example on Thasos, were probably carved from massive squared blocks rather than from amorphous masses roughly corresponding to the shape of the final statue.

Jens Daehner, who has thoroughly studied the Dresden statues, has distinguished not only a difference of hands in the workmanship but also a difference of period. Both youthful figures date from the early Hadrianic period but are the products of different workshops. One of the bearded warriors also dates from the Hadrianic period, but the other is early Antonine. Apparently the delivery of the statues took place over a period of about twenty years (about AD 120–140). Presumably a succession of talented sculptors had to be engaged to finish each statue as it arrived in Rome. The question remains of how much work was required in the urbs.

As finished in Rome, the Dresden fighters are sophisticated works, fully integrated into polished Roman standards. It may nevertheless be possible to see faint traces of specifically



8 a: Wrestler found near Rome, Albertinum, Dresden. Thasian marble (photo: J. Herrmann); b: Alexander, Thasos, Museum. Thasian marble (macroscopic identification) (photo: A. van den Hoek); c: Warrior found near Rome, Albertinum, Dresden, Hm 236. Thasian marble (EPR, MGS) (photo: J. Herrmann); d: Portrait of Hadrian, Rhode Island School of Design, Providence. Thasian marble (XRD) (photo: RISD 59 050)

Thasian or north Aegean workmanship in them. The beardless fighter has hair that in the front view is elaborately detailed, but in the sides and in back, the unusually broad, heavy locks of hair resemble those of the dolomitic marble Alexander on Thasos (fig. 8 a–b)[23]. This bulkiness may reflect the shaping on Thasos. The locks of the hair around the forehead in one of the bearded warriors (fig. 8 c) recall the hair of a portrait of Hadrian, probably from Asia Minor, also made of Thasian dolomitic marble and carved by a northern Greek sculptor (fig. 8 d)[24]. The similarities probably reflect a Thasian background for the two sculptors at work in Rome.

[23] Blondé – Muller – Mulliez 1985; Muller – Blondé – Mulliez 1987, 34 fig. 8; Koukouli-Chrysanthaki 1988; Herrmann 1990, 91 fig. 10; Herrmann – Newman 2002a, 222 fig. 19.

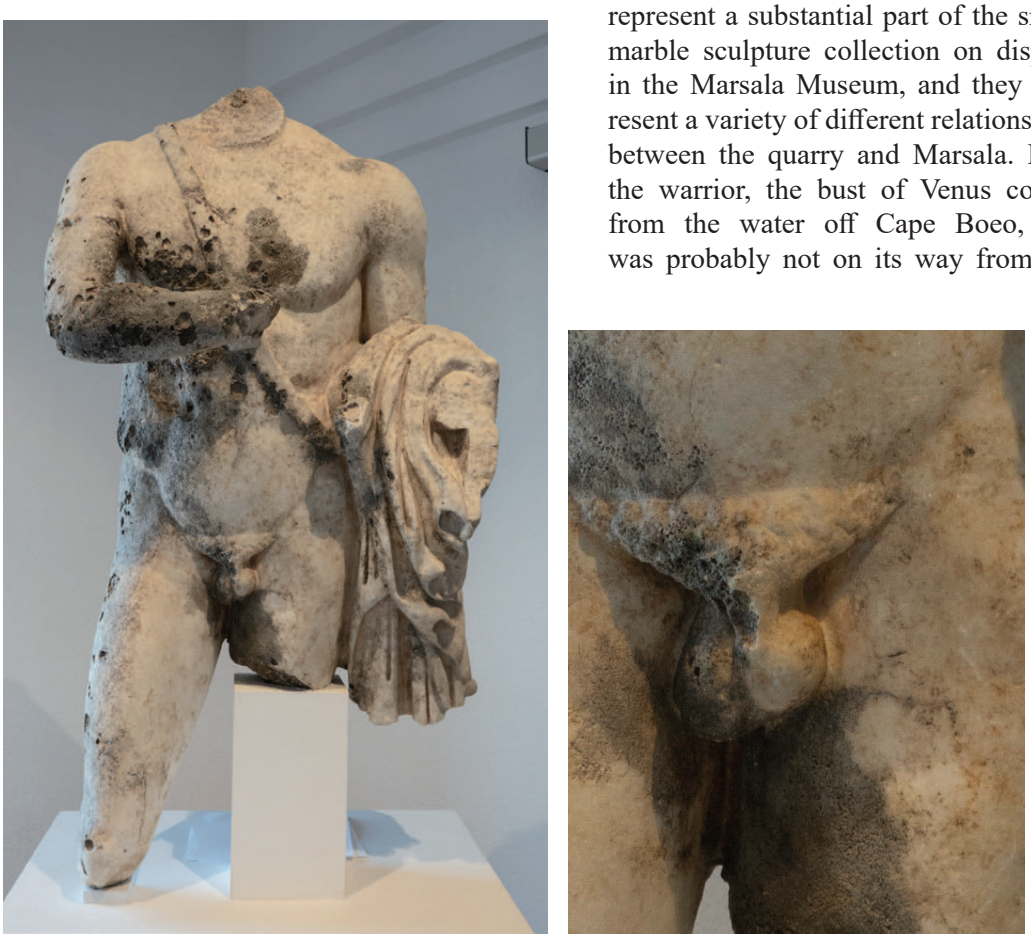
[24] Evers 1994, 155 f. cat. 94; Borromeo – Herrmann – Herz 2009, 44 f.; Herrmann 2023, 100 fig. 6.

The theme of nude warriors apparently had another manifestation on Thasos, but here the kind of evidence is different. In this case, it is a find from a shipwreck. A torso found off Cape Boeo, Marsala, Sicily, ancient Lilibeo, represents a warrior with a sword-belt who is striding forward and apparently reaching for his weapon (fig. 9)[25]. The warrior has been dated to the 2nd or 1st century BC. The museum allowed us to take a sample, which Robert H. Tykot has analysed with XRF. It proved to be dolomitic marble, confirming the marble's Thasian appearance. There seem to be no other examples of this type of statue on Thasos or anywhere else. The statue seems to have been unfinished and on the way to market, where it would have received some final touches. A strut connects the warrior's wrist to his chest. Presumably this reinforcement would have been cut away when the statue reached its destination. The statue's surface, which is pitted and stained by undersea creatures, does not seem to have been polished. Since the statue was apparently on its way from a workshop to its destination, then Thasos, the source of its marble, is a logical source of its workmanship.

The deep channels in the drapery also indicate that the work on Thasos at times went well beyond shaping the basic volumes. The locks of pubic hair are also sketched out and would have needed only a light finishing at the statue's destination.

Several other statues in the Marsala Museum also appeared to be Thasian marble, and analysis with pXRF confirmed that they contain magnesium and therefore are dolomitic marble and from Thasos (tab. 3).

These Thasian marble sculptures represent a substantial part of the small marble sculpture collection on display in the Marsala Museum, and they represent a variety of different relationships between the quarry and Marsala. Like the warrior, the bust of Venus comes from the water off Cape Boeo, but was probably not on its way from the



9 Warrior from the sea at Cape Boeo, Museo Archeologico Regionale Lilibeo Marsala. Thasian marble (pXRF) (photos: A. van den Hoek)

25 Museo Archeologico Regionale Lilibeo Baglio Anselmi, Marsala, inv. 4583.

USF no.	Museum no.	Description	Magnesium
40127	4583	Warrior from Cape Boeo	yes
40128	12123	Bust of Venus from Cape Boeo	yes
40129	11045–11046	Torso of Asclepius	yes
40130	8967	Fragmentary head of goddess	yes
40131	10746	Cuirass	yes

Table 3 Analysis with pXRF at the University of South Florida by Robert H. Tykot of samples of Roman marble sculpture in the Museo Archeologico Regionale Lilibeo Marsala

quarry to the customer. It is a fragment (chest and shoulders) and seems highly polished; it is likely that it was part of a finished statue that was broken into pieces to be used as ballast in a boat. The torso of Asclepius seems squared off, as if it had been carved from a block, and it therefore was probably not carved in the Aegean. The fragmentary head of the goddess is only the top left quarter, but the thick locks of cleanly chiselled hair strongly resemble the hair of a goddess from Smyrna in Izmir which is also made of dolomitic marble from Thasos[26]. The fragmentary Marsala goddess could well have been shipped in an almost finished state from a workshop in northwestern Asia Minor. The cuirass (from a cemetery in Marsala) was presumably a funerary monument. It strongly resembles the cuirasses of the fighters in Dresden and Thasos and was probably shipped from Thasos to Marsala in its present finished state.

CONCLUSION

The duplicate statues and this undersea find, all in medium-to-coarse-grained dolomitic marble from Thasos make it clear that sculptors on Thasos did indeed produce large-scale ideal statues for export in Late Hellenistic and Roman Imperial times. Their known markets are few, but there must have been many more. The process of finishing them at their destinations would usually have concealed any traces of their preparation in or near the quarries.

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[26] Herrmann – Newman 1995, 83 tab. 3.

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THE USE OF PROCONNESIAN MARBLE IN THE ARCHITECTURE OF IMPERIAL EPHESOS

AN ARCHAEOLOGICAL EVALUATION

Abstract
According to recent provenance analyses, Proconnesian marble was used for the construction of seven buildings in the Imperial period of Ephesos. These include four large bath-gymnasium complexes, two monumental temple buildings and the funerary monument of a local benefactor. This paper aims to examine the archaeological implications of these observations against the backdrop of Ephesos' privileged position in the use and trade of marble, as well as the rise in popularity of Proconnesian marble during the 2nd century AD. The people of Ephesos had several local quarries at their disposal which produced high-quality white marble well-suited for architectural purposes. Its use has been attested in multiple constructions since the Archaic period. At the same time, the city's harbour enabled the cost-effective import of various stones. Examining the different ways in which Proconnesian marble was employed in the buildings mentioned, as well as the general advantages of using this marble type, helps us to approximate potential reasons for importing it. Another interesting aspect is the chronological development of the use of Proconnesian marble in Imperial Ephesos.

INTRODUCTION

As part of a research focus of the Austrian Archaeological Institute (OeAI)[1], for the past decade nearly all known marble buildings in Ephesos have been sampled and submitted to multivariate provenance analysis. These studies were conducted by Walter Prochaska[2] (OeAI), employing a combination of stable isotope analysis, trace element analysis and fluid inclusion analysis, and Natalia Toma[3] (Technical University of Darmstadt), who used isotope analysis and electron paramagnetic resonance (EPR). As a result, we have gained a clearer picture of the marble distribution in Imperial Ephesos, which in turn has opened up new and interesting research questions.

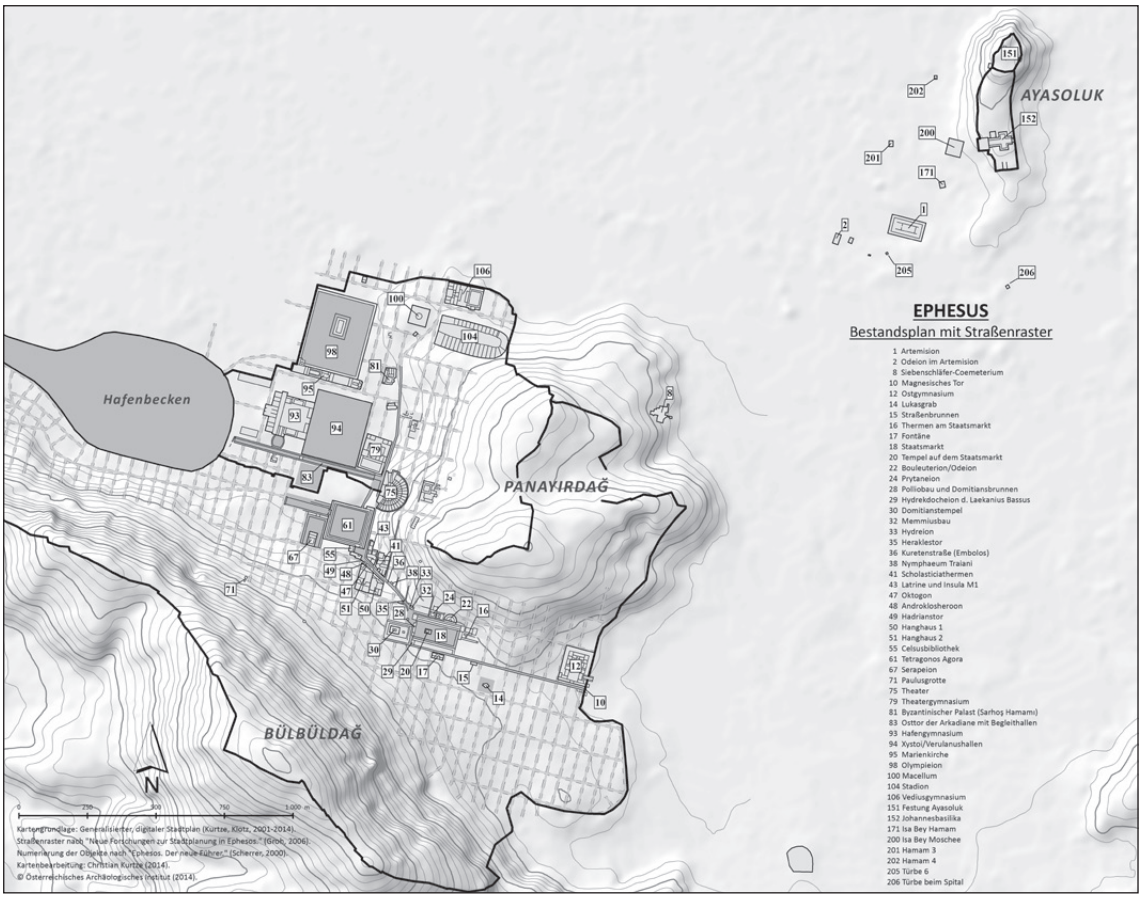
One important result of these analyses was that imported Proconnesian marble was used for the construction of seven prominent buildings (fig. 1) in Imperial Ephesos. Almost all of them were public buildings, namely the four big bath-gymnasia of Ephesos (Harbour Baths, Theatre Baths, Vedius Gymnasium and East Gymnasium) as well as the so-called Serapeion temple and the imperial cult temple of Hadrian, also known as the Olympieion. In addition, the monumental tomb of local benefactor Titus Flavius Damianus, located 2.7 km southeast of Ephesos adjacent to the road to Magnesia on the Maeander, was also found to have been constructed in Proconnesian marble; however, in this case, the final analyses of the samples are still ongoing.

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1 See <https://www.oeaw.ac.at/en/oeai/research/historical-archaeology/object-itineraries/provenance-studies-white-marbles> (30.06.2023).

2 See Prochaska – Grillo 2010; Kerschner – Prochaska 2011, 132–144; Prochaska – Grillo 2012; Jahresbericht 2012; Jahresbericht 2013; Jahresbericht 2014; Jahresbericht 2015; Jahresbericht 2016; W. Prochaska in: Ruggendorfer 2016, 337–345; W. Prochaska in: Quatember 2017, 171–179; Jahresbericht 2019; Anevlavi et al. 2020.

3 Toma 2020, 377–397. 422–429. The isotope analyses of the samples taken by Natalia Toma were performed by Nils Andersen (Kiel University), while the EPR spectroscopy was conducted by Donato Attanasio (National Research Council [CNR], Rome).



1 Map of Ephesos showing six of the seven relevant buildings: no. 12 (East Gymnasium). no. 67 (Serapeion). no. 79 (Theatre Baths). no. 93 (Harbour Baths). no. 98 (Olympieion). no. 106 (Vedius Gymnasium) (graphics: OeAW-OeAI/C. Kurtze)

The evidence of Proconnesian marble being used for these constructions is intriguing when considering that Ephesos disposed of a large number of high-quality white marble quarries situated in its territory. Analyses show that these quarries played a crucial role for Ephesian architecture[4].

In a recently completed master's thesis conducted at the University of Vienna[5], the author aimed to analyse and compare the usage patterns of Proconnesian marble in the mentioned buildings and examine the chronology of this use. By viewing these results against the background of Ephesos' and Prokonnesos' situation in the empire-wide stone trade, an attempt was made to identify the factors that could have informed the decision to use this marble type.

DIFFERENT PATTERNS OF USE

The state of archaeological research, the number of samples taken and the methods used for their analysis vary from building to building, which particularly in the cases of the bath-gymnasia,

4 Prochaska – Grillo 2012, 585; Russell 2013, 146 f. For the classification of the Ephesian marbles into groups, see Yavuz – Bruno – Attanasio 2011, 224; W. Prochaska in: Ruggendorfer 2016, 341 f.; Anevlavi et al. 2020, 17.

5 The author would like to thank Sabine Ladstätter (†) for supervising the thesis, entitled »Prokonnesischer Marmor im kaiserzeitlichen Ephesos. Versuch einer archäologischen Auswertung«, and Walter Prochaska for granting access to the results of his research.



2 Corinthian capital of the Ephesos type from the Harbour Baths, Proconnesian marble (photo: W. Prochaska)



3 Corinthian capital of the Ephesos type, from the palaestra of the Harbour Baths, Ephesos I marble (photo: W. Prochaska)

makes it difficult to accurately determine their marble distribution. However, it is possible to detect some general usage patterns, which allow the examined buildings to be differentiated into two groups.

The Bath-Gymnasia

The first group comprises Ephesos' four big bath-gymnasium complexes (see fig. 1, no. 12 [East Gymnasium]. no. 79 [Theatre Baths]. no. 93 [Harbour Baths/Gymnasium]. no. 106 [Vedius Gymnasium]). In the case of these buildings, bases and capitals made of Proconnesian marble (fig. 2) were used in combination with polychrome column shafts consisting of Docimeian Pavonazzetto marble, granite from the Troad or Syene (Aswan) or regionally imported breccias[6].

Combining polychrome stones and white marble is a design choice which is typical for luxurious bath buildings across the Roman Empire as it emphasised the expensive coloured stone components, thus highlighting the building's prestige[7].

However, marble from Prokonnesos was not the only variety of white marble in use in the bath-gymnasia: in at least three of the buildings, local marble varieties Ephesos I and II were employed next to Proconnesian marble for elements of the rising architecture, including bases, capitals (fig. 3) and parts of the entablature[8]. Further sampling would be necessary to understand better the extent of local white marble use in relation to the use of Proconnesian marble in the bath-gymnasia and the reasoning behind it.

Both the use of white marble from different sources and the combination of white and coloured marble contrast significantly with the usage patterns which can be observed for the other buildings.

6 Plattner 2016, 698; Anevlavi et al. 2020, 13; Toma 2020, 379–390. 423–428; analysis results of Walter Prochaska (pers. comm.).

7 Toma 2020, 142.

8 Jahresbericht 2016, 33; Toma 2020, 423–428; analysis results of Walter Prochaska (pers. comm.).



4 Frieze block from the pronaos of the Serapeion, Proconnesian marble (photo: S. Insulander)

The Temples and the Tomb of T. Flavius Damianus

The second group consists of the two monumental temple complexes (Serapeion and Olympieion; see fig. 1, nos. 67. 98) and the Damianus tomb.

The Serapeion in particular makes for a good case study since it was the most extensively sampled building[9], with 70 samples taken, and it has recently been the subject of intensive archaeological and architectural research[10]. In both temples, less representative architectural components such as steps, door thresholds and floor slabs were sampled, in addition to elements of the rising architecture[11], which allows for a more detailed view of marble distribution within these buildings.

In this group of buildings, the marble used for their construction was largely obtained from a single source: the entire rising architecture of both the Olympieion and



5 Column drum fragment from the Olympieion, Proconnesian marble (photo: W. Prochaska)

9 See Prochaska – Grillo 2012, 588 f.; Jahresbericht 2012, 49; Jahresbericht 2013, 44; Jahresbericht 2014; Reiner 2016; Toma 2020, 428 f.

10 See Schulz 2017; Schulz 2019. The detailed publication of these new results is currently in preparation.

11 Reiner 2016, 15. 25–27; analysis results of Walter Prochaska (pers. comm.).



6 Floor slab from the Olympieion, local stone (photo: W. Prochaska)

the Serapeion temple building was made of Proconnesian marble (figs. 4–5)[12]; as far as can be inferred from preliminary analyses, this was also the case with the tomb of Damianus. In contrast to the bath-gymnasia, the preferred material for the columns was white marble[13]. The column shafts of the Serapeion stand out as they were monolithic and measured 12 m in height[14]. The choice to import all rising architecture parts from the same quarrying source indicates that these components were ordered from the Proconnesian quarries in the course of a single, large contract[15]. It is important to note, however, that for the temenos halls of the Serapeion, column shafts made of Docimeian Pavonazzetto marble seem to have been used in combination with column base pedestals and capitals in Proconnesian marble[16].

It is also interesting to note that the grave monument of T. Flavius Damianus was located very close to the Ab-u Hayat white marble quarries[17]. However, these quarries specialised in sarcophagus production[18] and thus were not a suitable candidate for supplying the marble needed for the monument.

The analyses of floor slabs and steps from the so-called Serapeion showed that a wide variety of marbles were employed for these objects: Ephesos I marble was used as well as marble from Prokonnesos, Dokimeion-Altıntaş and possibly Thasos[19]. In the case of the Olympieion, three sampled floor slabs (fig. 6) and a threshold were all found to be made from local stones[20].

12 Prochaska 2013b, 44; Plattner 2016, 698.
13 Ursula Quatember has suggested that white, fluted column shafts may have been seen as more traditional and thus more appropriate for the temple buildings and the tomb of Damianus, see Quatember – Scheibelreiter-Gail 2018, 274.
14 Schulz 2017, 361; Schulz 2019, 46.
15 Schulz 2017, 361; Toma 2020, 410.
16 Toma 2020, 428 f. tabs. 206–207 sample nos. 10.3.8.2–4.
17 Anevlavi et al. 2020, 13 f. fig. 3.
18 See Anevlavi et al. 2020.
19 Reiner 2016, 25 fig. 17 nos. EPH/82/2014. EPH/83/2014. EPH/86/2014–EPH/90/2014. EPH/207/2014.
20 Analysis results of Walter Prochaska (pers. comm.).



7 Upper profile of the plinth zone in the western wall of the so-called Marble Hall in the Harbour Baths, Ephesos Ia marble (photo: W. Prochaska)

Since all of these architectural elements were subject to heavy use and wear, sourcing them from local quarries may have been a simple and low-cost solution. Some of them could also have entered the temples in the context of repair and replacement. The paving slabs made of imported marble could have been acquired for the construction project independently of the order for the Proconnesian rising architecture, as the framework for the trade in wall and floor revetment was different from the trade in monumental architectural elements[21]. Another possibility is that they were taken from other buildings in Ephesos and reused, as was the case for several steps of the staircase leading up to the Serapeion temple, which were made of marble from Dokimeion-Altıntaş and originally belonged to an architrave in an as yet unidentified building of the Traianic period[22].

CHRONOLOGY

The quarries of Prokonnesos became of transregional relevance from the Flavian period onward and kept growing in importance in the course of the 2nd century AD, exporting their marble to Rome and several provinces for major construction projects[23]. This development was greatly facilitated by their location next to a natural harbour. At the same time, the city of Ephesos underwent significant urbanistic changes in the late 1st and the 2nd century AD, a development which was related to euergetism and the bestowal of neocorate titles. Therefore, it is necessary to investigate when the imports of Proconnesian marble to Ephesos began.

For this question, the Harbour Baths are the most relevant, but also the most problematic building, since they were only partially excavated at the end of the 19th and in the early 20th century.

21 See Russell 2011, 148; Russell 2013, 134; Toma 2020, 202.
22 Jahresbericht 2013, 44; Jahresbericht 2014, 54.
23 Bruno et al. 2002, 291–297; Attanasio – Brilli – Bruno 2008, 747; Russell 2013, 147 f.

The complex consists of the bath block, the palaestra and the so-called Halls of Verulanus or *xystoi*, a type of sports field. The palaestra is generally but not unanimously dated to the Domitianic period, which makes it the earliest structure of all the buildings examined in the context of the thesis, while the bath building was constructed in the Hadrianic period[24]. Three architectural elements which can be assigned to the first construction phase (fig. 7)[25] were sampled and found to be made of local Ephesian marble, whereas three objects from the Hadrianic phase (fig. 8)[26] could be determined to have been made from Proconnesian marble. Thus, the use of Proconnesian marble in the Harbour Baths can be detected with certainty only for the Hadrianic period. The other Imperial-era buildings in which Proconnesian marble was used can be dated between the Hadrianic period and the late 2nd century AD.



8 Composite capital from the frigidarium of the Harbour Baths, Proconnesian marble (photo: W. Prochaska)

More than 40 individual quarries, mostly producing white marble, have been identified to date in the hinterland of Ephesos, making it the city in Asia Minor with the most white marble resources in its territory[27]. When seen in the context of other sampled buildings in Ephesos, it becomes clear that up until the 2nd century AD, local white marble was the predominant building material in the city[28]. This pattern changed from the Hadrianic period onward, when marble began to be imported from Prokonnesos, to be used for several prestigious construction projects either exclusively or next to local material. What could have prompted this change?

POSSIBLE REASONS FOR THE IMPORT OF PROCONNESIAN MARBLE IN EPHESOS

While the question of why cannot be conclusively answered, an attempt at approaching it was made. It is important to view these stone imports against the backdrop of Ephesos' privileged position in the marble trade: the city was located at a natural harbour at the mouth of the river Kaystros into the Aegean Sea, at a junction for important maritime trade routes towards the West and the Middle East as well as for land routes to the Anatolian hinterland or along the Asia Minor coast[29]. This location enabled easier and cheaper imports and exports of stone.

Most of Ephesos' local marble resources were of a high quality and perfectly suitable for architectural purposes. One issue, however, could have been the monumentality of some of the construction projects, particularly the Serapeion and the Olympieion. Georg Plattner has suggested that perhaps by the 2nd century AD, the local Ephesian quarries could not produce blocks or cylinders of a sufficient size for these immense buildings, making it necessary to obtain them

24 Plattner 2016, 698.
25 See Strocka 1988, 295; Baier 2006, 68–75.
26 See Strocka 1988, 302; Baier 2006, 75–80. 120–126.
27 Russell 2013, 70.
28 Plattner 2016, 698; Anevlavi et al. 2020, 13.
29 Steskal 2014, 327; Steskal – Bjørnstad 2018, 123.

from another source[30]. In this context, it is important to note that several of the construction sites were located near the Ephesian harbour. Due to the strong differences in costs between land and sea transport[31], perhaps shipping the massive components directly from the quarries of Prokonnesos to the harbour of Ephesos was less expensive than having them transported by land from the surroundings of the city[32].

Obtaining building materials could also be informed by certain relationships between quarries, clients and contractors or marble traders[33]. Since epigraphic references to these contractors are as yet lacking for the Ephesian buildings, this aspect cannot be examined. However, it bears thinking about, especially considering the combination of polychrome marbles and Proconnesian marble in the bath-gymnasium complexes, which could have been imported together by a contractor, possibly with connections to specific quarries, as different parts of one order for architectural elements[34]. This may be relevant, particularly in regard to Docimeian Pavonazzetto marble, for which Ephesos played an important role as transshipment harbour[35].

Regardless of the specific reasons for importing marble for these monumental constructions, Ephesos was in the ideal position to do so, while Proconnesian marble was an accessible, high-quality choice for import. Thus, seven highly prestigious buildings in Ephesos can be added to the long list of edifices across the Roman Empire made from Proconnesian marble.

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30 Plattner 2016, 699.
31 See Russell 2013, 95–140.
32 Plattner 2016, 699.
33 Russell 2013, 202–207.
34 Cf. Toma 2020, 410.
35 Russell 2011, 150; Toma 2020, 103.

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INCOMPLETENESS AND IMPERFECTION IN THE ARCHITECTURAL DECORATION OF DIOCLETIAN'S PALACE IN SPLIT

Abstract
In different buildings in Diocletian's Palace, there are a certain number of incomplete, imperfect, or wrongly fabricated elements of architectural decoration. They are all made in local limestone, while this phenomenon cannot be detected in the elements made in different imported marbles. The incomplete elements can be divided into two categories: the elements with partially finished mouldings belong to the first category; to the second, the elements with partially carved or omitted motifs. There is often inconsistency in the use of finished, semifinished and unfinished decoration on buildings. The imperfection is revealed by detailed observation of different decorated ensembles. It is manifested by the presence of unfinished elements, by their position in the ensemble and by the lack of fine tuning of joints of adjacent blocks. Mostly their position is one of reduced visibility (caused by the height they were placed at or by other elements blocking the view), so the general perception of the buildings was not disturbed. That points out that the ›lack of interest‹ in correcting and avoiding these incompletions and imperfections could be related to economisation in production and adaptation to construction dynamics (possibly accelerated by the time limit).

INTRODUCTION

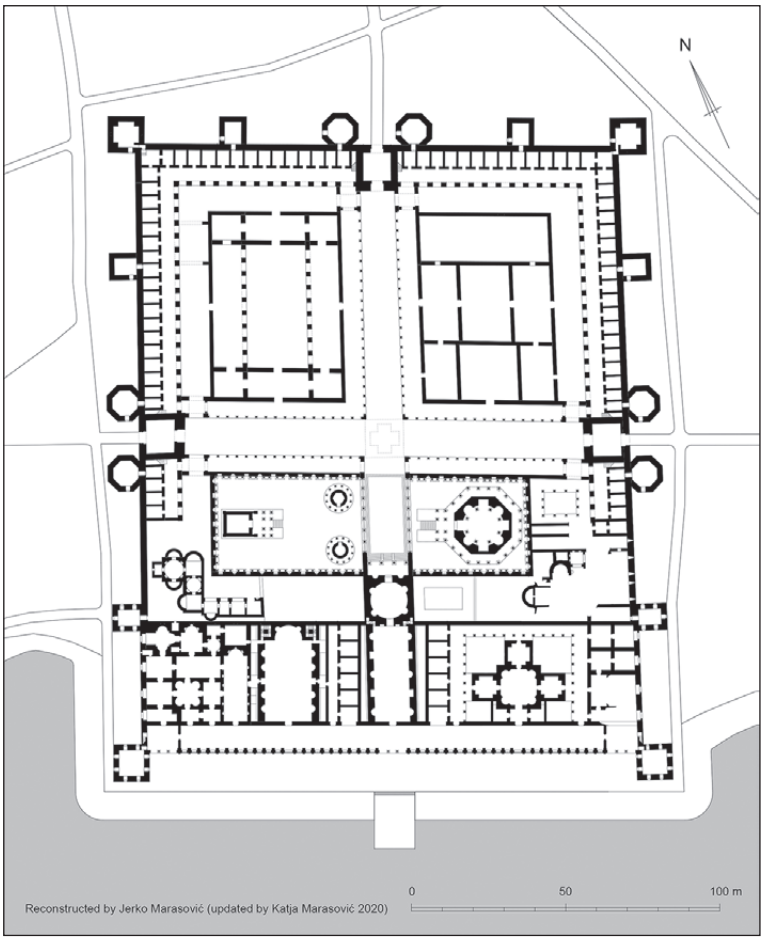
In different buildings and ensembles of Diocletian's Palace in Split, there are a certain number of incomplete, imperfect, or wrongly made elements of architectural decoration.

This research is mostly limited to elements *in situ*, which provide an architectonic context, allowing certain conclusions to be drawn regarding the relationship between those elements and their position in the buildings. We will present the most significant examples. The following ensembles and buildings of the palace are taken into consideration: the main land gates, the central court of the palace (traditionally called the Peristyle) with the monumental porch of Diocletian's apartment (traditionally called the Prothyron), the preserved buildings of the sacro-funereal zone (Mausoleum and Prostyle temple), and the southern façade of the palace (fig. 1).

LAND GATES

The three land gates of the palace – East, West, and North Gate – form a monumental façade flanked by octagonal towers. The façade of the East Gate and the West Gate has the same, relatively simple layout, while that of the North Gate (the main entrance to the palace) is more complex. Each façade has two levels. The lower levels have the same layout – consisting of a gateway surmounted by a relieving arch and flanked by two semicircular niches –, but there are differences in the upper level. All the façades are surmounted by a large crowning moulding (composed of plain *cyma recta* and fillet).

On the East Gate and the West Gate, there is a row of semicircular apertures in the upper level. An uninterrupted plain string course running across the façade marks the division between the levels (fig. 2). The string course is composed of fillet, convex moulding, crowned by a raking fillet. It extends to the octagonal towers, marking the separation between the floors. The projections of the towers covered a narrow lateral part of the façade (including the joint of the towers and the façade). The remains of the towers on the East Gate and the West Gate reveal a practice that is of interest with respect to string course decoration.

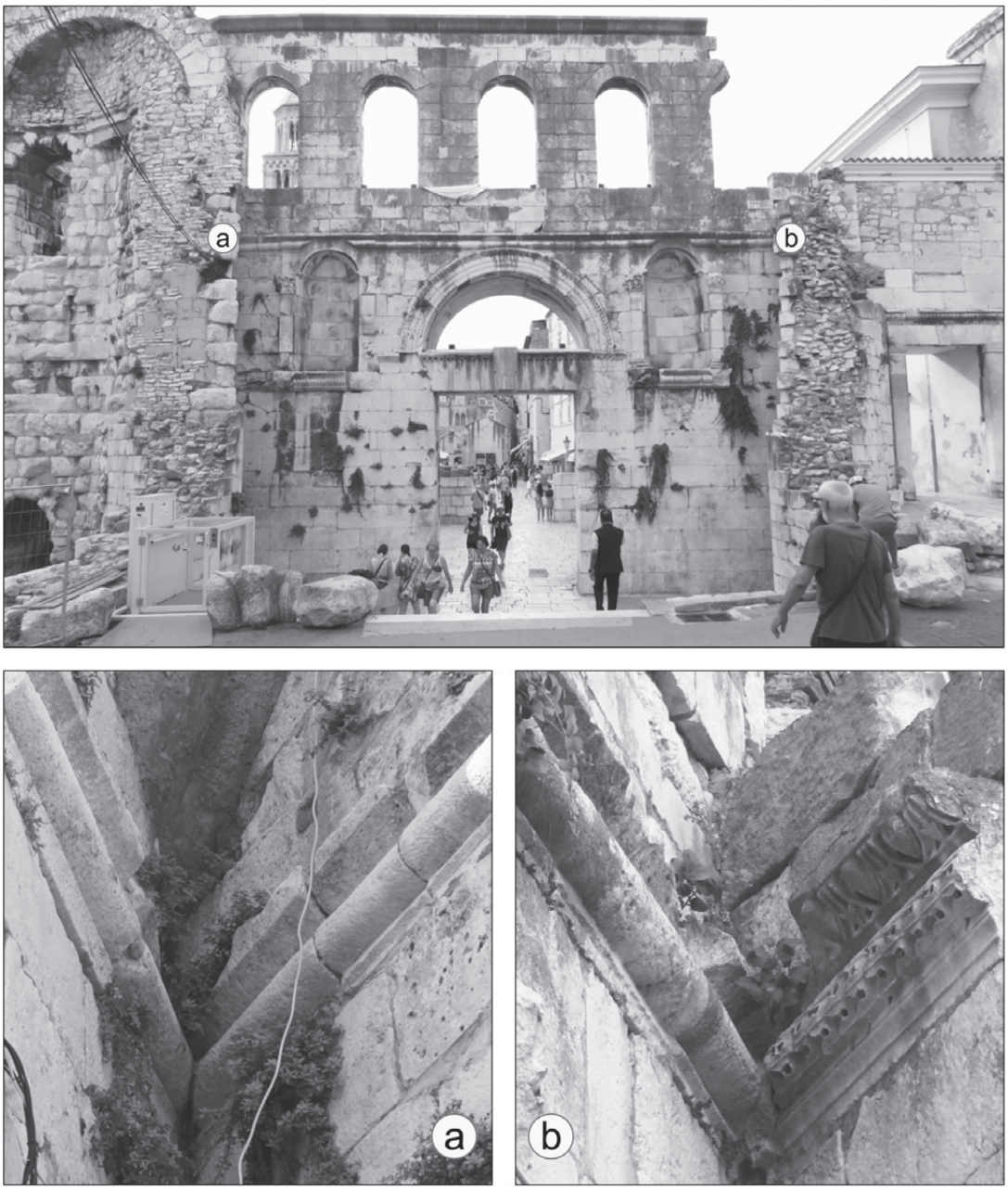


1 Restitution of the ground plan of Diocletian's Palace (graphics: J. Marasović, updated by K. Marasović 2020)

On the East Gate, two preserved string course blocks of the South Tower are plain, their profile seeming to correspond to that on the façade (fig. 2 a), while on the opposite, northern tower (fig. 2 b), the one block preserved *in situ* is decorated (a motif of overlapping laurel leaves is applied to the convex profile, egg and dart on a raking fillet, and bead and reels on astragal inserted between two profiles). The profile of this block differs slightly from one of the blocks on the façade (however, due to the position of the block, it is not possible to see the details). A similar situation appears on the West Gate: the string course on the façade is plain, while the only block of the northern octagonal tower preserved *in situ* is decorated (the motif on a convex part corresponds to that on the block of the East Gate tower, while an anthemion motif is applied on the raking fillet). The profiles of this block and the blocks of the façade clearly differ, which is visible on sections drawn by G. Niemann[1].

The string course does not traverse the façade of the North Gate (fig. 3). On each lateral edge of the facade, hidden from view by the tower projection, there are two string course blocks. They seem to represent a sort of extension of the tower string course on the façade. The first block on the east façade edge is decorated (having the same repertoire of motifs as the block of the West Gate tower), while the others are plain (fig. 3 a–b).

[1] Niemann 1910, fig. 37.



2 East Gate, joint of the string course of the façade. a: South Tower. b: North Tower (photos: K. Marasović)

We can assume that the string course on all octagonal towers was decorated[2]. The use of a plain string course on the façade but decorated ones on the octagonal towers is, according to S. McNally, a planned contrast – a plain string course harmonises the more complex layout of the façade, while on the rather simple towers, it represents a visual accent[3].

The question arises of the inconsistencies in the positioning of decorated blocks on the gates. The given examples show that these inconsistencies occur in positions that were not visible or

2 In their ideal reconstructions of the North Gate, G. Niemann, and E. Hébrard and J. Zeiller show the decorated string course on the towers, see Niemann 1910, pl. 4 (giving in perspective the connection between the façade and the West Tower and a joint of the plain and decorated string course block); Hébrard – Zeiller 1912, pl. on p. 34.

3 McNally 1996, 24.

were scarcely visible, being hidden by the octagonal towers. Therefore, they could be connected to or caused by the construction dynamics, and by economisation of time and resources by reducing unnecessary adjustments[4].

Several semifinished elements of architectural decoration exist on the North Gate. In the upper façade level, there is a row of six large consoles (which once supported a semi-engaged archivolted colonnade). They reveal different stages of moulding and completion of the decor (fig. 3 e–j). Consoles belong to the S-volute type, with *pulvinus* decorated by a laurel leaf bundle. On the lateral sides, S-volutes are framed by horizontal and vertical raking fillets, while two horizontal raking fillets represent the upper and lower framing elements on the front side. On the bottom side of the consoles, two motifs are sculpted: an acanthus leaf on consoles e, f, i, and j, and a taurine-human head on consoles g and h. The outer lateral sides of consoles e and j were hidden by the octagonal towers. On the east lateral side of console e, there are only plain framing raking fillets and the edge of the console (corresponding to the contour of an S-volute) (fig. 3 e). On console j, the S-volute is carved up to a certain point of plasticity, and the horizontal and vertical raking fillets framing the S-volute are plain (fig. 3 j). On the front side, the *pulvinus* has not been carved; this side has a plain raking fillet topping the flat surface of the stone block. The leaf applied on the bottom side of console j shows different degrees of plasticity – the plasticity of the visible half of the leaf is completed, while on the half the sight of which was blocked by the tower, it was left unfinished (fig. 3 b)[5].

Console g is the only console with completed decor (fig. 3 g). Other consoles have some undecorated elements, or the carving of the motifs reveals different stages of completion: on the east lateral side of console f, the relief carving of the motif on the vertical raking fillet is rather shallow (fig. 3 f), and it is the same on the west lateral side of console h, while on its east side, this element is not decorated (fig. 3 h). On both lateral sides of console i, the framing raking fillets are undecorated (fig. 3 i).

Another element of architectural decoration on the North Gate reveals some unfinished parts – the pilaster capitals of the niches flanking the gateway. On their sides, the acanthus leaves may be semifinished precisely on the parts closer to the façade wall[6] (fig. 3 c–d). On the fronts of the capitals, leaves and the other elements are completed. It is quite possible that column shafts were placed in front of the pilasters, so visibility thereof was reduced, or even completely blocked[7]. However, if this was the case, it is rather interesting that all the elements on the front of the pilaster were entirely finished.

PERISTYLE AND PROTHYRON

From the central square of the palace – the Peristyle – access is gained to two temenos areas placed at the sides, and on the south side, to the monumental porch of Diocletian's residence – the Prothyron (fig. 4 a).

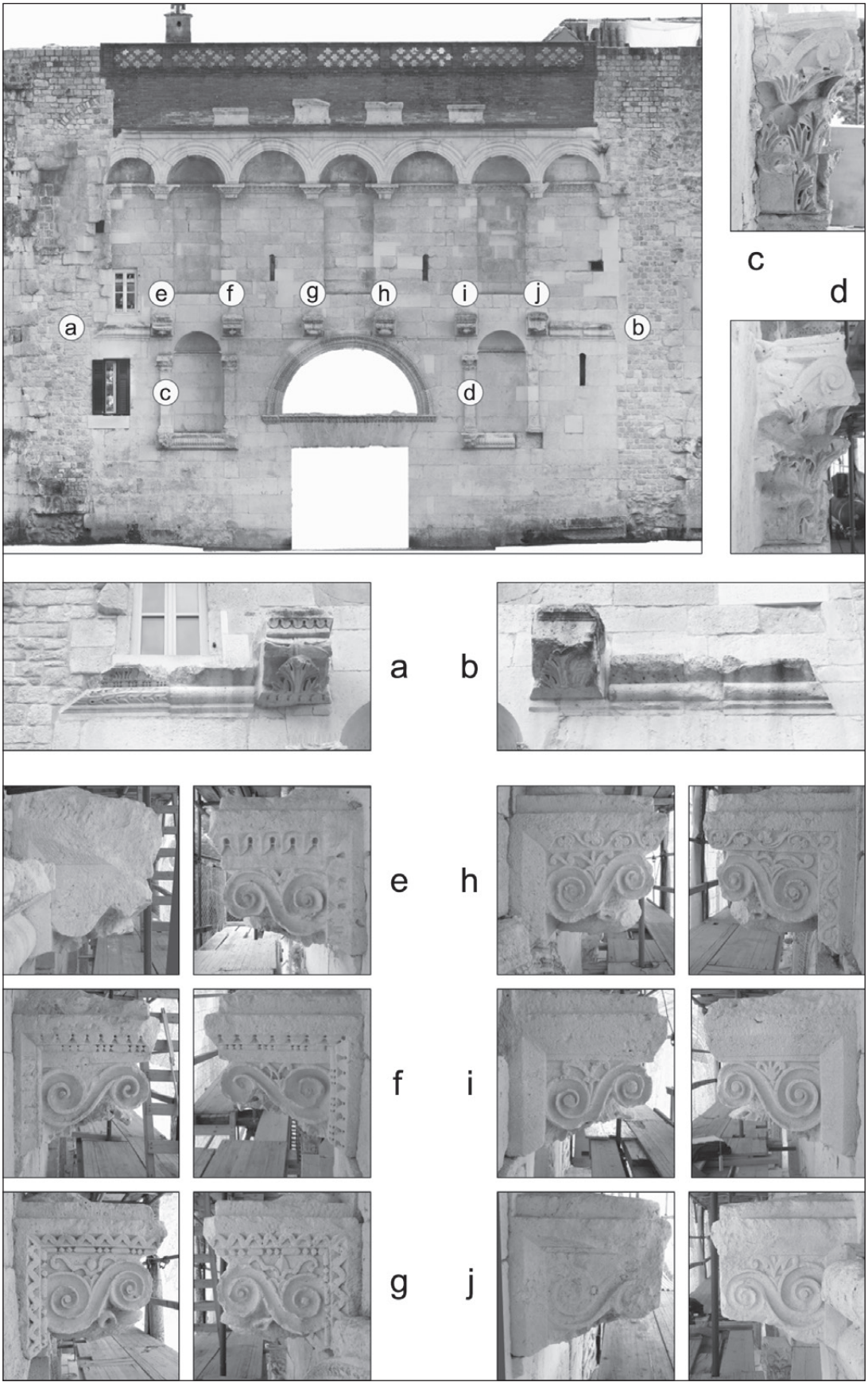
The sides of the Peristyle consist of archivolted colonnades, bearing walls surmounted by crowning mouldings (composed of architrave, convex frieze and Corinthian cornice). Column shafts, probably *spoliae*, are made of two types of *marmorae* (Proconnesian and red Asuwan

[4] McNally 1996, 24, assumes that these inconsistencies could also be caused by the engagement of different crews working on the production of these elements.

[5] G. Niemann (1910, 23 f.) mentions that the consoles e and j were not decorated on the outer non-visible lateral sides. His drawings figs. 21 and 22 show different stages of motif execution on the vertical and horizontal fillets of the frame on the lateral sides. E. Hébrard and J. Zeiller (1912, 41) give a drawing of one console (probably the one marked as console i in this article, with some differences in details) with plain frame raking fillets on a lateral side.

[6] Matetić Poljak 2009a, 207 fig. 29.

[7] Opinions differ on the question of whether colonettes were placed in front of the pilasters, see McNally 1996, 24. G. Niemann (1910, pl. IV) shows pilasters visible on his restitution of the North Gate, while E. Hébrard and J. Zeiller (1912, fig. on p. 34) place the colonettes carrying an arch in front of them.



3 North Gate. a–b: String course of the façade. c–d: Pilaster capitals. e–j: Consoles (photos: M. Žabčić, D. Matetić Poljak)

granite). The other elements (bases, capitals and entablature) were produced in local limestone. Originally, the *intercolumnii* were closed by stone grids. The entrance to the temenos areas was arranged in the fifth *intercolumnium* counting from the *decumanus*. The east colonnade is today completely visible, while a large part of the west one is incorporated in the walls of posterior buildings.

A closer look at the east colonnade reveals unfinished parts on different elements: column bases, capitals, and cornices. Column bases belong to the Ionic-Attic type with a plinth. One-half of the base, that facing the Peristyle, has completely carved moulding consisting of two toruses and scotia, while on the opposite side, the one facing the temenos area (which was not visible), the moulding represents a semi-fabricated stage – above the plinth, a raking fillet and a fillet succeed. An interesting inconsistency is related to the stages of carving of the moulding of the bases flanking the entrance to the temenos (both their sides were visible): on the base flanking the entrance from the north side, it is completed, while on the other, south of the entrance, it is not (fig. 4 g).

The Corinthian capital of the fourth column counting from the *decumanus*, has some elements of the upper register left roughly shaped and unfinished (one abacus corner, a volute and a caulicole below it) on the side facing the *intercolumnium*. Viewed from the square, this ›anomaly‹ is barely noticeable[8] (fig. 4 h).

The crowning cornices of colonnades have a few unfinished or semifinished parts. On the same block, it is possible to find plain and decorated consoles and plain and decorated coffers beside each other (as is the case for the east colonnade pillar, where parallelepiped plain consoles with amorphic protuberant forms in the coffer centres are followed by completely decorated ones) (fig. 4 f). The degree of motif completion may vary from fully elaborated motif plasticity to just incised motif contours. The joints of adjacent blocs often show imperfections, caused by the process of installing finished decorated blocks in their positions. The adjustment of the joints of blocks sometimes results in a shortened width of coffers or consoles. The anthemion motif carved on *cyma recta* therefore has a ›sequenced‹ development. In some cases, these imperfections are caused by neglecting the order in which the finished blocks should have been installed (fig. 4 e).

The joint of the colonnade's cornices and horizontal cornices of the Prothyron pediment is surprisingly rough and imprecise[9] (fig. 4 b). The east horizontal cornice reappears on the temenos side, rotated at an angle of 90° in relation to the front of the pediment. Unfortunately, it is not possible to see if a segment of the cornice on the joint with the east colonnade pillar has been cut off or not. For a precise joint of two cornices at an angle of 90°, in order to maintain console-coffer alternation, a precise adjustment of consoles and coffers would have been needed. This was not done, and the edges of colonnade cornices at the joint seem to be cut in an improvised manner (fig. 4 c–d).

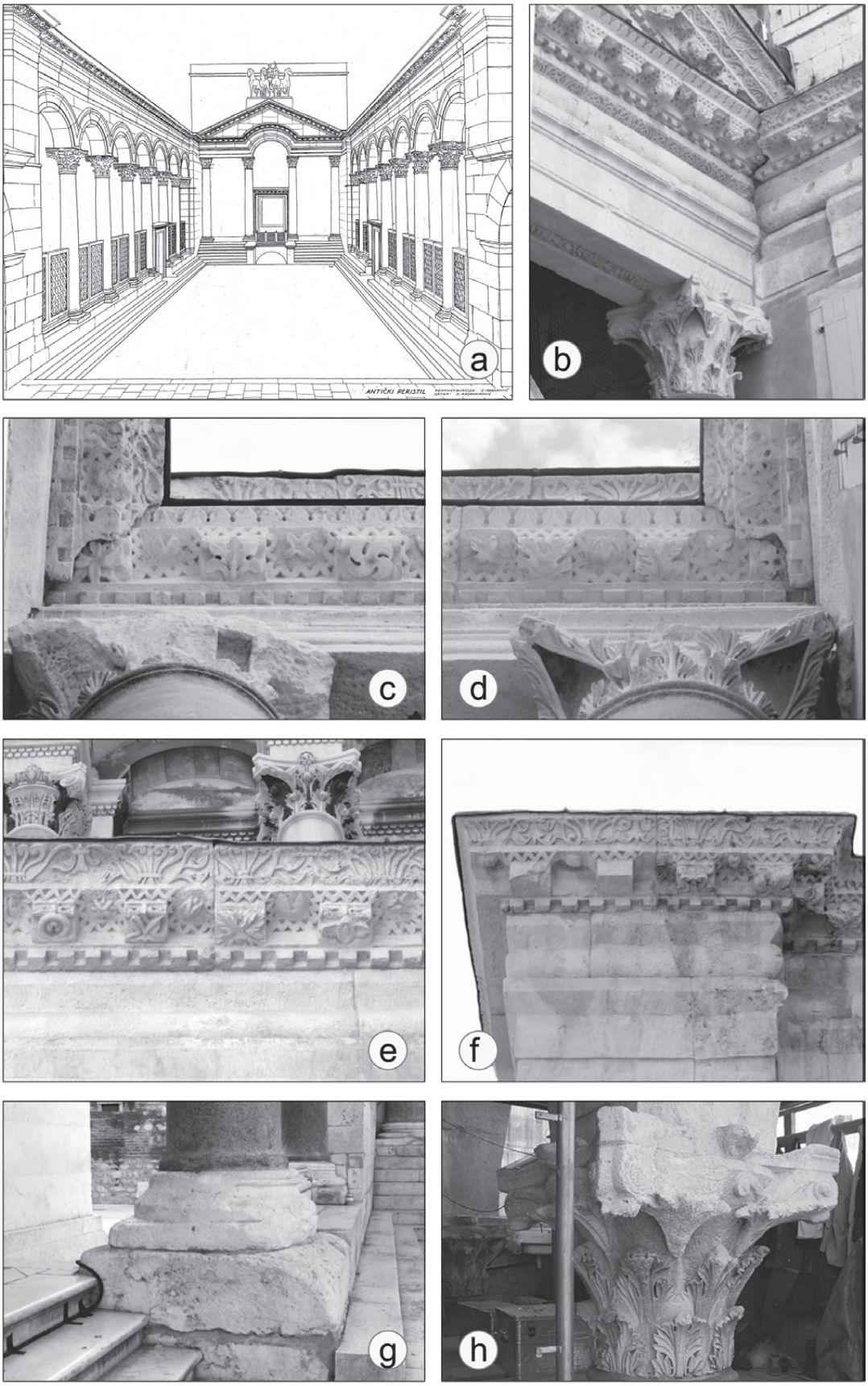
MAUSOLEUM

Enclosed by temenos walls, a view of the Mausoleum was given only through the colonnade of the Peristyle. Above the temenos walls, the upper part of the cella and the roof were visible from the *decumanus*, while from the south, the view was blocked by the wall enclosing Diocletian's residence. During the construction, this fact was taken into consideration (fig. 5 a).

The Mausoleum porch was destroyed by the construction of a medieval belfry. The central part of the porch was covered with a barrel vault, and the two sides by coffered rectangular slabs (fig. 5 b). Five blocks of the barrel vault have been found in the vicinity of the Mausoleum: they have coffers arranged in a so-called diamond-in-the-square scheme (fig. 5 d). On two blocks belonging to the first row of the barrel vault, the lower part of which was partially hidden by the

[8] Matetić Poljak 2009a, 204 fig. 10.

[9] G. Niemann (1910, 47) mentions a non-organic joint of two cornices, without entering into details.



4 a: Restitution of the Peristyle (graphics: J. Marasović). b: Joint of the Peristyle and Prothyron entablature. c: East corner. d: West corner. e: Colonnade cornice. f: Pylon of east colonnade. g: East colonnade base. h: East colonnade capital (graphics and photos: K. Marasović)

projection of the cornice below it, the decoration was carved only on a visible part, and the part that was not visible was left undecorated[10] (fig. 5 c).

The cornice of the portico still has eight blocks located *in situ* (on the south and southeastern sides of the octagon), and a few blocks have been found in the temenos[11]. As with the cornices of the Peristyle colonnades, different stages of motif completion (spanning from undecorated forms up to the completely finished ones) appear on consoles and coffers on adjacent or even on the same block. *Cyma recta* is sometimes plain, but mostly the anthemion motif is carved in different degrees of plasticity. The ›sequenced‹ development of the motif here is also caused by the order of installation of blocks and by the adjustment of their joints (fig. 5 e). A certain number of blocks found in the temenos area exhibit different degrees of motif completion. Even though it is not possible to determine their original position, we can assume that it was on sides of the octagon which were not visible through the Peristyle colonnade.

The Ionic cornice crowning the Mausoleum is decorated with anthemion on the *cyma recta* and with a zig-zag motif on the cornice base. On those sides of the octagon which were clearly visible from the *decumanus*, the motifs are completed, while on the south, southeast and southwest sides, some blocks are completed, but there are also blocks with plain *cyma recta* and plain cornice base and plain *cyma recta* and a zig-zag motif on cornice base (fig. 5 f).

In the interior of the Mausoleum, two architectural orders are superposed. As most of the entablement elements were replaced with replicas during the restoration in the 19th century, we will confine ourselves to the presentation of two different cases of incompletion.

Behind the column capitals on both architectonic orders, pilaster capitals are inserted in the cella wall. They are not clearly visible, as the columns partially cover them. The fronts of the pilaster capitals are entirely completed, while on the narrow sides, some elements may be partially finished: parts of the acanthus leaves and the angular volutes.

The frieze running under the dome represents the best-known example of unfinished architectural decoration and sculpture in Diocletian's Palace. Originally it was composed of 24 panels (one was destroyed by opening the window in the east wall in the 17th cent.), with scenes belonging to four iconographic themes: erotes carrying garlands (above which a mask is placed) or erotes holding laurel wreaths inside which a bust appears (one identified as Diocletian, one as Diocletian's wife Prisca and the third representing a head with a wing-like form on the top), erotes in hunting scenes and erotes in a chariot race. Reliefs are made in a summary manner on all plates: the contours of the figures rising from the background are undercut, the figures are lacking details and the finishing is rough. There are several panels with unfinished parts and one on which the entire motif lacks the finishing touch (representing defined figure contours raised from the background) (fig. 5 g).

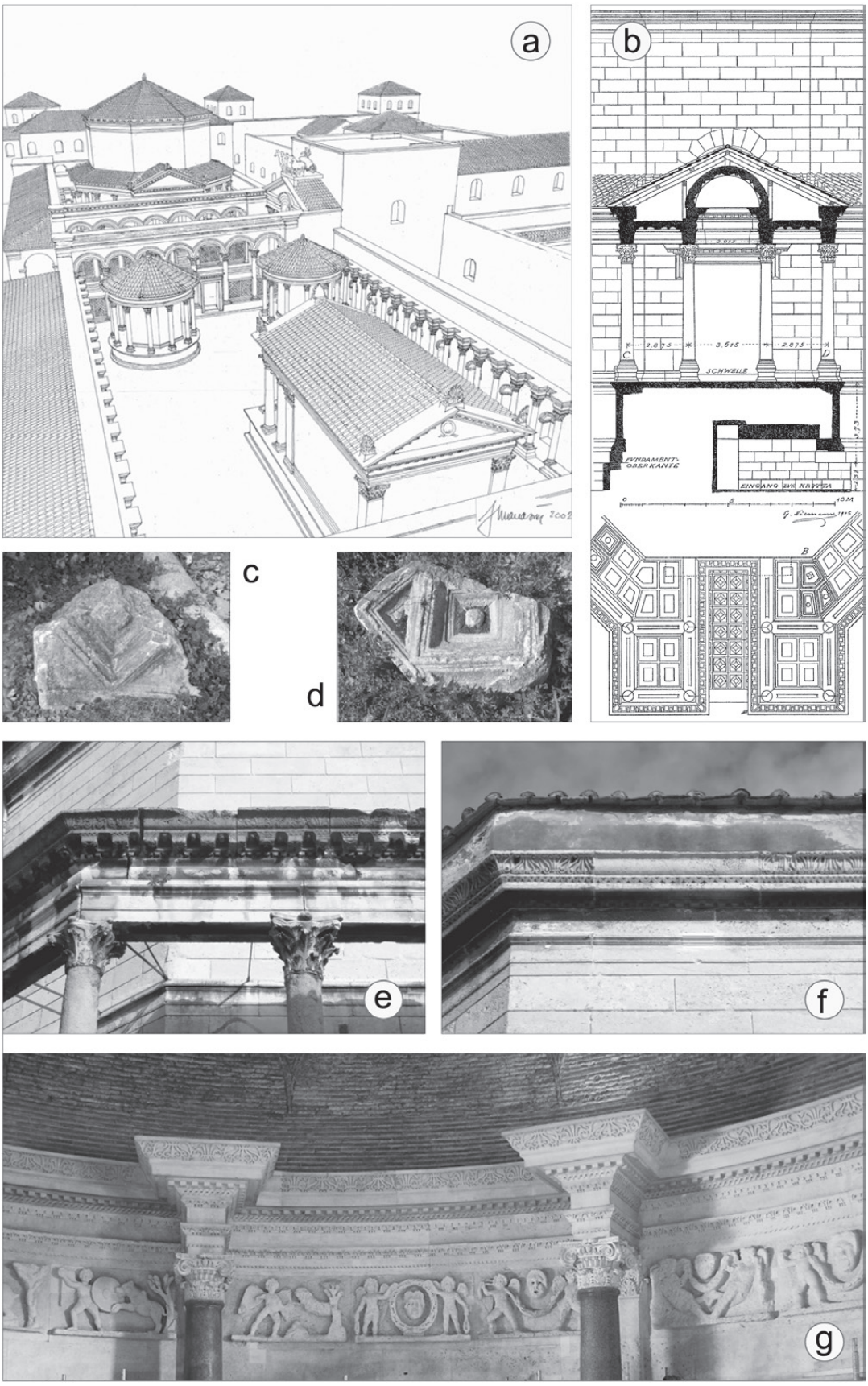
These scenes had an important iconographic and symbolic value, which is why it is quite unusual that we find different phases of carving in them. The hypothesis that the relief was covered with stucco has been rejected, since no traces of that material have been found. Relating the rough modelling to the engagement of local workshops is also questionable, as local workshops were skilled in dealing with local limestone[12]. Placed under the dome at a height of 12 m, with a weak light entering the cella through the main door and an arch above it, relief details were barely visible, so the choice of rough modelling of the figures is quite understandable. It is possible that the installation of unfinished panels was a result of the construction dynamics.

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10 Matetić Poljak 2009b, 790–792.

11 Recently, two blocks have been reinstalled on the entablature on the north west side of portico (however, there is no evidence that they were originally in that position).

12 Marasović – Marasović 1968, figs. 61–89; McNally 1996; Cambi 2005, 170 f. N. Cambi thinks that the rough modelling of the figures is caused by the engagement of local workshops carving new model patterns. This is probably not the cause: the patterns are not so complicated and local workshops were skilled in carving local limestone.



5 a: Restitution of the sacro-funereal zone (graphics: J. Marasović). b: Mausoleum porch (from Niemann 1910, fig. 90). c–d: Coffers of Mausoleum porch's barrel vault. e: Portico cornice. f: Crowning cornice. g: Frieze in the Mausoleum (photos: K. Marasović)

PROSTYLE TEMPLE

The rectangular temple is rather well preserved, but its porch no longer exists[13]. This building has several richly ornamented zones: in the exterior – the east wall *antae* and entablature (only the architrave is preserved), the frame and cornice of the cella door, the entablement on the south, the north and west walls, and the pediment on the west wall; in the interior – the cornice crowning the wall and the barrel vault. In almost every zone, there are unfinished, imperfect, and in some cases wrongly made elements.

On the east wall, which was partially hidden by the porch columns, there are two cases of unfinished mouldings and motifs. The base moulding of the north anta consists of flattened Ionic-Attic moulding, but as it passes to the wall, the moulding is simplified, constituting raking fillet and fillet. On the south anta, mouldings are reversed: a simplified form is applied on the antae base, and flattened Ionic-Attic moulding on one block on the wall (fig. 6 b). A similar situation is repeated on the antae architrave, which has the lower dividing moulding decorated with bead and reel, and the crowning moulding with eggs and darts, while these motifs are omitted on the adjacent architrave of the wall (fig. 6 c).

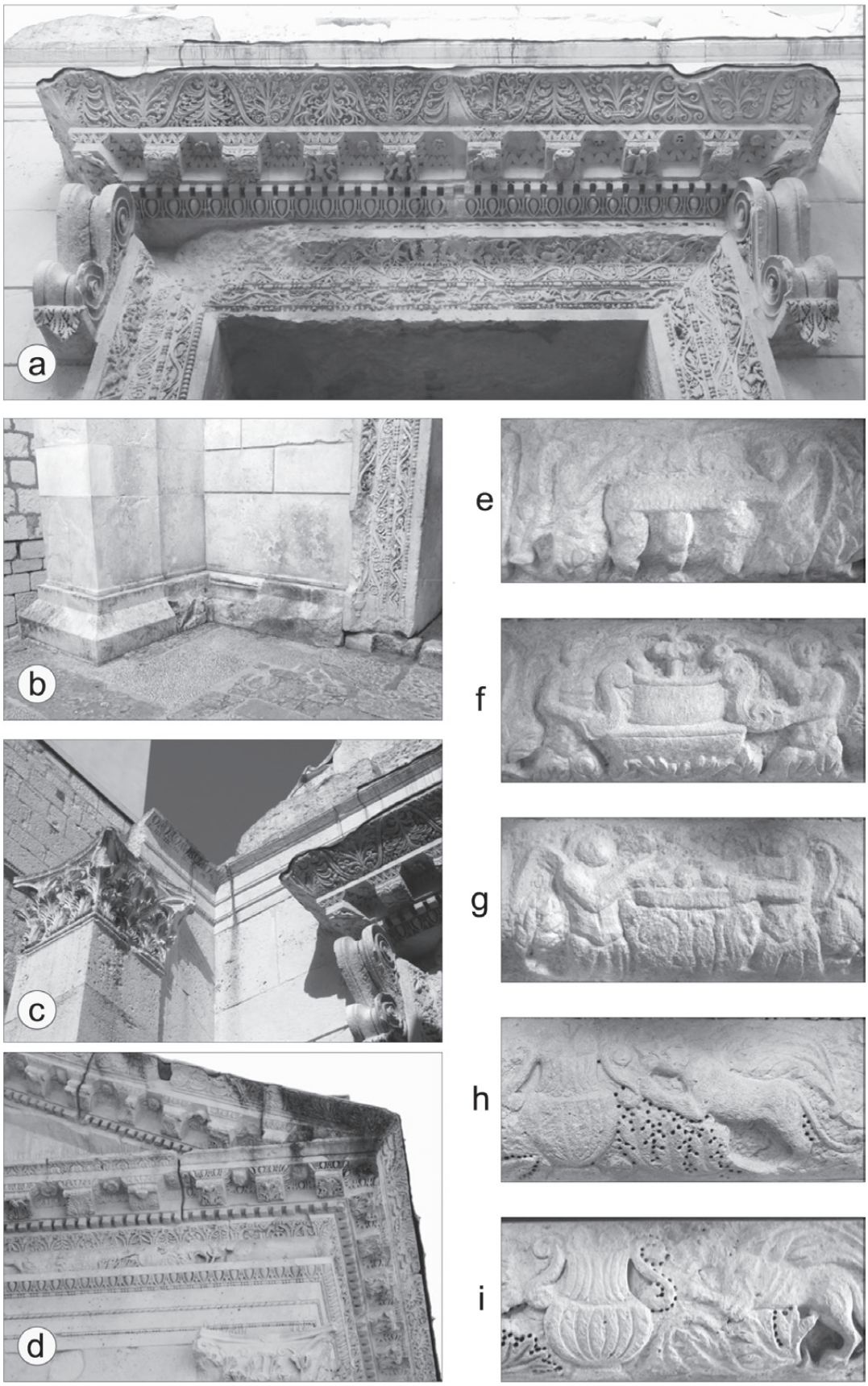
The frieze and cornice crowning the building are well preserved on three sides of the temple (north, south and west sides), but the pediment and the cornices of the porch have been destroyed. As is often the case in the palace, the frieze is convex, crowned by raking fillet. Different degrees of incompletion are present on the frieze on the west side. A smaller part of it (northwest angle of the temple) is incorporated into a posterior house, therefore a narrow segment is covered by the house wall. The crown moulding is decorated by a stirrup-framed leaf and darts. The central frieze block and the block at the southwest temple angle are plain and the motif of crown moulding on the central block is outlined. Different iconographic themes are represented on two larger frieze segments. Scenes on the left (north) segment represent vegetablised erotes and are therefore linked to the frieze running along the north side of the temple, which is composed of different scenes involving vegetablised erotes and lion griffins. Scenes on the right (south) segment are linked to the frieze on the south side of the building, composed of a repetition of pairs of antithetical griffins confronting a kantharos.

On the left segment, five scenes are represented, separated from each other by acanthus plants: the first shows an eros cutting a branch off a plant; the second, two erotes placing round objects on a tripod (fig. 6 e); the third (the central one), shows two erotes each holding the anse of a kantharos (in which a palm-like plant is growing), one putting his hand in the kantharos, the other putting in, or taking out of, the kantharos a round object (fig. 6 f). After this central scene, the second and the first scenes are repeated in symmetrical order.

The carving of scenes stopped in the early stage of the process. In the first, second, and third scenes (counting from the left), the contours of the figures are deeper, the shaping and gradation of plasticity has begun, and the forming of the sunk background has started in several areas (fig. 6 e–f). As the frieze profile is convex, on the bottom side (visible from the ground), the degree of figure plasticity in this carving phase is stronger and the contours are deeper and clearer, in contrast to the rather shallow ones on the upper part of the frieze. In the fourth and fifth scenes, only shallow contours of figures are present, and these are difficult to distinguish from the background (fig. 6 g).

A similar situation appears on the right segment of the frieze, where a scene with griffins and kantharos is repeated twice, separated by a foliate mascaron. Besides simple outlining of the figures, drilled holes in some areas are used during the first stage of figure separation from the background; in some areas the background has been carved and the shaping of the gradation of figure plasticity has begun (leg of a griffin) (fig. 6 h–i).

[13] Scholars sometimes designate this temple the Temple of Jupiter or Small Temple.



6 a: Door cornice of the Prostyle temple. b: Anta base. c: Anta architrave. d: Pediment and entablature on the west side of the temple. e–i: Frieze on the west side of the temple (photos: D. Matetić Poljak)

Carving of the west frieze was obviously abandoned at an early stage. These scenes (especially the ones with erotes) had an iconographic and symbolic content. Therefore, the question of why they were not finished necessarily arises[14]. It is possible that acceleration of the tempo of construction was the main reason. We should keep in mind that the visibility of the frieze was reduced by its position and by a temenos wall (erected at the distance of 2 m), and this is therefore a position where it would be easy to make economies in the execution.

Both horizontal cornices crowning the building and the posterior pediment have unfinished elements similar to those in the cornices of the Peristyle and Mausoleum, including a certain number of acanthus leaves on consoles, coffer soffit central motifs and frames, partially finished motifs on the crowning cornice, or else the cornice is left plain. Due to the adjustment of the joint of two adjacent blocks, the width of the consoles and soffit coffers may be shortened. The development of the anthemion on *cyma recta* is often sequenced. On the west side of the temple, they are more frequent (fig. 6 d).

The crowning wall cornice, running on three walls in the interior, reflects a similar practice in the composition of adjacent blocks and the adaptation of their joints (fig. 7 e). An interesting approach in joining two cornices at the cella angles exists: at the northwest angle, two consoles are fused into one, forming a rather unusual M shape, while at the southwest angle, the cornices enclose a square coffer (fig. 7 c–d). The use of two different ›angle solutions‹ represents, on the one hand, another example of inconsistency in the palace, and on the other, a quite creative result of improvisation during the work process, which facilitated assembly of the blocks.

The temple is vaulted by a barrel vault, composed of forty voussoirs, each containing two coffers (fig. 7 a). Every coffer has a central motif (a masque, floreal, or vegetal motif, fruit basket, etc.) and a coffer frame composed of seven ornamented zones. On several voussoirs in the first row, similarly to the coffers of the Mausoleum porch barrel vault, the lower horizontal coffer frame side and a part of the vertical frame side are plain, as these parts were not visible, being hidden by the cornice crowning the wall[15] (fig. 7 b).

The temple door cornice is an evident example of imperfection in the corpus of the architectural decoration of the palace. Unlike the monolithic door cornices of the Mausoleum, Prothyron and Vestibule[16], it consists of two blocks of similar length, joined at the door axis (fig. 6 a). This joint indicates that something went wrong during its production. At the centre of the cornice, there is a coffer, and part of its frame and soffit are carved in one block, and the right frame side on the other. The development of the anthemion on *cyma recta* is interrupted at the joint. On the right block (the north one), a small part of the *cyma recta* near the block edge is left undecorated. The length of the monolithic cornice probably exceeded the planned dimension and needed to be corrected. As it was not possible to correct the length at block angles (the cornice has pentagonal consoles at angles), a part of it (probably corresponding to one console and one coffer) was cut off in the centre of the block, and therefore the block was divided into two segments[17]. The carving of the anthemion was stopped before this correction.

SOUTHERN FAÇADE OF THE PALACE

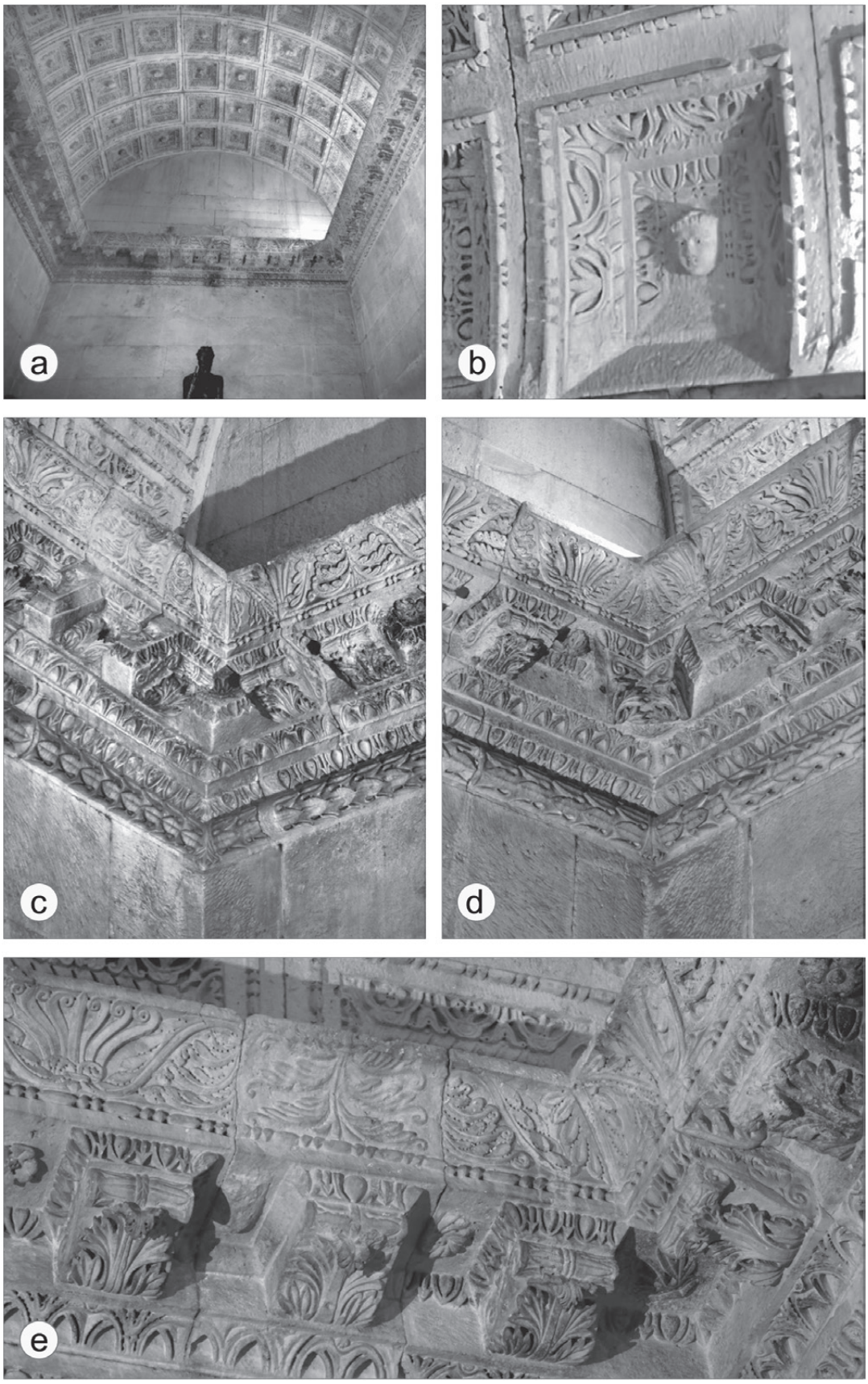
The southern façade of the palace offers examples of imperfection and of inconsistency regarding unfinished motifs. An engaged colonnade runs along the façade with three large loggias (one in the centre and one at each end of the colonnade) and by one large semicircular opening arranged

[14] McNally 2009, 289, assumes that, due to their iconographic importance, the scenes with erotes were intended for some other position in the building (probably the front east side), but were installed impromptu in the current position. There is no evidence for this hypothesis.

[15] McNally 1996, 61.

[16] Traditionally called the first room of Diocletian's apartment.

[17] Cambi 2005, 171.



7 a: Interior of the Prostyle temple. b: Coffer of the barrel vault. c: Cornice south corner. d: Cornice north corner. e: Cornice (photos: Ž. Bačić)

in between them (fig. 8 a). Except for the columns of the loggias, all colonnade elements are made of local limestone. The imperfection of this colonnade is visible on the capitals (of quite an original type with plain calathus and simple abacus) whose heights vary (corresponding to the height of the wall block in which they are carved) (fig. 8 b). The unfinished motif carving is visible on the crowning moulding of the frieze of the east loggia: on one horizontal frieze block it is decorated with stirrup-framed leaves and darts, while on the other horizontal blocks and on the arch, this moulding is plain (fig. 8 c).

Due to the narrow seafront in front of the palace (12.4 m), the entire southern façade was visible only from a distance, from the sea[18]. The obvious difference in the height and dimensions of the capitals can be explained by the fact that a closer view of them was not possible, no attention therefore being paid to unifying the height.

CONCLUSION

The incompleteness and imperfections of elements in the corpus of architectural decoration of Diocletian's Palace in Split, are not exclusive to this monument. Numerous examples exist in Roman architecture throughout the centuries[19]. In Late Antiquity, as mouldings and relief of motifs were simplified, they became more obvious (however, there is still not enough evidence to prove that they were more frequent)[20]. No study devoted to this interesting issue of architectural decoration in the palace exists. To date, scholars have addressed only some examples[21]. However, despite the early stage of research into this topic, the examples presented permit some general conclusions. It is only on elements or ensembles made of local limestone that incompleteness or imperfection can be discerned. Unfinished elements fall into two categories: elements with unfinished mouldings and elements with unfinished motifs. Most of those elements were finished at the construction site, before or after they were placed in their position in the building. The position in the decorative ensemble when built in often creates imperfections, caused by the placing side by side of completed and incomplete elements and by adjustment of the joints of finished blocks before incorporation. These imperfections are noticeable in the sequenced development of certain motifs and in varying dimensions in the element's components due to cutting off components of the moulding, etc.

The position of these elements and ensembles is usually one of reduced visibility (due to height or to the view being blocked by another element), so they do not disturb the perception of the decorative programme of the buildings as a whole.

The degree of completion of an element is connected to the construction dynamics and economising on the work process (the finishing of hardly visible element parts was probably considered an unnecessary expense in terms of time and work). However, the question of why the completion of iconographically important scenes of the Prostyle temple and the Mausoleum was abandoned is still intriguing.

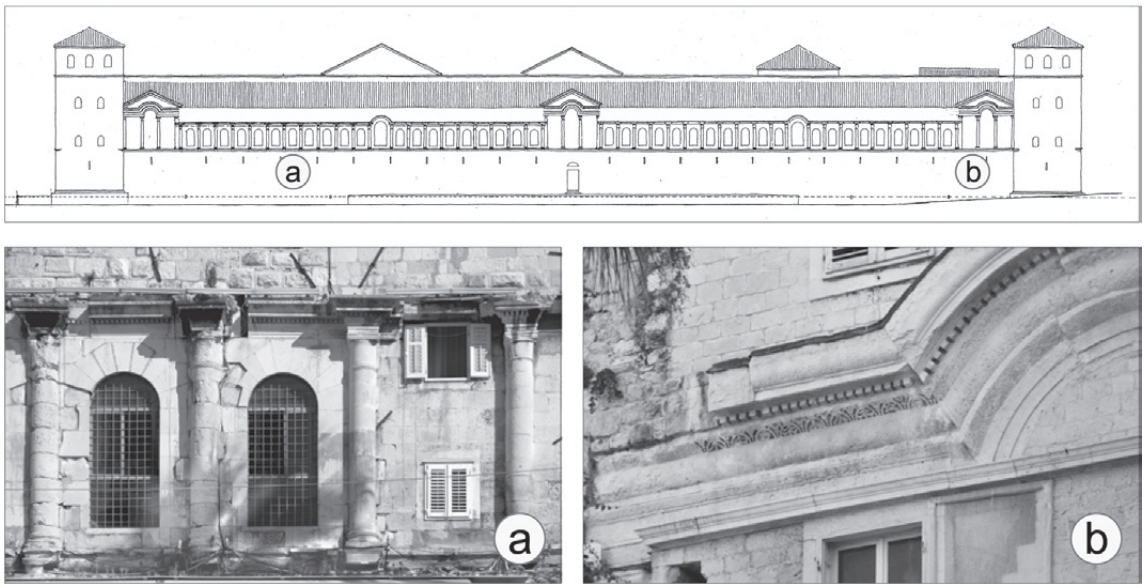
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18 Marasović 2019.

19 Amy – Gros 1979; Adam 2005, 53–61; Milella 2019.

20 Caré 2005, 63–78, enumerates examples of semifinished elements from the Tetrarchic period in Rome.

21 McNally 1996; S. McNally (2002; 2009) discusses inconsistencies of finished and unfinished motifs on land gates, the unfinished or semifinished relief panels in the Mausoleum and friezes of the Prostyle temple; S. Buble (2009) mentions discontinuity of motifs on the cornices of the Prostyle temple and Prothyron pediment, and the semifinished block of base profile of the Prostyle temple. L. Crema (1959; 1960), N. Duval (1965) and H. Kähler (1965) also refer to unfinished elements.



8 Restitution of the south façade. a: Segment of colonnade. b: East loggia entablature (graphics: J. Marasović; photos: Ž. Bačić)

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Diego Romero Vera – Daniel Becerra Fernández

MARMORA REUSED IN THE CHURCH OF SANTA MARÍA DE LA OLIVA (LEBRIJA, SEVILLE, SPAIN)

Abstract
In this paper we study ten shafts from the Roman period that were reused in the church of Santa María de la Oliva (Lebrija). In particular, these spolia shed some light on public architectural programmes and on the types of ornamental rocks used in Nabrissa Veneria.

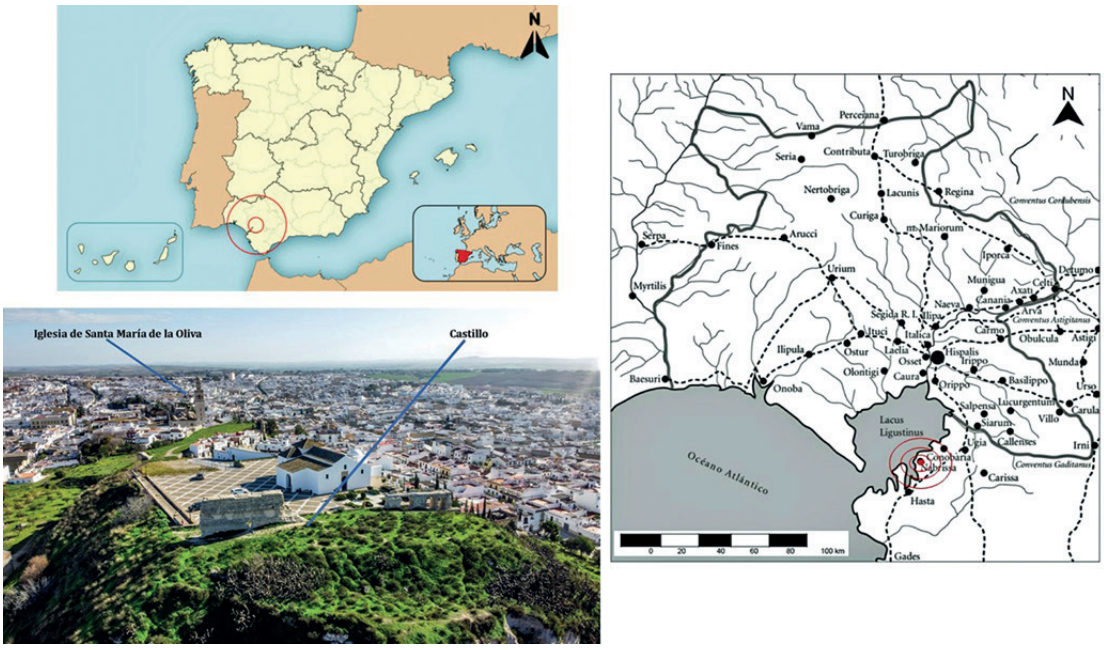
INTRODUCTION

Lebrija is a municipality with a rich history in the south of the province of Seville (fig. 1). Called Nabrissa in ancient times, it was a coastal town strategically located on a natural elevation (the present-day Cerro del Castillo Hill), which dominated a large territory on the eastern shore of the ancient Lacus Ligustinus. This area was therefore very favourable for the development of navigation and commercial contacts[1], as Strabo himself indicates[2], citing Nabrissa as one of those riverside cities. Pliny notes that Nabrissa was situated between the estuaries of the river Baetis and also indicates that the *cognomen* of the city was Veneria[3]. This has led some scholars to propose that Nabrissa Veneria was raised to the rank of a colony by Caesar. However, there is no epigraphic or archaeological argument to support this hypothesis, while the aforementioned epithet has been linked to the vernacular cult of the Morning Star, associated in Roman times with Venus Marina, protector of navigation[4]. However, it is most likely that this city received municipal legal status in the Flavian period, as did most of the Hispanic *civitates peregrinae*[5].

In recent times, especially in the last 20 years, some emergency excavations have been carried out in Lebrija. However, these archaeological works have shed little light on the urban morphology of the Roman city. Unfortunately, much of the information we have about Roman Lebrija comes from decontextualised chance finds, most of which have not been preserved and of which we have only a minimal description. These include tombs, remains of buildings, sculptures, coins, mosaics and some column shafts and capitals[6]. Special mention should be made of three examples of funerary sculptures of lions that were found in the city[7]. Despite all this, we know very little about this city in Baetica, and the scarce epigraphy does not offer much information about public life in this civic community.

The various studies on Nabrissa published to date have overlooked the architectural materials of undoubtedly Roman manufacture that were reused as building materials in the church of Santa María de la Oliva. Specifically, these are a group of ten marble shafts and an Ionic-Italic capital

1 Caro Bellido 1998; García Vargas – Ferrer Albelda – García Fernández 2008, 262–265; Trapero Fernández 2019.
2 Strab. 3, 1, 9; 3, 2, 5.
3 Plin. nat. 3, 3, 11.
4 Caro Bellido 1986/1987, 66–68.
5 Caro Bellido 1991, 38 f.
6 Bellido Ahumada 1985; Tomassetti Guerra 1997; Caro Bellido 1998.
7 Beltrán Fortes 2000, 438 f.

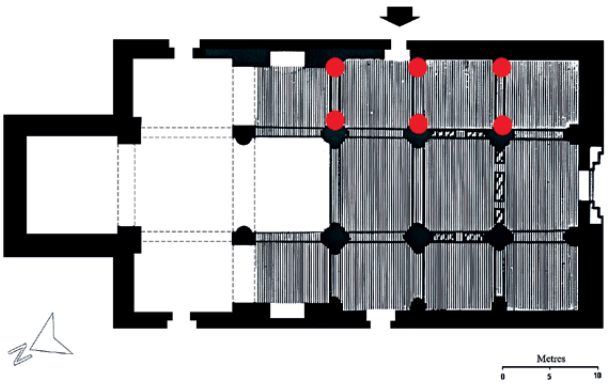


1 Geographical location of Nabrissa, the church of Santa María de la Oliva and the castle hill (Lebrija, Seville) (photo and graphics: D. Romero Vera, D. Becerra Fernández after Creative Commons content)

carved in calcarenite. This chapter will identify the ten marble shafts, but first the monument in which these spolia were reused must be described.

THE USE OF SPOLIA IN MEDIEVAL CHURCH BUILDING

Santa María de la Oliva is a church in the Mudejar style whose first phase dates from the reign of Alfonso X. Originally, the church had three naves supported by double horseshoe arches which, in turn, rest on columns attached to cruciform pillars[8]. Curiously, Roman shafts were used as supporting elements in the six pillars that delimit the two bays of the nave of the epistle. In the rest of the arcades, bricks or fragments of limestone shafts were used. Although it has been pointed out that the use of Roman materials in medieval buildings has a prestige component and that, likewise, in the time of Alfonso X there was a certain appreciation of antiquity, the fact is that in this case, there is no evidence of symbolic intentionality in their use[9]. The marble shafts are not placed in the most visible area or in the most sacred part of the church (fig. 2).



2 Location of the Roman marble shafts used in the medieval phase of the church of Santa María de la Oliva (graphics: D. Romero Vera, D. Becerra Fernández after Cómez 2005, 40 fig. 2)

8 Barroso Vázquez 1992; Cómez Ramos 2005.
9 Cómez Ramos 2012, 81 f.; Amores Carredano 2020, 65–76.



3 Reused Roman material assemblage in the church (photos: D. Romero Vera, D. Becerra Fernández)

The shafts show evidence of blows, possibly caused during their transport, and traces of having been repolished, which led them to lose part of their entasis. It is also striking that several fragments were adapted to obtain a complete shaft. Furthermore, fragments of marble and limestone were fitted together to obtain a complete shaft with the desired height. These operations reveal the effort involved in quarrying, moving and building with materials of different origins and qualities. The search for and extraction of these pieces and, above all, their adaptation to the new construction was necessarily a complex and costly activity[10].

From the point of view of the use of Roman material, it is noteworthy that only shafts were used, while no bases or capitals of that chronology were reused. In fact, the new capitals are decorated with Christian motifs of Romanesque and Islamic influence. This has led us to believe that they were made in a workshop where Muslim and Christian craftsmen trained in the north of the Iberian Peninsula worked together[11].

ANALYSIS OF ROMAN ARCHITECTURAL MATERIALS MADE IN MARMOR

Based on the above observations, we believe that these marble materials (fig. 3) may have belonged to buildings at Nabrissa that were located on or near the site of the medieval temple. It is true that this theory is impossible to prove, but certain evidence supports this hypothesis. First, we find other remains of building materials reused in the 16th-century phase of the church, specifically certain fragmented ashlars that retain traces of the use of *ferrei forfices*. It is therefore possible that these were brought to the surface during the opening of the foundations. Furthermore, in 2002, an archaeological excavation was carried out a few metres from the church in which Roman remains were documented at a level relatively close to present ground level

10 Greenhalgh 2009; Esposito 2012, 63–75; Utrero Agudo 2020, 34–40.
11 Cómez Ramos 2005, 36–38.



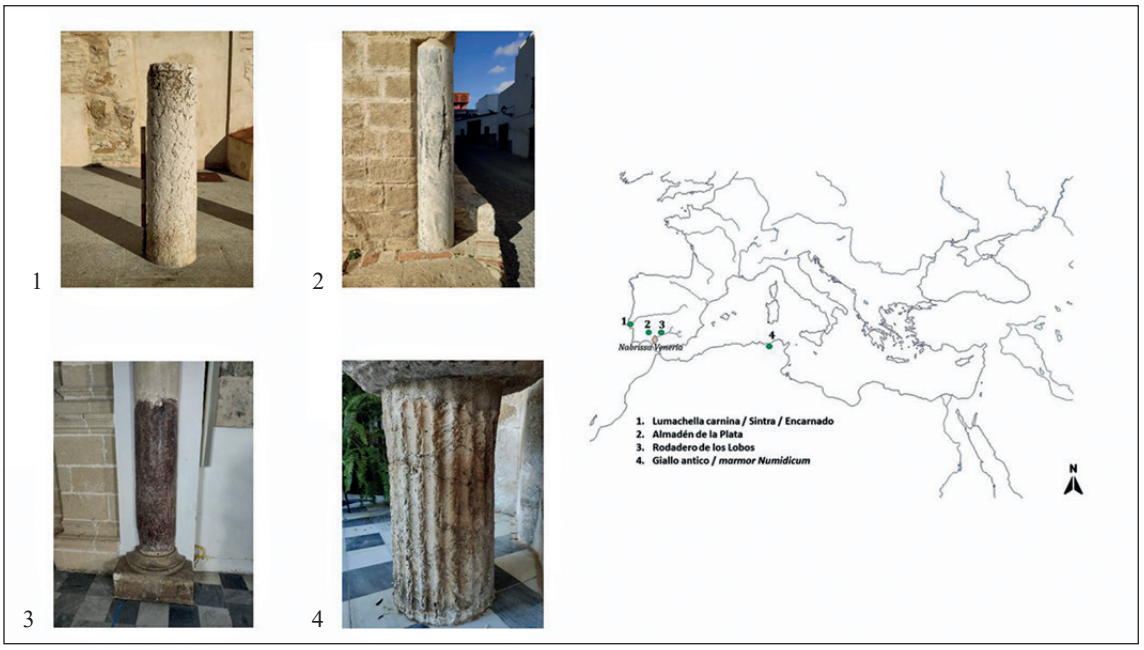
4 Baptismal font formed by a fragment of a Giallo antico shaft supporting an Ionic-Italic capital made of calcarenite (photo: D. Romero Vera, D. Becerra Fernández)

(specifically, a street with a brick vaulted sewer and the remains of several *domus*)[12]. However, the archaeological soundings carried out inside the church did not reach pre-foundational levels, so it is not known what the site was used for before the medieval Christian period or whether there were any structures from the Roman period[13]. Finally, there is evidence of the chance discovery of other presumably Roman columns in the vicinity of the church of Santa María de la Oliva[14].

It is very difficult to imagine the Roman buildings to which these shafts originally belonged because, unfortunately, we do not have bases and, above all, capitals that could provide us with a stylistic analysis. On the basis of their dimensions and raw materials, we can at least venture to attribute these materials to public buildings. We must, nevertheless, be cautious about attributing these pieces to the public realm because there is no general rule and there are many cases of large shafts being used in private buildings. However, marble shafts larger than 40 cm in diameter tend to belong to public buildings, while those between 30 and 40 cm are considered small and medium-sized and were usually used in peristyles and other domestic environments[15]. In terms of their dimensions, almost all the shafts analysed here are fragments (only one of them – shaft C in figure 3 – seems to be complete, as revealed by the presence of the sumoscape and the remains of the imoscape). However, as is well known, in Roman times the ratio between the diameter of the shaft and its height was 1 : 8[16]. Knowing the diameter of the shaft, we can assume that we would be looking at buildings with a shaft about 10 Roman feet high (with the exception of the two shafts of pink limestone marble from Sintra located on the outside of the temple). There is no doubt that these are polychrome monocylindrical shafts carved in marble of relatively good quality, mainly Marmor Numidicum from Tunisia, fossiliferous limestone from Sintra and, to a lesser extent, in material known as »Rodadero de los Lobos« limestone from the Sierra de Córdoba and marble from Almadén de la Plata[17]. Therefore, although the use of these materials in a religious building would not be unreasonable, we cannot rule out their belonging to other constructions of a public nature.

It seems clear that the shafts do not come from a single building. If we take into account variables such as raw material, typology and dimensions, we can establish as a starting hypothesis that the material reused in the church would come from at least four public buildings in Nabrissa. The most numerous group of shafts deserves special attention; they consist of five monocylindrical pieces carved in the same material, fossiliferous limestone from Sintra, which must have

12 Quirós 2006, 241–261.
13 Romero Vera (in press).
14 Bellido Ahumada 1985, 1–29.
15 Márquez Moreno 1998, 120 f.
16 Wilson Jones 1989, 37.
17 See below.



5 Map showing the areas of extraction of the marmora identified in the church of Santa María de la Oliva (photos and graphics: D. Romero Vera, D. Becerra Fernández)

originally been about 10 Roman feet in height and a foot and a quarter in diameter and which undoubtedly belonged to the same building in Nabrissa.

In the cloister, the »Patio de los Naranjos«, we find a baptismal font that reuses Roman materials (fig. 4). It consists of an Ionic-Italic capital made of calcarenite rock and a fragment of a fluted shaft made of Giallo antico, 40 cm in diameter and which can be broadly dated to the High Imperial period, that was used to support the baptismal font. This shaft demonstrates the use in Nabrissa Veneria of one of the most prestigious materials in the *orbis Romanus*.

TYPES OF MARMORA IDENTIFIED

The macroscopic analysis of the spolia in the church of Santa María de la Oliva in Lebrija identified marble from Almadén de la Plata – without ruling out the possible origin of the anticline of Estremoz – fossiliferous limestone from Sintra, also called Lumachella carnina, Giallo antico and the ornamental rock known as »Rodaderos de los Lobos« (fig. 5, 3). Most of the marble material present in this temple is of Hispanic origin, with the exception of one example of North African marmor. At present, archaeometric techniques are being applied to identify the origin of the marble used in the shaft that, to the naked eye, is made of marble from Almadén de la Plata, together with other white marble found in the current municipality of Lebrija. In the case of the other ornamental rocks studied, the help of archaeometry was not required, as their macroscopic characteristics make them recognisable.

- The marble from Almadén de la Plata (province of Seville) was a highly prized stone in western Baetica at the end of the Augustan principate[18], partly due to the proximity of the quarries to the navigable river Baetis, an important waterway that contributed decisively to the distribution of this material. It is found not only in a large number of Roman cities

18 Beltrán Fortes et al. 2018.

in the Guadalquivir Valley[19] and such other cities in Baetica as Baelo Claudia[20], but also in more distant areas such as Segobriga[21], the Balearic Islands[22] and North Africa[23]. The macroscopic characteristics of this material can be confused with those of the marble from the Estremoz Anticline, although this material is less frequent in Baetica. For this reason, we intend to carry out an archaeometric study in order to be able to categorically establish its provenance.

- The Giallo antico or Marmor Numidicum comes from Chemtou, Tunisia. It is a very compact, fine-grained, yellow recrystallised limestone with red and brown hues and can be easily identified[24], although some varieties can be confused with local ornamental rocks such as Santa Tecla stone, more compact and without its characteristic ribbing, or Buixcarrò stone[25].
- The Lumachella carnina, »lioz encarnado« or fossiliferous limestone from Sintra is pinkish, sometimes white or reddish, etc., with pinkish, vinous and sometimes whitish veins. In this ornamental rock we can observe many types of marine fossil remains and it is one of the marmora from Hispania documented in Rome[26], as revealed by some materials reused in the Basilica of Sant'Agostino[27] and certain columns used in the Villa Adriana. Even so, its use was not very frequent outside the Hispanic area. This limestone comes from Sintra, Portugal, and was extracted from a series of quarries located in the present-day »concelho« of Sintra. It is a material that began to spread throughout the Mediterranean at the beginning of the empire and was frequently used to make columns and floor coverings[28].
- The limestone known as »Rodaderos de los Lobos« has a purplish hue and was extracted from the area known today as »Cortijo Piquín«, in the vicinity of the city of Cordova[29]. It was exploited from the end of the Republican period – together with the »Piedra de Mina« – until the middle of the 3rd century AD, and later with Abd-al-Rahman III[30]. It appears constantly in the pavements of Madinat al-Zahra[31]. As a case in point, this stone material was used in Italica in the mouldings of three pedestals, now preserved *in situ* in the gallery of the portico of the theatre with a chronology dating from the Augustan period[32], as in the case of its use in Colonia Patricia[33]. Thus, the diffusion of this lapidary material is wider than initially thought, in line with other ornamental rocks from the Sierra de Córdoba; for instance, the »Piedra de Mina« documented in different parts of Italica[34] or in a *labrum* from Baelo Claudia which has not yet been published. These quarries and the dispersion of their materials are currently being studied within the framework of the project »Specific Archaeological Activity of Surface Archaeological Prospection of the Roman Quarries Located in the Southern Sector of the Ossa-Moren a Area: Sierra de Córdoba and Sierra Norte de Sevilla, in the Provinces of Cordova and Seville (Expte. 13558)«, led by M. L. Loza Azuaga.

19 Beltrán Fortes et al. 2012.
20 Álvarez Pérez et al. 2009a; Beltrán Fortes et al. 2018.
21 Álvarez Pérez et al. 2012.
22 Álvarez Pérez et al. 2012.
23 Beltrán Fortes et al. 2012, 269.
24 Price 2007, 90 f.
25 Álvarez Pérez et al. 2009b.
26 Belli 1842, 48.
27 Gnoli – Marchei – Sironi 2004, 240.
28 Mañas Romero – Fusco 2008, 513–515.
29 Ontiveros Ortega et al. 2021.
30 Ventura Villanueva – Gasparini 2017, 178 fig. 14.
31 Vallejo Triano 2010, 552.
32 Rodríguez Gutiérrez 2004, 51 n. 13; Loza Azuaga et al. 2021, 178 f.
33 Ventura Villanueva 2009.
34 Becerra Fernández 2019, 690; Ontiveros Ortega et al. 2021, 948 f.

FINAL REMARKS

According to the current state of knowledge, we can affirm that Roman marble and other elements of architectural decoration were reused in the construction of the Mudejar church of Santa María de la Oliva. This reuse in the medieval period seems to be more practical than symbolic, since the reused marble pieces were not located in the most prominent areas of the church and had a structural function. The Roman materials documented in the interior of the church are of a size that suggests they originally belonged to buildings with a shaft about 10 Roman feet high. Likewise, although this is an unsettled question, we consider that these shafts could have come from at least four public buildings in ancient Nabrissa Veneria. In this sense, the unitary group reused in the right aisle, made up of five shafts of Lumachella carnina, stands out. According to our hypothesis, those former buildings in Nabrissa would have been used as a quarry to obtain building materials for use in the medieval church. These Roman materials also include a calcarenite capital reused as the upper part of a baptismal font, which today appears to be supported by a fragment of a grooved shaft of Giallo antico.

The vast majority of the marmora reused in the church of Santa María de la Oliva in Lebrija are from southern Hispania, with the exception of the Giallo antico from North Africa, which is the only marble material documented from outside the Iberian Peninsula. The presence of this ornamental rock is evidence of the use in Nabrissa of one of the most important and prestigious marmora of the empire. Fossiliferous limestone from Sintra is the most abundant material among the shafts studied.

Finally, this study has served to analyse unpublished archaeological remains that reflect the execution of construction projects of considerable importance in Nabrissa Veneria, in which polychrome marble and white veined marbles were used. This brief study has therefore contributed to shedding some light on the use of marble in a Roman city for which we have little archaeological information.

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Raphael Rosenberg

SINCE WHEN HAVE STONE SLABS BEEN LAID SYMMETRICALLY – AND WHY?

Abstract
Book-matching is the symmetrical layout next to each other of slabs that were cut from the same stone block. It is a specific, nowadays ubiquitous technique whose history has yet to be written. The paper discusses the oldest existing examples of book-matching – in Ephesos (Terrace House 2) and Rome (Pantheon) – and concludes that book-matching was most likely invented in Rome around AD 100. The analysis of passages from Pliny that have not yet been considered together, shows that the invention of book-matching happened at a time when not only incrustations with coloured marble but more generally marbling with different materials elicited particular interest. The preliminary results of an eye-tracking experiment where test persons looked at different types of reproductions of book-matched slabs show that a) the eyes often follow the course of visual structures – the veins of the plain slabs and the symmetries of book-matched layouts; b) vertical symmetry axes stimulate the attention for symmetries more than horizontal axes; and c) participants seem to prefer irregular rather than flawless, artificially mirrored slabs.

INTRODUCTION

Polychrome stone patterns are among the oldest and longest-lasting forms of ornament – from the Neolithic to the present day. Grinding and polishing multicoloured minerals creates various patterns with veins and spots. The fact that over millennia these patterns were also realised in wood veneer, ceramics, glass, wall painting, and paper shows how popular they were and still are. I suggested using the term »marbling« as a wide-ranging denomination for irregular, variegated patterns and pointed to the fact that the aesthetic interest in marbling is probably an anthropological constant but also depends on habituation, since people in some places and some epochs used marbling more frequently than others[1]. The decoration of buildings with marbled stone slabs began at the latest in the Minoan culture of the 2nd millennium BC and remains current.

The continuity in the use of polychrome stone slabs is an exceptional phenomenon in the fluctuating history of taste. Historical changes do occur – depending on the one hand, on the availability and choice of the material, and on the other hand, on different layouts. Arguably, the major milestone in the history of polychrome marble incrustation is the invention of book-matching: the arrangement of reversed stone slabs sliced from the same block next to each other. Considering the ubiquitous distribution of book-matching despite the effort needed to implement it, there can be no doubt that it exerted and still exerts a strong appeal.

Although essential contributions were made recently, the history of book-matching remains understudied. In this paper, I try to pinpoint when and where this technique was invented and why it was and still is often used. The first section shows that book-matching was probably invented in Rome around AD 100. By analysing passages from Pliny that have not yet been related to each other, the second section argues that it was a time with an extraordinary interest not only in incrustations with coloured marble but more generally in marbling with diverse materials. In the third section, I try to explain the aesthetic appeal of book-matched incrustations, including references to an experiment with eye-tracking.

[1] Rosenberg 2021.



1 Ephesos, so-called Marble Hall of Terrace House 2, ca. AD 119 (photo: OeAW-OeAI/N. Gail)

THE EARLIEST OCCURRENCES OF BOOK-MATCHING

Book-matching is a specific form of *opus sectile*. Given that we do not have an ancient noun, we might use the neologism »*opus sectile symmetricum*«. Its history has not been systematically researched. We do not know who invented it, when and where, nor how its use was spread. A spectacular example of *opus sectile symmetricum* is the Cipollino verde revetment of the so-called Marble Hall (Room 31) of Terrace House 2 in Ephesos (fig. 1), excavated and reconstructed some years ago by the OeAI. Based on an inscription on the back of one of the slabs, it was possible to fix the date of the decoration of the hall to AD 119[2]. More recently, C. W. Passchier and his colleagues made a thorough geophysical analysis of the slabs and reconstructed their production in detail[3]. They distinguished close pairs of slabs separated by a saw cut (15 mm) and distant pairs separated by a saw cut plus two slab thicknesses. They thus reveal how sophisticated the technique of the stone cutters was, but they did not discuss possible models: are there any earlier mirrored claddings?

I am unaware of any intentional book-matched *opus sectile* that can be securely dated before AD 119 – neither in Roman nor in pre-Roman monuments, and not even Pompeian-style wall paintings. To avoid misunderstandings, we need to address the zebra-stripe decoration, which has been discussed as a fifth Pompeian wall painting style[4] and according to F. Barry mimicked book-matching[5]. Zebra stripes are a recurrent painted wall decoration in Roman Campania from ca. AD 50: parallel black and white stripes, usually divided into large panels framed by red or yellow borders. The stripes are often diagonal and mirrored within the panel (V- or X-shaped stripes) or between two panels (alternation of right- and left-slanting stripes)[6]. The zebra-stripe decoration is sober, simple to paint, and easy to recognise. S. R. Joshel and L. H. Petersen recently suggested that this pattern had a specific function: to mark the spaces where slaves would stay and move without an express order or invitation to do otherwise[7]. Since zebra stripes fill framed rectangular fields, it is arguable that they emulate stone slabs. Some authors have taken the similarity to stone blocks literally and suggested that zebra-stripe decorations imitate specific stones like Bardiglio. J. E. Rauws convincingly contradicted this argument and pointed out

2 Thür – Rathmayr 2014, 127.
3 Passchier et al. 2021.
4 Rauws 2015.
5 Barry 2020, 151.
6 See the examples in Oplontis: <https://hdl.handle.net/2027/fulcrum.6395w877s> and <https://hdl.handle.net/2027/fulcrum.3t945s38s> (22.07.2023). For a broader overview, see Goulet 2001.
7 Joshel – Petersen 2019, esp. § 614–620.



2 Ephesos, Room 36 of Terrace House 2, ca. AD 119 (photo: A. M. Tupy)

that zebra stripes are more ornament than mimesis[8]. They are strictly parallel, never feature any of the irregularity typical for marble veins, and never add any patch of colour to the plain black and white. We therefore cannot maintain that book-matched marble slabs inspired zebra stripes. A telling example is Room 4 of the Villa of Poppea in Oplontis[9]: the dado is painted with zebra stripes, and the wall above imitates large marble slabs with irregular veins. The diagonal zebra stripes are symmetrically slanted to the left and right, whereas the more sophisticated marble imitation shows no sign of mirroring.

Book-matching was technically possible since craftsmen could use several slabs from the same block. In fact, in at least two cases – in a floor in Ephesos[10] and a dado in Herculaneum[11] – single slabs were set symmetrically to each other around the middle of the 1st century AD. But this happened once by chance and was not part of the design; it was not repeated with the adjacent slabs.

Archaeology provides us with rich information on Terrace House 2. During the construction phase II (ca. AD 120), Residential Unit 6 belonged to C. Flavius Furius Aptus, a wealthy man who was also a *pro poleos* priest of Dionysus. We assume he commissioned the remodelling of the ›Marmor Hall‹, with the book-matched Cipollino verde, as a sizeable representative space. It might have served as a meeting and ritual place for the Dionysus cult[12]. It is charming to imagine how wine was consumed while looking at those highly dynamic marble veins. Aptus and his artisans had a particular interest in book-matched revetments. We find them in three more rooms of

8 Rauws 2015, 55. Cf. Cline 2015; Clarke – Muntasser 2019, 1964.

9 See the figure <https://hdl.handle.net/2027/fulcrum.rb68xd48g> (22.07.2023).

10 In the Peristyle Court 31a of Terrace House 2 three out of 27 large slabs are loosely mirrored. The floor is dated in construction phase I, i.e., in the middle of the 1st cent. AD, see Thür – Rathmayr 2014, 228 pl. 350, I.

11 In the House of the Relief of Telephus in Herculaneum, two Pavonazzetto slabs mirror each other with a white marble frame in between, see Cerulli Irelli 1990, pl. 147; cf. Barry 2020, 359 n. 71. The symmetry is more precise than in Ephesos. However, if the craftsmen had planned a book-matched display, we would expect them to repeat it – in the dado and elsewhere –, especially since the House of the Relief of Telephus is richly decorated with *opus sectile*, see Savalli – Pesaresi – Lazzarini 2015.

12 Thür – Rathmayr 2014, 849–853.



3 Rome, Pantheon, ca. AD 117 (photo: Bibliotheca Hertziana)

his house[13]. I illustrate Room 36 (fig. 2) with book-matched revetments of Cipollino verde in the lower and Breccia di Sciro in the upper zone[14].

Besides Ephesos, only two book-matched revetments from the 2nd century are currently known. In the Villa of Silin, near Leptis Magna (Lybia), a room is covered with pairs of high vertical Greco scritto marble panels[15]. It has been dated to the 2nd century without clues to give a precise date. The other is the Roman Pantheon. Its interior is entirely adorned with polychrome marble, except for the dome. The upper level was destroyed and rebuilt in the taste of a classicizing baroque from 1756 onwards[16]; however, the floor and ground level's stone

13 Rooms 36, 36 a and 36 c: Thür – Rathmayr 2014, 230 f. 233. 243 f. pls. 269–271. 283–284. 288.

14 They seem to be from the same construction phase II as the ›Marmor Hall‹ (Room 31); the Cipollino verde slabs probably derive from the same part of the quarry or even the same block. However, Room 36 was refurnished during construction phase III, i.e. approx. 30 years later, by Aptus, see Thür – Rathmayr 2014, 81. 233. 243–244.

15 DeNuccio 2002, 49 figs. 22. 51.

16 See Pasquali 2015 with a detailed account.



4 Rome, Pantheon, ca. AD 117 (photo: Bibliotheca Hertziana)

coverings date back to the 2nd century. They might be the most sophisticated and possibly the best-preserved polychrome revetments from ancient Roman times. Unfortunately, no detailed archaeological or geological study of them is available. Reports of the restoration campaign of 1992–1994 were not published[17].

The *opus sectile* in the Pantheon was analysed more than once[18], and several authors underlined the decorative rather than tectonic display[19]. However, too little emphasis was placed on the gem-like impression. The revetments are developed around book-matched fields that I would describe as polychrome stone pictures – squared or round, framed or unframed, and with diverse stones. The floor is divided like a chessboard with alternating dark round and light square fields, the latter with Pavonazzetto, often book-matched (fig. 3, bottom right). A Corinthian Giallo antico order articulates the lower level. Columns and apses alternate with aediculae in wall sections between pilasters. A comprehensive description would go beyond the purpose of this article. I will limit myself to the axis visible in figure 3, and the similar details in figure 4. The dado of the *aediculae* is carefully composed with three pairs of book-matched Pavonazzetto slabs. The three pairs bear similar motifs, but the middle is broader and more prominent. The wall on either side of the aedicula is divided into rectangular book-matched fields with double frames. The dark breccia ones in the middle are restored in this area and painted. The upper section of the wall (fig. 4) is particularly impressive. Between the capitals, book-matched dark and light breccia fields alternate. The dark ones are twinned: two slabs from the same block are joined symmetrically at a vertical axis. The light ones are quartered: four slabs from one block are joined at a horizontal and

17 S. Pasquali (2015, 338 n. 38) states that »extensive replacement work – recognizable by the different techniques used to anchor the pieces to the wall – was identified on the occasion of the restoration campaign carried out in 1992–1995.« She thanks Mario Lolli Ghetti for this information but does not seem to have had access to restoration documentation.

18 Bitterer 2013, esp. 163–165 with a discussion of the state of the art. See also the photographs available online: <http://repository.edition-topoi.org/collection/BDPP/object/41> (22.07.2023).

19 E.g. Heilmeyer 1975, esp. 335. See Bitterer 2013, 173: »Die konstruktive Realität wird durch die Dekoration gekonnt und fast vollständig verschleiert, so dass dem Betrachter die statischen Zusammenhänge nicht klar werden.«

at a vertical axis[20]. Below, behind the gable, the wall is divided into three fields, highlighted by several framings[21]. The two external ones are square and contain a tondo with twinned half-circular dark breccia slabs; in some sections, they are quartered[22].

In the absence of a thorough investigation, conclusions about the revetments of the lower floor of the Pantheon are inevitably provisional. However, there is no reason to doubt that the layout of the *opus sectile* dates from the 2nd century[23]. It is, however, unclear how many slabs are original and to what extent those substituted have been replaced in accordance with the original. Drawn and printed reproductions do not provide detailed information about the single slabs, their colours, or whether they were book-matched[24]. We cannot completely rule out the possibility that the book-matched panels result from later restorations, but this is highly unlikely, since we find these exact varieties of stone over the large rotunda. The decoration required an enormous number of slabs. This would have left some written sources if anyone had gathered and exchanged them after the Trajanic/Hadrianic period[25].

The *opus sectile* in the Pantheon is far more complex than in Ephesos. Is it, therefore, later? We miss sources to reconstruct the Pantheon's chronology in detail. We know the building was rebuilt from foundation to dome after lightning struck and it burned down in AD 110. The major construction efforts seem to have happened before Trajan died in 117, although they were completed by his successor Hadrian[26]. As T. Bitterer suggested, at least the design for the wall incrustations must have been made during Trajan's reign[27]. It is also unlikely that Roman stone cutters imported such a groundbreaking technology from Euboea and Ephesos. I therefore suggest that book-matching was invented in Rome after 79 (since we do not find traces in Pompeii) and before the first dated example in 119. Perhaps imperial artisans working at the Pantheon were the inventors. More likely, however, simpler book-matched designs were created some years earlier in other buildings of the capital not known today, and these provided the impetus for decorating the Pantheon with book-matched stone pictures[28].

Besides Ephesos, the Pantheon, and Silin, no *opus sectile symmetricum* is known until the 6th century. Did examples exist that have not survived? We do not have many upright walls with marble

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20 This is the case in the sections illustrated here. However, dark fields are partly also quartered, while some light ones are not book-matched.

21 The terms »twinned« and »quartered« are not yet widely used, but they are very helpful in describing book-matched incrustations that almost always use perpendicular layouts. Cf. Barry 2020, 175.

22 This is the case above the first aedicula right of the entrance.

23 For stylistic and technical reasons, it cannot have been made in Late Antiquity or the Middle Ages and we have numerous reproductions from the beginning of the 16th cent. recording the current layout of the Pantheon's incrustations. The oldest is a drawing by Raphael, dated between 1506 and 1508, and assumed to be a copy of an older drawing, see Faietti et al. 2020, 351 cat. VIII 1. The most detailed from the 19th cent. is a woodcut by Palladio, see Palladio 1570, IV 82.

24 S. Pasquali (1996; 2015) illustrates several reproductions. Many more may be found in the database of the »Census of Antique Works of Art and Architecture known in the Renaissance«: <https://www.census.de/en/home/> (22.07.2023). Giovanni Paolo Pannini made the oldest detailed and coloured reproductions of the interior of the Pantheon. The oldest is from the 1730s, before the upper floor was altered, see Pasquali 1996, passim; Pasquali 2015, 331 f. For the lower floor, Pannini's paintings coincide not only with the structure but also with the colour of the *opus sectile*. His brush strokes imitate marbling but do not reproduce book-matching's symmetry. I suppose that this mainly depends on the paintings' size, where the book-matched marble pictures measure less than 2 cm.

25 More explicit than those collected by S. Pasquali; see Pasquali 1996, 33. 45; Pasquali 2015, 338.

26 Hetland 2015.

27 Bitterer 2013, 160.

28 F. Barry (2020, 173) hypothesised that wood veneer could have been the model for marble book-matching. The technique of sawing costly, i.e. contrasting, grained wood varieties into thin veneers and gluing them onto larger available wood varieties was common in Rome, and long before that, in Egypt. Since the 16th cent. AD, book-matching was often practised with wood veneer. However, I am not aware of any ancient example nor any painted imitation. Barry refers to examples of intarsia with small wooden pieces but without evidence of veneer mirroring. See Mols 2020, esp. 97; Rosenberg 2021, 195 f.



5 Venice, Santa Maria dei Miracoli, 1481 and 1489 (photo: R. Rosenberg)

incrustations from this time, but it is remarkable that we also have a few imitations of book-matching in paintings or mosaics[29]. All three examples from the 2nd century are outstanding. Obviously from the 2nd to the 5th century, book-matching was something extraordinary, sought after by special patrons for specific reasons. The incidence abruptly changes during the time of Emperor Justinian. Beginning with the Hagia Sophia in Constantinople and San Vitale in Ravenna, book-matching became fashionable and has been used in countless sites – first in Byzantium[30], soon after in Islamic mosques[31], and later in other places[32], though not everywhere. From 1204 on, Venice is the city with the strongest book-matching tradition[33]. Santa Maria dei Miracoli, one of the first Renaissance churches of the Serenissima, is just one spectacular example. It has book-matched claddings all

29 Barry 2020, 359 n. 71.
30 Barry 2020, esp. 175–181.
31 Guidetti 2021.
32 Gamboni 2021.
33 Rosenberg 2021, 208–211.

around the exterior *and* the interior. The architect, Pietro Lombardo, used them both for aesthetic and symbolic purposes. All around the exterior, in the lower zone (fig. 5), each field figures a (Christian) cross in Rosso di Verona with four book-matched slabs of Pavonazzetto toscano around it and a grey Bardiglio frame. In the interior, the cladding is less symbolic and more aesthetic[34]. Since the 19th century and until today, book-matching has become a global phenomenon for decorating buildings – for façades, entrances, and staircases. At the time of writing, I find many advertisements for book-matched marble revetments of bathrooms on the internet.

PLINY ON MARBLING

If my dating of book-matching's invention is correct, Pliny the Elder, who died in AD 79, never saw any such revetments. This would explain why he never mentioned symmetrical layouts of stone slabs, although he describes extensively the patterns created by polishing natural materials – varieties of stone, but also wood, animal horns, and tortoise shell. These descriptions occur in different places in the »Naturalis Historia« – books 13 and 16 on botany and book 37 on mineralogy. Regardless of the different materials, Pliny points to analogous designs and uses similar terms and arguments.

In book 37, Pliny recounts that his contemporaries would pay huge sums for stones figuring particular veins. Most coveted, due to their patterns and colours, were the ›myrrhine‹ stones: »Their value lies in their varied colours: the veins, as they revolve, repeatedly vary from purple to white or a mixture of the two, the purple becoming fiery or the milk-white becoming red as though the new colour were passing through the vein. Some people particularly appreciate the edges of a piece, where colours may be reflected such as we observe in the inner part of a rainbow. Others prefer thick veins (any trace of transparency or fading is always a fault) and also specks and spots.«[35] According to Pliny, Emperor Nero paid 1 million sesterces for a single myrrhine bowl.

In books 13 and 16, we find surprisingly similar descriptions of what Pliny considers the most precious variety of wood – citrus wood[36]. He writes that the »outstanding merit of citrus-wood tables is to have wavy marks forming a vein or else little spirals.«[37] Remarkably, the price for citrus tables was similar and as extravagant as for myrrhine bowls: King Juba is reported to have auctioned two citrus tables for 1.2 and 1.3 million sesterces[38].

Pliny explains that certain woods are cut into veneers to cover those whose veins are less attractive and adds that both animals' horns and tortoiseshell were also used to embellish wooden furniture: »The principal woods for cutting into layers and for using as a veneer to cover other kinds of wood are citrus, turpentine-tree, varieties of maple, box, palm, holly, holm-oak, the root of the elder, and poplar. Also the alder, as has been stated, supplies a tuberosity that can be cut into layers, as do the citrus and the maple; no other trees have tuberosities so much valued. The middle part of trees is more variegated, and the nearer the root the smaller and the more wavy are the markings. […]. And this was not enough: the horns of animals began to be dyed and their tusks cut in slices, and wood to be inlaid and later veneered with ivory. Next came the fancy of ransacking even the sea for material: tortoiseshell was cut up to provide it, and recently, in the principate of Nero, it was discovered by miraculous devices how to cause it to lose its natural appearance by means of paints and fetch a higher price by imitating wood.«[39]

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34 See the analysis by L. Lazzarini (2003), who also mentions that in restoration campaigns, many slabs were exchanged with stones similar to the original ones. Cf. Barry 2020, 234–238.

35 Plin. nat. 37, 8, 21–22.

36 Plin. nat. 13, 30, 100–102; 16, 84, 231.

37 Plin. nat. 13, 30, 96.

38 Plin. nat. 13, 29, 92.

39 Plin. nat. 16, 84, 231–233.

When describing citrus wood and myrrhine, and more generally the aesthetic appeal of stones and wood, Pliny uses similar terms – especially the word »macula«[40]. The scarcity of myrrhine and citrus wood may have increased their value. However, reading Pliny's remarks in regard to such different materials, it is clear that for his contemporaries, the decisive factor enhancing the aesthetic appeal of certain varieties of stone, wood, horn, and tortoiseshell lay in their patterns, contrast, colours, and irregular grain flow. Famously, Pliny had a critical stance on the enthusiasm of his contemporaries for coloured marble[41]. Nonetheless, his account reveals the enthusiasm of his contemporaries for any marbling in general. It is, therefore, no coincidence that book-matching was invented some decades later.

WHAT MAKES BOOK-MATCHING SO ATTRACTIVE?

There are two general and complementary explanations for the aesthetic appeal of polychrome stone slabs: the mimetic and the amimetic. Remarkably, both also offer good explanations for why book-matched slabs are even more appealing than single slabs.

The mimetic approach suggests that when looking at polished stone slabs, we are fascinated to discover figures – of faces, people, animals, strange creatures, landscapes, and so on. This phenomenon was described in relation to clouds by Philostratus the Elder and Shakespeare, with reference to stains by Leonardo da Vinci, and many others. For the history of art, H. W. Janson coined the term »images made by chance«[42]. More recently, D. Gamboni suggested using the more open concept of »potential images«[43]. Any polished polychrome stone produces multiple potential images, and different viewers may perceive different images. Finding such images is a rewarding game for our vision. Book-matching significantly increases the potential for such images. This is due to the symmetry of faces and bodies: book-matched slabs have a much greater potential to evoke faces and figures than plain slabs[44].

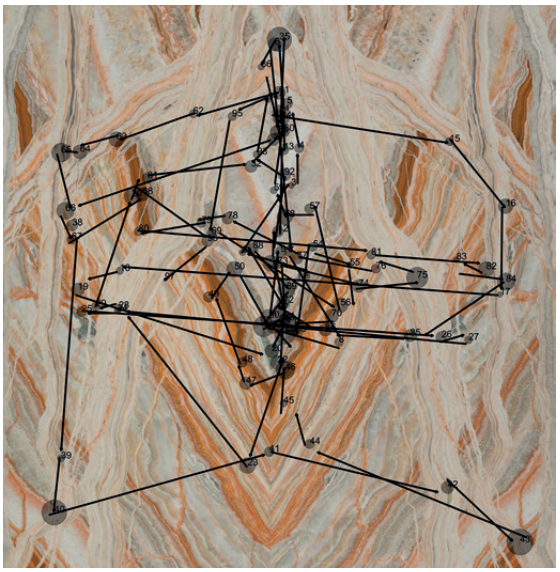
The amimetic approach argues that polished slabs disclose structures specific to each mineral – recurring veins and patches with specific forms and colours. Repetition is crucial for any ornamental design, from the simplest meanders to the most complex »rocailles«. Repetition leads to the perception of structures. Polished stones also reveal structures, but in contrast to other ornaments, the structures of stone slabs are irregular. Therefore, the detection of structures becomes a challenge for the viewer, who is compelled to detect them repeatedly[45]. Book-matching increases the regularity of irregular stone structures but does not remove all irregularities.

In order to find out how book-matching affects perception, G. Brodnik, T. Kamencek and I conducted an eye-tracking experiment in my Lab for Cognitive Research in Art History (CReA). We enrolled 63 participants and asked them to look for 30 seconds at photographs of eight marble slabs – two plain slabs and six book-matched slabs (two twinned with a vertical symmetry axis, two twinned with a horizontal symmetry axis, and two quartered). There were two versions of each book-matched slab: the real one with irregular symmetries and a flawless one made by mirroring one of the slabs in Photoshop. We had two groups of participants. Each one of them saw only one of the two versions. While looking at the photographs on a high-resolution computer monitor, the eye movements of the participants were recorded with a non-invasive high-speed remote eye tracker (EyeLink 1000 Plus by SR Research). The participants were students of art history – people interested in art, although not professional experts, especially not in regard to marble slabs.

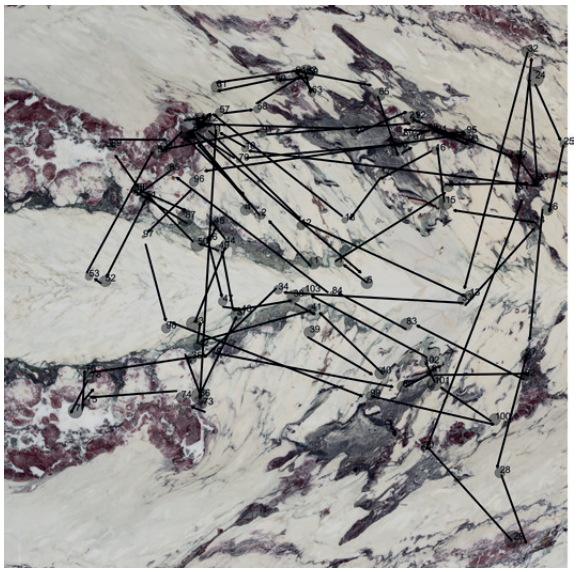
40 Plin. nat. 13, 30, 96–99; 16, 26, 66; 16, 84, 231; 37, 8, 21–22.
41 Plin. nat. 35, 1, 2–3.
42 Janson 1961.
43 Gamboni 2002.
44 Gamboni 2021 with a discussion of known and rather unknown examples from the history of art.
45 Rosenberg 2016; Rosenberg 2021.



6 Eye movements (saccades) of one test person looking at the image of a marble slab for 30 seconds (graphics: CReA, University of Vienna)



7 Eye movements (saccades) of the same test person looking at the image of vertically book-matched marble slabs for 30 seconds (graphics: CReA, University of Vienna)



8 Eye movements (saccades) of the same test person looking at the image of horizontally book-matched marble slabs for 30 seconds (graphics: CReA, University of Vienna)

The analysis of the results is ongoing, but we can already draw some conclusions:

1. As usual, the eyes run wild, but it is clear that they are particularly interested in following the course of the visible structure – the veins of the plain slabs (fig. 6) and the symmetries of book-matched slabs (figs. 7–8)[46]. Notably, the symmetry axis was also a major focus of attention.

[46] An algorithmic comparison delivers statistical evidence for this result that we had predicted in connection with a previous study with just a few 18th-cent. coloured papers; see Rosenberg 2016; Rosenberg 2021.

2. When comparing twinned slabs with vertical and horizontal axes, it is clear that the vertical ones stimulate the eye to look for symmetries (fig. 7) much more than those with horizontal axes (fig. 8) – on average more than twice as much.
3. Participants prefer irregular mirroring when comparing actual, irregular with artificial, flawless book-matching, but the numeric difference is small and might not be statistically significant.

This experiment suggests that as we had expected, when we look at polychrome stone slabs, our attention is driven by grain patterns. We can conclude that if looking at marble slabs triggers pleasure, this is related to us following the structures of the veins and spots. In the case of book-matching, a significant share of our attention is driven by symmetry. Greater regularity in the design triggers a higher regularity in the physiological act of seeing. On the one hand, this seems to confirm the explanations of both the mimetic and the amimetic approaches.

On the other hand, if the higher amount of regularity stimulates more eye movements (i.e. saccades) that follow the symmetry but lower preference judgments, this might be a hint that we like to discover structures – mimetic and/or amimetic – but dislike them when they are too prominent. The evaluation of the study is still in progress, and these questions will need to be addressed in more detail. It also needs to be acknowledged that the study has two major limitations. Firstly, it was conducted with photographic reproductions on a large, high-resolution screen but far from the visual effect of true stone slabs. Secondly, our participants would look for 30 seconds. This is probably more than people in normal conditions would look at *opus sectile* walls, but significantly less than the added time of persons living in and/or visiting such rooms repeatedly.

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Julio C. Ruiz

ROMAN MARBLE STATUES IN TARRACO (HISPANIA CITERIOR)

IMPORTS AND LOCAL PRODUCTION

Abstract
The distinction between imported sculptures and works produced in local workshops is easier in large ensembles, as is the case in Tarraco, capital of the province Hispania citerior. The aim of this work is to assess the hypotheses formulated by various researchers, based on several criteria. These criteria are, mainly, the degree of fidelity with respect to the original model, the raw materials used and the stylistic quality of the works. Attention has been paid to the type of representation (divinities or portraits), dimensions and qualitative aspects of the marbles used. The results of this study show that some of the statues were probably sculpted in local workshops. However, many sculptures were quite likely made in foreign workshops, both in Rome and in the Eastern Mediterranean. This study provides new data on the production process of Roman marble sculptures in this important city of Hispania.

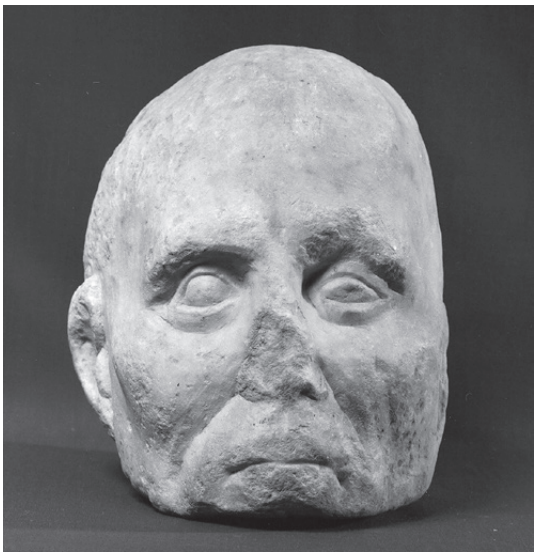
INTRODUCTION

In recent years, I have investigated systematically the Roman sculptures found in the Hispano-Roman city of Tarraco, ancient capital of the Roman province Hispania citerior (currently Tarragona, in the Spanish region of Catalonia)[1]. The results of this research have been presented in a volume of the »Corpus Signorum Imperii Romani«[2]. This context is suitable for analysing the production centres of the Roman sculptures found in this city. Many of these works were studied previously by E. M. Koppel[3], who formulated various hypotheses about the workshops from which the sculptures came[4]. Other researchers have come up with several proposals as well[5]. The evaluation of all these hypotheses is the main objective of this contribution.

ROMAN STATUES IN TARRACO: LOCAL AND IMPORTED WORKS

The oldest free-standing sculptures in Tarraco are carved of Miocene biocalcarenites extracted from quarries near the city[6]. They are portrait statues[7] and draped torsos[8], life-size or larger,

1 Within the research for my PhD thesis, see Ruiz 2022a. For the state of the art, see Ruiz (forthcoming a).
2 Ruiz (forthcoming b).
3 Koppel 1985; Koppel 2000; Koppel 2002; Koppel 2004a; Koppel 2004b.
4 Koppel 1985, 50. 142 f.; Koppel 2000, 83; Koppel 2002, 52–56.
5 Willers 1987, 279 f.; Balty 1988, 618; Bauchhenss 1990, 701; Rodà 1990; Garriguet 2001, 98–100; Balty 2006, 235; Garriguet 2006; Pensabene 2006; Ruiz 2018.
6 Gutiérrez 2009, 113–208.
7 MNAT, inv. 45578. 45640. 45641; Koppel 1985, 87 nos. 112–114 pls. 44–45; Koppel 2009, 509; Ruiz 2022a, 342 f. nos. 410. 412–413; Ruiz 2022b, fig. 2 h–j.
8 MNAT, inv. 391. 393. 45643. P-2770. P-2772. P-12907. P-12908; Koppel 1985, 77–80 nos. 98–100 pls. 38–39; 87–89 nos. 115–117 pls. 46–47; Koppel 2009, 505–509 figs. 1–3; Ruiz 2022a, 285 no. 314; 286–288 no. 316; 288 f. nos. 318–320; 344 nos. 423–425; Ruiz 2022b, fig. 1 a–g. See also the female torso in Ruiz 2021; Ruiz 2022a, 267–269 no. 301; Ruiz 2022b, fig. 3.



1 MNAT, inv. 467. Portrait head of an old man from the 3rd quarter of the 1st century BC (photo: Archive MNAT/P. Witte)

which are dated between the second half of the 1st century BC and the beginning of the 1st century AD. These sculptures were made in the city itself, but they follow statuary types created in Rome. This fact shows that the workshops knew the official models, so the craftsmen who were part of these *officinae* surely came from Italy[9].

Almost all the free-standing sculptures from Tarragona were made of white and greyish marbles. These are recorded from the second half of the 1st century BC, and initially most of them had to be imported[10]. Among them is the portrait of an old man[11] (fig. 1) in Luni-Carrara marble[12], dated to the third quarter of the 1st century BC. Its dating coincides with the chronology of the statues in local stone[13]. Koppel thinks it was imported[14], but other researchers consider that this portrait could belong to a local workshop[15].

In contrast to other regions of the Iberian Peninsula, in the northeast of Hispania there are no marble quarries[16]. Consequently, the presence of marbles in this area can only be explained by importation of this material. In this city, research on the different types of marble used in the sculptures is sorely lacking. In recent times, only two such studies on this matter have been published. One of them was applied to a selection of pieces, found in the area of the provincial temple of Augustus[17]. The second study is based just on petrographic parameters and only includes a free-standing sculpture (fig. 5 c) and a sarcophagus, both carved in Thasos marble[18]. Therefore, the main reference is currently a paper published about 40 years ago, based solely on the observations of thin sections[19]. The authors of that study concluded that the marble most used in Tarraco was the Luni-Carrara, followed by the marbles of the Greek island of Paros. The use of other marbles, such as those from the island of Thasos and Mount Pentelic, is exceptional. These marbles could have arrived without any intervention, to be transformed at a later date in local workshops. However, it is expected that many of the sculptural manufactures were acquired in various stages of elaboration.

Koppel considers that most of the sculptures found in Tarraco were made in this city. According to her, the origin of the workshops goes back to the third quarter of the 1st century BC, when the first portrait statues in local stone were made[20]. However, as J.-C. Balty states, this argument does not guarantee that the later marble sculptures were also produced *in situ*[21]. In any case,

9 Koppel 1985, 142; Koppel 2002, 51; Koppel 2009, 510; Ruiz 2021, 212; Ruiz 2022b.
10 Ruiz 2018.
11 MNAT, inv. 467; Koppel 1985, 90 f. no. 120 pl. 50; Ruiz 2022a, 343 no. 416; Ruiz 2022b, fig. 2 k.
12 Ruiz 2018, 105; Rodà 2020, 109 n. 12.
13 Ruiz 2022b.
14 Koppel 2002, 52 f.
15 Nogales – Rodà 2014, 82; Ruiz 2018, 105. 114; Rodà 2020, 109.
16 On the types of stones quarried in the northeast of Hispania in Roman times, see Gutiérrez 2009.
17 Àlvarez et al. 2012.
18 de Mesa – Royo – Rodà 2014.
19 Mayer – Àlvarez 1985, 187–190.
20 Koppel 1985, 142; Koppel 2002, 51–56; Koppel 2009, 510.
21 Balty 1988, 618.



2 Some imperial and private portraits from the 2nd century BC. a: MNAT, inv. 389. Portrait head of Hadrian. b: MNAT, inv. 386. Portrait head of Marcus Aurelius. c: MNAT, inv. 12248. Portrait head of an unknown woman from the Antonine period (photos: Archive MNAT/P. Witte)

Koppel has recognised that the sculptures of Tarragona, especially the portraits and the iconic torsos, are clearly dependent on the official art of Rome[22]. This circumstance does not automatically imply that all sculptures are imported, but it is not possible to distinguish a local style that can be attributed to a workshop of craftsmen established in Tarraco[23].

The existence of local workshops was most likely motivated by the importance of Tarraco, but Koppel does not justify her hypothesis. Additionally, her distinction between local and imported works is heavily dependent on a qualitative criterion. Following this idea, she attributes to the Tarragona *officinae* the sculptures of lesser quality[24]. As Balty pointed out, this criterion is not definitive for considering certain works as local or imported[25].

Nevertheless, Koppel noticed that in the sculptures of Tarraco a remarkable artistic licence can be glimpsed in the choice of statuary types. This could be explained by a limited number of models available to local artisans[26]. This circumstance, and the qualitative criterion, led her to consider certain works as local manufactures. These are mainly portraits[27], among which the author mentions a posthumous portrait of Trajan[28], a portrait of Hadrian[29] (fig. 2 a), a male portrait from the Hadrianic period[30], two heads depicting Alexander the Great[31], a male portrait bust[32], and a female head[33].

It is very difficult to ascribe several sculptures to the same *officina*, but Koppel has proposed some exceptions[34]. Regarding the portraits, the researcher mentions the two young imperial effigies of the Julio-Claudian dynasty found at the theatre[35]. She has also attributed to the same

22 Koppel 1985, 142 f.
23 This has been noticed by some researchers, see Willers 1987, 279; Bauchhenss 1990, 701.
24 Koppel 1985, 142 f.
25 Balty 1988, 618.
26 Koppel 1985, 142.
27 Koppel 1985, 50. 93 f. 142 n. 69.
28 MNAT, inv. 388; Koppel 1985, 93 f. no. 124 pl. 53, 3–6; Ruiz 2022a, 344 no. 420.
29 MNAT, inv. 389; Koppel 1985, 94 f. no. 126 pl. 55; Ruiz 2022a, 177 no. 137.
30 MNAT, inv. 45582; Koppel 1985, 93 f. no. 125 pl. 54; Ruiz 2022a, 344 no. 421.
31 MNAT, inv. 461. 45642; Koppel 1985, 89 f. nos. 118–119 pls. 48–49; Ruiz 2022a, 343 nos. 414–415.
32 MNAT, inv. 45593; Koppel 1985, 81 no. 16 pls. 41–42; Ruiz 2022a, 164 no. 108; Ruiz 2022b, fig. 5.
33 MNAT, inv. P-879; Koppel 1985, 80 no. 104 pl. 40, 3; Ruiz 2022a, 284 f. no. 313; Ruiz 2022b, fig. 4 a.
34 Koppel 1985, 142.
35 MNAT, inv. 45000. 45001; Koppel 1985, 13–15 nos. 1–2 pls. 1–2; Ruiz 2022a, 224–226 nos. 215–216.

workshop two other Julio-Claudian imperial portraits, depicting Tiberius[36] and probably Nero Caesar[37], dated during the reign of Caligula. Koppel believes that they were possibly sculpted in a workshop of Tarraco[38], a hypothesis supported by J. A. Garriguet[39].

P. Pensabene argues that the imperial portrait workshops were subjected to frenetic activity, requiring close contact with the imperial chancellery[40]. This would only be viable due to the geographical proximity of the *officinae*. Accordingly, workshops specialising in portraits of emperors and their relatives were to be based in Rome, mainly during the Julio-Claudian period[41]. For this reason, Pensabene thinks that the imperial portrait statues of provincial areas were mostly sculpted by metropolitan workshops[42].

Researchers have considered that most of portraits from the 2nd century AD found in Tarraco were sculpted in workshops located in this city. This assertion applies mainly to imperial effigies[43]. The hypothesis is based on the conclusion that most of the heads from this period are made of Lunense marble[44]. This marble was imported, to a greater extent, not only in Tarraco, but throughout the western Mediterranean[45]. It is plausible that it was acquired in the rough, to be carved by local sculptors, who could have a strong background in the standardized imperial iconography[46].

The hypothesis about the existence of this workshop must be re-evaluated. This is best illustrated by the heads of Marcus Aurelius[47] (fig. 2 b) and Lucius Verus[48], discovered near the colonial forum. Koppel thinks it is likely that they were made in a local *officina*[49]. Thereafter, they have been considered as the greatest exponent of a local workshop that worked with marble from Luni-Carrara in the middle of the 2nd century AD[50]. However, the portrait of Marcus Aurelius has subsequently been considered the work of a metropolitan workshop[51]. According to Balty, both effigies were elaborated in Rome, despite the differences in their carving techniques[52].

Other portraits from the same period[53] present a similar problem. This is the case of a private female head from the Antonine period[54] (fig. 2 c). Koppel considers that it is a foreign work, again because of its high quality[55]. The subjectivity of the qualitative criterion is exemplified by a portrait of Hadrian[56] (fig. 2 a). Koppel thinks it is probably a local work[57] and has linked it to a portrait of Trajan[58]. The iconographic particularities of the latter led her to consider its elaboration

36 MNAT, inv. 45002; Koppel 2000, 81–83 pls. 1–4; Ruiz 2022a, 219 no. 204.
37 MNAT, inv. 45003; Koppel 2000, 83 f. pls. 5–8; Ruiz 2022a, 220 no. 205.
38 Koppel 2000, 83.
39 Garriguet 2006, 163.
40 Pensabene 2006, 107–109.
41 Balty 2006, 231.
42 Pensabene 2006, 109.
43 Koppel 1985, 93 f. 142; Koppel 2002, 53; Nogales – Rodà 2014, 88.
44 Mayer – Àlvarez 1985, 189 n. 15.
45 Gutiérrez – Rodà 2012; Pensabene 2012.
46 Rodà 1990, 301; Gutiérrez – Rodà 2012, 297.
47 MNAT, inv. 386; Koppel 1985, 33 f. no. 46 pl. 13; Ruiz 2022a, 203 no. 192.
48 MNAT, inv. 387; Koppel 1985, 34 f. no. 47 pl. 14; Ruiz 2022a, 203 no. 193.
49 Koppel 1985, 34. 142 n. 69.
50 Rodà 1990, 301; Gutiérrez – Rodà 2012, 297.
51 This statement is based on its fidelity to the original model and its high stylistic quality, see Garriguet 2006, 173 f.
52 Balty 2006, 235.
53 They are also carved in Luni-Carrara marble, according to the published analyses, see Mayer – Àlvarez 1985, 189 n. 15.
54 MNAT, inv. 12248; Koppel 1985, 95 f. no. 128 pl. 57; Ruiz 2022a, 258 no. 281.
55 Koppel 1985, 142.
56 MNAT, inv. 389; Koppel 1985, 94 f. no. 126 pl. 55; Ruiz 2022a, 177 no. 137.
57 Koppel 1985, 94.
58 See above n. 28.



3 Some draped torsos from Tarraco. a: MNAT, inv. 7585. *Togatus* with *bulla* found at the theatre. b: MNAT, inv. 6920. Female draped torso from the colonial forum. c: MNAT, inv. 45602. Cuirassed torso found at the theatre (photos: Archive MNAT/P. Witte)

in a Tarraco workshop, probably the same one that carved the portrait of Hadrian[59]. Balty sees no significant differences between the private female head and the portrait of Hadrian[60]. In fact, he describes it as excellent, and argues that it was manufactured in Rome[61].

In addition, in Tarragona there are several draped torsos. None of their heads are preserved, but their typologies allow them to be considered as portrait statues. They have mostly been defined as images of the Julio-Claudian dynasty[62]. All these iconic torsos are characterised by a high stylistic quality and can be compared to sculptures from Italy, and even from Rome. For this reason, Koppel has interpreted as imported several torsos, all of them found at the most important public buildings of the city[63]: the *togati* from the theatre[64] (fig. 3 a) and two female statues from the colonial forum[65] (fig. 3 b). By contrast, she ascribes to local *officinae*[66] two fragments of draped torsos from the colonial forum: a *togatus*[67] and a female figure[68]. The reasons for Koppel's opinion are, once again, limited to the quality of the sculptures[69].

59 Koppel 1985, 93. 142.
60 Balty 1988, 618.
61 Balty 2006, 235.
62 Garriguet 2001, 51–57 nos. 71–79 pls. 31–32.
63 Koppel 1985, 50. 142 f.
64 MNAT, inv. 7584. 45600. 7585. 45599; Koppel 1985, 15–19 nos. 4–7 pls. 4–6; Ruiz 2022a, 227 nos. 217–220.
65 MNAT, inv. 381. 6920; Koppel 1985, 38 f. nos. 56–57 pls. 17–18; Ruiz 2022a, 188 f. nos. 157. 161. She expresses doubts about the second female torso.
66 Koppel 1985, 50. 142 n. 69.
67 MNAT, inv. 385; Koppel 1985, 36 no. 50 pl. 16, 2; Ruiz 2022a, 189 no. 159.
68 MNAT, inv. 384; Koppel 1985, 36 no. 49 pl. 16, 1; Ruiz 2022a, 190 no. 163.
69 Garriguet 2001, 99 f. n. 169.



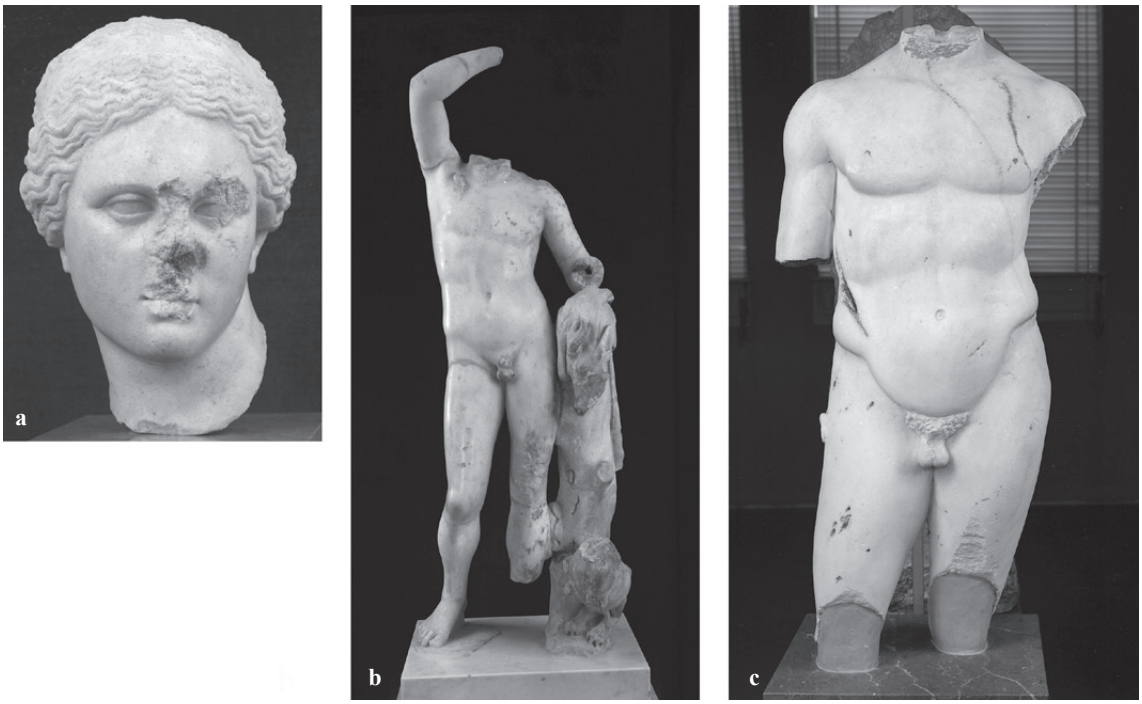
4 MNAT, inv. 12258. Statue of a child with the attributes of Herakles, found at the *schola* of the *collegium fabrum* (photo: Archive MNAT/P. Witte)

Garriguet[70] attributes to the same workshop three *togati* with *bulla*, dated in the middle of the 1st century AD: two of them come from the theatre[71] (fig. 3 b), and the third was found in the colonial forum[72]. This hypothesis is based on formal and stylistic parallels with other, similar contemporary Hispano-Roman statues[73]. The *togati* from the theatre are almost identical, while their relationship with the *togatus* from the city forum is merely stylistic. Koppel thinks that the latter was carved by a local artisan[74], an opinion based on the fact that it is elaborated in Lunense marble[75].

In the theatre, three practically identical cuirassed torsos were found[76] (fig. 3 c) that excite greater interest. Traditionally they have been dated to the middle of the 2nd century AD. Because of this, along with the heads of Marcus Aurelius and Lucius Verus, I. Rodà related them to the local production of statues in Luni-Carrara marble[77]. By contrast, E. Rodríguez-Almeida dated them in the reign of Domitian for iconographic reasons and considered that they were sculpted in a workshop in Rome[78]. Garriguet shares Rodà's hypothesis. This researcher argues that the iconographic particularities of the torsos are more understandable in a provincial context[79]. Soon after, Koppel and Pensabene proposed that they were produced in a workshop in the Eastern Mediterranean[80]. Recently the dating of these torsos to the beginning of the Imperial period has been reaffirmed[81].

The ideal sculpture poses a quite different research problem. Koppel considers a large proportion of the mythological statues to have been made by local artisans[82]. The researcher mentions several pieces that, according to her, were carved in the *officinae* of Tarraco[83]. Almost all of them are made of Parian marble and are copies, variations or reworkings of Classical and Hellenistic Greek models[84].

70 Garriguet 2001, 99.
71 MNAT, inv. 7585. 45599; Koppel 1985, 17–19 nos. 6–7 pl. 6; Ruiz 2022a, 227 nos. 219–220.
72 MNAT, inv. 382; Koppel 1985, 35 f. no. 48 pl. 15; Ruiz 2022a, 189 no. 160.
73 Garriguet 2001, 99.
74 Koppel 2002, 53 f.
75 Mayer – Àlvarez 1985, 189 n. 15.
76 MNAT, inv. 7582. 7583. 45601; Koppel 1985, 19 f. nos. 8–10 pls. 7–8; Ojeda 2019; Ruiz 2022a, 227 nos. 222–224.
77 Rodà 1990, 301.
78 Rodríguez-Almeida 1994, 204. 211 n. 38.
79 Garriguet 2001, 100.
80 Koppel 2002, 55; Pensabene 2006, 112 f.
81 Ojeda 2019.
82 Koppel 2002, 54.
83 Koppel 2002, 53 f.
84 Mayer – Àlvarez 1985, 188 f.



5 Some replicas of Greek models from the Classical period found at Tarragona. a: MNAT, inv. 383. Head of a variant of the Aphrodite of Knidos, found at the colonial forum. b: MNAT, inv. 372. Torso of Dionysus, variant of the »Pouring Satyr« of Praxiteles. c: MNAT, inv. 379. Torso of a probable replica of the Ares Borghese, excavated from the area of the colonial forum (photos: Archive MNAT/P. Witte)

One of these statues depicts a child with the attributes of Herakles, dated by Koppel to the middle of the 2nd century AD[85] (fig. 4). This statue was excavated from the *schola* of the *collegium fabrum*. Koppel thinks that it was carved in the same local workshop as two other mythological sculptures found in the same building and associated with the decoration of its peristyle[86]: a female torso, probably Victoria[87], and a reclined nymph, that was used to decorate a fountain[88]. The latter shows a less accurate finish.

However, some mythological sculptures present an excellent quality and reach higher dimensions. All of them, also made of Paros marble[89], are replicas of Greek models from the Classical period with Hellenistic and Roman reworkings. These include a head of Apollo found in the vicinity of the colonial forum[90] and the head of Minerva from the *schola* of the *collegium fabrum*[91], both attributed by Koppel to local *officinae*[92]. These two heads are the most remarkable of the statuary repertoire of the buildings from which they come, so Rodà believes that they are works made in foreign workshops[93]. This statesment is also valid for a variant of the Aphrodite of Knidos from the colonial forum[94] (fig. 5 a). Koppel considered it as an

85 MNAT, inv. 12258; Koppel 1985, 54 f. no. 78 pl. 26; Ruiz 2022a, 165 no. 112.
86 Koppel 1985, 142.
87 MNAT, inv. 12272; Koppel 1985, 59 f. no. 83 pl. 30; Ruiz 2022a, 166 no. 117.
88 MNAT, inv. 12275; Koppel 1985, 60 f. no. 85 pl. 31, 2–4; Ruiz 2022a, 167 no. 118.
89 Mayer – Àlvarez 1985, 188 f.
90 MNAT, inv. 470; Koppel 1985, 39 f. no. 58 pl. 19; Ruiz 2022a, 203 no. 191.
91 MNAT, inv. 12259; Koppel 1985, 58–60 no. 82 pl. 29; Ruiz 2022a, 166 no. 116.
92 Koppel 2002, 53 f.
93 Rodà 1990, 305.
94 MNAT, inv. 383; Koppel 1985, 41–43 no. 60 pls. 21–22; Ruiz 2020, 200 fig. 6; Ruiz 2022a, 188 nos. 155–156; 255 no. 276.

import[95], which has been validated by Pensabene, who thinks that the head was produced in a metropolitan or Attic workshop[96].

There are also other mythological sculptures of life size or even larger, which are replicas and variants of Greek models. Among them we can find a fragmented statue of Apollo from the public baths[97] and a statue of Dionysus, variant of the »Pouring Satyr« of Praxiteles[98] (fig. 5 b). Both are carved in Paros marble[99], and once again Koppel thinks they were made in *officinae* of Tarraco[100]. The statue of Dionysus comes from an area where, in antiquity, there was an opulent residential district. In this area, a female figure, identified as a Hora, was found[101], whose high stylistic quality led Koppel to assess it as an imported work[102].

There is some controversy as to the carving location of a male torso found near the colonial forum, identified as a replica of the Ares Borghese, and dated in the Hadrianic period[103] (fig. 5 c). This sculpture is made of dolomitic marble from Thasos[104]. Koppel has considered it a local work[105], but other researchers think that the sculpture was imported to Tarraco fully manufactured[106].

Most of the mythological sculptures found in Tarragona depict characters from the Dionysian thiasos[107]. They are generally small or medium format and have a less accurate finish. Some of these sculptures have been dated to the end of the 1st century AD, but most of them have been dated during the 2nd century AD. Koppel has proposed that their manufacture is local[108]. The study by Pensabene, applied to the workshops in the whole of Hispania, is of great interest for this genre of sculptures[109]. This researcher starts from the fact that throughout the Imperial period, the prestige of possessing mythological sculptures motivated growing demand by the elite members of society. Due to this circumstance, the prefabrication of sculptures in workshops linked to quarries became increasingly important. At the same time, this phenomenon resulted in a decrease in costs, making it increasingly economical to acquire prefabricated works at various stages of elaboration. Therefore, the sculptures could reach their final destination semi-finished, with the expectation that they would be completed by local artisans, although this did not always transpire[110]. The inattention to the finishing of certain pieces can be attributed to this phenomenon, and not necessarily to less experienced local workshops. According to Pensabene, this circumstance could largely explain the development of the ideal sculpture in Hispania and in the rest of the Roman world mainly during the 2nd century AD[111].

FINAL REMARKS

The observations of Pensabene are very convincing and lead me to emphasise the idea that the qualitative criterion is not decisive for attributing sculptures to local low-skilled artisans. In

95 Koppel 1985, 142.
96 Pensabene 2006, tab. 2.
97 MNAT, inv. 37237/38; Koppel 1985, 99 f. no. 141 pl. 61; Koppel 2004b, 98 f. figs. 98–101; Ruiz 2022a, 262 no. 291.
98 MNAT, inv. 372; Koppel 1985, 69–71 no. 92 pl. 33; Ruiz 2022a, 180 no. 143.
99 Mayer – Àlvarez 1985, 188 n. 13.
100 Koppel 2002, 53 f.
101 MNAT, inv. 378; Koppel 1985, 73 f. no. 95 pls. 36–37, 1; Ruiz 2022a, 183 no. 147.
102 Koppel 1985, 142.
103 MNAT, inv. 379; Koppel 1985, 40 f. no. 59 pl. 20; Ruiz 2022a, 187 no. 154.
104 Mayer – Àlvarez 1985, 188; de Mesa – Royo – Rodà 2014, 488 f.
105 Koppel 2002, 54.
106 de Mesa – Royo – Rodà 2014, 487.
107 Ruiz (forthcoming b).
108 Koppel 2002, 54.
109 Pensabene 2006, 125.
110 Pensabene 2006, 132.
111 Koppel 1998, 310; Rodríguez Oliva 2009, passim.

addition, observations on quality are often subjective, and several variables must be borne in mind. The weight of serial manufactures, carved in large production centres and meant to be completed at the places of destination, cannot be ignored.

In conclusion, it can be said that we are facing a field of research in which it is currently very difficult to achieve concrete results. These can be obtained by means of a meticulous observation of each sculpture. However, the evaluation of the hypotheses expressed by the various authors allows us to outline the main lines of reflection for future research.

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Rita Scognamiglio

NEW METHODOLOGIES FOR THE STUDY OF FRAGMENTARY MARBLES (OPLONTIS VILLA B) AT TORRE ANNUNZIATA, ITALY

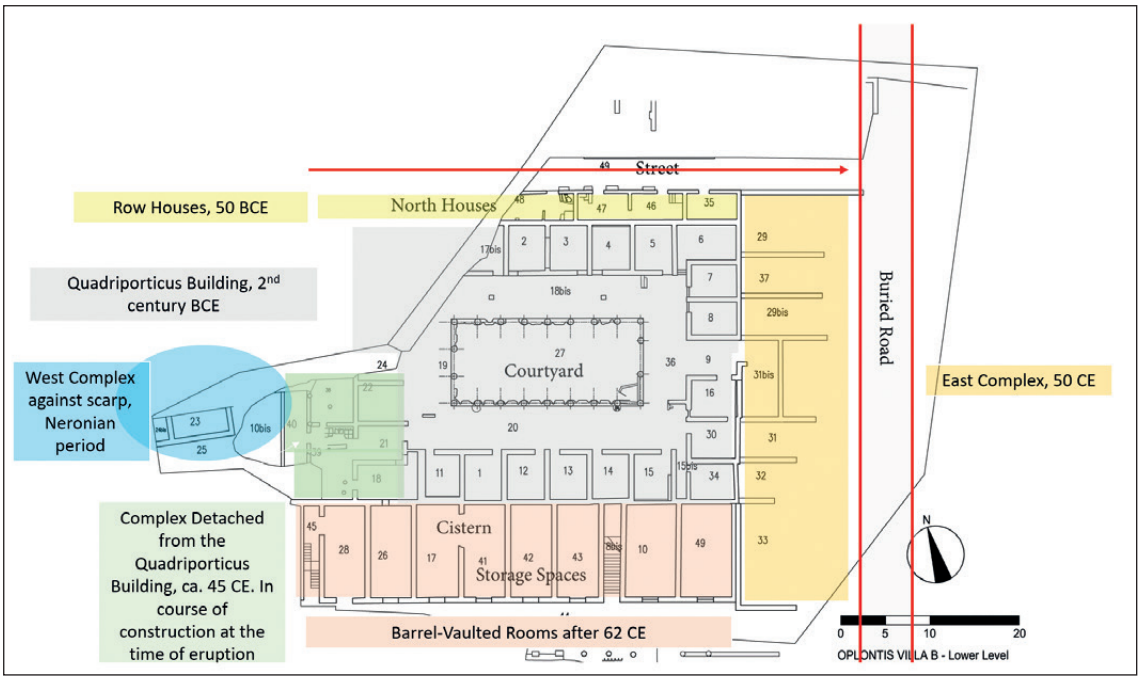
Abstract
The complex originally called Villa B (or Villa of Lucius Crassius Tertius), located in present-day Torre Annunziata, Italy, was not a villa but rather a kind of emporium focused on the handling of wine and perhaps other agricultural products. Following the initial excavation of the site by the Soprintendenza Archeologica di Pompeii (1974–1991), the Oplontis Project has, since 2012, conducted a series of explorations, including geo-prospection, conventional trenches beneath the AD 79 levels, analysis of the organic remains, and study of the old finds. Although the documentation concerning the excavation of the marbles has almost completely disappeared, this paper presents the results of a study of two groups of marbles found in the Italian excavations in two different places within Oplontis Villa B: Building 23, built at a higher level and orientated differently than the rest of the complex, and Room 10. By studying and drawing more than 1,000 pieces, it was possible to classify the different categories of objects to determine their role in the decoration. Furthermore, this paper presents a typology of the different types of mouldings based on their profiles and dimensions. A comprehensive database of the marbles, accompanied by all of the drawings, will be available for further study. It is important to note that there is no bedding cement on the backs of any of these elements. Combining this information with the results of the study of all the fragments, of the excavations journal, of the two places of discovery and three recently-published studies of the stone elements of Villa A, it is clear that the finds did not belong to the decoration of Building 23 and of Room 10. Rather, they were stored there, probably after the earthquake in AD 62, to be sold or relocated. As such, they fit with the profile of Oplontis Villa B as a centre for storage and sale – not only of foodstuffs – but also of marble revetments.

The so-called Villa of Lucius Crassius Tertius likely belonged to Oplontis – a town that appears on the Tabula Peutingeriana. This ancient Roman itinerary places Oplontis between Pompeii and Herculaneum; although this is the sole instance of this name in any ancient source, scholars have long identified Oplontis as a suburb of ancient Pompeii[1].

Recent work of the Oplontis Project has concluded that – at least in its late phase – it was not a luxurious seaside villa like Villa A (the so-called Villa of Poppaea), located 300 m to the east[2]. Unlike Villa A, Oplontis Villa B (= Oplontis B) was a kind of emporium focused on the handling of wine and other products[3]. Indeed, at the time of the eruption, it was storing over 1,400 used amphorae ready to be refilled with wine[4]. Recent excavations have shown that it was close to the sea[5].

Oplontis B (fig. 1) is not a single building but rather a complex of buildings arranged around a central nucleus made up of a two-storey colonnaded building (the Courtyard Building), with row-houses on the north (North Houses) and a group of spaces attached to the Courtyard Building on the east (East Complex). To the south there is a row of barrel-vaulted spaces, entirely separate

1 See Clarke – Muntasser 2014; Fergola 2014; Marasco 2014.
2 See Clarke – Muntasser 2014; Clarke – Muntasser 2019.
3 See Fergola 2014.
4 Maggi 1977, 50; Thomas 2015; Muslin 2016; Thomas 2016; Muslin 2019; Emmerson 2020, 161 f.; Clarke et al. 2021, 103–105; Van der Graaff et al. 2023.
5 See Di Maio 2014.



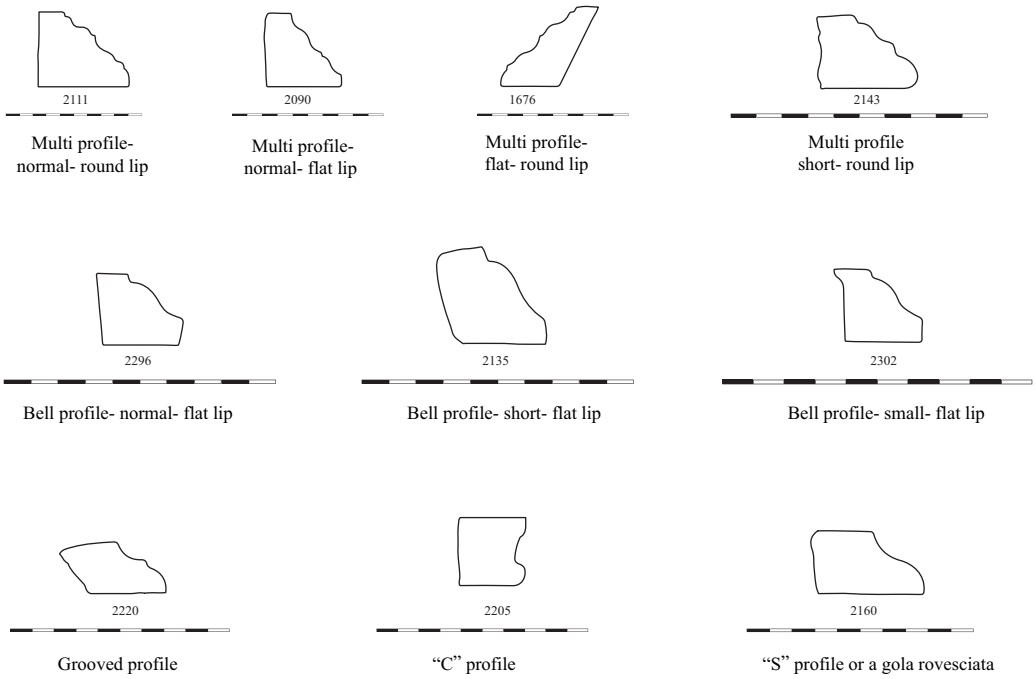
1 Oplontis Villa B. Plan, lower level (graphics: The Oplontis Project)

from the Courtyard Building and supporting living quarters on the upper floor. The West Complex is the most mysterious building, because it was impossible to excavate it to the AD 79 levels. Whereas the North Houses, the East Complex, and the barrel-vaulted rooms with living spaces above them seem to be part of the same insula, the building in the west is quite far from it and oriented differently. To the east of this insula runs a major north-to-south road connecting the interior with the sea; a small street runs east-to-west between the North Houses[6].

The nucleus of the ›Villa‹ (the courtyard and the rooms surrounding it on two storeys), like the East Complex, was likely built around the end of the 2nd century BC. Just after the earthquake of AD 62, Oplontis B was enlarged through the construction of the barrel-vaulted rooms on the south side, not far from the ancient shoreline. The North Houses were built around 50 BC, whereas the West Complex, against scarp, dates to the Neronian period. The West Complex, against the scarp below the Scuola Media Parini, dates to ca. AD 45, as does the group of spaces detached from the Courtyard Building. Recent excavations demonstrated that this building, involving spaces 18, 21, 22, and 40, was in the course of construction (or reconstruction) at the time of the eruption[7].

Oplontis B was excavated by the Soprintendenza Archeologica di Pompeii (between1974 and 1991)[8], and later by the Oplontis Project between 2012 and 2023[9]. The marble finds analysed in this study were found during the excavations by the Soprintendenza. In Room 42, one of the barrel-vaulted spaces in the south of the site, the excavators left a large quantity of marble placed in boxes without any labels. There was just one box with a label, on which was written: »21/08/1984 Scavo B Ambiente 10 piano inf«. In this box, today divided into three boxes (699-1. 699-2. 699-3) were found four white marble slabs, one moulding in white marble, six hexagons

6 Clarke et al. 2021.
7 Van der Graaff et al. 2023.
8 On the history of the excavations, see Fergola 2004, 17.
9 On the excavations by the Oplontis Project, see Thomas – Van der Graaff – Wilkinson 2013; Van der Graaff 2016; Van der Graaff et al. 2016; Van der Graaff et al. 2019; Muslin 2019; Van der Graaff et al. 2020; Clarke et al. 2021.



2 The mouldings typology (drawings: R. Scognamiglio)

in Bardiglio marble, two hexagons in Palombino, three squares in Bardiglio, six rhombuses and another eight rhombus fragments. All the rhombus fragments are in Palombino.

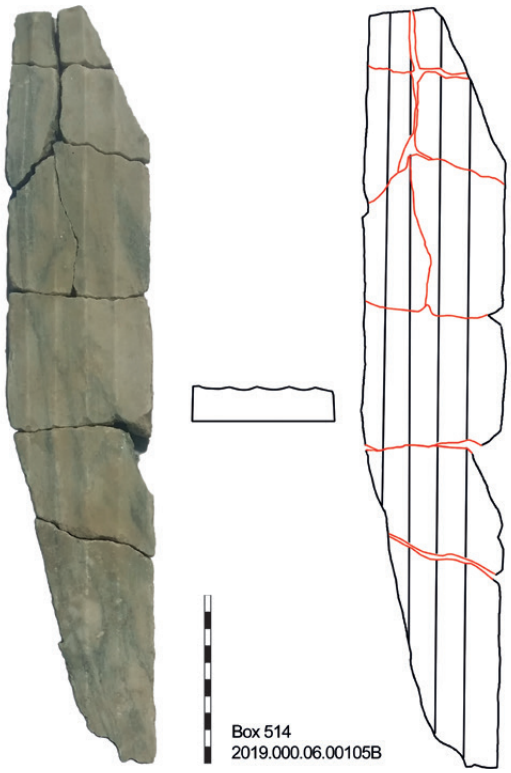
There are few mentions of these marbles in the excavation journal. A first mention from the first excavation in March 1973 comments: »In room n. 23, innumerable fragments of painted plaster were found in the NW corner, close to the N escarpment [...]. Mixed with these plaster fragments, numerous fragments of polychrome marble slabs were found, presumably attributed to a sectile floor whose origin remains at the moment unknown.«[10] It is worth noting that despite the fact that the excavators recorded a large quantity of thin marble slabs, they completely ignored the massive presence of the mouldings.

The second mention dates to 11 July 1984: »In the morning the excavation resumed in room 10 [...]. Hexagonal marble tiles belonging to the upper floor were also recovered, some of them in fragments.«[11] This second mention can also be connected with the finds in the boxes 699 (1–3) because in box 696 there is only one hexagon. The different date could be linked with the discovery of the last marble finds in Room 10. Despite the notice on the label mentioned above, the excavation journal entry for 21 August 1984 does not mention marbles at all.

To recap, if we follow the excavation journal, there are two groups of marbles: one found in the lower-level Room 10 and another, more conspicuous group found in Building 23.

Faced with such a mass of finds, one wonders if these marbles are part of the decoration of the two buildings, 23 and 10, or if they originally decorated Villa A (or one of the many other rich buildings situated in Oplontis or in other areas). We cannot prove that the hexagons, squares and rhombuses belonged to a floor in the upper level of Room 10, as hypothesized in the excavation journal, and, finally, we do not know the function of Building 23 at the time of the eruption. Unfortunately, further excavation of Building 23 is not possible for safety reasons. Hence, to answer

10 Journal of the excavations 7–8 March 1973 (translation by the author).
11 Journal of the excavations 11 July 1984 (translation by the author).



3 One of the grooved pilasters in Cipollino (photo and drawing: R. Scognamiglio)

our questions, it is necessary to study this material separately[12].

I shall first discuss the mouldings because there is a very big quantity of them and they show a great variety of forms. I tried to join all the fragments distributed in more than 27 boxes, then I drew all the pieces to create a typology.

I named the mouldings according to the shape of their profile, including multi-profile mouldings, »bell-profile« mouldings, »grooved profiles«, and »C«, and finally »S« (or a »gola rovesciata«) profiles (fig. 2). Each of these moulding categories has a first subcategory, according to their characteristics (the dimensions, for example), while the last subcategory concerns the lip (round or flat). Multi-profile mouldings are characterised by multiple steps, indentations and protrusions. Bell-profile mouldings have a shape like a bell; grooved mouldings have one or more grooves (identified by a large indentation); and the terms C and S refer to a group of mouldings shaped like these letters of the alphabet.

The normal multi-profile group represents right-angled mouldings, while the flat ones have an angle greater than 90°, and finally the short type represents complete short mouldings that do not exceed 20/25 cm in length.

As regards the bell profile, there is a normal group with a height that is not less than 4 cm; the small size group is less than 4 cm in height; and the short ones are complete mouldings no longer than 22 cm. All the bell-profile mouldings have a flat lip.

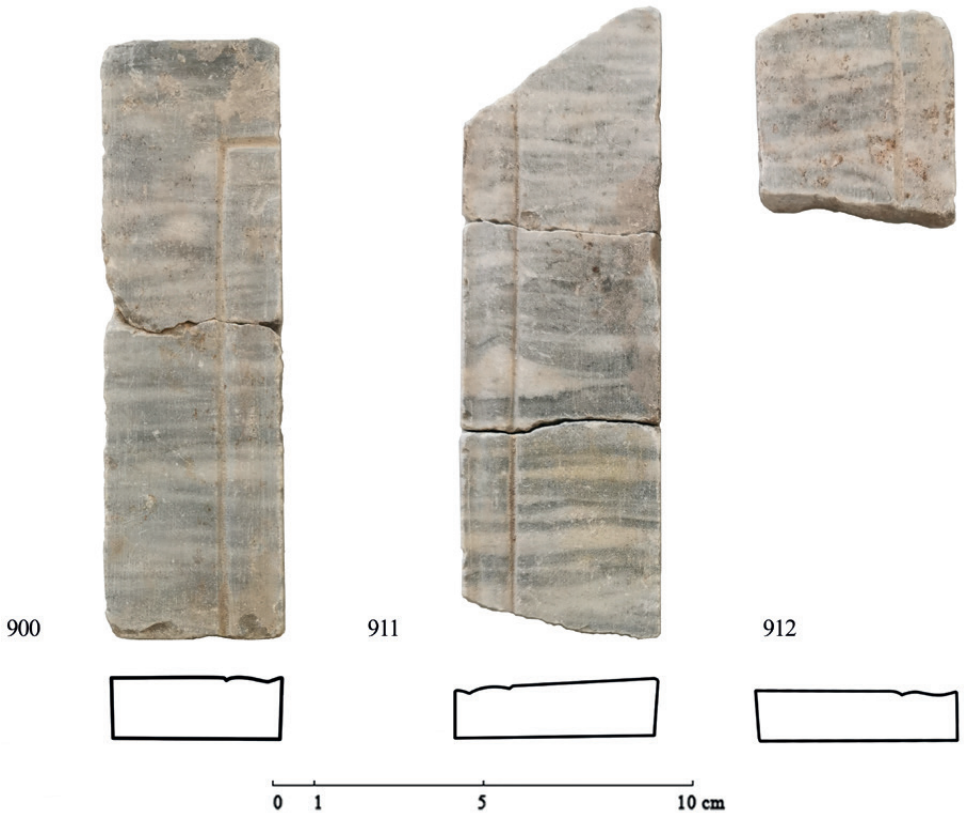
A very important part of the study was the processing of a database with all the information about the fragments, including a description of them. The database allowed me to carry out a quantitative, qualitative and typological study of the finds. From the resulting diagram, we note (although we must bear in mind that this is partial data relating only to the finds) that the most representative mouldings are multi-profile-round lip and bell profile-flat lip.

The most used marble is Giallo antico for multi-profile and bell-profile mouldings, whereas for grooved and S-profiles, white and red marble dominate.

In the boxes there was a very interesting group of 68 fragments of grooved pilasters in Cipollino marble, found in hundreds of fragments (fig. 3). Just one of them is complete (50.7 × 9.5 × 2 cm). The Villa B pilasters have the same dimensions as those that decorate the sales counter of the Thermopolium in Herculaneum situated on the *decumanus maximus*[13]. Like them, they lack both capitals and bases.

[12] All the objects are named according the definitions provided by Francesca Boldrighini, Marilda De Nuccio, Maria Luisa Frandina, Riccardo Fusco, Marina Milella, Paola Pascucci, Stefania Pergola, Stefania Trevisan and Lucrezia Ungaro in Boldrighini et al. 2007. The identification of the types of marble is the result of visual examination. At the moment, no sampling for laboratory analysis is planned.

[13] Herculaneum, *decumanus maximus*, looking south towards shop at V.10 in the centre. See Pompeii in Pictures, <https://herculaneum.uk/Streets/Decumanus%20Maximus.htm> (16.04.2025).



4 Fragments of some moulded straight bands (photos and drawings: R. Scognamiglio)

Another type among the finds consists of rods, even though they are not very representative in this study. They can give us an idea of the variety of the objects found in Oplontis B. There are 63 fragments of rods. They are mostly in Rosso antico, Cipollino and Giallo antico. They were used, for example, on the top of a marble wainscot in the northeast corner of the *oecus cyzicenus* situated in the Casa dei Cervi in Herculaneum[14].

Among the finds, there is also a small group of strips, or »listelli«, divided into simple »listelli«, throat »listelli« and trapezoidal-section »listelli«. The most-used marble for the simple »listelli« is Cipollino, while for the throat and for trapezoidal-section »listelli« it is Africano.

There are just four examples of short polygonal mouldings in Cipollino marble. Their length is between 22 and 25 cm.

There are a few straight bands, probably used to frame an element in the wall or in the floor. They are mostly in slate and Africano.

A bigger group of bands is called »fasce rettilinee scorniciate« (moulded straight bands) (fig. 4). They are mostly in a white-and-grey-striped fine-grained marble. According to an examination of a photo sent to Lorenzo Lazzarini and Fabrizio Antonelli, it could be a Lunense venato; however, according to María Pilar Lapuente Mercadal, it could be a sort of Cipollino.

Among the finds, I distinguished a group of unique fragments. There are five small and thin slabs of Gabbro eufotide and granite, one fragment of a column, one fragment in serpentine and one in porphyry (fig. 5). There are no other fragments executed in these marbles.

Two fragments of one or two pilaster capitals are part of this unique group (fig. 6). In the preliminary drawing, we can see that the biggest fragment preserves intact the left and the right

[14] Herculaneum IV.21, large Triclinium 15, northeast corner. See Pompeii in Pictures, <https://herculaneum.uk/Ins%204/Herculaneum%204%2021%20p8.htm> (16.04.2025).



5 Fragments of slabs of Gabbro eufotide and granite, one fragment of a column, one fragment in serpentine and one in porphyry (photos: R. Scognamiglio)

sides, but the decoration is incomplete because it leaves out the volute on the left side. It is possible that this fragment was initially a pilaster capital, then it was cut into more parts to be reused, perhaps because it had broken or changed from its original function. This capital is very similar, in terms of decoration, to another one in the collection, which Dario Del Bufalo dated back to the 2nd century BC[15].

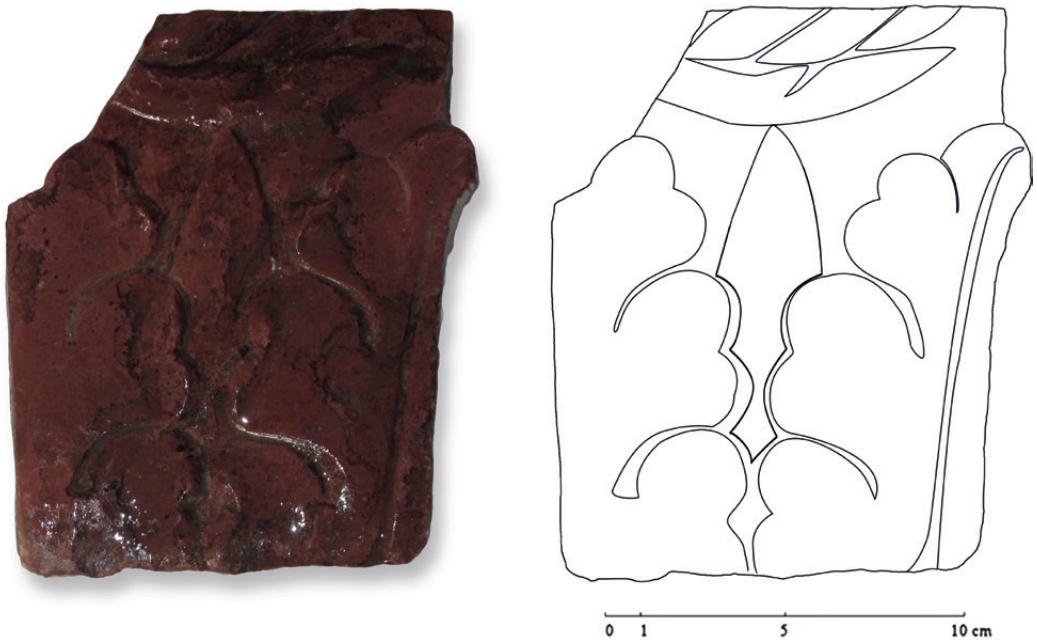
The small and thin decorated *crustae* in Pavonazzetto constitute a very unusual group of fragments (fig. 7). The decoration, a square with concave sides, delineated by parallel incisions 1 cm apart, makes a kind of double frame. This motif appears in black-and-white mosaic pavements during the period of the Third Style, usually with an L-design at its centre[16].

There is a great quantity of slabs in the boxes. I distinguish only the slabs that preserve their edges, either rounded or moulded. Regarding the slabs without a distinguishing edge, there are 955 fragments with a variable thickness between 0.4 and 4 cm. At the moment, I have catalogued them according to the type of marble, but this result, as we can imagine, makes no sense without a study of the weight of the fragments, their dimensions, and an attempt to join all the fragments.

The slabs with a rounded edge have small mortar residues on one side or sometimes on both sides, according to their use. The most common marble is white. These round-edged slabs could have been placed vertically to border an impluvium or placed horizontally to border a base or other architectural feature. The same round-edged slabs can be seen *in situ* at Oplontis Villa A, where they border a fountain in Room 16.

As for the slabs with a moulded edge, there are just nine of them in white marble. They could be used, for example, to border something like the interior part of an impluvium as we can see

15 Del Bufalo 2002, 417 no. 126.
16 Clarke 1991, 131 f.



6 One fragment of a pilaster capital in Rosso antico (photo and drawing: R. Scognamiglio)

in situ in Herculaneum, Casa di Nettuno e Anfitrite[17].

There are also 22 triangular slabs that formed part of the decoration of a floor or a wall, because their thickness varies between 0.7 and 4 cm. As you can see in the diagrams, the type of marble and the thickness are equally distributed: Bardiglio, Bianco, Giallo antico and Pavonazzetto. There is just one 4 cm-thick slab.

Hexagons, squares and rhombuses (fig. 8) are very similar in size, shape and marble to those discovered, according to the excavation journal, on 11 July 1984 in Room 10, but in this box there was no label. It is impossible to say for sure whether they all belonged to the group found in Room 10 or whether some of them came from Building 23. Only on the back of one of them are there traces of mortar, while the other pieces are completely clean. There is just one other rhombus in box 585, no. 1883. It is in Bardiglio and is of the same size as all these fragments. At the moment, I do not have enough elements to reconstruct a single floor with all of these fragments placed together.



7 Fragment of a decorated *crustae* in Pavonazzetto (photo: R. Scognamiglio)

[17] Herculaneum V.7, Impluvium in atrium, looking east. See Pompeii in Pictures, <https://herculaneum.uk/Ins%205/Herculaneum%205%2007.htm> (16.04.2025).



8 Floor tiles (hexagons, squares and rhombuses) in Palombino and Bardiglio (photos: R. Scognamiglio)

What was Building 23? This building is situated near the escarpment in the northwest corner of the excavation. It was built at a higher level and is orientated differently than the rest of the complex. It was excavated by the Soprintendenza in 1975. The Oplontis Project team has not yet explored this structure because no intervention is possible there. We can only rely on the excavation journals from the 1970s and on a preliminary reading of the data by Ivo van der Graaff. The building was probably a thermal bath. Given the brickwork, it is a building from the Imperial period, probably built in the Claudian era[18]. No furnishings were found inside[19].

18 Clarke – Muntasser 2019, fig. 21, 363 (Room 31, south wall).
19 Van der Graaff et al. 2023.

CONCLUSIONS

The accumulation of marble found in this structure cannot be part of the internal decoration of Building 23, because it is known that it was decorated with white plaster, both internally and externally.

Due to the variety of objects and types of marble used, these marbles cannot belong to a single room of a single building but rather belong to at least several rooms in one or more buildings. The different types of mouldings, rods and strips, and the different types of marble for each category are too many for a single environment. The filling-in of the windows at a time after construction suggests that at some point, perhaps after the earthquake in AD 62, the building lost its original function and was used as a storage area for materials to be resold or relocated in the structures that had suffered damage from the earthquake. At the moment, we do not know if this building in its new function has some connection with the commerce of Villa B.

»In the morning the excavation resumed in room 10 [...]. Hexagonal marble tiles belonging to the upper floor were also recovered, some of them in fragments […].«[20] This is what I know about these pieces from the journal of the excavations. This description corresponds to the description of the objects in box 699 because it contains hexagons, some of them in fragments. Room 10 in the lower level is a barrel-vaulted storage area, built after the earthquake of AD 62, in which the skeletons were found. The room on the upper floor of Room 10 belonged, along with the other upper-floor rooms, to the residential part of Oplontis B. The excavators supposed that the tiles belonged to the upper floor, but according to the excavation journal, all the floors of the upper level were in Cocciopesto, now for the most part lost. In 1973, a threshold in Africano marble (77 × 28 × 15 cm) was found on the upper level and is still *in situ*. This object was not located in the floor. It does not make sense to store such a heavy material on the upper floor.

The small quantity of marble tiles is insufficient for a floor and the small traces of mortar on the backs of the objects suggest a reuse of this material, including the threshold. Perhaps all of them were reused objects waiting to be relocated nearby or – less likely – to be resold.

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I would like to thank John R. Clarke and Ivo van der Graaff for sharing their knowledge and providing access to the necessary documents. My gratitude also goes to Lorenzo Lazzarini and Fabrizio Antonelli for their help with the identification of a marble. Thanks also to Simon Barker and Clayton Fant for helping with the identification of the granites.

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Robert H. Tykot – John J. Herrmann, Jr. – Annewies van den Hoek

A ROMAN DORIC PORTICO OF NAXIAN MARBLE AT ALEXANDRIA TROAS

Abstract
There has been little evidence that marble was exported from Naxos during Roman times. Architectural elements at Alexandria Troas, however, are proven with isotopic analysis and measurements of grain size to be from Naxos, and the analyses demonstrate that this Cycladic island did, indeed, play a role in the Roman marble trade. The identification of the marble also makes it likely that design elements accompanied the marble from the southern Aegean to the north at Alexandria Troas.

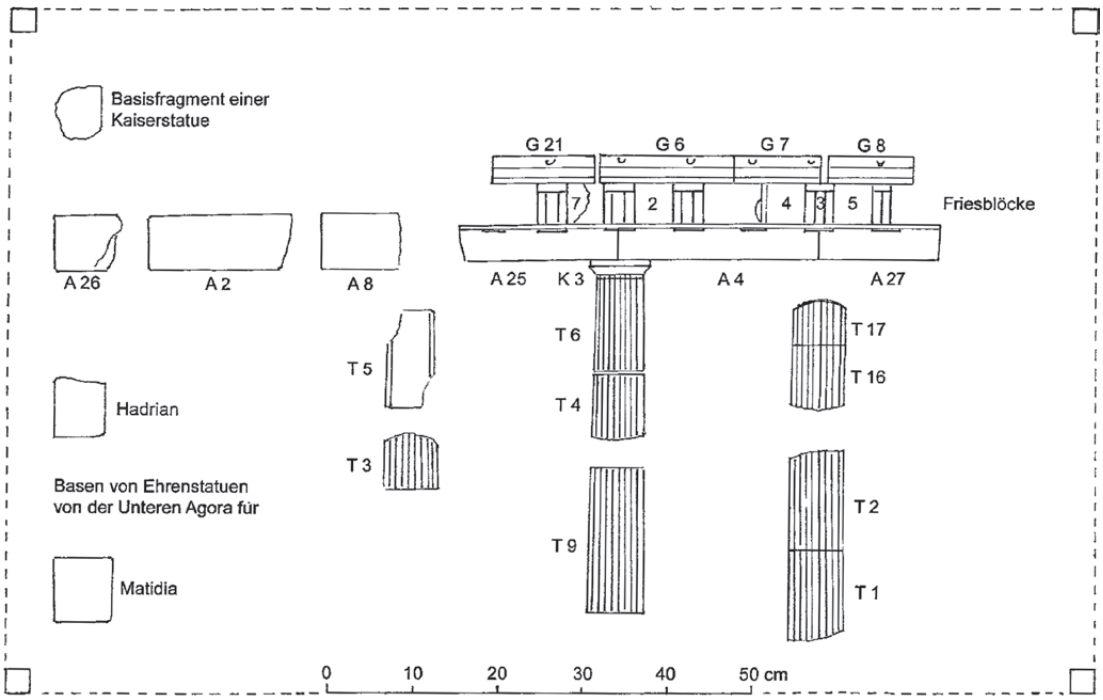
Marble architectural elements of a Doric portico were excavated between 2004 and 2007 by a German and Turkish team at Alexandria Troas on the northwest coast of Türkiye[1]. A small group of the best-preserved pieces was reassembled on the ground in the display area of the site (figs. 1–4 a). The elements came from long porticoes bordering Alexandria's Lower Agora and were dated to the early 2nd century AD. While the Doric outer face of the architrave was an undivided block (figs. 1–2), the inner face was given an Ionic profile, with continuous frieze and a stepped architrave topped by a cymation (figs. 3–4 a). A corner of a pediment was also found (fig. 4 b).

In the publication by H. Wiegartz and D. Çobanoğlu, the marble was identified macroscopically as Proconnesian and described as a bright marble with grey layering[2]. On a visit to the site,



1 Alexandria Troas, Lower Agora, Doric portico (photo: A. van den Hoek)

1 Wiegartz – Çobanoğlu 2008.
2 Wiegartz – Çobanoğlu 2008, 188.



2 Reconstruction of the Doric portico and statue bases from the Lower Agora, Alexandria Troas (drawing: H. Wiegartz after Wiegartz – Çobanoğlu 2008, 188 fig. 1)

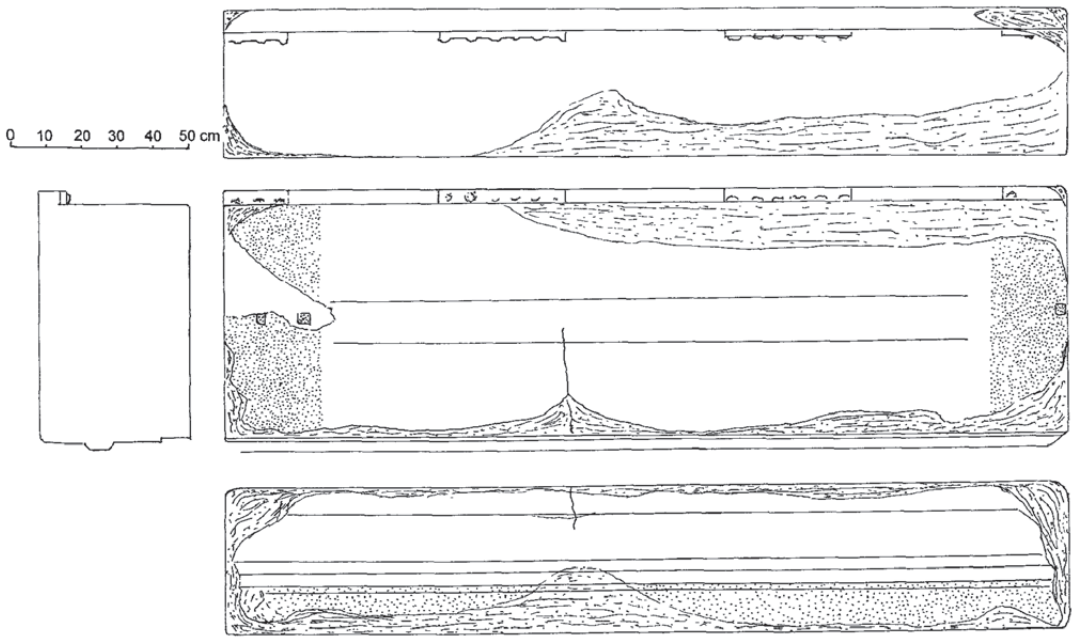
however, the marble seemed too white and too large-grained to be Proconnesian, and it looked much like the marble of Thasos, as if some elements were the dolomitic marble of Cape Vathy and others were the calcitic marble of Aliki or Cape Fanari. In any case, the marble looked very different from the typical banded Proconnesian marble used in other architectural elements stored nearby.

Seven tiny chip samples were taken from various elements of the portico/colonnade. The samples were analysed with a petrographic microscope and a stable isotope ratio mass spectrometer at the University of South Florida. To our surprise, all but one of the samples proved to have isotopic ratios of carbon and oxygen far distant from Thasian values and compatible with the Apollonas quarry on Naxos (tab. 1; fig. 5). The very large maximum grain size (MGS) of five of them (> 5 mm) confirmed the Naxian origin. No other marble except Aliki, Thasos has an MGS over 5[3]. One section of column has a radically different isotopic signature, but it could be from the Melanes quarry on Naxos, as well as Prokonnesos, Ephesos, or Paros (II).

Marbles with similar isotopic ratios also appear in the western Mediterranean (Algeria and Spain), but they are very implausible sources for objects excavated in the northern Aegean area.

Naxian marble is a conspicuous presence in the Archaic period in Greece, above all for the large kouroi still present in some of the island's quarries. At that time the marble even reached northwest Anatolia: an Archaic funerary stele in Naxian marble in the Museum of Fine Arts, Boston, came from Thymbra Farm in the Troad[4]. Thereafter, however, the marble seems to have receded in commercial importance. A column in Pergamon has been identified as Naxian because of its very coarse grain[5], but otherwise the marble currently seems to be unknown outside Naxos during the Roman domination of the Greek world. These architectural elements at

3 Gorgoni et al. 2002, fig. 2.
4 MFA 03.753: van der Merwe et al. 2002, 179 (HI-361).
5 Cramer 2004, 169. 174.



3 Architrave A4, Lower Agora, Alexandria Troas (drawing: H. Wiegartz after Wiegartz – Çobanoğlu 2008, fig. 6)

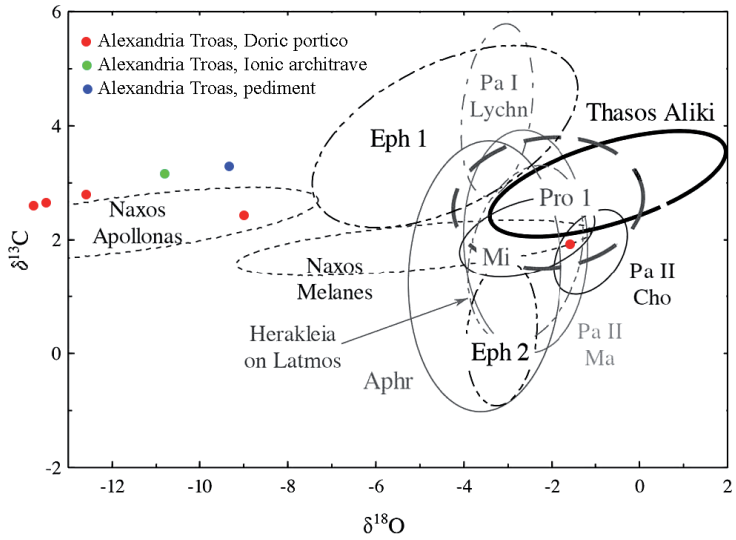


4 Alexandria Troas, Lower Agora. a: Ionic reverse (inner face) of the Doric architrave (A8, USF 38511). b: Pediment corner (G1, USF 38510) (photos: J. Herrmann)

Alexandria Troas, however, demonstrate that Naxos nevertheless did play a role in the Roman marble trade.

In Alexandria the marble portico took the place of a previous Doric portico in limestone, which has been dated to Late Hellenistic times. The foundations connected with the marble portico make use of concrete, a characteristically Roman technique, and are probably of Roman Imperial date[6]. Stratigraphic evidence for the date of the colonnade is not yet available. Wiegartz and Çobanoğlu observe that the statue bases in the agora are no earlier than the end of the 1st century AD, and some are certainly Hadrianic (fig. 2). They conclude that the colonnade probably dates from about the time of Hadrian (AD 117–138)[7]. This middle Imperial date, however, appears to be too late

6 Wiegartz – Çobanoğlu 2008, 219 f.
7 Wiegartz – Çobanoğlu 2008, 220.



5 Isotopic ratio of architectural elements in the forum of Alexandria Troas: isotopic diagram of eastern coarse marbles (after Attanasio 2018, 286; graphics: J. Herrmann)

USF	Wiegartz – Çobanoğlu 2008	Description	MGS (mm)	$\delta^{13}C$	$\delta^{18}O$	Possible sources
38505		Doric portico, cornice	1.5	2.7	–13.5	Nax-Ap
38506		Doric portico, frieze	7.5	2.4	–8.9	Nax-Ap
38507	T6, p. 190 pls. 47–48	Doric portico, upper column drum		1.8	–1.8	Nax-Mel, Par II-Cho, Pro 1, Eph 2
38508	K3, p. 194 pl. 53	Doric portico, capital	5.2	2.8	–12.5	Nax-Ap
38509		Doric portico, architrave	7.0	2.6	–13.9	Nax-Ap
38510	G1, p. 208 pl. 63, 1	Pediment	9.1	3.3	–9.2	Nax-Ap
38511	A8, p. 199 pls. 48. 51	Ionic-Doric architrave	6.4	3.1	–10.8	Nax-Ap

Table 1 Architectural elements from the Lower Agora of Alexandria Troas (analysis at the University of South Florida) (Eph = Ephesos; Nax-Ap = Naxos Apollonas; Nax-Mel = Naxos Melanes; Pa II-Cho = Paros, Chorodaki; Pro = Prokonnesos)

stylistically[8]. Generally the Doric order had dropped out of use by the 2nd century AD[9]. Two Doric colonnades at Ephesos have been attributed by W. Alzinger to the Augustan period, and he cites the Augustan Agora Gate at Athens as a parallel[10]. Like the Athenian gate and the Prytaneion at Ephesos, the colonnade of Alexandria Troas is a retrospective (or Classicistic) version of the Doric order, and it could likewise be Augustan in date.

The undersides of the architraves at Alexandria Troas have narrow, undecorated soffit panels with a linear outline (figs. 1. 3), and this too has a relatively early look. Middle Roman Imperial soffits in Asia Minor and Rome usually have concave ends, wide panels and dense ornamentation[11]. Soffit panels are very unusual on Doric entablatures; almost all other published soffit decorations appear on Ionic entablatures and are used with Ionic or Corinthian capitals. It may be significant that the inner faces of the architraves of the portico at Alexandria Troas are Ionic (that

8 As pointed out to me by Patrizio Pensabene (pers. comm.).
9 Waelkens 1989, 79 f.
10 Alzinger 1974, 51–55 figs. 42–43. 65–66.
11 Wegner 1957; Kökmen Seyirci 2014.



6 Kos, agora, portico, 2nd century BC, said to be local marble (photo: J. Herrmann)

is, with a continuous frieze over a stepped architrave) (figs. 3–4 a). The soffits can be considered a similar Ionic feature. Very similar soffits appear under the entablatures of the Doric porticoes of the agora of Kos (fig. 6). The Kos agora dates from the 2nd century BC, and the marble used is said to be from the island's own (fine-grained) quarries[12]. The vast Doric agora from Kos could well have been a source of design ideas for the extensive Lower Agora at Alexandria Troas. L. Lambrinou has pointed out how exchanges of influences in Doric design travelled back and forth across the Aegean in Hellenistic times[13], and this may be another such cross-Aegean exchange, mediated by the trade in marble.

The Doric order was used in porticoes in the Cyclades during the late Hellenistic period[14]. The source of the marble for these colonnades seems to be unknown, but the Alexandria Troas portico raises the question of whether it could have been Naxian.

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12 Rocco – Livadiotti 2011, 396.
13 Lambrinou 2018.
14 Coulton 1976, 230–234 (Delos). 264 (Naxos). 269 (Paros).

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PROVENANCE IDENTIFICATION I: MARBLE

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Ali Bahadir Yavuz

ANALYSIS AND DISCRIMINATION OF ANCIENT RED MARBLES INCLUDING ROSSO ANTICO FROM CAPE TAINARON AND ASIATIC RED VARIETIES FROM CARIA

Abstract
This paper reports a detailed database of ancient red marbles including grain size, isotopes, electron paramagnetic resonance (EPR), and trace chemical data for 115 quarry samples from six different sites located in the Greek Peloponnesos and Mani as well as in Asia Minor at Iasos and in the quarries newly discovered near Milas. Besides stressing a few diagnostically relevant macroscopic differences between marbles of different provenance, the results demonstrate that good discrimination is obtained by exploiting isotope and grain size data, whereas trace and EPR values are important for solving specific problems, such as discrimination of different Greek or Asiatic sources. The new database has been used to provenance a small but highly relevant number of artefacts including six sculptures of Hadrianic age mostly coming from the emperor's villa. The result is that none of these sculptures were made using Tainaron rosso antico. They were, in fact, all carved using Asiatic varieties, mostly from Iasos and perhaps in one instance from Milas.

INTRODUCTION

Rosso antico is the name traditionally used for the ancient red marble that, already known since approx. the mid-2nd millennium BC in Minoan times, was introduced in Rome during the Late Republic and then widely used mostly for architectural decoration but also, especially in the Hadrianic period, for the production of famous and prized sculptures[1]. The grain size is very fine and the various shades of red exhibited by Rosso antico are due to the presence of relatively large amounts of haematite and other iron and manganese oxides (up to 1 % or 10,000 ppm). Although white-banded specimens are not uncommon, the most prized varieties are quite homogeneous in colour, if an exception is made for the presence of some thin black veins and rare white spots. The origin of Rosso antico was not known[2], until the ancient quarries located at Profitis Elias near the village of Dimaristika north of Cape Tainaron in the southern Mani Peninsula were rediscovered in the mid-19th century[3]. It was only in 1971, however, that R. Gnoli first stated explicitly that Rosso antico must be identified with the marble quarried at Cape Tainaron and concluded, accordingly, that this marble was used for carving famous sculptures such as the »Capitoline faun« and many others. Since then the two terms, Rosso antico and Red Tainaron marble, have been used almost as synonyms, with the consequence that red marble artefacts, especially if homogeneously coloured, are still commonly assumed to be made of this Greek variety almost by default, even in the absence of archaeometric evidence.

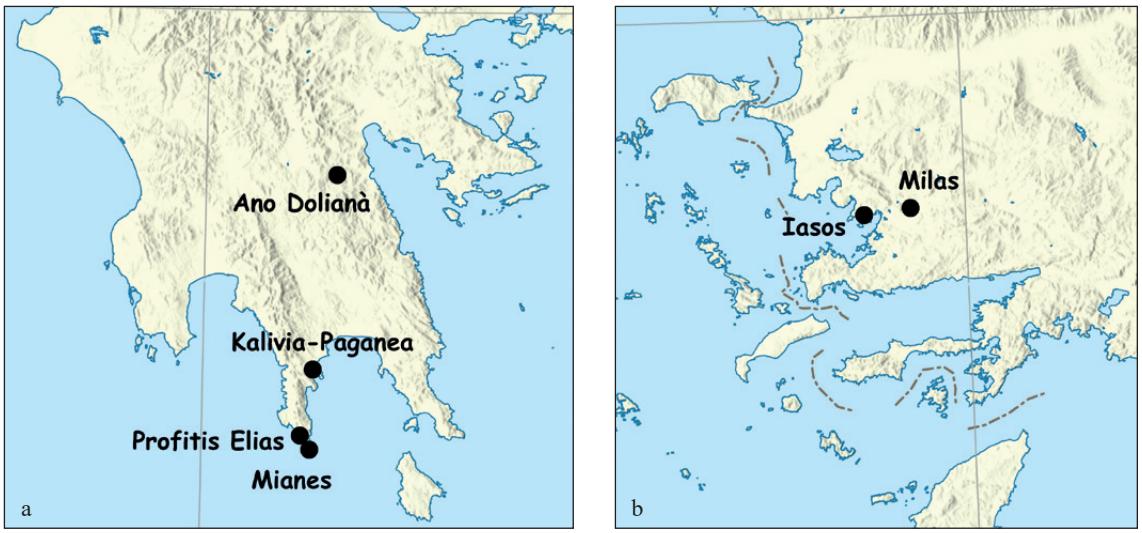
Besides Tainaron Rosso antico, however, other red marbles were known to and exploited by the Romans. Apart from a few sites of lesser importance also located in the Peloponnesos and the Mani Peninsula, the region of Caria in Asia Minor was another important source of red marbles.

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1 Gnoli 1971, 189.

2 F. Corsi suggested that Rosso antico might coincide with the marble quarried near the Carian city of Alabanda and mentioned by Pliny nat. 36, 62, see Corsi 1828, 91–94.

3 Henzen 1857, 154–158.



1 Approximate location of the six red marble quarry sites sampled in a: Peloponnesos and b: Caria (graphics: D. Attanasio)

Well known quarries, already mentioned by Byzantine authors[4], are located near the ancient city of Iasos and produced Marmor Iassense, also known as Carian marble, whereas another large red marble site has very recently been discovered near the village of Kalınağıl, a few kilometres southeast of Milas[5]. This latter includes several modern, quasi-abandoned quarries that still occasionally produce the marble commercially known as Ege Bordo or Rosso Laguna and where remains of ancient workmanship have been almost completely erased. It must be stressed that the Milas red marble is often fairly homogeneous in colour and therefore suitable as a substitute for Tainaron rosso antico, though somewhat coarser in grain. As opposed to this, uniformly coloured examples of Marmor Iassense are rare. Much more often, the red marble of Iasos exhibits swirling white bands or is brecciated, features which explain the names of Cipollino rosso or Rosso brecciato used by modern Roman stonemasons. Generally the identification of Iasos marble artefacts is simply based on their peculiar macroscopic appearance, whereas the relative rarity of uniformly coloured varieties explains why Marmor Iassense has not been considered a likely alternative for Tainaron rosso antico. Moreover Marmor Iassense seems to have been used at Rome only since the 3rd century AD, becoming widespread during the 4th century and Byzantine times[6]. Of course, nothing is known at present about the use of the recently discovered Milas marble.

Turning to more quantitative aspects it should be noted that, despite the considerable amount of archaeometric work published since 1971[7], when Gnoli first proposed his identification of Rosso antico with Red Tainaron marble, the provenance problem has not yet been fully clarified. This is due not only to the newly discovered Milas red marble quarries, but also, and perhaps

4 The verses on marbles written by Paolo Silenziario in his »Description of Haghia Sophia« are reported by R. Gnoli, see Gnoli 1971, 43–49. 245.

5 Bruno et al. 2012. It has been claimed that red marbles also exist within the so-called City Quarries of Aphrodisias. This opinion, first proposed by K. T. Erim long ago (for a summary of pertinent literature see Bruno 2012, 706) has been accepted by many later publications, see Lazzarini 1990, 244; Lazzarini 2007, 85 f.; Pensabene 2013, 359. However, several surveys carried out by us during the last decade definitely demonstrate that no such red marble exists at Aphrodisias.

6 Berti – Peirano 2023 and references therein.

7 Lazzarini 1990; Gorgoni et al. 1992; Gorgoni – Lazzarini 1995; Lazzarini 1999; Andreoli et al. 2002; Gorgoni – Lazzarini – Pallante 2002; Lazzarini 2004; Lazzarini 2007 and references therein.

mostly, to the fact that incomplete or partially published databases continue to be the rule and to the widespread belief that red marble provenance can be unequivocally established simply by eye. Detailed data, including isotopes and chemical analyses of major and minor elements, have been published for the different varieties of Greek Rosso antico quarried at Cape Tainaron and in other Peloponnesian locations[8], but not for Marmor Iassense, in which case only summary graphs are available[9], making it difficult or impossible to implement quantitative provenancing procedures. Now, after discovery of the Milas quarries, development of a comprehensive and fully published database has clearly become more urgent. This paper tries to fill the gap, and even if available data both from quarries and archaeological artefacts are still limited because more analytical methods and more artefacts would be necessary, it shows that the provenance of the Rosso antico marble used for many famous artworks is much less obvious than commonly thought.

QUARRIES AND SAMPLING

At present the red marble database includes 115 quarry samples collected from six different sites. Site location and sampling details are given in figure 1 and table 1[10]. With the exception of the recently discovered Milas quarries near Kalınağıl, all other red marble sites have long been known and repeatedly surveyed and sampled. Here it is enough to recall that the quarries at Profitis Elias represent by far the largest red marble occurrence in the Peloponnesos and Mani. Small red marble quarries and outcrops, however, are scattered throughout the region, and traces of ancient workings can be seen at Dolianà, Kalivia-Paganea and Mianes, among others. These quarries are all rather small and could clearly provide only small amounts of stone. Therefore, even though all the locations mentioned above were sampled, special attention was paid to Profitis Elias, where 36 samples were collected from four different quarries, identified using the nomenclature adopted by L. Moschou and colleagues[11].

At Iasos the three areas named Area 1–3 by A. Andreoli and colleagues were surveyed and sampled[12]. The first, located on the Arigedige Tepe, is crossed by the road leading towards Milas and is located at a short distance from a beautiful Ottoman cistern found along the same road. Areas 2 and 3 are about 3 km northwest of Iasos 1, on the slopes of the Cirkinçe Tepe. Remains of ancient workers' huts are visible at Area 3. Finally, 20 samples were collected from the modern fronts of the two largest marble quarries of the Milas red marble site near Kalınağıl.

As already stated, intensive modern exploitation of the site has completely erased any trace of ancient working. The only surviving evidence might be a cylindrically shaped element that has been found reused as a grinding stone in a nearby farmhouse[13]. To conclude, it is useful to note that although the samples collected often exhibit white veins or spots, only the red fraction was used for the analyses.

ARCHAEOLOGICAL SAMPLES

While the red marble database was being established, a few ancient artefacts, including four sculptures and three architectural elements, were sampled and analysed for the purpose of verifying whether or not reliable site discrimination is possible. Subsequently, this rather limited collection of artefacts was expanded by also taking into account already published data. Five more pieces, three sculptures and two cornices, were included. All artefact samples are listed in table 2 together

8 Lazzarini 2007, 84 f. tabs. 2–3.
9 Gorgoni – Lazzarini – Pallante 2002.
10 Only mean variable values and standard deviations are given here. For the full database, see the appendix table.
11 Moschou – Raftopoulou – Hatziteodorou 2002.
12 Andreoli et al. 2002, 14.
13 Bruno et al. 2012, 566.

Marble site	Samples	Lat. N	Long. E	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %	Fe ppm	Mn ppm	Sr ppm	Insoluble residue %
Dolianà, Upper Quarry and Lower Quarry	10	ca. 37.4323	ca. 22.6785	0.47 0.1	–0.63 0.17	2.60 0.12	956 222	85 17	138 118	838 319	445 107	4.8 4.3
Kalivia-Paganea	8	36.66927	22.51099	0.34 0.1	–0.91 0.14	1.80 0.63	471 164	65 8	1091 588	766 252	815 191	6.9 5.6
Mianes	7	36.40665	22.48010	0.32 0.1	–1.18 0.16	1.83 0.14	–	–	1077 453	618 134	854 67	13.3 5.1
Profitis Elias, Quarry E	12	36.50490	22.46551	0.22 0.1	–0.65 0.15	1.75 0.20	708 166	87 14	233 233	1741 331	617 67	11.5 5
Profitis Elias, Quarry Γ, cattle shelter	4	–	–									
Profitis Elias, Quarry A, heavily white-veined	10	36.50055	22.46390									
Profitis Elias, Quarry B, workers' huts	10	36.49900	22.46348									
Iasos, Area 1	14	37.30079	27.65432	0.35 0.1	–1.66 0.37	2.46 0.28	1277 674	111 27	303 227	1661 980	575 93	7.2 4
Iasos, Area 2	10	37.31197	27.62197									
Iasos, Area 3	10	37.31279	27.59632									
Milas, Kalınağıl	20	37.25482	27.87742	1.24 0.3	–2.54 0.28	2.66 0.15	1239 447	129 30	534 450	2658 943	611 111	18.4 4

Table 1 Details of the sampling carried out at six red marble sites including quarry coordinates, number of samples and average values with standard deviations (second line) of the main analytical variables. Experimental methods and procedures have been reported in detail elsewhere, see e.g. Attanasio – Brilli – Ogle 2006; Prochaska 2013 (Lat. = latitude; Long. = longitude; MGS = maximum grain size; EPR = electron paramagnetic resonance; ppm = parts per million)

No.	Artefact	Inv./ Label	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %
1a	»Capitoline faun«, this work	657	–	–1.90	2.18	–	–
1b	*»Capitoline faun«, lit. data*		–	*–0.88*	*–0.28*	–	–
2	»Vatican faun«	821	0.3	–1.33	2.55	–	–
3	Fragm. head, Hadrian's Villa	VA26	0.3	–2.19	2.68	3667	182
4	*Isis priest, Rome*	*1214*	–	*–2.63*	*1.76*	–	–
5	*Isis priest, Venice*	*117*	–	*–2.56*	*2.48*	–	–
6	Hippo, Copenhagen	1415	0.3	–1.64	2.61	1899	146
7	Slab, Leptis Magna	L09.16	0.4	–0.40	1.65	1185	101
8	Slab, Leptis Magna	L09.17	0.3	–0.53	1.41	2233	164
9	Cornice, Leptis Magna	L09.14	0.8	–2.25	2.33	931	103
10	*Cornice, Vatican*	*955*	–	*–0.47*	*1.33*	–	–
11	*Cornice, Vatican*	*962*	–	*–0.58*	*1.58*	–	–

Table 2 List of the eleven archaeological red marble artefacts discussed in this study together with available analytical properties. Data obtained from literature, excerpted from Lazzarini 2007, 89 tab. 6, are highlighted in italics

with their main properties, while the six sculptures are shown in figure 2. The most famous artwork examined in this study is certainly the »Capitoline red faun«, which although already reported[14], was resampled and reanalysed. The reason is that earlier results in the literature were highly unexpected and hard to explain. All in all, therefore, eleven objects, including six sculptures and five architectural pieces, were taken into account and will be discussed in the following.

In any case, it must be stressed that the selection in table 2 is quite limited and therefore can provide only preliminary information on the use and distribution of red marbles in Roman times. In the future, if a more accurate picture is required, much more extensive and systematic sampling and testing will be needed.

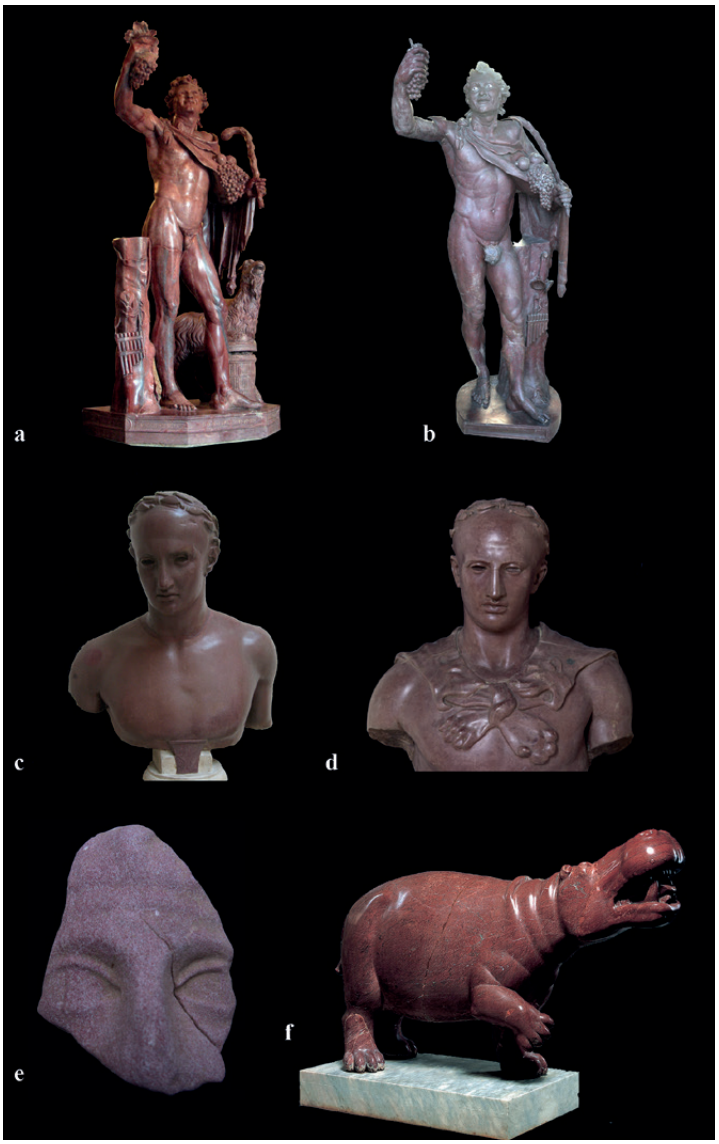
Focusing in particular on architectural artefacts, it must be admitted that the selection is not only small but also somewhat haphazard. Its main value, as shown by the provenance results discussed in the next section, is that of demonstrating the widespread use of Greek red marbles for architectural decoration. At variance with this, the selection of sculptures, though also limited, is certainly much better focused and able to illustrate the use of sculptural red marbles for especially relevant contexts and historical periods. Five out of six sculptures originate from Hadrian's Villa at Tivoli[15], whereas the last one, the red hippopotamus now in the Ny Carlsberg Glyptothek at Copenhagen, is of uncertain provenance but might come from the Gardens of Sallust in Rome[16]. In this way, a fairly reliable picture of the use of red sculptural marbles during their peak time in the first half of the 2nd century AD is obtained.

Turning to analytical results, table 2 shows that many relevant data are missing. In particular grain sizes and EPR values are available only for some samples, whereas trace chemical data are totally absent. When dealing with results from literature, it is, unfortunately, quite common that isotopes, which are still the most widespread marble provenancing tool, are the only numerical data available. In the case of the newly measured artefacts, the absence of important analytical results is due to different reasons, including the extremely tiny samples that were available, especially for sculptures, or to the fact that some artefacts were tested several years

14 Lazzarini 2007, 89 tab. 6.

15 The provenance from Hadrian's Villa of the two Isiac busts, artefacts nos. 4 and 5, hypothetically identified as portraits of Antinoos, although likely, is not unanimously accepted, see Berti – Peirano 2023, 4.

16 Moltesen 2002, 344–346 cat. 118 by J. Lund.

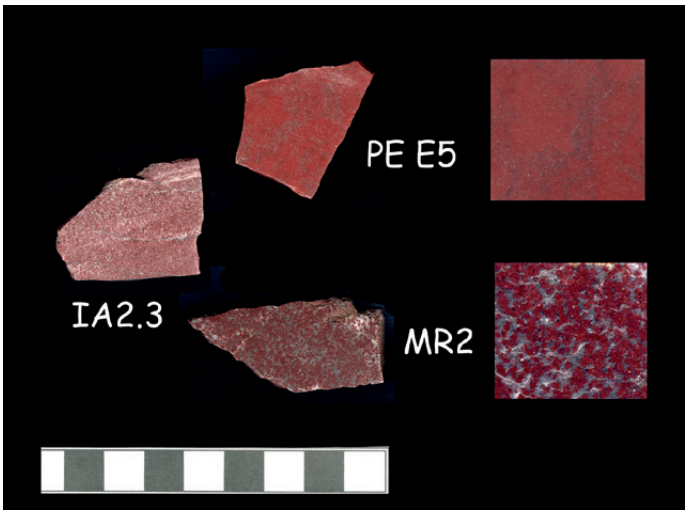


2 The six red marble sculptures considered in this study. a: »Capitoline faun« (Rome). b: »Vatican faun« (Vatican City). c: Isiac priest (Rome). d: Isiac priest (Venice). e: Fragmentary head (Hadrian's Villa). f: Hippopotamus (Copenhagen). Data for busts c and d is from literature (graphics: D. Attanasio, M. Bruno)

ago when trace analysis had not yet become a routine tool in our laboratory. The consequence is that in several instances, provenances will be established primarily on the basis of isotopes, sometimes with the support of grain size information. Luckily enough, this combination of properties, no matter how limited, will prove to be capable of providing the key information that is being sought.

SITE DISCRIMINATION

Regardless of the specific site of provenance, uniformly coloured red marbles all look relatively similar and, upon examination with the naked eye, can be difficult to distinguish. Closer inspection, however, demonstrates that they often exhibit some distinctive macroscopic properties that can be useful for a preliminary screening. With a mean maximum grain size (MGS) value of 1.24 mm, in fact the red marbles of Milas are markedly coarser than all other varieties

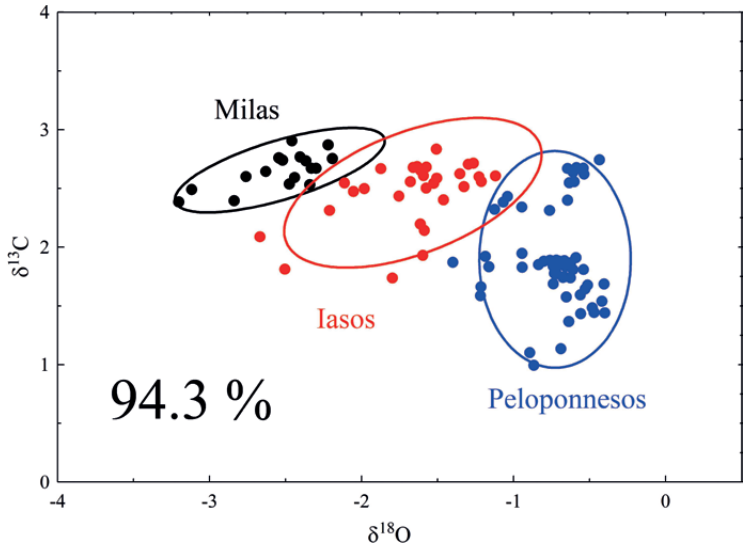


3 Ral and slightly magnified (4 ×) images showing the different sizes of haematite particles in Cape Tainaron (PE E5), Iasos (IA2.3) and Milas (MR2) marbles (graphics: D. Attanasio)

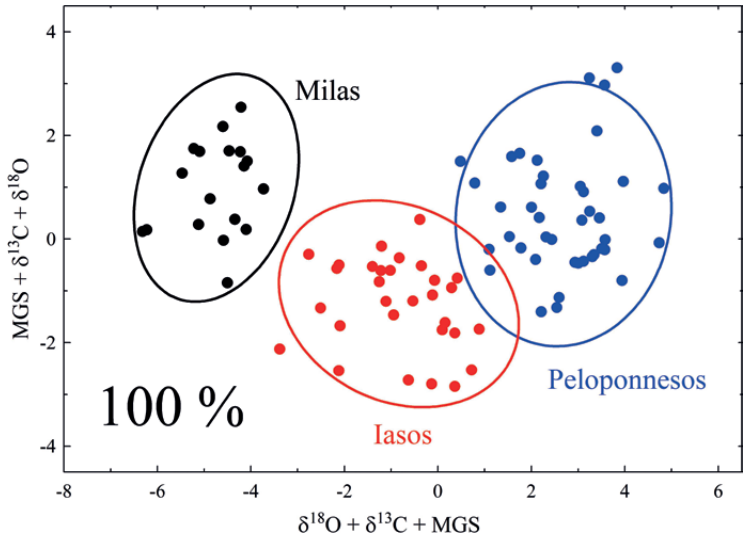
quarried either in the Peloponnesos or at Iasos, where average MGS values are always below 0.5 mm. Another, perhaps, more diagnostic peculiarity of red marbles is the fact that different varieties exhibit different colour distributions. It is known, in fact, that the red colour of the marble is due to the presence of fine haematite particles evenly distributed within a bulk of greyish calcite[17]. In the case of Asiatic red marbles, either from Iasos or Milas, the red particles exhibit diameters up to almost 1 mm and are much coarser than normally found in Greek Rosso antico varieties, as shown in figure 3. The result is that, after polishing, Asiatic red marbles show a sort of ›dusty‹ aspect markedly in contrast with the compact red colour of Tainaron and other Greek Rosso antico varieties. Based on these properties, i.e. grain size and colour distribution, a trained eye may be able to distinguish Greek from Asiatic provenances and even Iasos from Milas marbles. Like any other physical or chemical property, however, both grain size and colour distribution exhibit considerable variability, with the consequence that provenance determinations based exclusively on inspection by eye of these properties can be risky.

Turning to analytical data, the raw and statistical graphs of figure 4 provide a useful summary of the different properties of different red marble varieties and the related possibility of achieving reliable discrimination. In this first approximation approach, all Greek varieties have been classified into a single group without attempting any discrimination between Profitis Elias and other Greek quarrying locations. This is due not only to the comparative similarity of their analytical properties but also, and more importantly, to the fact that the primary goal of this study was that of achieving clear discrimination between Greek and Asiatic, either Iasos or Milas, red marbles. Within these limits, the isotopic graph of figure 4 a shows quite satisfactory results. Marbles from the Peloponnesos, Iasos or Milas exhibit fairly similar $\delta^{13}C$ ratios but different $\delta^{18}O$ values, which allows almost complete separation of the three sites. It is worth noting, however, that the data point distribution of Peloponnesian marbles is rather inhomogeneous, with at least two different groups clustering at low and high $\delta^{13}C$ values. This is obviously due to the choice of grouping together all Peloponnesian marbles, even though all Dolianà and some Kalivia-Paganea samples exhibit appreciably higher $\delta^{13}C$ values. In any case, statistical analysis demonstrates that the rate of isotopic discrimination is, by itself, already very high

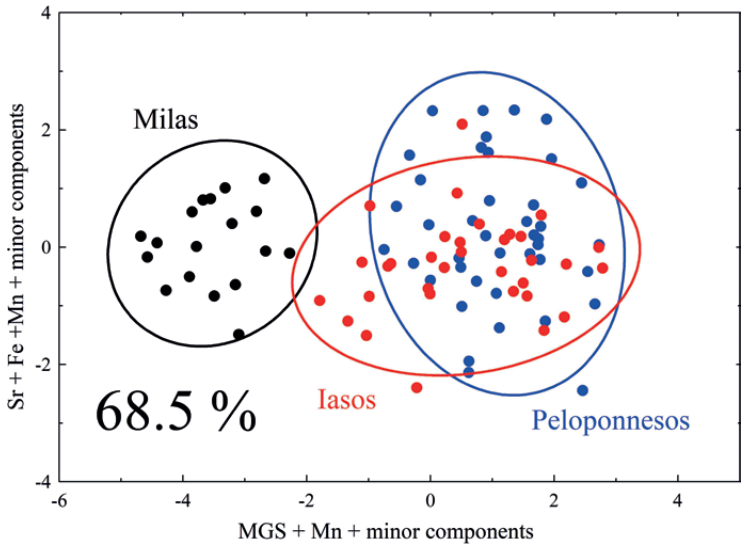
17 Gorgoni – Lazzarini – Pallante 2002, 201; Lazzarini 2007, 87.



a

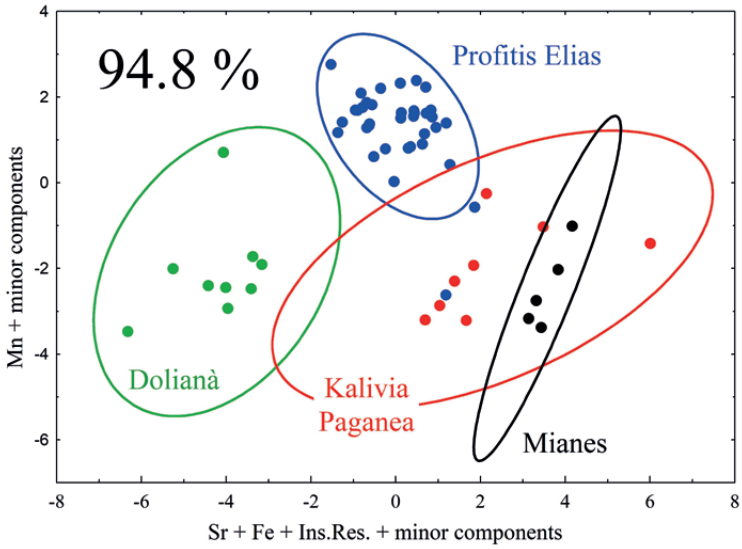


b



c

4 Graphical discrimination of Peloponnesos, Iasos, and Milas red marbles. Rates of discrimination are given. a: Raw isotopic graph. b: Statistical graph combining isotopic and MGS variables. c: Statistical graph combining Mn, Fe, Sr, and MGS variables (graphics: D. Attanasio)



5 Statistical graph obtained by discriminant analysis of the four locations sampled in Peloponnesos using Mn, Fe, Sr, and insoluble residue variables (graphics: D. Attanasio)

(94.3 %)[18]. The next step is obviously that of including grain size information in the analysis, because this property, as already discussed, helps to distinguish the coarser Milas marbles from Iasian or Peloponnesian varieties. As a matter of fact, the graph of figure 4 b, obtained by linear discriminant analysis carried out using isotopes and MGS simultaneously, demonstrates that complete site separation has been achieved.

Given the results just discussed, alternative approaches to red marble discrimination may seem to be unnecessary. Despite this, verifying whether or not different analytical variables such as trace elements or EPR data are similarly powerful and may provide additional or alternative information is still a relevant issue. As an example, the graph of figure 4 c shows results obtained using manganese (Mn), iron (Fe) and strontium (Sr) trace values together with MGS data. The overall rate (68.5 %) is lower than expected, even though it includes the significant contribution provided by MGS data. The result obtained using traces alone (Mn, Fe, and Sr) is only 55 %, much lower than the 94.3 % obtained by isotopic discrimination. EPR variables (i.e. intensity and line-width) appear to perform considerably better (75.2 %), but the result is still well below the rate of isotopic discrimination. The reasons why concentration-related variables, such as chemical traces or EPR parameters, which often make a crucial contribution to marble discrimination, are relatively ineffective in this case, are not obvious. Probably this is, at least partly, due to the high level of impurities present in red marbles and their related high variability, two features which tend to blur and fade differences. Despite this, trace or EPR data can be useful for the solution of specific problems. As an example, the graph in figure 5 illustrates an attempt to discriminate between the four red marble varieties sampled in the Peloponnesos using four variables including Mn, Fe, Sr, and the insoluble residue. The rate of success (94.8 %) is considerably higher than that obtained using isotopes and grain size (85.4 %) and demonstrates that different approaches and different combinations of variables can be beneficial for solving specific discrimination problems. In any case, attempts to discriminate between Greek red varieties must be considered purely preliminary, because with the exception

[18] This value represents the percentage of database samples correctly reassigned to their true quarries of provenance using the discriminant variables under scrutiny. It does not mean, however, that the same rate of success is obtained when dealing with archaeological samples. This partly depends on the assumption that detailed and representative sampling of the quarries has been carried out.

of Profitis Elias, the number of samples per site is not enough for accurate characterisation. It is for this reason that the statistical source fields, i.e. the ellipses, are not well determined and therefore unusually wide.

PROVENANCE OF ARCHAEOLOGICAL ARTEFACTS

Considering the major role that isotopes play for the discrimination of red marbles, the graph in figure 6, which reports artefact isotopic data plotted against the 90 % probability ellipses of the three main red marble production areas, undoubtedly represents the most important tool available for determining their provenance. In the graph, black and red symbols are used for plotting sculptural or architectural samples, respectively, while hollow symbols have been adopted for data from literature, and solid symbols represent analyses carried out purposely for this work.

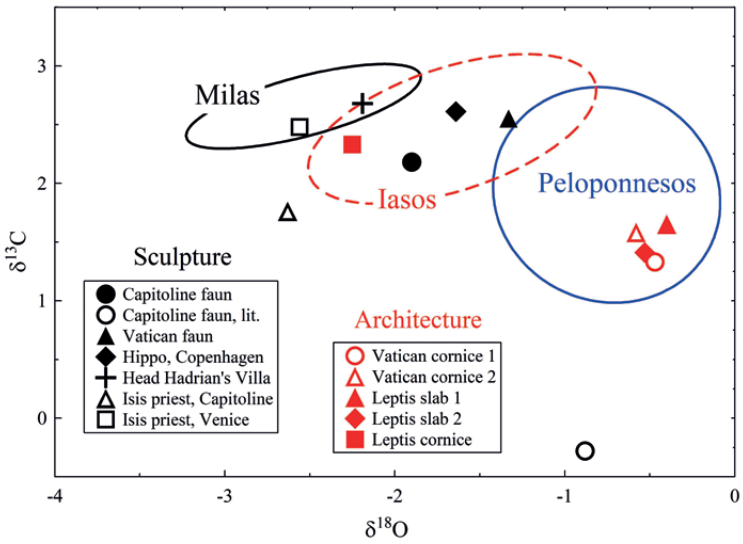
Inspecting the graph, the first result to be stressed is that, with the exception of the »Capitoline faun« discussed below, new and literature data exhibit quite satisfactory agreement. Both, in fact, seem to rule out the use of Greek Rosso antico for the sculptures, suggesting at the same time that this marble was widely exploited for the manufacture of decorative and architectural objects. Even if, as already stated, the architectural selection is undeniably small and unsystematic, the fact that four out of five samples are made of Greek Rosso antico is worth noting. Quite interesting is also the fact that they cluster in an area typical of the Profitis Elias quarries, ruling out, for instance, the possible use of Dolianà marbles. The last architectural sample comes from a cornice and was collected at Leptis Magna as a typical example of Cipollino rosso from Iasos, an identification now fully confirmed by isotopic data.

Turning to sculptures, the first point to be dealt with is the large difference that the isotopic values measured for the »Capitoline faun« in our laboratory ($\delta^{18}O = –1.90$; $\delta^{13}C = 2.18$ ‰) show with respect to previously reported literature data ($\delta^{18}O = –0.88$; $\delta^{13}C = –0.28$ ‰)[19]. This latter, in fact, is totally incompatible with existing databases and seems to suggest provenance from unknown red marble quarries. As opposed to this, we measured values that, besides excluding any possible provenance from Greek quarries, are fully compatible with the uniformly coloured variety quarried at Iasos. The strong disagreement is difficult to explain but might be related to sampling problems, which can occur when dealing with a heavily restored artefact such as the »Capitoline faun«. It is worth noting that strong support for our result comes not only from the possibility to explain easily the marble provenance but also from the fact that relatively similar data were also obtained for the »Vatican faun«, a replica of the more famous Capitoline sculpture that was also found at Hadrian's Villa, where it could have been displayed as a pendant of the »Capitoline faun«[20].

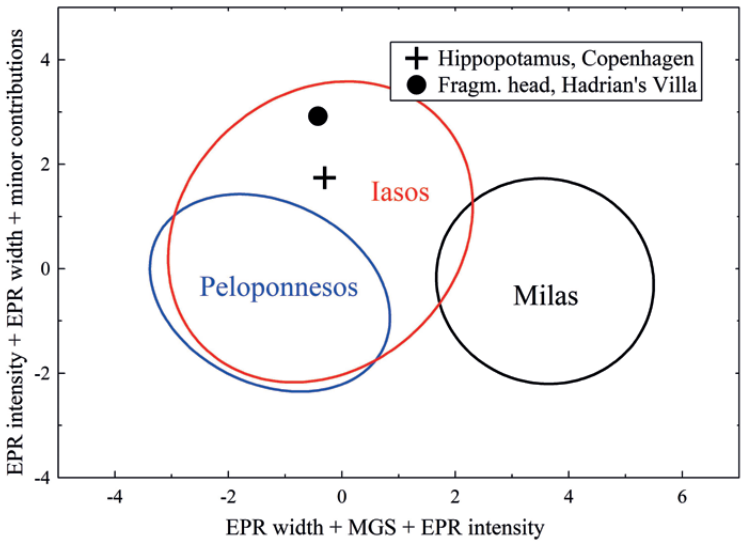
Besides the two red fauns, the other four sculptures tested are also all made using Asiatic red varieties with no example whatsoever of Greek Rosso antico. The hippopotamus now in Copenhagen, possibly coming from the Garden of Sallust and dated to the 2nd century AD, is another clear example of Iasos red marble, while provenance of the remaining three sculptures, though undoubtedly Asiatic, is somewhat more uncertain.

The Capitoline bust of an Isiac priest plots as a moderate outlier, but it very probably belongs to the same Iasos quarries already identified for the other sculptures discussed so far. Clear discrimination between Iasos and Milas on the basis of isotopes alone, however, is not possible for the Isiac priest in Venice and the fragmentary head sampled at Hadrian's Villa. Additional analytical information would be necessary, but is available only for the head from Hadrian's Villa, in the form of grain size and EPR data, and not for the Venice bust. Therefore provenance of the Hadrian's Villa head was verified by discriminant analysis using MGS and EPR variables. With the aim of obtaining an independent result, isotopic data were not included in the statistical procedure. In addition, the Copenhagen hippopotamus, for which a similar set of MGS and EPR

[19] Lazzarini 2007, 89 tab. 2.
[20] La Rocca – Parisi Presicce 2017, 18–25 cat. 1 (M. Cadario).



6 Isotopic plot of the eleven red marble artefacts investigated in this study. Black and red symbols are used for sculptural and architectural samples, respectively, while hollow symbols represent data from literature and solid symbols analyses carried out for this work (graphics: D. Attanasio)



7 Statistical graph obtained by 3-variable discriminant analysis (MGS, EPR intensity and linewidth) of the red marble database. Despite a strong Peloponnesos/Iasos superposition, the Iasian provenance of the two artefacts is quite clear (graphics: D. Attanasio)

data does exist, was also tested in order to check the outcome of the analysis with the aid of an artefact whose provenance had already been clearly established. The graph in figure 7 summarises relevant results and fully confirms the Iasos provenance of the Copenhagen hippopotamus, clearly assigning the same origin to the fragmentary head from Hadrian's Villa.

The overall outcome, therefore, is that five of the six sculptures tested were made using Iasos red marble and are notable examples of the uniformly coloured red variety that, though uncommon, was present in the quarries. The sixth sculpture, i.e. the Isiac bust in Venice, is also made of Asiatic red marble. Its precise site of provenance, however, cannot be safely identified simply on isotopic grounds. New sampling and additional analyses would be necessary to obtain conclusive results. In any case, no example of Tainaron rosso antico marble could be identified, despite the fact that this variety is still commonly considered to be the sculptural red marble par excellence used in antiquity.

CONCLUSIONS

Demonstrating that Asiatic varieties and not the Rosso antico marble quarried at Profitis Elias north of Cape Tainaron were used for the manufacture of all tested red marble sculptures is certainly the most important piece of information delivered by this study. The result is even more striking if we consider that all the sculptures are dated to the first half of the 2nd century AD, a time when the popularity of red marble sculptures reached its peak and they were used in abundance for the lavish decoration of Hadrian's Villa at Tivoli.

It is fair to recall that some results, such as the Asiatic marble provenance of the Isiac busts in Rome and Venice confirmed by this work, were already known and had been reported. However, for some reason, probably connected with the unfortunate analysis carried out on the »Capitoline faun«, the general value of these data had not been fully perceived or properly stated. The consequence is that the opinion of a widespread, virtually exclusive, use of Tainaron rosso antico for sculpture has not been weakened in any way and is still generally accepted in the archaeological and art-historical literature.

The new results of course change this picture completely, and it must be added that considering recent advances in marble archaeometry and the discovery of unknown marble quarries[21], they were not entirely unexpected. Five of the six sculptures tested originate from Hadrian's Villa[22], where the presence of Aphrodisian workshops has been related to the extensive use of Asiatic white and also black marbles, mostly from Göktepe but also from Dokimeion or the Aphrodisias city quarries[23]. Results obtained at Hadrian's Villa but also in Rome and many other locations stress the tight connection existing between the Aphrodisian sculptors and the marble that, whenever possible, they much preferred to use and that came from their homeland in Caria. Within this picture, the possible use of red Carian marbles by these sculptors had already been suggested on macroscopic grounds[24]. Now the new analyses strengthen and complete the panorama, demonstrating, in fact, that the Aphrodisian sculptors exploited the full palette of colours and textures of their homeland marbles, therefore including not only the fine-grained white and black marbles of Göktepe but also the white coarse-grained marbles from the city quarries of Aphrodisias as well as the red marbles quarried at Iasos and, perhaps, also at Milas.

A final remark is that if the traditional name Rosso antico still has to be used, it should probably be linked to the Asiatic varieties used to manufacture the most prized red marble artworks rather than to the variety quarried at Profitis Elias, whose sculptural use has yet to be verified. In any case and in order to avoid new misunderstandings, the generic term »Rosso antico« should always be accompanied by a geographic specification.

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Appendix Table Extended red marble database including 115 quarry samples and 11 variables

No.	Sample	Quarry	Site	Group	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %	Mg %	Fe ppm	Mn ppm	Sr ppm	Zn ppm	Insoluble residue %
1	PEE-1	Profitis E	Profitis Elias	Peloponnesos		–0.67	1.88	7.082	0.840	0.287	220	1683	720	25	9.95
2	PEE-2	Profitis E	Profitis Elias	Peloponnesos		–0.64	1.37	8.192	0.991	0.146	212	1768	541	21	8.56
3	PEE-3	Profitis E	Profitis Elias	Peloponnesos		–0.74	1.69	6.991	0.933	0.148	198	1868	626	22	12.17
4	PEE-4	Profitis E	Profitis Elias	Peloponnesos		–0.47	1.44	5.906	0.793	0.177	308	1577	556	22	7.92
5	PEE-5	Profitis E	Profitis Elias	Peloponnesos		–0.65	1.58	4.579	0.688	0.133	271	1500	548	19	7.60
6	PEE-6	Profitis E	Profitis Elias	Peloponnesos		–0.72	1.89	9.936	1.066	0.182	300	1846	608	25	15.65
7	PEE-7	Profitis E	Profitis Elias	Peloponnesos		–0.53	1.64	6.621	0.821	0.147	101	1742	572	17	7.21
8	PEE-8	Profitis E	Profitis Elias	Peloponnesos	0.15	–0.48	1.48	7.162	0.830	0.146	153	1708	526	18	6.99
9	PEE-9	Profitis E	Profitis Elias	Peloponnesos		–0.61	1.81	7.660	0.867	0.158	158	1762	663	20	10.86
10	PEE-10	Profitis E	Profitis Elias	Peloponnesos		–0.63	2.55	7.801	0.926	0.137	214	1646	713	19	8.17
11	PEE-11	Profitis E	Profitis Elias	Peloponnesos		–0.40	1.69	7.110	0.934	0.098	112	2129	549	18	26.33
12	PEE-12	Profitis E	Profitis Elias	Peloponnesos		–0.42	1.54	4.727	0.651	0.098	88	1150	632	18	27.13
13	PEA-1	Profitis A	Profitis Elias	Peloponnesos	0.2	–0.70	1.87	8.185	0.897	0.124	127	1760	731	19	11.53
14	PEA-2	Profitis A	Profitis Elias	Peloponnesos	0.2	–0.67	1.74	7.492	0.880	0.117	91	1844	585	17	10.19
15	PEA-3	Profitis A	Profitis Elias	Peloponnesos	0.2	–0.76	1.89	7.855	0.937	0.123	133	1737	647	18	11.40
16	PEA-4	Profitis A	Profitis Elias	Peloponnesos	0.15	–0.63	1.74	7.721	0.905	0.098	103	1884	581	17	11.13
17	PEA-5	Profitis A	Profitis Elias	Peloponnesos	0.2	–0.70	1.88	9.848	1.076	0.134	115	2143	622	20	16.66
18	PEA-6	Profitis A	Profitis Elias	Peloponnesos	0.25	–0.59	1.91	8.657	1.049	0.097	85	2068	720	19	13.07
19	PEA-7	Profitis A	Profitis Elias	Peloponnesos	0.2	–0.84	1.85	9.238	1.049	0.091	84	1863	614	17	12.92
20	PEA-8	Profitis A	Profitis Elias	Peloponnesos	0.3	–0.73	1.79	12.122	1.284	0.096	86	2519	495	16	16.41
21	PEA-9	Profitis A	Profitis Elias	Peloponnesos	0.25	–0.56	1.59	6.066	0.831	0.137	360	1946	574	21	10.54
22	PEA-10	Profitis A	Profitis Elias	Peloponnesos	0.2	–0.80	1.88	6.784	0.842	0.114	188	1801	679	20	10.24
23	PEB-1	Profitis B	Profitis Elias	Peloponnesos	0.15	–1.21	1.66	6.445	0.737	0.073	1097	1111	729	22	2.94
24	PEB-2	Profitis B	Profitis Elias	Peloponnesos	0.25	–0.72	1.77	7.655	0.958	0.122	224	2101	491	22	15.77
25	PEB-3	Profitis B	Profitis Elias	Peloponnesos	0.2	–0.62	1.87	5.870	0.794	0.123	140	2056	709	24	9.82
26	PEB-4	Profitis B	Profitis Elias	Peloponnesos		–0.51	1.68	4.794	0.727	0.094	194	1492	649	19	9.85

No.	Sample	Quarry	Site	Group	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %	Mg %	Fe ppm	Mn ppm	Sr ppm	Zn ppm	Insoluble residue %
27	PEB-5	Profitis B	Profitis Elias	Peloponnesos		–0.67	1.75	4.677	0.737	0.132	152	1926	547	20	8.83
28	PEB-6	Profitis B	Profitis Elias	Peloponnesos		–0.73	1.78	7.302	0.938	0.111	121	2094	564	19	10.08
29	PEB-7	Profitis B	Profitis Elias	Peloponnesos	0.2	–0.66	1.83	4.941	0.698	0.107	107	1654	660	19	4.88
30	PEB-8	Profitis B	Profitis Elias	Peloponnesos		–0.67	1.75	5.997	0.814	0.110	159	1752	585	17	7.36
31	PEB-9	Profitis B	Profitis Elias	Peloponnesos		–0.72	1.79	6.316	0.737	0.099	266	1537	661	17	7.64
32	PEB-10	Profitis B	Profitis Elias	Peloponnesos		–0.56	1.43	4.802	0.669	0.132	780	653	651	19	7.23
33	PET-1	PE gamma	Profitis Elias	Peloponnesos	0.4	–0.54	1.81	6.440	0.765	0.243	163	1465	637	17	13.85
34	PET-2	PE gamma	Profitis Elias	Peloponnesos	0.3	–0.67	1.88	8.502	0.929	0.229	161	1574	669	17	14.98
35	PET-3	PE gamma	Profitis Elias	Peloponnesos	0.25	–0.74	1.84	7.736	1.003	0.186	144	1820	610	18	16.42
36	PET-4	PE gamma	Profitis Elias	Peloponnesos	0.2	–0.40	1.44	5.766	0.852	0.270	970	1507	555	23	12.64
37	DR-1	Dolianà	Dolianà	Peloponnesos	0.45	–0.64	2.40	9.655	0.792	0.147	64	684	447	22	2.83
38	DR-2	Dolianà	Dolianà	Peloponnesos	0.25	–0.54	2.67	7.925	0.889	0.270	79	579	297	23	5.40
39	DR-3	Dolianà	Dolianà	Peloponnesos	0.35	–0.60	2.56	13.747	1.226	0.286	82	1619	358	24	11.28
40	DR-4	Dolianà	Dolianà	Peloponnesos	0.55	–0.43	2.74	8.455	0.723	0.108	57	638	595	17	0.55
41	DR-5	Dolianà	Dolianà	Peloponnesos	0.35	–0.54	2.62	10.298	0.781	0.118	151	796	564	16	0.03
42	DR-6	Dolianà	Dolianà	Peloponnesos	0.65	–0.59	2.68	6.042	0.652	0.121	56	635	531	18	3.45
43	DR-7	Dolianà	Dolianà	Peloponnesos	0.55	–1.04	2.43	8.651	0.771	0.105	152	797	491	16	1.86
44	DR-8	Dolianà	Dolianà	Peloponnesos	0.45	–0.61	2.64	9.648	0.988	0.284	178	660	344	25	11.20
45	DR-9	Dolianà	Dolianà	Peloponnesos	0.65	–0.64	2.67	11.591	0.850	0.146	112	821	498	23	1.88
46	DR-10	Dolianà	Dolianà	Peloponnesos	0.35	–2.28	2.22	17.641	1.058	0.152	451	1152	330	23	9.52
47	KS-1	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.35	–1.07	2.38	3.968	0.585	0.070	696	529	824	20	2.62
48	KS-2	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.2	–0.76	2.31	6.798	0.736	0.168	980	910	939	23	4.35
49	KS-3	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.35	–0.95	2.34	2.407	0.557	0.074	412	556	926	20	0.86
50	KS-4	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.3	–1.12	2.32	2.516	0.556	0.062	364	509	919	23	0.73
51	KS-5	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.4	–0.89	1.10	5.586	0.709	0.155	1670	1268	621	29	8.22
52	KS-6	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.4	–0.69	1.13	5.889	0.709	0.195	1127	735	603	26	9.71
53	KS-7	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.35	–0.87	0.99	5.952	0.728	0.220	1548	824	585	22	13.59

No.	Sample	Quarry	Site	Group	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %	Mg %	Fe ppm	Mn ppm	Sr ppm	Zn ppm	Insoluble residue %
54	KS-8	Kal-Pagan	Kalivia Paganea	Peloponnesos	0.4	–0.94	1.83	4.589	0.652	0.086	1936	799	1099	20	15.19
55	M-1	Mianes	Mianes	Peloponnesos	0.5	–1.40	1.87	5.263	0.755	0.185	1232	715	867	244	11.73
56	M-2	Mianes	Mianes	Peloponnesos	0.35	–2.00	0.04	3.955	0.684	0.169	1143	617	792	28	10.59
57	M-3	Mianes	Mianes	Peloponnesos	0.35	–1.99	–0.63	4.414	0.713	0.236	1922	526	767	37	11.58
58	M-4	Mianes	Mianes	Peloponnesos	0.2	–1.22	1.59	5.037	0.694	0.198	1168	540	811	17	10.54
59	M-5	Mianes	Mianes	Peloponnesos	0.35	–1.19	1.92	5.121	0.713	0.216	854	582	866	20	11.56
60	M-6	Mianes	Mianes	Peloponnesos	0.3	–0.95	1.95	4.462	0.694	0.180	592	868	936	14	24.66
61	M-7	Mianes	Mianes	Peloponnesos	0.25	–1.16	1.83	4.072	0.665	0.186	632	476	937	17	12.55
62	MR-1	Milas	Milas	Milas	0.7	–2.54	2.76	13.667	1.394	0.194	347	3395	657	23	17.88
63	MR-2	Milas	Milas	Milas	0.9	–2.52	2.74	18.139	1.394	0.197	828	4187	635	24	17.76
64	MR-3	Milas	Milas	Milas	1.1	–2.19	2.75	12.053	1.213	0.199	710	2096	700	22	17.46
65	MR-4	Milas	Milas	Milas	1.6	–2.48	2.54	9.683	1.258	0.255	597	2667	541	27	25.00
66	MR-5	Milas	Milas	Milas	1.7	–3.73	–5.36	2.845	0.973	0.157	2289	1665	239	35	26.29
67	MR-6	Milas	Milas	Milas	1.6	–2.63	2.64	11.511	1.407	0.206	436	2908	635	26	16.85
68	MR-7	Milas	Milas	Milas	1	–3.20	2.39	11.165	1.382	0.319	255	1546	731	34	23.25
69	MR-8	Milas	Milas	Milas	0.9	–2.84	2.40	18.612	1.909	0.234	479	4689	513	27	25.48
70	MR-9	Milas	Milas	Milas	1.05	–3.12	2.49	25.830	2.050	0.224	431	4231	570	23	20.11
71	MR-10	Milas	Milas	Milas	0.9	–2.37	2.73	8.868	1.034	0.183	252	2689	707	22	14.19
72	MR-11	Milas	Milas	Milas	1	–2.41	2.77	10.735	1.213	0.209	281	1777	576	28	19.52
73	MR-12	Milas	Milas	Milas	1.7	–3.35	1.01	12.331	1.467	0.208	421	2693	524	30	16.24
74	MR-13	Milas	Milas	Milas	1.4	–2.44	2.59	9.971	1.194	0.160	276	2238	587	19	20.13
75	MR-14	Milas	Milas	Milas	1.2	–2.54	2.76	10.002	0.992	0.199	356	1793	731	25	14.62
76	MR-15	Milas	Milas	Milas	1.75	–2.46	2.90	11.843	1.213	0.185	190	3208	610	21	15.73
77	MR-16	Milas	Milas	Milas	1.4	–2.22	2.87	8.869	0.960	0.155	633	2052	707	20	15.53
78	MR-17	Milas	Milas	Milas	1.3	–2.30	2.67	12.393	1.350	0.205	702	3134	600	25	19.64
79	MR-18	Milas	Milas	Milas	1.4	–2.33	2.67	8.697	0.938	0.183	451	1685	698	19	11.42
80	MR-19	Milas	Milas	Milas	1.7	–2.34	2.53	13.329	1.310	0.208	521	2934	609	25	14.66

No.	Sample	Quarry	Site	Group	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %	Mg %	Fe ppm	Mn ppm	Sr ppm	Zn ppm	Insoluble residue %
81	MR-20	Milas	Milas	Milas	1.4	–2.76	2.60	7.696	0.990	0.232	232	1572	656	25	16.71
82	IR1.1	Iasos1	Iasos	Iasos	0.2	–1.52	2.54	10.068	1.054	0.180	186	1500	711	22	6.24
83	IR1.2	Iasos1	Iasos	Iasos	0.35	–1.35	2.62	10.292	1.064	0.178	188	1668	636	18	7.58
84	IR1.3	Iasos1	Iasos	Iasos	0.3	–2.67	2.09	13.225	1.352	0.217	1272	3404	694	18	6.99
85	IR1.4	Iasos1	Iasos	Iasos	0.25	–1.12	2.61	3.609	0.690	0.135	273	261	463	15	4.75
86	IR1.5	Iasos1	Iasos	Iasos	0.25	–1.60	1.93	8.468	0.930	0.188	201	932	429	15	5.09
87	IR1.6	Iasos1	Iasos	Iasos	0.35	–1.21	2.56	12.085	1.160	0.219	407	2072	649	24	11.32
88	IR1.7	Iasos1	Iasos	Iasos	0.25			9.220	0.939	0.176	232	1382	655	18	10.55
89	IR1.8	Iasos1	Iasos	Iasos	0.35			9.591	0.891	0.125	636	1052	776	16	7.28
90	IR1.9	Iasos1	Iasos	Iasos	0.45	–1.59	2.61	8.499	1.141	0.111	49	487	706	11	4.28
91	IR1.10	Iasos1	Iasos	Iasos	0.5	–1.66	2.68	9.625	1.141	0.135	507	1858	764	10	11.04
92	IR1.11	Iasos1	Iasos	Iasos	0.55	–1.87	2.67	13.511	1.477	0.136	573	2710	529	15	7.07
93	IR1.12	Iasos1	Iasos	Iasos	0.3	–1.26	2.72	6.426	0.795	0.175	218	560	513	11	7.68
94	IR1.13	Iasos1	Iasos	Iasos	0.45	–1.59	2.14	2.550	0.594	0.150	68	434	494	11	3.80
95	IR1.14	Iasos1	Iasos	Iasos	0.25			4.524	0.690	0.177	308	263	506	12	1.99
96	IR2.1	Iasos2	Iasos	Iasos	0.35	–2.05	2.47	34.886	1.902	0.202	164	2561	541	15	7.93
97	IR2.2	Iasos2	Iasos	Iasos	0.45	–1.68	2.56	9.894	1.074	0.160	401	2059	620	15	10.08
98	IR2.3	Iasos2	Iasos	Iasos	0.35	–1.61	2.65	26.362	1.445	0.151	386	1678	605	14	1.68
99	IR2.4	Iasos2	Iasos	Iasos	0.6	–2.11	2.55	7.386	0.915	0.236	348	3495	562	23	18.86
100	IR2.5	Iasos2	Iasos	Iasos	0.55	–1.57	2.68	11.701	0.986	0.127	350	1902	598	12	8.76
101	IR2.6	Iasos2	Iasos	Iasos	0.5	–1.98	2.50	19.876	1.445	0.152	175	2615	525	14	9.29
102	IR2.7	Iasos2	Iasos	Iasos	0.35	–1.75	2.44	38.512	2.496	0.174	396	3734	436	15	15.04
103	IR2.8	Iasos2	Iasos	Iasos	0.45	–1.63	2.69	10.562	1.000	0.114	346	2214	613	14	9.47
104	IR2.9	Iasos2	Iasos	Iasos	0.45	–1.58	2.50	44.983	2.667	0.127	350	3893	514	13	10.01
105	IR2.10	Iasos2	Iasos	Iasos	0.35	–1.51	2.59	17.148	1.050	0.089	242	1239	611	9	0.06
106	IR3.1	Iasos3	Iasos	Iasos	0.2	–1.23	2.60	12.015	1.054	0.200	148	1087	556	11	5.66
107	IR3.2	Iasos3	Iasos	Iasos	0.25	–1.33	2.51	12.800	1.183	0.190	165	1528	523	14	10.48

No.	Sample	Quarry	Site	Group	MGS mm	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	EPR intensity %	EPR width %	Mg %	Fe ppm	Mn ppm	Sr ppm	Zn ppm	Insoluble residue %
108	IR3.3	Iasos3	Iasos	Iasos	0.2	–1.30	2.71	14.591	1.196	0.215	172	1256	474	14	4.37
109	IR3.4	Iasos3	Iasos	Iasos	0.3	–2.51	1.81	17.928	1.455	0.139	116	1075	511	12	7.52
110	IR3.5	Iasos3	Iasos	Iasos	0.25	–1.80	1.74	13.028	1.088	0.212	177	1240	526	13	0.20
111	IR3.6	Iasos3	Iasos	Iasos	0.25	–2.21	2.31	25.450	1.374	0.174	507	1420	689	11	6.96
112	IR3.7	Iasos3	Iasos	Iasos	0.2	–2.87	–0.41	4.663	0.758	0.125	148	708	470	13	3.63
113	IR3.8	Iasos3	Iasos	Iasos	0.35	–1.61	2.20	13.727	1.194	0.162	125	1327	562	12	5.71
114	IR3.9	Iasos3	Iasos	Iasos	0.25	–1.46	2.40	12.140	1.067	0.159	183	1187	500	15	5.62
115	IR3.10	Iasos3	Iasos	Iasos	0.25	–1.51	2.83	14.744	1.112	0.162	127	1203	605	11	3.37

Vincent Barbin – Rémy Chapoulie – John J. Herrmann, Jr. – Aleksander Minchev – Brigitte Spiteri – Vasil Tenekdjiev – Annewies van den Hoek

CATHODOLUMINESCENCE OF THASIAN CALCITIC MARBLE ARCHITECTURAL DECORATION OF EARLY BYZANTINE TIMES IN VARNA, BULGARIA

Abstract
Some pieces of Early Byzantine architectural decoration in the courtyard of the Archaeological Museum of Varna appeared to be marble from Thasos rather than the usual Proconnesian marble. Since the two marble types are often optically similar, cathodoluminescence was used to determine which option was correct. Four of the six pieces tested proved to be Thasian, probably from the quarries at Aliki, and two were Proconnesian. The archaeological and art-historical consequences of these identifications were also explored. One simple capital was prefabricated on Thasos, but in two other cases the marble seems to have been exported as raw material. A Proconnesian capital is an unusual variant of a standard type.

On the basis of macroscopic inspection, many scholars have maintained that Proconnesian marble products strongly dominated the market for architectural decoration in the Black Sea region during the Roman period and throughout Early Byzantine times (4th–7th cent.)[1]. Recent scientific analysis has lent support to this impression: a study of 20 Byzantine marbles from Sozopol and other nearby Bulgarian sites has shown Proconnesian dominance of the marble supply, but the study also revealed the use of small quantities of local, Thasian, and Pentelic marble[2]. At the Archaeological Museum in Varna, Bulgaria (ancient Odessos), our optical inspection of the many fragments of Byzantine marble architectural decoration in the museum's courtyard also suggested that Proconnesian marble and Proconnesian sculptural types generally prevailed in this area. A few pieces, however, seemed to have a coarser grain than the others, and this suggested a possible provenance from the calcitic marble quarries of the north Aegean island of Thasos. The soft grey spots on some pieces also reinforced this idea. The Thasian hypothesis was also supported by an Ionic capital in the courtyard: it is a type known to have been exported in a prefabricated state from Thasos in the 4th and 5th centuries[3]. Small chip samples were taken from the six suspected Thasian pieces, which were two capitals and four chancel barriers (panels coming from enclosures of the altar area of Early Byzantine churches).

It is widely known that some quarries on Thasos produced pure white dolomitic marble used for sculpture in antiquity and that this dolomite is easily separated from the calcitic marbles that were normally used for sculpture in antiquity. Thasian calcitic marble (primarily from the quarries of Aliki and Cape Fanari), however, is more difficult to separate from other calcitic marbles and especially from Proconnesian marble both on a macroscopic basis and when making use of most scientific methods. The colour and markings of both marble sources are similar, and they display considerable overlap in their isotopic ratios of carbon and oxygen and maximum grain size

1 Barsanti 1989; Vanderheyde – Prochaska 2011, 353.
2 Vanderheyde – Prochaska 2011, 372; Anevlavi et al. 2022.
3 Herrmann – Sodini 1977.

Sample	Description	Colour	Source
1	Corinthian capital with a cross	Blue	Prokonnesos or Paros Lychnites
2	Plate from a chancel screen; relief frame	Blue	Prokonnesos or Paros Lychnites
3	Ionic capital	Medium orange	Thasos
4	Plate from a chancel screen decorated with a cross	Medium orange	Thasos
5	Plate from a chancel screen decorated with a roundel filled with a rosette	Medium orange	Thasos
6	Plate from a chancel screen decorated with triangles and a diamond shape	Medium orange	Thasos

Table 1 Cathodoluminescence of Varna samples at the University Bordeaux Montaigne. Technical data: high voltage: 12kV; current density: 200 micro-amperes; vacuum 50 mTorr; Cathodyne system; optical microscope Leica × 25 magnification

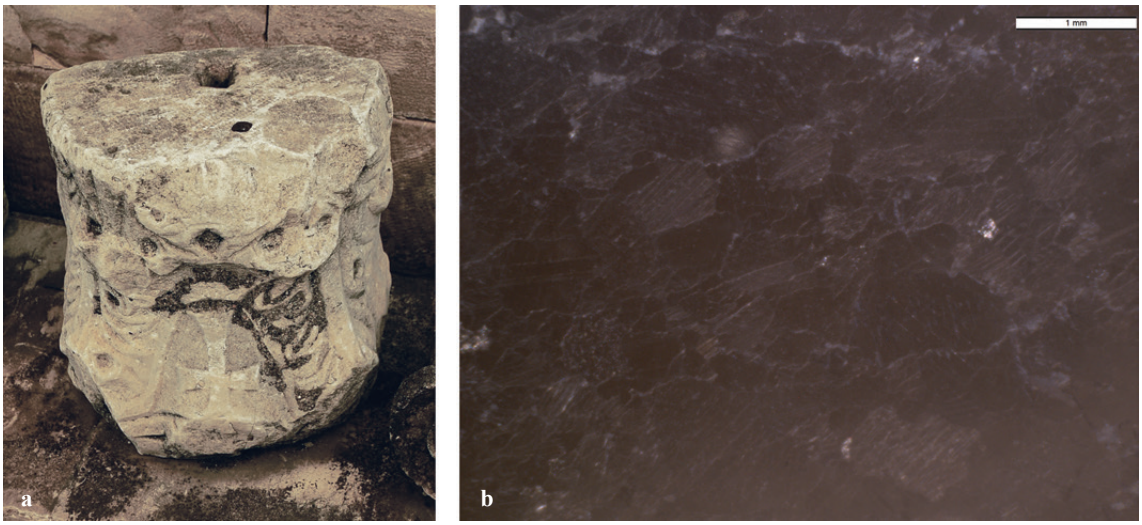
(MGS), although in general marble from Aliki tends to have coarser grain. Cathodoluminescence (CL), however, distinguishes the two sources clearly (tab. 1): Proconnesian tends to have a dark blue-black CL, and Thasian calcite luminesces orange[4]. Examination of the Varna samples with CL made it clear that two of them were Proconnesian and four were Thasian marble, including the Ionic capital of Thasian type.

One of the Proconnesian pieces is a small fragment of a typical Early Byzantine chancel barrier with no distinguishing features (fig. 2 a–b). The other, however, is an Early Byzantine Corinthianising capital of an unusual type: it has a lower ring of six acanthus leaves and an upper zone with volutes supported by four more acanthus leaves (sample 1, fig. 1 a–b). The arrangement is like that of ›lyre‹ capitals, which were frequently exported from Prokonnesos in the 5th and early 6th centuries. The Varna piece, however, has several unusual features. It has a large cross that separates the volutes and stands on a kind of leaflet or pedestal. Proconnesian ›lyre‹ capitals in Ravenna, Italy, have such crosses between the volutes[5], as do ›medallion‹ capitals, a related type also exported from Prokonnesos, including two Bulgarian examples in Nessebur and Varna itself. Claudia Barsanti notes other atypical features of the two Bulgarian pieces and considers them the work of local sculptors finishing blocks sent from Prokonnesos[6]. The cross covering the centre of the capital, however, is a widespread feature, whose centre of diffusion was probably Prokonnesos, rather than it being a provincial innovation.

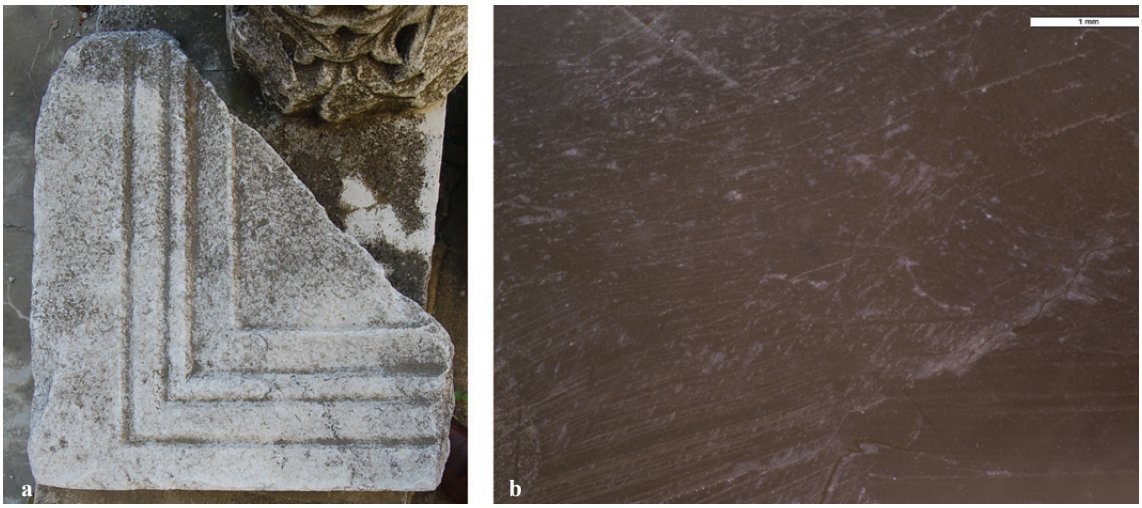
Other unusual features of this capital indicate that it is, indeed, a provincial work. Its cross is larger than usual and stands on the unprecedented leaf or pedestal. Unlike standard ›lyre‹ capitals, the volutes are not connected to one another but spring from the base of the cross. The capital seems unusually elongated, and its acanthus is unusual. In Proconnesian capitals the veins normally flow smoothly down to the base, but here the veins of the upper leaves run directly into the central stem, and the traditional three-point lobes break apart into isolated points. There are parallels for this in the Aegean area, as in the foliage of Early Byzantine pieces at Corinth[7] and Nea Anchialos[8], and in a ›barbarised‹ capital at Delphi[9]. Here, however, the chaotic character of its foliage suggests that this capital is the work of a local craftsman, who took some liberties and misunderstood some of his cosmopolitan models.

Two of the Thasian marble pieces are very modest, standardised works. The Ionic capital (sample 3, fig. 3 a–b) is a simple type exported from the calcitic marble quarries at Aliki in the 4th and

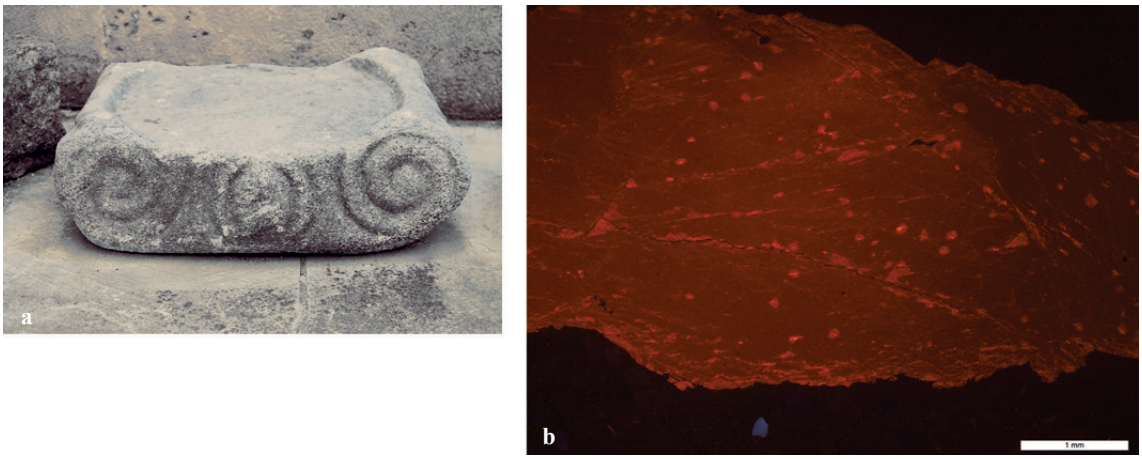
4 Barbin et al. 1989, 863–865 fig. 2; Barbin et al. 1992; Herrmann et al. 2002; Mentzos – Barbin – Herrmann 2002; Barbin et al. 2018, 312.
5 Olivieri Farioli 1968, cat. 20–22 figs. 19–21.
6 Barsanti 2017, 395 figs. 11–12.
7 Sodini 1977, 146. 433 fig. 17.
8 Sodini 1977, fig. 48.
9 Kautzsch 1936, 235 cat. 846 pl. 50; Sodini 1977, fig. 14.



1 a: Corinthianising capital, Varna Archaeological Museum (sample 1), late 5th century. Proconnesian marble (photo: J. Herrmann). b: CL photo of sample 1. Scale is 1 mm (photo: R. Chapoulie, B. Spiteri)



2 a: Fragmentary chancel barrier, Varna Archaeological Museum (sample 2), 5th or 6th century. Proconnesian marble (photo: J. Herrmann). b: CL photo of sample 2. Scale is 1 mm (photo: R. Chapoulie, B. Spiteri)



3 a: Ionic capital, Varna Archaeological Museum (sample 3), ca. AD 410–450. Thasian marble and workmanship (photo: J. Herrmann). b: CL photo of sample 3. Scale is 1 mm (photo: R. Chapoulie, B. Spiteri)

5th centuries[10]. The fragment of a chancel screen with a cross (sample 4, fig. 4 a–b) is also a very common type widely exported from both Thasos and Prokonnesos in the 5th and 6th centuries[11].

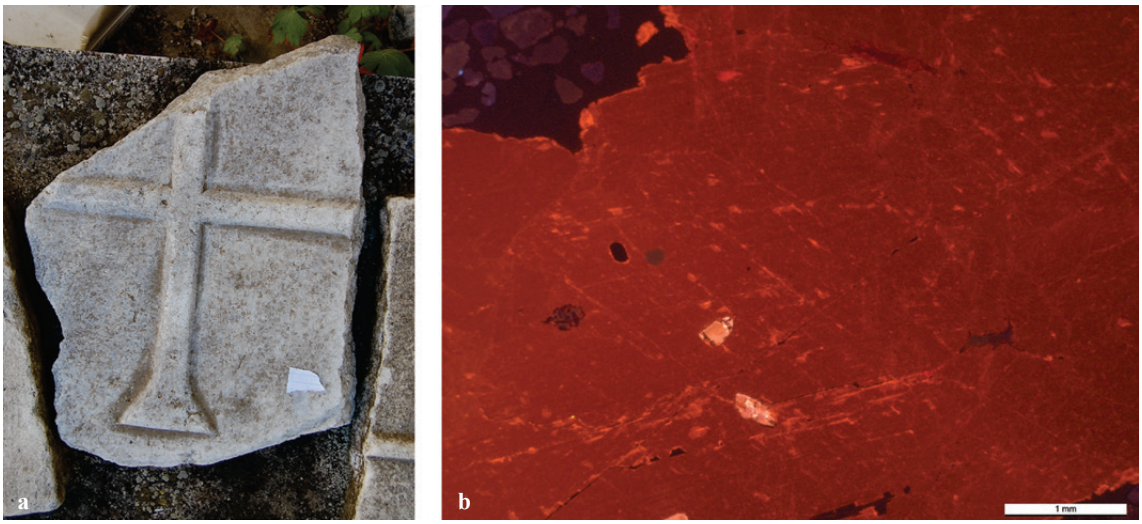
Two of the fragmentary pieces in Thasian marble, however, have unusual and ambitious decorative compositions. One (sample 5, fig. 5 a–b) is a panel decorated with a roundel filled with a rosette and ivy leaves. The roundel was woven into the side of a large diamond (lozenge), which is now largely missing. The other unusual piece (sample 6, fig. 6 a–b) is a chancel screen decorated with triangles and a diamond (or lozenge). The panel may have been completed with a grid of such polygons. A stylised cluster of foliage decorates the diamond, and an ivy leaf decorates one of the triangles. It is likely that the two fragments are the products of a single workshop, since they make use of similar detached ivy leaves and have robust but careful workmanship.

The chronology of the two fragments is somewhat problematic. The basic composition of sample 5 (with the interlaced roundel and diamond) is paralleled closely in a chancel panel in Veliko Tarnovo, Bulgaria, dated to the 11th century[12]. Further examples, also dated to the 10th to 12th centuries, are in Istanbul[13], Chios[14], Corinth[15], the Byzantine Museum, Athens, Bari[16], and the Metropolitan Museum of Art, New York[17]. These parallels suggest a similar Middle Byzantine date for the Varna fragment. This, however, is an unlikely time for exportation of marble from Thasos, since quarrying seems to have stopped when the island was devastated by Slavic invaders in around 620[18]. The marble could have been reused in the Middle Byzantine period, but an Early Byzantine date for the carving is supported by the fact that its interlacing bands are split only by a single groove, as is typical of Early Byzantine interlace. The bands of Middle Byzantine interlace have a double groove, and they usually tie into the outer border of the panel. The ivy leaf ›fillers‹ in the rosette also resemble those of Middle Byzantine interlace, but they are also similar to a fragment of panelling with ivy leaves between the arms of a Christogram excavated in the courtyard of the Fatih Camii in Istanbul. The fragment probably came from Holy Apostles, Justinian's burial church[19]. The Varna fragment could be a precocious example of the interlaced diamond-and-roundel pattern.

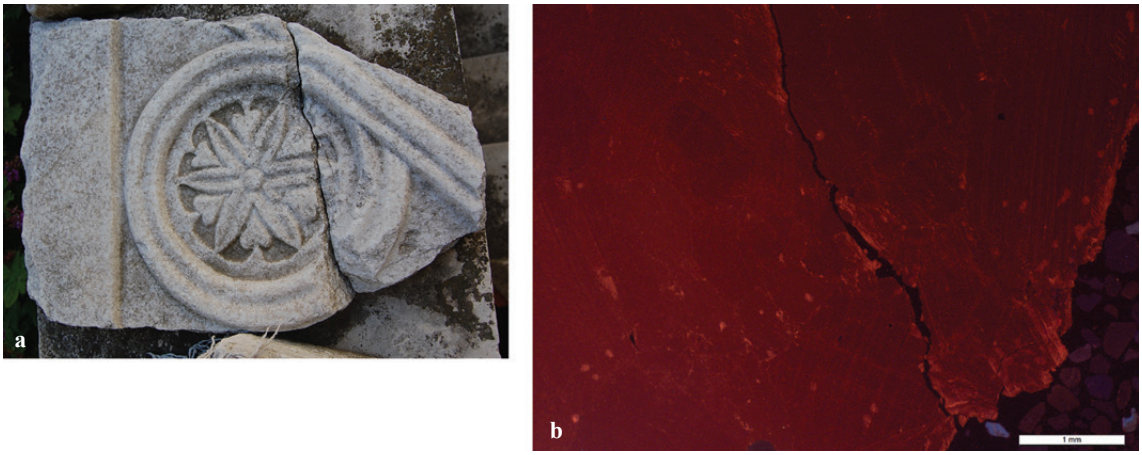
The Varna fragment with the diamond and triangles (sample 6, fig. 6 a–b) shows a distinctive technique from Early Byzantine times; a low ridge follows the outline of the polygons, giving them greater visual strength. The same technique can be seen in many panels of the 5th and 6th centuries, and the technique does not seem to have been used in the Middle Byzantine period. On the other hand, the extreme stylisation of the foliage in Varna fragment sample 6 indicates that it was carved after Justinianic times; the cluster of four petals separated by rings (fig. 6 a) is based on but less naturalistic than the clusters of three-petalled blossoms seen in the Hagia Sophia[20]. The Varna fragment therefore belongs in the span after AD 565 but before AD 620. The high quality and originality of these two Varna fragments (figs. 5–6) is rare on Thasos or in Macedonia, and although their marble was quarried on Thasos, it was probably decorated by a workshop in Constantinople or Prokonnesos.

The Thasian presence may have been rare in the Black Sea region, but the pieces in the Varna museum courtyard demonstrate that, if only in small quantities, Thasian marble products were imported into the area over a span of two centuries. While the Ionic capital was routine prefabricated

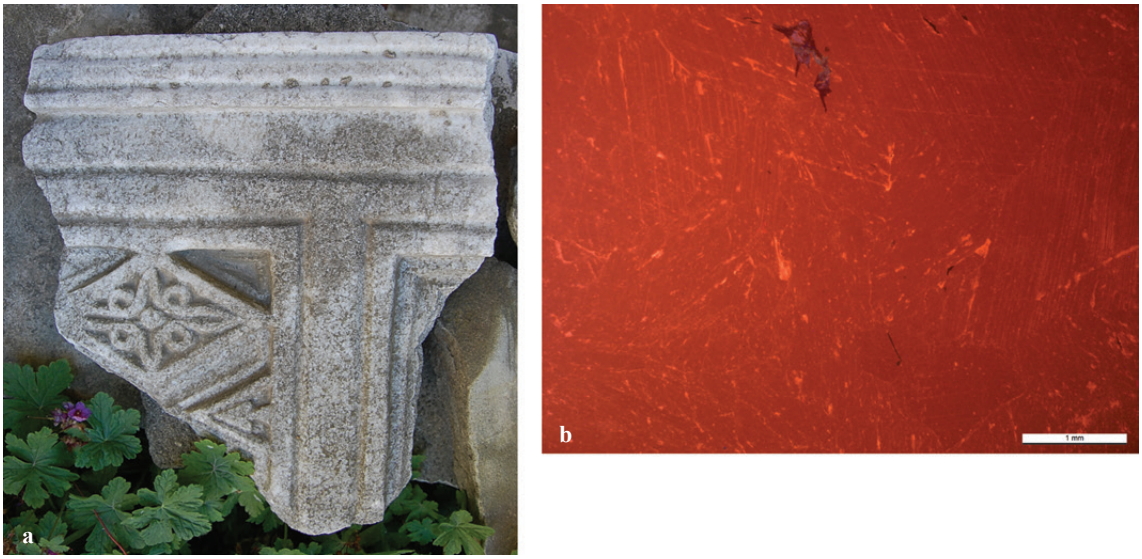
10 Herrmann – Sodini 1977, esp. 505 figs. 17–19. 28.
11 E.g. Guidobaldi – Barsanti – Guiglia Guidobaldi 1992, figs. 222–227. 233.
12 Veliko Tarnovo, Museum. Unpublished (?). Information from the museum label.
13 Sheppard 1969, 69 figs. 9–10.
14 Pennas 2008, 458–464 figs. 2–3. 8–9; 597.
15 Scranton 1957, cat. 9–10; Vanderheyde 2008, 350 fig. 8.
16 Milella Lovecchio 1981, figs. 12. 16–17.
17 Marble decorative panel 47.100.47.
18 Grandjean – Salviat 2000, 33; Attanasio et al. 2018, 285.
19 Guiglia – Barsanti – Flaminio 2011, 367 f. fig. 11.
20 Cf. Guidobaldi – Barsanti – Guiglia Guidobaldi 1992, figs. 249. 254. 265. 267; Herrmann et al. 2002, figs. 21. 23.



4 a: Fragmentary chancel barrier, Varna Archaeological Museum (sample 4), 5th or 6th century. Thasian calcitic marble (photo: J. Herrmann). b: CL photo of sample 4. Scale is 1 mm (photo: R. Chapoulie, B. Spiteri)



5 a: Fragmentary chancel barrier, Varna Archaeological Museum (sample 5), AD 565–620. Thasian calcitic marble (photo: J. Herrmann). b: CL photo of sample 5. Scale is 1 mm (photo: R. Chapoulie, B. Spiteri)



6 a: Fragmentary chancel barrier, Varna Archaeological Museum (sample 6), AD 565–620. Thasian calcitic marble (photo: J. Herrmann). b: CL photo of sample 6. Scale is 1 mm (photo: R. Chapoulie)

work from Thasos, two other pieces seem to have been rich compositions decorated by sculptors from Prokonnesos or Constantinople. The relatively exotic Thasian marble seems to have been treated as a prestigious material. A Corinthianising capital in Proconnesian marble, on the other hand, is an unusual, but somewhat provincial variant carved by a local sculptor (fig. 1 a–b).

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Maurizio Castoldi

LOCAL GREEN ›MARBLES‹ IN AUGUSTA PRAETORIA (AOSTA, NORTHERN ITALY)

Abstract
Research in recent years about imported and local marbles from the excavations of the forum and thermae of Augusta Praetoria (Aosta), Augustan colonia founded in 25 BC to control the territory between Alpis Poenina and Alpis Graia, revealed floor and wall slabs made of local green marble, known as Verde Alpi. The excavations in the sacred area of the forum, in the »Terme del Foro« (Forum Baths) and especially in the »Grandi Terme« have revealed fragments of ophicalcite slabs, with different lithological characteristics. To date, at least 20 types of green marble are known to have been exploited in the Aosta Valley: among these, the Roman slabs have a bright green background with white speckles of calcite, very similar to Verde St. Denis marble. Green marble decorative systems pose chronological questions: as a replacement stone for the most expansive Thessalian Verde antico, could it represent an important terminus post quem, fixing their stratigraphic contexts not earlier than the 2nd century AD? The percentages for Augusta Praetoria indicate how the locale alpine green stone is almost absent in the forum, in contrast to a decent abundance from the city baths. Some recent investigations have identified two possible extraction sites, near the villages of Saint-Vincent and Verrayes, a few kilometres from Aosta.

The city of Augusta Praetoria (Aosta), founded by Augustus in 25 BC, at the peak of the Romanisation process in the Alpine borders[1] (fig. 1 a–b), assumed a role of controlling the territory, a necessary junction for transit routes through the Alpis Graia and Alpis Poenina passes and for the management of natural resources and raw materials supply: gravel and sand, river conglomerates, limestone and other materials used in the construction of the main monuments of the Augustan colonia[2]. When the city experienced a real process of monumentalisation in the Julio-Claudian period, the procurement of other building materials was undertaken, particularly local marbles, including the so-called Bardiglio, a silicate marble quarried near the villages of Aymavilles and Villeneuve[3]. Among these lithic materials, the one traditionally known as Verde Alpi, petrographically identifiable as ophicalcite, deserves some attention. Also quarried in contemporary times and very widespread commercially, this lithotype quarried in the Aosta Valley is not a marble (this designation comes from its commercial characteristics: polishable and fine-grained), but rather a serpentinite formed by metamorphism with abundant calcite veins, also characterised by secondary minerals, especially magnetite[4]. Compared to the panorama of white and coloured marbles in the Roman public complexes of Aosta, the so-called local green marble represents a minimal statistical incidence: only three monumental contexts have slab fragments made of this material, the »Terme del Foro«, the forum and the »Grandi Terme«. The excavations of the »Terme del Foro« have uncovered fragments of Verde Alpi (fig. 2) relating to the second building phase, particularly the cold halls. For the forum (fig. 3), the amount of ophicalcite amounts to only two fragments, unfortunately in this case lacking certain stratigraphic relationships.

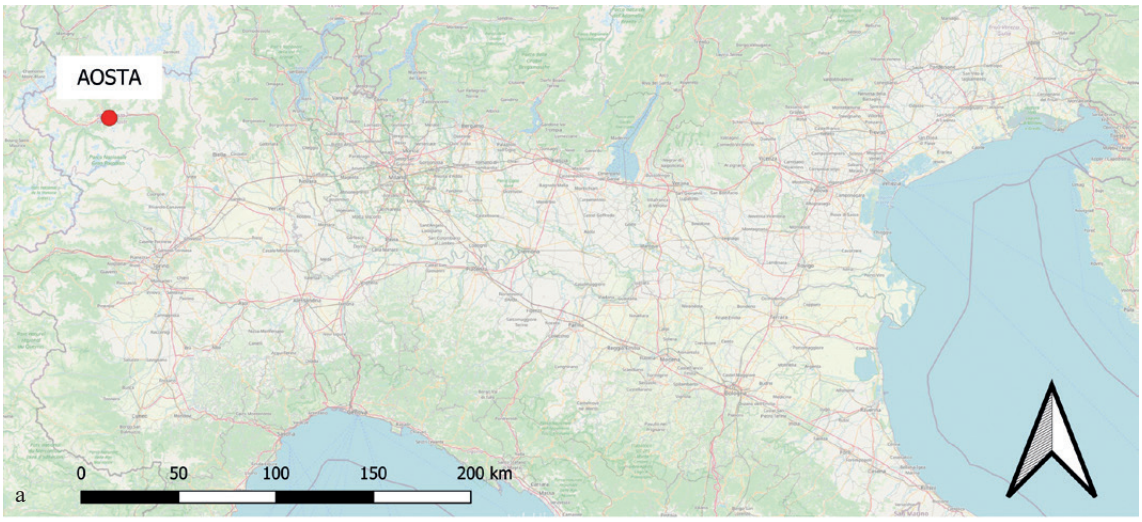
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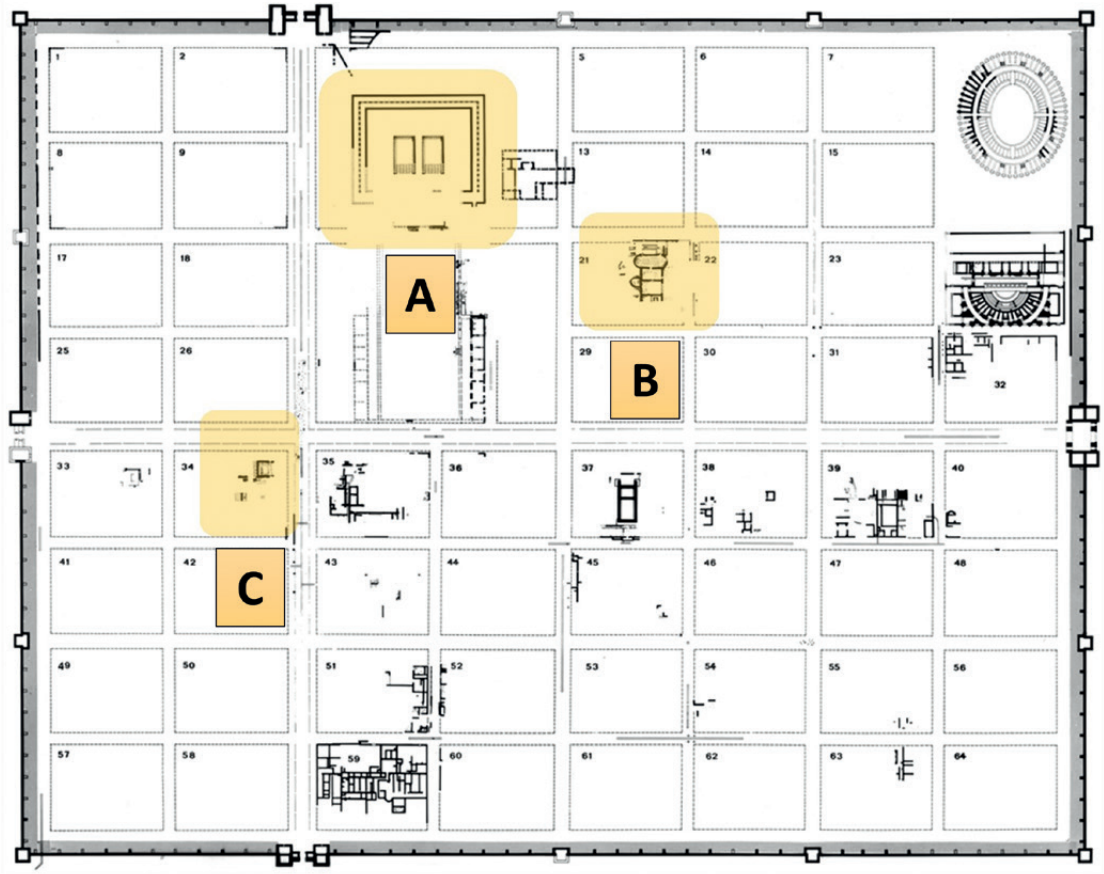
1 For the role of Augusta Praetoria in the Roman colonisation of western Alpine borders, see Framarin 2014.

2 On the main building stones used in Augusta Praetoria, see Castoldi 2023. See also Mollo Mezzena 2000; Appolonia – De Leo 2007; Mollo Mezzena – Framarin 2007, 298.

3 On the local Bardiglio extraction, supply and petrography, see Borghi et al. 2006; Appolonia – De Leo 2007; Betori – Gomez Serito – Pensabene 2009.

4 For the petrographic characterisation of ophicalcite, see Prinetti 2014.

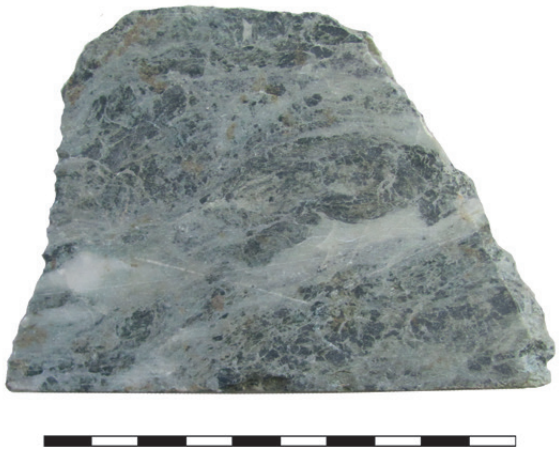




1 a: Augusta Praetoria in the Cisalpine area. b: Augusta Praetoria in the colonia plan. A: Forum. B: »Terme del Foro«. C: »Grandi Terme« (graphics: M. Castoldi after <openstreetmap.org> [30.06.2023]; plan of Roman Aosta. Courtesy of the Soprintendenza per i Beni e le attività culturali – Regione autonoma Valle d'Aosta)

THE »GRANDI TERME« COMPLEX

It seems of particular interest, however, to point out that most of these finds come from a single bath complex, known as the »Grandi Terme«, where the ophicalcite was used in the remaking of the decorative layout, not before the 2nd century (fig. 4). An archaeological dig dating back to the 1990s unearthed a few remains of some wall structures in the city quarter facing E. Aubert Street



2 Local ophicalcite slab fragment from the sacred area of the forum (photo: M. Castoldi. Courtesy of the Soprintendenza per i Beni e le attività culturali – Regione autonoma Valle d'Aosta)



3 Local ophicalcite slab fragment from the »Terme del Foro« (photo: M. Castoldi. Courtesy of the Soprintendenza per i Beni e le attività culturali – Regione autonoma Valle d'Aosta)

(corresponding to the western portion of the ancient *cardo maximus*). The northeastern rooms were identified as cold rooms, attributable to different chronological phases, while a little evidence pertaining to a hypocaustum emerged to the south. The building as a whole must have included large rooms, with a laterally reversed arrangement and maybe double exedra, according to a monumental scheme, the modular solutions of the so-called imperial baths[5]. The most important structures date from the first half of the 1st century AD: these are, in particular, a quadrangular-shaped basin with stone steps with a decorative apparatus in lithic slabs, probably in local Bardiglio marble[6]. A second building nucleus further south, near the »Passage du Verger«, has been interpreted as a sector of the baths, articulated in several phases between the 1st and 3rd centuries[7], equipped with a hypocaustum. This sector shows clear signs of burning (perhaps due to the presence of a praefurnium [?]), and a refunctionalisation of the rooms is suggested by the construction of a *caementicium* dock, when the floor of the room was destroyed. The original hypocaustum cavity was filled with waste material from the demolition of the structures, in particular from *tubuli* and marble slabs, marble mouldings and fragments of coloured plaster. Important elements for the chronology of these marbles come from the stratigraphic deposits formed in front of the southern closure of the hypocaustum: among them, the only pavement with traces of a mortar-structured arrangement relates to the third phase of the complex and has been identified as preparation for an outdoor area, obliterated by rubble datable to the 4th century by pottery fragments. Excavation of the deposit below that pavement also returned 128 coins in a sawn amphora (probably a Dressel 6A, with a PCF mark), associated with a Dressel 6B, in a lying position. Numismatic analysis of the coins allowed the profile of Emperor Claudius and his father Nero Drusus to be identified, with the allegorical image of Spes on the versus. Maybe the amphorae, with their contents, constitute part of a ritual offering to the devotional sphere of the waters, referring to the expansion phase of the building, datable to the second half of the 1st century[8].

5 For the plan restitution hypothesis of the »Grandi Terme« in Aosta, see Mollo Mezzena 2004; Mollo Mezzena – Framarin 2007, 296 f.

6 For a detailed description of the cold rooms, as mentioned, probably pertaining to the early 1st-cent. building phase, see Mollo – Framarin 2007, 296 f.

7 For a first publication, briefly presented, of the structural findings pertinent to the »Passage du Verger« site, see Framarin 2004 (items partially updated in Framarin 2010).

8 For all the above considerations and related to the finding and probable interpretations of the ritual deposit with amphorae and coins, see Framarin 2010. This context is related to other possible coeval ritual deposits of Augusta Praetoria in Armirotti et al. 2021.



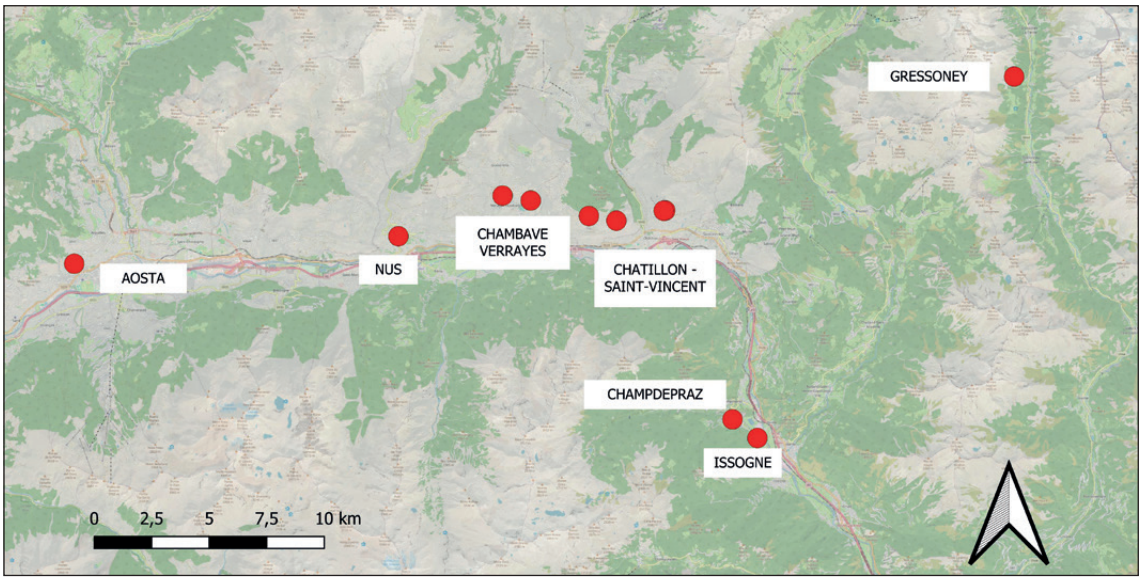
4 Local ophicalcite slab fragments from the »Grandi Terme« (photo: M. Castoldi. Courtesy of the Soprintendenza per i Beni e le attività culturali – Regione autonoma Valle d'Aosta)

THE GREEN ›MARBLE‹ SLABS FROM THE »GRANDI TERME«

The survey that intercepted the Roman structures of the »Passage du Verger« allowed the recovery of 52 stone artefacts pertaining to the pavement and parietal apparatus. Almost all of these finds are slab elements: the statistical breakdown of slab products by individual lithotypes inevitably reveals a prevalence of green marbles, which make up 65 % of the total artefacts; the remaining 35 % consists of white marble artefacts (mouldings, slabs) with either a uniform blue-grey veined background or a uniform blue-grey background. The ophicalcite slabs consist of amorphous fragments, among which only three can be traced back to rectangular morphology and for which we can assume an original placement in parietal equipment: in fact, these three artefacts have a hole with a circular cross-section for the iron hook used to attach them to a wall.

Due to the extremely fragmentary state, it is not possible to identify any modular dimensions, but only minimal and incomplete measurements, with widths between 9 and 14 cm and lengths between 12 and 21 cm. The thicknesses noted for almost all of the slab fragments can perhaps be put down to uniform manufacturing processes: the white marble slabs all show an average thickness of about 2.3–2.5 cm, while most of the green marble slabs show a rather standardised thickness of about 1.5 cm. Finally, regarding possible traces of processing and fabrication of these finds: on the lower surface of two green marble slabs, we can find signs that can be interpreted as residual traces of sawing.

Regarding the type of material, the main holotype, and the largest in terms of quantitative attestation, is defined by a green and grey-green background, rather dark, with important veining and mottling of a greyish-white or pure white colour and, in some specimens, also characterised by the evidence of some small inclusions of an even darker green colour, probably chlorite garnets. These aspects appear identical to those found in the artefacts found in the forensic complex and the Forum Baths. Two sherds differ in the colour of the dark green background, with the presence of calcite constituting substantial veins and true rounded clasts of even 1 cm in size.



5 The main modern quarries of local green ›marbles‹ in the Valle d'Aosta territory (graphics: M. Castoldi after <openstreetmap.org> [30.06.2023])

NEW ARCHAEOLOGICAL PROBLEMS RELATING TO ALPINE GREEN ›MARBLES‹

The literature concerning the historical use of this decorative rock is very small, its use traditionally being known only from the discovery, in the early 20th century, of the first finds in an area corresponding to the middle Valle d'Aosta, between the village of Montjovet and the city of Aosta (fig. 5)[9]. Although the use of local serpentinites (but not ophicalcites) is known for the production of millstones datable to the late Roman age and the Middle Ages[10], the discovery of slab fragments in the Augusta Praetoria excavations raises questions about the exploitation of local green ›marbles‹ in the Imperial age on at least two problematic levels. The first is that of the definition of holotypes: the few works that have been published have been able to determine very precisely at least 63 local green ›marble‹ lithic types and, above all, as many extractive fronts, linked, however, exclusively to the intensive cultivation of the last hundred years. The finds examined in the present work have pointed to the use of at least two holotypes, perhaps attributable for most of the attestations to the St. Denis or Issorie type, and for individual fragments, with many uncertainties, to the Avise Green or the light classical Verde Alpi. At the current state of knowledge, there is no trace within the territory of Valle d'Aosta of green marble extraction datable to the Roman age: for this reason, a petrographic mapping of the holotypes extracted in the modern age seems necessary in order to narrow the reference area and to carry out a search for possible ancient cultivation sites. Regarding the chronological references, the use of green marbles in the Roman Empire dates from the Hadrianic age: it is precisely the discovery of ophicalcite fragments that contributes to the dating of the reconstruction of some »Grandi Terme« halls, placing them in a chronological framework not earlier than the 2nd century. The case of the forum is different: the marbling of the complex occurred in the middle of the 1st century, and the presence of this stone could indicate an unprecedented high-imperial

9 For historical information about the first intensive exploitation of the local Verde Alpi in the 1920s, see Mannoni F. 2006; Mannoni R. 2017.

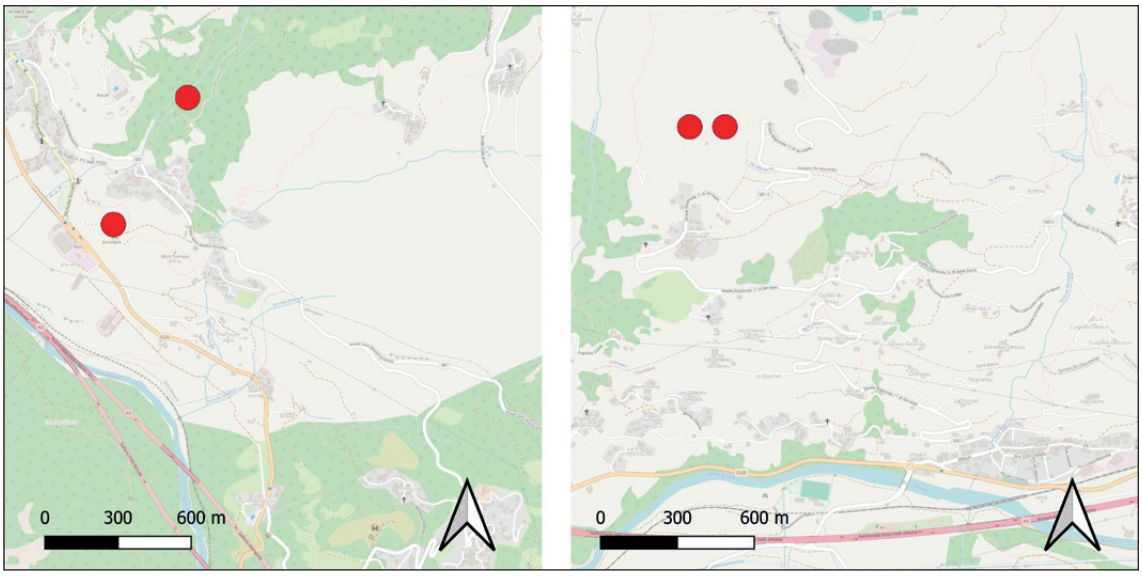
10 For the production, distribution and petrography of local serpentinite millstones, see Castello – De Leo 2007; Cortelazzo 2007.

interest in green lithologies (in accordance, of course, with the proximity of the source of supply) or, more likely, a later revision of the decorating programme.

The second consideration opens up new research related to the use of the material, with the aim of identifying types of products made of green marble from Valle d'Aosta, defining their area of destination, thus assuming a distribution on a local scale or with real export, as well as, with much more difficulty, a chronological range. Given the findings, the material appears to be exclusively suited to the manufacture of slab products, put in place indoors in public buildings (private domus in Augusta Praetoria equipped with floor *sectilia* and wall marble decorations do not show any traces of green marble). However, it seems important to remember the existence of an artefact that might indicate the diffusion of Verde Alpi. It is a single column shaft in Verona, at the Museo Maffeiano, cited by L. Lazzarini as an example of an element made of a green lithotype replacing Tessalic[11] (a stone with a completely different petrographic composition and with divergent textures and chromatics), in particular precisely in Alpine ophicalcite. At the museum and in the rare bibliographical references, the only existing indications about the finding of the column agree in attributing the artefact to a modern manufacture, probably dating back to the 16th century[12], and in indicating its origin from the village of Ponton, at the entrance to Valpolicella. Thanks to the collaboration of M. Bolla of the Musei Civici di Verona, it was possible to view and photographically document the column, which is about 4.5 m high with a top decorated in the round, rather worn superficially and fractured in the lower portion. The stone used, on close autopsy-type analysis, appears to be entirely similar to the Alpine ophicalcite from Valle d'Aosta, with an aesthetic characterisation overlapping that of the holotype from St. Denis. To the Maffeian column we must juxtapose the discovery of a slab fragment found at another site that emerged in Regio X and, in particular, in ancient Brixia: an excavation context identified to the east of the forum and composed of a few rooms possibly for private use and a public building on a podium, probably a temple, also returned a Verde Alpi slab fragment[13]. The two attestations now mentioned, Verona and Brescia, if confirmed in terms of the lithic species used and if the chronological frame of the column at the Maffeian does indeed fall sometime around the Roman period, would suggest evidence of an eastward traceability of Aostan green marble, an unpublished phenomenon, along diffusion and commercialisation paths that would represent, from a scientific point of view, a completely unexplored reality to be investigated in all its complexity. In this regard, the flows of another stone element coming out of the Augusta Praetoria area can perhaps help determine a reference for understanding the dynamics related to ophicalcite, namely the local Bardiglio. A recent study has identified the attestation of this stone as an epigraphic support along an east-facing route constituted by the river Po and some of its tributaries, all the way to present-day eastern Piedmont[14]. In considering this, however, it should not be overlooked that there are at least three other ophicalcites and serpentinites quarried in the territory of ancient Cisalpine[15]: Verde Cesana (Piedmont), Verde Polcevera (Liguria), and Verde di Torre Santa Maria (Sondrio, Lombardy), lithotypes of which no traces of ancient quarrying are known *in situ*, but only a few fragments for local use (see Verde Polcevera[16]).

In Valle d'Aosta, the Verde Alpi quarries known for exploitation in the modern age are arranged between the city of Aosta and the lower valley: a single site immediately north of Augusta Praetoria is noted as the western limit of the mining district, which closes towards the east with the sites of Issogne and Champdepraz. The greatest concentration of outcrops affected by anthropogenic

11 For this proposal, see Lazzarini 2007, 234.
12 For the historical data about the Verona column shaft, see Bolla 2019, 19–21.
13 About the slab fragments and related lithotypes in the Brixia public context, see Dell'Acqua 2017, 183–185.
14 On the local Bardiglio trade and distribution in western Cisalpine, see Castoldi 2016; Armirotti – Castoldi 2019.
15 Ciscato 2000, 61 f.
16 For the probable Polcevera green slab fragments from the Albintimilium thermal complex, see Bozzi 2017, 207.



6 Location of quarries near the villages of Saint-Vincent and Verrayes, Valle d'Aosta (graphics: M. Castoldi after <openstreetmap.org> [30.06.2023])

intervention, however, is attested among the municipal territories of Chatillon, Chambave, Verreyes, Montjovet, and Nus[17]: each of these localities has several quarries of modern age and, based on autopsy analysis of the lithic species, they are all characterised by a holotype with a grey-green background with broad white streaks of calcite (compatible with the fragments found in Roman Aosta). In contrast, the type at the Gressoney site in the upper Ayas Valley appears to be different, with a dark green, in some cases almost black, background with very narrow, linear white bands. Today there is no complete mapping of quarries (active and disused) of ophicalcite in the Aosta territory, no petrographic database of extracted lithotypes, and no reconnaissance has ever been carried out in order to attest any traces of ancient quarrying.

THE QUARRIES

For the presentation of data here, in relation to the artefacts of the »Grandi Terme«, an attempt has been made to circumscribe a potential area of interest, narrowing the focus to two quarrying districts because of their particular proximity to some frequentation route dating back to the Roman age. These are the locality of Cillian, in the village of Saint-Vincent, and Marseiller, near Verreyes, in a localised area between 15 and 20 km east of Aosta (fig. 6). In the first case, the sector investigated was within about 500 m of one of the best attestations of the Roman road infrastructure in this area, the Roman Cillian bridge, a masonry structure lined with white limestone blocks of which the eastern blind arch was preserved, with works to support the impost of the central arcade, which collapsed in the early 19th century[18]. Here it was possible to detect two probable quarrying fronts that seem to be devoid of evidence related to modern exploitation: the first, 120 m southeast of the bridge, defined by a front approx. 2–3 m high with a single large extraction wall, and a second, ca. 400 m north of the bridge, in the valley of the Cillian creek, with a broad front, up to ca. 4 m high, and with traces of quarrying of single small quadrangular blocks (fig. 7). The case of the Marseiller quarry is different, where an ancient frequentation route is attested by numerous significant finds. In this village, near a medieval

17 For a preliminary overview of known Verde Alpi quarries, see Ciscato 2000, 59 f.
18 About the Cillian Roman bridge, see Mollo Mezzena 1992, 66; Armirotti 2003, 74–80; Ronc 2014, 204.



7 Probable ancient extraction site of Cillian, Saint-Vincent (photo: M. Castoldi)



8 Probable ancient extraction site of Marseiller, Verrayes (photo: M. Castoldi)

chapel (15th cent.), the remains of a probable necropolis were found, with reused epigraphic material (including a dedication to Apollo on an Aymavilles Bardiglio slab, an element that suggested the presence of a field sacellum) and ceramic material dated to the 2nd–3rd centuries[19]. Also in this case, the Roman presence appears quite significant and attests to the certain frequentation of the area in ancient times: between 500 and 600 m north of the chapel, two fronts of an ophicalcite quarry are present, certainly exploited even in modern times, as evidenced by signs of machine mining. From the topographic and morphologic items, the possibility of ancient frequentation of the site is also possible: some details of the main wall visible in the lower front may reveal a supply that, if not Roman, is almost certainly pre-industrial (fig. 8).

Certainly all these data are preliminary observations and investigations, far from being exhaustive, and should be contextualised in a systematic survey of the area with a complete mapping of known quarries and, where present, possible traces of ancient extraction.

ACKNOWLEDGEMENTS

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INSCRIPTIONS AND THEIR MARBLE(S)

SOME EXAMPLES FROM ROMAN CORINTH

Abstract
In Roman times, Corinth was one of the most significant harbour cities in the Mediterranean, and it represented a political and commercial point of connection between East and West. In this research context, marble provenance studies provide significant details that contribute to outlining the map of trade and economy of the Greek city. Inscriptions are extremely important for this purpose, as they carry precise information about the time of production, the function and the commissioners of the monument itself. Thirteen samples taken from inscriptions, dating from the 1st to the 3rd century AD have been analysed, using a series of methods which include petrographic investigations and chemical and isotopic analysis. Statistical treatment for each sample has been applied and the artefacts have been compared with a database of 4,500 quarry samples from the classical marble quarries known in antiquity. The identification of the origin of the marble used for these inscriptions allows light to be shed on how the use of marble changed during this time in combination with local limestone, according to the type and the function of the monument, as well as to the status of the people involved.

INTRODUCTION

Among all monuments, inscriptions are extremely important for the study of marble provenance, as they carry precise information about the time and the circumstances of production, the function and the commissioners of the monument itself. To achieve significant results, it is necessary to select for analysis a wide range of monuments with different functions (funerary, honorific, votive, inscriptions on buildings), a dating that is as precise as possible and clear information on the dedicators. This specific kind of study has as a forerunner the work by W. Prochaska, G. Ambros, F. Mitthof and S. Ladstätter (†) on the analysis of 35 dated inscriptions from the Sanctuary of Apollo Hylates in Kyrion (Cyprus), which proved the increasing use of marble from Asia Minor, especially Ephesos, from the 2nd century AD on an island which had no marble sources within its territory[1].

The choice of Corinth[2] for this study was based on the intention to examine more extensively the use of marble in a city that in Roman times had one of the most significant harbour systems in the Mediterranean, which allowed it to be the main transition zone between the western and the eastern trading networks[3]. The Colonia Laus Iulia Corinthiensis was founded

1 Prochaska et al. 2017.

2 For an overview on the history of Corinth, see Wiseman 1979; on the society, see Engels 1990; Schowalter – Friesen 2005; Friesen et al. 2010; Friesen et al. 2014.

3 On the two harbours, see Pettegrew 2016, 151–157. 198–205. On Lechaion, the harbour dedicated to commerce with the West and central Greece, see Rothaus 1995; Güngör 2018; Loven et al. 2018; Athanasopoulos 2020; Athanasopoulos et al. 2023; Athanasopoulos 2024; Athanasopoulos et al. (forthcoming). On Kenchreai, the harbour on the other side of the diolkos, see Hawthorne 1965; Scranton – Shaw – Ibrahim 1978; Rothaus 2000. The isthmus represented a transition zone, but the southern Peloponnese routes were still the centre of major maritime traffic, see Pettegrew 2016, 161–165.



1 Map of the Eastern Mediterranean (blue points: quarry locations; red point: ancient Corinth; green points: the area of the Peloponnese) (graphics: OeAW-OeAI/V. Anevlavi after C. Kurtze)

by Caesar in 44 BC above the Greek commercial city-state[4], over a century after the destruction following the battle of Corinth in 146 BC[5]. The creation of a Roman colony in this position was of strategic importance, as Caesar aimed to control the trade on the isthmus and to expand Roman commerce towards the east. The city soon became an important trade and distribution centre that connected Rome to Asia Minor[6]. Its population was originally mainly made up of freedmen, who had a key role in the development of the city, as they served as agents of wealthy families who planned to establish their commercial activities here, to control the trade between East and West and especially the import of luxury goods from the East to the capital. Some of these families might have acted as *negotiatores* in this region well before the foundation of the colony[7]. The central strategic position of Corinth influenced not only trade but also military events[8] and culture: for instance, Corinth played a strategic role during the expedition of M. Antonius Orator against the pirates[9] and during the events of the civil war between Antonius and Octavianus[10]; under Claudius, it was chosen by Paul to found a strong Christian church[11], and for centuries it was the heart of traditional Greek festivals and games. While the trade with

4 On the first building activities in the colonia, see D'Hautcourt 2001.
5 On the events of 146 BC, see Gebhard – Dickie 2003.
6 On Corinth as a commercial centre, see Williams 1993; Pettegrew 2016.
7 On the population of the early years of the colony, see Spawforth 1996; Millis 2010; on the presence of *negotiatores* from Italy before the foundation in 44 BC, see Gebhard – Dickie 2003, 277; Pettegrew 2016, 148 f.
8 See Pettegrew 2016, 113–134 for the intention to use the isthmus as a portage for military fleets.
9 This is documented by a famous verse inscription (CIL I 2662).
10 Pettegrew 2016, 130–132.
11 Engels 1990, 107–110.



PM-KOR-30 PM-KOR-31

PM-KOR-32 PM-KOR-34

2 The sampled artefacts, part I (photo: OeAW-OeAI/V. Anevlavi)

the eastern provinces is very strong and archaeologically attested[12], politically the elites of this Roman colony were deeply connected with the city of Rome. In 27 BC, with the foundation of the province of Achaia by Augustus, Corinth passed from the administration of the governor of Macedonia to the new province and became the provincial main centre and seat of the imperial cult, to which several buildings in the colony were devoted[13]. In addition to the monuments sponsored by private citizens, buildings and public facilities were financed by the imperial family to support Corinth on various occasions. For instance, many of Corinth's public buildings were constructed or restored under Augustus, and big renovations were undertaken by Emperor Vespasian and his sons after the earthquake that levelled Corinth in AD 77[14]. On that occasion, the city was rebuilt by Vespasian and temporarily renamed Colonia Iulia Flavia Augusta Corinthiensis, returning to the old name after the reign of Domitian[15]. Signs of imperial patronage continued in the 2nd century, when Hadrian, on his way to the Judaic wars, stopped at the city and donated a new bath and an aqueduct[16]. These dynamics become clear and are known from the epigraphic material that survived in the city. It is therefore of primary interest to find out where the marble for these monuments came from.

RESEARCH QUESTIONS AND METHODOLOGY

The research question for this paper is the provenance of marble inscriptions and the material chosen by the Corinthian elites for the construction of their monuments. Whether there is a variation

12 Williams 1993. The study of pottery confirms an Eastern orientation of the Corinthian trade in the 1st and 2nd cent. A consistent movement of goods westwards has also been observed, see Pettegrew 2016, 158–165.

13 See, among others, Camia – Kantirea 2010; Spaeth 2011.

14 Suet. Vesp. 17 on the renovation of cities destroyed by earthquakes, among them also Corinth.

15 Wiseman 1979, 506 f. and n. 267.

16 Wiseman 1979, 507.

Lab no.	Artefacts	Museum no.	Description	Provenance
PM-KOR-24	Slab with funerary inscription	I 2282	Marble; fine-grained; white colour	Penteli
PM-KOR-26	Statue base with honorific inscription	I 520	Limestone; white colour	Local limestone
PM-KOR-30	Block with honorific inscription	I 2178	Limestone; white to greyish colour	Local limestone
PM-KOR-31	Statue base with honorific inscription	I 2	Marble; fine-grained; white colour	Penteli
PM-KOR-32	Epistyle block with building inscription	I 428	Marble; fine-grained; white colour	Penteli
PM-KOR-33	Statue base with honorific inscription	I 15	Limestone; white colour	Local limestone
PM-KOR-34	Statue base with honorific inscription	I 16	Limestone; white colour	Local limestone
PM-KOR-35	Statue base with honorific inscription	I 1751	Limestone; white colour	Local limestone
PM-KOR-56	Stele with funerary inscription	S 1026	Marble; medium-grained; white colour	Prokonnesos
PM-KOR-68	Statue base with honorific inscription	I 2433	Marble; fine-grained; white colour; schistosity	Penteli
PM-KOR-76	Epistyle block with building inscription	–	Limestone; white colour	Local limestone
PM-KOR-78	Epistyle block with building inscription	I 932+36	Marble; fine-grained; white colour; schistosity	Penteli
PM-KOR-82	Herm with inscription	I 870	Marble; fine-grained; white colour	Penteli

Table 1 The sampled artefacts with their description and provenance results

in the use according to different periods or the function of the monument, and finally, if the use of a specific type of marble corresponds to the commercial power and interconnection of Corinth in Roman times, especially during the first two centuries AD, is also investigated.

A historical (especially epigraphic) research method has been combined with archaeometrical analysis to tackle these research questions. For the provenance analysis of white marbles, a series of methods are used. The techniques applied to the samples include macroscopic observations, chemical (trace elements) and isotopic analysis. Statistical treatment for each sample is applied. In particular, the oxygen (O) and carbon (C) isotope ratios ($^{13}C/^{12}C$ and $^{18}O/^{16}O$) of marble samples are determined[17].

Extensive quarry sampling has led to a large database of standardised oxygen and carbon isotope ratios[18]. In previous years, inductively coupled plasma mass spectrometry (ICP-MS) analysis has been employed to expand the database and increase the number of chemical variables, particularly in the low or sub-ppm range. Several elements, such as rare earth elements (REE), proved to be very distinctive. The results obtained with this method show several trace elements that can discriminate very successfully between the studied varieties of marble of different origins. Such elements are magnesium (Mg), manganese (Mn), strontium (Sr), iron (Fe), lanthanum (La), cerium (Ce), cadmium (Cd), barium (Ba), yttrium (Y), ytterbium (Yb), uranium (U), etc. In combination with the traditionally determined analytical variables and the evaluation by multivariate statistical analyses, this enabled clear discrimination between the archaeological and geological

17 Attanasio – Brilli – Ogle 2006.
18 Prochaska – Attanasio 2021.



3 The sampled artefacts, part II (photo: OeAW-OeAI/V. Anevlavi)



PM-KOR-76



PM-KOR-78

4 The sampled artefacts, part III (photo: OeAW-OeAI/V. Anevlavi)

samples[19]. The analytical variables obtained were processed via statistical analysis (STATISTICA and SPSS). The archaeological samples were compared with a database of 4,700 geological samples from marble quarries and outcrops from antiquity, including Doliana and sources from the Peloponnese, Aphrodisias, Carrara, Prokonnesos, Dokimeion, Penteli, Paros, Thasos, Miletos/Herakleia, Ephesos, etc.

In the case of Corinth, 13 inscriptions have been selected, six in Greek and seven in Latin, which were produced over the course of three centuries (from 1st–3rd cent. AD), are dated with a high degree of certainty, have different functions and are located on different objects (tab. 1). Apart from a few exceptions, the inscriptions are connected with the urban elites. Because of the peculiar role of the city of Corinth, these inscriptions are mainly connected with acts of euergetism, the imperial cult, and public honours, traits strikingly present in Roman Corinth.

[19] Prochaska – Attanasio 2021.

HISTORICAL AND ARCHAEOMETRIC ANALYSIS OF THE SAMPLED ARTEFACTS

Only thanks to the combination of the historical method with the archaeometric one was it possible to interpret the results of the analysis and answer the research questions. The analysis shows the use of three different types of stone. The most common is Penteli, which was quarried in Attica but was exported throughout the Roman Empire. This was used as an alternative to limestone from a local quarry in the Peloponnese, which was only employed regionally. In only one case has stone from Prokonnesos been identified (see fig. 1 for the locations of the main quarries in the Mediterranean).

Firstly, the petrographic analysis assists the study by grouping the samples and providing preliminary results. Two main groups can be observed: one of Pentelic marble, and the other of local limestone. For example, PM-KOR-32 is a fine-grained calcite marble with a maximum grain size of < 1 mm. The grain boundaries are only slightly intermeshed. A slight schistosity can be observed, which is exacerbated by the occurrence of thin layers with minor accumulations of accessory minerals. These are mica, chlorite and opaque minerals. The most frequent accessory mineral is quartz, occurring evenly distributed throughout the sample. The nature of the trace minerals and the overall slight schistosity of the sample match the characteristics of Pentelic marbles (figs. 5–6).

The second group, with the example of PM-KOR-76, is a white marble, characterised by a strongly heteroblastic texture in the sense that relics of shell fragments of the limestone protolith occur in a very fine-grained ground-mass. The marble is very pure, and under the petrographic microscope practically no accessory mineral can be observed, except very minute flakes of carbonaceous organic matter. A schistose orientation with elongated relics of corroded shell fragments in a linear matrix of very fine-grained calcite crystals is ubiquitous (figs. 7–8).

This type of marble in the interface of limestone to marble was already described by Y. Maniatis and colleagues[20]. Generally, Doliana quarry samples are more metamorphosed; however, we do not know the full spread of textures there. Maniatis and colleagues describe more localities in that region. They did not differentiate between Doliana and Mani for their three reliefs. The ›Doliana‹ geological samples that can be found in our database are neither Mani nor Doliana according to the analytical evidence. It could be an indication of another Peloponnesian location in that area.

In this section, the analysed inscriptions are presented in chronological order and from a historical point of view to display their meaning and function in the social and cultural context of the city.

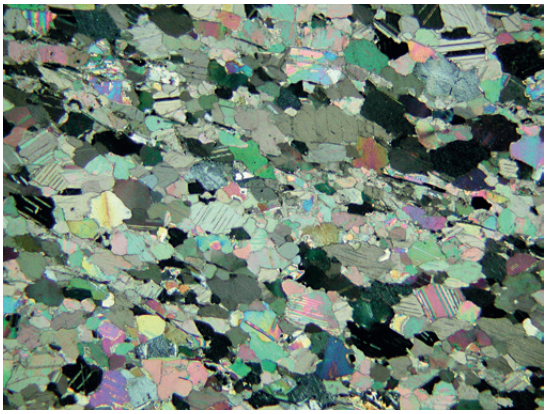
The first inscription (PM-KOR-30)[21] can be dated within the 1st century AD, more likely to the first half because of the palaeography (fig. 2). It is inscribed on the front of a rectangular block of local limestone. The text contains a short dedication to the deified Caesar. The block was found in the theatre, where it probably belonged to a monument devoted to the cult of the imperial family, as part of the sculptural programme which included portraits of the deified emperors[22]. This inscription shows the strong relationship that connected Rome and Corinth, which was often expressed in forms of the imperial cult in all contexts of urban life. Moving from the theatre to the Roman forum, the next analysed monument (PM-KOR-32) is one of the epistyle blocks in Pentelic marble from the circular monument of Cn. Babbius Philinus[23], dated to the early

[20] Maniatis et al. 2021.

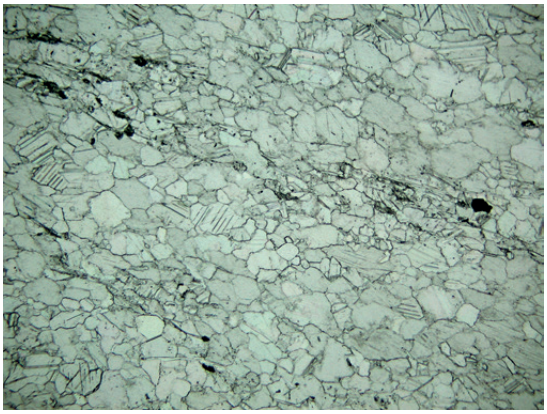
[21] Corinth 8, 3, no. 50: *Divo Iul[io] / Caesari / [sacrum].*

[22] It is, however, not certain whether the monument was originally located in the theatre. Its findspot only tells us where it was located from the 4th cent. AD onwards, but it is unclear whether it was there before as well, see de Grazia Vanderpool 2018, 370.

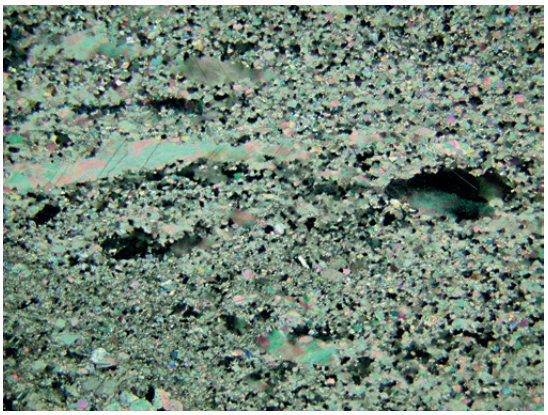
[23] Corinth 8, 2, no. 132: *[C]n(aeus) Babbius Philinus aed(ilis) pontif[ex] / [d(e)] s(ua) p(ecunia) f(aciendum) c(uravit) idemque IIvir p(robavit)*. On Babbius' monopteros and the other buildings on the western terrace, see R. L. Scranton in: Corinth 1, 3, 64–67; Torelli 2001, 148–152; White 2005, 73–97. 104–110.



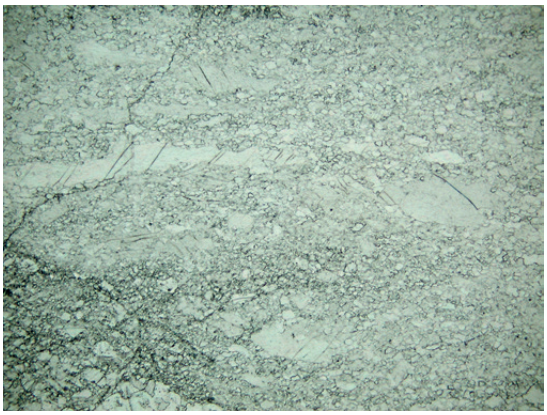
5 Microphoto of sample PM-KOR-32 (polarised light; image length 6 mm) (photo: OeAW-OeAI/ W. Prochaska)



6 Microphoto of sample PM-KOR-32 (transmitted light; image length 6 mm) (photo: OeAW-OeAI/ W. Prochaska)



7 Microphoto of sample PM-KOR-76 (polarised light; image length 6 mm) (photo: OeAW-OeAI/ W. Prochaska)



8 Microphoto of sample PM-KOR-76 (transmitted light; image length 6 mm) (photo: OeAW-OeAI/ W. Prochaska)

1st century AD (fig. 2). Philinus was a rich freedman of Greek descent who had also dedicated a fountain to Neptunus[24], which might have formed a unitary complex together with the monopteros. He was probably responsible for the construction of other buildings in Corinth (see below)[25]. As the Latin inscription reads, Cn. Babbius Philinus was *aedilis* and pontifex of the Roman colony, he undertook the construction at his own expense, and he approved it when he became *duovir*. One of the other monuments probably financed by Philinus is the Southeast Building, south of the Julian basilica, with its porticus. Its inscription (PM-KOR-78)[26] runs on an epistyle in Pentelic marble, broken into four fragments, which have been found in different locations (fig. 4). The inscription only contains the office of *duovir* of the colony and that of pontifex together with the mention of the porticus, whose construction was probably financed by the magistrate. The name of Cn. Babbius Philinus has been hypothetically restored because of his known euergetism towards the city and because he was, at the time of the first publication of the text, the only one

[24] Corinth 8, 2, 2 f. for the inscription and Torelli 2001, 149, for the hypothesis of a complex of buildings.

[25] See the inscriptions Corinth 8, 2, 98–101, no. 131; Corinth 8, 3, 155, no. 294.

[26] Corinth 8, 2, no. 122; Corinth 8, 3, no. 323: *[Cn(aeus) Babbius Philinus IIv]ir pont[(ifex) tabularium] / et porticum coloni[ae? --- colo?]nia*. The restitution of *tabularium* was made by O. Brooner in Corinth 1, 5, 27 f., who also recognised that a fourth fragment containing only the letters NIA most likely belonged to the same epistyle.

attested in the colony who was simultaneously *duovir* and pontifex[27]. Nevertheless, the discovery in the same building of an inscription dedicated by Philinus' son confirmed the involvement of the family in the construction and renovation of this complex and therefore the earlier restitution[28]. The fourth analysed monument is dated a bit later, possibly to the reign of Vespasian (PM-KOR-26)[29]. It is a statue base on local limestone, found close to the Peirene fountain, which was probably restored or set up as new (fig. 3). The honorific monument is dedicated to L. Aquilius Florus Turcianus Gallus, proconsul of Achaia under Augustus[30], whose career is also known from a bilingual inscription from Athens[31]. The monument was set up more than 50 years after the proconsulate of Turcianus Gallus. The reason for this is unknown and could be connected with some particular occasion that led to the renovation of the statue[32]. The precise dating of this monument is possible thanks to the presence of Ti. Claudius Anaxilas[33] who struck coins at the end of the reign of Nero (AD 67/68) as a *duovir* of Corinth and, as *quinquennalis* of the colony, financed the monument for Turcianus Gallus (*sua pecunia*)[34]. Chronologically, the next inscription is the dedicatory inscription of Temple E (PM-KOR-76). It runs on two adjoining blocks of the epistyle, whose material has been identified as limestone (fig. 4). The temple was built in the early 1st century AD, shortly after the death of Augustus, but the building underwent many renovations, and towards the end of the 1st century AD it was significantly modified[35]. In the past, the temple had been recognised as the one dedicated to Octavia, the sister of Augustus, mentioned in Pausanias' description, but this interpretation is very debated today[36]. The dedicatory inscription, which was very likely inscribed sometime after the reconstruction phase following the earthquake which took place around AD 77[37], does not help with the identification, as it is only partially preserved[38]. Nevertheless, what remains of the text seems to be incompatible with

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27 M. L. White has recently noted, however, that T. Manlius Iuvencus (Corinth 8, 3, 25, no. 154 = Corinth 8, 2, no. 81) was also both *duovir* and pontifex at a time compatible with the construction of the buildings mentioned in the inscription, see White 2005, 81–84 and n. 64.

28 Corinth 1, 5, no. 28: *[Cn(aeus)] Ḅabbiuș Cn(aei) f(ilius) Aeṃ(ilia) [I]taḷiç[us]*. See this interpretation also by Brooner in Corinth 1, 5, 27–29; Torelli 2001, 169 f.

29 Corinth 8, 2, no. 54 = AE 1919, 1: *[L(ucio) A]quillio C(ai) f(ilio) Pom(ptina) / [Fl]oro Turciano Gallo / [Xviro] stlitib(us) iud(icandis) trib(uno) mil(itum) leg(ionis) VIIII Mac(edonicae) / [qu(aestori)] [proq]uaest(ori) Cypro ex auctoritate Aug(usti) / [trib(uno) pl(ebis)] pr(aetori) proco(n)s(uli) provinciae Ach(aiae) / [---]TI Ti(beri) Claudi Anaxilas et / [--- II]vir(i?) quinq(uennales) sua pecunia*. In l. 6, the editor A. B. West reconstructs Dinippus, thinking that he was the second *duovir quinquennalis* at the time. This is because West dates the text to AD 52/53 and the *cursus honorum* of the well-known Tiberius Claudius Dinippus (for whom, see the inscriptions Corinth 8, 2, nos. 86–87. 89–90; Corinth 8, 3, nos. 158–163. 393–394) is compatible with this date. However, the new date that assigns the coins mentioning Tiberius Claudius Anaxilas to the end of the reign of Nero (AD 67/68), for which, see below and in particular n. 33, makes this reconstruction unlikely.

30 L. R. Dean (Dean 1919) suggests that Gallus was proconsul between 14 and 12 BC. By contrast, A. B. West (Corinth 8, 2, no. 54) tries to fit the dating of the proconsulship of Turcianus Gallus during the reign of Claudius. This dating seems not to be compatible with the epithet of the *legio VIIII Macedonica*, which at that time had already changed its name to Hispana (RE XII 2 [1925] s. v. *legio VIIII Hispana*, 1664 [E. Ritterling]). On the other hand, the proconsulship during the reign of Claudius would be possible, as Achaia was an imperial province, joined to Moesia only for a short time until AD 44.

31 CIL III 551 (= IG II 2, 4126) and Miller 1992, 13–15 no. 4. See also PIR² A993 [L. Aquilius Florus Turcianus Gallus].

32 Renovations of statues are mentioned in inscriptions in CIL X 6649; CIL XI 3801; CIL XIV 2805.

33 The coins struck by Ti. Claudius Anaxilas were originally dated to the beginning of the reign of Nero. However, M. Amandry has noticed that their iconography is compatible with a date towards the end of the reign of Nero, and he dates them to the years AD 67/68, i.e. at the time of Nero's trip to Greece, in a form of praise to the emperor. For this, see Amandry 1988, 19–21.

34 The expression is probably to be supplemented with *sua pecunia [refecerunt]*.

35 On Temple E, see Williams – Zervos 1960; Anderson 1967; Walbank 1989; Williams 1989.

36 M. Walbank suggests that it could be the Capitolium, see Walbank 1989 contra Torelli 2001, 161–164.

37 Walbank 1989, 387.

38 Corinth 8, 3, no. 333: *[--- e]t liberi eius s(ua) p(ecunia) [---]*.

imperial patronage for the imperial cult, as the building seems to have been built or restored by a private citizen, who paid for it from his own pocket (*sua pecunia*), and by his children (*et liberi eius*). The next inscription, PM-KOR-68[39], runs on a statue base on Pentelic marble which was placed in the peristyle court of the theatre (fig. 3). The base held a bronze statue of a boy who won various competitions, which are listed in the text of the inscription, probably as an actor, as a singer, or both. The statue was set up by the boy's father with permission from the city council, and it is dated between AD 70 and AD 80[40]. The next dedication, PM-KOR-33[41], was also engraved on the front of a statue base in limestone (fig. 3). The original location where the monument was displayed is unknown, as it was found in secondary use, built into the Byzantine ramp north of the propylaea. The honorific inscription in Latin is addressed to L. Papius Lupercus, who had been granted *ornamenta* as *aedilis*, *agonothetes*, *duovir* and *duovir quinquennalis* by the colony in the 1st century AD. Lupercus was a benefactor of the city, although he was not born in Corinth, as is made clear by his electoral tribus, the Falerna, to which only Italic cities are ascribed[42]. It is therefore possible that Lupercus was an Italic citizen and had been attracted to Corinth by commercial interests. As in the previous inscription, the monument is dedicated and paid for by a family member. The identity of the dedicant(s) has been debated. Dean thinks that three different people dedicated this base and they were Lupercus' daughter, named in l. 7, and two of Lupercus' freedwomen, called Methe and Avia[43]. It would be peculiar, however, within this type of inscription, not to indicate the status of the women and their relationship to Lupercus. It was therefore suggested that ll. 6–7 should be translated as »Papia, daughter of Lucius, wife of Donatus, and his grandmother Methe.«[44] A third option, and perhaps more likely one, is that there is only one dedicant and it is Lupercus' grandmother called Papia Methe. Her naming formula would then be complete, with the indication of her *gentilicium* and *cognomen*, the names of her father and her husband[45]. She was married to a certain Donatus, who was probably an influential and famous member of the Corinthian elite if he could be recognised by the reader of the inscription simply by his *cognomen*. Two funerary monuments are made in Pentelic (PM-KOR-24) and Proconnesian marble (PM-KOR-56), respectively, and both are dated to the 2nd century. The first (PM-KOR-24)[46] is a slab that was applied at the entrance of a chamber

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39 Corinth 8, 3, no. 272 = Corinth 9, 3, no. 71: Λ. Βείβιον Φλῶρον / παῖδα κωμῳδόν / Πατρέα καὶ Κορίνθιον, νει/κήσαντα ἐν Ἄργει τὸν ἀγῶ/να τῶν Ἡραίων καὶ τὸν δι/ὰ πάντω<ν>, καὶ ἐν Κορίνθῳ / Καισάρεια δὶς κατὰ τὸ ἐ/ξῆς καὶ τὸν διὰ πάντων, / ἐν Σικυῶνι Καισάρεια / καὶ τὸν διὰ πάντων, / ἐν Ἐπιδαύρῳ Ἀσκλη/πεῖα καὶ τὸν διὰ πάν/των. Λ. Βείβιος Οὔρ/σουλος ὁ πατὴρ ἀν/έστησεν. / ψ(ηφίσματι) β(ουλῆς). J. H. Kent writes the cognomen of the father as Οὔρσυλος (ll. 13–14), whereas the form written on the stone is clearly Οὔρ/σουλος, which is the correct and expected rendering of the Latin cognomen Ursulus in Greek. For this, see Nastasi 2024, 333.

40 Kent originally assigns the text in Corinth 8, 3, 110 f., no. 272 to the 3rd cent. AD on palaeographic grounds. However, Robert (1966, 753) and later Rizakis (1995, 384) prefer an earlier date because the formulae adopted to refer to the games at which the honorand was victorious are incompatible with those adopted in the 3rd cent. We accept an earlier date for the inscription. For this, see also Nastasi 2024, 334 f.

41 Dean 1922, 456 no. 21 fig. 3; AE 1923, 7; Corinth 8, 2, no. 105: *L(ucio) Papio L(uci) f(ilio) / Fal(erna) Luperco / aed(iliciis) et IIvir(alibus) eț agonothetic(is) eț / quinq(uennaliciis) ornamen[t(is)] / ornato d(ecreto) d(ecurionum) / Papia L(uci) f(ilia) Donati uxo[r] / Methe avia*.

42 Kubitschek 1889, 270.

43 Dean 1922, 456.

44 Piérart 2021, 317.

45 This interpretation is found in Rizakis – Zoumbaki – Kantirea 2001, 361 COR 456. 460. According to this interpretation, grandmother and grandson have the same gentilicium, which implies that grandmother and grandfather shared the same nomen. Cases of a husband and wife having the same name are the norm for freed slaves, but are also attested among freeborn people. This is found, for example, in CIL V 1841, where Retinacia L. f. Secunda is mentioned with her husband C. Retinacius C. f., or in CIL XI 5278, where Alfia C. f. Mimisia was the wife of either C. Alfius Rufus or C. Alfius Quadratus, and all of them are freeborn (examples are from Nuorluoto 2023, 153. 187; see Nuorluoto 2023 for more examples).

46 Corinth 8, 3, no. 287; Hoskins Walbank – Walbank 2015; AE 2015, 1383: *V(ivus) M(arcus) Aenius / Onesiphorus sibi et / vivis Calp[et]anae Hilarae / uxori et [-] Aenio M(arci) f(ilio) Aem(ilia) / Onesiph[or]o f(ilio) posterisq(ue) suis.*

tomb, where it was found, near Cheliotomylos (fig. 3)[47]. The person responsible for the construction of the family tomb was Aenius Onesiphorus, who had it built during his lifetime for himself, his wife, their son and his offspring. Onesiphorus' wife, Calpetana must have been a member of an influential family in the Peloponnese. As M. E. Hoskins Walbank and M. B. Walbank point out, the family name is rare and the presence of a Calpetanus Corinthus in Sykion shows the Corinthian origin of the family that had its own slaves and freedmen[48]. Onesiphorus, who does not indicate his filiation, was probably a rich freedman. The second funerary monument, PM-KOR-56[49], has a completely different nature. It is a stele which was found in the area north of the Lechaion road basilica, clearly not *in situ* (fig. 3). It is dedicated by Turrania Sosipatra to Ptolemaios, who, judging from the iconography, might have been her husband. Sosipatra bore a common Latin family name (Turrania). Sosipatra and Ptolemaios could have a different status: she could have been a freeborn citizen or a freedwoman, while he might have been a freedman – in this case, he and Sosipatra would both be *liberti* of a Turranius bearing the same name –, a slave or a native. The text can be dated on the basis of the palaeography to not earlier than the second half of the 1st century AD, more probably to the 2nd century AD, even if the iconography, with two figures with their right hands clasped in the gesture of parting, is clearly Classical and was also used in Hellenistic times[50]. The stele had perhaps been produced in the 3rd or 2nd century BC but was not used until the 2nd century AD, when it was engraved and employed as a funerary monument. Alternatively, it was intentionally decorated with Classical/Hellenistic iconography. A herm in Pentelic marble with a portrait of Herodes Atticus can also be dated to the 2nd century AD (PM-KOR-82)[51]. This was found near New Corinth, not in its original location (fig. 3). The text of the inscription translates as »Herodes used to walk here«, where the exact meaning of walking is actually walking while teaching and talking about philosophy. Herodes Atticus was a famous philosopher of his time and teacher of the future emperors Marcus Aurelius and Lucius Verus[52]. He had an especially strong relationship with Corinth, where his activities as a benefactor of the city are well known. He was himself the owner of quarries of Pentelic marble, which he might have used to build and restore buildings in the city[53]. Also, other members of his family, like his father Ti. Claudius Atticus[54] and his wife Appia Regilla[55], received monuments in Corinth. The character of the lettering and style of the sculpture indicates that the herm was set up shortly after the death of Herodes Atticus in AD 179, which is also compatible with the use of the past tense in the text of the inscription (»he used to walk«)[56]. The original location of the herm is unknown, but if it was set up in a public space, it is possible that it was commissioned by the city council as a way of thanking the famous philosopher and benefactor of the city[57].

47 On the tomb, see Hoskins Walbank – Walbank 2015.

48 ILGR 82; AE 1977, 780.

49 Corinth 8, 1, no. 131: Τυρανία Σωσίπατρα / Πτολεμαίω χαίρειν.

50 Parallels from Beroia can be found in Allamani-Souri 2008, 293 f. cat. 5. 7. In Corinth 9, no. 262, the stele is dated to the 2nd cent. AD, probably after the inscription.

51 Corinth 8, 1, no. 85 = SEG 2, 52: Ἡρώδης / ἐνθάδε / περιεπάτει. On this herm, see also Corinth 9, no. 169; Calandra – Gorrini – Saporiti 2016.

52 See RE III 2 (1899) 2678 s. v. Ti. Claudius Atticus (E. Groag).

53 Hirt 2010, 89; Pensabene 2013, 268. On the Herodes' projects in Corinth, see Pausanias in his »Description of Greece« (Paus. 2, 1, 17).

54 Corinth 8, 2, no. 58. See also RE III 2 (1899) 2677 f. s. v. Ti. Claudius Atticus (E. Groag).

55 Corinth 8, 1, no. 86; Corinth 8, 3, no. 128: »This is a statue of Regilla. An artist carved the figure which has translated all her prudent moderation into stone. It was given by great Herodes Atticus, pre-eminent above others, who had attained the peak of every kind of excellence, whom she took as her husband, Herodes famous among Hellenes and furthermore a son (of Greece) greater than them all, the flower of Achaia. O Regilla, the City Council, as if hailing you Tyche, has set up the marble statue before Tyche's sanctuary.« (Translation: J. H. Kent).

56 Calandra – Gorrini – Saporiti 2016, 616.

57 See also Calandra – Gorrini – Saporiti 2016, 618.

The next two statue bases are two examples of the several monuments in Corinth, both in Latin and Greek[58], dedicated to Cn. Cornelius Pulcher[59]. The first one, PM-KOR-31, is in Pentelic marble, and the second one, PM-KOR-34, is in limestone. The statue base PM-KOR-31[60] was found on Lechaion road and it is to be dated in Hadrianic times after the institution of the Panhellenion, which is mentioned in the inscription (fig. 2). Pulcher was *duovir* of the city and *agonothetes* of the Isthmian and the Panhellenic games, ἀρχιερεύς and ἑλλαδάρχης of the Achaean *koinon*, *procurator* in Epiros and *iuridicus* in Egypt. Like Lupercus (PM-KOR-33), he was also not a native of Corinth, as he was born in Epidauros, but he had been attracted to Corinth by the opportunities that the city offered, and there he had started the political career that had led him to high imperial positions[61]. This statue is dedicated to Cn. Cornelius Pulcher by his sister Calpurnia Frontina. The second statue base of Pulcher that has been analysed is much smaller in dimensions and it contains a simpler dedication by a certain L. Gellius Iustus (PM-KOR-34) (fig. 2)[62]. This statue base is the twin of a second one dedicated to Pulcher by Iustus' father, Menander. A hypothesis is that both statues were set at the entrance of the propylaea[63]. Finally, the last inscription (PM-KOR-35)[64] is also the only one which is dated to the 3rd century, a period when Corinth was undergoing a phase of decline (fig. 3). The inscription is engraved on the limestone base for a bronze statue dedicated to the Emperor Trebonianus Gallus. Trebonianus Gallus reigned for only two years from AD 251 to 253 and monuments in his honour are extremely rare. This particular inscription has been dedicated by the city, which is indicated simply as ἡ πόλις. The name of the emperor is misspelt (Λίβιος instead of Οὐίβιος)[65].

DISCUSSION

The archaeometric analysis of the artefacts (tab. 2) allows some general conclusions to be drawn on the use of different types of marble in ancient Corinth, according to the time and context:

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58 Corinth 8, 1, nos. 81–83 (PM-KOR-34); Corinth 8, 3, nos. 138–143 in Greek; Corinth 8, 2, nos. 71–72 in Latin. This Cornelius Pulcher is not to be confused with another *agonothetes* of the Isthmian games in AD 41 (IG IV 795), who has been identified by M. Kajava in a fragmentary inscription from Corinth (Corinth 8, 3, no. 153), see Kajava 2002.

59 On Cn. Cornelius Pulcher, see PIR² C 1424.

60 Corinth 8, 1, no. 80 = IG IV 1600: Γν(αῖον) Κορνήλιον Τιβ(ερίου) Κορνηλίου Πούλχρου υἱὸν Φαβία Ποῦ[λ]/χρον στρατηγὸν / τῆς πόλεως Κορινθίων πενταετηρικόν, ἀγωνοθέτην Καισαρείων Ἰσθμίων, ἀρχιερ[έα] / τῆς Ἑλλάδος καὶ ἑλλαδάρχην ἀπὸ τοῦ κοινοῦ τῶν Ἀχαιῶν συ[νεδ]ρίου διὰ βίου, Ἠπείρου / ἐπίτροπον, Αἰγύπτου καὶ Ἀλεξανδρείας δικαιοδότην, ἄρχον[τα τοῦ] Πανελληνίου καὶ ἱερέα / Ἀδριανοῦ Πανελληνίου, ἄλλας τε μεγάλας δωρεὰς ἐπιδόντα καὶ τὴν ἀτέ[λειαν] τῇ πόλει παρασχόντα / Καλπουρνία Φροντεῖνα ἡ ἀδελ[φή].

61 See Engels 1990, 68 f. on the hypothesis that both Cn. Babbius Philinus and Cn. Cornelius Pulcher migrated to Corinth; more recently see Oppen – Chang 2024.

62 Corinth 8, 1, no. 83 = IG IV 1601: Γν(αῖον) Κορνήλιον Ποῦλχρον / Λ(ούκιος) Γέλλιος Ἰοῦστος.

63 B. D. Meritt in: Corinth 8, 1, no. 83.

64 Corinth 8, 3, no. 116: Τὸν κύριον ἡμῶν τὸν / μέγιστον καὶ θειότατον / Αὐτοκράτορα Καίσαρα Γάιον / <Οὐ>ίβιον Τρεβωνιανὸν Γάλλον / Εὐσεβῆ Εὐτυχῆ Σεβαστὸν ἡ πόλις.

65 The misspelling of the name, written Λίβιος with initial Latin L, has been interpreted by J. H. Kent (in Corinth 8, 3, no. 116) as a demonstration that the name of the emperor was not well known and that the writer tried to write Livius instead of Vibius. This hypothesis cannot be ruled out. Another option is that a process of dissimilation took place. In the 2nd cent. AD, the most common way to render Latin v was through Greek <β> rather than <ου>. The result of the rendering of Vibius in Greek would then be Βίβιος, with the same consonant, which was undergoing a process of fricativisation, in two adjacent syllables. This might have caused problems of pronunciation which led to the dissimilation of the first consonant into l. The letter was also written in Latin characters through a mistake by the stonecutter, possibly determined by the Romanness of the name. A simple spelling mistake can nevertheless not be excluded. It could be hypothesised that the version from which the text was copied was in minuscule letters, in which the shape of b and l would have been similar, leading to a spelling mistake. For this hypothesis, see Nastasi 2024, 149–150.

Early Use of Proconnesian Marble

Proconnesian marble was one of the most famous materials in antiquity and one of the most widely used, even though it was not one of the best-prized marbles. This activity had begun by at least the 6th century BC and continued well into the Byzantine period[66]. The mass production of marble started in the second half of the 1st century AD during the Flavian period[67]. The marble quarries on the island cover a large area, over 40 km², centred on the harbour at Saraylar, from where the material was exported[68]. Proconnesian marble is used in only one analysed inscription, the stele PM-KOR-56. This element reinforces the hypothesis that the stele might have been produced around the 3rd/2nd century BC, while the inscription was engraved only in Roman times, perhaps in the 2nd century. The use of Proconnesian marble in Classical and Hellenistic times is known, even if not so frequent[69], and it is possible that this marble was imported to the Isthmian city in a period before the destruction of 146 BC and that it was also used for funerary monuments produced in series, like this stele.

Pentelic as the Most Used Marble in the 1st and 2nd Centuries AD

The quarries in Penteli began to work intensively after the Persian Wars (5th cent. BC)[70]. The excellent characteristics of the material, such as the high quality, fine-grained texture, density and clarity, led to the large trade in marble. In Athens, it was used mainly in the time of Pericles for the construction of monuments. Pentelic marble can also be found in later periods, such as the Hellenistic and Roman eras. In Roman times, the peak of extraction is dated to the 2nd century AD, when Herodes Atticus was the owner of large portions of Pentelic quarries. The export of Pentelic marble is documented at local and regional levels throughout the Imperial age[71]. In Corinth, this marble was used homogeneously during the 1st and 2nd centuries AD for buildings on the forum, honorific inscriptions on statue bases and private funerary monuments. It is possible that the increase in the use of Pentelic marble in Corinth is to be associated with the creation of the province of Achaia, where Penteli was the main marble quarry, and with the building of monuments in its main centre in the following years. Monuments in this marble were commissioned both by private persons (PM-KOR-24. PM-KOR-31. PM-KOR-68) and by city magistrates (PM-KOR-32. PM-KOR-78) and were exhibited both in a more private context, like the chamber tomb, or in public spaces like the forum. The use of Pentelic marble in Corinth must have remained consistent in the 2nd century, as Herodes Atticus, to whose memory a famous herm with his portrait is dedicated (PM-KOR-82), was one of Corinth's main benefactors and donated new buildings to the city.

Local Limestone as an Alternative to Pentelic Marble

A white local limestone is used from the 1st to the 3rd century as an alternative to Pentelic marble. It first appears in PM-KOR-30, part of an honorific monument to the deified Caesar, dated to the first decades of the 1st century. It seems to be used for different types of renovation, like PM-KOR-26, an honorific monument dedicated by the city to L. Aquilius Florus Turcianus Gallus, proconsul of Achaia under Augustus, which was probably renewed in the second half of the 1st century AD. In the same way, some architectural elements of Temple E, including the

66 Kokkorou-Aleura et al. 2006.
67 Attanasio – Brilli – Bruno 2008.
68 Attanasio – Brilli – Bruno 2008.
69 Kokkorou-Aleura et al. 2006; Adam-Veleni – Tsangaraki – Chatzinikolaou 2017. On the use and export of Proconnesian marble from the 1st cent. AD, see Pensabene 2013, 320–330.
70 Orlandos 1958; Korres 1994.
71 Al-Bashaireh 2021.

Lab no.	$\delta^{18}O$ (PDB)	$\delta^{13}C$ (PDB)	$MgCO_3$ %	Mn [ppm]	Fe [ppm]	Sr [ppm]	Cr [ppm]	V [ppm]	Y [ppm]	Cd [ppm]	Ba [ppm]	La [ppm]	Ce [ppm]	Pr [ppm]	Dy [ppm]	Ho [ppm]	Yb [ppm]	Pb [ppm]	U [ppm]
PM-KOR-24	–8.07	3.02	1.16	51.70	183.53	186.02	1.98	0.02	0.63	0.15	3.55	0.817	0.839	0.102	0.068	0.015	0.049	2.166	0.038
PM-KOR-26	–0.49	2.82	0.16	5.38	52.31	156.00	2.19	0.07	3.70	0.64	7.70	1.940	0.244	0.193	0.204	0.054	0.150	2.731	0.048
PM-KOR-30	–1.13	2.52	0.45	8.50	101.51	371.88	1.96	0.19	2.48	0.31	4.82	1.443	0.117	0.161	0.181	0.046	0.123	1.243	0.021
PM-KOR-31	–4.88	2.53	2.01	124.94	619.82	170.58	1.62	0.06	3.26	0.20	6.99	1.510	2.142	0.384	0.394	0.087	0.261	4.940	0.187
PM-KOR-32	–5.09	2.50	2.22	298.70	985.05	183.58	1.68	0.38	4.58	0.40	2.29	1.621	3.158	0.457	0.515	0.113	0.269	4.683	0.051
PM-KOR-33	–0.96	2.68	0.09	2.25	51.10	433.21	1.92	0.03	0.18	0.10	3.48	0.118	0.042	0.015	0.014	0.003	0.008	0.188	0.066
PM-KOR-34	–0.54	2.46	0.94	19.85	51.21	238.74	2.26	0.08	0.30	0.26	2.69	0.271	0.071	0.031	0.027	0.006	0.015	21.308	0.063
PM-KOR-35	–0.60	2.54	0.52	4.71	47.42	241.43	2.22	0.10	0.13	0.04	1.53	0.128	0.031	0.014	0.011	0.003	0.006	2.543	0.038
PM-KOR-56	–2.46	2.11	2.06	9.19	242.37	237.52	2.33	0.48	0.49	0.29	4.27	0.492	0.884	0.099	0.060	0.013	0.034	1.490	0.201
PM-KOR-68	–7.55	2.61	1.87	87.57	255.96	183.67	2.35	0.14	4.31	0.21	2.36	1.426	1.029	0.257	0.358	0.084	0.217	219.603	0.144
PM-KOR-76	–0.64	2.78	1.93	11.61	56.22	382.60	2.52	0.21	0.14	0.04	6.49	0.112	0.025	0.011	0.011	0.002	0.006	0.755	0.085
PM-KOR-78	–6.22	4.15	3.07	42.09	389.41	159.25	1.96	0.08	3.74	0.11	0.91	2.101	3.230	0.452	0.421	0.092	0.219	2.680	0.017
PM-KOR-82	–7.48	2.42	2.01	82.58	251.19	180.62	2.26	0.15	3.02	0.25	2.18	0.990	0.760	0.196	0.253	0.059	0.156	3.848	0.082

Table 2 The analytical data

architrave and the inscription itself, belonging to the renovation of the late 1st century, are in the same material (PM-KOR-76). It is therefore possible that limestone was used for reconstructing parts of the temple together with marble from other quarries[72]. The same local limestone instead of Pentelic marble is also used for monuments to the same person, like the two statue bases for Cornelius Pulcher. One, dedicated by his sister, bigger in dimensions and which records the main stages of Pulcher's career, is in Pentelic marble (PM-KOR-31), the other, smaller, with a simpler dedication by a Corinthian citizen, is in limestone (PM-KOR-34). This particular circumstance seems to point to the use of different types of stones according to the dedicators of the monument.

The Use of Local Limestone from the 3rd Century AD

In the 2nd century AD, Corinth reached the apogee of its size and prosperity and then declined little by little[73]. Little evidence survives of the city during the 3rd century and localisation of production in the Late Imperial period can be observed[74]. It is possible that, in this period, white limestone from local quarries was also used for public and official monuments, as seems to be shown by the dedication to the emperor by the city of Corinth made in this material in the advanced 3rd century (PM-KOR-35). However, this assumption would need further analysis of marble monuments dated to the Late Imperial period to be confirmed.

FUTURE RESEARCH

In the next step of the research, these results will be combined with those from the »Provenance Matters«[75] project, within the framework of which samples from other Corinthian monuments, such as statues and architecture, have been taken and are in the process of being analysed. The final aim is to investigate the same research questions addressed in this paper on a larger scale and identify more possible particular patterns in the use of specific materials for different purposes (tab. 2).

AUTHOR CONTRIBUTION

Part II was co-authored by Vasiliki Anevlavi and Walter Prochaska. Part III was co-authored by Chiara Cenati and Laura Nastasi. In this part, PM-KOR-30, PM-KOR-32, PM-KOR-76, PM-KOR-68, PM-KOR-24, PM-KOR-82, PM-KOR-31, PM-KOR-34 were studied and discussed by Chiara Cenati, and PM-KOR-78, PM-KOR-26, PM-KOR-33, PM-KOR-56, PM-KOR-35, PM-KOR-68 by Laura Nastasi, in collaboration with each other. Parts I, IV and V are joint work.

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72 Anevlavi et al. 2025.
73 See also Pettegrew 2016, 206–239.
74 Engels 1990, 64.
75 Innovation Fund: »Provenance Matters. A Multi-proxy Approach for the Determination of White Marbles in the Roman East« (Project no. ÖAW4009).

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GEOLOGICAL PROVENANCE OF ROMAN BUILDING AND ORNAMENTAL STONES USED IN THE COLONIA CLUNIA SULPICIA (HISPANIA TARRACONENSIS)

Abstract
Colonia Clunia Sulpicia, located in the north central part of Hispania, was a Roman municipality under Tiberius and capital of the *conventus iuridici* of the Tarraconensis in the 1st century AD and the hideout of Servius Sulpicius Galba in AD 68. From the 3rd century, the city declined, still inhabited on the arrival of the Muslims (8th cent.), but deserted in the 10th century. Local Miocene lacustrine limestone was used for Roman buildings. Espejón quarries, near Clunia, supplied different lithotypes of white limestone and ornamental stones with vivid colours. Foreign materials such as Cipollino mandolato from Campan are common in pavement slabs. Decorative pieces (plates, mouldings, cornices, listels, rods, etc.) and diverse statuary, in white marble and white-and-grey banded marbles, from the theatre and the Los Arcos I and II thermal complex have been archaeometrically studied. The multimethod analytical approach provides evidence of the market competition between the Mediterranean and the Western marble districts, in particular those located in southern Gaul from the Pyrenean Saint-Béat district and the Lusitanian of the Estremoz Anticline. The re-evaluation of the marble provenance used to carve the impressive goddess Fortuna statue has revealed the combination of Marignac marble from the Saint-Béat district (head) and Pentelic marble (body).

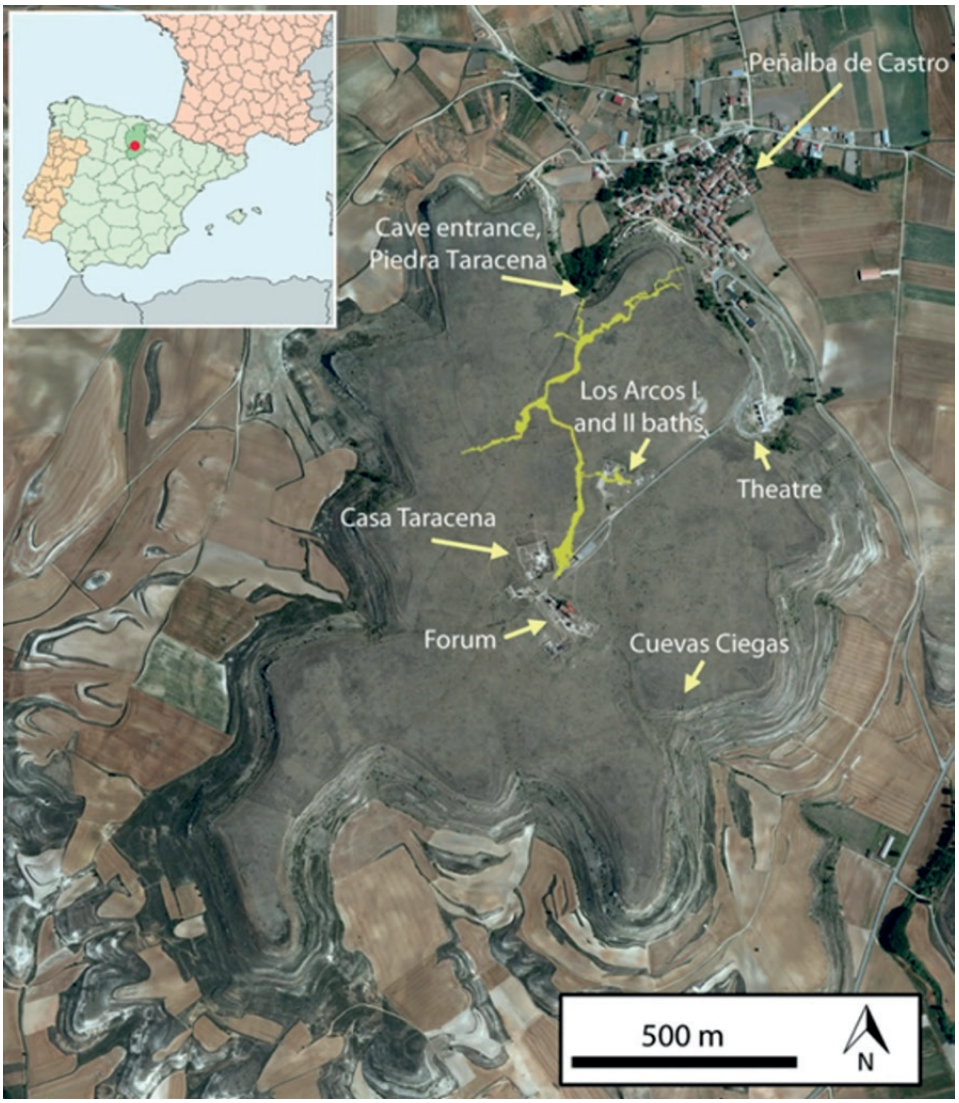
INTRODUCTION

The present paper deals with the marbles and other geological materials used in Colonia Clunia Sulpicia in Hispania. The main objective is to offer an overview of the stone raw materials used, paying particular attention to the differentiation of local, regional, supraregional or imported marbles from the Mediterranean area. The aim is particularly focused on the first archaeometric study using a multimethod approach applied to the main marble elements stored and/or exhibited at the archaeological site.

Located in the north central part of Hispania (fig. 1), at modern-day Peñalba de Castro (Burgos province), Colonia Clunia Sulpicia was founded near the Iberian city of Kolounioukou mentioned in the wars of Numantia and Sertorius. It is assumed that the Roman city was founded by the time of Augustus[1]. Under Tiberius, the Roman city minted coins with the status of municipality. Head of a *conventus iuridici* of the Tarraconensis, established under Claudius, it was the refuge during the end of the mandate of Nero, of Servius Sulpicius Galba, ephemeral emperor, from whom it takes its name and, perhaps, the origin of its category of colony. It acted as an important administrative centre[2], and a junction of roads between the Mediterranean influence (via the Ebro Valley), Lusitania and the Bay of Biscay territories.

The city was monumentalised in the 1st century (Flavian period), with a forum, a thermal complex (Los Arcos I and II baths) and a theatre. The latter, built at the end of the 1st century AD, has an estimated capacity of 8,000–9,000 spectators[3], thus suggesting that Clunia and its surroundings reached a population of about 30,000 inhabitants.

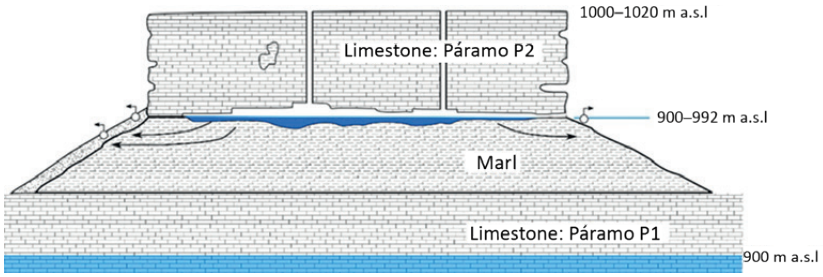
1 de Palol 1994.
2 de la Iglesia – Tuset 2010; de la Iglesia – Tuset 2012.
3 Cuesta 2012.



1 Location of Colonia Clunia Sulpicia (red dot) in the north central part of Hispania plotted on a contemporary provincial map. Clunia Hill with a large flat inselberg of about 130 ha (at 1050 m asl and 60 m over the surroundings) with the place of the main Roman buildings, caves and natural underground galleries modified by Romans (yellow) (graphics: University of Zaragoza/GTE)

From the 2nd century, the city began a long decline, as is archaeologically proven. In AD 169 the theatre was partially dismantled and transformed into an amphitheatre. The thermal complex of Los Arcos I underwent important transformations, with reoccupations until the time of Theodosius, and was even transformed into a terra sigillata workshop. Something very similar happened with Los Arcos II. In the *tabernae* of the forum, already at the end of the 2nd century, there was a drop in activity, although some of them survived until the 3rd century. Despite the decline, the city is mentioned in the 3rd century in the classical itineraries of causeways, and the basilica was used until the end of the 4th century. Some buildings continued to be used as such, but others were already used as a necropolis in the 4th century, pointing out a significant reduction of the city limits. In the 5th century, Christianity was already established[4]. Muslim chroniclers cite Clunia in their

4 de Palol 1983.



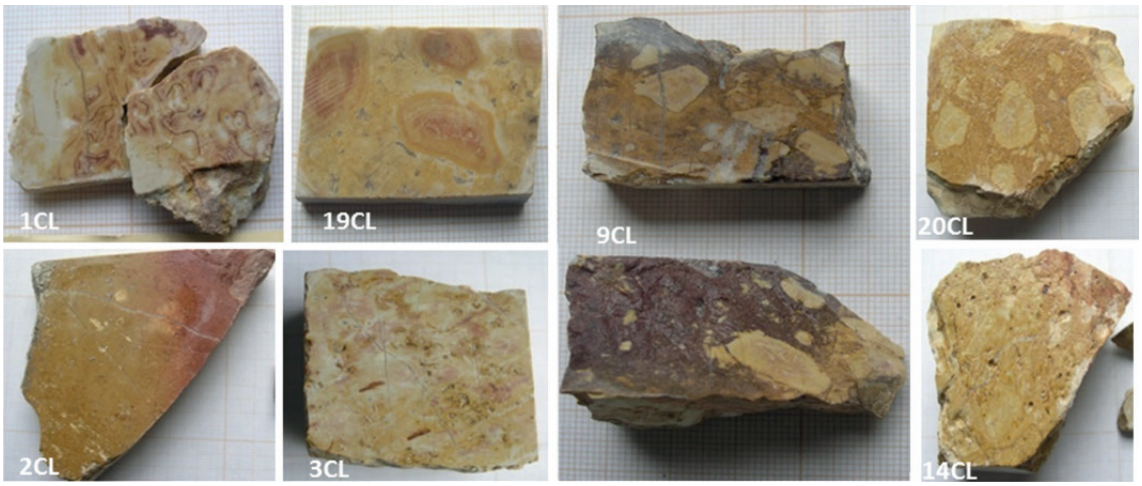
2 Geological sketch of Clunia Hill. Blue: perched upper aquifer and lower regional aquifer (graphics: University of Zaragoza/GTE)

conquest of Spain, 8th century, pointing out that the population existed, at least nominally[5]. In the 9th century, it is listed among the localities taken by King Alfonso III of Asturies[6]. Repopulated by Count Gonzalo Fernández of Castilla in 912[7], it was recovered twice more by the Muslims, the last time under Abderramán III (10th cent.), before returning definitively to Christian hands. Over time, the ruins of Clunia became a quarry for the nearby villages of Peñalba de Castro, Coruña del Conde and others. During the 17th century, based on classical sources, interest arose in locating this Roman city. However, the first neoclassic visitors were surprised by the degree to which the city had been dismantled[8]. In 1913, attention was paid to the ruins by Vicente Hinojal, Narciso Sentenach and Ignacio Calvo, who began the first excavations[9], followed by the more systematic work of Blas Taracena between 1930 and 1935[10]. In 1960, Pedro de Palol resumed the excavations. Subsequently, Francesc Tuset and Miguel Ángel de la Iglesia directed the archaeological and restoration work from 1995 to the present[11].

LOCAL GEOLOGY, GEOMORPHOLOGY AND HYDROGEOLOGY

Clunia is located on the flat top of an inselberg at the northern edge of the Duero Tertiary Basin[12]. Clunia Hill has a polygonal perimeter (fig. 1) due to the existence of subvertical fractures running from northwest to southeast through which a karst system has developed. Three subhorizontal units of the continental Miocene of the Duero Basin (fig. 2) form the hill. The upper (P2) and lower (P1) units are lacustrine limestones in metric strata. P1 is compact, clear grey in fresh and dark grey in weathered rock. P2 is slightly pinkish when fresh and grey or red when weathered. Both limestones are similar under the petrographic microscope, with micrite carbonate organised in small spheres, peloids dominate the micro texture accompanied by stem remnants, occasionally filled with sparite. There are also scarce angular grains of quartz sand. For its part, P2 is widely karstified and shows abundant macroscopic vertical tubification filled with Terra rossa. Between the two calcareous units, there is a level of whitish marl. Under the petrographic microscope, the intermediate marl is quite similar to P1 and P2, but the micritic mud also presents a high content of argillaceous matrix. The marl serves as an impermeable base for a small local recharge aquifer, hosted in a large cave system and the porous P2. The aquifer was used during Roman times for water supply via hand dug wells and a draining gallery. A detailed study on this subject is presented in a study by María R. Cuesta

5 Cuesta 2011.
6 Ortega 2019.
7 Camacho 2014.
8 Loperráez 1788.
9 Calvo 1916.
10 Taracena – Huguet – Schlunk 1947.
11 de la Iglesia – Tuset 2010; de la Iglesia – Tuset 2012.
12 Cuesta et al. 2020.



3 Examples of ornamental slabs in different yellow Espejón limestones and breccia, but also purple-red and yellow varieties from the veneer and pavement of the thermal complex. Museum of Clunia (photos: M. P. Lapuente Mercadal)

and colleagues[13]. Alternative water supplies such as a big aqueduct or a long siphon have been suggested, but no archaeological evidence has yet been found.

The most important public buildings of the city (forum and baths) and several richly decorated houses were found on the flat top of P2. The theatre, located on the northwest slope of the hill, has the upper tier excavated in P2, but the lower rows and the *scaena* are supported on the intermediate level of marls. P2 and P1 limestones have served as building raw materials and several modest quarries have been located on and near the hill. Around 96 % of the architectural elements of Clunia were carved in limestone[14] including both the local Miocene and the regional Upper Jurassic white limestone quarried at the nearby Espejón quarries.

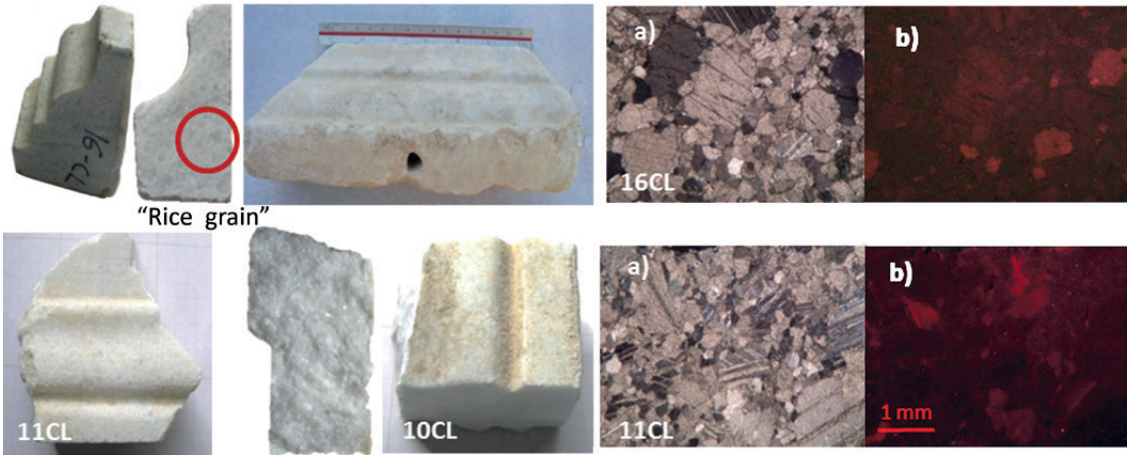
ORNAMENTAL COLOURED MARMORA AND OTHER RAW MATERIALS

As Clunia is located about 7 km as the crow flies from the Cameros-Demanda sector of the Iberian Chain, several geological resources (Jurassic-Cretaceous facies) were regionally available, among which the Espejón marmor (limestone, breccia to conglomerate), mainly used as ornamental material but also for epigraphy[15], deserves special mention. The quarries have been exhaustively studied during the last decade in the context of their historic use[16].

A large number of carved ornamental Espejón pieces have been found at Clunia exhibiting different yellow patterns (fig. 3). Some plates of this origin remain in the *tabernae* of the forum. The doorframe of the forum is also made of this material.

Other marmora visually documented from the thermal complex are several green-coloured plates – Cipollino mandolato – from Campan, northern Pyrenean Gaul, and red-coloured plates, today known as Red Ereño, a red biomicrite limestone (Lower Cretaceous) with abundant white rudist fossil shells from the current Basque country. Information on the quarries, use and the main characteristics is presented in studies by Àureli Àlvarez and colleagues and Laura Damas and colleagues[17].

13 Cuesta et al. 2020.
14 Gutiérrez Behemerid 2003.
15 Àlvarez et al. 2009.
16 García Entero et al. 2018; García Entero 2020.
17 Àlvarez et al. 2009; Damas et al. 2022.



4 Examples of several architectural pieces carved on Saint-Béat marble with a characteristic ›rice grain‹ texture (red circle) found in Clunia. a: Two photomicrographs in crossed polarisers illustrate the characteristic core-mantle microstructure. b: CL patterns are in agreement with the varieties observed in white Saint-Béat (photos: M. P. Lapuente Mercadal)

Additional regional raw material like the soft kaoliniferous sands of the Utrillas formation (Fm.) (Middle Cretaceous) were used, probably as material for foundations as evidenced by the presence of small polished white and red quartzite pebbles throughout the site. A few quartz arenite sandstone ashlars from the same formation were also used as refractory material in the furnaces of the Los Arcos I baths.

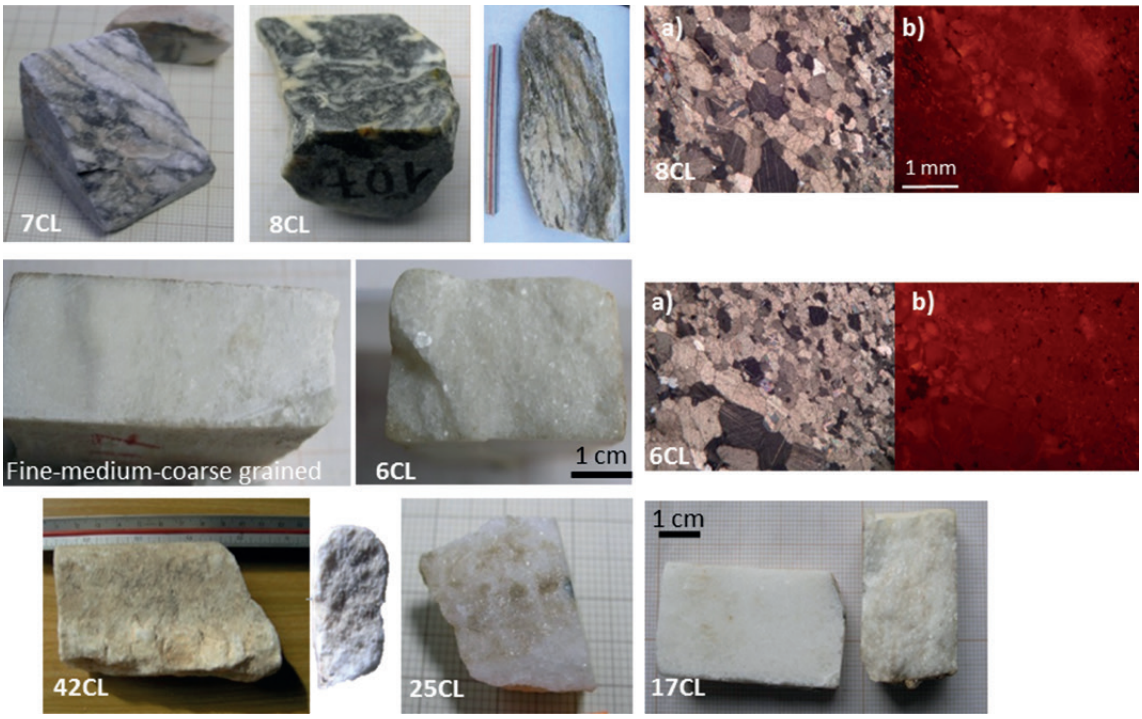
SCULPTURAL AND ARCHITECTURAL DECORATIVE MARBLES

A large number of white and grey-and-white marbles, from different ornamental architectural elements (veneers, slabs, mouldings, listels and rods), were found at different places in Clunia, mostly in the forum and baths. María P. Lapuente Mercadal and colleagues[18] conducted a first unpublished study on the petrography of different varieties of marbles from the thermal complex. Since that time, no studies of the marbles and ornamental rocks of Clunia have been carried out until the present, with the exception of the statue of the goddess Fortuna that is re-evaluated here, with a different origin for the marble proposed.

The methodology employed in the present study is the usual combination, step by step, of petrography (macro- and microscale, cathodoluminescence [CL] and stable carbon and oxygen isotopes); see the protocol of analyses in any of our previous contributions[19].

A number of decorative architectural elements in different states of fragmentation have been recovered during the different excavation campaigns. Among them, the large amount of white marble identified as Pyrenean marble of Saint-Béat is striking. Figure 4 shows different examples of mouldings and illustrates the macro and micro features including the cathodoluminescence behaviour. All their analytical characteristics point to the quarries of this well-known marble located on the northern slopes of the Central Pyrenees, near Lugdunum Convenarum[20]. In particular, the petrographic and CL features of white Saint-Béat were widely explained in a paper by Héctor Royo and colleagues[21]. Another, recently published, paper has summarised the geological characteristics of the French Haute-Garonne marble quarries, including calcitic and dolomitic

18 Lapuente – Cisneros – Ortiga 1985.
19 Lapuente 2014.
20 Fabre – Sablayrolles 2002; Royo 2016.
21 Royo et al. 2018.



5 Examples of different architectural elements carved on Estremoz Anticline marble in various colorations and grain sizes from the thermal complex of Clunia. a: Two photomicrographs under crossed polarisers. b: The respective CL patterns, illustrating the heterogeneous textural and CL distribution (photos: M. P Lapuente Mercadal)

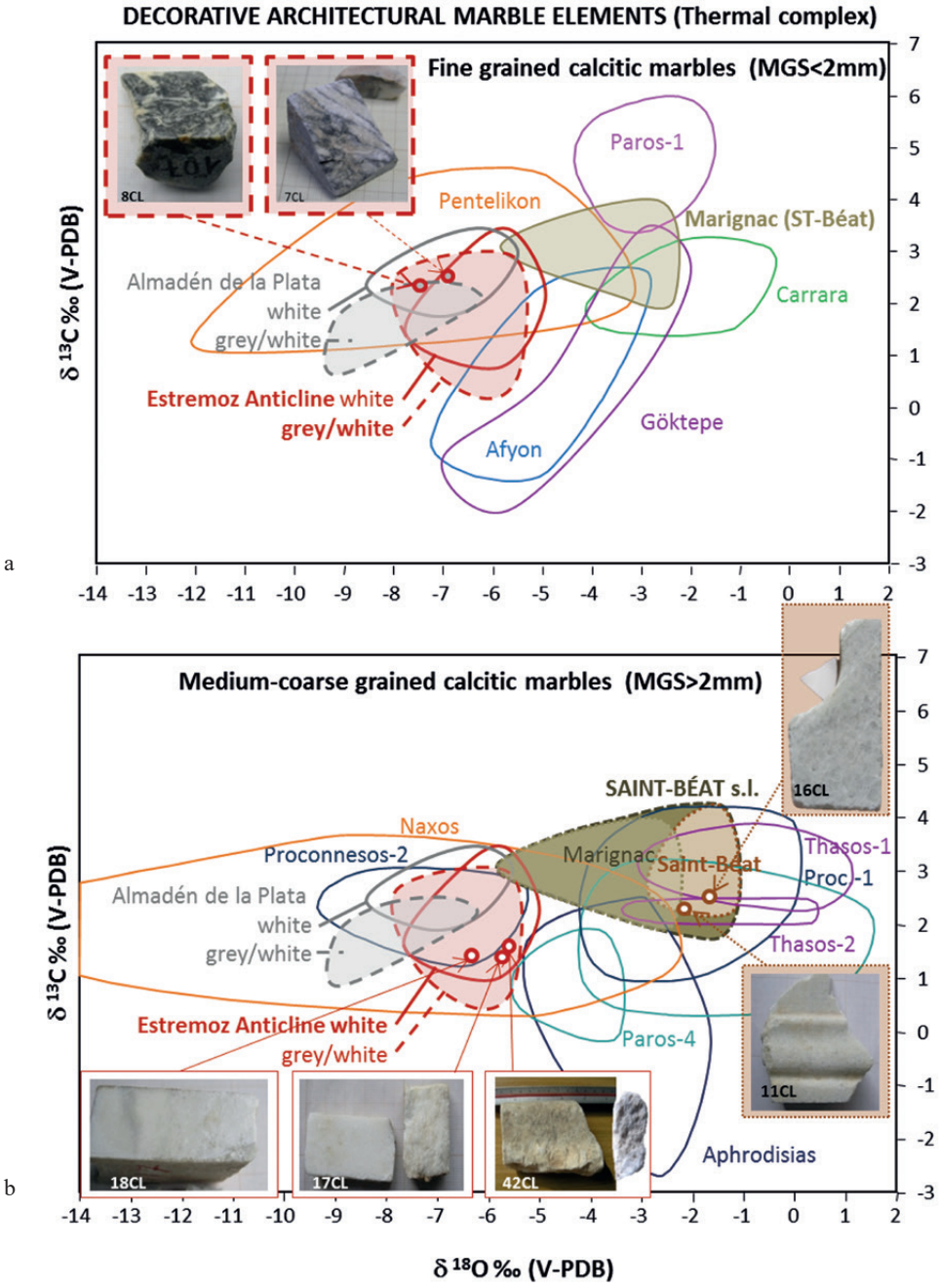
lithotypes, with an updated isotopic diagram[22]. The application of the multimethod analytical protocol have made it possible to say with certainty which Pyrenean marble varieties were used in the Tarraconense province and which of those previously proposed without comparative analytical support should be ruled out. Decorative architectural elements and statuary pieces analysed scattered all around in the Conventus Caesaraugustanus have served to check the key identification parameters of the Pyrenean marble sources, helping us to obtain a better perspective of the dissemination and distribution of this material in the neighbouring territories and, in particular, in the southern part of this important geological barrier[23].

As is shown in figure 4, this marble has a characteristic ›rice grain‹ texture, a very distinctive macroscopic appearance[24], though not exclusive to the Saint-Béat marble. Several marble portraits located in the storehouse and museum of Clunia, including one of Nero, can be macroscopically assigned to the same provenance. However, further analytical studies must be carried out to ensure this assignment.

Belonging to the same public buildings, we also have pieces of architectural decoration in marble that can be analytically assigned to the Lusitanian quarries of the Estremoz Anticline, related to Emerita Augusta. Figure 5 shows some examples of marbles from this source with different patterns and grain sizes. Their comparison with our analytical database[25] guarantees this assignment. In addition to the petrographic and CL photomicrographs shown for two representative pieces, their isotopic signature is illustrated in figures 6 a and 6 b along with those from the Pyrenean origin.

The multimethod analytical approach, visual observation, thin section petrography, CL and stable carbon and oxygen isotopes provide evidence of the combined use of marble elements from

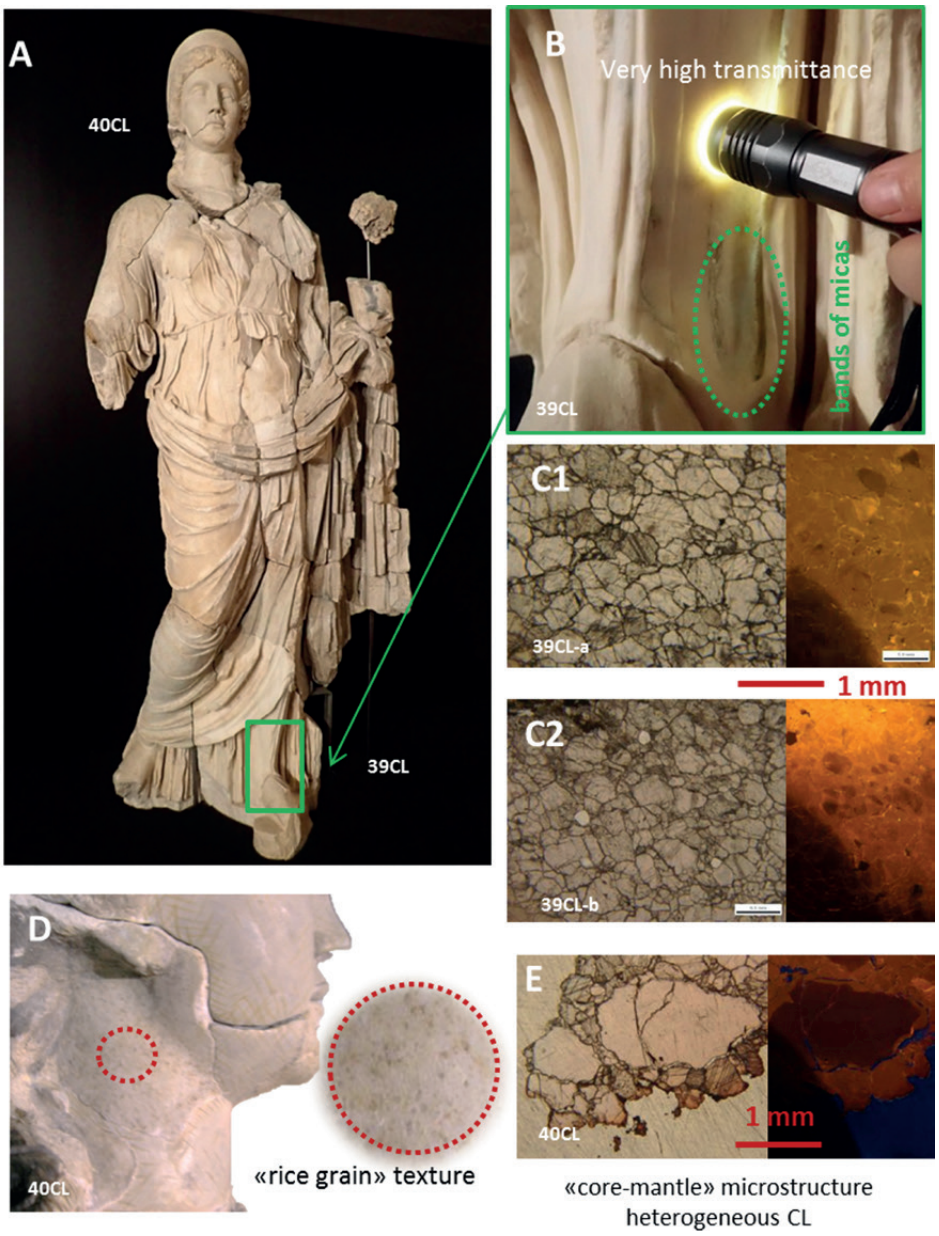
22 Lapuente Mercadal 2022a.
23 Lapuente Mercadal 2022b.
24 Royo et al. 2018.
25 Lapuente 2014; Royo et al. 2018; M. P. Lapuente Mercadal – T. Nogales-Basarrate, in this volume.



6 Isotopic diagram of several marbles from the baths (Los Arcos I and II) of Clunia. a: Diagram for the fine-grained calcitic marbles. b: Diagram for the medium- to coarse-grained calcitic marbles. Note that in these diagrams, the isotopic fields of white marbles and grey-and-white veined marbles have been separated for the two most important Hispanic districts (Estremoz Anticline and Almadén de la Plata), according to the update given by M. P. Lapuente Mercadal and T. Nogales-Basarrate in this volume (graphics: M. P. Lapuente Mercadal)

at least two marble districts located at some distance from one another, that is, the marble districts located in southern Gaul (Saint-Béat) and the Lusitanian source of the Estremoz Anticline. It is interesting to note that Clunia is about 450 km in a straight line from Emerita Augusta and 370 km from Saint-Béat.

Other decorative elements in fine-grained marble whose analytical parameters do not match either of the two mentioned origins are being subjected to complementary analyses to investigate their supraregional origin or whether they were imported from the Mediterranean marble areas.



7 a: Reconstructed statue of the goddess Fortuna exhibited at the Museum of Clunia carved in two different marbles. Two samples (39CL and 40CL) were taken to re-evaluate the marble provenance. b: The body marble exhibits a very high transmittance of light. It does not show any of the pink veining typical of the Estremoz Anticline in pieces of such extraordinary size and yet contains micaceous banding parallel to the maximum length of the piece. c: Photomicrographs (in parallel polarisers) illustrate on the left the fine-grained marble (MGS < 1 mm) and the homogeneity of the microstructure in two different parts of the body; on the right, the heterogeneous CL distribution in high intensity. d: The detail view of the marble head shows the typical ›rice grain‹ texture. e: The photomicrograph shows the very common ›core-mantle‹ microstructure and on the right, the heterogeneous CL with dark relict in the core. All these features are perfectly in line with those of Marignac (see Lapuente Mercadal 2022) (photos and graphics: J. A. Cuchí, M. P. Lapuente Mercadal)

SCULPTURAL MARBLES FROM THE THEATRE: THE GODDESS FORTUNA AND OTHER PIECES

The broken statue of the goddess Fortuna (2.3 m high and more than 200 pieces, weighing over 2,000 kg) was found during the excavations in the theatre directed by Francesc Tuset during the first decade of 21st century. The figure, carved in two different marbles, body and head, has

undergone complex restoration work and is now on display in the Clunia Museum (fig. 7 a), where an exhibition poster documents the study carried out for the purpose of its musealization[26]. In it, the identification of the two marbles is assigned to the Hispanic quarries of Almadén de la Plata (head) and the Estremoz Anticline (body). This information is reproduced in a paper by Milagros Burón and colleagues[27]. However, in our opinion, this identification, apparently made by bibliographic comparison, lacks sufficient scientific support, since the macroscopic features alone clearly point to other more plausible options.

Therefore, a new study was performed for the present paper. Visual observation, thin sections, petrography, cathodoluminescence and stable carbon and oxygen isotopes have resulted in a new and double assignment for the materials of the statue. As is shown in figures 7 and 8, based on the above criteria, the head is made of Marignac (Saint-Béat district) marble. The rest of the body is carved in white Pentelic marble, well characterised by its maximum grain size (MGS) < 1 mm, homogeneous texture with anisotropic microstructure, fine white mica bands, high transmittance of light and very heterogeneous high CL.

White marble fragments from other statues found in the theatre have also been analysed. Paros-1 Lychnites (1CL, 8CL), Pentelic (34CL) and Carrara (35CL) varieties provide other evidence of the use of Mediterranean marbles, as deduced from their petrographic and CL parameters (fig. 8 b) and the isotopic signature (fig. 8 a).

CONCLUSION

The present work is a first approach at the archaeometric study of the marbles, marmora and other raw geological materials from Clunia Sulpicia (Hispania). Several stone supply markets have been identified: a) local Miocene limestones from the Duero Basin used for building elements; b) regional resources (sand, pebbles, sandstone and white Upper Jurassic limestone) from the nearby Espejón area, along with different decorative coloured marmora from the same origin; c) supraregional marmora (Campan, Red Ereño) and marbles from different provenances, namely at least two supraregional areas (Saint-Béat district from the northern Pyrenees and Lusitanian from the Estremoz Anticline, but not Baetican marbles); and d) marmora from the most important classical districts of the Mediterranean.

In terms of estimated quantitative comparison, two considerations should be noted: first, the massive use of local and regional limestone in architectural elements over other minor use of sandstone; and second, the regional coloured Espejón marmora used in combination with supraregional marbles as ornamental decorative architectural elements to embellish different spaces (public buildings and richly decorated *domus*).

From what has been studied so far, the Lusitanian marbles were used in different decorative elements (slabs, listels, pavements, etc.) both in white, of different qualities, as well as in different grey and white veins and banded, but not in statuary. However, Saint-Béat marbles have been documented in both decorative architectural elements and statuary. Moreover, the Marignac marble variety found in statuary (head of Fortuna) was also identified in different statuary pieces from the theatre of Caesaraugusta[28].

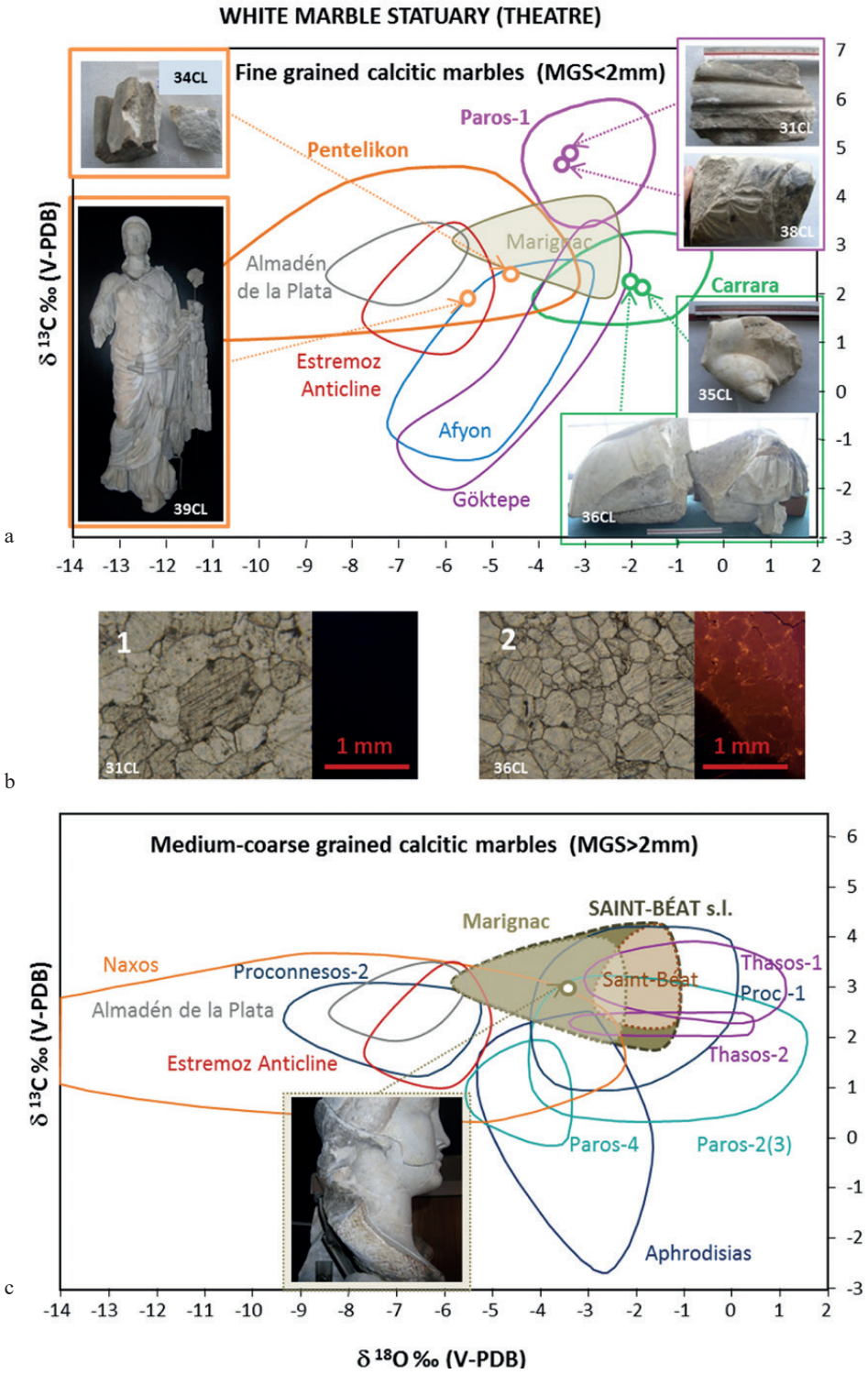
A multimethod analytical approach is always needed to assign a marble origin, as evidenced by the re-evaluation of the provenance of the marble used for the goddess Fortuna. Finally, the cases shown reaffirm the complementarity of the analyses: the carbon and oxygen isotopes are necessary, but the identification is based on macro, petrographic and CL characterisation, and finally the combination of data and the archaeological criteria aids interpretation of the marble provenance.

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26 Gisbert – Mateos 2009.

27 Burón et al. 2018.

28 Lapuente – Turi – Blanc 2009; Lapuente Mercadal 2022b.



8 a: Isotopic diagram for fine-grained marbles with the isotopic signature of several statuary marbles from the theatre of Clunia. b: Two examples of photomicrographs (parallel polarisers) and their respective CL behaviour. 31CL matches the characteristics of Paros-1 Lychnites and sample 36CL with Luni-Carrara. c: The isotopic signature of the head is projected within the isotopic field defined for Marignac and clearly outside that of Almadén de la Plata (photos and graphics: M. P. Lapuente Mercadal)

A future integral study focused on the diachronic use of marble in the different spaces will offer us a better perspective on the importance of the strategic location of Clunia as a receptor centre of different cultural influences and marble supplies.

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IN LIGHT OF NEW DATA

PRELIMINARY RESULTS OF THE PROVENANCE ANALYSIS OF THE 6th-MILLENNIUM BC SMALL MARBLE ARTEFACTS FROM ULUCAK HÖYÜK AND UĞURLU HÖYÜK, WEST ANATOLIA AND NORTHEASTERN AEGEAN TÜRKIYE

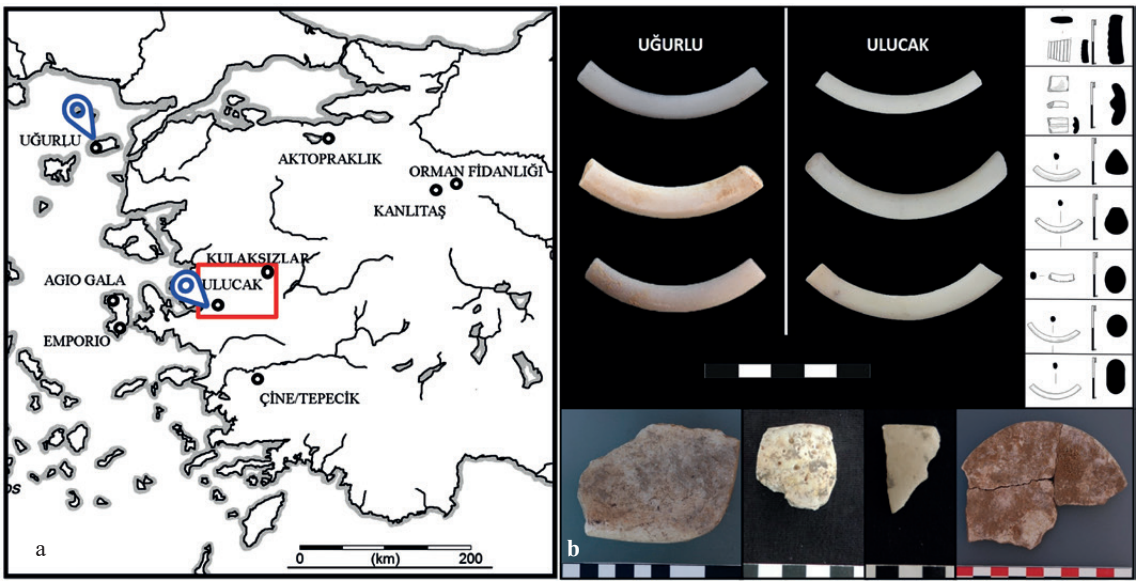
Abstract
It is widely accepted that in the prehistoric period, some symbolic values were attributed to small objects made of stone such as figurines, bracelets, beads, or bowls. While small marble items have been found in Western Anatolia since the late 7th millennium BC, marble bracelets first appear in 5600/5500 BC, which is a period in which important changes took place in cultural and social life. Marble bracelets and other small artefacts may be described not as a commodity in the regional exchange system but as an object of prestige used to signal social identity, location, or relationships. Our research focuses on the provenance analysis of such small marble finds unearthed during the excavations of Ulucak Höyük and Uğurlu Höyük. According to the preliminary results of our analysis (petrographical, geochemical, and statistical analysis), it appears that the objects from both settlements are closely related to the possible source areas in the Manisa region. Small artefacts such as bracelets and stoneware are more likely to be transported over long distances. Since the amount of raw material needed for the production of the finds is low, it eliminates the need for a significant quarry for the supply. For this reason, stream pebbles or exposed marble blocks from local outcrops may have been used as primary or secondary raw materials. According to these preliminary results, the Manisa region was a prominent source for the production of these artefacts, and more systematic sampling is planned for the next phase of the study.

INTRODUCTION

The fact that marble bracelets and small marble objects were found in the settlements of Western Anatolia and the Eastern Aegean Islands in the 6th and 5th millennium BC, proves that the symbolic meanings of this era were common, accepted and used by wider communities. The observation that such small prehistoric objects diversified and increased in later periods suggests that their symbolic and practical importance increased over time. The finds whose raw material is marble also have a separate (autonomous) place within this group of finds. The marble finds that constitute the subject of this article were unearthed during excavations in Ulucak and Uğurlu which are located in Western Anatolia and the northeastern Aegean, respectively. Ulucak Höyük is located in Central-West Anatolia, 25 km east of Izmir (fig. 1 b). The site was first founded ca. 6850 calBC and continued to be occupied until 5670 calBC without interruption. Material evidence from Neolithic layers at Ulucak, represented by levels VI–IV, suggests a strong continuity while a sudden cultural change has been attested at Level III, around 5650/5600 calBC, after a short break between Level IV and III[1].

Marble bracelets appear as a new type of find in this period and are dated to approx. 5650/5600 and 5300 BC. The contextual evidence for marble bracelets at Ulucak is rather weak, since no substantial architectural remains have yet been found. This period is represented by hut-like

[1] Çevik 2018; Çevik – Erdoğu 2018.



1 a: Working area (red square) and settlement location (graphics: B. Erdoğu). b: Small marble artefacts (bracelet and bowl fragment) from Uğurlu Höyük and Ulucak Höyük (photos: B. Erdoğu, Ö. Çevik)

buildings, a stone-paved platform, and several plastered surfaces[2]. Ulucak III revealed a total of 88 marble bracelets. None of these samples are complete, they are all in pieces (fig. 1 a). All of the finds have circular or semicircular profiles (round, oval, lenticular, deltoid, or semicircular). The inner diameters of the bracelets vary from 3–8 cm. However, no evidence (workshop remains, parts in production, etc.) has yet been found to indicate that the bracelets were produced in Ulucak. Within the scope of this study, analyses of six bracelet samples found in the Ulucak excavations were carried out[3].

The site of Uğurlu is located in the western part of the island of Gökçeada (Imbros) in the northeastern Aegean (fig. 1 b). Stratigraphic excavations at Uğurlu have clarified the spatial extent of the settlement from the initial Neolithic occupation onwards (6800 calBC) and brought to light evidence for the 5500 calBC cultural transition[4]. In the excavations of Uğurlu, different types of finds have been uncovered whose raw material is marble, such as vessels, figurines, beads, and bracelets. Within the scope of this article, one bracelet, one bead and six stone vessel pieces were analysed.

The marble bracelets and vessel pieces were recovered at the site of 30 pits surrounding a special-purpose building in the western part of the settlement. The inner walls and bottoms of these round-shaped pits, which are thought to be for ritual purposes, were plastered with yellow clay[5] (fig. 1 a). Within most of the pits, large amounts of pottery sherds, animal bones and various rare objects were discovered. Both the special-purpose building and the 30 pits date to around 5500–4900 BC. Seven marble bracelets were found during the excavations, the inner diameters of which vary between 8.5 and 9 cm. They have round, oval and deltoid cross-sections. Marble vessels consist of shallow dishes and miniature bowls.

It is important to note that even though it belongs to a later period, the Kulaksızlar marble workshop is also located in this region (see below). This evidence suggests that the production of marble objects and the use of marble raw materials have a greater antiquity in the Manisa region.

2 Erdoğu – Çevik 2019.
3 Erdoğu – Çevik 2019.
4 Erdoğu 2018.
5 Karamurat – Atakuman – Erdoğu 2021.

PREVIOUS STUDIES

In general, the production of stone bracelets dates back as early as the Pre-Pottery Neolithic B (PPNB) in the Near East[6]. In Western Anatolia, it first manifests itself between the years 5600 and 5500 BC, while in the northeastern Aegean it is at the beginning of the 6th millennium BC. In addition to Ulucak Höyük and Uğurlu Höyük, similar bracelets have been found in Orman Fidanlığı Höyük, Eskişehir[7] and Kanlıtaş Höyük[8], Çine Tepecik Höyük, Aydın, Emporio and Agio Gala on the island of Chios[9] and in Aktopraklık Höyük, Bursa[10]. There is also evidence of marble bracelet production in some settlements such as Kanlıtaş and Orman Fidanlığı in the Eskişehir region. However, no archaeometric analyses have yet been carried out on the marble bracelets recovered from the settlements in the Eskişehir region.

The Kulaksızlar marble workshop is a unique workshop in Western Anatolia, known to have produced various figurines, including Kilia figurines, as well as marble vessels dated to the 5th millennium BC[11] (fig. 1 b). The results of stable isotope analysis suggest that the marble bracelets belonging to Ulucak and Uğurlu may be related to marble samples taken from Kulaksızlar[12]. Although the Kulaksızlar workshop was dated much later than the small marble findings from Ulucak and Uğurlu, it is likely that the Manisa-Akhisar region, which has rich marble resources, attracted attention in previous periods. In the study of B. Erdoğu and Ö. Çevik, isotope analysis was performed on 17 samples from Ulucak Höyük, four samples from Uğurlu Höyük, and six samples from the Kulaksızlar marble workshop. However, stable isotope analysis alone is far from providing us with reliable results for the identification of the origin of marble objects. Since there are no reference samples representing the raw material source area in the above-mentioned study, it was not possible to suggest where the raw material could have been obtained. The samples were only compared among themselves, and it was concluded that all of the finds could belong to three different clusters. The samples of the Kulaksızlar workshop were represented in two of these three possible clusters.

In addition, one of the arguments mentioned in the publication is that there is no source of marble raw materials on the island of Gökçeada[13]. Furthermore, in some publications on the geology of the island, the existence of metamorphic units (Çamlıca metamorphics) containing marble spreading over a very limited area (about a few hundred square metres) is mentioned. However, their quality is very low for the production of such objects[14].

SAMPLING AND METHODOLOGY

This study focuses on the raw material provenance of the marble bracelets unearthed in the Ulucak and Uğurlu excavations, as well as some marble finds such as stone vessels and beads.

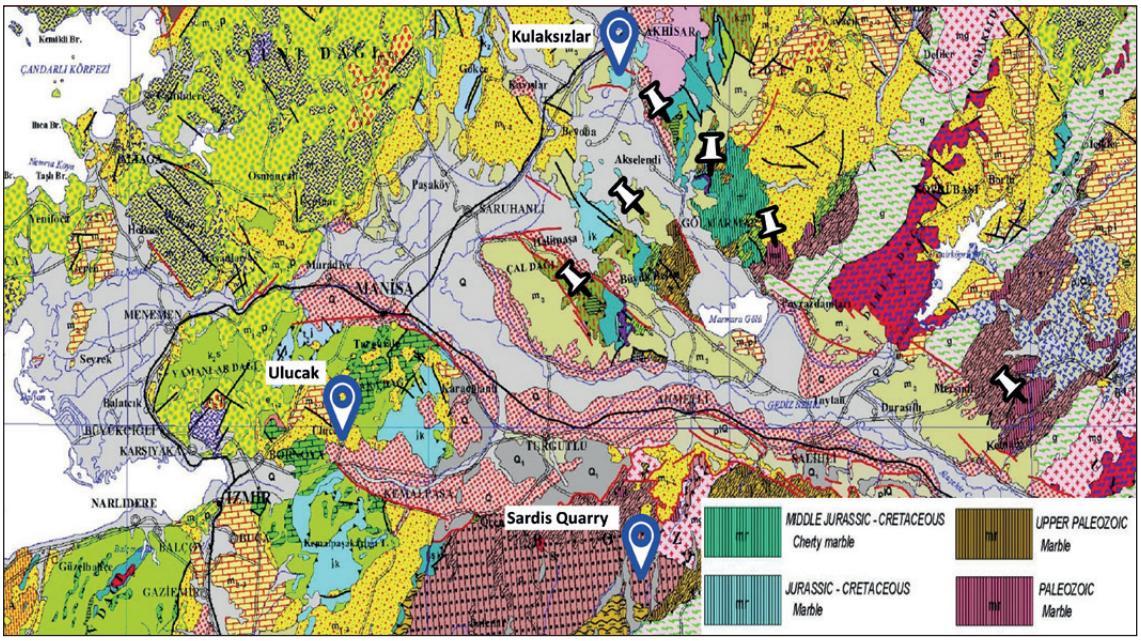
Sampling

In this study, isotope analyses and inductively coupled plasma (ICP) analyses (trace element and rare earth elements [REE]) of 14 archaeological objects were performed (tab. 1; fig. 1 a).

6 E.g., Cafer Höyük; see Cauvin et al. 2011, figs. 34–37.
7 Ay-Efe 2001.
8 Baysal et al. 2015.
9 Hood 1981.
10 Karul – Avcı 2013.
11 Takaoğlu 2005.
12 Erdoğu – Çevik 2019.
13 Erdoğu – Çevik 2019.
14 Sarı et al. 2015.

Settlement	Bracelet	Stone Vessel	Bead	Fragment
Ulucak Höyük	6	–	–	–
Uğurlu Höyük	1	5	1	1
Total: 14 samples	7	5	1	1

Table 1 Number of samples according to the type of find

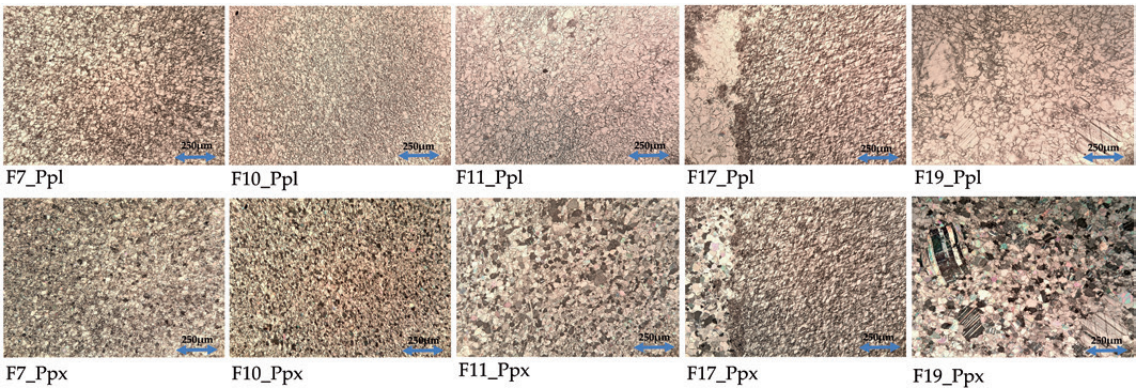


2 Geological map of the working area and location of geological units containing prominent marble formations. The Institute of Mineral Research and Exploration (MTA) (graphics: Mineral Research and Exploration General Directorate, Türkiye)

A preliminary survey and geological sampling campaign were conducted. Rock (geological) samples belonging to four different geological units of marble quality in the Manisa-Akhisar region mentioned above were analysed. A large proportion of these specimens, which were collected from 17 different outcrops, are not fine-grained (large 0.5–1.2 mm). All of the archaeological specimens have a fine-grained texture (0.5–1.2 mm)[15]. For this reason, similar analyses (thin section, isotope, and inductively coupled plasma mass spectrometry [ICP-MS]) were performed on five samples from the geological samples that were found to be finely textured (fig. 2).

The sampled geological units with distinctive marble formations are located in the Manisa region (Western Anatolia) to the north of Gölmarmara (fig. 3). The geological units belonging to the Menderes Massif have different characteristics (age, lithology, formation)[16]. Some geological units containing marble in the Menderes Massif, which spread over a large part of Western Anatolia, contain large or regional ancient marble quarries such as Göktepe, Aphrodisias, Miletos, Denizli, and Sardeis[17]. These geological data strengthen the possibility of finding a marble quarry used in ancient times in the research area[18].

15 The grain size specification after Prochaska – Attanasio 2022.
16 Bozkurt – Oberhänsli 2001; Candan et al. 2001; Okay 2001.
17 Degryse et al. 2009a; Degryse et al. 2009b; Prochaska – Grillo 2012; Scardozzi 2017; Scardozzi 2019; Anevlavi et al. 2020.
18 Degryse et al. 2009a; Degryse et al. 2009b.



3 Thin sections of fine-grained field geological samples (graphics: M. Dirican)

In addition, there is a possibility that the resource areas mentioned above may have been used in previous periods as well. Some of the best evidence for this situation is the marble finds belonging to the settlements of Kulaksızlar and Ulucak. Marble finds recovered from these settlements belonging to the 6th and 5th millennium BC include small finds such as conical beakers, idols, kilia figurines and bracelets. In particular, the Kulaksızlar settlement was found to be an atelier settlement where such finds were intensively produced for approx. 250 years (4500–4250 BC)[19].

On the island of Gökçeada, there are some metamorphic units containing marble[20]. These units, called Çamlıca metamorphites and outcropping in the northwest of the island, are spread over a very limited area of a few square kilometres. Since it is very difficult to reach the region by land, sampling of these geological units could not be undertaken within the scope of this research.

Methods

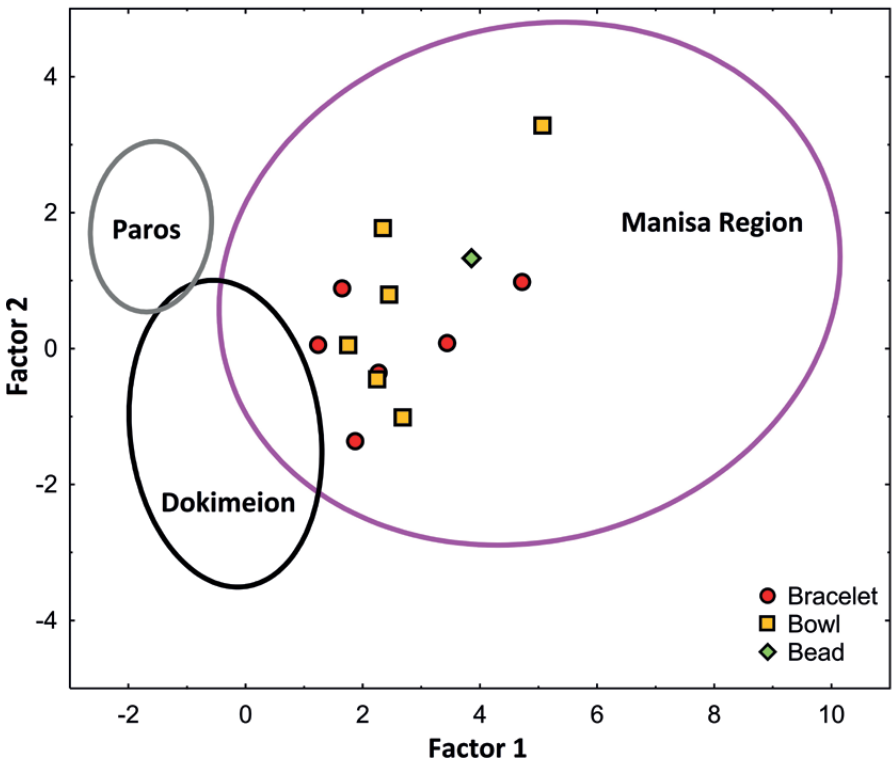
Analysis of marble provenance requires stable isotope analyses, a methodological approach that combines several methods such as trace element and rare earth elements (REE) elemental analyses, petrographic analyses, statistical analyses, etc. One of the reasons for this is that the number of potential raw material resource areas, and therefore the number of samples, is very high. The other reason is the heterogeneous nature of analytical, i.e. multivariate, data[21]. Especially in pure white marble, a limited number of textural features can be detected petrographically.

Isotope analyses are a well-established, basic and pioneering method used in marble provenance research[22]. However, the use of the method alone is far from sufficient for provenance research. Trace element analysis – for example neutron activation analysis (NAA) – is one of the old methods tried before isotope analysis in marble research[23]. Despite this, it has experienced an increase in demand again, especially in recent years. This is because measurements can be made at ppm levels, especially thanks to more sensitive and advanced methods such as ICP-MS. In this way, among the elements that can enter the crystal lattice at ppm level, such as magnesium (Mg), manganese (Mn), strontium (Sr), iron (Fe), lanthanum (La), cerium (Ce), cadmium (Cd), barium (Ba), yttrium (Y), ytterbium (Yb), uranium (U), etc., some have been effective in distinguishing different sources[24].

19 Takaoğlu 2005; Takaoğlu 2017; Takaoğlu 2021.
20 Sarı et al. 2015.
21 Maniatis 2004; Shackley 2008.
22 Attanasio – Brilli – Ogle 2006.
23 Rybach – Nissen 1965; Prochaska – Attanasio 2021; Anevlavi et al. 2022.
24 Prochaska – Attanasio 2021; Anevlavi et al. 2022; Prochaska – Attanasio 2022; Vola et al. 2022.

Lab no.	Location	$\delta^{13}C$	$\delta^{18}O$	Fe (ppm)	Mg (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Sr (ppm)	Y (ppm)	Cd (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)	Yb (ppm)	U (ppm)
MD 80	Ulucak	2.8	–6.9	37.466	3307.34	1.28	1.30	35.84	165.55	0.169	0.211	4.519	0.085	0.113	0.007	0.05
MD 81	Ulucak	2.6	–4.5	39.689	2596.29	1.27	0.95	10.88	125.31	0.112	0.189	3.072	0.082	0.109	0.002	0.03
MD 82	Ulucak	1.7	–5.1	22.851	5145.47	4.96	0.84	3.68	229.69	0.237	0.614	2.927	0.102	0.140	0.010	0.10
MD 83	Ulucak	2.2	–4.5	24.939	3170.78	1.41	1.06	11.86	176.11	1.698	0.369	3.358	0.561	0.382	0.072	0.09
MD 84	Ulucak	1.7	–6.6	576.913	6410.53	1.77	0.61	93.29	154.20	1.700	0.186	3.081	1.023	0.782	0.087	0.09
MD 85	Ulucak	1.4	–10.3	553.940	8364.60	2.11	0.84	27.09	236.51	0.837	0.203	5.732	0.737	1.224	0.035	0.14
MD 86	Uğurlu	1.4	–5.0	56.638	1717.39	1.24	1.05	12.67	79.44	0.236	0.362	2.214	0.139	0.183	0.010	0.03
MD 87	Uğurlu	3.9	–7.5	58.135	12130.86	1.23	0.45	9.11	215.10	0.214	0.148	3.440	0.107	0.179	0.010	0.03
MD 88	Uğurlu	2.4	–11.7	121.823	16845.28	1.25	0.41	11.05	131.62	0.265	0.164	3.584	0.148	0.268	0.013	0.03
MD 89	Uğurlu	2.5	–6.1	462.638	11788.07	2.75	2.32	67.27	187.64	0.936	0.376	17.839	0.348	0.242	0.042	0.04
MD 90	Uğurlu	3.7	–14.5	816.006	16728.28	1.35	1.07	61.77	130.98	2.758	0.350	4.481	1.101	0.723	0.109	0.08
MD 91	Uğurlu	2.1	–5.2	210.454	40626.18	1.77	1.68	26.00	239.74	0.782	0.299	7.890	0.369	0.313	0.034	0.02
MD 92	Uğurlu	2.4	–5.3	331.197	3578.02	1.46	0.69	26.73	140.78	1.060	0.285	3.809	0.512	0.740	0.061	0.04
MD 93	Uğurlu	0.9	–6.4	223.982	49576.16	1.33	0.49	19.33	191.08	0.199	0.187	2.185	0.124	0.220	0.010	0.04
MD 28	Field	4.1	–5.3	84.394	7835.00	1.42	0.57	74.49	165.88	2.527	0.409	1.881	1.461	1.230	0.144	0.12
MD 29	Field	3.9	–5.7	257.105	12844.60	2.01	0.87	41.76	130.11	5.056	0.344	1.698	2.768	2.291	0.242	0.07
MD 31	Field	3.4	–9.4	682.672	7362.76	1.60	0.50	71.12	241.79	2.965	0.500	2.014	1.752	2.472	0.163	0.11
MD 32	Field	–0.5	–6.8	17.061	1528.99	1.38	0.98	4.45	402.82	0.155	0.173	2.596	0.121	0.113	0.005	0.13
MD 33	Field	–2.8	–8.2	207.390	2941.89	1.71	0.67	35.11	133.28	1.128	0.260	2.303	1.314	1.965	0.073	0.84

Table 2 Results of ICP-MS and isotope analysis



4 Discriminant analysis results (graphics: M. Dirican, V. Anevlavi)

After each analytical treatment, statistical evaluation is required for the discrimination of the results. In particular, a very good distinction can be made between archaeological and geological samples using multivariate statistical methods[25].

In this research, petrographic analyses of geological samples collected from the field were undertaken. Due to the lack of sufficient size of archaeological samples, no petrographic analysis was conducted on these (fig. 3). Isotope analyses and ICP-MS analyses were applied to both geological and archaeological samples (tab. 2).

Isotope and trace element data of the samples were processed by means of multivariate discriminatory analysis for statistical evaluation. As mentioned above, all of the archaeological samples examined in this study have a fine-grained texture (fig. 3). In the statistical evaluation phase, data from Paros and Dokimeion quarries, which are known as finely textured (0.5–1.2 mm) raw material resource areas in the literature, were also used[26]. STATISTICA computer software was used for these calculations (fig. 4).

DISCUSSION

The preliminary results of the discriminant analysis show that marble objects from both settlements are possibly related to the source areas in the Manisa region (fig. 4). This makes small artefacts such as bracelets and vessels more likely to be transported over long distances. Ulucak is close to possible source areas in the Manisa region, but Uğurlu is at a distance of more than 300 km to the north. Unlike Ulucak, in Uğurlu, besides the marble bracelets, there are also different artefacts made of marble such as vessels and beads.

[25] Prochaska – Attanasio 2021; Anevlavi et al. 2022; Prochaska – Attanasio 2022.
[26] Prochaska – Attanasio 2021; Anevlavi et al. 2022; Prochaska – Attanasio 2022.

After the change in social and cultural life in Western Anatolia in 5600/5500 BC, traces of settlement show that a semi-nomadic, pastoral community emerged in Ulucak. Perhaps such semi-nomadic communities in the region may have played a role in the exchange of marble raw materials or finished products.

For instance, it is known that some marble vessel finds discovered in Çukuriçi Höyük could be transported over long distances. In their research dated 2021, V. Anevlavi and W. Prochaska showed that the raw material source of the vessels, dated to similar and later periods, were made of coarse-grained white and grey marble and came from the island of Naxos.

However, since the amount of raw material needed for the production of the finds is low, it eliminates the need for a significant quarry for supply. For this reason, stream pebbles or exposed marble blocks from local outcrops may have been used as primary or secondary raw materials sources.

Although it belongs to a later period, the Kulaksızlar marble workshop is also located in this region. This evidence suggests that the production of marble objects and the use of marble raw materials have a greater antiquity in the Manisa region (further archaeological sampling is needed). On the other hand, Uğurlu is located closer to the marble units in the Troas region. The closest possible source areas in this region were identified by J. Zöldföldi in her 2011 doctoral study. According to this research, possible source areas are located on the Biga Peninsula near Ezine (Çanakkale/Türkiye). This source area yields a stone which is called Bergaz marble, which has been defined as fine-grained dolomitic marble. In the same study, stones from the other source areas on the Biga Peninsula are defined as coarse-grained, (white, greyish-white and reddish-white) calcitic marble[27].

According to these preliminary results, more systematic sampling is planned in the Manisa region (the east of Manisa; the region within the triangle of Manisa, Akhisar and Salihli) and other possible areas for the next phase of the study.

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John J. Herrmann, Jr. – Robert H. Tykot –
Annewies van den Hoek

MARBLE IN THE MUSÉE NATIONAL D'ARCHÉOLOGIE DE SÉTIF (ANCIENT SETIFIS), ALGERIA

PROVENANCE INVESTIGATIONS WITH PXRF AND ISOTOPES OF CARBON AND OXYGEN

Abstract
Marble sculptures and architectural decoration at the ancient city of Setifis (Sétif) in modern Algeria were sampled and analysed making use of isotopes of carbon and oxygen and portable X-ray fluorescence (pXRF) to determine the minerology and trace elements. Grain size and markings were observed macroscopically. The results are used to assess the possible sources of the marble used in the various artefacts. The laboratory measurements give clear source indications in some cases, while in others the results are uncertain. Macroscopic consideration, however, can usefully supplement the scientific data and sometimes provide a most probable source for a given marble. Some marble proved to have come from familiar sources on the northern shores of the Mediterranean, such as Paros and Thasos. They were probably supplemented in Setifis by the Algerian quarry on Mt. Filfila. It is also likely that marble and a sculptor from Aphrodisias were involved in one statuette at Sétif.

METHODOLOGY

The Musée National d'Archéologie at Sétif contains ancient marble artefacts from the ancient Roman Setifis and some sites in its province in eastern Algeria. The city was founded in AD 97 as the capital of the new province of Mauretania Sitifensis, between Mauretania Caesariensis and Numidia. Marble figural sculptures from the museum are characterised by establishing their ratios of stable isotopes of carbon and oxygen. Portable X-ray fluorescence (pXRF) is used to determine the presence of magnesium, strontium, and manganese. Grain size and markings are observed macroscopically. The results are used to establish and assess the possible sources of the marble used in the various artefacts.

Marble identification in Algeria is complicated by the presence of an important source of white and grey marble on Mt. Filfila, located on the country's Mediterranean coast. Isotopically Filfila marble overlaps the signatures of many Aegean marbles (see fig. 5). Filfila marble is also highly variable in several other archaeometric parameters, such as maximum grain size (MGS) and electron paramagnetic resonance (EPR) values[1]. In spite of these obstacles, analysis with stable isotope mass spectrometry and pXRF often makes it possible to confidently establish the most probable source for a given marble. In a few cases, macroscopic features and art-historical considerations can also be useful and even decisive in establishing priorities.

In spite of Setifis' founding at the end of the 1st century AD, the museum contains a marble pyxis or perfume jar of a type known in Greece from the Bronze Age to the Hellenistic period (fig. 1)[2]. The pyxis in Sétif has much in common with Hellenistic pyxides, which tend to have a relatively high body and domed lid, but the lid is ridged and has a knob, as in Classical marble

1 Herrmann et al. 2015b.
2 Weinberg 1959; Gaunt 2013.



1 Pyxis (*unguentarium*), Musée d'Archéologie de Sétif, unknown marble, ca. 330–200 BC (photo: A. van den Hoek)



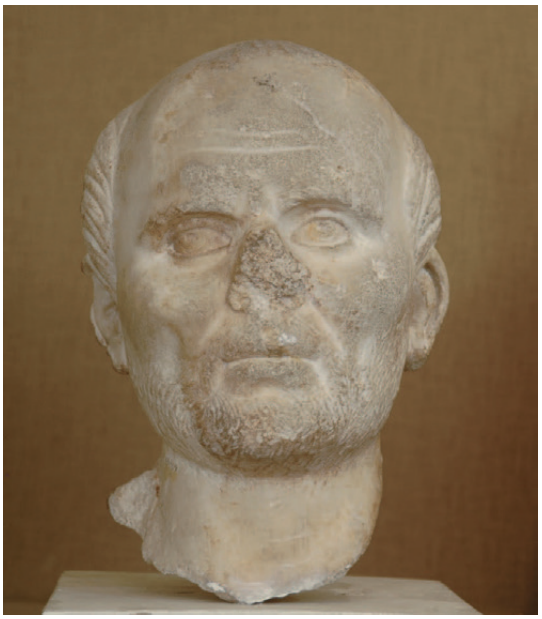
2 Cnidian Venus, Musée d'Archéologie de Sétif, Parian marble, 2nd century AD (photo: A. van den Hoek)

pyxides[3]. The type is not otherwise known, but it probably dates to early Hellenistic times and probably came from a Carthaginian or Numidian tomb somewhere in the neighbourhood of Sétif. We did not sample its marble, but like some of the other known examples, it appeared to be Parian. Pliny mentions that Parian marble was considered unsurpassed as a material to preserve unguents[4].

Another striking example of Greek exportation to Sétif was a small-scale copy of the Aphrodite of Knidos, a famous work by Praxiteles from the 4th century BC (fig. 2)[5]. In this case, the large-grained, grey-spotted marble appears to be from Paros on both macroscopic and isotopic grounds (see fig. 8 a). It could also be Ephesos marble, but white marble from that source has rarely been found in the western Mediterranean. The Aphrodite has a rather rare type of rectilinear, profiled base that recalls an altar. One of the parallels is the base of the statuette of the so-called Varvakeion Athena in Athens, an impressively detailed small-scale copy of the Athena Parthenos by Phidias[6]. The Varvakeion Athena has been identified macroscopically as Pentelic marble[7]. Both it and the Sétif Cnidian Aphrodite seem to be souvenirs of religious and artistic significance produced in Greece and given dignity by their rectilinear, altar-like bases.

A portrait of an old man proved to be Thasian marble (fig. 3). As is widely recognised, the marble of Cape Vathy on Thasos is the only known large-grained, dolomitic marble used in antiquity. Analysis with pXRF established that the portrait is dolomitic marble, and its isotopic ratios also fell solidly into the field for Cape Vathy and slightly above the quarry samples from Mt. Filfila

3 As suggested by Jasper Gaunt (pers. comm.).
4 Plin. nat. 36, 62 cited in Gaunt 2013, 386.
5 Delivorrias – Berger-Doer – Kossatz-Deismann 1984.
6 Demargne 1984, cat. 220 pl. 729.
7 Baldini 2021, 61.



3 Portrait of a balding man, Musée d'Archéologie de Sétif, dolomitic marble from Thasos, ca. AD 130 (photo: A. van den Hoek)

(see fig. 8 a). Sculptures of Thasian dolomitic marble have been identified in many other cities of Algeria, including Guelma[8], Annaba[9], Djemila[10], Timgad[11], Lambèse[12] and Cherchel[13].

Typologically the Sétif portrait it is very similar to portraits of Emperor Vespasian (AD 69–79). The baldness and the wrinkle patterns are quite distinctive, as in a portrait of Vespasian from Pergamon in Baltimore[14], which has been identified optically as Thasian marble[15]. There are, however, significant typological differences; unlike Vespasian, the Sétif man has a stubble beard. His cranium, furthermore, is too small and egg-shaped for Vespasian, and the furrows in his cheeks are too close to his mouth[16]. While the portrait in Sétif does not seem to represent Vespasian himself, in any case, it clearly reflects admiration for that emperor. It is also substantially later than the time of Vespasian; the detail of his eyes is incised, a feature that can be found no earlier than about AD 130.

The head is not only made of Thasian marble, but it may also have been carved by a sculptor from the northeast Aegean. Like the Vespasian from Pergamon in Baltimore, the Sétif head is carved with a decisive, linear technique that gives the portrait an elegance and energy. The Hadrian in Thasos is a similar case of beautification of a Roman prototype[17]. Details like the eyes and eyebrows are almost schematic. The Vespasian portraits from Rome are fleshier[18]. A contemporary and somewhat similar Thasian marble portrait in Rome, the Manlius Faustus in the Vatican, has a softer treatment of the area around the eyes, and a richer relief in the stubble beard, eyebrows and hair[19]. In that case the sculptor produced a work in Thasian marble better integrated into the traditions and techniques of the western Mediterranean.

The Vespasian-like head probably was not carved in or near Sétif; it has a reinforcement or brace at the back of its neck – probably to strengthen a weak point during shipment. Whether the sculptor produced the portrait in his home area in the northern Aegean, possibly Pergamon, or in a Thasian-friendly workshop in the west is uncertain.

A colossal head and torso in the Sétif Museum comes from an acrolithic statue of Jupiter (fig. 4). It was found at Mons, halfway between Cuicul and Setifis, and is thought to have been

8 Herrmann et al. 2015b.
9 Herrmann et al. 2015a.
10 Antonelli et al. 2010.
11 Tykot et al. 2018.
12 Calligaro et al. 2013; Tykot et al. 2018.
13 Attanasio – Bruno – Landwehr 2012, 533–535.
14 Vermeule 1968, 229–232. 237 fig. 129; İnan – Alföldi-Rosenbaum 1979, 89 cat. 37 pl. 31; Zanker 1983, 23. 48 pl. 30, 1; Pollini 1984, 552–555 figs. 10–12.
15 By John B. Ward-Perkins and John Pollini, see Pollini 1984, 553. I fully agree with the identification.
16 Pollini 1984, pls. 72–73.
17 Herrmann 2023, 97.
18 Zanker 1983, 48 pl. 30, 2; Pollini 1984, pls. 72–73.
19 Macroscopic identification of the marble, see Fejfer 2008, 119 f. fig. 75.



4 Colossal acrolithic bust of Jupiter/Zeus, Musée d'Archéologie de Sétif, marble probably from Mt. Pentelikon, possibly from Mt. Filfila, AD 209–211 (photo: A. van den Hoek)

located in the cella of the temple excavated there[20]. The head and torso were originally complete with other, now-missing blocks of stone, but this is a familiar combination of head and torso cut off below the navel for colossal seated images of Jupiter/Zeus[21]. The left side of the torso was cut straight, presumably for a mantle draped over the shoulder. The right forearm was made of a separate piece of marble and attached with a dowel.

The marble appears to be fine-grained, and its isotopic ratios offer three fine-grained options: Pentelic, Afyon, and Filfila (see fig. 8 b). The isotopic ratios are well centred in the Pentelic field and fall at the margins of the other two, making Pentelic the preferred choice. If so, however, this would be a very poor-quality piece of Pentelic. It is filled with small spots and fine wandering black veins. This is unlike the pure white marble from Afyon, and the markings seem unusually intrusive for Filfila, although somewhat comparable with an area in the ›Roman Quarry‹ on Mt. Filfila. Despite the distracting markings, the sculpture was made with great care; the nipples are inlaid with a whiter marble.

In spite of its conspicuous spots and lines, the marble is treated like a scarce commodity. The bust is made of a thin slab. The back was either made of a separate piece of stone or was fastened to a background. A single hole for a small pin is evident in the back of the torso. This economy also suggests that the stone is a prestigious import, and hence Pentelic rather than the local Filfila.

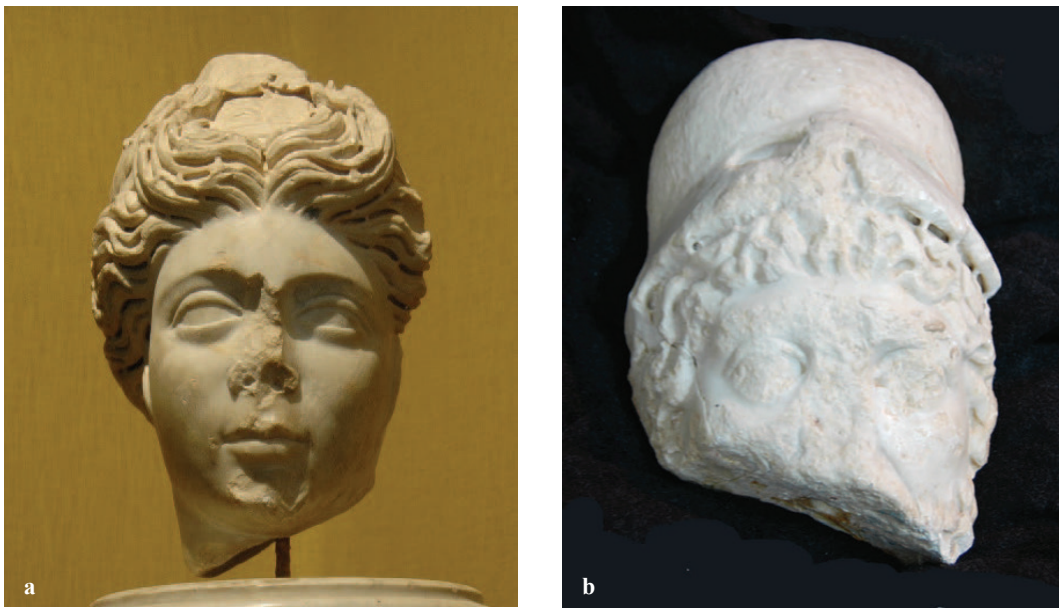
The ornamental drillwork, with deep channels and little bridges, dates the Jupiter to late Antonine or Severan times. An inscription in the temple at Mons provides the precise date of AD 209–211[22]. The statue must have been carved locally to fit the various pieces together, and the schematic treatment of the face and the very large eyes indicate provincial workmanship.

Two heads in the Sétif Museum also display even more exaggerated versions of the ornamental drillwork seen in the colossal Jupiter. One head is a Venus or Diana with braids of hair

20 Ginther 1940, 136; Galand 1949, 50 n. 1; Christol – Albèche 2007; <https://www.photosetbalades.fr/galerie-d-hier/afrique-du-nord/mauretanie-cesarienne-mons/> (04.04.2025).

21 LIMC VIII (1997) 347 f. nos. 257. 261 s. v. Zeus (I. Leventi – V. Machaira); LIMC VIII (1997) 427 f. nos. 39. 41. 47 s. v. Zeus/Iuppiter (F. Canciani).

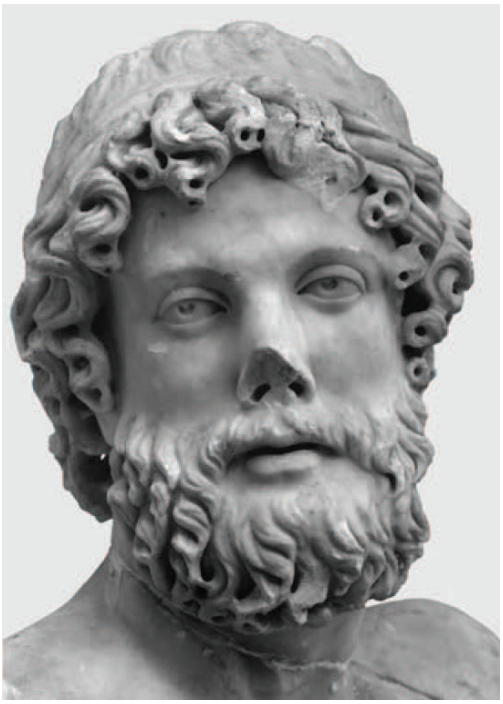
22 Christol – Albèche 2007; <https://www.photosetbalades.fr/galerie-d-hier/afrique-du-nord/mauretanie-cesarienne-mons/> (04.04.2025).



5 a: Head of Venus or Diana, Musée d'Archéologie de Sétif, marble probably from Mt. Filfila, 3rd or 4th century AD. b: Head of Mars, Musée d'Archéologie de Sétif, marble possibly from Mt. Filfila, 2nd or 3rd century AD (photos: A. van den Hoek)



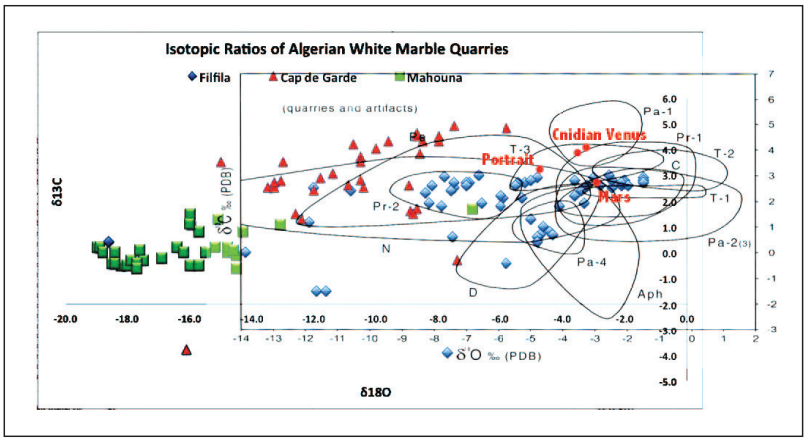
6 Head of a god or hero, probably Aesculapius, Musée d'Archéologie de Sétif, late 2nd to 4th century AD, marble probably from Göktepe but possibly from Afyon or Mt. Filfila (photo: A. van den Hoek)



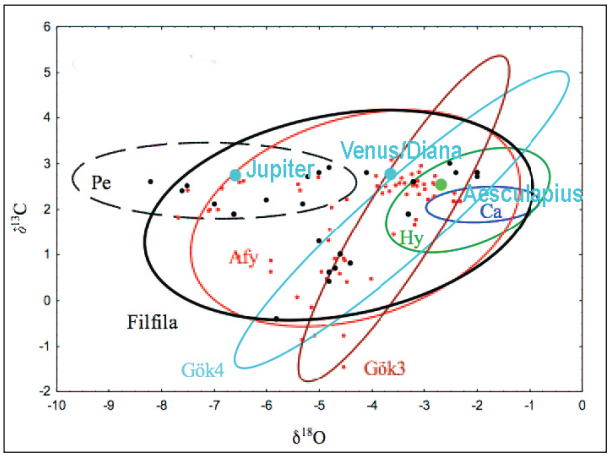
7 Head of Zeus/Jupiter from the Quirinale, Rome, Ny Carlsberg Glyptotek, Copenhagen, inv. 620, marble from Göktepe, late 2nd or late 4th century AD (photo: after Vorster 2012/2013, fig. 47 b)

tied up on top of her head (the knot with its loops is almost entirely missing) (fig. 5 a). The other head is a Mars wearing a helmet (fig. 5 b). In both, the hair is rendered with a very conspicuous network of drill channels and bridges. The skull of the goddess is excessively high and somewhat misshapen, and the channels and bridges in her hair are so conspicuous that they can be compared to the network of hair in the Alexander tondo of Aphrodisias and, as a result, dated to

a



b



8 a: Isotopic signatures of coarse-grained marble sculptures at Sétif; diagram of main white marble quarries of antiquity from Herrmann et al. 2015b (graphics: J. Herrmann): Aph = Aphrodisias city quarries; D = Dokimeion (Afyon); C = Carrara; N = Naxos; Pa = Paros; Pr = Prokonnesos; T = Thasos; T3 = Thasos dolomitic (Cape Vathy). b: Isotopic signatures of fine-grained marble sculptures at Sétif; diagram of main fine-grained white marble quarries of antiquity from Herrmann et al. 2015b (graphics: D. Attanasio, J. Herrmann): Afy = Afyon (Dokimeion); Ca = Carrara; Gök = Göktepe; Hy = Mt. Hymettos; Pe = Mt. Pentelikon

the 4th century[23]. The absence of detail in the eyes would be unusual in Severan times and very rare in the 4th century, but the feature can be found in about two dozen late antique portraits, including several from (relatively) nearby Libya[24], and in an occasional ideal sculpture[25].

The marble of the goddess is fine-grained, has a few soft grey spots, is dull, and has a slightly greyish overall tone. The isotopic ratios are compatible with Filfila, Afyon or Göktepe (see fig. 8 b), but the appearance of the stone makes the attribution to Filfila preferable, since the other two are rarely spotted. The marble of the Mars is whiter but somewhat coarser-grained, and it has a few faint grey streaks on the left side of the helmet. Its isotopic signature is compatible with the medium- to coarse-grained marbles from Prokonnesos, Paros, Herakleia, or Filfila (see fig. 8 a). The markings, however, favour the local marble from Mt. Filfila.

A bearded head in the Sétif Museum excavated in Setifis itself is carved of a beautiful, translucent, uniform white marble (fig. 6). The ring diadem he wears suggests an interpretation as

23 <http://laststatues.classics.ox.ac.uk/database/detail.php?record=LSA> no. 213 (04.04.2025).

24 <http://laststatues.classics.ox.ac.uk/database/detail.php?record=LSA> nos. 73. 76–77. 81. 120. 245. 334. 382 (?). 412. 440. 567. 697. 857. 1098. 1117. 1128. 1198. 1203. 2115. 2140–2141. 2513. 2637 (04.04.2025).

25 <http://laststatues.classics.ox.ac.uk/database/detail.php?record=LSA> no. 1229 (Hercules) (04.04.2025).

USF no.	$\delta^{13}C$	$\delta^{18}O$	Dolomite	Mn/Sr	Identification, Sétif, Musée d'Archéologie	On-site marble description	Possible & preferred source
9427	3.1	–4.8	dol	High Mn	Portrait of a bald man, ANT.343	Coarse grain, somewhat greyish: possibly Vathy but probably Paros II	Thasos, Cape Vathy
9428	2.8	–3.7		Low Sr	Head of Venus or Diana, ANT.344	Fine-grained grey, somewhat translucent: Carrara or Afyon (?)	Filfila, Afyon, Göktepe (?)
9429	2.5	–2.7		Low Mn, Low Sr	Head of Aesculapius (provenance Sétif), ANT.346	Fine-grained white, translucent: Afyon (?)	Göktepe, Afyon, Filfila, Carrara (?)
9430	2.7	–6.5			Head and torso of Jupiter (provenance Mons)	Fine-grained white marble, grey lines with a tendency to zigzag: Filfila (?)	Filfila, Pentelikon, Afyon
9431	3.6	–3.5			Base of statuette of Venus of Knidos (unknown origin)	Coarse grain, grey spots: Annaba (Cap de Garde) or Paros (?)	Paros 1-Marathi, Ephesos 1
9432	2.7	–3.0		Low Mn, Low Sr	Head of Mars, S.68.85.05, 3849/43, 4455	Par-Mar, Pro-1, F	Göktepe, Filfila, Afyon, Hymettos, Carrara (?)
10905	3.9	–3.4			Cnidian Venus statuette, torso, Ant.351		Paros 1-Marathi, Ephesos 1

Table 1 Analysis of marble sculptures in the Musée d'Archéologie de Sétif, by Robert H. Tykot, Department of Anthropology, University of South Florida

Aesculapius, although the god's wreath is usually thicker[26]. The head bears a striking resemblance to a Zeus/Jupiter in Copenhagen (who wears a flat ribbon diadem) (fig. 7)[27]. In both heads, undulating curls hang down onto the forehead and end in drilled ringlets. The handling of the beard on the cheeks, the slender proportions and the mild expression are also common features. The Zeus was excavated on the Esquiline Hill in Rome with several other statues of gods, and the group is famously the work of sculptors from Aphrodisias, who signed the base for the statues[28]. As Donato Attanasio, Matthias Bruno, Ali B. Yavuz, and Walter Prochaska have shown, the marble of the Esquiline/Copenhagen statues and many other sculptures in the western Mediterranean come from Göktepe, a marble source only 40 km from Aphrodisias[29]. The isotopic ›signature‹ of the Sétif head, in fact, almost coincides with that of one of the Copenhagen statues[30], and on this basis, it could well be from Göktepe (fig. 2).

In hopes of determining clearly if Göktepe marble was used for the Aesculapius, we examined the remains of its powder sample with pXRF. The sample did not, however, display a strong presence of strontium (tab. 1), which is a distinctive characteristic of most Göktepe marble. However, as Attanasio has shown, one quarry at Göktepe (Quarry 2C) has low strontium values, and it is the quarry that produced the Esquiline sculptures in Copenhagen[31]. Attanasio informs us, however, that Quarry 2C is very small but that the Sétif head might have come from some other as yet unknown ancient quarry in the area. In fact, other pockets of fine, white, low-strontium marble (although not true ancient quarries) can be found near the known Göktepe quarries[32].

26 Holtzmann 1984, 866 cat. 47.
27 Ny Carlsberg Glyptotek, Copenhagen, inv. 620, see Vorster 2012/2013, 462 f. fig. 47 a–b.
28 Moltesen et al. 2008, 352–372; Vorster, 2012/2013, 395–405. 460–465; Attanasio et al. 2021.
29 Attanasio et al. 2015, fig. 8; Attanasio et al. 2021, 140–144.
30 Attanasio et al. 2015, 575 fig. 8 (Poseidon); Attanasio et al. 2021, fig. 6, 11.
31 Attanasio et al. 2015; Attanasio et al. 2021, 140–144.
32 Attanasio et al. 2015, 576. 580. 585 tab. 3.

Aphrodisian sculptors usually made use of marble from Göktepe but on occasion from other sources, including Paros, Mt. Pentelikon and Carrara[33]. This variety of materials indicates that, at times at least, Aphrodisian sculptors worked abroad, probably in Rome. The isotopic ratios of the Sétif head correspond to the fine-grained marbles not only from Göktepe, but also from Mt. Filfila and Afyon. Perhaps Carrara should be included as a possible source as well. All of these alternatives for the marble of the Sétif head have problems too; Filfila and Carrara rarely have such translucence, and Carrara usually tends to have higher levels of manganese (EPR intensity). Sculptures in Afyon marble usually have a fairly high manganese level, and isotopic ratios of these sculptures usually fall into an area different from that of the Sétif head[34]. An undiscovered quarry at Göktepe seems to be the most likely source for the Sétif head, and Afyon seems to be the best second choice. In any case, even if the marble of the Sétif Aesculapius is not from Göktepe, the iconographic and stylistic character of the sculpture make it clear that it was produced by a workshop located in or stemming from Aphrodisias. Because of the dedicatory inscriptions and in spite of their ›second-century appearance‹, the Esquiline/Copenhagen sculptures are currently dated to the later 4th century[35], and the Sétif head probably should be too.

CONCLUSIONS

The analysis of marble samples with laboratory methods is difficult enough in most regions around the Mediterranean, but in the case of Algeria – and perhaps neighbouring Tunisia – it is further complicated by the presence of a local source of white marble at Mt. Filfila in eastern Algeria that had great local significance, at least in the realm of architectural decoration. Because of these difficulties, it was possible to determine with virtual certainty the provenance of only two ancient marble sculptures in the Sétif Archaeological Museum. Making use of pXRF and isotopic analysis, the male portrait could be shown to be Thasian dolomite marbler and the statuette of the Cnidian Aphrodite to be Paros Lychnites. Unambiguous results, however, could not be achieved with the other five sculptures. In those cases, we have offered attributions, based on traditional expertise: that is, familiarity with quarries, sculptures, and scientifically based identifications of ancient sculptures elsewhere. In establishing our preferences, however, choices were made only among the options offered by laboratory analysis. Scientific analysis was able to narrow our focus by eliminating many of the known ancient sources. In one case, therefore, our identifications can be called scientifically proven, but in the other five, scientific techniques are only some of the tools used to provide attributions of the marble sources present at Sétif.

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33 Attanasio 2021, 128–132 tab. 6, 1.

34 Donato Attanasio (pers. comm.). This is the case of the Afyon marble sculptures at Sperlonga, see Bruno – Attanasio – Prochaska 2015, fig. 8.

35 On the basis of their post-Constantinian dedicatory inscription, see Vorster 2012/2013, 395–400, with bibliography. It is difficult, however, to dispel the suspicion that this is a case of late rededication of older statues – even though, as Christiane Vorster points out, there are no traces of late Roman repairs to them.

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THE LUSITANIAN ESTREMOZ ANTICLINE, THE MAIN MARBLE SOURCE IN THE WESTERN ROMAN EMPIRE

Abstract
The Estremoz Anticline (EA), located in the Alto Alentejo of Portugal, is an elongated Variscan macrostructure of the Ossa Morena Zone (OMZ) in the Iberian Massif, about 40 km long and 5–7 km wide. Contrary to what was thought until very recently, the marble of this anticline, in all varieties, was not exclusively destined for the local Lusitanian market. Due to the large extension of its marble outcrops and its great aesthetic and technical quality, among the Hispanic and southern Gallic marbles, the marble of the EA is the noble material most widespread in different archaeological remains, not only from all Roman provinces of Hispania but also in several places in North Africa, making it the main marble source in the western Roman Empire. This statement is based on our own experience after more than three decades of archaeometric research in Hispania studying marble samples from both quarries and artefacts. In this contribution we will provide new and updated isotopic diagrams to discriminate the EA marbles from other Hispanic and from the classical ones. We will show their application to new so far unpublished cases from Lusitania and the Tarraconense provinces. Finally, we will stress the importance of using the combination of a complete analytical protocol including the carbon (C) and oxygen (O) isotopic signature to guarantee the authentication of the EA marbles in Roman artefacts.

INTRODUCTION

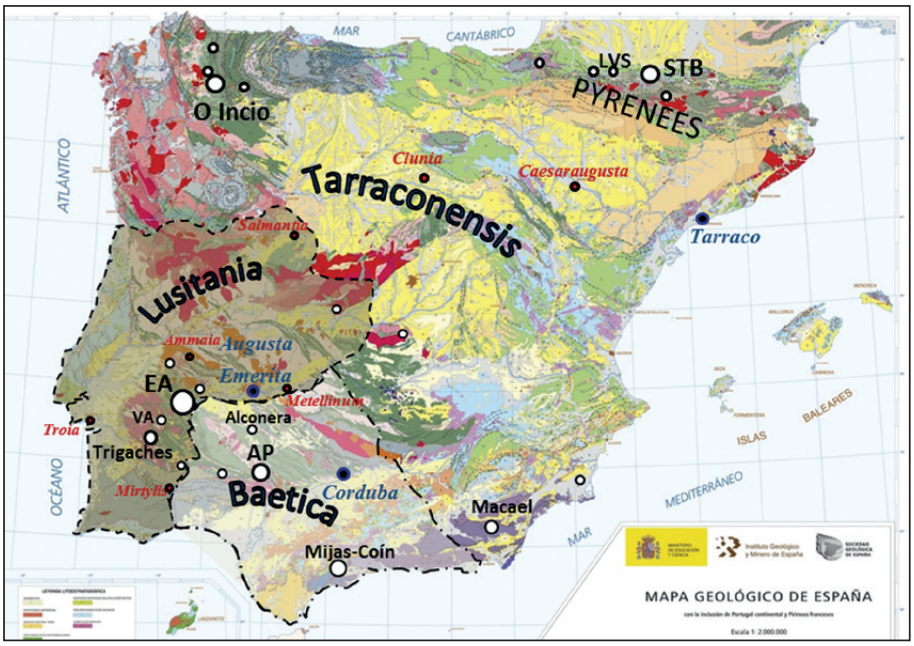
Before detailing the objectives of this contribution, the identification of Hispanic marbles is contextualised in order to provide a framework for this research focused on the western part of the Roman Empire.

ANALYTICAL DATABASE FROM UNIZAR

After more than three decades of archaeometric studies carried out at the University of Zaragoza (UNIZAR), we have compiled an extensive reference collection of Hispanic and Gallic quarry marbles with a reliable database of their fingerprints based on a multimethod analytical approach. The methodology adopted combines at least petrography (macro and microscale), cathodoluminescence (CL) and carbon (C) and oxygen (O) stable isotopes, as is explained in several papers[1] and references therein.

Basically, the Hispanic marbles are located in the metamorphic carbonate materials of the Iberian Massif and the Alpine Chain (i.e. the Baetic mountain range in southern Iberia and the Pyrenees on the border with France) (fig. 1). From all these territories, the Ossa Morena Zone (OMZ), in the southwestern peninsular, has captured our attention since the 80s of the last century, and in close collaboration with the Roman Art National Museum of Mérida, we have been outlining over time which marbles were most highly prized by the Romans based on an analytical database building up from a growing collection of quarry marbles. Application to hundreds of Hispanic marble pieces has given us the opportunity to compare which analytical parameters are the most suitable for identifying Hispanic marbles in order to discriminate them not only from each other but also from classical marbles[2].

[1] See e.g. Lapuente − Turi − Blanc 2000; Lapuente et al. 2014; Lapuente Mercadal et al. 2016; Lapuente et al. 2018.
[2] Lapuente et al. 1999; Nogales-Basarrate − Gonçalves − Lapuente 2008; Nogales-Basarrate et al. 2015.



1 Map showing the location of the archaeological sites and marble extraction points mentioned in the paper, based on the Geological Map IGME 2015 and their situation in the three Hispanic Roman provinces, with their capitals. The abbreviations of the quarrying districts are: Estremoz Anticline (EA), Almadén de la Plata (AP), Viana do Alentejo (VA), Saint-Béat (STB) and Louvie-Soubiron (LVS) (graphics: M. P. Lapuente)

Since our general paper focused on the discrimination of white marbles[3], among Hispanic and between Hispanic and classical marbles, our knowledge of their use in Roman times has been evolving. Focusing on the southwestern peninsular, two marble districts in the OMZ were highly appreciated by the Romans, namely the Estremoz Anticline (EA) and the Almadén de la Plata (AP), while many other small quarrying sites such as Viana do Alentejo and others, drawn on the Iberian map of figure 1, were of restricted local use, except that of Trigaches, whose use was much more widespread than initially thought. In fact, the Lusitanian Trigaches marble exploited at São Brissos, near to Evora, whose macroscopic appearance is very distinctive, was not the object of analytical characterisation for many years, but we had to incorporate it in the analytical database when we had to identify it in several pieces found relatively far away from its place of exploitation[4]. On the other hand, as the Alconera marmora, easily identifiable by their reddish-violet colouring, were exploited and used in different Roman monuments (e.g. the Augusta Emerita theatre), we also included in our database the true marble (white and grey) exploited in Alconera.

For quite a long time, differentiation between the EA and AP marbles proved difficult, as macroscopically, the white varieties, many with slightly pinkish tones, are common in both areas, with both even presenting common textures petrographically. This hindrance had repercussions for the assignment of both origins, and the importance of AP marbles outside Baetica was overestimated, frequently being identified in supraregional areas using petrography, or even petrography and CL, but without a comparative analytical basis of quarry samples (see the example of the misidentification of the head of the goddess Fortuna from Clunia, located in the Tarraconense province, which had been identified as AP marble[5] but is, in fact, a Marignac marble from the Saint-Béat

3 Lapuente − Turi − Blanc 2000.
4 González-Soutelo et al. 2022.
5 Gisbert − Mateos 2009.

district according to our recent study[6]. However, since the application of the full analytical protocol including C and O isotopes, the picture has changed, and the assignment to EA or AP has been more precisely established (as will be explained below).

Apart from southwestern Iberia, there are two areas to which we have turned our attention in the last years. The first is northwestern Iberia, present-day Galicia, which was investigated in the doctoral thesis of Marie-Claire Savin[7] and whose marbles are introduced in one contribution of these proceedings[8]. And the second, the area of Pyrenean marbles, is a territory which for many years has mainly been explored in the central part (on both sides) and completed with its western part, on the »Nappe des Marbres«, incorporated into the doctoral thesis of Hernando Royo[9]. Regarding the Pyrenean marbles, apart from the small quarry of Artiés[10], of the five surveyed areas, so far two have been analytically tested on Hispanic pieces: several quarries of the Saint-Beat District and the Ossau Valley, both located on the northern French side of the Pyrenees. Concerning the white marble of Saint-Béat, the petrographic and CL features had already been explained in detail[11], but all the varieties, including calcitic and dolomitic lithotypes, have recently been summarised in the context of the geological framework of the main French Haute-Garonne marble quarries[12]. Concerning those from the Ossau Valley[13], the characterisation shows several white and grey varieties of Louvie-Soubiron marble very similar to those of Carrara marbles, white and Bardiglio. However, their isotopic signature helps in their discrimination, a feature which was key to identification in several samples from the pavement of the orchestra of the theatre in Caesaraugusta, pieces that previously had been visually assigned to Carrara. Indeed, the application of the multimethod analytical protocol has made it possible to determine with certainty which Pyrenean marble varieties were used in the Tarraconense province and which ones should be ruled out from those previously proposed without comparative analytical support[14].

On the whole, the updated analytical database of the main Hispanic/Gallic marbles with extensive information on petrography, CL patterns and updated isotopic diagrams is being prepared and will be published in due course. Of all of them, the district of the EA is undoubtedly the most important in terms of the technical quality of the materials and the number of varieties, but also in the exceptional size of its outcrops. This singularity is also being addressed by Portuguese colleagues[15], who quite rightly are presenting their outlook from the point of view of the EA marble distribution, taking into account the transport networks, logistics and distribution points based on the field evidence but also from the compilation of the Roman archaeological pieces previously published elsewhere as EA marble. From our archaeometric perspective it is, however, censurable that a large proportion of those compiled pieces were uncertainly assigned to the EA marbles, either through macroscopic observation or using petrographic methods, mostly carried out in the 1980s, and published, for example, in an outdated monograph[16], based on the petrographic appendix in the same volume[17], and in a collaborative paper[18] whose results are in many cases pending revision using the complete analytical protocol.

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6 J. A. Cuchí – M. P. Lapuente Mercadal – F. Tuset – R. Cuesta, in this volume.
7 Savin 2021.
8 M.-C. Savin – A. Gutiérrez Garcia-Moreno – S. Gonzáles Soutelo – M. P. Lapuente Mercadal, in this volume; see also Gutiérrez Garcia-Moreno et al. 2016.
9 Royo Plumed 2016.
10 Royo et al. 2015.
11 Royo et al. 2018.
12 Lapuente Mercadal 2022.
13 Lapuente Mercadal et al. 2021.
14 Lapuente Mercadal (in print).
15 See e.g. Moreira 2022; Trapero Fernández − Carneiro − Moreira 2023.
16 Cisneros 1988.
17 Lapuente Mercadal 1988.
18 Lapuente − Cisneros − Ortiga 1988.

EA/AP DISCRIMINATION: MARBLES WITH CERTAIN THEORETICAL DISSIMILARITIES IN THE METAMORPHIC HISTORY – METHODS USED FOR THEIR DISCRIMINATION

The analytical differentiation of the EA marbles from the AP marbles has been particularly important, which in our archaeometric experience is only possible using a combination of techniques. Both carbonate sequences of the OMZ derived from comparable Cambrian-Ordovician carbonate sequences with intercalated volcanic rocks, which were subject to a complex structural tectono-metamorphic evolution with the progressive and continuous deformation associated with shear zones. However, on a regional scale, the structure and metamorphic evolution of the »Almadén de la Plata Core« is related to a macro syn-metamorphic shear zone located on the southern border of the OMZ[19]. This is why the two metamorphic sequences attained a different intensity in the metamorphic grade; and while the EA marbles experienced low-grade regional metamorphism related to the early Variscan crustal thickening (greenschist facies), the AP marbles experienced a particular prograde history, with temperatures of crustal anatexis conditions apparently caused by mantle upwelling[20]. In short, the different geological processes had a more intense effect on the bottom of the metamorphic sequence, and therefore the infrastructure of the AP marbles is linked to calc-silicate rocks, blastomylonitic gneisses, migmatites and amphibolites[21].

This different metamorphic history is likely to be useful for application in provenance studies[22], a statement which these authors advance with regard to the applicability of the $^{87}Sr/^{86}Sr$ isotopes, whose ratios surely were affected by the different geological processes. Certainly, the same argument related to the different geological processes, as a tool marker, can be applied to the CL analyses. The application of CL to the study of white marbles has provided us with clear positive results, being very useful for the AP marbles, as they exhibit higher CL intensity than EA marbles[23]. In this regard, we are also working on providing, in the near future, new data on the quantification of CL following the guidelines set out for the classical marbles[24].

The use of $^{87}Sr/^{86}Sr$ analyses in marble provenance studies is not new, since the pioneering work[25] was the paper by Mauro Brilli and colleagues[26], the most comprehensive essay on white classical marbles. However, in spite of the increasing number of archaeometric studies carried out during the last decade, little use has been made of the $^{87}Sr/^{86}Sr$ ratios due to several factors, among them, not only the high cost compared to the stable C and O isotope analysis, but also to the lack of uniformity of the databases in terms of the analytical protocol used in the acid attacks to obtain the isotopic ratios[27]. To support this point, we direct the reader to the discussion arising from the differences in elemental concentrations found in the same Göktepe marble samples analysed by two different reference laboratories[28].

As far as the strontium (Sr) isotopes in the Hispanic marbles are concerned, some attempts have been made. On the one hand, not the white marbles but the Cipollino-type marbles[29] outcropping in several quarries of the OMZ and in Macael (Anasol variety) were characterised. Additionally, the Belgian team who worked for many years on the archaeological excavations of the Lusitanian town of Ammaia used the $^{87}Sr/^{86}Sr$ ratios in relation to the provenance of a selection of

19 Abalos Villaro − Gil Ibarguchi − Eguiluz 1991.
20 Eguiluz Gil et al. 2000.
21 Díaz Azpiroz et al. 2004.
22 Moreira et al. 2020.
23 Lapuente − Turi − Blanc 2000; Lapuente − Blanc 2002; Lapuente et al. 2014; Lapuente − Royo 2016.
24 Blanc − Lapuente Mercadal − Gutiérrez Garcia-Moreno 2020.
25 Herz − Mose − Wenner 1982.
26 Brilli − Cavazzini − Turi 2005.
27 See e.g. the explanations given in the methodology in Brilli − Cavazzini − Turi 2005, 1546 and compare to e.g. Wielgoz-Rondolino et al. 2020, appendix A3.
28 Attanasio et al. 2020; Brilli et al. 2020.
29 Morbidelli et al. 2007.

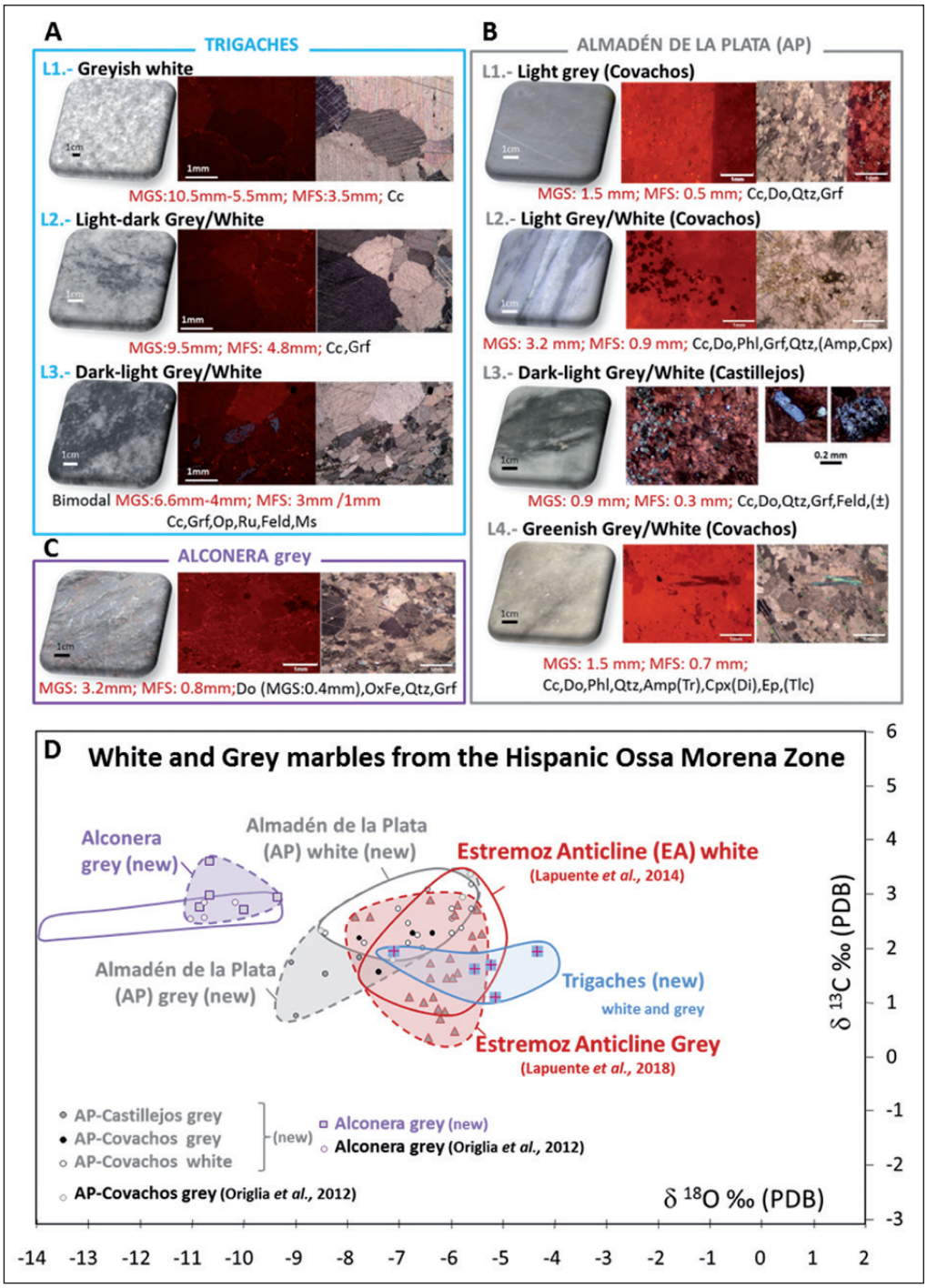
white veined marbles, among the hundreds recovered[30]. Using different analytical protocols, these authors compared new $^{87}Sr/^{86}Sr$ isotopic data from the EA with those of the Cipollino samples[31] and those for the classical marbles[32], finding significant differences with the Hispanic but a certain overlapping with the classical marbles. Using petrography and Sr isotopes, they conclude that the EA quarries are the most likely source of the Ammaia marble, but from our point of view, two shortcomings undermine their conclusions. On the one hand, they did not perform any analyses on the local-regional marble outcrops[33]. On the other hand, the lack of complementary analyses, such as the C and O stable isotopes, a method that contrasts with the innumerable papers existing in the specific bibliography, means that the conclusions could have been different, as we will see later, explaining the case of Ammaia in this contribution.

Finally, from a geological perspective of age correlation, geologists from the University of Évora[34] have published data and statistics of $^{87}Sr/^{86}Sr$ ratios obtained from different Palaeozoic carbonate sequences of the OMZ, including those aforementioned metamorphic outcrops close to Ammaia (Assumar and the Alter do Chào-Elvas sectors), whose range of ratios are quite similar to those of the EA marbles. In addition, these authors, comparing the differences between the Sr isotopic data of different Palaeozoic carbonate sequences of the OMZ with those provided in different bibliographic sources, argue that the degree of overlap is much lower than that shown by the isotopic fields of C and O, and therefore the $^{87}Sr/^{86}Sr$ isotopic signature »seems to be a better approach to differentiate the OMZ marbles from each other and from the Mediterranean marbles.«[35] This potential assessment should have been supported by their own archaeometric analyses, but on the contrary, they compile data acquired by others[36] to conclude that $^{87}Sr/^{86}Sr$ ratio analyses have been decisive in the EA origin of the marble artefacts of Ammaia. This argument, however, loses weight in the re-evaluation of the provenance analyses undertaken in this contribution, as we will see below.

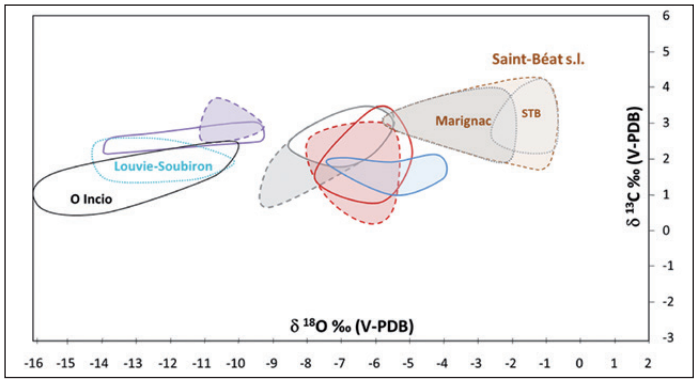
Without detracting from the aforementioned attempts, the basic problem is, in our opinion, comparing $^{87}Sr/^{86}Sr$ isotope ratios obtained using different analytical protocols with the added handicap of not having a uniform database for the different Hispanic and classical outcrops.

Concerning the stable isotopes, while C and O isotopes have already proved to be a very useful technique to differentiate EA from Carrara marbles, since the first papers written by Portuguese colleagues[37], among others, discrimination of other Hispanic marbles has not been an easy task throughout this time. Several papers pointed out the possibility of using them as a complementary method[38], and this is especially useful with white varieties to differentiate them from the classical ones[39]. Other efforts[40] have proved to be less functional, as very different chromatic varieties have been combined in the same isotopic diagram, which considerably increases the degree of overlapping of the isotopic signature. From our perspective, this difficulty is solved by proposing the combined use of stable isotopes according to chromatic varieties and supported by CL. However, the issue of grey and grey-white banded marbles had to be addressed independently, and in view of the results obtained in the analyses performed on the EA marbles[41], it has been necessary to

30 Taelman et al. 2013a; Taelman et al. 2013b.
31 Morbidelli et al. 2007.
32 Brilli − Cavazzini − Turi 2005.
33 See the map of the geological location of Ammaia in fig. 1 of Taelman et al. 2013a, 372, showing that the marble outcrops of Assumar and the Alter do Chào-Elvas sectors are much closer to Ammaia than the Estremoz Anticline.
34 Moreira et al. 2019, and several papers elsewhere.
35 Moreira et al. 2020, 86.
36 Taelman et al. 2013b.
37 Cabral et al. 1992; Cabral et al. 2001.
38 Lapuente − Turi 1995; Àlvarez Pérez − Mayer Olivé − Rodà de Llanza 1998.
39 Lapuente − Turi − Blanc 2000; Lapuente et al. 2014.
40 Origlia et al. 2011.
41 Lapuente et al. 2018.



2 Distinctive characteristics of the white and grey marbles incorporated in the analytical database of UNIZAR. a: Lithotypes differentiated in Trigaches (São Brissos, Portugal) in relation to their macroscopic, microscopic and CL pattern appearance. An outstanding feature is the very coarse grain size of the calcite crystals (Cc), see maximum grain size (MGS); darker shades show accessory minerals: graphite (Grf), opaques (Op), rutile (Ru), feldspar (Feld), muscovite (Ms). b: In Almadén de la Plata (AP), four varieties of greys have been differentiated, all of them with high/very high intensity of CL; with grain sizes from coarse (L2) to medium (L1 and L4) and fine (L3); the accessories observed are: dolomite (Do), quartz (Qtz), graphite (Grf), phlogopite (Phl), amphibole (Amp) type iremolite (Tr), clinopyroxene (Cpx)-type diopside (Di), epidote (Ep), talc (Tlc) and destabilised silicates (+/–). c: At Alconera, a coarse-grained heteroblastic grey variety has been described, containing microdolomite, iron oxides (OXFe), quartz and graphite. d: Updated C and O isotopic diagram for the most important Hispanic marbles from the Ossa Morena Zone based on new values and those provided by Origlia et al. 2012 in relation to the isotopic fields defined in Lapuente et al. 2014 for the white marbles, and in Lapuente et al. 2018 for the grey marbles of the EA (graphics: M. P. Lapuente)



3 Updated $\delta^{18}O$ versus $\delta^{13}C$ diagram with the isotopic fields of the most important calcitic quarry marble districts from the western part of the Roman Empire (graphics: M. P. Lapuente)

improve discrimination by increasing the representativeness of the number of samples analysed from the AP and other OMZ quarries.

AIMS OF THIS CONTRIBUTION

Two main objectives are dealt with in this contribution: first to provide updated isotopic C and O diagrams to discriminate better EA marbles (from other Iberian and from the classical ones), and second, to highlight the importance of using the isotopic signature (stable C and O) in combination with petrography and CL to certificate the EA marble in Roman artefacts.

As a first goal, new additional marble quarry samples, not only white but also grey and grey/white, have been incorporated into our analytical database in order to redefine better the isotopic fields of the most important Iberian marbles. Having focused on discriminating EA marble from other Hispanic marbles and from the main classical marbles, we checked their markers of identification in a vast number of marble artefacts found in the Augusta Emerita territory, mainly in statuary, but also in epigraphy, funerary settings and decorative architectural elements of the major public buildings. The analytical data of many of these pieces are presented here for first time[42].

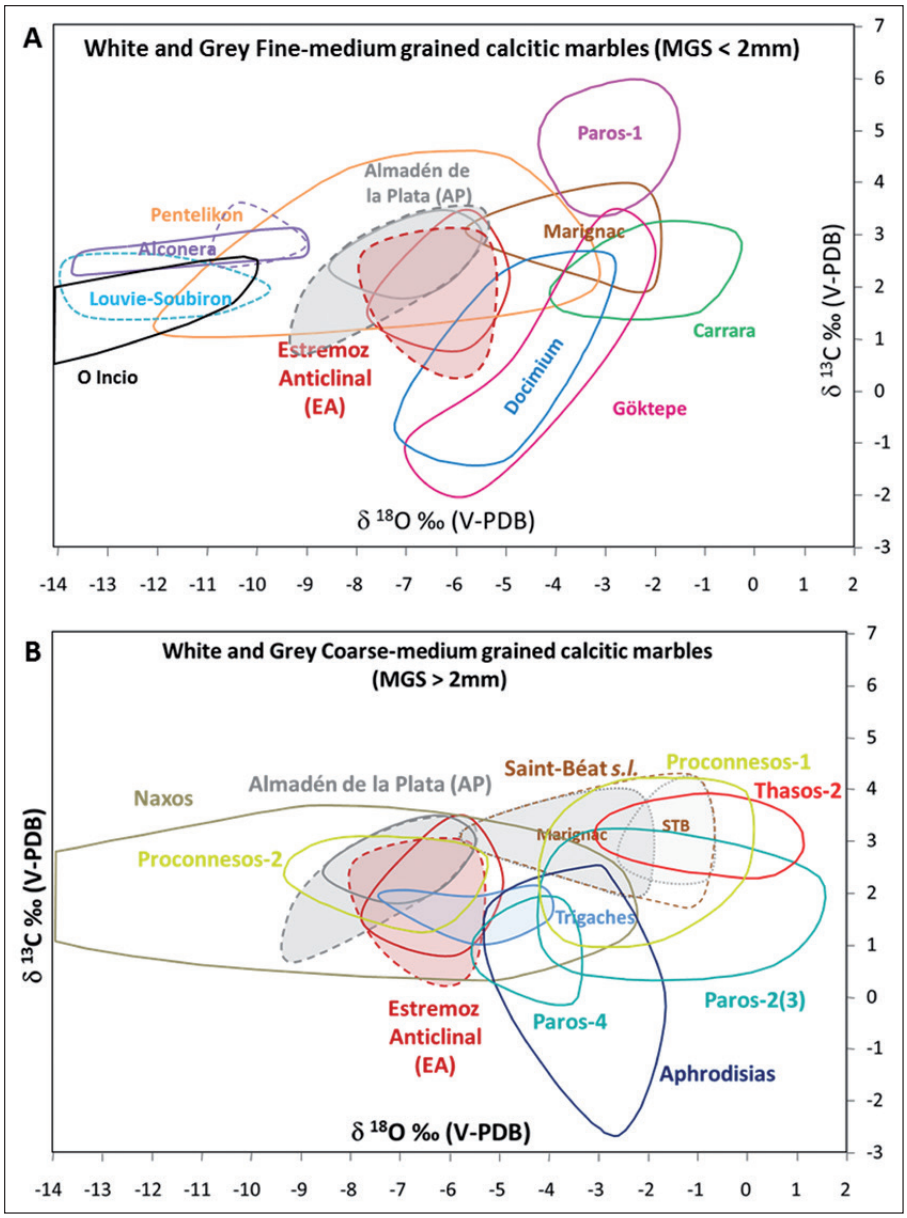
NEW ANALYTICAL DATA IN WHITE AND GREY QUARRY MARBLE COLLECTION FROM THE OSSA MORENA ZONE

In different campaigns, thanks to the excavation and fieldwork carried out by Javier Beltrán's team from the University of Seville, we proceeded to sample both main quarries of Almadén de la Plata (AP), Covachos and Castillejos, taking more samples, including greyish varieties. Concerning these quarries, several references are available[43]. For the same purpose, we have revisited and completed the sampling of marbles from Trigaches (São Brissos), Alconera (Badajoz) and Viana do Alentejo (VA), all representative of the OMZ.

The main characteristics of each new lithotype from the OMZ, that is, different grey varieties from Trigaches, Almadén de la Plata (AP) and Alconera, are shown in figure 2 a–c. They combine images of the macroscopic, microscopic and CL patterns, using the conventional methodology widely explained in previous papers. The VA marbles are intentionally

42 This research is sponsored by the MINECO/FEDER project »*Sulcato marmore ferro*. Quarries, Workshops, Craftsmen and Customers of Artistic Productions in Stone from Hispania Tarraconensis« (SULMARE, PID2019-106967GB-I00) and by the project »Augusta Emerita. Modelo urbano, arquitectónico y decorativo en Lusitania-I« (PID2020-114954GB-I00).

43 See e.g. Beltrán et al. 2011; Ontiveros et al. 2012; Rodríguez et al. 2012.



4 Updated $\delta^{18}O$ versus $\delta^{13}C$ diagrams with the isotopic fields of the most important calcitic quarry marble districts from the western part of the Roman Empire (Hispanic/Gallic) plotted with the isotopic fields for the classical marbles. a: Diagram for marbles with maximum grain size (MGS) < 2 mm. b: Diagram for marbles with MGS > 2 mm, after different references (graphics: M. P. Lapuente)

excluded in this figure as they are impure marbles with strongly greenish tones, but they will be part of the comprehensive monograph on the Hispanic marbles in preparation. In addition, in figure 2 d, a new redrawn updated isotopic diagram is displayed, integrating supplements of already acquired data on white EA/AP marbles[44] and on grey EA marbles[45].

The same diagram, but adding the isotopic fields of other Hispanic and Gallic calcitic marbles positively identified in Hispanic artefacts, is plotted in figure 3. So that they can be used for archaeometric studies focused on fine medium-grained marbles (MGS < 2 mm), and for coarse

[44] Lapuente et al. 2014.
[45] Lapuente et al. 2018.

medium-grained marbles (MGS > 2 mm), they are plotted against the most important classical marbles (fig. 4 a–b).

APPLICATION OF THE CARBON AND OXYGEN ISOTOPIC DIAGRAMS ON ARCHAEOLOGICAL PIECES

We will focus here on the application of the C and O isotopes as a complementary method to assign the marble quarry provenance of different Hispanic archaeological artefacts. Therefore, the reader must understand that although the rest of the characteristics (macro, micro and CL) are not specified, certainly all the pieces have been previously analysed following our step-by-step identification protocol. In this sense, with the projection of their isotopic signature in the updated isotopic diagrams, we want to check their EA marble provenance and, at the same time, the diagrams provide a demonstration of the usefulness of the C and O technique.

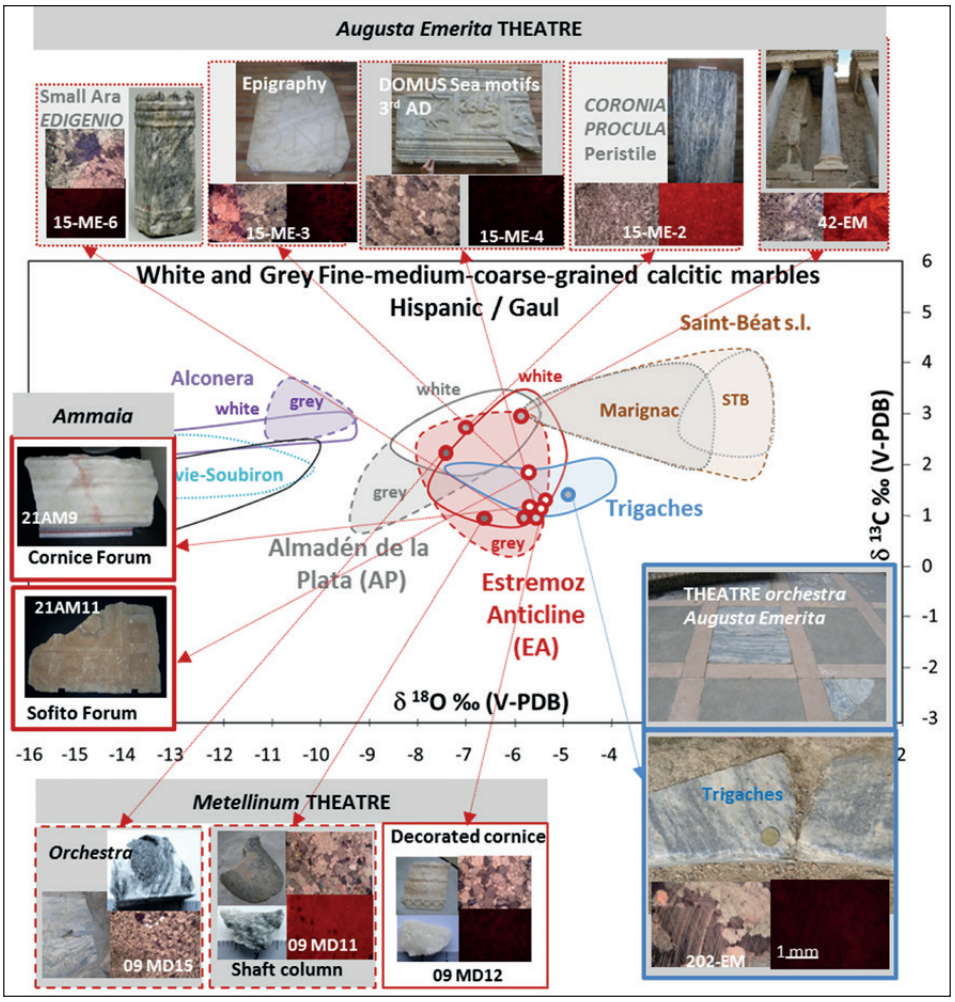
LUSITANIAN MARBLE PIECES AND RE-EVALUATION OF SPECIAL CASES FROM CLUNIA AND AMMAIA

Over the last decade we have been increasing the number of Lusitanian archaeological pieces analysed, both of white marble and white/grey veined marble. They include not only decorative architectural elements, epigraphy and funerary stelae pieces but also statuary carved on white marble. It should be noted, however, that in the case of the statuary, there are many more pieces analysed that will not be mentioned here, as their provenance, also certified by the complete analytical protocol, has resulted in different imported origins being assigned. This is the case, for example, of Göktepe marble authenticated in the Quinta das Longas collection[46].

In figure 5, different architectural decorative elements and also epigraphy and pieces of stelae recovered from the area of the Augusta Emerita theatre are displayed. Most of them are greyish-white marbles or veined (banded) in white/grey, whose features match well with those explained for the EA marble[47]. In addition, architectural elements from the theatre of Metellinum and from the forum of Ammaia are also shown in the same figure. As is evident from the isotopic diagram, their C and O isotopic signatures fall inside the isotopic fields defined for white EA or for grey EA respectively, with the exception of one sample (202-EM). In more detail, with regard to the orchestra pavement of the Augusta Emerita theatre, a combination of two different white/grey marbles were used, one from the EA and one from Trigaches, whose isotopic signature perfectly matches the Trigaches quarry field (drawn in blue).

Some extra considerations can be highlighted associating EA elements from different places and uses. Apart from the similar greyish-white marble used as decorative elements in both theatres (Augusta Emerita and Metellinum), or those white marbles from the forum of Ammaia, (a ceiling decoration, soffit, and a cornice with a pinkish-veined white marble), all clearly assigned to white EA, there are two different banded lithotypes in grey/white. One is similar to the EA lithotype[48], defined as homoblastic fine-grained with heterogeneous distribution of CL in medium-high intensities, with distinctive $\delta^{13}C > 2$ ‰. This type is recognised in samples 15-ME-2 (pedestal with inscription of Coronia Procula), 42-EM (the impressive columns of the Augusta Emerita theatre) and 09MD15 (the slab from the pavement of the orchestra of the Metellinum theatre). On the other hand, the second heteroblastic marble, banded in grey/white and similar to other EA lithotypes[49], is documented on the small Ara Edigenio (sample 15-ME-6). Additionally,

46 Lapuente Mercadal − Nogales-Basarrate − Carvalho 2021.
47 Lapuente et al. 2014; Lapuente et al. 2018.
48 Lapuente et al. 2018, 396 fig. 6 g.
49 Lapuente et al. 2018, 396 fig. 6 h.



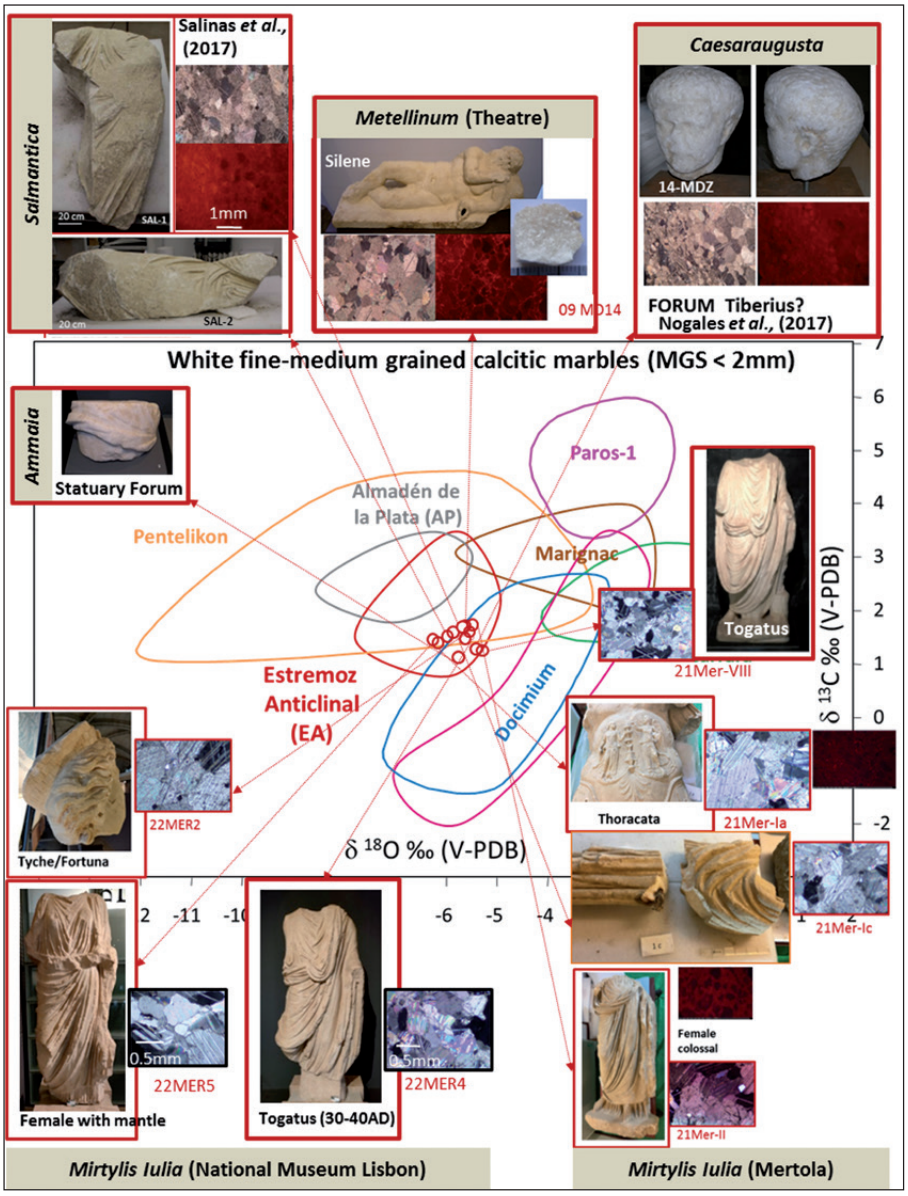
5 Isotopic signature of the archaeological samples (grey and white calcitic marbles) used as architectural decorative elements and epigraphy in different places in Lusitania, plotted on the updated diagram of figure 3. Except the Trigaches marble used in the slab pavement of the theatre of Augusta Emerita (orchestra) in combination with greyish/white banded marbles from EA, all the isotopic data falls inside the EA isotopic field, in agreement with the lithotypes explained in Lapuente et al. 2014 and Lapuente et al. 2018 (graphics: M. P. Lapuente)

this latter marble variety is related to some of the reused columns certified as EA marble from the Romanesque Portal of Glory of the Santiago de Compostela Cathedral[50].

Concerning statuary in white marble, different analysed pieces are shown in figures 6 and 7. In the first, samples of Lusitanian statuary from Salmantica, Metellinum, Ammaia and Mirtylis Iulia are certified as fine-medium-grained white marble from the EA, comparable to the white marble groups B and C described above[51], with different CL patterns but all with a homogeneous isotopic signature, $\delta^{13}C$ (1 to 2 ‰) and $\delta^{18}O$ (–5.15 to –6.2 ‰).

As for the coarse to medium white marble used for statuary, in figure 7, three different pieces from the capital of Lusitania, Augusta Emerita, but also from other Lusitanian places such as Tróia and Mirtylis, are displayed. All are authenticated as coarse medium-grained EA marbles with isotopic signatures very close to each other, similar to the lithotype group E defined on the basis of marbles from the National Museum of Roman Art, in Mérida[52].

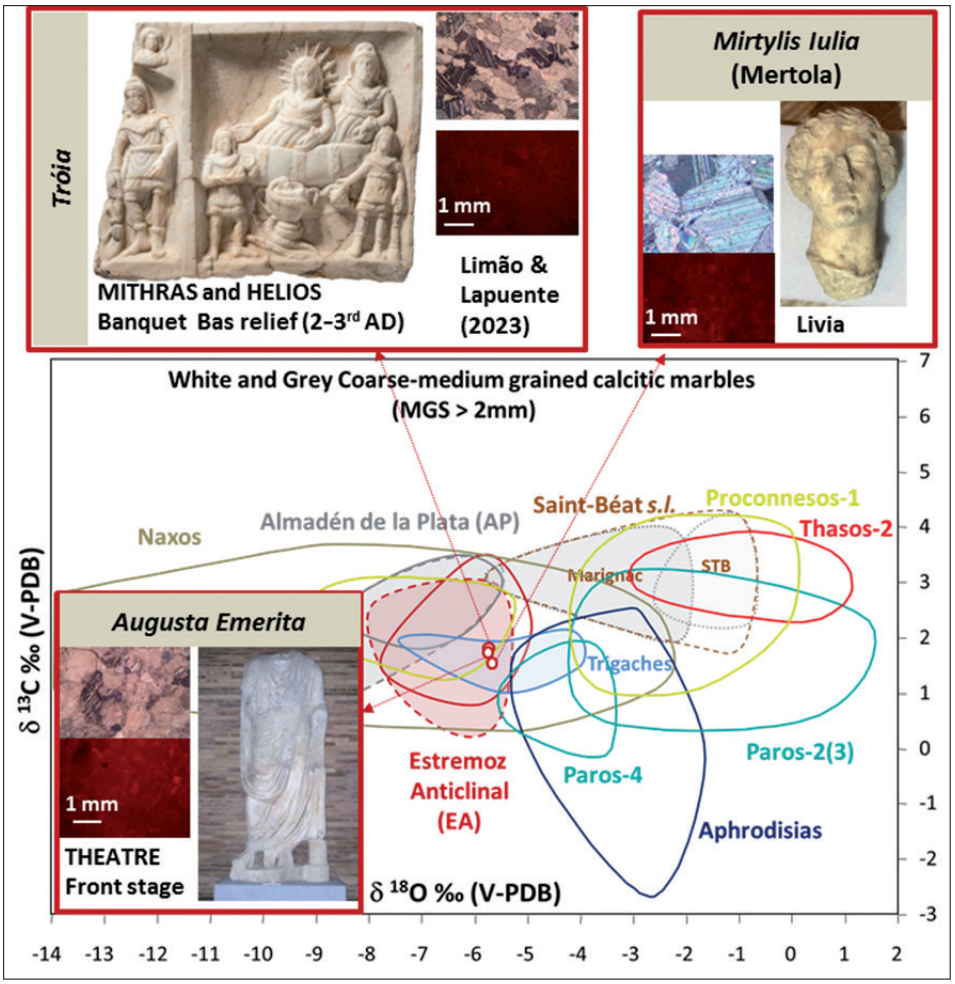
50 Lapuente Mercadal et al. 2020.
51 Lapuente et al. 2014.
52 Lapuente et al. 2014.



6 Isotopic signature of the archaeological statuary samples (white fine to medium calcitic marbles) analysed from different places in Lusitania and in Caesaraugusta plotted on the updated diagram of figure 4 a, useful for discrimination from the classical white marbles (MGS < 2 mm). Note the concentration of the data inside the EA isotopic field, but in the overlapping area with Pentelikon and/or Dokimeion, for which the CL patterns help in their discrimination. They are comparable to the archaeological marble groups B and C described in Lapuente et al. 2014 (graphics: M. P. Lapuente)

It is worth noting the usefulness of the identification parameters found in those pieces from the capital of Lusitania, which logically, due to its geographical proximity (110 km) to the EA, was supplied with different varieties of EA marble. Their respective archaeometric studies have facilitated the task of identifying the provenance of marbles used in other decorative and sculptural programmes in territories far away from the immediate sphere of distribution of this raw material. This is the case for a possible portrait of Tiberius found in Caesaraugusta (fig. 6) which is at the moment the authenticated EA marble found furthest east on the Iberian Peninsula[53]. Another

[53] Lapuente Mercadal et al. 2016; Nogales-Basarrate − Lapuente − Rodà 2017.

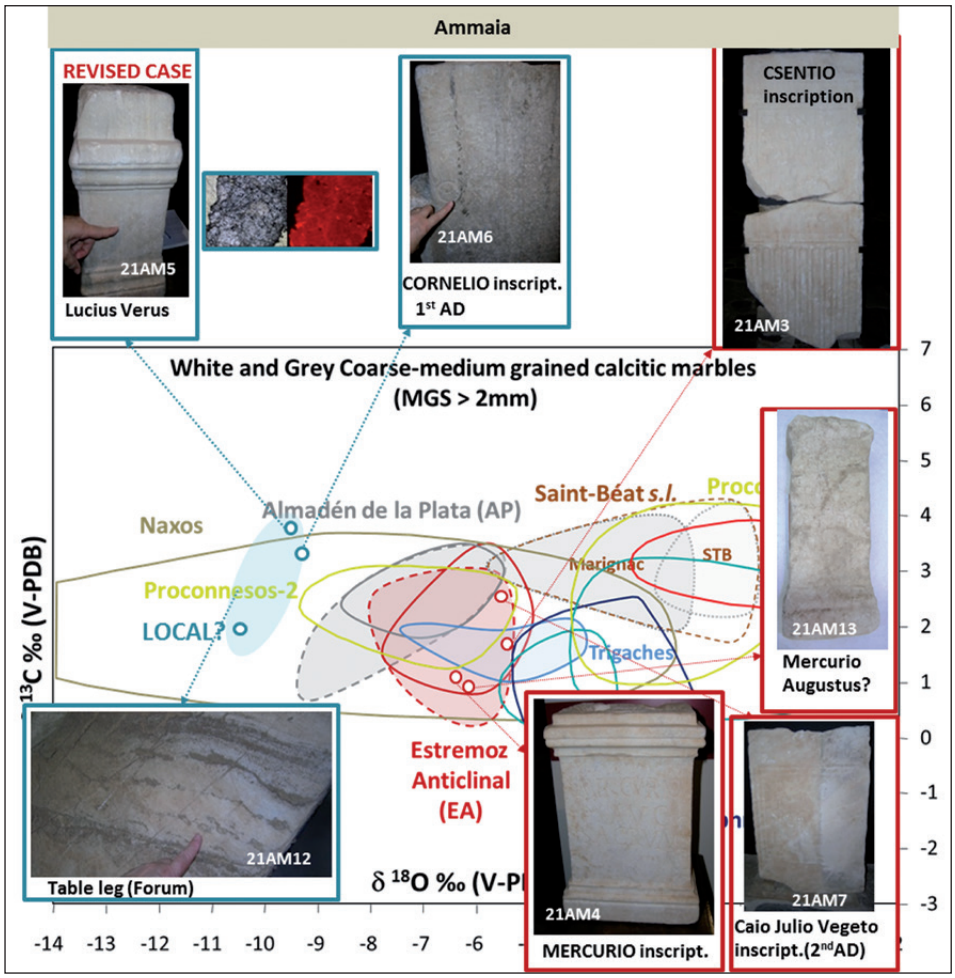


7 Isotopic signature of the archaeological statuary samples (white coarse to medium calcitic marbles) analysed from different places in Lusitania plotted on the updated diagram of figure 4 b, useful for discrimination from the classical white marbles (MGS > 2 mm). Note the concentration of the data inside the EA isotopic field. They are comparable to the archaeological marble group E described in Lapuente et al. 2014 (graphics: M. P. Lapuente)

example relating to decorative architectural material is that of the different EA marbles authenticated in pieces from Clunia[54].

Those examples are relevant, but no less important is the re-evaluation of pieces that had been identified as EA marbles without C and O isotopes, now resulting in a different provenance. We refer to two cases: the first is the goddess Fortuna sculpture from Clunia whose body was previously classified as EA marble[55] using petrography and CL, but after our study the provenance is clearly a Pentelic marble[56]. And the second case relates to pieces from Ammaia previously analysed by petrography and $^{87}Sr/^{86}Sr$ isotopic ratios[57]. However, we have had the opportunity to apply C and O isotopes to the same samples and to others recently found in Ammaia, and the results point to the use of several marble sources, not only EA, as explained below.

54 J. A. Cuchí – M. P. Lapuente Mercadal – F. Tuset – R. Cuesta, in this volume.
55 Gisbert − Mateos 2009.
56 J. A. Cuchí – M. P. Lapuente Mercadal – F. Tuset – R. Cuesta, in this volume.
57 Taelman et al. 2013a.



8 Isotopic signature of the archaeological pieces (epigraphy and furniture) carved on white coarse to medium calcitic marble analysed from Ammaia (Lusitania,) plotted on the updated diagram of figure 4 b. The Lucius Verus pedestal (sample 21AM5) is a revised case, as it had previously been reported as EA marble (sample DT10_AMM_ARCH_038 in Taelman et al. 2013a). Note that there are two groups of marbles, the inscriptions on the right are white marble pieces with scarce reddish or pinkish veins whose isotopic signatures perfectly match with the EA isotopic field, and the pieces on the left, which are all impure white coarse-grained marbles with subparallel bands of accessory minerals. Apart from the high CL intensity (shown in the CL pattern of the revised case), all the group have a very low $\delta^{18}O$, whose projection on the isotopic diagram falls completely outside the domain of the EA marbles (graphics: M. P. Lapuente)

Indeed, in figure 8, a selection of Ammaia artefacts, different pedestals, mostly with inscriptions, and one piece of furniture, all carved on white marble, are displayed. Macroscopically there are clearly two different groups of marble: samples 21AM3, 21AM4, 21AM7, 21AM13 are white marble pieces with scarce reddish or pinkish veins whose isotopic signatures perfectly match with the EA isotopic field. And there is a second group of pieces whose aesthetic quality is different (samples 21AM5, 21AM6, 21AM12): all impure white coarse-grained marbles with subparallel bands of accessory minerals (dolomite, quartz, opaques and phyllosilicates), with high CL intensity, whose isotopic signature is very significant, because they have a very low $\delta^{18}O$, completely outside the isotopic domain of the EA marbles. Which marbles are they? What is certain is they are not marbles from the EA and they are not in the UNIZAR analytical database, but on the basis of economy of resources, it is logical to think that they are most likely local/regional marbles from outcrops closer to Ammaia, such as those mentioned in the introduction to this paper, that is, the metamorphic terrains of Assumar or the Alter do Chào-Elvas Complex, whose Sr isotope values

seem to coincide with those of the Estremoz Anticline (based on mentioned data)[58]. This concerns the Lucius Verus piece (21AM5) shown in figure 8 that was reported as EA marble when it was analysed by petrography and Sr isotopes[59].

CONCLUSIONS

To understand the title of this contribution, we have spent more than three decades studying Hispanic marbles. Our assertion is based on two main points: a) our own Hispanic and French Pyrenean marble quarry collection, in which we have been progressively applying the same analytical protocol to create a database that at least takes into account petrography, CL and stable isotopes; and b) archaeometric experience, during this time analysing hundreds of archaeological and historical marble pieces, which leads us to insist on the need to use the same methodology to authenticate the origin of the Hispanic marble.

In this paper we have shown new analysed cases, others in which the analysis has been completed, and revised cases in which the previous identification was not conclusive or was carried out using methods that did not provide a sufficient contrast, with the ultimate aim of stressing the importance of using a good combination of techniques to certificate the EA origin, in which the updated isotopic diagrams have been of invaluable help.

There is no doubt that the more different analyses are performed on quarry marbles, the greater the degree of knowledge of the differentiation patterns of each type of marble will be. The use of $^{87}Sr/^{86}Sr$ analyses in the marble provenance studies on white marbles certainly could help the task of marble provenance, not as a substitute for stable isotopes but as a complementary method. This is the case in a recent paper[60] in which the Sr isotopes have been used to identify more clearly the differences between Göktepe and Carrara marbles[61].

As a recommendation, if using other methods involving acid attacks, it would be necessary to create a complete in-house database in order to be sure of its reliable application, since the different methodologies followed in different laboratories, have a considerable impact on the values obtained, and therefore it would not be acceptable to compare data from different reference sources.

Finally, to extract global historical considerations concerning the Hispanic marbles it is essential to reach a higher degree of assurance about identifications made in the past, complete with C and O isotopes those previous identifications made only using petrography, even with CL, discarding those carried out without proven techniques.

In any case, from what has been done so far, we can say that the new analytical contributions reaffirm the importance of the marble of the EA not only in Lusitania but also in the Tarraconense province, entering into competition with Gallic and Mediterranean marbles in sculpture in northeastern Iberia. On the other hand, the grey marbles, which until now were thought to be a second-class material destined exclusively for local markets, were distributed together with white marbles to supraregional destinations for architectural decorations. While many questions still remain to be answered, after more than three decades of archaeometric studies, we now have a better understanding of the use of marble in the western Roman Empire.

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58 Moreira et al. 2019.

59 Taelman et al. 2013a.

60 Wielgosz-Rondolino et al. 2020.

61 This method was also used to confirm Göktepe marble in one sample from the Quinta das Longas sculpture collection, see Lapuente Mercadal − Nogales-Basarrate − Carvalho 2021.

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WHITE MARBLES FROM ASIA MINOR AT ROMAN ATHENS

NEW PROVENANCE IDENTIFICATION RESEARCH ON FIGURAL SCULPTURES FROM THE AGORA

Abstract
This study presents the results of white marble provenance identification for seven Roman-period statuettes found during excavations in the Athenian Agora and its environs. The statuettes were selected for study because their very small grain size seemed visually inconsistent with the local marble from Mount Pentelikon. The statuettes are so roughly worked that they can be identified objectively as unfinished. They were examined *in situ* with a standard light source and analysed for strontium (Sr) and manganese (Mn) with a portable X-ray fluorescence (pXRF) instrument. Samples were collected from each statuette for further analyses. The analytical techniques included: 1) verification measurements of maximum grain size (MGS) and most frequent grain size (MFS) under a stereoscopic microscope, and qualitative examination of the crystalline features of the marbles; and 2) isotopic ratio mass spectroscopy (IRMS) for measurements of the stable isotopes of carbon (C) and oxygen (O). The results of the above analyses were compared to the data for known ancient marble quarries from Greece, Turkey, and Italy, a dataset having been compiled through the fieldwork and analyses of the Laboratory of Archaeometry, National Centre for Scientific Research (NCSR) Demokritos (Athens, Greece), and through the inclusion of additional data published in the scholarly literature. The results demonstrate that marble from Afyon (near ancient Dokimeion, in the region of Phrygia) was imported to Athens for carving in local workshops.

INTRODUCTION

Small, free-standing images of gods and goddesses were among the most frequent products of Athenian marble-carving workshops during the Roman period. Little marble divinities were set up in houses for the purposes of private cult and, to a lesser extent, in sanctuaries and shrines as votive offerings. Excavations in the Athenian Agora, conducted by the American School of Classical Studies at Athens (ASCSA) since 1931, have unearthed nearly 700 examples of the genre, comprising about one in six of all figural sculptures discovered at the site[1]. The majority of the statuettes stood ca. 20–40 cm high in a complete state. The most popular subjects are divinities who provided health, well-being, and prosperity: Aphrodite, Asklepios, Hygieia, Herakles, Pan, and Apollon, among many others.

Our research on this corpus began by studying the sources of white marble used for statuettes of Asklepios, a healing god worshipped throughout the Mediterranean Basin. Three statuettes of Asklepios from the Athenian Agora were selected for an initial study because the stone appeared visually inconsistent with local Pentelic marble, the usual material for Athenian statuary. Archaeometric analyses established that the marbles of the three statuettes were obtained in Asia Minor[2]: two instances of marble from the quarries near Dokimeion in the region of Phrygia (modern-day Afyon) (Agora S 854. S 1807), and one from the quarries at Göktepe, near Aphrodisias, in the region of Caria (Agora S 480)[3].

1 Martens 2025.
2 Martens – Maniatis – Tambakopoulos 2023.
3 Attanasio et al. 2021. For the statuary of Asklepios from the Agora excavations, see Martens 2018.



1 Unfinished statuette of the Giustini-type Asklepios, front and back (Agora S 854) (photos: C. Mauzy/Ephorate of Antiquities of Athens City, Ancient Agora; ASCSA: Agora Excavations; © Hellenic Ministry of Culture and Sports/ Hellenic Organization of Cultural Resources Development [H.O.C.RE.D])

We concluded that two of the statuettes were probably brought to Athens as ready-made works (Agora S 480. S 1807), while one statuette (Agora S 854), carved from Dokimeian marble, is unfinished and therefore was being carved in a local workshop (fig. 1). The latter result marked the first time that white marble from Asia Minor had been identified scientifically among the unfinished sculptures of Athens. This study, part of an ongoing project to identity the range of marbles used in Athenian workshops in the Roman period, builds on our earlier results. We present the identification of marble provenance of seven additional unfinished statuettes from the Agora excavations, which again were selected because their very small grain-size is inconsistent with locally available Pentelic marble.

THE UNFINISHED STATUETTES

The subjects of the statuettes in this study are identifiable on the basis of established iconographic features. The statuettes represent Aphrodite in the half-draped Anadyomene type (Agora S 409, fig. 2 a) and in a type baring the left leg (Agora S 1755, fig. 2 b); Hygieia in the Trentham Hall (Agora S 1898, fig. 2 c) and Hope (Agora S 2108, fig. 2 d) types; Apollon, holding the bow (Agora S 2946, fig. 3 a); and Asklepios in the Giustini type (Agora S 3331, fig. 3 b; Agora S 854, fig. 1). One statuette, a representation of a striding male figure (Agora S 3128, fig. 3 c), has not yet been identified; however, the presence of the snake at the right side of the figure is suggestive evidence for Apollon.



2 Unfinished statuettes. a: The Anadyomene-type Aphrodite (Agora S 409). b: Aphrodite baring her left leg (Agora S 1755). c: The Trentham Hall-type Hygieia (Agora S 1898). d: The Hope-type Hygieia (Agora S 2108) (photos: C. Mauzy/Ephorate of Antiquities of Athens City, Ancient Agora; ASCSA: Agora Excavations; © Hellenic Ministry of Culture and Sports/Hellenic Organization of Cultural Resources Development [H.O.C.RE.D])

The statuettes are so roughly worked that it is possible to classify them, without hesitation, as unfinished. The surfaces of the sculptures bear abundant traces of tooling. The point chisel, generally applied first in the sequence of tools, is prominent on four examples (Agora S 409. S 1898. S 2108. S 2946). It is clear in those instances that the statuette was abandoned at an early stage of sculpting, perhaps due to accidental breakage, given the fragmentary conditions of the pieces. The three other statuettes (Agora S 1755. S 3128. S 3331) achieved a more advanced stage of carving, exhibiting greater use of the flat chisel to render the main features of the subject; however, they still preserve parts of the matrix around delicate contours. In the case of the striding male figure, the screen of marble was left in place to protect the vulnerable area around the trailing right foot[4]. If sculpting had progressed further, the stone would have been removed using the drill. Finally, there are no surviving traces of surface finish on the statuettes, such as polish or pigments, that would indicate that carving had reached completion.

4 Cf. Van Voorhis 2018, 40.



3 Unfinished statuettes. a: Apollon holding a bow (Agora S 2946). b: Giustini-type Asklepios (Agora S 3331). c: An unidentified striding male figure, possibly Apollon (Agora S 3128) (photos: C. Mauzy/Ephorate of Antiquities of Athens City, Ancient Agora; ASCSA: Agora Excavations; © Hellenic Ministry of Culture and Sports/Hellenic Organization of Cultural Resources Development [H.O.C.RE.D])

Very few sculptures from the Agora excavations have been found in a context of primary use or display – a result of the long history of inhabitation at the site and the continual reuse of marble for building projects. The statuettes in this study are no exception, all having been found in contexts of non-primary deposition. Only the roughed-out statuette of Hygieia (Agora S 2108) was excavated from an ancient stratigraphic context. The statuette was found in the Post-Herulian Wall, where it had been abandoned, along with other unfinished sculptures, as material to fill the inner core of the fortification. The Post-Herulian Wall was constructed after the Herulian sack of Athens in AD 267, to protect primarily the area north of the Acropolis. The find-spot furnishes a terminus ante quem of ca. AD 275–300, for the statuette of Hygieia. Moreover, the context suggests that the statuette was being carved in the years before the invasion, ca. AD 250–267. Several marble-carving workshops operated nearby in the neighbourhood southeast of the Agora square, and it is possible that the statuette was discarded from one of those establishments[5].

The association with an archaeologically attested marble-carving studio is more circumstantial for a second statuette. The statuette of the half-draped Aphrodite Anadyomene (Agora S 409) was found beneath the modern surface in the area of the Library of Pantainos. Marble-carvers rented working space in the west stoa of the library complex during the 3rd century AD, until the building was destroyed during the Herulian sack[6]. Examples of the output of the workshop were excavated

5 Harrison 1960, 370; Thompson 1960, 333; Thompson – Wycherley 1972, 187; Lawton 2006, 12 fig. 8.

6 Shear 1933, 308; Shear 1935, 394–398. 415 f.; Stevens 1949; Harrison 1953, 6. 48 f.; Thompson – Wycherley 1972, 114. 187; Thompson 1976, 133. 296; Walters 1988, 65 n. 68; Camp 1992, 142; Katakis 2002, 514 n. 1622; Lawton 2006, 22 f.; Camp 2010, 133; Stewart 2013, 619–622. 641 f.; Van Voorhis 2018, 47; Martens 2021, 381.



4 Statuette Agora S 3128. *In situ* examination with transmitted light from a standard light source showing high translucency and very fine grain sizes (photo: Y. Maniatis/Ephorate of Antiquities of Athens City, Ancient Agora; ASCSA: Agora Excavations; © Hellenic Ministry of Culture and Sports/Hellenic Organization of Cultural Resources Development [H.O.C.RE.D])

from the destruction debris of the building. The sculptors specialised in small-format works, such as statuettes and table supports, but were also engaged in the production of larger-scale works, including portraits. Given the find-spot, it is possible to suggest, tentatively, that the statuette of Aphrodite was also a product of that studio.

To summarise, the seven statuettes – all objectively unfinished – date to the Roman period. The statuettes of Hygieia (Agora S 2108) and Aphrodite (Agora S 409) can be dated more closely, probably to the mid-3rd century AD, given their find-spots and the proposed connections to archaeologically-attested studios.

SAMPLES AND METHODS

With the permission of the Ephorate of Antiquities of the City of Athens and the Directorate of Conservation of the Hellenic Ministry of Culture, we first examined all statuettes *in situ* and non-invasively, and then collected samples for further analyses in the laboratory.

In situ Examination and Analysis

The objects were examined non-invasively at the conservation laboratory of the Agora excavations. A cold light source, a millimetre scale, and a magnifying lens (10 ×) were used for measuring the maximum grain size (MGS) and the most frequent grain size (MFS), and for characterising the colour, the marble fabric, and other qualitative features, such as the translucency, veins, and inclusions (fig. 4)[7]. This *in situ* examination is essential because it allows the observation and recording of the physical characteristics of the marble in several parts of the whole object, in this way obtaining an overall and average assessment of the marble features, and overcoming the limitations of the single collected sample, which is unavoidably small. In addition, the objects were

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analysed non-invasively using a portable X-ray fluorescence (pXRF) instrument (Thermo-Niton) with the program »Soils«, in order to determine the concentration of trace elements, particularly strontium (Sr) and manganese (Mn).

Sampling and Laboratory Examination and Analysis

Following the *in situ* examination, small samples in the form of marble flakes were obtained from each object by applying a small chisel on a preexisting break surface. The sampling was therefore practically non-invasive as regards the artistic, aesthetic and historical information of the object. These flakes were used for the following laboratory examination and analysis:

- Examination of the flakes under a stereoscopic optical microscope, qualitative examination of the marble crystalline features, and comparison of the MGS and MFS with that measured *in situ* for the whole object.
- Stable isotope analysis (IRMS) for carbon and oxygen.

A description of these techniques and the methodology for provenance determinations can be found in the relevant literature[8].

For stable isotope analysis, small grains of marble were cleaned by rinsing them briefly in diluted hydrogen chloride (HCl). They were then ground into a very fine powder, from which a sample of ca. 30 mg was submitted for isotope analysis to the GeoZentrum Nordbayern of the Friedrich-Alexander Universität Erlangen-Nürnberg, faculty of sciences. The method involved reacting the marble powders with 100 % phosphoric acid at 70 °C using a Gasbench II connected to a ThermoFisher Delta V Plus mass spectrometer. All values are reported in per mil relative to VPDB. Reproducibility and accuracy were monitored by replicate analysis of laboratory standards calibrated by assigning a $\delta^{13}C$ of +1.95 ‰ to NBS19 and –47.3 ‰ to IAEA-CO9 and a $\delta^{18}O$ of –2.2 ‰ to NBS19 and –23.2 ‰ to NBS18. Reproducibility for $\delta^{13}C$ and $\delta^{18}O$ was ±0.0x and ±0.0y (1 standard deviation), respectively. Standard NBS19 was additionally analysed as a quality control sample.

It was initially planned to use electron paramagnetic resonance (EPR) spectroscopy for measuring the samples; however, the instrument at the institute was not available for use.

Databases

The results of isotopic analyses and MGS were compared with the data from known ancient marble quarries, assembled over the last 30 years at the Laboratory of Archaeometry, NCSR Demokritos[9] and with data published in the literature[10]. The data were gathered into a single isotope database. The physical properties and qualitative crystalline features of the marble obtained from the *in situ* examination and the microscopic examination in the laboratory were also compared with the extensive sample bank of the above-mentioned quarry regions existing in the laboratory. The Sr analysis results were compared with published data[11].

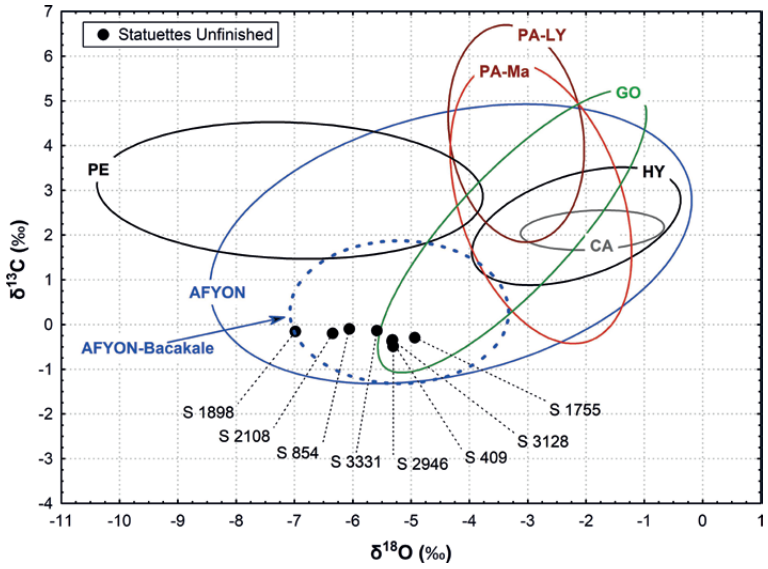
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8 Craig 1957; Polikreti – Maniatis 2002; Maniatis 2004; Attanasio – Brilli – Ogle 2006; Tambakopoulos 2013.

9 Mandi 1993; Polikreti 1999; Maniatis – Polikreti 2000; Vakoulis 2000; Maniatis et al. 2012; Tambakopoulos – Maniatis 2012; Tambakopoulos 2013; Tambakopoulos – Maniatis 2017; Maniatis et al. 2021; Maniatis et al. unpublished.

10 Herz 1987; Bruno et al. 2002; Gorgoni et al. 2002; Attanasio – Brilli – Ogle 2006; Herz 2006; Attanasio – Bruno – Prochaska 2016.

11 Gorgoni et al. 1992; Attanasio – Bruno – Prochaska 2011; Attanasio – Bruno – Prochaska 2016; W. Prochaska (pers. comm.) about Sr data from Mani quarries.



5 The isotopic signature of the unfinished statuettes against the isotopic fields of known quarries with fine-grained marble (graphics: Y. Maniatis)

RESULTS AND DISCUSSION

The results obtained from the examination and analysis of the seven statuettes are presented in table 1. Another unfinished statuette (Agora S 854) was presented at the XII ASMOSIA conference at Izmir[12]; its results are included for comparative reasons. The MGS and MFS values demonstrate that the statuettes were carved from extremely fine-grained marble, with MGS < 0.5 mm. Furthermore, all of the sculptures, except Agora S 1755, seem to have a rather high translucency. Statuette S 1755 differs in this respect, as its marble appears milky and opaque.

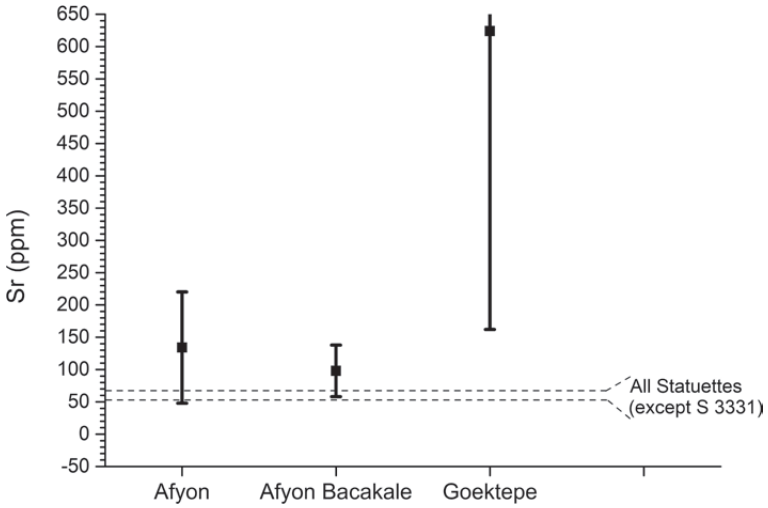
The isotopic signatures of these statuettes are compared statistically to the isotopic fields of known quarries exhibiting very fine grain sizes, namely Afyon, Göktepe (GO), Penteli (PE), Hymettos (HY), and Carrara (CA), in addition to Paros-Lychnites (PA-LY) and Paros-Marathi (PA-Ma) (fig. 5). As can be seen, all of the statuettes fall in the lower part of the Afyon field and some overlap with the lower end of the Göktepe field. All other fine-grained quarries are excluded. Therefore, the only two quarries under consideration for the origin of the marble of these unfinished statuettes are Afyon and Göktepe. In order to distinguish between these two quarries, we use the Sr content, which is a trace element that differentiates them[13]. Figure 6 shows the 2s ranges for Sr of these two quarries and the Sr values of the statuettes. The lowest Sr value documented for Göktepe white marble is 162 ppm. As can be seen from this diagram and from table 1, the Sr values of the statuettes are far lower than the lowest Göktepe values, therefore excluding the Göktepe quarries and leaving Afyon as the only possible source. Furthermore, the Sr values of the statuettes are concentrated in a very narrow range at 53–66 ppm, with one statuette slightly lower at 40 ppm (Agora S 3331). These values correspond to the lowest part of the Sr range of the Afyon field and indicate that they are all most likely from the same part of the Afyon quarry region. Lower Sr values within the Afyon quarry district are exhibited in the Bacakale quarry (fig. 6), the so-called Röder I quarry[14]. It should be noted that the Sr values measured with pXRF tend to be slightly lower, by 10–20 ppm, than the values measured with atomic absorption spectroscopy[15], with which the published data plotted in figure 6

12 Martens – Maniatis – Tambakopoulos 2023.
13 Attanasio – Bruno – Prochaska 2011; Attanasio et al. 2015; Magrini et al. 2016; Attanasio et al. 2021.
14 Röder 1971; Attanasio – Brilli – Ogle 2006.
15 Magrini et al. 2016.

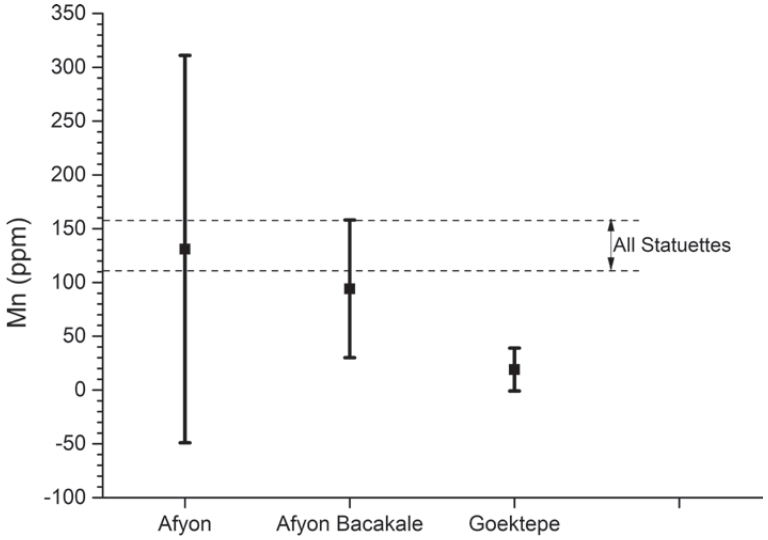
Inv.	Statuette type	Marble and sample description	Translucency (cm)	MGS (mm)	MFS (mm)	Sr (ppm)	Mn (ppm)	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	Provenance
S 409	Aphrodite, half-draped Anadyomene type	Extremely fine whitish/light greyish marble, wax-like appearance; translucent	3.5	0.4	0.2	59	125	–5.33	–0.37	Afyon (Bacakale)
S 1755	Aphrodite, baring the left leg	Extremely fine-grained, milky white, almost opaque; orange vein?	<1.0	0.2	0.1 (?)	60	111	–4.94	–0.29	Afyon (Bacakale)
S 1898	Hygieia, Trentham Hall type	Extremely fine-grained whitish/light greyish marble, wax-like appearance; translucent	2.5	0.4	0.2	58	157	–6.98	–0.16	Afyon (Bacakale)
S 2108	Hygieia, Hope type	Extremely fine-grained whitish/light greyish marble	2.0	0.5	0.1 (?)	66	157	–6.34	–0.20	Afyon (Bacakale)
S 2946	Apollon, holding the bow	Extremely fine-grained white marble; translucent	2.0	0.1	<0.1	59	125	–5.31	–0.49	Afyon (Bacakale)
S 3331	Asklepios, Giustini type	Extremely fine-grained whitish marble	2.5	0.2	<0.1	40	139	–5.59	–0.14	Afyon (Bacakale)
S 3128	Striding male figure (Apollon?)	Extremely fine-grained whitish marble; translucent	3.5	0.2	0.1	62	158	–5.32	–0.34	Afyon (Bacakale)
S 854*	Asklepios, Giustini type	Extremely fine-grained, whitish, wax-like; fine purple veins	3.0	0.1	<0.1	53	141	–6.06	–0.10	Afyon (Bacakale)

* S 854 was published in the AMOSIA XII proceedings of the conference at Izmir. It is included here for comparison.

Table 1 Optical, isotopic and pXRF results of the unfinished statuettes from the Athenian Agora



6 Sr concentration of the studied statuettes against the quarry regions compatible with the isotopes (graphics: Y. Maniatis)



7 Mn concentration of the studied statuettes against the quarry regions compatible with the isotopes (graphics: Y. Maniatis)

were obtained. Additionally, the Mn concentration[16] (fig. 7) further emphasises the Afyon origin and excludes Göktepe; it is also in agreement with the Bacakale quarry.

The most important characteristic of the Bacakale quarry is the low $\delta^{13}C$ isotope values. In figure 5, we have indicated with a dash ellipse the range of $\delta^{13}C$ and $\delta^{18}O$ values measured for the Bacakale quarry (Röder I)[17]. The $\delta^{13}C$ values for the statuettes studied are all, without exception, below 0 ‰. There are no other quarries within the Afyon district and the nearby Altıntaş quarries that exhibit $\delta^{13}C$ below 0 ‰. Therefore, we can conclude without doubt that the marble of these statuettes originates from the quarries at Afyon, and particularly, from the Bacakale section (fig. 8). The almost indistinguishable $\delta^{13}C$ values, and the great similarity of the Sr and Mn values indicate that the marble for all these statuettes came to Athens from this particular quarry, and

16 Attanasio – Bruno – Prochaska 2011.
17 Attanasio – Brilli – Ogle 2006; Attanasio – Bruno – Prochaska 2011.



8 Photo of the Afyon quarries area. The pin shows the Bacakale quarry within the general Afyon quarry district (map from Google Earth, graphics: Y. Maniatis)

possibly from blocks extracted in close proximity to one another. A main criterion for selecting and transferring this marble to Athens was its fine-grained character, which facilitated desirable surface finishes, and its high translucency.

CONCLUSIONS

A systematic scientific approach was applied in order to determine the marble provenance of these eight unfinished statuettes found in the Athenian Agora. This involved *in situ* examination of the physical properties of the marble with transmitted light, pXRF analysis for Sr and Mn, laboratory microscopic examination, and stable isotope analysis. We have established that the marble came from the quarries at Afyon – that is, near ancient Dokimeion, in the region in Phrygia – and, in particular, from the specific district of Bacakale.

White marble from the Bacakale quarry district was imported to Athens during the Roman period for the purpose of making figural sculpture, especially statuettes of gods and goddesses. It is clear that the sculptures presented here were *not* brought to Athens as partly-worked sculptures, roughed-out in the quarries for later finishing at a workshop. This is a reasonable conclusion for two main reasons. First, the small dimensions of these works would make such a process impractical. The range of estimated original heights for the statuettes herein is 16–32 cm. After the 6th century BC, there is, to our knowledge, no evidence of quarry discards for roughly-fashioned figures of this size. Second, several statuettes can be associated with specific marble-carving workshops in the Athenian Agora (e.g. Agora S 409. S 2108). Those workshops produced comparably unfinished sculptures that are carved from stones exhibiting visual characteristics consistent with Pentelic marble[18].

[18] Martens 2021.

So far, the use of Dokimeian white marble is most visible in Athens during the late 2nd and 3rd centuries AD. As discussed above, the find-spots of two statuettes (Agora S 409. S 2108) suggest that Dokimeian marble was being used for local carving in the mid-3rd century AD. This chronological finding is in agreement with other data from Athens. Of particular importance is a colossal head of the Emperor Septimius Severus (AD 193–211), which was found on the west side of the Agora[19]. D. Attanasio, M. Bruno, and W. Prochaska have established that the imperial portrait is carved from Dokimeian marble[20]. While it is not possible to determine where the portrait was carved, our research shows that Athens cannot be excluded.

Dokimeian marble seems to have been reserved for special uses. It was not used widely, and it must be emphasised that Pentelic marble remained the stone of choice for local sculptors. The surface qualities of Dokimeian marble, namely its ability to be brought to a high polish, seems to have been a main reason for its local appeal. For images of the gods and goddesses, the glossy polish may have been considered an appropriate luxury, perhaps in imitation of chryselephantine statuary. So far, there is no evidence that the stone was considered more suitable for any particular divinity or subject, although wider provenance investigations may add clarity to this question. Finally, in some instances, it is probable that sculptors travelled with the stone. A migrant sculptor from Phrygia has been hypothesised in the case of a statuette of Asklepios from the Agora excavations (Agora S 854) on the basis of associated finds, including other unfinished sculptures with peculiar iconographic features and a set of bronze deities from a household shrine[21].

The unfinished statuettes in this study illustrate the value of cross-disciplinary approaches for the investigation of marble production. By studying marble provenance results together with style, iconography, technique, and archaeological provenance, it is possible to conduct more refined analyses of workshop identification.

ACKNOWLEDGEMENTS

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[20] Attanasio – Bruno – Prochaska 2019, 224 no. 2.

[21] Martens 2021.

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ARCHAEOMETRICAL STUDY OF MARMORA FROM THE *VETUS URBS* OF ITALICA (SANTIPONCE, SEVILLE, SPAIN)

Abstract
This paper shows the archaeometric analyses carried out on marmora located at the Cerro de San Antonio (San Antonio Hill), within the archaeological site of Italica (Santiponce, Seville, Spain). This area of the site was an outstanding topographic point of the so-called *vetus urbs* of Italica. Various Roman public buildings stood here and the archaeological elements studied here would have formed part of their architectural decoration. For this study, samples of stone material have been selected from the theatre and the Temple of Isis, located in the *porticus post scaenam*, as well as from the excavation of no. 19 Feria Street. The materials have been analysed with petrographic, mineralogical and geochemical methods. The results confirm a major presence of Hispanic marmora from sources within the Baetican and Lusitanian provinces. As an appendix, we present a specific study of the stone materials from the Sierra de Córdoba (Cordoba Mountains) and Alconera (Badajoz) quarries, as well as those of the Trigaches and Ficalho (Portugal) quarries.

INTRODUCTION

The objective of this paper has been to carry out an archaeometric study of a set of architectural decorative elements and various pedestals – one epigraphic – found in the so-called *vetus urbs* of the Roman city of Italica, which was later promoted to municipal status by Augustus and to a colony by Hadrian – Aelia Augusta Italica. During this emperor's time, an enormous urban expansion was carried out, tripling the city's perimeter and known as the *nova urbs*[1].

The three places in question are located on what is known as the Cerro de San Antonio, an important enclave where significant building activity took place from the Augustan period on, with the construction of the theatre on the eastern slope, as well as an imperial cult space located on the upper area (fig. 1). In Hadrian's time, a porticoed public space of notable dimensions was added to the former architectural complex and, although it has still not been well investigated, a hypothesis regarding the existence of an *aedes Hadriani*[2] is also proposed. On the other hand, the no. 19 Feria Street samples have been visually identified as marble materials from the main imperial quarries[3], based on the main Roman marmora repertoires and on specific typological reference works[4]. Further, in previous studies other stone materials have been analysed and published[5].

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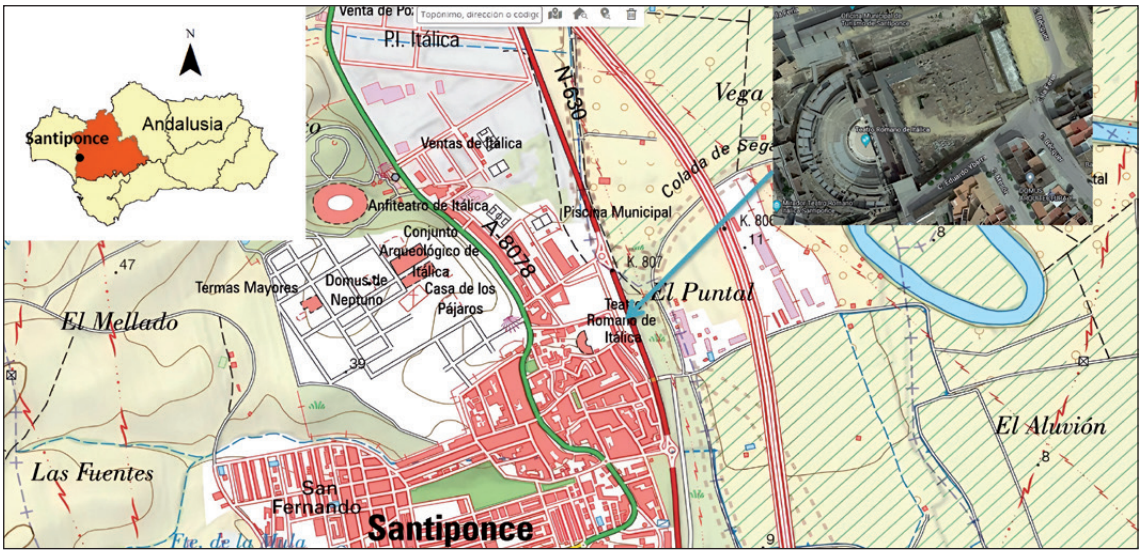
1 Cf. Cortés Copete – Lozano Gómez – Alarcón Hernández 2022, with previous bibliography.

2 Jiménez Sancho 2012; Rodríguez Hidalgo – Jiménez Sancho 2015; Ontiveros Ortega – Rodríguez Gutiérrez – Navarro Martinez 2016.

3 Loza Azuaga et al. 2021; cf. Becerra Fernández 2017.

4 Gnoli 1971; Dolci – Nista 1992; Cisneros Cunchillos 1998; Williams-Thorpe – Potts 2002; Beltrán Fortes – Loza Azuaga 2003; Borghini 2004; Gnoli – Marchei – Sironi 2004; Mañas Romero – Fusco 2008, 505–513; Nogales-Basarrate – Beltrán Fortes 2008; Àlvarez Pérez et al. 2009a; Àlvarez Pérez et al. 2009b; García-Entero 2013; Pullen 2015; Beltrán Fortes – Loza Azuaga – Ontiveros Ortega 2018; Becerra Fernández – Ontiveros Ortega – Beltrán Fortes 2021. See also the Oxford University Corsi Collection, the Lithoteca of the Department of Prehistory and Archaeology of the University of Seville and the Arqueodata database on marble of the Geology Laboratory of the Andalusian Institute of Historical Heritage of Seville.

5 Rodà de Llanza 1997; Rodríguez Gutiérrez 2008 (»marmora del teatro«).



1 Geographic location of the analysed archaeological materials (graphics: E. O. Ortega)

Samples	Description and analysis techniques
CFe_1	Coating plate, bluish-grey marble; OP, XRD, XRF
CFe_5	Coating plate, bluish-grey marble; OP, XRD, XRF
CFe_8	Coating plate, greenish-grey and white banded marble; OP, XRD, XRF
CFe_10	Coating plate, medium- to coarse-grained white marble; OP, XRD, XRF
CFe_22	Coating plate, white marble with pink veins of medium to coarse grain; OP, XRD, XRF
CFe_24	Coating plate; micritic limestone; OP, XRD, XRF
CFe_27	Coating plate, fine-grained white marble; OP, XRD, XRF
CFe_51	Coating plate, medium-grained white marble; OP, XRD, XRF
CFe_52	Coating plate, Cipollino-type grey banded marble; OP, XRD, XRF
Iseo_4	Frieze with a Lesbian cymatium reused as a threshold slab, very coarse-grained white marble; OP, XRD, XRF
Iseo_5–6	Base and body of pedestal, grey micritic limestone with white veins, Mina limestone (Cordoba Hill); OP, XRD, XRF
Teatro11_1	Pilaster base, very fine-grained and opaque white marble; OP, XRD, XRF
Teatro11_2	Coating plate, coarse-grained white marble; OP, XRD, XRF
Teatro11_3	Column base, medium grain size white marble; OP, XRD, XRF
Pedestal of Amoena_1	Base of pedestal, polychrome marble; OP, XRD, XRF
Pedestal of Amoena_2	Base of pedestal, polychrome marble; OP, XRD, XRF
Pedestal of Amoena_3	Body of pedestal, polychrome marble; OP, XRD, XRF

Table 1 Identification of the archaeological pieces from Italica analysed in this work. Abbreviations: OP: optical petrography; XRD: X-ray diffraction; XRF: X-ray fluorescence

The city of Italica is characterised by the lavish use of marbles imported throughout the Roman Empire for both public and private spaces[6], as clearly seen, for example, in the Traianeum and the »Casa Demetrio de los Ríos«[7]. However, the use of regional marbles in the register

[6] Rodà de Llanza 1997; Williams-Thorpe – Potts 2002, 169; Nogales-Basarrate – Beltrán Fortes 2008; Rodríguez Gutiérrez 2008; Becerra Fernández 2017; Beltrán Fortes – Loza Azuaga – Ontiveros Ortega 2018.

[7] Amores Carredano – Becerra Fernández 2022. The »Casa Demetrio de los Ríos« also appears in the scientific literature as »Casa del Patio Rodio«, although after the study carried out on it and the verification of the absence of this type of patio, its excavator, F. Amores Carredano, renamed it.

also stands out, especially elements from the quarries of Almadén de la Plata and Sierra de Mijas[8].

In the province Hispania ulterior Baetica, there were various marble extraction areas in Roman times, such as the well-known quarries of Mijas (Malaga)[9], Almadén de la Plata (Seville)[10] and Alconera (Badajoz)[11]; likewise, there were other limestone outcrops and minor ornamental rock exploitations[12]. These stone materials were mainly used in the different Baetic localities, but generally restricted to a local or regional scope[13], although materials from Almadén de la Plata quarries have been documented in other peninsular places outside of Baetica province, such as Segobriga (Saelices)[14], and even in present-day Morocco, such as the cities of Tingis and Thamusida[15]. Other Baetican quarries are less well known, like those located in the Sierra de Córdoba, and geologically related to the Alconera quarries[16], whose range of use and commercialisation has not yet been established. Therefore, this work also focuses on providing analytical data that will improve the existing knowledge on the use of these local materials which were used in the city of Italica.

MATERIALS AND METHODS

Materials

A total of 68 samples from the northeastern sector of the *vetus urbs* of Italica were obtained from this area under research, of which 17 were selected for this study. This set was chosen for reasons relating to the organisation of work, also emphasising the pieces that macroscopically seemed to be of local origin and those that did not visually correspond with the most known typologies. On the other hand, we sought to establish a selection proportional to the archaeological elements in question: nine samples are of materials from the excavation of no. 19 Feria Street, two from the Temple of Isis, three from the theatre and another three from an epigraphic pedestal that was located in the *post scaenam porticus* (tab. 1).

To carry out this archaeometric study, we have used as reference samples those found in the Arqueodata database created by the Geology Laboratory of the Andalusian Historical Heritage Institute (IAPH) in collaboration with the Department of Prehistory and Archaeology of the University of Seville. This database includes a collection of ornamental and construction stones that were commonly used in southern Hispania, as well as a record of mineralogical-petrographic, geochemical and isotopic analytical data of more than 300 samples from quarries exploited in Hispania and archaeological pieces from a significant number of sites in the Roman province of Baetica, in particular, and from the rest of the territories that made up ancient Roman Hispania, to a lesser extent.

Methods

The analytical methods proposed in this paper are based on the characterisation of the rocks using different analytical techniques[17], including optical petrography (OP)[18], X-ray diffraction (XRD) and X-ray fluorescence (XRF)[19].

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8 Rodà de Llanza 1997; Beltrán Fortes – Loza Azuaga 2003; Becerra Fernández – Ontiveros Ortega – Beltrán Fortes 2021.

9 Beltrán Fortes – Loza Azuaga 2003; Beltrán Fortes – Loza Azuaga 2008; Beltrán Fortes et al. 2012.

10 Ontiveros Ortega et al. 2012; Beltrán Fortes et al. 2013; Taylor 2015.

11 Origlia et al. 2011.

12 Loza Azuaga – Beltrán Fortes 2013; Ontiveros Ortega – Beltrán Fortes – Loza Azuaga 2019.

13 Beltrán Fortes – Loza Azuaga 2003; Beltrán Fortes – Loza Azuaga 2008; Beltrán Fortes – Loza Azuaga – Ontiveros Ortega 2018.

14 Àlvarez Pérez – Cebrián Fernández – Rodà de Llanza 2008.

15 Origlia et al. 2011; Origlia et al. 2012.

16 Ontiveros Ortega et al. 2021.

17 Moens et al. 1988.

18 Herz 1955.

19 Conforto et al. 1975.

Thin sections were examined with a Leica DMLP petrographic polarising microscope and camera and a Leica DFC digital image capture system. Calcite and dolomite were distinguished by applying a staining technique with alizarin red S. The mineralogical composition was evaluated by XRD, using a D8I 90 BRUKER diffractometer with copper anode tube and following a standard semi-quantitative method ($\Delta 2\theta$ = 3–70º; 392 step = 0.015º; t = 0.1 s; tube conditions: 40 kV and 30 mA; divergence slit: fixed 0.5º; turn 30 rpm; nickel filter in the tube and duration: 6 m 54 s). The chemical analysis of major and trace elements was carried out with a Phillips XRF instrument using the minitraces method and a PANalytical AXIOS Rh spectrometer as the wavelength dispersion equipment. A tablet with 0.1 g of powered rock sample, mixed with 0.06 g of wax to act as a binder was prepared. The mixture was then pressed at a pressure of 200 KN on a boric acid mould for one minute, obtaining a 40 mm-diameter cylindrical tablet in which the samples were located inside a diameter of 10 mm. Major and trace chemical elements have been determined this way, obtaining quantitative values for major elements and semi-quantitative values for trace elements. This method requires only a small amount of the samples and can be used as a reference standard for their comparative study with archaeological pieces.

RESULTS AND DISCUSSION

Characterisation of the Archaeological Pieces

Firstly, the following varieties have been differentiated following petrographic observation:

Variety 1

This group includes samples CFe_1, CFe_5, CFe_8A–B, CFe_27 and CFe_52. These stone materials are visually characterised by their grey, white and greenish banding, similar to some types already observed in the Traianeum of Italica[20]. Based on petrographic characteristics, their region of origin could be either Almadén de la Plata (Seville, Spain) and/or Estremoz (Portugal).

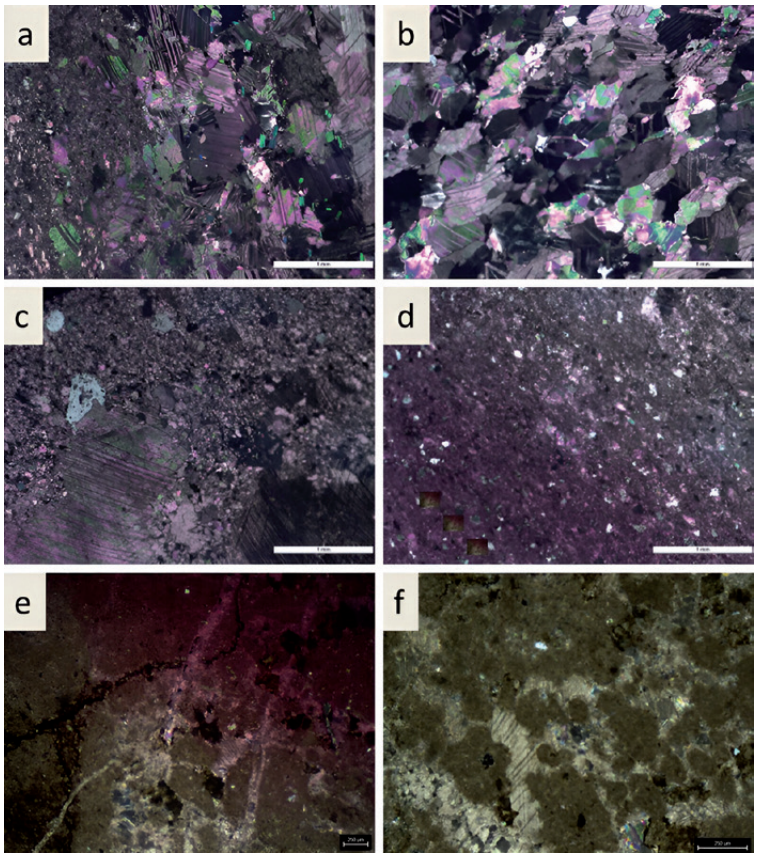
This variety corresponds to banded marbles that alternate grey stripes with mylonitic, blastomylonitic and mortar textures, with fine grain size and a high content of non-carbonated components. The white bands present equigranular and oriented granoblastic textures, with maximum grain size (MGS) > 1 mm, and 0.5 mm-sized blasts predominate. Finally, the greenish bands are characterised by oriented textures and a defined cleavage by blasts of white mica and clay minerals (fig. 2 a–b). As accessory minerals, quartz grains, feldspars, zircon, apatite and metallic ores are observed, most in the form of magnetite, in addition to micas altered to sericite and illite.

Its mineralogical composition, obtained by XRD, indicates significant amounts of mica (10 %), clay minerals (> 4 %), quartz, plagioclase, and traces of zircon, dolomite and in some samples, graphite. Its calcite content is variable, in the most coloured bands its calcite content may be less than 50 %.

Variety 2

These stone materials are visually characterised by presenting white and pinkish banding. This group includes samples AMOENA_1, AMOENA_2, AMOENA_3 and CFe_24. It corresponds to a recrystallised limestone with a nodular and compact appearance, with important contents of detrital components, mainly quartz (from 10–50 μm), white mica, feldspars and metallic ores. Within this carbonate matrix, calcite grains are observed, whose size can exceed 2 mm (fig. 2 c–d).

[20] Becerra Fernández – Ontiveros Ortega – Beltrán Fortes 2021.



2 Petrographic observation. a–b: Variety 1 with textural banding, predominance of fine grain size and presence of mica, feldspars and metallic ores. c–d: Variety 2, composed of white-pinkish limestone with calcite porphyryoblasts in a carbonate matrix rich in quartz grains. e–f: Variety 3 or limestone of Piedra de Mina (graphics: E. O. Ortega)

These visual and textural varieties have been observed in Alconera (Badajoz, Spain)[21], although it is possible that similar lithotopes can be located in the Cordoba Mountains sector[22], specifically, the quarries of Cortijo Piquín and/or quarries of Las Ermitas, among other possible outcrops[23], known by the name of Rodadero de los Lobos limestone (Cordoba, Spain)[24].

Its mineralogical composition, obtained by XRD, indicates contents between 75 and 85 % for calcite and contents greater than 10 % for mica and quartz and feldspars; dolomite is not detected.

Variety 3

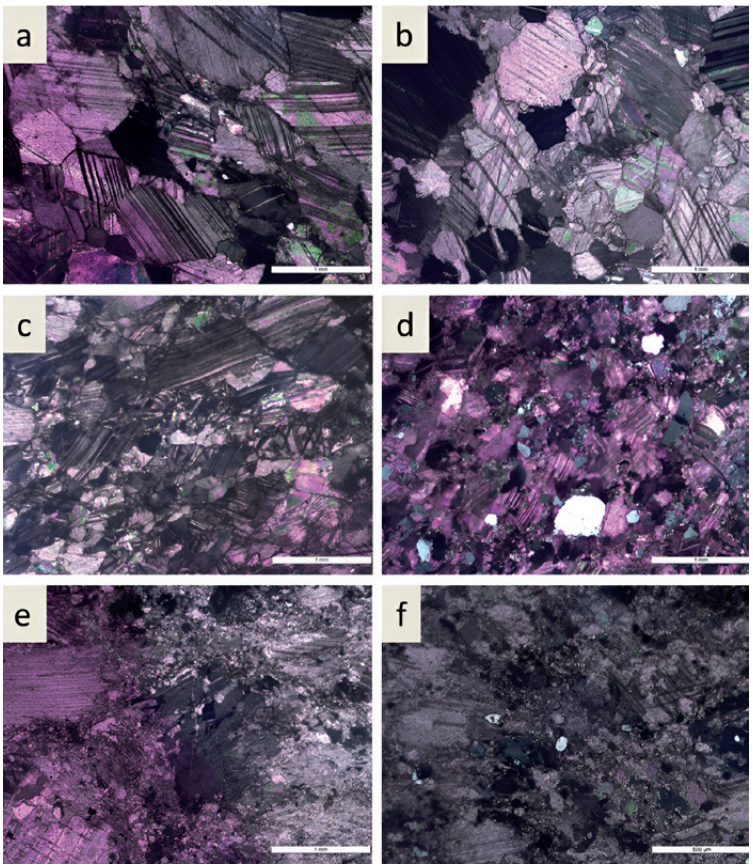
This is a grey limestone, used for the production of the ISEO_5 piece. This limestone presents a high content of micritised bioclasts, algae and oolites/peloids, together with iron (Fe)-enriched

21 Lapuente Mercadal – Turi 1995; Casal Moura – Carvalho 2007, 263–348; Lopes – Martins 2015; Menningen et al. 2018; Moreira – Lopes 2019; Moreira et al. 2020.

22 Ontiveros Ortega et al. 2021.

23 We are currently conducting a study of the quarries of the Sierra de Córdoba within the specific archaeological activity of superficial archaeological prospecting of the Roman quarries located in the southern sector of the Ossa-Morena area, Cordoba Mountains and northern Seville Mountains, in the provinces of Cordoba and Seville (File 13558), directed by M. L. Loza and approved by the General Directorate of Historical and Documentary Heritage of the Ministry of Culture and Historical Heritage of the Junta de Andalucía. This project aims to locate, document and characterise the different Roman extraction fronts for ornamental stones in the Cordoba Mountains.

24 Ontiveros Ortega et al. 2021.



3 Petrographic observation, Variety 4 (white marble). a–b: Variety 4, Type 1. c–d: Variety 4, Type 2. e–f: Variety 4, Type 3 (graphics: E. O. Ortega)

stitolitics and veins filled with recrystallised calcite (related to biological activity) and pores also filled with sparitic cement (fig. 2 e–f). This variety is closely connected with the limestone of Piedra de Mina located in the mountains of Cordoba[25].

Variety 4

These materials correspond to white marbles with variable grain size. Samples included in this group are CFe_10, CFe_22, ISEO_4 and ISEO_6.

It corresponds to a marble with a serial grain size ranging from fine to coarse, with inequigranular granoblastic textures. The calcite blasts present deformation lamellae and a MGS of 1.4 mm. Grain size granulation is observed due to dynamic recrystallisation processes (mylonitic zone) and kink-band structures, with two deformation phases. The contact between grains is variable, straight, penetrative, angular and with development of styrolitic surfaces (fig. 3 a–b).

This variety is associated with fine-grain-size-oriented textures (fig. 3 c–d) and mortar textures with a MGS greater than 1 mm. The blasts present irregular edges with development of styrolytic or penetrating surfaces (fig. 3 e–f). The quartz grains (size 100–200 µm) present subidioblastic forms, undulating extinction and development of subgrain boundaries and zircon inclusions. In addition, feldspars of around 0.4 mm size, titanite and apatite are observed. Quartz grains are observed filling microcracks or together with apatite and Fe oxyhydroxides.

[25] Márquez Moreno 1995.

Samples	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	SO_3
CFe_01	13.37	1.76	0.68	0.07	1.04	48.53	0.26	0.36	0.05	0.19	0.06
CFe_05	0.59	0.1	0.1	0.07	0.73	61.28	0.07	0.05	0.02	0.03	0.05
CFe_08A	10.88	4.22	0.58	0.07	1.37	44.67	0.41	0.6	0.04	0.04	0.09
CFe_08B	19.56	5.75	2.73	0.11	1.86	38.06	0.18	2.1	0.19	0.07	0.04
CFe_10	0.77	0.12	0.05	0.02	1.15	61.13	0.1	0.04	0.02	0.03	0.07
CFe_22	2.17	0.47	0.09	0.02	0.52	60.84	0.09	0.15	0.03	0.07	0.07
CFe_24	8.08	1.73	0.7	0.05	0.95	52.67	0.14	0.85	0.07	0.17	0.06
CFe_27	7.28	2.72	0.44	0.02	1.37	51.98	0.15	0.63	0.05	0.04	0.1
CFe_51	1.16	0.17	0.07	0.02	1.03	57.92	0.12	0.07	0.02	0.02	0.06
CFe_52	1.16	0.25	0.12	0.04	1.57	60.52	0.08	0.15	0.02	0.02	0.05
AMOENA_1	2.26	1.03	0.2	0.05	0.49	51.89	0.06	0.3	0.02	0.03	0.05
AMOENA_2	1.29	0.51	0.31	0.05	0.23	53.96	0.04	0.27	0.02	0.02	0.03
AMOENA_3	3.42	0.74	0.21	0.04	0.36	52	0.05	0.41	0.03	0.04	0.04
ISEO_4	1.92	0.32	0.05	0.01	0.32	52.99	0.05	0.18	0.02	0.03	0.05
ISEO_5	8.05	1.66	0.62	0.04	0.64	48.07	0.13	0.96	0.05	0.03	0.07
ISEO_6	0.11	0.03	0.02	0.01	0.79	57.28	0.05	0.02	0.01	0.05	0.04
TEATR11_3	0.44	0.04	0.06	0.02	0.97	53.78	0.05	0.03	0.01	0.11	0.04
P. PORTIC	0.48	0.05	0.04	0.01	0.48	52.81	0.04	0.03	0.01	0.02	0.04
TEATR11_1	0.14	0.03	0.02	0.01	0.39	55.86	0.04	0.02	0.01	0.01	0.04
TEATR11_2	0.66	0.11	0.05	0.02	0.34	54.08	0.04	0.05	0.01	0.02	0.04

Table 2 Chemical composition of the majority of elements in the archaeological samples analysed in %

Based on its petrographic characteristics, its origin could be found in the regions of Almadén de la Plata (Seville, Spain) and/or Estremoz (Portugal).

Variety 5

These materials are visually characterised by their white coloration and very coarse grain size. The TEATRO11_1 sample is included within this variety and can be attributed to Trigaches marble (Évora-Beja Massif, Portugal).

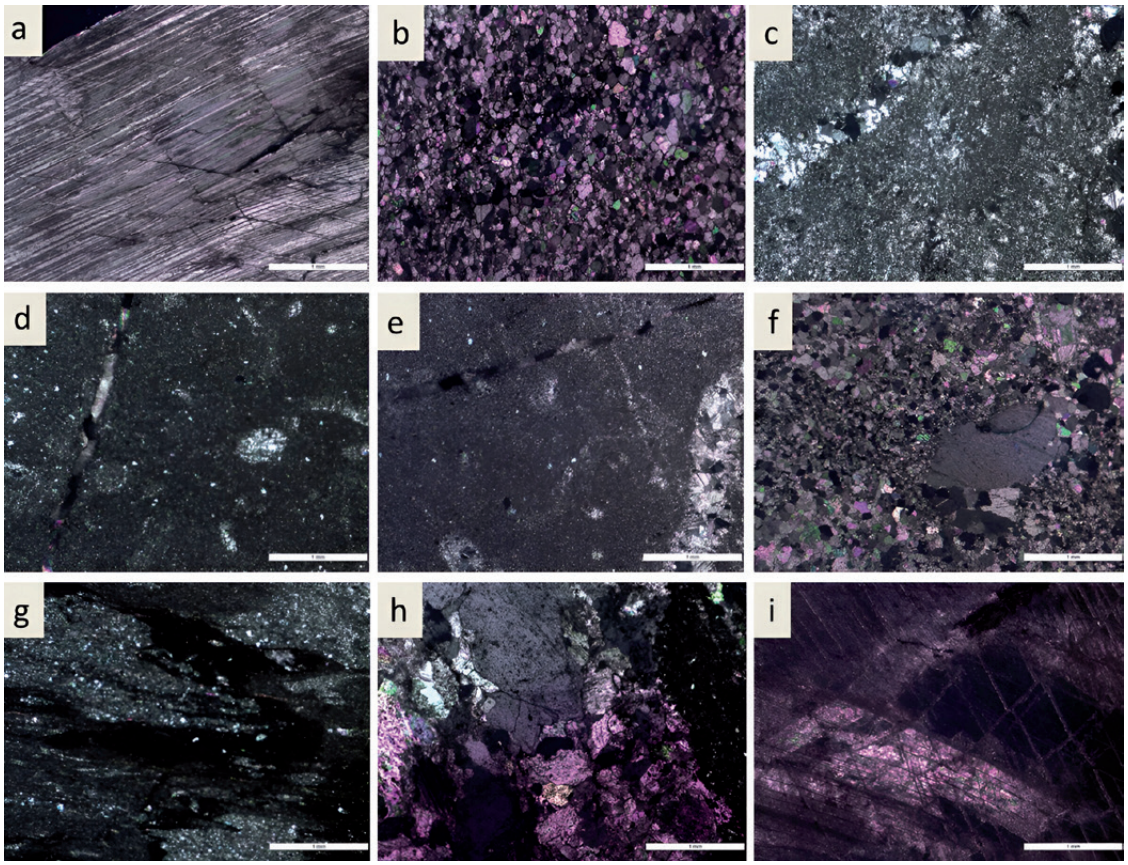
It is a coarse-grained marble with inequigranular and heteroblastic mosaic granoblastic textures. The calcite blasts present deformation lamellae and microcracks, with an MGS greater than 3 mm and it is common to observe microcracking and crushing due to grain cataclasis (fig. 4 a).

Variety 6

This stone variety is visually characterised by a white coloration and very fine grain size. The TEATRO11_2 sample corresponds to this variety and is attributed to Ficalho marble (Évora-Beja Massif, Portugal). It is a calcitic marble with a very fine grain size with mosaic textures of the homoblastic type with the development of triple points. The calcite blasts present a MGS of less than 0.25 mm and no development of twins or undulating extinction are observed (fig. 4 b).

Secondly, the chemical composition of the majority of elements in the analysed samples are presented in table 2.

Variety 1, banded marbles, is characterised by high SiO_2 contents, in addition to Fe_2O_3 and K_2O, which is attributed to the presence of quartz, feldspars and micaceous minerals such as micas and biotites. The highest MgO contents presented by the greyish varieties are related to the presence of dolomite, detected by XRD.



4 Petrographic observation. a: Variety 5, archaeological piece, attributed to Trigaches marble. b: Variety 6, archaeological piece, attributed to Ficalho marble. c–d: Alconera Sector (Badajoz), quarry sample, white variety. e–f: Alconera Sector, sample from quarry Ajamonado variety. g: Cordoba Mountains sector, sample from quarry, Rodadero de los Lobos quarries. h–i: Cordoba Mountains sector, sample from the limestone quarry of Mina (graphics: E. O. Ortega)

Variety 2, white marble with pinkish bands, and Variety 3, grey limestone with white veins, correspond to limestone rocks, also with a high content of impurities; their variable composition in SiO_2 and to a lesser extent in MgO, Fe_2O_3 and K_2O stand out, which is attributed to their quartz and mica contents.

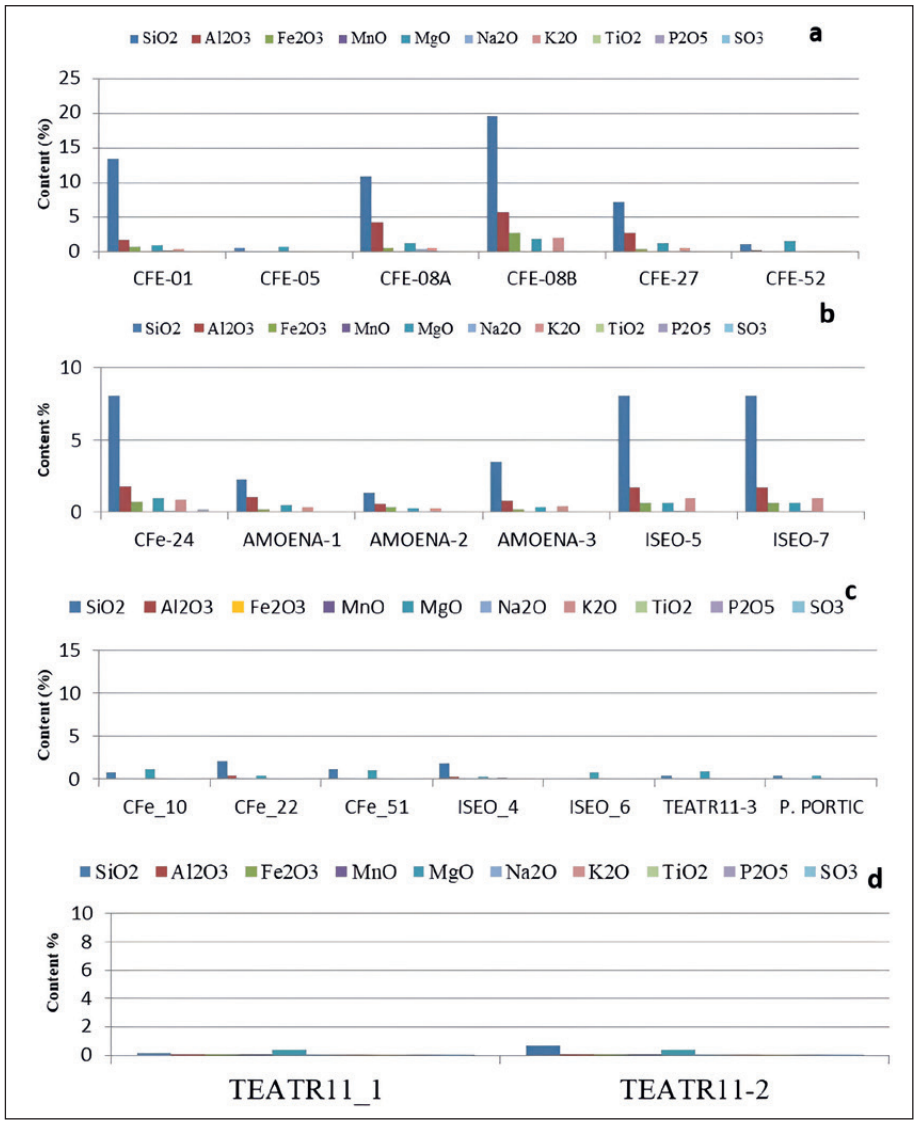
Finally, Variety 4, Variety 5 and Variety 6 correspond to very pure marbles (fig. 5).

As can be seen in figure 6, where the chemical composition of a selection of samples from the Almadén de la Plata and Extremos quarries can be observed, in the samples from Almadén de la Plata, the Mg content is higher, and conversely, the K_2O content is higher in the samples from Estremoz. For Variety 1 and Variety 4, whose origin was attributed to Almadén de la Plata (Seville, Spain) or Estremoz (Portugal), based on the MgO and K_2O contents, the Almadén de la Plata sector is established as the most probable origin[26].

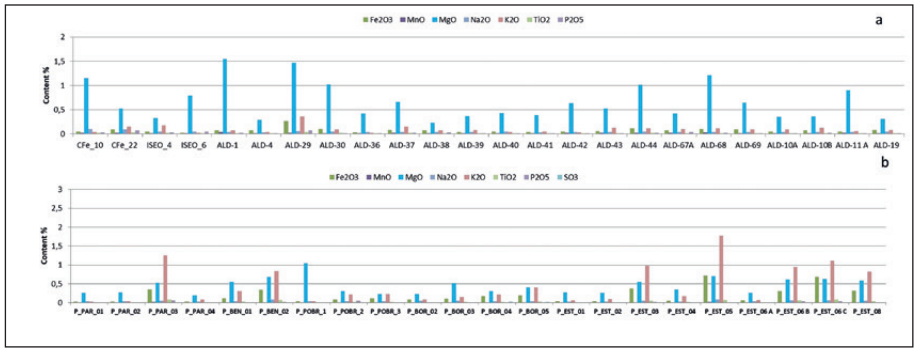
Discussion

The results of this archaeometric study carried out on archaeological pieces recovered in the *vetus urbs* of Italica and of the comparative study of quarry samples (see appendix) confirm the use of

[26] Ontiveros Ortega et al. 2012.



5 Chemical composition. a: Variety 1. b: Variety 2 and Variety 3. c: Variety 4 and Variety 5. d: Variety 6 (graphics: E. O. Ortega)



6 Chemical composition of Almadén de la Plata y Estremoz sector samples from the Archaeodata database (see Becerra Fernández – Ontiveros Ortega – Beltrán Fortes 2021) (graphics: E. O. Ortega)

local marmora in significant proportions, especially with regard to the varieties difficult to identify macroscopically, that is, white and white banded marbles. The use of coloured ornamental stones from the mountains of Cordoba – Mina limestone – in Italica at Cerro de San Antonio, as well as non-Baetican stone material, has been verified archaeometrically. Aspects related to the periods of use of these materials in Italica as well as their decorative use within the city are pending, to be addressed in depth in further studies. Current studies demonstrate that ornamental stones from the mountain range of Cordoba were used in different cities of the ancient Roman Baetica province, as in the case of Nabrissa Veneria[27] and now, as shown here, in Italica.

In relation to the coloured varieties (red banded limestone; grey, white and greenish banded marbles; and a greyish limestone are included) a possible local origin has been attributed, specifically from the quarries of the Cordoba Mountains and Alconera sectors, based on similar lithotypes that have been observed in the Roman theatre of Cordoba[28].

Also, based on current research carried out on these two stone extraction sectors, the origin of piece ISEO_5 could possibly be attributed to the grey limestone variety called »Piedra de Mina« (Cordoba Mountain range, Spain) and on the other hand, the red-and-white variety used in the production of the epigraphic pedestal of Amoena, to the variety Ajamonada of Alconera (Badajoz, Spain), although it cannot be ruled out that similar varieties are also located within the mountains of Cordoba.

Regarding Variety 1 of banded marbles, it should be noted that its chemical and textural composition is highly variable; however, its local origin cannot be rejected, becoming an important line of research to be developed in the future.

CONCLUSIONS

As conclusions, after the archaeometric analysis carried out on a representative number of archaeological pieces from the northeastern sector of the *vetus urbs* of Italica, specifically the Cerro de San Antonio and the theatre, we can resume:

- The materials analysed correspond to ornamental stones from quarries located in the south of the Iberian Peninsula, mostly from the Baetica and Lusitania provinces. We highlight a variety of banded marbles, whose provenance has not been confirmed, although, most likely of local origin, which has been suggested as an interesting line of research to be developed in the future.
- A white marble with pinkish bands attributed to the Ajamonada variety from the Alconera sector has been identified. It has been pointed out that this variety can also be found in the mountain range of Cordoba, based on its geological similarity, a line of research currently under study.
- The Piedra de Mina stone variety has been identified in the architectural complex of the Roman theatre of Italica. Its source has been clearly identified with the Cordoban Mountains sector.
- Among the architectural elements found out of context are marbles from Almadén de la Plata (identified by their MgO and K_2O content), as well as Lusitanian marbles, specifically varieties extracted from Trigaches and Ficalho. The use of Estremoz marble is not so clear.
- The use of these varieties of stone materials in this sector of the city of Italica helps to broaden our knowledge on the distribution of Roman decorative stones extracted from the mountains of Cordoba and from the south of present-day Extremadura, proving that it was greater than previously known. This fact suggests that these decorative stone materials will also be detected in other sites in the ancient Roman Baetica province.

[27] Romero Vera – Becerra Fernández 2023.
[28] Ontiveros Ortega et al. 2021.

Samples	Description and analysis techniques
ALC_1	Alconera (Badajoz): white marble with development of banding and styrolithic surfaces; light greenish-grey marble; OP, XRD, XRF
ACL_3	Alconera (Badajoz): fine-grained grey marble; OP, XRD, XRF
ALC_7	Alconera (Badajoz): reddish-purple nodular limestone of the Ajamonada variety; OP, XRD, XRF
RD_1	Cordoba Mountains: reddish-purple limestone/sandstone violácea; OP, XRD, XRF
PM_1	Cordoba Mountains: grey limestone with white veins; OP, XRD, XRF
Navh1–4	Évora-Beja-Aracena Massif: fine-grained white marble; XRD, XRF
Ficall_1–3	Évora-Beja-Aracena Massif: very fine-grained white/grey marble; XRD, XRF
Tri_1–4	Évora-Beja-Aracena Massif: greyish white marble with very coarse grains; XRD, XRF

Table 3 Description of the quarry samples studied. Abbreviations: OP: optical petrography; XRD: X-ray diffraction; XRF: X-ray fluorescence

Thanks to this study we verified that it is absolutely necessary to carry out an in-depth study of the Cordoban quarries and the distribution of the materials extracted from them, identifying the deposits in which these materials have been located and characterising the different fronts of quarries already found and those to be identified in the future.

ACKNOWLEDGEMENTS

This research work has been made possible thanks to the project »Italica Adrianea: la *Nova Urbs*. Análisis arqueológico del paradigma urbano y su evolución, y contrastación del modelo (PID2020-114528GB-I00)«, financiando por Ministerio de Ciencia, Innovación y Universidades – Agencia Estatal de Investigación/10-13039/501100011033 and the research groups »Historiografía y Patrimonio Andaluz (P.A.I., HUM-402)« and »Antiguas ciudades de Andalucía: de la investigación arqueológica a la rentabilización social (P.A.I., HUM-882)«. Our thanks go to Professor Aureli Àlvarez Pérez for his collaboration in taking samples from the quarries of Alconera (Badajoz).

APPENDIX

Introduction

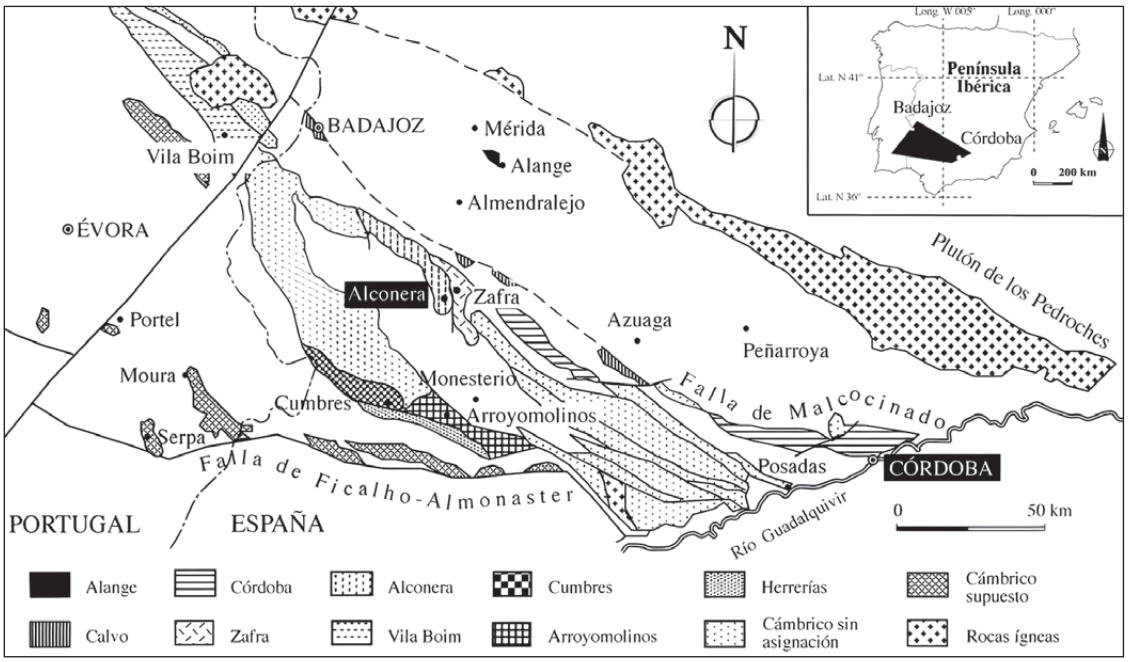
According to the conclusions of this work, it is possible to affirm that, among the Spanish marmora used in Italica, apart from the well-known varieties of marbles from Almadén de la Plata[29] (Seville, Spain) and from the Anticline of Estremoz (Portugal)[30], there is a significant presence of marble from the mountains of Cordoba (Cordoba) and Alconera (Badajoz), as well as from Trigaches and Ficalho (Portugal). That is why we consider it expedient to insist on the geological and petrographic characteristics of these exploitation areas.

A total of eight samples extracted from outcrops of the different quarries indicated above have been selected for this study (tab. 3). The analysis methods used are similar to those applied to the archaeological samples.

Geological Setting

The marmora quarries of the Cordoba Mountains and Alconera are located in the central domain of the Ossa-Morena Zone, composed of intercalations of detrital and carbonate levels with

[29] Ontiveros Ortega et al. 2012; Taylor 2015.
[30] Origlia et al. 2011; Moreira et al. 2020.



7 Geological setting of the Fm. Alconera and Fm. Pedroches (from Liñán Guijarro et al. 2008, 125 fig. 2)

various horizons of trilobites and archaeocyanates, of Ovetense age[31]. The quarries in the Cordoba Mountains sector are associated with the so-called geological formation (Fm.) Los Pedroches and the Alconera quarries with the Fm. Alconera[32] (fig. 7). The main difference that can be highlighted between these two Fm. is related to the volume of carbonate levels that each one presents. The Fm. Alconera is characterised by the predominance of carbonate levels over the intercalations of detrital material. By contrast, in the Fm. Los Pedroches, the carbonate sedimentation basin was lower, and the lithic and sandy levels are predominant, compared to the carbonate ones.

In these quarries, we can find carbonate rocks with recrystallised marly components and a variable colour of white, greyish, dark grey, pink and purple from the macroscopic point of view. On the one hand, the Fm. Los Pedroches has a section or lower part composed of a package of calcimicrobial limestones with archaeocyanates, oolitic and oncolitic limestones, and an upper section composed of alternating carbonate and terrigenous material (arcose and shales), without archaeocyanates[33]. On the other hand, the Fm. Alconera is composed of a package of detrital materials at the base, followed by a series of carbonated detritals rich in quartz, feldspars and micas towards the top[34].

The Trigaches and Ficalho marble quarries are located in the Évora-Beja-Aracena Massif or the Évora-Aracena-Lora del Río metamorphic belt[35]. This belt includes three major exposures of metamorphic complexes (high to medium-grade metamorphic terrains surrounded by lower-grade metamorphic rocks). These metamorphic complexes are characterised by the development of high-temperature – low-pressure metamorphic conditions that reached upper amphibolite to granulite facie, where mylonitic foliation is characteristic[36]. The Évora-Beja domain includes the tectono-stratigraphic sectors of Montemor-Ficalho and the Beja Massif, both sectors subjected to medium- to very high-grade thermal metamorphism.

31 Moreno-Eiris 1987; Fernández-Remolar 2001.
32 Liñán Guijarro – Perejón Rincón 1981; Liñán Guijarro 1984.
33 Liñán Guijarro – Dabrio González 1974.
34 López Munguira – Nieto García – Sebastián Pardo 1993.
35 Crespo-Blanc 1989.
36 Pereira – Silva – Ribeiro 2010.

The fine-grained marbles are related to the Montemor-Ficalho sector and the Trigaches-São Brissos marbles belong to the Beja Massif domain, marbles with a medium to very coarse grain size, coming from carbonate rocks (limestone and dolomites) metamorphosed with intercalations of plutonic rocks of intermediate and acidic character[37]. They are marbles with granoblastic to lepidoblastic textures and in some cases cataclastic. The calcitic varieties are characterised by presenting a compositional banding rich in calcite grains with phlogopite, tremolite and diopside, and other greyish dolomites. The most common mineralogical associations are calcite, dolomite, quartz, phlogopite, tremolite-actinolite, diopside, fosterite and wollastonite.

Material Characterisation

Cordoba Mountains and Alconera (Badajoz)

The petrographical Alconera stone study shows features similar to those described by F. Origlia and colleagues[38]. It is characterised by a strong lineation from homoeoblastic to heteroblastic. The stones present fine-grained (MGS from 0.2–0.8 mm) and coarse-grained (> 2 mm MGS) relict blasts. The grain boundaries are embayed and highly interlocked (sutured type). Calcite is the dominant constituent, associated with a subordinate content of dolomite. The non-carbonate fraction minerals – iron (Fe) oxides and titanium (Ti) oxides –, coarser calcite veins and veinlets of carbonaceous matter are observed. It is common to observe fossil remains and galleries related to biological activity filled with sparitic carbonate cement, together with a micritic matrix (fig. 4 c–e). The white varieties present a recrystallised carbonate matrix and calcite blasts larger than 1 mm (fig. 4 f).

The mineralogical composition of the analysed samples obtained by XRD indicates that the stone materials located in the Alconera sector are richer in calcite, with dolomite contents that can reach 3 %. By contrast, in the Cordoba Mountains sector, higher quartz and phyllosilicate contents are observed.

Within the Cordoba Mountains sector, the materials analysed correspond to two different lithotypes: a purplish carbonated sandy variety from the ancient quarry remains at Cortijo del Piquín, known as Rodadero de los Lobos limestone; and a greyish limestone located in some quarries near the stream of Los Pedroches, called Piedra de Mina limestone (quarries with evidence of ancient extractions).

Rodadero de los Lobos limestone is characterised by jointly presenting two types of textures in contact. On the one hand, they show arkose levels with a recrystallised clayey carbonate matrix, with abundant content of quartz grains and feldspars (fig. 4 g); and on the other hand, a recrystallised carbonate texture attributable to marbles with heteroblastic textures and MGS around 2 mm in size (fig. 4 h).

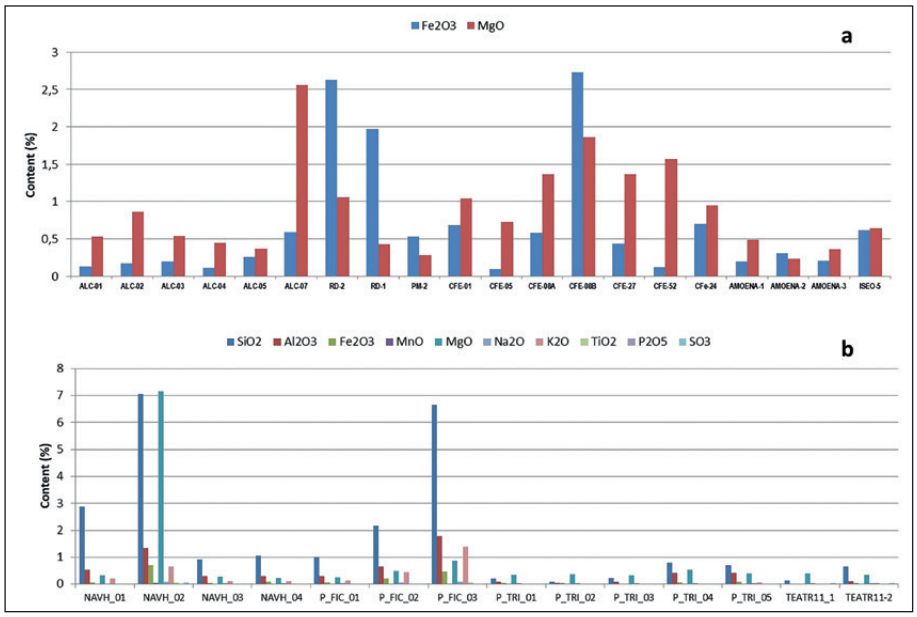
The Piedra de Mina corresponds to a limestone with a very compact appearance and cloudy texture (enriched with iron oxide) and the development of styrolitic surfaces also enriched with Fe oxyhydroxides, together with twinned calcite blasts. In general, inclusions or fine veins filled with recrystallised calcite are frequent in these materials (fig. 4 i).

The geochemical analysis (tab. 4) carried out on these typologies indicates that they correspond to carbonate rocks with variable impurity contents, especially SiO_2. The Rodadero de los Lobos limestone and the Ajamonada variety from Alconera are those with the highest SiO_2 content. The geochemical differences to highlight are a higher Fe_2O_3 (3 %) content in the first case and a higher MgO (2.5 %) content in the second case (fig. 8).

37 Carvalhosa 1965.
38 Origlia et al. 2011.

Samples	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	Mn_3O_4	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3
ALC-01	0.834	0	0.235	0.128	0	0.528	54.581	0.025	0.033	0	0
ALC-02	1.87	0.023	0.564	0.169	0.043	0.859	53.616	0.033	0.175	0	0
ALC-03	11.118	0.14	2.346	0.196	0	0.537	46.704	0.414	0.577	0.033	0.059
ALC-04	1.403	0	0.259	0.114	0.047	0.446	54.641	0.026	0.08	0	0
ALC-05	0.298	0	0.148	0.256	0	0.367	55.098	0	0.044	0	0
ALC-07	5.685	0.042	1.002	0.591	0.048	2.557	48.533	0.28	0.213	0.043	0
RD-2	20.243	0.205	5.304	2.628	0.177	1.059	36.858	0.021	2.025	0.121	0
RD-1	1.996	0	0.402	1.971	0.195	0.432	52.603	0.032	0.136	0.022	0
PM-2	0.876	0	0.299	0.533	0.321	0.282	54.253	0	0.042	0	0

Table 4 Chemical composition of samples from the Alconera-Cordoba Mountains quarry sector analysed in %



8 Chemical composition of samples from the Alconera-Cordoba Mountains sector quarry (graphics: E. O. Ortega)

Montemor-Ficalho Sector

The marbles of Trigaches-São Brissos are calcite-rich and have distinctive features, such as their dark-grey to bluish tones (sometimes with dark-grey stripes) and their coarse-grained homogeneous mosaic texture (generally greater than 1 mm[39]; see fig. 4 a). The calcite-rich marbles are the most common variety; however impure lithotypes, also with very coarse-grained calcite but with the presence of olivine (forsterite) and other ferromagnesian minerals, have been described[40]. Another particularity of these marbles is the foul odour when struck, due to the presence of dispersed organic matter. The marbles of the Ficalho sector are characterised by having a very fine grain size and calcitic composition. They present an equigranular mosaic texture with development of triple points (fig. 4 b).

[39] Carvalho et al. 2013.
[40] Ferreira et al. 2013.

Samples	SiO_2	Al_2O_3	Fe_2O_3	Mn_3O_4	MgO	CaO	Na_2O	K_2O	Ti_2O	P_2O_5	SO_3
Navh_01	2.88	0.55	0.06	0.02	0.33	54	0.03	0.2	0.01	0.01	0.01
Navh_02	7.06	1.34	0.71	0.04	7.16	40.91	0.09	0.66	0.06	0.01	0.07
Navh_03	0.91	0.31	0.05	0.01	0.29	55.55	0.04	0.12	0.01	0.01	0.02
Navh_04	1.05	0.3	0.08	0.02	0.23	54.64	0.04	0.12	0.01	0.01	0.02
P_Fic_01	1.02	0.31	0.07	0.01	0.26	56.27	0.05	0.14	0.01	0.02	0.01
P_Fic_02	2.17	0.66	0.2	0.02	0.5	58.07	0.06	0.44	0.02	0.01	0.01
P_Fic_03	6.66	1.8	0.46	0.03	0.87	52.52	0.09	1.4	0.06	0.02	0.01
P_Tri_01	0.2	0.09	0.05	0.01	0.34	62.35	0.04	0.03	0.01	0.01	0.01
P_Tri_02	0.1	0.04	0.04	0.01	0.37	54.99	0.04	0.02	0.01	0.01	0.01
P_Tri_03	0.23	0.1	0.03	0.01	0.32	65.76	0.05	0.03	0.01	0.01	0.01
P_Tri_04	0.81	0.41	0.07	0.01	0.53	56.89	0.05	0.02	0.02	0.01	0.02
P_Tri_05	0.71	0.42	0.1	0.01	0.39	58.98	0.04	0.06	0.02	0.01	0.01

Table 5 Chemical composition of Montemor-Ficalho Trigaches-São Brisso sector samples analysed in %

The chemical composition of major elements of the Trigaches y Ficalho (Montemor-Ficalho Trigaches-São Brisso sector) samples is shown in table 5. Ficalho marbles present higher SiO_2 and K_2O contents. The Trigaches marbles are less impure, with contents in SiO_2 of less than 1 %.

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Olga Palagia – Yannis Maniatis

THE MARBLE PROVENANCE OF THE PEDIMENTAL SCULPTURES OF THE ATHENA ALEA TEMPLE AT TEGEA

Abstract
The pediments of the 4th-century Temple of Athena Alea at Tegea represented the Calydonian boar hunt (east pediment) and the battle between Achilles and Telephos near the river Kaikos (west pediment). The fragmentary statues attributed to these two pediments have long been thought to be made of Doliana marble. The compositions were assembled from a selection of fragments of similar size and style which were excavated out of context in the Sanctuary of Athena Alea. The statues are now distributed between the Tegea Archaeological Museum and the National Archaeological Museum in Athens. However, isotopic analysis of five pieces and *in situ* optical examination, as well as, pXRF analysis of another twelve pieces, have revealed that the marble of the figures attributed to the pediments come from three different sources (Paros, Penteli and Doliana). It is here suggested that the fragments of warriors in Pentelic marble belong to the battle scene of the west pediment. The east pediment statues should normally be of the same marble as the west, but none of the fragments assigned to this pediment seem to be in Pentelic marble. Two possibilities present themselves: either the east pediment was made of Parian marble or the Parian marble statues belong to different monuments. As for the two fragments in Doliana marble, they could either be replacement pieces or they could belong to free-standing dedications.

INTRODUCTION: THE STATUES OF THE PEDIMENTS

The traveller Pausanias (8, 45, 5) described the Temple of Athena Alea at Tegea as one of the largest in the Peloponnese and attributed its design to the Parian sculptor Skopas. He specified that the temple was Doric with an additional Corinthian colonnade (meaning the engaged columns in the cella) and provides precious information on the themes of the pediments[1], and on the iconography of the sculptured decoration of the altar[2]. He tells us that the east pediment of the temple represented the Calydonian boar hunt, while the west showed the battle between Achilles and Telephos in the valley of the river Kaikos near Pergamon. This battle was a prelude to the Trojan War. Both stories involved local mythological figures. The Calydonian boar hunters included the local heroine Atalante, while Telephos, hero of the battle at the river Kaikos, was the son of Auge, a Tegean princess, and Herakles. The altar of Athena Alea carried a depiction of the birth of Zeus by the goddess Rhea, with the infant Zeus being held by the Arcadian nymph Oinoe. The central group was flanked by four nymphs on either side. Pausanias adds that there were images of the Muses and their mother Mnemosyne. The scene of the birth of Zeus was probably a relief frieze, while the Muses and their mother Mnemosyne, mentioned separately by Pausanias, may well have been free-standing figures[3]. In addition, Pausanias states that Skopas made statues of Asklepios and Hygieia in Pentelic marble, which stood on either side of the cult statue of Athena

1 Paus. 8, 45, 6–7. The Temple of Athena Alea was also decorated with acroteria and sculptured metopes, which are not discussed here because the provenance of their marbles has no impact on the marble of the pediments.

2 Paus. 8, 47, 3.

3 Pausanias describes the Muses as *agalmata*, a word usually employed for free-standing statues. Opinion is divided, however. Mehmet Ç. Şahin (1972, 86–91) suggested that all scenes were in relief, while Aenne Ohnesorg (2005, 177) states that it is not clear whether they were free-standing or in relief. Geoffrey B. Waywell (1993, 83) has suggested that the birth of Zeus was a relief scene but that the Muses were free-standing, placed between the columns of the altar court (see below, n. 9 for the altar court).



1 Tegea sculpture. a: Male head NAM 179. b: Helmeted head NAM 180. c: Boar's head NAM 178 (photos: Hans R. Goette)

Alea[4]. It is interesting that Pausanias took the trouble to specify the provenance of the marble used by Skopas for his statues.

The temple and its architectural sculptures are now dated to the third quarter of the 4th century BC[5]. The sculptures are divided between the National Archaeological Museum in Athens and the Tegea Archaeological Museum (TEG). Excavations in the Sanctuary of Athena Alea began in 1879 and the earliest sculptures recovered, two male heads (fig. 1 a–b), a boar's head (fig. 1 c) and the head of a goddess, not connected to the architectural sculptures of the temple, made their way to Athens[6]. The rest were excavated between 1900 and 1910 by the French School of Athens, and again in 1964 and 1971 by the Greek Antiquities Service and are now housed in the Tegea Archaeological Museum[7]. The altar of Athena Alea was excavated in the period 1900–1910. The French excavators uncovered the foundations of a large altar, about 23 × 11 m[8], but these were eventually filled in and are now under the modern road between the temple and the church of St. Nicholas. The monumental dimensions of the altar led to the suggestion that it was surrounded by a colonnaded court, which was decorated with sculptures, similar to the altar of the Temple of Artemis at Ephesos[9]. The sculptures recovered from the excavations of the Sanctuary of Athena Alea are heavily weathered and in a fragmentary state, because they had been reused as building material in late Roman and Byzantine houses. A few were even retrieved from the walls of modern houses in the village of Tegea[10].

The Tegea Archaeological Museum was refurbished in 2014. A gallery chiefly dedicated to the Temple of Athena Alea at Tegea contains fragments of the pediments, metopes and acroteria, architectural blocks with mouldings, as well as fragments of antefixes and of the engaged Corinthian capitals from inside the cella[11].

4 Paus. 8, 47, 1.

5 For the date, see Østby 2013, 171 f. with n. 6.

6 Mendel 1901, 242. Male head NAM 179 (fig. 1 a); see Stewart 1977, 16–18 no. 9 pls. 7; 8 a–b; 38 c–d. Helmeted head NAM 180 (fig. 1 b); see Stewart 1977, 23 f. no. 17 pls. 14 c–d; 15; 35 c–d. Boar's head NAM 178 (fig. 1 c); see Stewart 1977, 14 f. no. 5 pl. 5 a. The heads fig. 1 a–c were extracted from the walls of a modern house. Female head NAM 3602; see Waywell 1993, 83 fig. 6; Leventi 2013. This head is generally thought to be of Parian marble. It was found under a column drum, in the destruction levels of the temple, without its body, see Mendel 1901, 260. It is usually identified with a Muse and attributed to the sculptured decoration of the altar.

7 On the history of the excavations of the Sanctuary of Athena Alea, the architectural sculptures of the temple and its altar, see Mendel 1901; Dugas – Berchmans – Clemmensen 1924, ix; Christou – Demakopoulou 1965; Demakopoulou 1966; Stewart 1977, 26 no. 21.

8 Dugas – Berchmans – Clemmensen 1924, 66–69.

9 Şahin 1972, 86–91; Norman 1984, 190 f.; Waywell 1993, 83; Bammer 2013, 287–302; Pedersen 2013, 277–281.

10 See n. 6 above and n. 24 below.

11 On the Athena Alea gallery in the new Tegea Archaeological Museum, see Karapanagiotou 2017, 69–72.



2 East pediment of the Athena Alea Temple, as reconstructed in the Tegea Archaeological Museum. From left to right: female torso TEG 2297, headless quadruped TEG 2400, dog's head TEG 89, male torso in two fragments TEG 64+1309, fragment of male torso TEG 65, fragment of male torso TEG 66 (photo: O. Palagia)

The reconstructed pediments currently on view in the Tegea Archaeological Museum (figs. 2–4) are based on the study by Andrew Stewart, published in his book »Skopas of Paros« in 1977[12]. They do not include the fragments that remained in Athens (fig. 1 a–c)[13]. Nor do they include the head of Telephos in lionskin cap which was stolen from the Tegea Archaeological Museum in 1992 and has not been recovered[14]. The fragments attributed to the east pediment, depicting the Calydonian boar hunt, are displayed in the Tegea Archaeological Museum from left to right as follows (fig. 2): headless female torso in chiton and himation (fig. 3 a)[15], headless quadruped (fig. 3 b)[16], head of a dog[17], male torso, composed of two fragments[18], fragment of upper male torso[19], fragment of lower male torso[20]. The fragments attributed to the west pediment, depicting the battle of Achilles and Telephos, are displayed in the Tegea Archaeological Museum, from left to right, as follows (fig. 4): fragment of a reclining female figure in peplos and himation (fig. 5 a)[21], fragment of a helmeted head[22], male torso[23], left arm with shield band (fig. 5 b)[24], helmeted head (fig. 5 c)[25], fragment of a male head[26].

Andrew F. Stewart attributed to the pediments an assortment of fragments, some of which had already been assigned by Charles Dugas[27], which he thought were appropriate to the themes of

12 Stewart 1977, 14–30 pls. 5–19. 53.
13 See n. 6 above.
14 TEG 60; see Stewart 1977, 22 f. no. 16 pls. 13; 14 a–b; Palagia – Coulson 1993, 271 no. 1.
15 TEG 2297. Excavated in 1965. Its excavator thought that it could not belong to the pediments of the Temple of Athena Alea because of its separately carved head, see Demakopoulou 1966, 153. Attributed to the east pediment by Stewart 1977, 16 no. 8 pl. 6 b–c.
16 TEG 2400. Excavated in 1965. The animal appears to be a rearing horse. Its excavator did not identify the animal nor did she associate it with the pediments of the Temple of Athena Alea, see Demakopoulou 1966, 154. Andrew F. Stewart (1977, 15 no. 7 pl. 6 a), however, interpreted the animal as a dog and attributed it to the east pediment.
17 TEG 89. See Stewart 1977, 15 no. 6 pl. 5 b–c.
18 TEG 64+1309. See Stewart 1977, 19 nos. 12–13 pls. 9 c; 10–11.
19 TEG 65. See Stewart 1977, 18 f. no. 11 pl. 9 a–b.
20 TEG 66. See Stewart 1977, 21 no. 14 pl. 12 a–b.
21 TEG 194. See Stewart 1977, 26 no. 20 pl. 17 b.
22 TEG 1597. See Stewart 1977, 28 no. 24 pl. 19 a.
23 TEG 67. See Stewart 1977, 29 f. no. 26 pl. 19 c–d.
24 TEG 2409. See Stewart 1977, 26 f. no. 21 pl. 17 c. Found embedded in the wall of a modern house.
25 TEG 154. See Stewart 1977, 24 f. no. 18 pl. 16.
26 TEG 63. See Stewart 1977, 27 no. 22 pl. 18 a.
27 Dugas – Berchmans – Clemmensen 1924, 76–116.



3 Tegea sculpture. a: Female torso TEG 2297. b: Headless quadruped, possibly a horse TEG 2400 (photos: O. Palagia)



4 West pediment of the Athena Alea Temple, as reconstructed in the Tegea Archaeological Museum. From left to right: reclining woman TEG 194, helmeted head TEG 1597, male torso TEG 67, arm with shield band TEG 2409, helmeted head TEG 154, fragment of male head TEG 63 (photo: O. Palagia)

the pediments. His attribution of the figures was not based on their find-spots because they had all been reused in later structures as building material. The main criteria were scale and style, but even those were not meticulously applied, for he argued that the figures of the west pediment were larger than those of the east by analogy with the scale discrepancy detected in the pedimental statues of the early-4th-century Temple of Asklepios at Epidauros[28]. He reached the conclusion

[28] Stewart 1977, 7. In the case of Epidauros, however, the figures of the east pediment appear to be larger than those of the west, see Yalouris 1992, 62. The scales of the figures within the pediments of the Temple of Asklepios also seem to vary according to their position, see Yalouris 1992, 62.



5 Tegea sculpture. a: Fragment of reclining woman TEG 194. b: Left arm with shield band TEG 2409. c: Helmeted head TEG 154 (photos: O. Palagia)

that the reconstructed standing height of the figures of the west pediment should be about 1.9 m, whereas that of the east pediment figures should be 1.6 m[29]. This discrepancy is rather unusual and should have been tested against the most obvious criterion for attributing pedimental figures: marble provenance. Are all fragments made of the same marble? Stewart was content to follow the verdict of the German and French excavators who had worked on the site in the late 19th and early 20th centuries. Marble identification in those days was of course entirely visual. The marble of the boar's head (fig. 1 c) was attributed to the ancient quarry of Doliana which lies about 8 km outside Tegea[30]. The fabric of the temple is also thought to be of Doliana marble. The source of the marble of the pedimental sculptures was accordingly acknowledged to be Doliana[31]. The only dissenting voice came from Adolf Furtwängler in 1906, who suggested that though the west pediment with the battle scene was probably of Doliana marble, the east pediment with the boar hunt must be of

29 Stewart 1977, 7.
30 Dugas – Berchmans – Clemmensen 1924, 79.
31 Tegea temple made of Doliana marble: Østby 2013, 181 f. (reflecting all earlier views). Pedimental statues thought to be of Doliana marble: Dugas – Berchmans – Clemmensen 1924, 80; Picard 1933, 412; Stewart 1977, 6.

Parian marble[32]. Furtwängler's suggestion has not been accepted. As a general rule, the pedimental sculptures of Greek temples are all of the same marble unless we have repairs. A case in point is the west pediment of the Temple of Zeus at Olympia: whereas the pedimental statues are made of Parian marble, three out of the four corner figures are of Pentelic marble. They are, however, later replacements, probably from the 1st century AD, after the original statues were damaged[33].

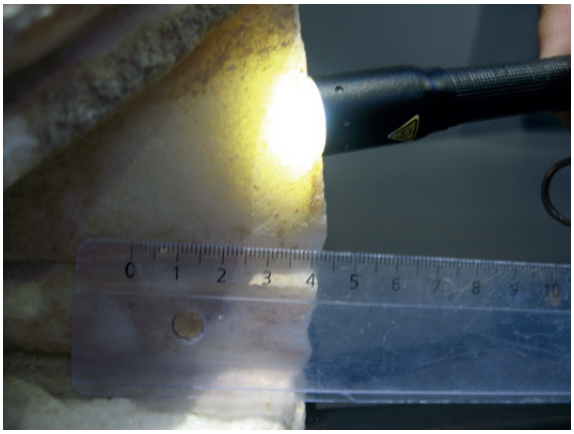
Thanks to the new display in the Tegea Archaeological Museum, it was possible to examine the pedimental statues at close range. Visual inspection, however, suggested that some figures were of Pentelic marble, while others appeared to be in Parian. It became clear that the provenance of the marbles could only be determined through scientific examination.

THE MARBLE PROVENANCE

Materials and Methods

We examined and analysed 15 sculptures, twelve in the Tegea Archaeological Museum and three in the National Archaeological Museum in Athens. We took samples from five representative fragments (figs. 1 a. c; 3 a; 5 a. c) exhibiting macroscopically different marble characteristics. All sculptures were first examined *in situ* non-invasively, and then the five selected ones were sampled and the samples analysed further in the laboratory.

In situ Examination and Analysis



6 Object TEG 194 (Reclining woman). Measuring the translucency and grain sizes *in situ* (photo: Y. Maniatis)

All 15 sculptures were examined in their entirety in the Tegea Archaeological Museum and the National Archaeological Museum in Athens. A cold light source, a millimetre scale and a magnifying lens 10 × were used for measuring the maximum grain size (MGS) and the most frequent grain size (MFS), and characterising the colour, the marble fabric and other qualitative features, such as the translucency, the veins and the inclusions (fig. 6)[34]. This *in situ* non-invasive examination is essential, as it allows the observation and recording of the physical characteristics of the marble in several parts of the whole object, thus obtaining an overall and average assessment of the marble features, overcoming the limitations of the sample, which is unavoidably small.

The objects were also analysed *in situ* non-invasively by means of a portable X-ray fluorescence instrument (pXRF) (Thermo-Niton) using the embedded program »Soils« in order to determine the concentration of trace elements and particularly that of strontium (Sr).

Sampling and Laboratory Examination and Analysis

As mentioned above, five samples were obtained from the selected sculptures (figs. 1 a. c; 3 a; 5 a. c). The samples were small, in the form of a few marble flakes extracted from a broken or

32 Cf. Neugebauer 1913, 10; Dugas – Berchmans – Clemmensen 1924, 79.
33 Palagia 2015.
34 Maniatis et al. 2021.

non-worked surface with a fine chisel. In this way, the sampling was practically non-invasive as regards the artistic, aesthetic or historical value of the object.

These flakes were used for the following laboratory examination and analysis:

- Examination of the flakes under a stereoscopic optical microscope, qualitative examination of the marble crystalline features and comparison of the maximum grain size (MGS) of the sample with that obtained from the whole object at the museums.
- Stable isotope analysis (IRMS) for carbon and oxygen.
- A description of these techniques and the methodology for provenance determination can be found in the relevant literature[35].

For stable isotope analysis, small grains of marble were cleaned by rinsing them briefly in diluted hydrochloric acid (HCl). They were then ground into a very fine powder, from which a sample of ca. 30 mg was submitted for isotope analysis to the GeoZentrum Nordbayern of the Friedrich-Alexander University Erlangen-Nürnberg, Faculty of Sciences. The method involved reacting the marble powders with 100 % phosphoric acid at 70°C using a Gasbench II connected to a ThermoFisher Delta V Plus mass spectrometer. All values are reported in per mil relative to VPDB. Reproducibility and accuracy were monitored by replicate analysis of laboratory standards calibrated by assigning a $\delta^{13}C$ of +1.95 ‰ to NBS19 and –47.3 ‰ to IAEA-CO9 and a $\delta^{18}O$ of –2.20 ‰ to NBS19 and –23.2 ‰ to NBS18. Reproducibility for $\delta^{13}C$ and $\delta^{18}O$ was ±0.0x and ±0.0y (1 standard deviation), respectively. Standard NBS19 was additionally analysed as a quality control sample.

Databases

The results of isotopic analyses and MGS were compared with data from known ancient marble quarries, accumulated over the last 30 years at the Laboratory of Archaeometry, National Centre for Scientific Research (NCSR) Demokritos[36] and with data published in the literature[37]. They were all combined in a single isotope database. The physical properties and qualitative crystalline features of the marble obtained from the *in situ* examination and the microscopic examination in the laboratory were also compared with the extensive sample bank of the above-mentioned quarry regions existing in the laboratory. The Sr analysis results were compared with published data[38].

Results and Discussion

The results of the examination and analysis are presented in table 1. As mentioned above, five out of the 15 objects were also sampled and analysed for carbon and oxygen isotopes. The rest were only examined and analysed *in situ* for Sr and other trace elements.

Objects Sampled and Fully Analysed

Figure 7 shows the isotopic signatures of the five samples fully analysed against the quarry fields compatible with their MGS measured. Figure 8 shows the Sr concentration of each of these

[35] Craig 1957; Polikreti – Maniatis 2002; Maniatis 2004; Attanasio – Brilli – Ogle 2006; Tambakopoulos 2013.

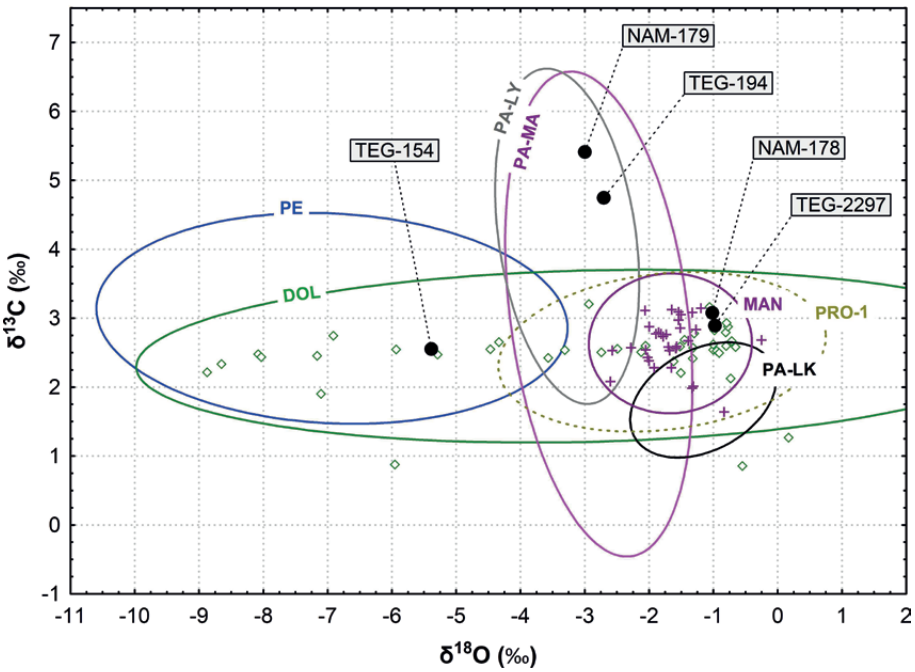
[36] Mandi 1993; Polikreti 1999; Maniatis – Polikreti 2000; Vakoulis 2000; Maniatis et al. 2012; Tambakopoulos – Maniatis 2012; Tambakopoulos 2013; Tambakopoulos – Maniatis 2017; Maniatis et al. 2021; Maniatis et al. (unpublished).

[37] Herz 1987; Bruno et al. 2002; Gorgoni et al. 2002; Attanasio – Brilli – Ogle 2006; Herz 2006; Attanasio – Bruno – Prochaska 2016.

[38] Gorgoni et al. 1992; Attanasio – Bruno – Prochaska 2016; Walter Prochaska (pers. comm.) about Sr data from Mani quarries.

Museum registration no.	Object	Marble and sample description	Translucency (cm)	MGS (mm)	MFS (mm)	Sr (ppm)	$\delta^{18}O$ ‰	$\delta^{13}C$ ‰	Provenance
East pediment									
NAM 179	Male head	White, generally fine-grained, a few larger grains; no veins; weathered	2.0	2.5	≤ 1.0	216	–3.0	5.4	**Paros (Ma/Ly)**
NAM 178	Boar's head	Whitish/greyish, fine-grained; no veins; opaque; weathered	≈0.0	2.0	1.0	111	–1.02	3.08	Doliana?
TEG 2297	Female torso	Whitish/crème, fine-grained; no veins; poor translucency	<1.0	2.0	1.0	93	–0.98	2.89	Doliana?
TEG 2400	Headless animal	White, generally fine-grained; no veins; weathering	2.5	1.5	1.0	152	n.m.	n.m.	Paros?
TEG 89	Head of dog	White, very weathered; chalky fabric; opaque	≈0.0	1.3	< 1.0	118	n.m.	n.m.	unknown
TEG 64+1309	Male torso in two parts	White, medium/fine grained; no veins; light weathering	2.0	2.0	1.0	187	n.m.	n.m.	Paros?
TEG 65	Male shoulder	White, fine-grained; no veins	2.0	1.5	≤ 1.0	160	n.m.	n.m.	Paros?
TEG 66	Fragment of male torso	White, fine-grained; no veins	2.5	1.2	≤ 1.0	177	n.m.	n.m.	Paros?
West pediment									
NAM 180	Helmeted head	White, very fine-grained; schistolithic veins; several pyrite inclusions	2.5	1.0	0.5	139	n.m.	n.m.	**Penteli**
TEG 194	Fragment of reclining woman	White, generally fine-grained, a few larger grains; no veins; highly translucent	4.0	2.5	1.0	149	–2.70	4.75	**Paros (Ma/Ly)**
TEG 1597	Fragment of helmeted head	White, very fine-grained; no veins	1.8	1.0	0.5	166	n.m.	n.m.	Paros/Penteli
TEG 67	Male torso	Whitish, very fine-grained; a lot of parallel cracking throughout; area on the chest of a few centimetres with quartz inclusions	2.0	≤ 1.0	–	160	n.m.	n.m.	Penteli?
TEG 2409	Arm with shield band	white, very fine-grained; clear silver schistolith veins; heavy weathering	–	1.0	–	149	n.m.	n.m.	**Penteli**
TEG 154	Helmeted head	White, fine-grained; schistolithic veins; weathered	1.0	1.0	0.5	156	–5.39	2.55	**Penteli**
TEG 63	Part of male head	White, medium/fine-grained; no veins; translucent	3.0	2.0	≤ 1.0	n.m.	n.m.	n.m.	**Paros**

Table 1 Optical, isotopic and pXRF results (TEG = Tegea Archaeological Museum, NAM = National Archaeological Museum in Athens). n.m. = not measured; bold = secure provenance



7 Isotopic signature of the Tegea samples fully analysed against the quarries corresponding to their MGS. PE = Penteli, DOL = Doliana, PA-LY = Paros-Lychnites, PA-MA = Paros-Marathi, PA-LK = Paros-Lakkoi, MAN = Mani, PRO-1 = Prokonnesos-1 (graphics: Y. Maniatis, StatSoft Statistica v.8)

samples compared with the published ranges of the relevant quarries shown in figure 7. We discuss each sample separately:

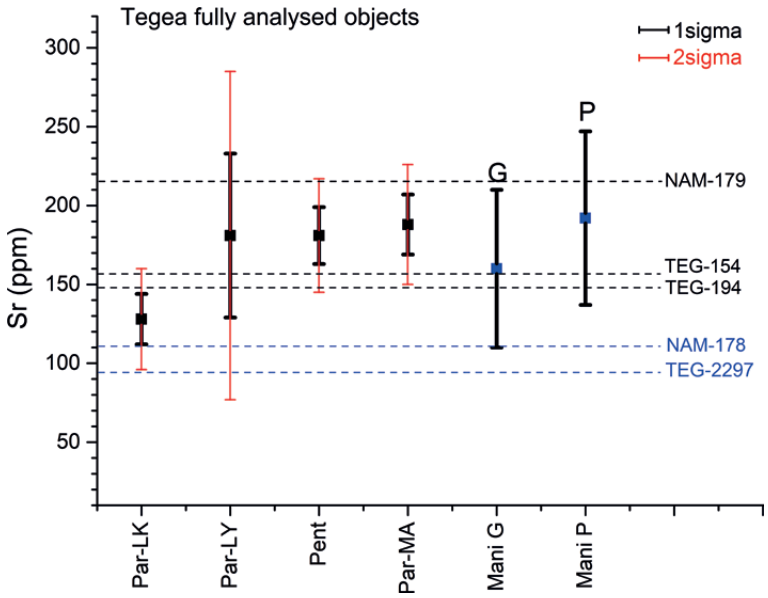
Helmeted head TEG 154 (fig. 5 c): its isotopic signature falls in the overlap of Penteli and Doliana. The grain-size distribution and the presence of foliation (schistolithic veins) leaves no doubt that its origin is Penteli.

Male head NAM 179 (fig. 1 a) and reclining woman TEG 194 (fig. 5 a): their isotopic signatures fall clearly and solely in the Paros-Marathi/Paros-Lychnites fields and their Sr content is in the range of PA-LY and marginally PA-MA. Their origin is clearly from Paros, either Paros-Lychnites or Paros-Marathi.

Boar's head NAM 178 (fig. 1 c) and female torso TEG 2297 (fig. 3 a): their isotopic signatures fall in the Mani, Doliana and Prokonnesos-1 fields. Prokonnesos can be excluded as it is not known to have been exported to mainland Greece in the 4th century BC. This leaves Mani and Doliana as the two possible options. We have no Sr data for Doliana but only for Mani. From that we can see that the Sr content of these two samples is practically outside the existing Sr ranges for Mani (fig. 8) and this may also agree with their marble quality. We can therefore conclude that their origin is most likely Doliana.

Objects Only Examined and Analysed by pXRF in situ (not Sampled)

The quantitative features of the marble of these objects (colour, veins, inclusions, translucency, MGS, MFS) – except for the dog's head TEG 89 –, point to either Penteli or Paros quarries. The Sr content is not of much help. It ranges between 152–177 ppm (tab. 1), which overlaps with the 2σ ranges of both quarries (fig. 8). Exceptions are the helmeted head NAM 180 (fig. 1 b), whose Sr is 139 ppm, slightly below the Pentelic range. However, the presence of schistolithic flakes across its sliding broken surface and the presence of iron pyrite inclusions abundant in the marble, leaves no doubt that this is Pentelic marble. The dog's head TEG 89, on the other hand, has a Sr content of 118 ppm, much lower than Pentelic and compatible only with Paros-Lakkoi and Paros-Lychnites. However, its chalky structure does not allow any judgement to be made



8 Sr content of the five Tegea samples fully analysed compared to Sr ranges for the relevant quarries shown in fig. 7. Sr data from Gorgoni et al. 1992; Attanasio – Bruno – Prochaska 2016 (Mani G); Walter Prochaska (pers. comm.) about Sr data from Mani quarries (graphics: Y. Maniatis, StatSoft Statistica v.8)

regarding its original marble quality. The arm with shield band TEG 2409 (fig. 5 b) has obvious silver schistolithic flakes across its broken edge, pointing clearly to Penteli, also compatible with its Sr content.

Using the marble qualitative features and similarities of certain trace elements, we tentatively assigned the provenance of the rest of the non-sampled objects to either Paros or Penteli with higher or lesser confidence, indicated with a question mark in table 1.

CONCLUSION

The fragmentary statues of the pediments of the Temple of Athena Alea at Tegea, as they are currently reconstructed in the Tegea Archaeological Museum (figs. 2–4), are made of three different kinds of marble, Pentelic, Parian and Doliana (see tab. 1). The inevitable conclusion is that a number of these fragments do not belong there. Where to begin? We have enough fragments of a battle scene in Pentelic marble (two helmeted heads NAM 180 [fig. 1 b] and TEG 154 [fig. 5 c], plus an arm with a shield band TEG 2409 [fig. 5 b]) to suggest that the west pediment showing the battle at the river Kaikos is of Pentelic marble. We may also recall Pausanias' statement that the statues of Asklepios and Hygieia by Skopas set up next to the cult statue of Athena Alea were of Pentelic marble, which indicates that Pentelic marble was employed in the sanctuary when the temple was being built. As for the rest of the fragments attributed to the same pediment, the fragment of a helmeted head TEG 1597 (fig. 4) and the male torso TEG 67 (fig. 4) may be of Pentelic marble, though without further analysis certainty is not possible (see tab. 1). But the fragment of a reclining woman TEG 194 (fig. 5 a) and the fragment of a male head TEG 63 (fig. 4) are of Parian marble (tab. 1) and must be excluded from the west pediment.

If the west pediment of the Temple of Athena Alea was of Pentelic marble, the odds are that the east pediment would be of the same marble. We have already seen that as a rule, Greek temple builders employed the same marble in both pediments of an individual temple. However, of the fragments assigned to the east pediment by Stewart (fig. 2), not a single one appears to be of Pentelic marble (tab. 1). The central figure of the boar NAM 178 (fig. 1 c), pivotal to a representation of the Calydonian boar hunt, is very likely of Doliana marble. The hunt also involved dogs, but the two dog fragments assigned to this pediment are problematic. The marble of the dog's head

TEG 89 (fig. 2) cannot be determined. The headless animal TEG 2400 (fig. 3 b), identified by Stewart as a dog, is more likely a horse, and its marble appears to be Parian. The female torso TEG 2297 (fig. 3 a), identified with the local heroine Atalante by Stewart, is most likely of Doliana marble. Its association with the Tegea pediments was already doubted by its excavator on account of its separately attached head[39]. The male head NAM 179 (fig. 1 a) has an oblique cutting on top which seems to indicate that it was flush against another surface. Stewart assigned it to the east pediment on the understanding that it abutted the raking cornice. It is nevertheless made of Parian marble. The fragments of the three male torsos (TEG 64+1309. 65. 66; see fig. 2), also attributed to the east pediment by Stewart, are likely made of Parian marble too, though the exact origin of their marble remains uncertain.

What to make of all this? Is it possible that the pediments of the Temple of Athena Alea were made of two kinds of marble, Pentelic for the west, Parian for the east? We have no other instance of a temple's pediments being made of two different kinds of marble, but we cannot exclude the possibility. Even so, among the fragments assigned to the east pediment, two are likely of Doliana marble, the boar's head NAM 178 (fig. 1 c) and the female torso TEG 2297 (fig. 3 a). The boar's head may well be a replacement figure assuming that the original boar statue was damaged. On the other hand, it may be part of a separate dedication. As for the female torso (fig. 3 a), it may well be part of a free-standing dedication. The headless quadruped TEG 2400 (fig. 3 b) may also belong to a free-standing dedication, as it is more likely a horse[40]. All these fragments were assigned to the pediments on account of their size, but we may assume that the sanctuary contained small-scale free-standing sculptures in addition to monumental ones.

However, the number of fragments in Parian marble points to another possibility. We have already seen that the altar of Athena Alea carried at least two sculptured scenes, described by Pausanias (8, 47, 3) as the birth of Zeus and the nine Muses accompanied by their mother Mnemosyne. Except for the infant Zeus, both scenes only appear to involve women. The head NAM 3602 has already been identified as one of the Muses from the altar[41]. The reclining woman TEG 194 (fig. 5 a) could also be associated with the altar. It is possible that the altar was decorated with further sculptures not mentioned by Pausanias, in which case our Parian marble fragments could belong there. Certainty is, of course, impossible.

In conclusion, the current reconstruction of the pediments of the Temple of Athena Alea in Tegea proposed by Stewart and implemented, at least in part, in the Tegea Archaeological Museum, is problematic and in need of revision on account of the disparate origins of their marbles. If we assume that both pediments were made of Pentelic marble, only five figures in the west pediment showing the battle of Achilles and Telephos appear to belong there. The rest of the figures now in the west pediment and nearly all figures assigned to the east pediment may have formed part of different monuments in the sanctuary. The heavily weathered condition of the fragments and their find-spots (embedded in later walls) do not allow much room for speculation.

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[39] See n. 15 above.
[40] See n. 16 above.
[41] See n. 6 above.

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FIRST ASSESSMENT OF MARBLE EXPLOITATION IN THE NORTHWEST OF SPAIN IN ANCIENT TIMES

Abstract
Marble outcrops are scarce in Galicia, the northwestern region of Spain. Nevertheless, a total of 168 marble artefacts dating from Roman times to the 13th century have been discovered in this region thus far. These pieces, often intricately carved and frequently repurposed, prompt inquiries regarding the origin of this specific type of stone. To gain a comprehensive understanding of potential local marble sources, an initial assessment of available information was conducted, followed by the examination and sampling of eight selected areas. These areas were prospected and underwent a preliminary visual evaluation to ascertain their viability as marble suppliers during the considered period, areas which are presented in this contribution. Contrary to previous assumptions, it is now evident that O Incio is not the sole plausible marble district utilised in Galicia during ancient times. Moreover, striking similarities between certain Galician marble varieties and those found in other regions of Iberia or the Pyrenees have compelled us to reassess previous attributions of provenance. As a result, this endeavour represents a significant advancement in the reconstruction of the historical map depicting exploited marble resources. While most of these quarries are currently abandoned or predominantly produce crushed aggregate rather than dimension stone, this study has unveiled a more intricate panorama than initially anticipated, particularly in relation to the Roman and medieval eras.

INTRODUCTION

»Surxindo de todas partes, de baixo do musgo ou das flores,
o granito puro e poderoso evoca un cruceiro«
(Hélène Fortoul, »Pierres de Galice«, 1928)

When contemplating the lithic resources of Galicia, it is usually the granite formations adorned with their brown cities and churches that capture attention, while marble assumes a relatively inconspicuous role. However, since the inception of the »Marmora Galicia« project[1], an extensive examination of previous studies and literary sources has revealed the existence of over 168 instances of marble pieces[2]. Noteworthy examples include significant Roman and medieval sculptures such as the »Crismón de Quiroga«[3], a Late Roman marble roundel, and the three marble

[1] This project started in 2012 within the framework of the HAR2011-25011 I+D+i project funded by the Spanish Government and has continued until now thanks to the strong collaboration between a Spanish-French team led by Silvia González Soutelo and Anna Gutiérrez Garcia-Moreno, under the HAR2015-65319-P (MINECO/FEDER), the PGC2018-099854-A-I00 (MICIU/AEI/FEDER, UE), the »Marmora et lapides Hispaniae« and the »ROMAE« (LaScArBx) projects. For some of the results of these projects, see González Soutelo – Gutiérrez Garcia-Moreno – Royo Plumed 2014; Gutiérrez Garcia-Moreno – Royo Plumed – González Soutelo 2014; González Soutelo et al. 2016; Gutiérrez Garcia-Moreno et al. 2016; González Soutelo – Gutiérrez Garcia-Moreno – Royo Plumed 2018; Gutiérrez Garcia-Moreno – Royo Plumed – González Soutelo 2018; González Soutelo et al. 2020; Lapuente Mercadal et al. 2020; González Soutelo et al. 2022.

[2] The majority of these artefacts are housed in museums or other heritage institutions, some are found in churches that are in use or have been repurposed, and only a few have been uncovered in archaeological contexts as a result of recent excavations. Unfortunately, certain items mentioned in written sources have not been located.

[3] Arias Vilas – Le Roux – Tranoy 1979, 105; Gómez Vila 2009.



1 Macroscopic appearance of the primary visually distinct marble types discovered within the Galician territory, dating from the 1st to the 13th century AD. The archaeological artefacts depicted in the figure are presented on a consistent scale and correspond to those referenced in table 1 (photos and graphics: M.-C. Savin)

columns flanking the double entrance of the »Puerta de Platerías« in the Cathedral of Santiago de Compostela.

80 % of the referenced artefacts are architectural elements (capitals, column shafts, bases, chancels, *mensulae* and thresholds), while the remaining 20 % comprise inscriptions and sarcophagi[4]. Through a detailed examination of the macroscopic features of the majority of these objects, the

4 For a short description of all these Roman and pre-Roman marble objects, see González Soutelo – Gutiérrez Garcia-Moreno 2020.

Marble visual varieties	Transl.	Examples
 1 Pure fine white	L–M	Roman statuary group of Dionysus and Ampelus, Castro of A Muradella, Mourazos, Verín
 2 Coarsed-grained white (2–4 mm)	L–M	Roman funerary plaque of Santa Eulalia de Bóveda (IRPLu 88)
 3 Fine-grained white with greyish bands	L	Three columns of the Platerías facade of Santiago de Compostela Cathedral
 4 Dull fine-grained white with greyish bands, zones and occasional orange veins	L	Altar table of Santa Comba de Bande Church
 5 Fine white to cream marble with occasional pink or red veins	M	Roman funerary plaques found at San Pedro de Cela (Pontevedra) (CIL XI Supp. 5614)
 6 Fine white with grey veins	L–M	Twisted column of the Portal of Glory (central arcade, north side) of Santiago de Compostela Cathedral
 7 Fine-grained white grey banded	L–M	Northwestern column of Santa Comba de Band church
 8 Coarsed-grained white-grey banded (2–4 mm)	L–M	Roman funerary plaque of Vilaboa (EE IX 283c)
 9 Medium-grained mid-grey	L	Northernmost column of the Portal of Glory (north side arcade) of Santiago de Compostela Cathedral
 10 Coarsed-grained grey (> 4 mm)	H	Iconostasis de San Pedro de Carcasía (conserved at the Museum of the Santiago de Compostela Cathedral
 11 Fine pink with parallel greenish stripes	L	Northern column in the Setecoros church

Table 1 Visual characteristics of the registered and observed archaeological pieces. The table includes information on the carbonate grain size, visually categorised as fine (< 1 mm), medium (1–2 mm), or coarse (> 2 mm). Additionally, the level of translucence (Transl.) is indicated as L (low), M (medium), or H (high)

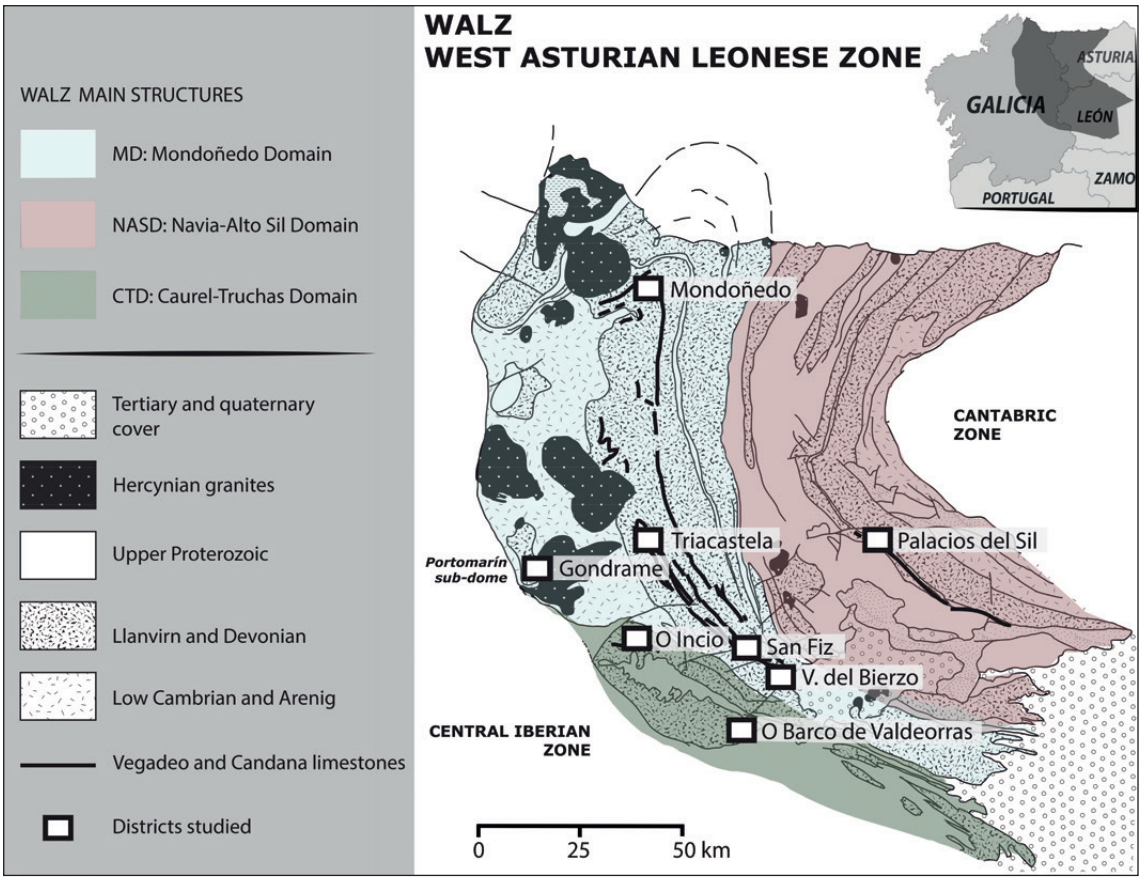
main characteristics of the utilised marble were initially recorded. Overall, eleven visually distinguishable marble types were observed based on grain size, colour patterns and translucency (fig. 1).

The presence of this assortment of marble artefacts and the infrequency of this resource in Galicia raises questions regarding its acquisition. Regrettably, there are no ancient or medieval literary sources detailing stone supplies in this region. Only a few scholars from the 18th to the mid-20th century briefly mention the existence of marble quarries[5].

Thanks to the efforts of the Geological and Mining Institute of Spain (IGME), the precise locations of various rock outcrops are now clearly determined, along with the identification of active and abandoned quarries. Furthermore, the same institution has published a valuable review of the current rocks and mineral deposits, as documented by Ferrero Arias and colleagues in 2008[6].

In the 1970s, archaeologists and historians became increasingly interested in studying ancient stone exploitation in Spain, particularly in relation to antiquity. Alicia Canto's pioneering work in compiling a list of Roman-era Spanish dimension stones[7] laid the foundation for subsequent

5 Cornide Saavedra y Folgueira 1783, 57; Larruga 1798; Madoz 1846, 428; Soler 1883; Amor Meilán 1936.
6 Ferrero Arias et al. 2008.
7 Canto 1977.



2 Simplified geological map of the West Asturian Leonese Zone (graphics: M.-C. Savin after Pérez Estaún et al. 1990)

research in this field. However, the northwest region of Spain has received limited attention in terms of marble research, with the focus primarily on O Incio as the marble source, described as the sole supplier of local marble in this corner of Hispania[8]. Petrographic analyses were sporadic and lacked a comprehensive reference database, impacting the accuracy and reliability of findings[9]. Notable among these efforts was a provenance study combining petrographic and cathodoluminescence analyses of artefacts from Astorga, the ancient city of Asturica Augusta[10], although some provenance assignments would require archaeometric re-evaluation in the light of the studies that have been carried out in the last decade. The location of Galicia, situated far from the Mediterranean and the commonly travelled marble trade routes in antiquity, was a significant factor that piqued our interest in this region.

A significant majority of these artefacts were carved from a dull white-grey banded marble, commonly associated with O Incio (type 7). The remaining varieties are represented by a limited number of objects, and in some cases, only a single piece (fig. 1 and tab. 1).

Once the range of marble varieties was established, the key points in our study were twofold. Firstly, it was imperative to accurately identify potential geological sources that could potentially match the marbles under investigation. Secondly, we aimed to determine whether these sources

8 Braemer – Deicha 1986; Lapuente Mercadal – Cisneros – Ortiga 1988; Lintz – Decrouez – Chamay 1991; Barbin et al. 1992; Attanasio – Brilli – Ogle 2006; Rodà de Llanza 2012.

9 E.g. Casas Ponsati – Vaquer Navarro – Vendrell Sanz 1996.

10 Cisneros Cunchillos – Aguilar – de Miguel 2010.

were exploited during ancient times, thus providing the necessary raw materials for the carving of the archaeological objects under scrutiny.

GEOLOGICAL SETTING

From a geological perspective, marbles sensu stricto constitute a mere fraction of Galicia's total surface area, amounting to less than 5 %[11]. These marbles are predominantly found in the eastern half of the province of Lugo, extending westward into the region of Castilla-León, particularly in the El Bierzo area. They are situated exclusively within the WALZ (West Asturian Leonese Zone), exhibiting a narrow, submerged alignment in a north to south-east direction (fig. 2). These marble bands, which are rarely exploitable, are interspersed with other rock formations, primarily schists, slates, and quartzites. Generally, the outcropping marble formations are either of insufficient quality or located in inaccessible regions[12]. Only the eight districts illustrated by the white squares in figure 2 hold potential for viable rock extraction. Stratigraphically, these marble formations can be classified into two groups of Cambrian age, namely Cándana and Vegadeo. Additionally, the O Barco de Valdeorras district corresponds to a more recent formation referred to as La Aquiana, belonging to the Upper Ordovician age[13].

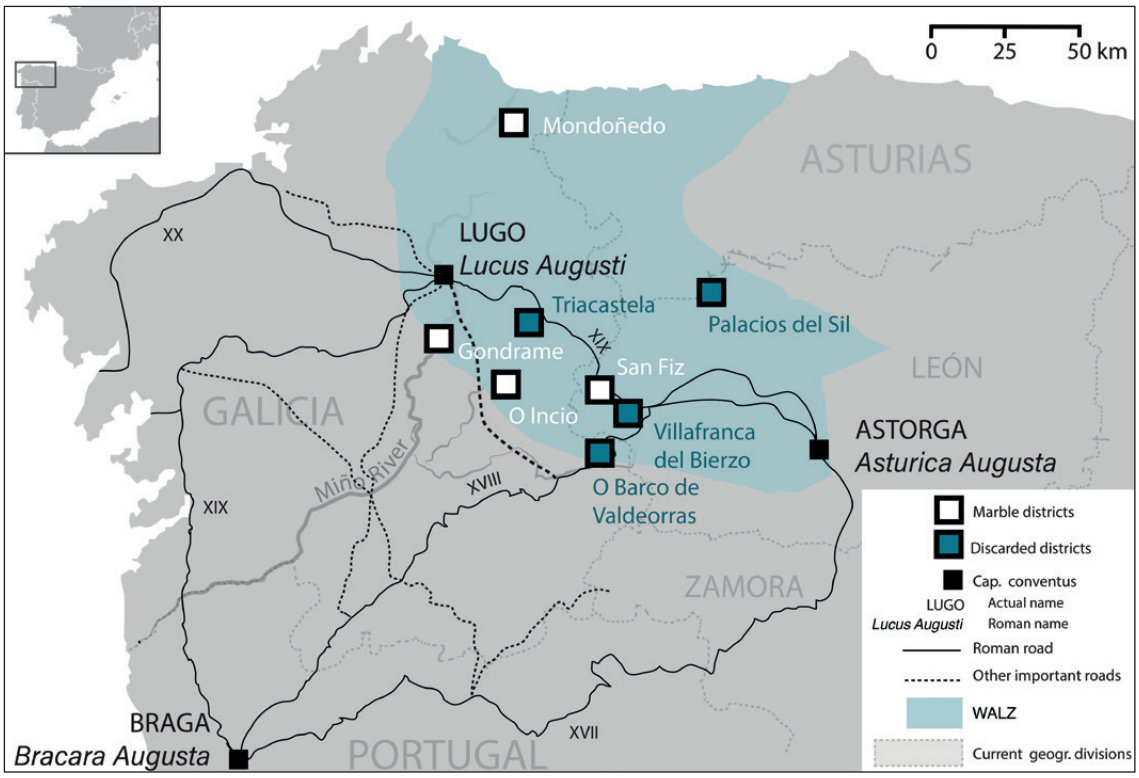
METHODOLOGY

The methodology employed in this study involved a systematic assessment of the eight aforementioned districts to ascertain whether they were subject to exploitation during antiquity or the Middle Ages. Initially, all available historical documents pertaining to each district were gathered and scrutinised to identify any references related to potential quarrying activities predating recent exploitations. Recognising that the passage of time and the ease of transportation had a multiplying effect on stones prices, even over short distances[14], we estimated the accessibility of the districts by considering the primary communication routes available during those time periods, encompassing both land and river transport. Given that Roman roads continued to be utilised during medieval times[15], the marble districts were plotted based on a map published in 2015 after conducting GIS processing (least cost paths analysis) of roads established in 2004, drawing upon a combination of 630 milestones, 44 other epigraphic documents, classical written sources, and remnants of road sections[16].

Following this, several field surveys were conducted within the quarrying districts and their surrounding areas. The primary objective of these surveys was to investigate the presence of historical extraction traces and the quarrying techniques employed at each site, based on the classification established by Jean-Claude Bessac[17]. These on-site visits also allowed for direct visual assessment of the available marble varieties, using simple macroscopic criteria such as colour, uniformity, presence of veins or bands, grain size, and translucency. Furthermore, these visits served as a solid foundation for defining the appropriate sampling strategy[18]. Finally, whenever possible, we documented the potential dimensions of extracted blocks by measuring abandoned blocks or observing negative marks on quarry faces.

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11 Taboada Castro – Silva Hermo – Barral Silva 1999.
12 Ferrero Arias et al. 2008.
13 Taboada Castro – Silva Hermo 1999; Gibbons – Moreno – Geological Society of London 2002.
14 DeLaine 1997, 216 f.; Russell 2013, 95.
15 Ferreira Priegue 1988.
16 Rodríguez Colmenero – Ferrer Sierra – Álvarez Asorey 2004.
17 Bessac 2003.
18 185 samples have been taken from these sites to archaeometrically characterise them. Some results are already available and others have been carried out within the framework of a PhD thesis, see Savin 2021.



3 Geographical positioning of the eight districts under study, along with the navigable water channels and the Galician Roman roads (graphics: M.-C. Savin after Rodríguez Colmenero – Ferrer Sierra – Álvarez Asorey 2004; Güimil-Fariña – Parcero-Oubiña 2015; Fonte – Parcero-Oubiña – Costa-García 2017)

DESCRIPTION OF THE MARBLE DISTRICTS

The results for each of the eight selected districts are presented hereunder and several aspects (geological formation, visual varieties detected, accessibility and ancient extraction evidences) are summarised in table 2. The map (fig. 3) helps visualising the quarries' situation in relation to land routes and navigable water channels.

O Incio Area

The O Incio area is recognised as one of the two districts in Galicia where large blocks of marble have been extracted until recently for cutting in sawmills and subsequent distribution for ornamental purposes[19]. As already mentioned, a significant portion of the archaeological marble pieces found in Galicia have been visually attributed to this district. Due to the historical significance of this region, an archaeometric characterisation has already been conducted and published[20].

An exemplary application of O Incio marble can be observed in the Romanesque San Fiz church, located in the hamlet of Hospital, which is entirely constructed using this marble variety (fig. 4). Additionally, the utilisation of O Incio marble is evident in the marble slabs that adorn the current municipality hall in the central nucleus of houses within the O Incio region. These examples serve to highlight the usage and aesthetic appeal of O Incio marble in architectural and decorative contexts.

19 Ferrero Arias et al. 2008.
20 Gutiérrez Garcia-Moreno et al. 2016.

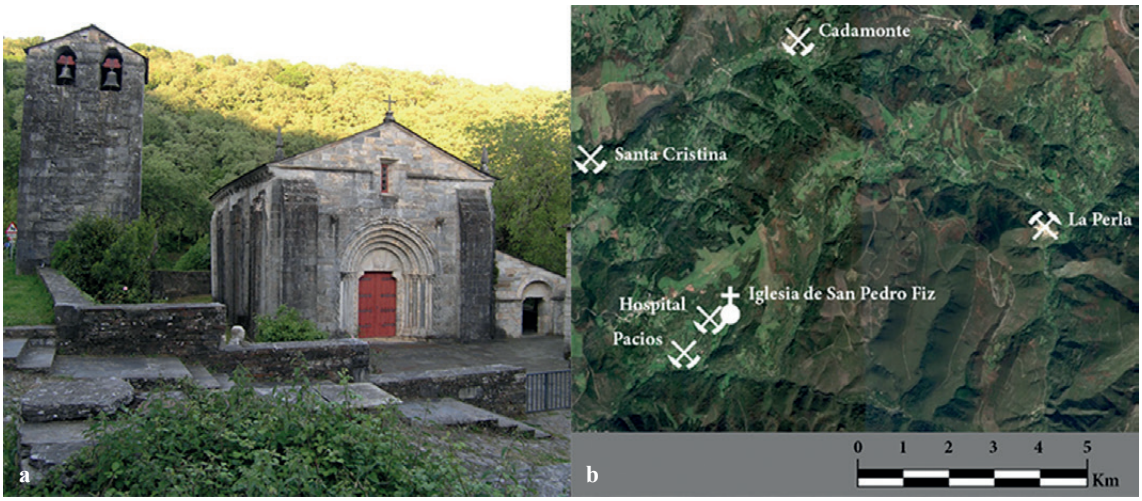
District	WALZ unit	Formation	Visual varieties	Distance (km)		Accessibility	Ancient extra marks
				Lugo	Astorga		
1 Olnico	CTD	Cándana (Vegadeo: La Perla)	3 dull fine-grained marbles (grain size c. 1 mm) with low translucency: ● White with greyish bands, zones and occasional orange veins ● White-grey banded ○ Dark grey	40	110	++ Cabe river, tributary to the Sil	Hospital, Pacios (orthogonal cuts, vertical surfaces)
2 Mondoñedo	MD	Vegadeo	Various fine-grained marbles with low translucency: ● White with greyish bands ● Pink with fine, parallel greenish stripes ○ Mid grey with parallel grey stripes ○ Dark grey	50	150	+++ Masma river (11–24 km from the Cantabrian Sea)	None
3 Gondrame	MD	Cándana	● Coarsed-grained white-grey banded (2–4 mm) with low translucency	23	130	+++ Miño valley (non navigable section of the river)	As Eiras (orthogonal cuts, vertical surfaces)
4 San Fiz do Seo	MD	Vegadeo	● Fine-grained pink with parallel greenish stripes ○ Fine white with parallel greenish stripes	66	73	+++ Roman road XIX (but the road layout is already uphill and conversely in this zone)	None
5 V. del Bierzo	MD	Vegadeo	Various fine-grained marbles: ○ White-grey laminated ○ Dull fine-grained with white greyish bands, zones and frequent pink veins ○ Dark grey ○ Pinkish	75	60	+++ Roman road XIX, few kilometres away the crossroads from road XVIII	None
6 P. de Sil	NASD	Cándana	○ Coarsed-grained (c. 2 mm) pinkish marble with occasional pink-orange veins	93	56	+ Far from road, river and maritime networks	Orthogonal cuts, vertical surfaces
7 Triacastela	MD	Cándana	○ Dark grey	38	103	+++ On the Way of St James since Medieval times	None
8 B. de Valdeoras	CTD	La Aquiana	× Non-exploitable (fractured stones)	80	60	+++ Roman road XVIII	None

Legend

● Visual match with archaeological marble pieces

○ No visual match with archaeological marble pieces

Table 2 Brief description of the visual varieties, the accessibility and the presence of ancient extraction marks present in each studied district



4 O Incio municipality. a: San Fiz church. b: Geographical situation of the quarries around the church (photo and graphics: M.-C. Savin)

A total of six quarries have been identified within the O Incio area. The quarries closest to the centre of O Incio are situated in the hamlets of Hospital and Pacios. Additionally, there are quarries located in Buxán do Viso, Santa Cristina do Viso, Vilamor de San Salvador do Mao (referred to as Cadamonte), and the quarry known as La Perla (although it is 7 km away from O Incio, it is included in this district as it is in the neighbouring municipality of Samos).

The potential for block extraction varies significantly among the different quarries. The Santa Cristina quarry face, for instance, currently exhibits extensive fracturing and appears to yield only small blocks measuring less than 0.5 m on each side. In contrast, other quarries offer the possibility of extracting larger blocks, reaching approx. 2 m in length.

Comparisons between the dimension stones visible on the quarry faces and the marble used in a substantial portion of the recorded archaeological objects show significant similarities. Materials from Santa Cristina and Buxán do not match the marble identified in the archaeological assemblage, thus they are excluded as potential sources.

The quarries in Hospital and Pacios have been previously studied[21], and subsequent surveys of the remaining quarries in this district, namely Cadamonte and La Perla, demonstrated that they produce materials that visually match those found in the archaeological records. Furthermore, these quarries exhibit a favourable rippability of the rock mass.

Mondoñedo Area

This is the second most significant district known for providing marble of ornamental value. At present, all marble dimension stone production takes place in this region[22]. However, only a few mentions of its use in modern times are found in the literature. One such mention is the funeral monument erected in memory of the composer Pascual Veiga, as referenced by the writer Ramón Otero Pedrayo[23].

During our field surveys, we confirmed the contemporary uses of Mondoñedo marble in municipal cemeteries. Nevertheless, to our surprise due to the relatively widespread availability of this stone in the area, no evidence of its earlier use was found in the surrounding buildings.

21 Gutiérrez Garcia-Moreno et al. 2016.
22 Ferrero Arias et al. 2008.
23 Pedrayo 1965, 172 f.



5 a: Funeral monument of Pascual Veiga (photo: M.-C. Savin). b: 19th-century photograph of the marble quarries of Sasdónigas in the municipality of Mondoñedo (from Amor Meilán 1936, 66). c: The abandoned exploitation at the same quarry (photo: M.-C. Savin)

A total of twelve quarries were identified in the vicinity of Mondoñedo, including those located in the neighbouring municipality of Lourenzá. However, only six of these quarries were surveyed due to limited access to those that are still active. Out of these, only the quarries of Sasdónigas, Reiriz, and O Moural have the capacity to readily supply blocks measuring up to 3 m in length (fig. 5). These three quarries allow the extraction of larger blocks, which makes them suitable for fulfilling dimensional requirements in terms of length.

The white variety, characterised by its rather homogeneous appearance, exhibits a noteworthy resemblance to the columns adorning the south façade of the Santiago de Compostela Cathedral. Additionally, the pink marble, finely layered with greenish stripes, bears striking visual similarities to the material employed in the construction of the northern column of the Setecoros church mentioned in the introduction. Analytical techniques will be applied in the near future in order to check this possible matching.

Gondrame Area

Similar to the situation in O Incio, the presence of marble outcrops in this region was already acknowledged by 18th-century scholars[24]. Additionally, a more recent reference has been discovered, providing further confirmation[25].

Two churches, the Romanesque churches of San Juan and San Pedro in Portomarín (fig. 6), are entirely constructed with these marbles and thus serve as splendid showcases of the visual diversity presented by the available marble varieties in the region. Located merely 3 km from Gondrame, Portomarín resides along the renowned pilgrimage route known as the Way of Saint James, leading to the venerated shrine of Saint James the Great at the Santiago de Compostela Cathedral. The corresponding 1 : 50,000 geological map indicated the presence of two quarries in the area. One quarry was located in the village of As Eiras, while the other was situated in the neighbouring village of Paradela, specifically in the vicinity known as Loio[26]. Adjacent to certain quarry faces, remnants of abandoned irregular blocks (sometimes subrectangular) measuring less

24 Cornide Saavedra y Folgueira 1783, 55; Larruga 1798, 111.
25 Garcia Iglesias 1999, 44.
26 This second quarry proved elusive, and only the quarry in As Eiras was successfully located and surveyed.



6 a: View of the main door of the Romanesque church of San Juan in Portomarín (photo: M.-C. Savin). b: Detail of the tool-marks found at the quarry of Gondrame near As Eiras (photo: A. Gutiérrez Garcia-Moreno). c: Abandoned, completely detached blocks at the same quarry (photo: A. Gutiérrez Garcia-Moreno)

than 1.5 m in length can still be observed. The largest of these blocks measures approx. 1.4 m in width, 0.8 m in height, and 1.1 m in depth. Furthermore, the low occurrence of fractures within the exposed rock layers at As Eiras suggests the potential for extracting even larger blocks.

This particular stone exhibits notable similarities with certain Roman inscriptions discovered in the region[27]. The close resemblance of the stone to specific archaeological artefacts, combined with the relatively accessible nature of these outcrops, is of particular interest. Notably, this region stands out as the sole location where a white-grey marble displaying such grain size (generally around 2 mm) has been observed. However, due to its resemblance to certain Pyrenean marbles, further examination is warranted to establish conclusive findings[28].

San Fiz Area

The inclusion of this area in our research is based on compelling evidence of marble exploitation for slab-cutting purposes[29]. Furthermore, its location on the western slopes of the Sierra do Courel Mountains, the same mountain range where the O Incio district is situated, adds to its significance. Additionally, previous studies have established a connection between this area and archaeological findings in Astorga, the ancient Asturica Augusta[30].

Marbles from this district were used in the construction of the church and fountain in the village of San Fiz. The district encompasses the open-pit quarries of San Fiz do Seo and Ambasmestas, situated near their respective villages. While existing literature suggests that only slab

27 See e.g. the Roman funerary stelae found in two different fragments (IRLu 30 and 88) and currently at the Provincial Museum of Lugo: Arias Vilas – Le Roux – Tranoy 1979. A first attempt to provenance its marble was made but with inconclusive results (Gutiérrez Garcia-Moreno – Royo Plumed – González Soutelo 2018), but recent ongoing analysis combining optical petrography, cathodoluminescence and isotopic analysis points in this direction.

28 See the recent update survey carried out in the past few years: Royo Plumed 2016; Royo Plumed et al. 2018; Lapuente Mercadal et al. 2021; Lapuente Mercadal 2022.

29 Cabrera et al. 1997.

30 Cisneros Cunchillos – Aguilar – de Miguel 2010.

production takes place due to the pronounced schistosity of the rocks, our own observations challenge this notion. Numerous abandoned blocks in these two quarries indicate the feasibility of extracting dimension blocks, with the largest block we observed measuring 0.5 m in width, 1.5 m in length, and 1.2 m in height.

The pink variety of marble found in this district, also present in the quarries of Mondoñedo, bears a striking resemblance to the marble used in the pinkish column of Setecoros church mentioned in the introduction.

Villafranca del Bierzo Area

As in the case of San Fiz, this area was included in spite of its position in the province of León due to its proximity to Roman roads and the existence of exploitable marble outcrops.

No clear evidence of the use of marble from this district has been found. Two opencast quarries (Corullón and Toral de los Vados) were located and surveyed. At Corullón, the abandoned blocks found on site were modest-sized (less than 1 m long, the biggest one being 0.6 × 0.5 × 0.5 m).

No clear match has been observed between the marble outcropping in this district and the marble objects in our assemblage. Nevertheless, as for the marble from the previous district, we cannot exclude the possibility of it being used in the province of León during ancient times.

Palacios del Sil Area

White marble from this area is known to have been used for ornamental purposes in the 18th century, as mentioned by the head mining engineer José María Soler in relation to the use of white marble from Tejedo del Sil and Cuevas del Sil in the construction of the Grand Staircase at the Palacio Real, in Madrid[31].

Several door and window frames with dressed stone in the village of Tejedo del Sil are made with local marbles. The marble used was medium- to coarse-grained (ca. 2 mm, sometimes more) and generally of white or slightly pinkish colour and with sporadic pinkish or orange veins.

Several abandoned quarry fronts were located in Tejedo del Sil along the path known as Camino de la Fontanina on the quarry of Vistousel and a quarry located in Cuevas del Sil. The presence of large, rectangular blocks abandoned nearby is worth mentioning; the dimensions of the biggest one are 1.5 × 1 × 0.5 m (quarry of Vistousel).

No match was observed between these rocks and the collection of archaeological pieces from Galicia under study. Nonetheless, the presence of white marble with pinkish veins strongly recalls some well-studied Portuguese varieties attested in the archaeological record of the Roman Hispania Baetica and Lusitania[32].

One cannot presume the use of this type of rock in the archaeological record kept on Galician territory, but this area is nevertheless of particular interest. Indeed, some marble veneers found during excavations in the town of Astorga (ancient Asturica Augusta) have been identified as coming from Portugal[33] but the present detection of these local rocks with similar characteristics to the Portuguese ones strongly suggests that we should be more cautious and re-examine previous provenance attributions; the interest is all the greater as it would significantly change the economic implications.

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31 Soler 1883, 24.

32 Lapuente Mercadal – Cisneros – Ortiga 1988; Lapuente – Turi 1995; Lapuente Mercadal et al. 1999; Lapuente et al. 2014; Nogales-Basarrate et al. 2015.

33 Cisneros Cunchillos – Aguilar – de Miguel 2010.

O Barco de Valdeorras Area

This district is in the surroundings of an area with huge importance in respect to mineral exploitation: the archaeological site of Las Médulas, the largest gold mines of the Roman Empire. Broken by mining collapses and neoformed by a polluting extractive industry[34], the landscape was profoundly and permanently modified, thus providing a spectacular example of the intensive exploitation for metal of this territory by the Romans. We explored nearby crystalline limestone quarries, but none of the surveyed quarries[35] matched the marbles found in the archaeological record. Therefore, these quarries can be ruled out as sources for the studied marble objects.

Triacastela Area

According to the »Codex Calixtinus«, a compilation of texts dated to the 12th century, pilgrims were invited to collect ›limestone‹ at Triacastela to supply the lime-kilns producing the mortar necessary for the construction of the Romanesque Basilica of Santiago de Compostela[36]. Located on the Way of Saint James, it seemed important to check the visual aspect the metamorphic limestone outcrops.

The eight quarries listed in the recent review of Galician industrial rocks and minerals[37] were surveyed. As in the previous case, we can dismiss these quarries as the likely origin of any of the marble objects under study because the material, a fine dark-grey marble, is distinctly different.

CONCLUSIONS

As shown in this quick review, the study of these quarry districts has revealed a more complex panorama than initially expected. Contrary to what was previously thought, it seems clear today that O Incio is not the only plausible marble district in the northwest part of the Iberian Peninsula (modern Galicia) that was exploited and used in the distant past.

The comparison of the locally available marble varieties with the Galician archaeological record allows us to discard four districts as the sources of marble used during the first thirteen centuries AD in Galicia: Triacastela, O Barco de Valdeorras, Villafranca del Bierzo and Palacios del Sil.

The remaining four potential districts provide quite distinct materials, with the exception of the case of the fine pink marble with parallel greenish stripes found at both Mondoñedo and San Fiz do Seo. Within each district there are generally several quarries providing the same visual varieties.

Disregarding the pink marble, the other varieties similar to the archaeological record found in the territory are white to grey marbles with fine or coarse grain (tab. 2). These marbles have the disadvantage of being extremely common and can therefore be confused with marbles from larger marble regions such as the Estremoz Anticline or the Pyrenees, or even from the Mediterranean Basin. Due to the diversity of visually distinguishable varieties and the characterisation problems of the latter compared to potential imported marbles, each variety requires a detailed archaeometric characterisation. This work has already been undertaken in the aforementioned PhD thesis[38] and will be the object of future specific publications in due time.

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34 López-Merino et al. 2014; Hillman et al. 2017.

35 Four of the eleven quarries listed in the recent review of Galician industrial rocks and minerals (Ferrero Arias et al. 2008, 59) were surveyed: they are the quarries of Pereda, Peña Argel, Xardoal and Jagoaza.

36 *[…] inde Triacastella, in pede scilicet ejusdem montis in Gallecia, ubi peregrini accipiunt petram et secum deferunt || usque ad Castaniollam af faciendam calcemad hopus basilice apostolice*. Transcription of Jeanne Vielliard in Vielliard 1978, 8.

37 Ferrero Arias et al. 2008, 59.

38 Savin 2021.

Concerning ancient quarrying techniques, the general lack of evidence preserved on the quarry fronts is a major hindrance. Neither clear evidence of Roman nor of medieval extraction have been identified although a few traces of quarrying by traditional methods have been noticed. Unfortunately, most quarries are in remote locations, in the shadow of a dense bush or destroyed by modern exploitations.

In a more holistic manner, granite, slate and metal resources are well known to Galician people, but there is very little awareness of marble resources. A few years ago, a journalist from the Galician newspaper »El Progreso de Lugo« wrote an article entitled »People are Surprised that the Church is Made of Local Marble«, regarding the O Incio church of Hospital[39]. We hope that the present study might help highlight the specific ornamental value of these often undervalued Galician marbles.

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[39] Casanova 2012.

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PROVENANCE IDENTIFICATION II: OTHER STONES

Georgia Delli – Wioletta Tenczar – Vasiliki Anevlavi

MACROSCOPIC OBSERVATIONS OF THE MARMOR IASSENSE FROM THE BISHOPRIC CHURCH IN PYTHAGOREIO (SAMOS)

A CONTRIBUTION TO THE STUDY OF THE MONUMENT

Abstract
In the eastern Aegean lies the island of Samos, well known for its ancient wealth and power. The centre of the island was the city of Samos, nowadays known as Pythagoreio. The current study focuses on the macroscopic observations of reused material in the 7th-century AD basilica in the Byzantine castle of the area. The church was built after the destructive attack by the Arabs in 665/666 (?) using salvaged material from the city. The research is mainly focused on coloured stones, especially the columns of the central aisle, which indicate imported sources. Part of the coloured material can be found either *in situ* within the basilica's peristyle or scattered around the castle grounds. Excavations revealed that the basilica was built on top of a Hellenistic-Roman villa that may have been used by Emperor Augustus. Material from Iasian quarries indicates the wealth and extensive trade network between Pythagoreio and other cities of the region in antiquity. This material cannot be found in any other archaeological sites or Byzantine churches on the island of Samos. These material aspects are preliminary observations, part of a general study of the basilica.

INTRODUCTION

Throughout antiquity and medieval times, the city of Samos, nowadays known as Pythagoreio, was the military, political and religious centre of the island. The city is located in the southeast of the island (fig. 1), at the east end of the gulf of Samos, also known as Tigani[1]. Nowadays, a modern town, Pythagoreio, has been established on top of the ancient remains. The island of Samos enjoyed a peaceful and wealthy way of life during Late Antiquity, with evidence so far indicating a lavish lifestyle[2]. Excavations by the Ephorate of Antiquities of Samos and the German Archaeological Institute have revealed parts of the ancient and medieval city[3]. A walled enclosure surrounded numerous temples, a gymnasium, an agora, and houses. During Late Antiquity, there were some alterations, with the addition of numerous early Christian basilicas, an early Christian cemetery similar to the one in Ephesos[4], a Roman aqueduct and several Roman villas scattered throughout the city and on the outskirts[5]. One of these villas, dated to Hellenistic-Roman times was built on the hilltop of the port and may have been used by Emperor Augustus[6].

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1 »Tigani« in Greek means frying pan. The characterisation was given due to the high temperatures during summer and the shape of the gulf.

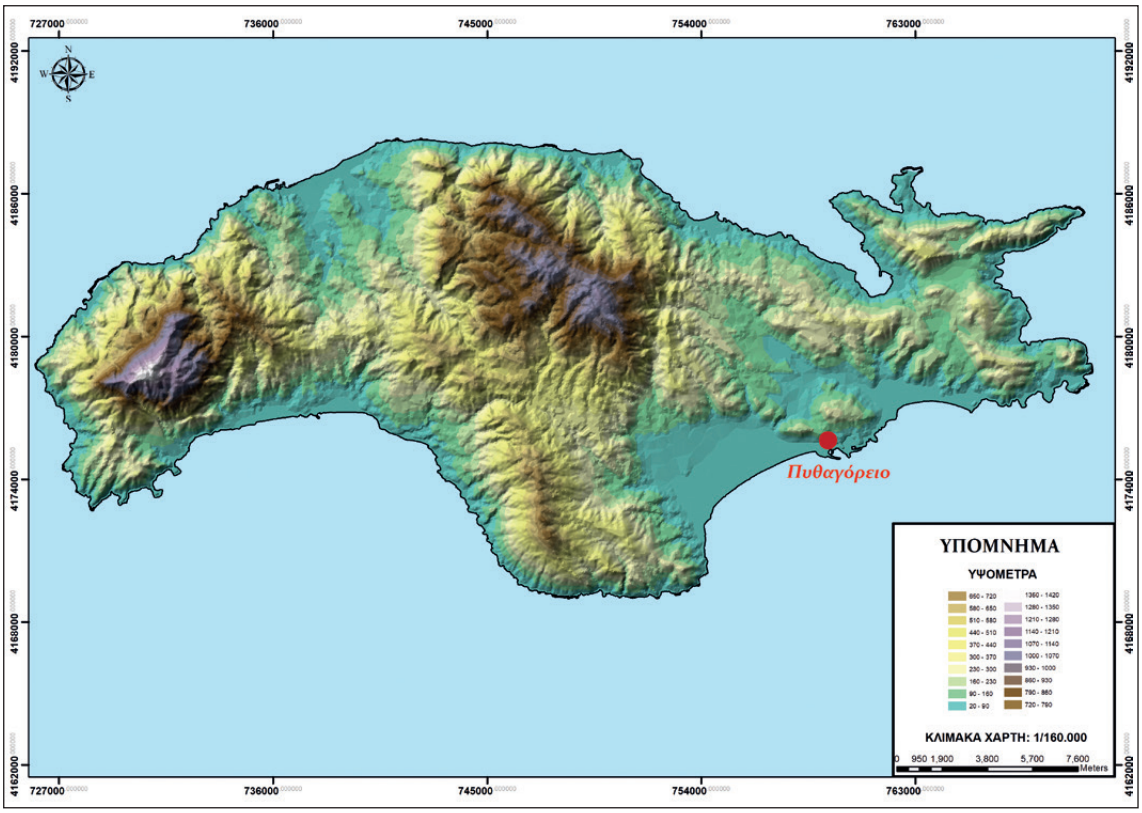
2 Poulou-Papadimitriou 1985, 383 f.; Reynolds 2010, 100; Opaiţ 2014; Reynolds 2017, 272; Reynolds 2020, 225.

3 The excavations have been published by the German Archaeological Institute in a series of volumes entitled »Samos«. The publications are complete with photographic evidence and ground plans. The excavations by the Ephorate of Antiquities have been published in the series of volumes with the title »Αρχαιολογικό Δελτίο«.

4 On the Cemetery of the Seven Sleepers at Ephesos, see Zimmermann 2019.

5 All of these excavations have been published, as mentioned in note 3, in the series »Samos« and »Αρχαιολογικό Δελτίο«.

6 Tölle-Kastenbein 1979.



1 Map of Samos with the location of Pythagoreio (red dot) (graphics: G. Delli)

It appears that only the upper class can be found in Samos, as the quality and variety of archaeological materials demonstrate. Excavated basilicas, along with investigated parts of the city and ceramic evidence, prove the wealth of Samos, as well as its connections through the trade network of the time[7]. A hoard of 200 gold coins from Megali Lakka, a small bay on the northeast side of Samos, shows the wealth the east coast accumulated based on trade activities[8].

In the second half of the 7th century, the aforementioned city was altered completely after the appearance of the Arabs in the Aegean. Based on the excavated archaeological material[9], the city was violently destroyed. After the destruction, no luxurious material of any kind can be found either in Samos or in any other part of the island. Trade declined to only basic agricultural products and any precious objects or materials showing the existence of an upper class are lately located inside the fortifications. Among these, marble objects such as elaborated altar parts appear, but they are dated to a later period, mainly the 11th century[10]. Only in the city of Samos are spolia from earlier buildings used in the church and the fortification[11].

The study under discussion focuses on the macroscopic observations of two reused materials/spolia, located in the 7th-century AD basilica in the Byzantine castle of Samos, underlining the importance of knowledge of the material and history.

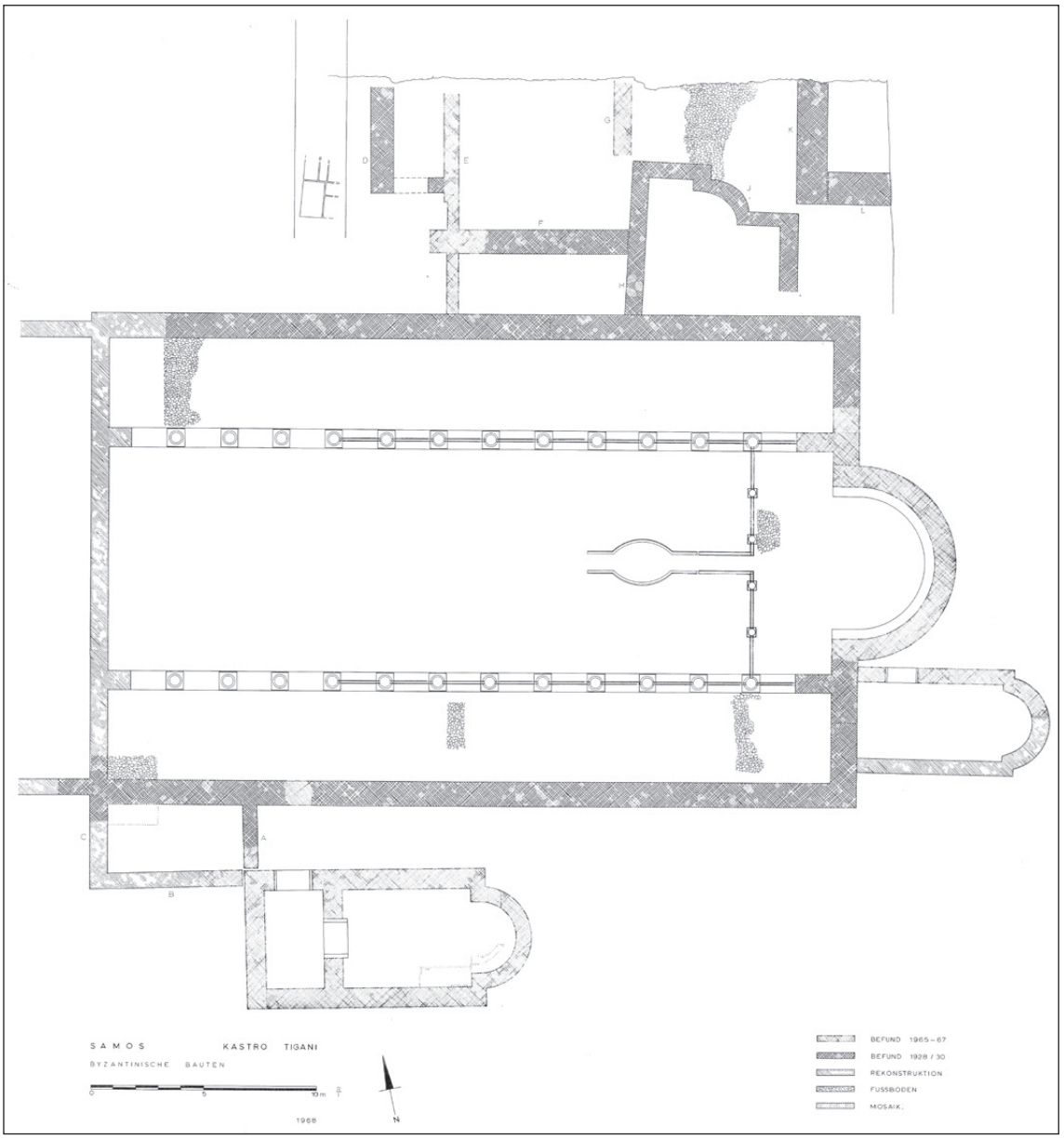
7 Poulou-Papadimitriou 1985, 386 f.; Giannouli 1998, 291; Deligiannakis 2016, 35.

8 Oeconomides – Drossoyianni 1989, 148; Kavvadia 2008, 34. Some researchers claim that this hoard could be something that was carried away from Asia Minor during the war between Heraclius (602–641) and Chosroes II (590–628), see Nikolaou 2004, 296 f.; Touratsoglou – Chalkia 2008, 12. All agree, however, on the salvatory character of the hoard, see Nikolaou 2001, 156 f.; Touratsoglou – Chalkia 2008, 13; Penna 2018, 55.

9 Michaud 1974, 697. 702; Hautumn 1981, 9; Viglaki 1982; Gerousi 1992, 266; Martini – Steckner 1993, 119–131; Savvides 1998, 153; Jantzen 2004; Deligiannakis 2016, 35; Mavrikou 2017, 13–15.

10 Delli (forthcoming b).

11 Tölle-Kastenbein 1974; Delli (forthcoming b).



2 Ground plan of the basilica in Pythagoreio Castle (from Tőlle-Kastenbein 1974, plan 9, photo: German Archaeological Institute)

THE BISHOPRIC CHURCH OF SAMOS

The church was built after the destructive attack by the Arabs in 665/666 (?) using salvaged material from the city and the buildings that pre-existed *in situ*. The building was excavated by Renate Tölle-Kastenbein of the German Archaeological Institute. The excavation and the finds were published in 1974. Tölle-Kastenbein claimed that this was the bishopric church of Samos, based on its size, decoration, and the fact that it was the only one of the Early Christian basilicas that was rebuilt after the destruction[12]. Alfons Schneider, who was the first to study the area of the castle, had also mentioned the building as a bishopric church, even before it was excavated[13]. These

12 Tölle-Kastenbein 1974, 104 f.
13 Schneider 1929, 112–119.

suggestions correlate with the fact that Samos had a bishop, as we are informed by the ecclesiastical sources[14]. Finally, so far, this is the only church dated to the later 7th century, which coincides with the reappearance in the sources of the bishop of Samos[15]. Some of the coloured material can be found either *in situ* within the basilica's peristyle or scattered around the castle grounds.

The church belongs to the basilica type, the dominant architectural construction of religious buildings during Late Antiquity. It is a three-aisled basilica ending to the east in one semicircular apse. The aisles are separated by two rows of columns. The church also had a small chapel to the south, the only element of the construction that is clearly visible today (fig. 2).

THE TWO STUDIED COLUMNS

The research is focused on the material of the coloured stones, especially the columns of the central aisle. The two columns are in the north row of columns of the basilica. All of the columns in both rows are spolia, but only the two studied pieces are distinctive due to their colour. They are positioned next to each other, and each of them stands on a base of grey marble, also spolia from earlier buildings[16]. The west column measures 0.4 × 0.42 m in diameter and 0.74 m in surviving height. The column at the eastern side measures 0.43 × 0.45 m in diameter and 0.78 m in surviving height.

RESEARCH QUESTIONS – METHODOLOGY – OBSERVATIONS

The rare and yet significant appearance of these two columns at Samos prompted the study of its origin and brought up the question of the importance of trade connections in Samian antiquity and the role of the bishopric church in material usage. To further support the significance of this specific building, we compared the bishopric church with other buildings on the island, looking for possible parallels.

The macroscopic analysis of several coloured stone elements of the church and its surrounding was based on grain size, distribution of colour, hardness and overall appearance. It allowed us to define four main groups of construction materials: limestone, white marble, Euromos marble, and Iassense marble. The provenance of the limestone is open to further investigations, through comparison with the ancient limestone quarries of the area[17]. Future investigations of the white marble material linked to the church will identify more possibly imported elements or probable local marble exploitation. A column made from Euromos marble[18] can be seen as a scattered element in the area of the castle, but unfortunately, the exact erected location cannot be identified.

The study of these two columns with a red colour from the central aisle of the basilica is a preliminary attempt to estimate the appearance of the imported material, part of which was reused during the construction of the church. After the first estimations, a macroscopic study of the geological substance focused on answering the question of the provenance of previously defined material types. The macroscopic observations and comparisons of these elements indicate the use of Iasian marble.

THE MARMOR IASSENSE

Marmor Iassense or Carium, as it used to be called by the Romans, is a highly characteristic red-coloured marble from Asia Minor (fig. 3). Many experts believe that it started to be traded

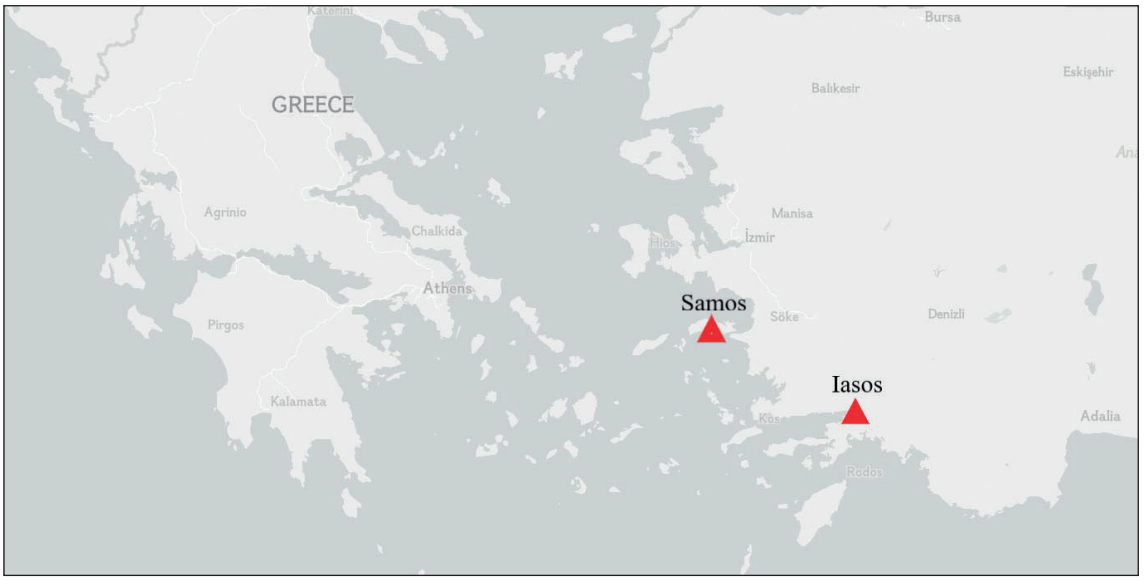
[14] Parthey 1866, 72.

[15] Mansi 1765, 1005: […] Ἰσιδώρου ἐλάχιστου ἐπισκόπου Σάμου ὁρίσας ὑπέγραψα […].

[16] To find a possible quarry related to the provenance of the bases, further investigation with the use of geochemical methods is recommended.

[17] Tziligkaki – Stamatakis 2018.

[18] Bruno et al. 2018.



3 Map of the Aegean region indicating the positions of Samos and the Iasian quarries (graphics: G. Delli)

extensively only in the 3rd century AD, although relatively recent studies suggest an earlier use of the red stones, dating up to the Hellenistic period[19]. The peak of popularity for intensive use of the red Marmor Iassense is easier to determine: it was reached during Late Roman Antiquity/Early Byzantine times[20]. Two ancient authors who lived during those times, Constantine the Rhodian and Paulus Silentiarius, confirm the importance of the red marble from the small, ancient town of Iasos through their description of the marvellous, very characteristic red-white columns inside two churches which are located in Constantinople[21]. Another example of columns made from Iasian marble was found in Ravenna, in the Santa Andrea Maggiore Church[22].

Carium was mostly used as a building material in architecture for columns and facing slabs, and it can also be found in a large variety of small objects and sculptures[23]. The wide range of different uses for which the marble was employed may be explained by the multiple possible variations of the stone discovered in the quarry pits.

Each era had its typical use for one of the marble varieties. Throughout the Hadrianic age, the brecciated variety was preferred; it was mostly used by the artisans and sculptors. During the Tetrarchy and the Constantinian age, people started to include the veined type in the decorative architecture of some of the most precious sacral buildings. The preferred use for veined red marble would be in tiles, columns, and slabs. Later, in the Justinianic era, Marmor Iassense was regarded as one of the most precious stones of Byzantine times. Often combined with other coloured marble, which was meant to bring stronger contrast to the composition, red marble became the most iconic part of the architecture. The decline of its importance is traced back by most scholars to the 7th century AD[24].

Geologically, there are three possible categories characteristic of Marmor Iassense: Venato, Brecciato and Marmor Iassense rosso uniforme[25]. Previous studies also confirmed the coexistence

19 Baldoni 2005, 108 f.
20 Andreoli et al. 2002, 13.
21 See Andreoli et al. 2002, 13.
22 Peirano 2018, 126. The use of Iasian marble can, however, be found at the Hagia Sophia Church in Constantinople, at Saint John's Church in Ephesos, at Saint Demetrios' Church in Thessaloniki, at Saint Vitale's Church in Ravenna, etc.
23 Lazzarini 2010, 141.
24 Baldoni 2005, 108 f.
25 Andreoli et al. 2002, 13.



4 General view of the bishopric basilica towards the east (photo: Ephorate of Antiquities of Samos and Ikaria)



5 View of the north row of columns towards the west (photo: Ephorate of Antiquities of Samos and Ikaria)

of the features of Venato and Brecciato types in just one outcrop[26]. Petrographically all three varieties qualify as impure marbles with a red colour due to the widely spread haematite particles. The Venato type, with its strongly contrasting white veins, was the most popular of them all, mostly due to its unique appearance and the relatively high quantities that could be extracted from the

[26] Baldoni 2005, 107.

outcrops. In comparison, breccia was less represented in the architecture of the time, mostly due to the smaller amounts produced[27]. The homogeneous Marmor Iassense rosso uniforme is the rarest of them all and has so far not been found in Pythagoreio on Samos. Nonetheless, closer study of the columns found in the church shows clearly the appreciation for this precious material expressed by the central position within the row of columns.

In the case of the row of four columns found *in situ* which mark the northern side of the basilica at Samos, two stand prominently in the middle (figs. 4–5). The columns manifest themselves through their intense red colour, contrasting strongly with other milder-toned building materials. The neighbouring columns resonate strongly through their white-greyish appearance, forming a soft background for the two most prominent parts of the row. The two red columns (described previously as the East and West columns) are an excellent example of the use of Marmor Iassense at Samos (figs. 6–7). The architects decided to decorate the basilica with columns in the red-veined marble of Venato type. In both cases, the intense redness created by the haematite particles of this impure marble is disturbed by irregularly spread white veins. Another strong irregularity can be observed in the thickness of the white and red veins, as well as in the intensity of the red colour. Additionally, there are a few relatively thin veins which vary in their appearance between intense dark red and ashy grey. All of them are neither horizontal nor parallel but rather follow a wavy, asymmetrical pattern.

CONCLUSIONS

Unfortunately, parallels to the bishopric church of Samos are not to be found on the island. The type of church is quite common during the 7th century in the Aegean region. The use of this lavish



6 West column (photo: Ephorate of Antiquities of Samos and Ikaria)



7 East column (photo: Ephorate of Antiquities of Samos and Ikaria)

27 Andreoli et al. 2002, 13.

material indicates the luxurious and prosperous living conditions of Samian inhabitants from the Roman period until the end of the 6th century.

The current observations of the coloured marble used during the construction of the bishopric church confirm the existence of a trade network between Samos and Asia Minor. Building materials from Euromos, as well as Iasian quarries, indicate the extensive trade network between Samos and Asia Minor during Late Antiquity. This material cannot be found in any other Byzantine church on the island of Samos. Therefore, the spolia of coloured stones of the bishopric church provide a piece of very important information. Firstly, the island was a significant one since it was on the main trade route between Constantinople and the eastern provinces, and secondly, after the first Arabic attacks and the loss of the eastern provinces, the survivors were no longer able to import quality material due to the new, weaker socio-economic status of their society. Consequently, in many cases across the empire, there was a tendency to reuse material to decorate their new main church and other buildings or architectural constructions (such as fortresses). Since the next group of quality marble and advanced techniques are dated to the 11th century, a gap is noticed, enhancing the significance of the reused material for the transitional years (7th–9th cent.).

The 7th century brought about great changes[28]. From an archaeological point of view, Samos experienced a major attack that devastated the island and made the inhabitants withdraw and reduce the pace of trade for as long as needed to organise their defensive network. After two centuries, Samos was one of the islands to emerge as prominent, organised as a naval theme and capable of resuming its engagement in large-scale trade[29]. During the 11th century, the island once again enjoyed a lavish way of life, as evidenced – this time scattered across the island – by the pieces of quality marble that have been found[30]. Of course, only through excavations can the apparent gap be confirmed or rejected if new material appears.

The use of Iasian spolia and this arrangement of the interior design of the church shows a deep appreciation of the reused building material and possibly an understanding of the economic value of the elements. Most likely it was the preciousness of the red columns that caused the builders of Pythagoreio to use the spolia from the Roman villa in the central place of their newly built bishopric church. This preliminary study contributes to a better understanding of the economy and the societal structure of the area and may serve as a model for other larger-scale research on local sources, imported sources and ancient sites, as well as on connections and long-distance trade and the subregional marble market.

FUTURE APPROACHES

Future analyses are recommended to determine the provenance of white marble and limestone. The addition of the geochemical analyses of white marbles, particularly isotope analysis and inductively coupled plasma mass spectrometry (ICP-MS), is needed to answer the remaining questions regarding the other possible trade routes connecting Samos with previously unknown parts of Asia Minor and supraregional quarries throughout antiquity. This pioneering research, in combination with further study of the mortar of the monument, will shed light on the history of the building and the general area of the island[31].

Although the provenance of the coloured marble could be determined based solely on its macroscopic features, the authors strongly advocate for the use of quantitative chemical analyses of the minor and trace elements or isotope analyses, especially in the case of the red-coloured columns. Iasian marble can be found in three varieties, and in some cases, it is almost impossible

[28] Malamut 1988, 67.

[29] Delli (forthcoming b).

[30] Delli (forthcoming b). These pieces come from monasteries, churches and fortifications, all of them dated to the 10th–11th cent.

[31] Delli (forthcoming a).

to distinguish it from other possible Rosso antico sources. Hence, the addition of isotope analyses will allow clear discrimination of different source regions of Rosso antico.

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Daniel P. Diffendale – Fabrizio Marra

ARCHAEOMETRIC APPROACHES TO VOLCANIC TUFF IN ANCIENT ROME

THE RECENT WORK OF THE QUADRATA PROJECT

Abstract
The various volcanic tuffs of the region around Rome supplied building materials to the city throughout its ancient history, but the variability of these rocks means that historically it has been challenging for archaeologists to securely identify quarry locations for given stones. The »Quarry-Proveniencing and Archaeological Dating of the Roman-Area Tuffs in Antiquity« project, or QUADRATA for short, combines architectural study, historiography, mass spectrometry, and petrography to attempt to answer these questions and pose new ones. The first four years of the project and its methodology are reviewed, and challenges for future work are identified.

INTRODUCTION

The development of ashlar masonry in the city of Rome during the Archaic (ca. 6th cent. BC) and Republican (5th–1st cent. BC) periods relied on the local availability of stone suitable for working into squared blocks. Roman builders found such material ready to hand, in multiple varieties of



1 Three different types of tuff used in the late 3rd-century BC temple platform at Sant'Omobono: from top, Lapis Albanus, Tufo Lionato (Anio lithofacies), Tufo giallo della Via Tiberina (photo: D. Diffendale)

volcanic tuff[1]. Certain varieties of tuff were used in Roman architecture from the 7th century BC, as cut stone from the 6th, as *caementa* for concrete from the 2nd, with quarrying continuing at least through the 3rd century AD[2]. The »Quarry-Proveniencing and Archaeological Dating of the Roman-Area Tuffs in Antiquity« project (QUADRATA), co-directed by the authors of this chapter, aims to couple the century-old archaeological study of the Roman tuffs with contemporary geological science, particularly geochemical trace element analysis, to reassess the local-stone economy of the ancient city (fig. 1)[3].

THE FORMATION OF THE ROMAN TUFFS

The landscape of Rome and its environs owes its shape to volcanic activity[4]. Multiple eruptions of two volcanic systems, the Monti Sabatini to the north of the city and the Alban Hills to the south, deposited great quantities of material, beginning 600 ka (1,000 years ago) with major eruptions ceasing around 36 ka. These violent prehistoric eruptions deposited tuffs across the valley of the palaeo-Tiber. These deposits were in turn eroded by the Tiber and its tributaries, which cut deep channels in the topography. The so-called Seven Hills of Rome owe their existence to the interaction of these processes.

The most important types of tuff exploited for building materials in Rome are the products of particularly powerful eruptions. Violent explosions of gas during the eruption of magma shatter the magma into particles called pyroclasts, which gives rise to pyroclastic flows, emulsions of pyroclasts with gases and air from the atmosphere. Extremely hot and extremely fast, while remaining dense and viscous, pyroclastic flows sweep across the landscape with sufficient velocity that they can even travel uphill. Once this velocity is spent and the flow comes to rest, the pyroclasts become consolidated into stone by the minerals formed by crystallisation from the gas or the breakdown of hot glass fragments. This is what is called an ash-flow tuff; particularly hot eruptions may result in *ignimbrites*.

Such was the eruption of the Alban Hills volcano 355,000 years ago that produced the tawny reddish-yellow tuff known geologically as Tufo Lionato. The emplacement of this deposit over a vast area – some 1,500 km² – means that the formation reflects differences in depositional properties, as well as the supply of materials from the magma chamber via the vent during the eruption. Broadly similar pyroclastic-flow deposits from the Monti Sabatini volcanic system include Tufo giallo della Via Tiberina from 548 ka and the Tufo rosso a Scorie Nere from 449 ka.

Much smaller volumes of magma, rising and mixing explosively with ground or surface water, create hydromagmatic eruptions, becoming pyroclastic surges that typically travel less than 10 km from the volcanic vent. The Lapis Albanus and Lapis Gabinus tuffs are hydromagmatic deposits of the Albano multiple maar and the Castiglione maar, respectively. The much older

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1 Italian »tufo« or »tufo vulcanico«, the latter to distinguish it from »tufo calcareo«, or calcareous tuff (usually, but not always, rendered in English as »tufa«). All of these terms descend from Latin tophus/tofus, which was used to describe both volcanic and calcareous varieties, itself probably a borrowing from an Italic language, likely Campanian Oscan. Both »tuff« and »tufa« have historic claims to describe the volcanic variety in English, but a laudable prescriptivist drive led by contemporary geologists aims to reduce confusion by restricting »tuff« to volcanic and »tufa« to calcareous stone.

2 Recent synthetic treatments of volcanic tuff and other building stones in Rome include Jackson – Marra 2006; Giampaolo – Lombardi – Mariottini 2008; Rosa 2021.

3 An initial stage of the QUADRATA project was undertaken by Daniel Diffendale while a fellow of the American Academy in Rome during the 2019–2020 academic year, see Diffendale et al. 2020, 572 f. In its current form, the project relies on occasional funding from grants, fellowships, and collaborating institutions. The first two words of the project's title have also appeared in print as »Quarry Provenience« and »Quarry Provenance«.

4 Perhaps the most popular introduction to the geology of Rome is Heiken – Funiciello – De Rita 2005 and the expanded Italian edition Funiciello et al. 2006, though this must be used with care, especially in relation to archaeology. An engaging account by a respected geologist is Alvarez 2009, especially Part II (though here too some of the geology needs to be updated). A more popular account in Italian is now Manni 2023.

(528 ka) Tufo del Palatino formation, commonly called »cappellaccio« by archaeologists and laypersons, seems instead to have been a hydromagmatic eruption on a massive scale.

ON TUFF CLASSIFICATION

Tuff nomenclature is a somewhat thorny topic. Multiple systems have been, and remain, in use, often inconsistently. There is the ancient Latin system, primarily known via Vitruvius, which can sometimes be matched up with contemporary systems but not always (and this was not itself a static system; the stone that Cicero, Vitruvius, Suetonius, and others knew as Lapis Albanus was named – or subsumed into the category of – Lapis piperinus by Isidore of Seville, writing in the early 7th century AD, attesting moreover the root of modern Italian »peperino« as well as the »piperno« of Naples). Nor was this the only system in use in antiquity; from Strabo we have Greek calques of some of the Latin names. We have no trace of what speakers of other languages – whether enslaved or wage-labourers of non-Latin origin – might have called them, although we have at least the Oscan word for tuff, probably the source of the Latin term *tofus*, in fact: *tavffud*. But this was a later borrowing; the native Latin term was simply *lapis*, »stone«. There is the popular or common system in use in Rome during the 19th century, which was sometimes drawn on by geologists and archaeologists. For anglophone archaeologists, tuff terminology was petrified by Tenney Frank's 1924 study of Roman building materials[5], while Italian systems have remained more fluid and less consistent. Then there is the contemporary geological system, which, like species in biology, aims to provide each rock having a unique origin with a unique moniker. (The geological understanding of what volcanic tuff is and how it was formed, moreover, has undergone many shifts over the past two centuries.)

The potential for confusion between these systems is vast, given that terms have been borrowed back and forth (e.g. the use of the classical Latin term Lapis Albanus for Peperino Albano [di Marino]). A further difficulty is the lack of shared basis: the Latin terms generally describe the stone based on its physical properties (colour) or its quarry of origin, while the modern popular system also relies on physical properties, though different ones from the ancient system. The archaeological vulgate draws piecemeal from the two former systems, and the contemporary geological terms, while defined according to specific rock deposits, use yet other names based on physical properties or type localities. Further, and especially important, the geological system makes use of geochemical discriminants, such that a geologically described Tufo Lionato can be identified as a particular product of the 355 ka eruption of the Alban Hills, while a popular or archaeological ›Tufo Lionato‹ could potentially refer to any tuff in the tawny range (reddish-brown, yellowish-red, etc.); although Tufo Lionato is the principal tawny tuff found in the environs of Rome, some other, less widespread, varieties could be confounded.

Vitruvius (2, 7, 1) categorised the tuffs around Rome among the *lapides molles*, the soft stones, which contrast with the *lapides temperatae*, including travertine, and the *lapides durae*, hard stones, such as silex. It is important to bear in mind that Vitruvius was first of all writing about the products of particular quarries, not of more generalized rock types (other than categories such as »soft«). That is, he was writing from the point of view of an architect, builder, and/or contractor, not that of a geologist. This sometimes gets lost in discussions of terminology; in the *locus classicus* for types of tuff recognised around Rome in ancient times, Vitruvius writes in the first instance not of *lapides*, stones, but of the products of specific *lapidicinae*, quarries, though the categories of »quarry« and »stone« tend to blur even in his text. The question of how Vitruvius' quarry names correspond with modern classifications is a thorny topic to be addressed elsewhere.

5 Frank 1924.

BRIEF TUFF HISTORIOGRAPHY

Simplifying vastly, the modern archaeological classification of the Roman tuffs can be attributed to the American ancient historian Tenney Frank in his 1924 book, »Roman Buildings of the Republic. An Attempt to Date them from their Materials«[6]. Drawing on contemporary geological knowledge, especially that of Antonio Verri[7], combining it with archaeological and historical evidence, Frank listed seven varieties of tuff with their known or suspected quarry locations: Cappellaccio, Grotta Oscura, Fidenae, Lapis Albanus, Lapis Gabinus, Anio, and Monte Verde. An indication of the inertial staying power of this classificatory system is the lists of tuff in Amanda Claridge's »Rome. An Oxford Archaeological Guide« and Filippo Coarelli's »Rome and Environs. An Archaeological Guide«, which both reproduce Frank's list, basically unchanged, nine decades later[8].

In the meantime, both geological and archaeological knowledge have advanced considerably. For example, for Frank all »tufas« were ash-fall tuffs, solidified by contact with water, in some cases aided by the presence of lime in the water or »by the action of a rain of hot water from the volcano«[9]; emplacement by lithification of a pyroclastic flow was still a debated hypothesis. Frank attributes variability between and within tuffs to variations in the source material, deposition in different kinds and depths of water, and the differential action of rain water. »Thus it is that differences in color, in coarseness and in compactness have arisen which enable the observer to identify the various materials found in Roman buildings with samples taken from ancient quarries, and by listing the materials found in buildings that are dated, to construct a kind of life history of each of the many quarries«[10]. In fact, Frank based his study on a collection of samples from quarries and monuments which would allow for future comparisons. (This collection, unfortunately, no longer exists.)

More accurate knowledge of the formation processes of the various tuffs offers greater possibilities for sourcing cut stone used in ancient monuments. Frank pointed out that because the volcanic flows that formed the Roman tuffs are inconsistent in their characteristics, the products of a single quarry may vary greatly in visual appearance, while the products of different eruptions separated by tens of thousands of years may appear identical on visual inspection. This clearly has ramifications for the visual criteria employed by archaeologists during the 20th century to distinguish between the tuffs, and a chemical discriminant would seem warranted. Already in 1924, however, Frank had correctly noted the difficulty in applying chemical analysis to tuff because of the transformational effects of atmospheric exposure on the major elements that compose the majority of tuffs (e.g. silicon dioxide, aluminium oxide, ferric oxide, calcium oxide). (Such effects can also impede attempts to identify tuff visually, since they can alter the colour of the exterior surface.)

TUFF ANALYSES UNDERTAKEN BY QUADRATA

Geological research in the 2000s demonstrated the possibility of using trace elements to discriminate between these various formations, and this was soon applied to archaeological questions. The QUADRATA project attempts to use this kind of geochemical analysis, together with allied analyses such as thin-section petrography, to provenience building stone used in ancient monuments in and around the city of Rome.

Because of the relative inhomogeneity of volcanic tuff, samples of ca. 10 cm³ are required, both from natural outcrops and from ancient monuments under study. These can easily be obtained using a rock hammer or a hammer and chisel, or often by detaching an already-fractured piece of tuff (fig. 2).

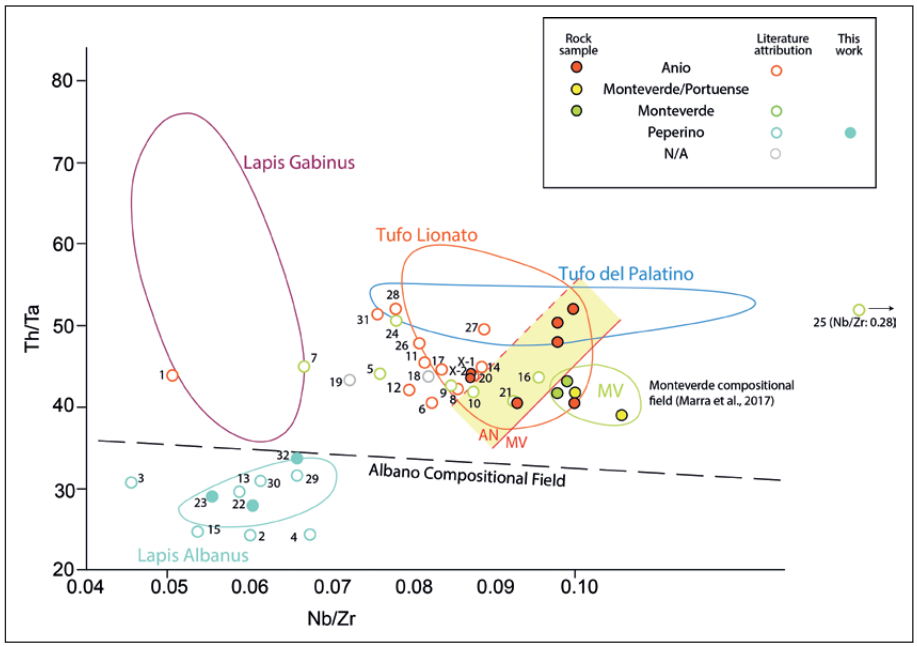
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6 Frank 1924, developing ideas first set out in Frank 1918.
7 Frank cites in particular Verri 1911 and Verri 1915.
8 Claridge 2010; Coarelli 2014.
9 Frank 1924, 11 f.
10 Frank 1924, 12.



2 Fabrizio Marra collecting a sample in the Tufo Lionato quarry at Tor Cervara (photo: D. Diffendale)

Samples are analysed for major and trace element composition by inductively coupled plasma mass spectrometry (ICP-MS). This analysis returns the relative abundance of major elements in the sample, as well as quantities of trace elements in parts per million. Certain trace elements and compounds with low mobility, such as zirconium (Zr), niobium (Nb), yttrium (Y), thorium (Th), tantalum (Ta), and titanium dioxide (TiO_2), are particularly useful in recognising distinct eruptive products. A large number of previous trace element analyses on volcanic rock samples, both from natural outcrops and from monuments, have shown that each volcanic lithofacies (that is, a part of a deposit with distinct compositional, structural, and textural characteristics) is characterised by relatively regular Zr/Y versus Nb/Y and Th/Ta versus Nb/Zr compositions, whose spread is comprised within a finite, identifiable compositional field (fig. 3). This is explained by the fact that such geochemical analyses are performed on relatively large bulk samples (in the order of 10 cm³), for which the concentration of the immobile elements is averaged and reflects the concentration in the original magma. It therefore represents a geochemical signature, distinctive of each rock, which we have used to distinguish between the products of different volcanic deposits employed in ancient Roman architecture. (It is important to note that such a distinction can rarely be made on the basis of a single graph; that is, both Zr/Y versus Nb/Y and Th/Ta versus Nb/Zr are necessary, and Zr/TiO_2 versus Nb/TiO_2 is also critical in some cases.)



3 An example of the Th/Ta by Nb/Zr diagram used to discriminate between different types of tuff, in this case Tufo Lionato and Lapis Albanus (graphics: F. Marra)

While this remains a useful application, we have more recently turned to using similar methods to discriminate within single formations in the hopes of proveniencing building stone to particular quarries. While such investigation is still in its early stages, initial results are promising.

Geochemical analysis using ICP-MS can and should in some cases be supplemented with thin-section petrographic analysis using optical microscopy[11]. Petrographic analysis can provide additional information on the depositional conditions of the sampled rock, depending on its stratigraphic height (i.e. its vertical provenience within the original deposit) and distance from the eruptive vent[12]. It was petrographic analysis, for instance, that indicated that the stone used for the podium of the Archaic temple at Sant'Omobono came from the basal part of the Tufo Lionato deposit[13]. This part does not outcrop in the vicinity of the temple site, and supports the geochemical provenience of the Anio Valley. It moreover allows the hypothesis, albeit unprovable, that Roman builders deliberately selected this part of the deposit, which would have been exposed to the river currents, in order to construct a podium meant to resist the destructive effects of Tiber floods.

Our 2019 study of tuff types employed in the Republican phases of the Roman temples at Sant'Omobono in Rome's Forum Boarium was directed at clarifying the provenience of Tufo Lionato and »peperino« blocks from the 5th through 3rd centuries BC[14]. Although the geochemistry duplicated some results that could be relatively securely identified macroscopically, for instance, a distinction between Tufo Lionato and the »peperini«, it was important to have demonstrated the method's capacity to make such broad distinctions before pursuing more detailed questions. But already here, we were using the method not just to provenience stone to particular geological formations – such as Tufo Lionato – but also to distinct lithofacies within such formations – the Anio and Monteverde lithofacies of Tufo Lionato, in this case. The results indicated, for instance, that all the samples of the Tufo Lionato employed in the 4th- and 3rd-century BC structures of the sanctuary came from the quarries along the river Anio, rather than a mix of Anio and Monteverde as previous scholarship had suggested.

Our 2019 study also involved Sant'Omobono as part of a broader reinvestigation of the Archaic 6th-century BC temple[15]. Here the geochemical results suggest that the stone used for the first-phase podium at Sant'Omobono was extracted from the quarries along the Anio. This is the earliest evidence for Roman builders sourcing building stone relatively far – 5 km as the crow flies or 15 km or more by river – from the city centre. Further, thin-section analysis indicates that the stone was quarried from near the base of the Tufo Lionato deposit, a better-consolidated lithofacies that is more resistant to weathering than the upper levels of the deposit more usually exploited in later centuries.

In our earliest study, in many ways, we were using the method to ask questions within the existing paradigm, essentially that laid out by Frank a century earlier: to which of Frank's categories could a particular block be assigned? But Frank, after all, had begun with quarries. Anio tuff was not a geologically distinct type of rock so much as just the type of stone that was extracted from the quarries along the Anio. For some types, the distinction is trivial: for instance, the full extent of the Lapis Gabinus formation is effectively coterminous with the limits of the quarries of the stone at the site of Gabii. For others, interesting discrepancies have crept in: while Frank intended Grotta Oscura as the product of the quarries at Grotta Oscura, over the course of the 20th century it became generalised in the archaeological literature – especially anglophone, but not exclusively so – as a term for any yellow tuff found at Rome, regardless of its quarry location.

This tracks in some ways with the developing geological literature, which over the course of the last century succeeded in identifying the extent and sequence of the various volcanic formations

11 Our petrographic analyses have thus far been conducted by Mario Gaeta of Sapienza University, Rome.
12 For examples of petrographic analysis, see e.g. Brocato et al. 2019, 125–128; Diffendale et al. 2019, 8.
13 Brocato et al. 2019.
14 Diffendale et al. 2019. For an introduction to the site, see Diffendale et al. 2016a.
15 Brocato et al. 2019.

around Rome, showing, for instance, that the Anio and Monteverde quarries both exploited the same geological deposit, termed Tufo Lionato by geologists (though even this name has not been stable over the same time frame). We must be careful – something that archaeologists talking about geology and geologists talking about archaeology have not always done – to be aware of what kind of categories we are using. So, a geological name is genetic, a species name, while archaeologists ideally prefer to refer to stone from particular quarries – though the tendency we have observed is for quarry names to become generalised into type names.

With the loss of reference collections, such as that assembled by Frank in the 1920s, and the increasing inaccessibility, or wholesale disappearance, of ancient quarries around Rome, the ability of archaeologists to make stone attributions based on quarry autopsy has waned (even if such attributions were not always reliable), and there has perhaps been a concomitant loss of attention to the quarries themselves: so the tuff types are reduced to a more or less canonical list, reproduced in introductory texts and guidebooks, with a brief physical description (»grey tufa of relatively poor quality [soft and friable]«; »yellowish, rather porous tufa«; »light greyish brown tufa peppered with white and darker [red and black] inclusions«; »reddish brown tufa«)[16]. These do not take into account physical variation within different deposits, nor the tendency of tuff to change colour between its wet and dry states or after exposure to the atmosphere. The potential of the QUADRATA project's archaeometric analyses to differentiate between increasingly more precise lithofacies of the same geological formation (for instance Anio, Monteverde, and Portuense facies of Tufo Lionato, or between basal and upper formations within the Anio facies), and the concomitant possibility of understanding better ancient extraction and construction practices, should therefore not be underestimated.

CHALLENGES

While the creation of an open database with the geochemical ›signatures‹ of tuff from various quarries in and around Rome would be useful, the current state of inquiry does not allow for this possibility[17]. A primary difficulty is the existence of analytical offsets due to ›instrumental drift‹: laboratory instruments (in this case the mass spectrometer) need to be recalibrated periodically, and within this period, small variations can be observed. While the effect is negligible during analysis to distinguish between different volcanic rocks, it is of greater importance when interpretation of the results relies on very small differences in geochemical composition, for example when discriminating between different outcrops of the same rock[18]. As a consequence, one cannot straightforwardly compare the results between different rounds of analysis, hence it is best to analyse all samples for a given study in a single laboratory batch. If the results from multiple analyses need to be compared, each should include multiple specimens from the same rock samples[19].

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16 Claridge 2010, 39.

17 We could also cite the dangers raised by Lyes 2023.

18 See also Marra – D'Ambrosio 2013 for small shifts in geochemical compositions when the same volcanic rocks are analysed at different laboratories or using different analytical methods (e.g. X-ray fluorescence [XRF] versus inductively-coupled plasma mass spectrometry [ICP]).

19 The authors are working to procure reference samples which can be drawn upon in multiple studies; those wishing to conduct geochemical analysis of Roman-area tuffs are urged to contact the authors so that control specimens can be provided.

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THE AESO MARMOR (ISONA, LLEIDA) AS EPIGRAPHIC MEDIA

NEWS FROM NEW TRENDS IN EPIGRAPHIC AND ARCHAEOMETRIC RESEARCH

Abstract
In the Roman city of Aeso, a significant number of Latin epigraphs has been documented, among them, an exceptional series of 30 pedestals for honorary and funerary statues, of which 22 have been preserved. A review of the module, shape, palaeography and *ordinatio* of the series of honorary pedestals of Aeso has been carried out. This has led to the identification of two different production series, one of which follows the patterns established by the Tarraco workshops, while the second reflects the continuation of the means applied to this type of monument. The petrographic analysis helped differentiate between the two types of pedestals, even though the material of the supports is, in both cases, a cretaceous limestone. Through the macroscopic analysis, we have been able to identify three different types of limestone, use of which fits with the two typological series defined.

INTRODUCTION

The Roman city of Aeso (modern Isona, located in the northeastern part of the province of Tarraconensis) has yielded a small but significant number of Latin inscriptions. An exceptional set of 30 pedestals used as stands for honorary and funerary statues has been documented, of which just 22 (see tab. 1) have been preserved[1]. Most of these pedestals were made for prominent local magistrates using a distinctive light-coloured local cretaceous limestone, the Pedra d'Isona[2].

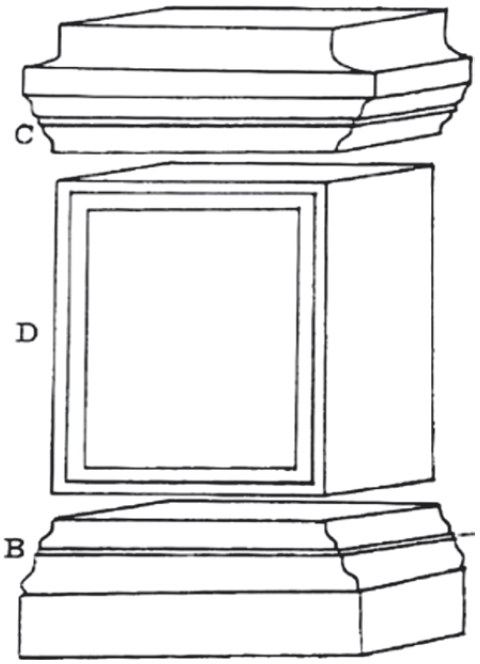
The preserved pedestals can be typologically divided into two categories[3]. The honorary group coincides in their dimensions and form with those of a similar kind to that produced by the workshops of Tarraco[4]. These popular monuments were widely distributed throughout the Conventus Tarraconensis[5], and the high quality of the marmor from Aeso allowed the development of an important local workshop that supplied public and private supports for inscriptions to the city.

The epigraphic workshops of Tarraco used a local limestone called »Pedra de Santa Tecla« that was of an excellent quality[6]. Recent studies have shown that the tripartite moulded honorific pedestal prevails over the monolithic type in cities with documented magistrates of the capital[7]. Given the visibility of these pedestals in the public spaces of the provincial capital, the working hypothesis outlined here is that a standardised type of honorific medium was chosen

1 IRC II p. 50.
2 Gutiérrez Garcia-Moreno 2009, 79.
3 Fabre – Mayer Olivé – Rodà de Llanza 1985, 672–675.
4 Alföldy 2011, 14, CV; Alföldy 2012, 438–441 (= Gorostidi Pi 2017, 351 f.).
5 Alföldy 1979, 185–188.
6 Gutiérrez Garcia-Moreno 2009, 211 f.
7 Gorostidi Pi 2020, 280–283; Beltrán Lloris – Gorostidi Pi 2022.

based on local aesthetic preferences. Such a medium might have spread to other cities, either through direct importation or via copying and imitation at a local level. Moreover, its potential spread may have been encouraged by the availability of stones of a similar quality and of itinerant stone-cutters.

AESO TRIPARTITE PEDESTALS: A CASE STUDY



1 Parts of a tripartite pedestal (from Di Stefano Manzella 1987, 278 fig. 80)

The tripartite honorific pedestals (30) represent an important part of the epigraphic corpus of the city of Aeso (41 in total), and as is also the case at Tarraco, they stand out for being monuments with a high degree of standardisation. These inscriptions are made up of three independent parts: a plinth, a central or parallelepiped block, and a crown (fig. 1).

The central block is the axis that articulates the whole monument. At Aeso, the central parallelepiped block of the first category[8] has dimensions ranging between 80 and 93 cm in height, 50 and 60 cm in width, and around 50 cm in depth. Two different limestones of local origin have been identified as used for its production. The epigraphic field is delimited by a moulding in the form of a listel and a *cyma reversa* between 9 and 7 cm thick (fig. 2). The text, which was made with a square capital, has a central *ordinatio* that tends to occupy the entire inscription area, although as in the case of the examples at Tarraco, monuments that are concentrated in the upper ⅔ of the epigraphic field have been documented. The size of the letters decreases from between 5–6 cm for the first lines and 2 cm for the final lines, with a consistent line spacing of between 1 and 2 cm. Examination of the palaeography shows the use of a Roman square capital and a well-defined bevel incision, with the letters R, M and N wide and the P unclosed[9].

This group includes pedestals IRC II 20, 42, and 45, which were not previously included because of their missing moulding. These are all blocks – except for IRC II 45 of which only the lower part survives – measuring 88 × 71 × 51 cm and 84 × 56 × 44 cm, which places them within the range described above for the inscriptions of this category. The three inscriptions have the palaeographic open M of this group and well-chiselled lettering. Chronologically, they should be dated to around the end of the 1st century AD and the first half of the 2nd century AD.

The last pedestal in the first category is IRC II 24, which was previously excluded from this group because of its moulding, its dimensions and the arrangement of the text[10]. Although it is likely to have been a taller and narrower pedestal than the rest of the examples of a parallelepiped shape in this group, its size is by no means an excluding factor. Its dimensions, except for its height, which is more similar to that of the second category, are within the parameters established by the first group. The function, palaeography, and material used for the pedestal also correspond

8 This series includes the following pedestals: IRC II 19–20. 23–24 (?). 26. 28–29. 31–32. 37–38. 40. 42. 45. 49. 54–55.

9 Fabre – Mayer Olivé – Rodà de Llanza 1985, 672 f.

10 Fabre – Mayer Olivé – Rodà de Llanza 1985, 673.



2 Pedestals belonging to the first category. a: IRC II 26. b: IRC II 54 (photos: H. Feliu Pérez)

to the standards described above. However, there are some elements that make their classification doubtful: the text and the moulding. The inscription has a centred and balanced *ordinatio* in the epigraphic field, but its arrangement tends to elongate towards the right-hand side, with three of its lines (l. 1, l. 5 and l. 9) ending with the last letter above the moulding. The cymatium, on the other hand, is composed of a listel and a *cyma reversa*, but the concavity of the ogee is smooth, which suggests that it is a different type of moulding. One hypothesis to explain these differences is that the block itself was discarded and then later reused, with a text being inscribed that ended up occupying more space than that originally provided by the epigraphic field. The moulding seems perhaps to be more the result of poor workmanship than of any intention by the stone-cutter to introduce a new type of cymatium. We also find another feature that could be considered indicative of an unfinished or careless execution: the chisel-marks in the recess that joins the epigraphic field with the moulding, which are visible on the upper part of the left side and on the whole of the right side.

The second category of tripartite pedestals from the city of Aeso was mainly used for funerary monuments[11]. The central blocks differ from those of the first group due to their height, which in this case is between 95.5 and 100.5 cm (fig. 3). Once again, two different types of limestone of local origin that were used for their production have been identified, with Isona (stone Type) 1 being the material common to both series. The main element that distinguishes them from each other is the moulding that delimits the epigraphic field. In this case it is in the form of a listel and roundel, or listel and two roundels separated by a half-round, instead of the typical decoration of

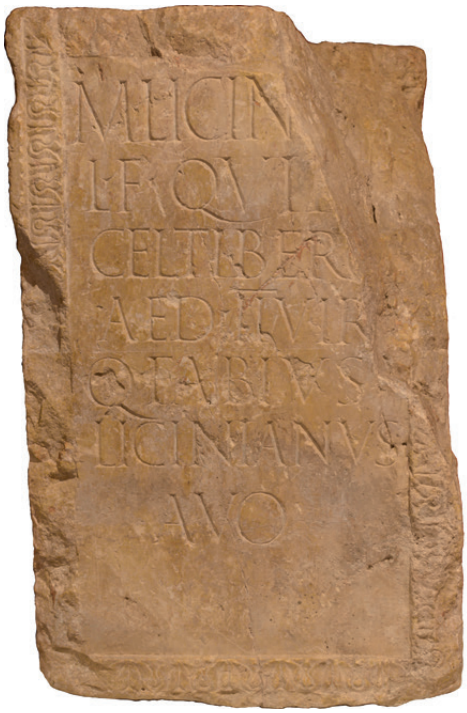
[11] This series includes the following pedestals: IRC II 33–34. 35 (?). 36.



3 Pedestals belonging to the second category. a: IRC II 33. b: IRC II 34 (photos: H. Feliu Pérez)

a listel and *cyma reversa* which is present in most of these types of monuments. Its dimensions are between 9 and 13 cm wide. The text is incised with a capital letter with shallow chiselling, and its content is denser, occupying most of the epigraphic field and marked by variable spacing and abundant use of nexuses[12].

However, we again find an inscription of dubious attribution, which in this case is pedestal IRC II 35. While its dimensions are reminiscent of a parallelepiped block from the first series, the moulding, which takes the form of a listel and a *cyma reversa*, is reminiscent of the cymatium with listel and double bevel of the inscription IRC II 34 and therefore of this second series. Despite having an *ordinatio* which tries to frame all its content, the palaeography of the text has a shallow chiselling, scarce interlineation and abundant nexuses. On the other hand, the fact that this was an honorific statue base is in complete contrast with the predominantly funerary use that the monuments of this category were usually produced for. Therefore, this



4 Inscription IRC II 27 (photo: H. Feliu Pérez)

[12] Fabre – Mayer Olivé – Rodà de Llanza 1985, 673.

Cat.	Material	Category	Size (in cm)	Function	Date
IRC II 19	Isona 1	1	79 × 57 × 54	Votive	2nd century AD
IRC II 20	Isona 3	1	(88) × (71) × (51)	Votive	2nd century AD
IRC II 23	Isona 1	1	(29.2) × (35.6) × (18)	Honorific	2nd century AD
IRC II 24	Isona 3	1 (?)	95 × 59 × 48	Honorific	2nd century AD
IRC II 26	Isona 1	1	89 × 57.5 × 57	Honorific	1st–2nd century AD
IRC II 27	Santa Tecla	–	92 × 55 × 53	Honorific	2nd century AD
IRC II 28	Isona 1	1	(94) × 62 × 58	Honorific	2nd century AD
IRC II 29	Isona 1	1	(77.5) × 59 × 51.5	Honorific	2nd century AD
IRC II 31	Isona 1	1	(80) × 53.8 × 53	Honorific	2nd century AD
IRC II 32	Isona 1	1	86 × 58 × 46	Honorific	2nd century AD
IRC II 33	Isona 2	2	95.5 × 59 × (?)	Funerary (?)	2nd–3rd century AD
IRC II 34	Isona 1	2	100.5 × 53.5 × 49	Funerary (?)	2nd–3rd century AD
IRC II 35	Isona 1	2 (?)	81 × 65.5 × 55	Honorific	2nd century AD
IRC II 36	Isona 1	2	99 × 52 × 41.5	Funerary (?)	2nd–3rd century AD
IRC II 37	Isona 1	1	(35) × (53) × (36)	Honorific	2nd century AD
IRC II 38	Isona 1	1	88 × 56 × 51.5	Honorific	2nd century AD
IRC II 40	Isona 1	1	93 × 64 × 58	Honorific	2nd century AD
IRC II 42	Isona 1	1	(84) × 56 × (44)	Honorific	2nd century AD
IRC II 45	Unidentified	1	(44) × 62 × 60.5	Honorific	2nd century AD
IRC II 49	Isona 3	1	85 × 59 × 50	Honorific	2nd century AD
IRC II 54	Isona 3	1	91 × 57 × 46	Honorific	2nd century AD
IRC II 55	Unidentified	1	88 × 58.5 × 59	–	2nd century AD

Table 1 Summary of the pedestals from the city of Aeso

pedestal should be placed somewhere between the two series identified above. Despite possessing common characteristic elements of both types, its appearance is more akin to the pedestals of the second typological series.

The exception to these two categories is pedestal IRC II 27, which is made of Santa Tecla stone. It has a high-quality finish, exemplified in its moulding, decorated with floral motifs, a feature that is only documented in three other epigraphs from Tarraco[13]. This is the only example that can be clearly considered an imported piece (fig. 4).

DISCUSSION

In addition to the central blocks, the tripartite pedestal consisted of two additional elements: a crown and a plinth (see tab. 2). We have also been able to document a wreath, four bases for a parallelepiped block, and an equestrian statue base in the city of Aeso. The materials used to make them are the same as those documented for the parallelepipeds. Both the plinth and the crown are made of Isona 1, while the equestrian base was made of Isona 3 (fig. 5).

Unlike the central blocks, these parts do not receive such a high degree of standardisation. Furthermore, the small number of examples prevents us from identifying patterns of serialisation. Nevertheless, certain elements are observable that point to serial production. Firstly, the width of the plinths is around 68–75 cm, which allows both the central block to fit in the plinth and the

[13] CIL II² 14, 1011. 1212. 1249.

Shape	Material	Size	Moulding	Overall appearance
Crown	Isona 1	(29.5) × (27) × (32)	Girdle, *cyma reversa* and *cyma recta*	Smooth
Plinth	Isona 1	37 × 74 × 74	Reverse cavetto, listel, *cyma recta* and listel	Chimed
Plinth	Isona 1	30 × 65 × 69	Shave off	Smooth
Plinth	Isona 1	(20) × (39) × (35)	*Cyma reversa*, listel and *cyma recta*	Smooth
Plinth	Isona 1	41 × 72 × 43	*Cyma reversa*, reverse fillet, *cyma recta*, listel and roundel	Polished
Equestrian plinth	Isona 3	38 × 68 × 183	Reverse cavetto, listel and *cyma recta*	Chimed

Table 2 Summary of the crown and plinths preserved in the city of Aeso



5 Frontal photography of a plinth. a: Made of Isona 1. b: Made of Isona 3 (photos: H. Feliu Pérez)

monument itself to fit the epigraphic landscape. This is important, as any inscription had to comply with set standards of erection and display. Another element that may indicate the presence of serial production on the plinths and the crown is the moulding that frames the lateral faces. In the preserved blocks from Aeso we find the same types of mouldings that are found in other cities such as Tarraco and Barcino. These mouldings appear in the form of a reverse cavetto, listel, and *cyma reversa* and *cyma recta* for the plinths, and a girdle, *cyma recta*, listel and a *cyma reversa* for the crown. However, in contrast to these cities, a greater variety of cymatia has been documented at Aeso, a variety that nevertheless retains an association with the typological developments of the mouldings described above and with a size of between 8 and 8.5 cm. Most of the blocks have a smooth or polished finish with varying levels of care applied to their lateral faces. On the other hand, the upper faces have a polished finish to facilitate the fitting of blocks between each other. A further two plinths with this polished face can possibly be identified, along with a third with *anathyrosis*.

In order to define the stone typologies used for the Aeso pedestals, a detailed macroscopic analysis of the diverse monuments was carried out. The result was the identification of three facies or types.

Isona 1

A homogeneous yellow limestone with tones that vary from golden to light yellow and which may have recrystallised facies. This type contains scattered areas of recrystallised white carbonates and, to a lesser extent, transparent carbonates. It occasionally shows fine orange stylolites where oxides are concentrated[14]. It may have areas with abundant recrystallised shell fossils. It is the most copious variety with ten examples (fig. 6).

[14] Gutiérrez Garcia-Moreno 2009, 79 f.



6 Macroscopic detail photography of the characteristic of the Isona 1 stone (photos: H. Feliu Pérez)



7 Macroscopic detail photography of the characteristic of the Isona 2 stone (photo: H. Feliu Pérez)



8 Macroscopic detail photography of the characteristic of the Isona 3 stone (photo: H. Feliu Pérez)

Isona 2

A very recrystallised yellow limestone with a shift to sparse red areas. Only one parallelepiped example with this material has been documented (fig. 7).

Isona 3

Recrystallised limestone formed by a pink background with variations ranging to bright pink and yellow. It presents numerous fossil shells of rudists and areas of recrystallised white carbonates. A total of four pedestals made of this limestone have been identified (fig. 8). In the Aeso area, a limestone with similar characteristics is known to have been exploited. The main difference between these two types of limestone is that the Aeso type has a grey instead of a pink matrix. It was mainly used for the construction of walls, especially the variety without recrystallised shell fossils[15]. A variety with fossils has been identified in plates IRC II 30 and 41. It is possible that these two materials come from the same quarry or were exploited from the same quarry front, while this is not the case with the varieties that have abundant recrystallised shell fossils.

The three facies were used interchangeably by the city's epigraphic workshops. The most common variety, Isona 1, is documented in inscriptions from the 1st to the 3rd centuries AD and was used for monuments from both typological series. On the other hand, the use of Isona 2 and Isona 3 seems to be more limited chronologically, to the end of the 2nd and the beginning of the 3rd century AD for the former, and during the 2nd century AD for the latter.

CONCLUSIONS

Detailed study of the pedestals and the quality of the surfaces indicate that we are dealing with a local workshop that imitated the model that had emerged in Tarraco. This is also evident in the plinths, although it has not been possible to detect any signs of serial production. There are two

15 Gutiérrez Garcia-Moreno 2009, 80.

phases of production that can be discerned through the style of execution of the monuments. The first category dates from the beginning of the 2nd century AD and includes most of the inscriptions that have a well-defined moulding and text. The second group, which dates from the end of the 2nd or the beginning of the 3rd century AD, is made up of larger blocks, around 95–100 cm high, with a coarsely elaborated moulding and a text that is rendered with a shallow incision[16]. These monuments do not present such a high degree of standardisation as can be seen on the pedestals from Tarraco, the city from where this specific tripartite model originates. Despite there being a considerable volume of preserved inscriptions, there was a low demand in the city. This low demand was, therefore, not enough to encourage the lapidary office of Aeso to specialise in the production of a specific epigraphic model for its honorary representations.

The ongoing study into the epigraphic landscape of Aeso will be marked by two lines of research: 1) identification of the lithotype quarries, which will help us both to define them geologically and to understand the extent and volume of their production in Roman times; and 2) a detailed investigation of the scale of the epigraphic production at Aeso through an analysis and comparison with other cities. This will enable us to understand the socio-political relations between the cities, the diffusion or imitation of the output from the stone workshops of Tarraco, and to specify the chronological ranges for their use.

ACKNOWLEDGEMENTS

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[16] IRC II 33–36.

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A PECULIAR ORNAMENTAL STONE IN THE CIVITAS TREVERORUM USED IN FUNERAL MONUMENTS AND THE ANCIENT THEATRE OF DALHEIM (GRAND DUCHY OF LUXEMBOURG)

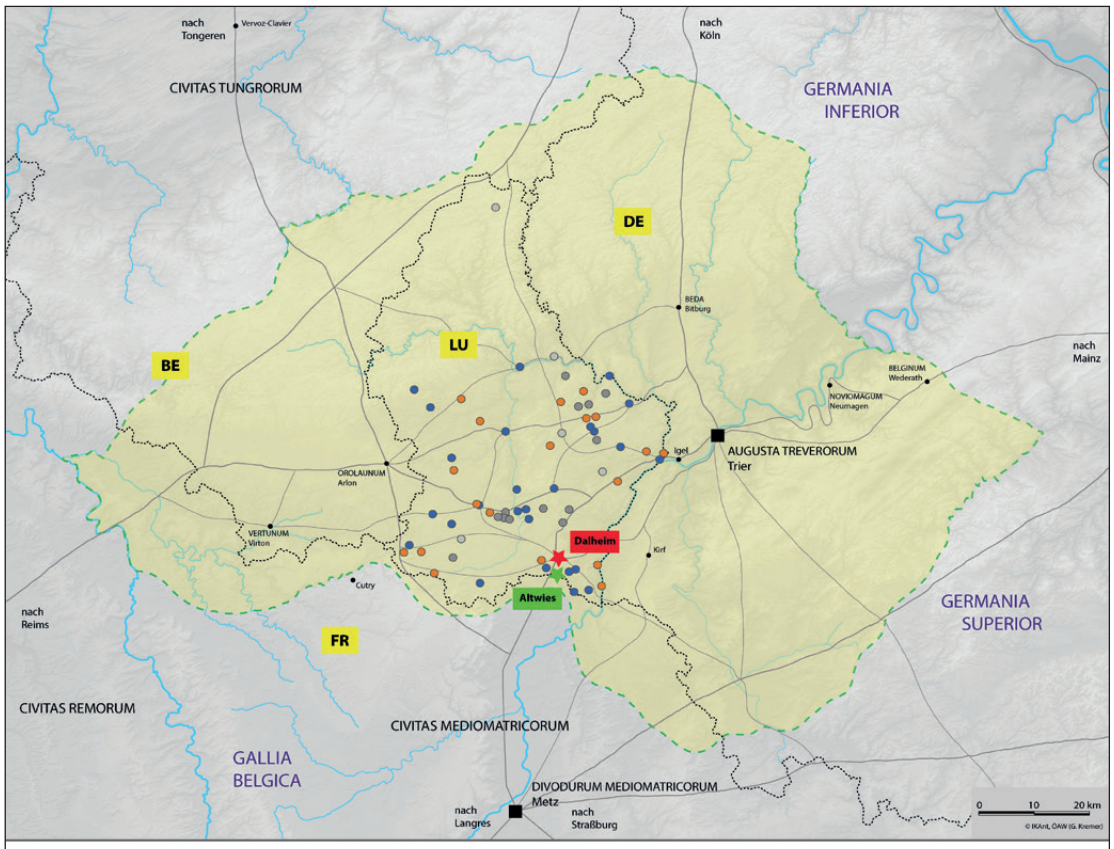
Abstract
Besides various white decorative limestones from the Moselle Basin in French Lorraine and red decorative sandstones of the Trier area (capital of the *civitas*), several Luxembourgish stones – three of which are new – have been identified in the western part of the Civitas Treverorum: these have been used not only for funerary monuments but also for architectural elements and as building materials. This paper introduces the stone of Altwies, a brand-new denomination, which was used to build the benches of the antique theatre in Dalheim, located a few kilometres from the extraction site and still visible today near the village of Altwies (Mondorf-les-Bains). Much later, these blocks were reused as building materials in the »Adler« monument. The stone from Altwies has also been used in a few ancient funeral monuments, parts of which were added to the tomb of the parson of Aspelt (20th cent.). Petrographical analysis was performed on both the archaeological material and the *in situ* natural rocks. During the Gallo-Roman period, open-air quarries of limited extension provided a white, coarse-grained and gravelly, bioturbated, quartzarenitic sandstone enclosing the pluricentimetric shells (often mouldic) of large molluscs and gastropods. Several facies of this particular sandstone coexist and can be distinguished based on differences in grain size and the frequency of the gravel and/or fossils. This rock represents a very localised facies, forming the base of channels in the sandstones and calcareous sandstones of the Lower Jurassic Luxembourg Sandstone Formation in the southeastern corner of the Grand Duchy of Luxembourg.

INTRODUCTION

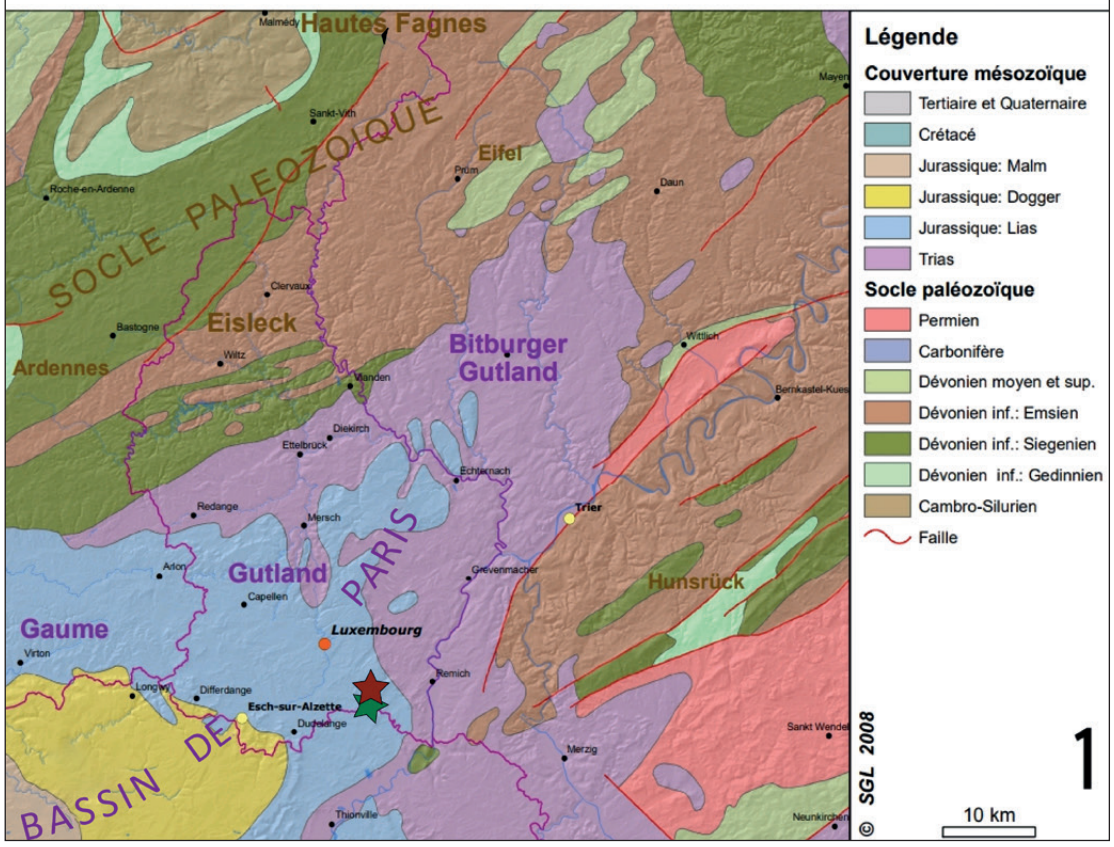
The funerary monuments from the Civitas Treverorum (fig. 1) are in the focus of current research projects conducted by the Austrian Academy of Sciences and the University of Luxembourg (western part of the *civitas*) and the University of Frankfurt, in cooperation with the Rheinisches Landesmuseum, Trier (eastern part of the *civitas*)[1]. The main objectives of the interdisciplinary part of the current research project on the funerary monuments of the western Civitas Treverorum are to obtain a better knowledge of the use of decorative stones in northern Gaul and to tackle some questions related to chronology and to the organisation of the workshops and their economics[2].

The Civitas Treverorum, in Gallia Belgica, is famous for the quantity and the richness of its Gallo-Roman funerary monuments, among them those of Neumagen, Arlon or Bertrange[3]. The territory of the Treveri (*civitas Treverorum*) covers four countries: the whole of the Grand Duchy of Luxembourg (Guttland and Eisléck) and limited areas in Germany, Belgium (part of the Belgian Ardennes and Belgian Lorraine), and France (part of French Lorraine) (fig. 1 a). Geologically speaking, it mainly corresponds to two major cross-border geological structural units: the Ardennes sensu lato and the Lorraine region sensu lato (fig. 1 b). A comprehensive summary of

1 Mahler 2017; Kremer 2018; Binsfeld et al. 2020.
2 Kremer – Dreesen – Goemaere 2022; Dreesen – Goemaere – Kremer 2024.
3 E.g. Numrich 1997; Kremer 2009; Metzler et al. 2016, 349–377. 750–812; Kremer 2019; Kremer – Ruppert 2019; Ruppert 2020; Dreesen – Goemaere – Kremer 2024; Kremer (in print).

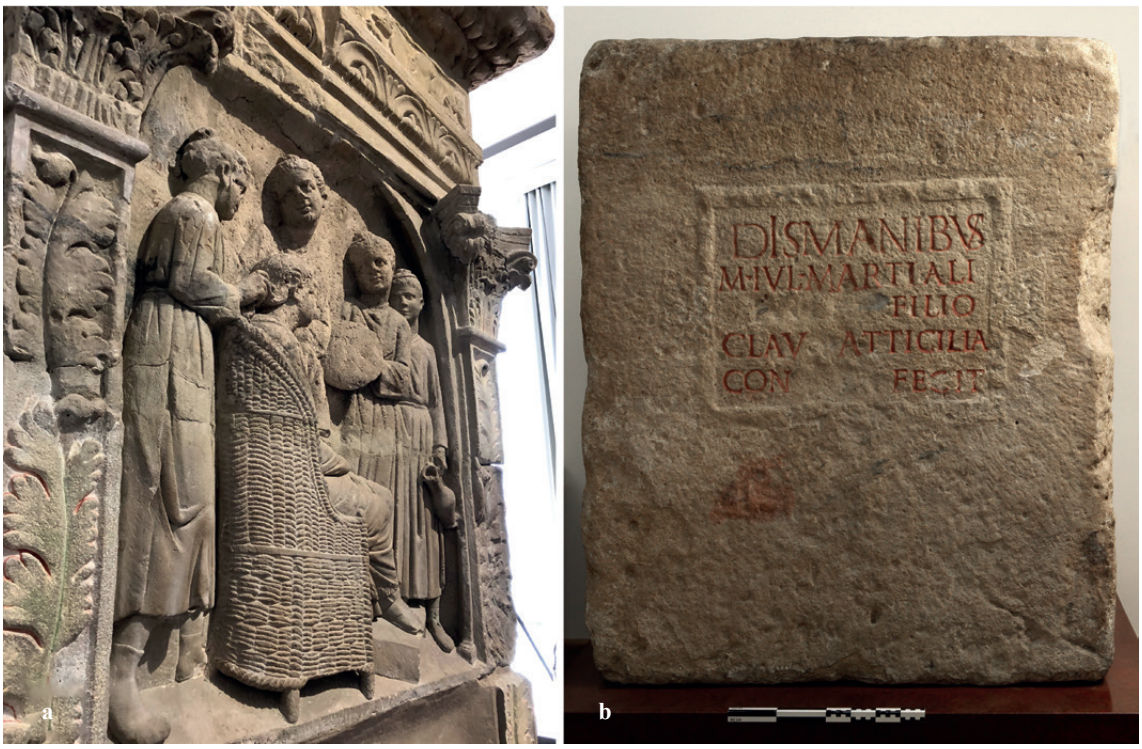


a



b

1 a: Map of the Civitas Treverorum with the find locations of the studied funerary monuments within the Grand Duchy of Luxembourg (graphics: G. Kremer). b: Simplified geological map of Luxembourg and adjacent areas (southeastern Belgium, northern France and western Germany) (graphics: R. Colbach, Geological Survey of Luxembourg)



2 a: Funerary monument composed of two different stone types, one of which is the Altwies stone. Rheinisches Landesmuseum in Trier, Germany. b: 1st-century funerary monument from Ellange, Luxembourg, made of Altwies stone. Musée national d'archéologie, d'histoire et d'art (MNAHA) in Luxembourg (photos: G. Kremer)

the geology of Belgium and Luxembourg is given by several authors[4]. Moreover, regional, national and European geological maps (at different scales) can be consulted or even downloaded via dedicated websites[5].

Petrographical analysis of thin sections was the main investigation tool that has been applied to both samples from archaeological materials and from *in situ* reference natural rocks. Some of the raw materials came from inside the *civitas*' territory, whereas others crossed the borders following the Moselle river axis. Besides several whitish decorative stones from the Moselle Basin (French Lorraine) and red decorative stones from the Trier area (capital of the *civitas*), different Luxembourgish stones have been identified in our study. These natural stones have been used not only for funerary monuments, but also for other architectural elements and as building stones. This short paper deals especially with the stone of Altwies (a brand-new denomination).

During antiquity, the stone of Altwies was used, among other things, for funerary monuments (fig. 2 a–b), including the one erected by Claudia Atticilia for her husband Marcus Iulius Martialis (fig. 2 b)[6]. This block, which probably formed the central part of an altar-shaped monument of medium size, is of particular interest, because it has been dated by epigraphic arguments as early as the last third of the 1st century AD[7]. It had been discovered in secondary use in the former chapel at the cemetery of Ellange (Ellingen) in 1917. The ancient quarries of Altwies are located at a distance of approx. 2 km as the crow flies from the locality of Ellange and about 1.5 km from the Vicus Ricciacum (Dalheim).

4 E.g. Waterlot et al. 1973; Maquil – Colbach 2007; Boulvain – Vandenberghe 2017.
5 Such as <www.europe-geology.eu>; <www.onegeology.org>; <www.geologie.lu>; <www.geoportal.lu>; <www.naturalsciences.be>; <www.infoterre.brgm.fr>; <www.geologie.wallonie.be> (25.11.2022).
6 MNAHA inv. 3456. See Wilhelm 1974, 77 f.
7 Krier 1997, 241–342.



3 Rows of stone seats (*ima cavea*, S2–S10) in the Roman theatre of Dalheim, made in the coarse-grained gravelly-shelly calcareous sandstone of Altwies. Note the mouldic porosity of the stone (photos: R. Dreesen)



4 a: Macroscopic view of the strongly weathered surface of a stone seat in the Roman theatre: the calcareous sandstone shows various pebbles and mollusc shells (gastropods and pelecypods). b: Detail of the weathered surface of the calcareous sandstone of Altwies (stone seat of the Roman theatre) showing scattered pebbles and a conspicuous mould porosity (photos: R. Dreesen)

Many varieties of this stone were also used as a raw material in the Roman theatre of Ricciacum[8], now Dalheim, in the southeast of Luxembourg (figs. 3–4). This vicus was located along the Lyon – Metz – Trier – Rhine Roman roads, halfway between Metz and Trier[9]. The theatre, erected at the end of the first quarter of the 2nd century, had been modified several times by the third quarter of the 3rd century, when it was finally abandoned after various Germanic raids, which caused great destruction in the settlement of Ricciacum[10]. With a diameter of 67 m in its last stage, the capacity of the ancient theatre is estimated at 3,500 spectators. The lower structures were covered by erosion products from the hillsides (colluvium) and rediscovered in 1985 during new archaeological excavations[11]. In the same year, this antique site was included in the inventory of Luxembourg's national cultural heritage. The theatre was built in a former quarry, but the rocks extracted here (Upper Keuper sandstones called »Grès rhétiens«) are quite different from the material used for the stone seats in the theatre. The latter were erected in construction phase 4 in

8 Sand 2018.
9 E.g. Krier 2010.
10 Krier 2011, 337.
11 Krier 1992.



5 a–b: The Eagle: Historical monument (1855/1957) displaying blocks of Altwies stone, probably in secondary use from the Roman theatre of Dalheim. The »Adler«, as the monument is called, is an 11.3 m-high column on which an eagle sits on a globe. The foundation stone for the monument was laid on 28 May 1855 in the presence of King-Grand Duke William III and his representative, Prince Henri of Orange-Nassau. In a decree, it was stated by the king that the monument should be built from material that came from excavations in the area. c–d: Tomb of Nikolaus Schmit (1837–1913), parson at Aspelt (LU). The base of the statue of Saint Andrew is partly built with reused carved Roman stones made in Altwies stone (photos: R. Dreesen)



a

b

6 a: Weathered face of a Roman stone quarry in the small wood-covered area north of the village of Altwies showing subhorizontal and cross-bedded stratification. The strong mouldic porosity and the presence of scattered pebbles are quite obvious. b: Detail of the rough surface of a quartzarenitic sandstone block found in the former Roman quarries of Altwies, displaying coarse grain size, scattered pebbles and a mouldic porosity (photos: R. Dreesen)

place of the previously wooden rows of seats[12]. The archaeologists date this construction phase to the end of the 2nd century at the earliest[13]. The installation of the stone rows of seats also took place in several phases, whereby interestingly, a different stone material was used for the first row of seats (*prohedria*), which is equipped with armrests at the ends[14]. The use of the Altwies stone for the rows S2 to S10, as well as for other elements of the theatre building, served to distinguish the different construction phases in the interpretation of the archaeological evidence[15]. The presence here of an altar fragment made of a fine-grained yellowish sandstone should also be noted[16]. Furthermore, the base of the »Adler« column of Dalheim, erected in 1855 to commemorate the recent archaeological discoveries, destroyed during WW II and rebuilt in 1957 (fig. 5 a–b), was made of squared blocks of the same rock type. They were part of the approx. 370 ashlars that formed a 10 × 12 m building excavated at this site in 1854[17]. What was first thought to be a huge tower, then a military camp, is now interpreted as a small military road post (*burgus*) from the beginning of the 4th century[18]. It had been erected at the highest point of the plateau with the reused blocks of the rows of seats from the Roman theatre located at a distance of barely 100 m[19].

Carved Roman stones from Altwies have also been found at the base of the statue of Saint Andrew from the tomb of Nikolaus Schmit, parson at Aspelt, Luxembourg (1837–1913) (fig. 5 c–d).

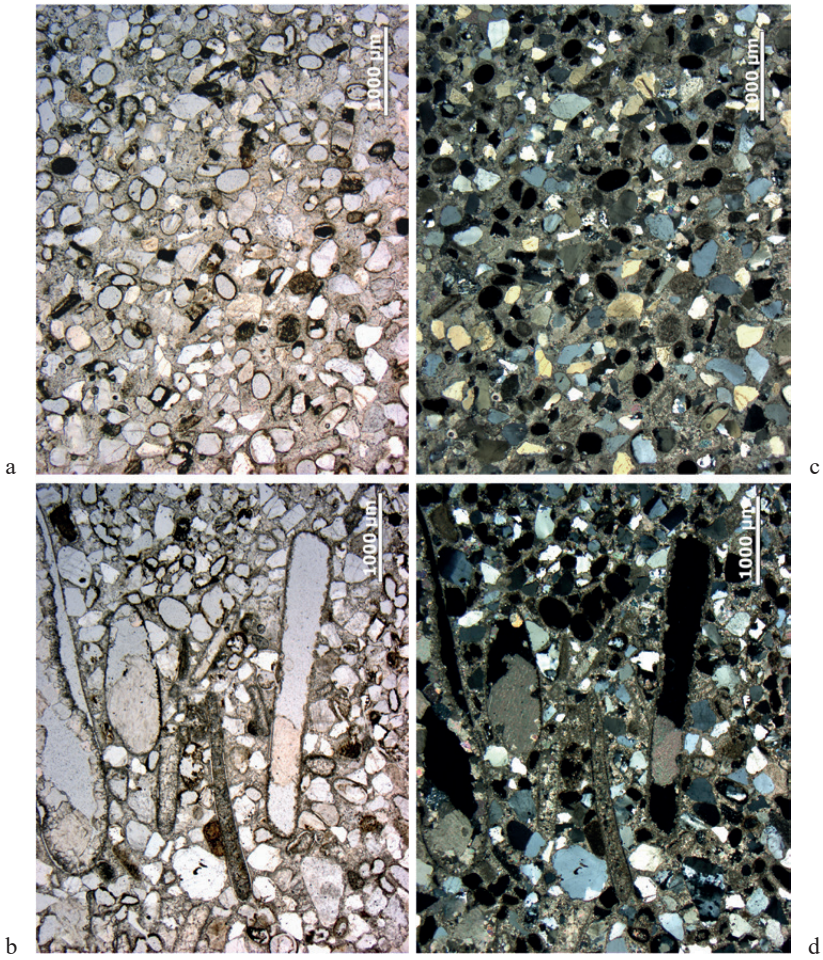
DESCRIPTION OF THE MATERIAL: PETROGRAPHY AND PROVENANCE ANALYSIS

Macroscopically, the stone of Altwies is a yellowish to white (when weathered), coarse-grained and gravelly quartzarenitic calcareous sandstone enclosing well-rounded milky-white quartz pebbles and quartzite pebbles of various colours. The sandstone is bioturbated and contains numerous pluricentimetric shells (often moulds) of large molluscs and gastropods (figs. 4–6). Rare moulds of ammonite shells have been observed as well. Several subfacies of this particular sandstone coexist: they can be differentiated based on differences in grain size and the frequency of pebbles and/or fossils.

Petrographically (fig. 7), the stone of Altwies is a medium-sorted to non-sorted, coarse-grained calcareous sandstone (sand grain diameters up to 2 mm) containing superficial ooids and large skeletal grains (up to 5 mm). The bioclasts are rounded, frequently recrystallised and include fragments of echinoderm, pelecypod and gastropod shells. The ooids are superficial, with nuclei that often consist of sand grains. The sand grains are angular to subrounded. They are composed of mono- and polycrystalline quartz, lithic fragments (quartzite, chert), rare weathered feldspars, mica flakes (muscovite) and heavy minerals (e.g. tourmaline). The calcite cement displays several succeeding generations: prismatic drusy spar, equal spar mosaics and syntaxial overgrowths (the latter around echinoderm fragments). An important mouldic porosity occurs, resulting from the dissolution of superficial ooids and/or rounded bioclasts. The yellowish patina may result from the staining by iron (hydroxides) of the walls of the dissolved allochems (figs. 6–7).

Genetically, this rock represents a local coarse-grained shallow-marine sandstone facies forming the base of marine channels (lag deposits [?]) near the top of the Luxembourg Sandstone Formation (»Grès du Luxembourg«). This particular facies is known locally as the »Lumachelle d'Altwies« or the Altwies coquina. The Luxembourg Formation consists of cross-stratified,

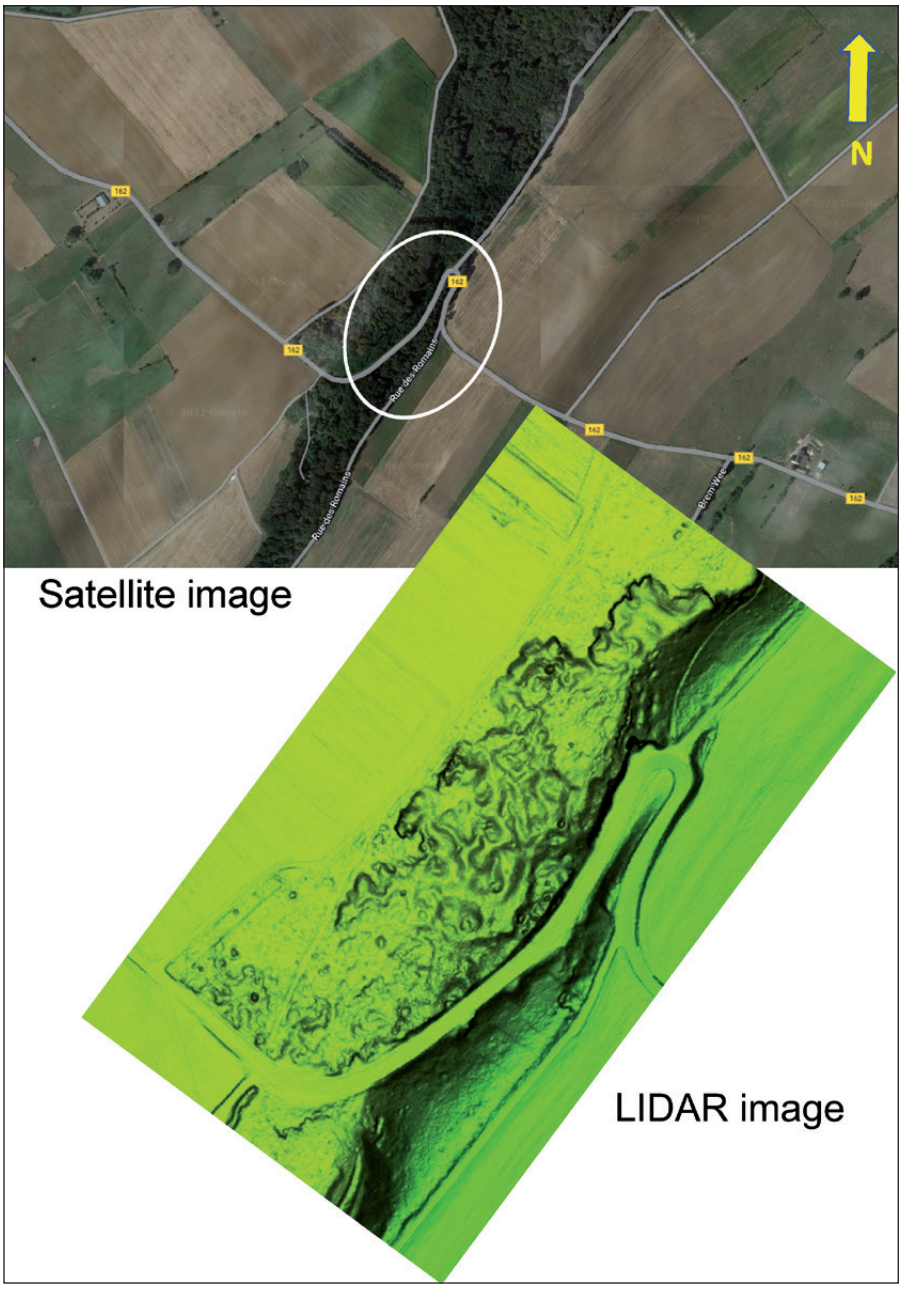
12 Henrich 2015, 24. 68 f. 194–196.
13 Henrich 2015, 289 and passim; Henrich 2018.
14 Henrich 2015, 124–128 and passim.
15 The distinction is made on the basis of the designations »Kalkstein« and »Sandstein«. The thorough petrographic analysis of the rocks used in the Dalheim theatre, on the other hand, is still pending.
16 Henrich 2015, 105–112 fig. 79; Henrich 2018, 36 fig. 5.
17 Namur 1854, 91.
18 Krier 2010, 26. 41.
19 Krier 2010, 42; Krier 2011, 337 fig. 1; Sand 2018, 48 fig. 1.



7 a: Micrograph of a thin section (DAL-21; plane-parallel polarised transmitted light) of a sample of the fine-grained calcareous sandstone from Altwies. Well-sorted calcareous sandstone with mouldic porosity due to the dissolution of superficial ooids. b: Same sample and same thin section but taken with crossed polarisers. c: Micrograph of a thin section (DAL-23-1a; plane-parallel polarised transmitted light) of a sample of a medium-grained calcareous sandstone with mouldic porosity resulting from mollusc shells. Same rock type as in the previous figure but less well sorted and containing larger fossil fragments. Calcareous sandstone with superficial ooids and large bioclasts. d: Same sample and same thin section (DAL-23-1b) but taken with crossed polarisers (graphics: R. Dreesen)

fine- to medium-grained calcareous sandstones and sandy limestones of Hettangian to Sinemurian age (Lower Jurassic) occurring throughout the southern part of the Grand Duchy of Luxembourg. The formation was deposited as an offshore sand wave complex on the southern margin of the London-Brabant Massif, controlled by storm waves and tidal currents[20]. A detailed sedimentological and diagenetic study of the various facies of the Luxembourg sandstone was carried out by Koen Van den Bril[21]. This author recognised a particular sandstone facies made of coarse-grained bioclastic gravel layers (facies 8) that is quite analogous to the facies of the Altwies Stone. The ancient quarry of Altwies (fig. 8) is located 1.6 km north of Altwies, along the CR162 road, between the localities of Filsdorf and Ellange, only a few kilometres from the modern sandstone extraction site. Geomorphologically, this quarry is located precisely on the escarpment of the Altwies Fault, passing just east of Altwies in a northeasterly direction. The downthrown southeastern block of this fault is made up of a Sinemurian marl and limestone alternation that is more easily eroded

20 Berners 1983.
21 Van den Bril 2008.



a

b

8 Satellite image (Google Maps, above) and LiDAR image (map.geoportail.lu, below) of the wood-covered area north of the village of Altwies (Mondorf-les-Bains) located close to the Luxembourg-France boundary. Note the irregular topography of ridges and depressions resulting from supposedly extensive stone quarrying during Roman times (GPS coordinates: 6.2639 E, 49.5268 N) (Data source: Administration du cadastre et de la topographie, Grand Duchy of Luxembourg; graphics: E. Goemaere)

than the sandstones of the Luxembourg Formation in the upthrown northwestern block, leaving an escarpment of 20–25 m in height, very noticeable in the landscape. It can be assumed that this escarpment predetermined the location of the ancient quarries, because this natural step in the landscape made the extraction of stone blocks much easier, as they could be taken out horizontally or on a downward slope.

Another outcrop exposes the same facies, near the village of Altwies (Mondorf-les-Bains), located on the eastern side of a road (Rue des Sources) along an intermittent river, below the Altwies viaduct (the A 13 motorway linking Pétange in Luxembourg to the Sarre region in Germany) and cutting the natural cliff (GPS coordinates: 6.2526E, 49.5182N). This gravelly and fossil-rich

sandstone facies occurs occasionally in the active sandstone quarry (Carrières Feidt S. A., production of sand and granulates) in Altwies (Mondorf), depending on the progress of the quarry faces. All the old buildings and constructions around Mondorf-les-Bains are built with fine-grained yellowish sandstones from the Luxembourg Formation.

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THE USE OF ALCOVER STONE IN ROMAN TIMES (TARRACO, HISPANIA CITERIOR)

CONTRIBUTIONS TO THE *OFFICINA LAPIDARIA TARRACONENSIS* II: EVIDENCE OF EARLY SUPPLIES OF EPIGRAPHIC MATERIALS BEYOND THE CITY OF TARRACO

Abstract
Roman inscriptions on Alcover stone found in Baetulo and dated to the Augustan period have made it possible to document for the first time the use of this stone for epigraphic supports outside Tarraco, where it was well known for honorific purposes about the same time.

INTRODUCTION

An important inscription related to M. Porcius (fig. 1), a well-known wine trader recorded in several amphora stamps from the Augustan period (fig. 2), has recently been discovered in Baetulo (modern Badalona, Barcelona)[1]. The inscription also stands out for its material, the »Pedra d'Alcover« (Alcover stone, from the ancient quarry near the homonymous village, close to Tarragona) (fig. 3), a sedimentary carbonate rock used only in Tarraco as an epigraphic support in the late Republican – early Imperial period[2]. By contrast, this type of stone is not documented in



1 [M(arcus)?] Porcius' inscription from Baetulo. Augustan period (from Rodà de Llanza – Forn – Moreno 2020, fig. 3)



2 M. Porcius stamp on a Pascual 1 amphora (photo: Badalona Museum, C. Forn)

1 Rodà de Llanza – Forn – Moreno 2020.

2 The present study is a follow-up of the paper published in the ASMOSIA XI proceedings. For epigraphic workshops and stone-cutters in early Tarraco using Alcover stone, see Alföldy 2012; Gorostidi Pi 2020.



3 Map of the Alcover quarries, near Tarraco (modern Tarragona) and Baetulo (modern Badalona) (graphics: A. Collado)

the surroundings of Baetulo, as shown in the geological map (fig. 4). For this reason, a review of the materials in the collection of the Badalona Museum has been carried out and has led to the identification of three more inscriptions in Alcover stone (fig. 5).

The use of such characteristic brown, grey or cream-coloured stone is in line with the first epigraphic honorific inscriptions dating back to the foundation times of the Colonia Tarraco and Augustus' stay in the city during the Cantabrian Wars (29–19 BC)[3]. Baetulo on the other hand, was founded by the Romans at the end of the Republican period. It underwent a massive urban development under Augustus thanks to a prospering wine industry for which the Laetanian coastal zone was renowned. Nevertheless, the city has yielded no inscriptions from that period until now[4].

DISCUSSION

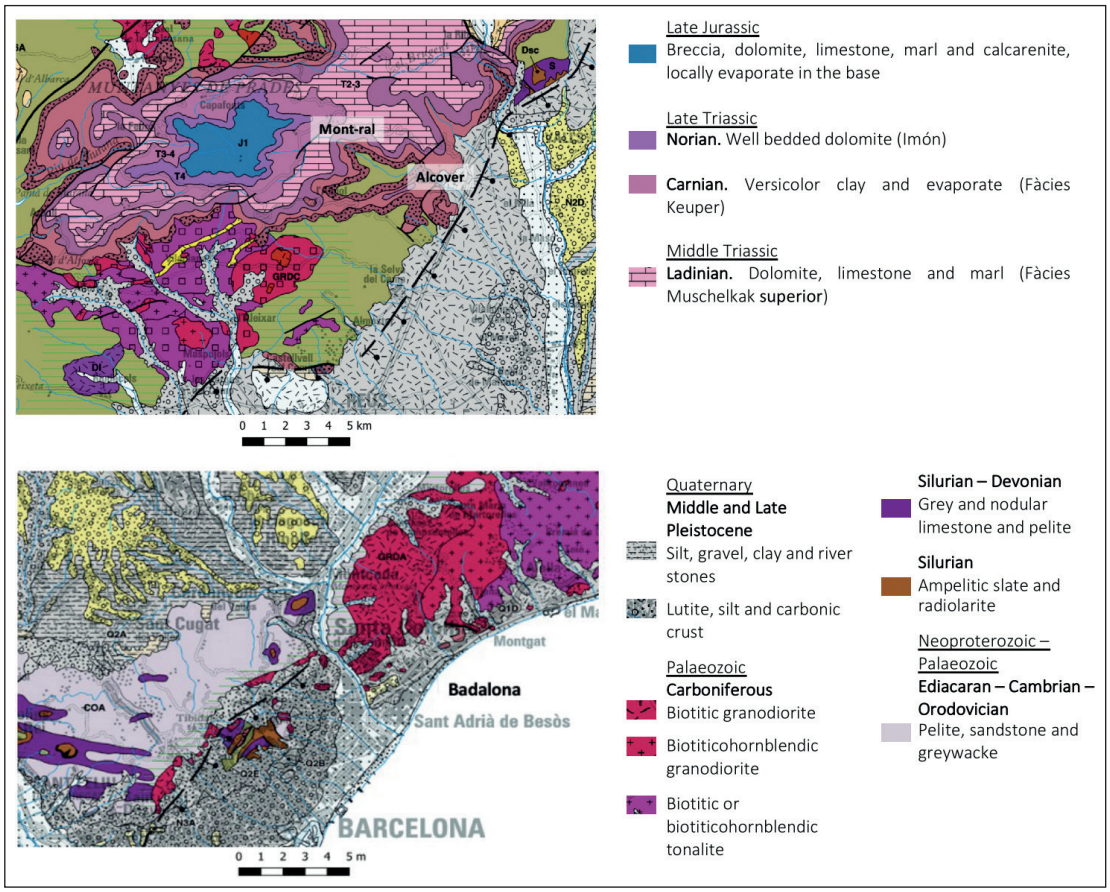
Given their morphology, content, and palaeography, the four inscriptions from Baetulo belong to the series of private monuments found in Tarraco in the Augustan and Tiberian periods (fig. 6). In those years, local stone workshops were producing a considerable number of public honorary monuments (fig. 6 a–b), mainly for wealthy freedmen and freeborn individuals (fig. 6 c–d).

The earliest chronology of Alcover stone workshops in Tarraco coincides with that of M. Porcius' inscription in Baetulo. Therefore, the Badalona inscriptions must date to the same period, as they may have all been commissioned in Tarraco to then be displayed in the city of destination. Such evidence allows us to document the first case of epigraphic media distribution outside of the capital of Hispania citerior, a phenomenon previously documented only for the »Pedra de Santa Tecla« (Santa Tecla stone), a pale pink or yellow-coloured stone also known as Tarraco marmor. This micritic calcite was also profusely widespread in the neighbouring cities[5]. This phenomenon was driven by the intense development of stone workshops that provided magnificence to the provincial capital's new buildings and public spaces under Vespasian.

ALCOVER STONE

Alcover stone is a compact calcareous mudstone from the Prades mountain chain (Serra de Prades), between the cities of Alcover and Mont-ral (Alt Camp, Tarragona, Spain). Macroscopically, Alcover stone can be identified as a homogeneous stone with very fine grains and a light-

3 Alföldy 2012; Gorostidi Pi 2020.
4 Rodà de Llanza – Forn – Moreno 2020.
5 Álvarez et al. 2009.



4 Geological map. a: Alcover district. b: Baetulo (from Coca – Alcañiz – Salas [n. d.])



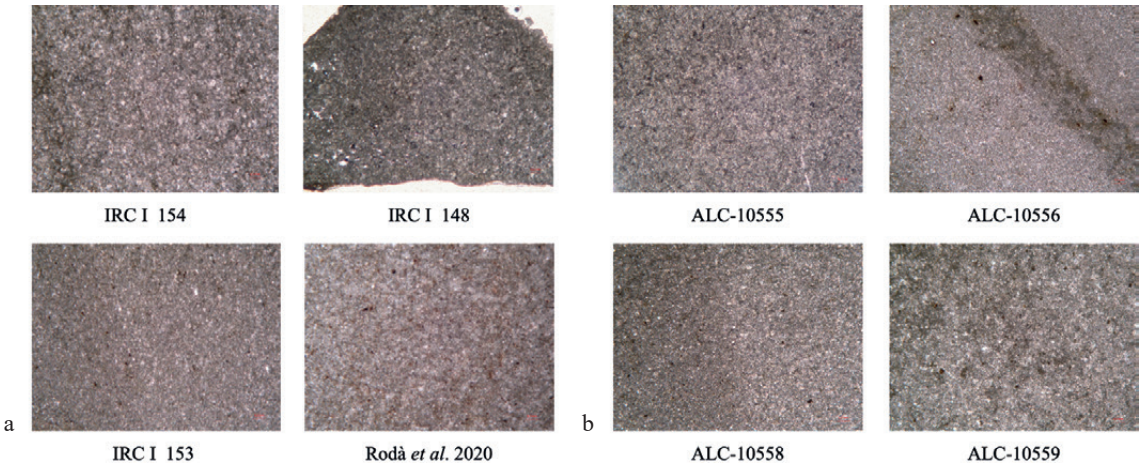
5 Inscriptions from Baetulo in Alcover stone: IRC I 148. 153. 154 (photos: Unitat d'Estudis Arqueomètrics – Institut Català d'Arqueologia Clàssica)

brown to grey colour, at times it can even present a red colour. Furthermore, this stone presents a strong bedding. The lamination contributes to the natural fracture of the rock into sheets between a few millimetres and 10 cm wide, which limited its use in Roman times as an epigraphic support, pavement slabs, wall veneers and tombstones[6].

6 Coca – Alcañiz – Salas (n. d.); Gutiérrez Garcia-Moreno 2009.



6 Tarraco Latin inscriptions from the Augustan period on Alcover stone: CIL II² 14, 864. 1023. 1270. 1620 (photos: The National Archaeological Museum of Tarragona)



7 a: Microscopic appearance of Baetulo's inscriptions. b: Microscopic appearance of Alcover stone (random quarry samples) (photos: UEA)

On the microscopic level, the Alcover stone is characterised as a dolmicrite or dolomite mudstone of hypidiomorphic, euhedral (50–80 μm) crystals with detrital quartz silt (10–30 %) and mica components. It appears in strong bedding sheets with millimetric internal lamination, sometimes separated by marly mud strata[7].

ALCOVER STONE IN BAETULO

Although the use of Alcover stone has previously only been documented in Tarraco and its close surroundings, the Baetulo inscriptions with this lithologic appearance that is so alike have allowed us to consider a common provenience, that is, that both types come from the same district quarry at Alcover. In order to confirm that hypothesis, samples of the inscriptions and Alcover quarry specimens have been examined under the microscope (fig. 7 a–b).

CONCLUSIONS

The result of the comparison between the samples examined allows the same origin to be established, which confirms the hypothesis. Accordingly, we can state that Alcover stone was used as a huge epigraphic medium for honorary monuments not only in the capital city itself but also for deliveries beyond Tarraco from the late Republican era onwards until the emergence and exploitation of Santa Tecla stone under the Flavians.

7 Gutiérrez Garcia-Moreno 2009.

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Rodà de Llanza – Forn – Moreno 2020	I. Rodà de Llanza – C. Forn – I. Moreno, Una nueva inscripción en Baetulo con el nomen Porcius, in: J. M. Noguera – I. López – L. Baena (eds.), Satyrica signa. Estudios de arqueología clásica en homenaje al profesor Pedro Rodríguez Oliva (Granada 2020) 313–324.

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COLUMN SHAFTS FROM HIPPO REGIUS

QUALITY SELECTION AND EASTERN EXPORTATION

Abstract
The distribution of the grey-and-white, diagonally streaked marble (Greco scritto, Grigio striato) from Cap de Garde, Algeria, near the ancient city of Hippo Regius, is re-examined. Its presence is spotty in its home region of Numidia and Africa Proconsularis, but new analyses with stable isotopes of carbon and oxygen confirm its use for column shafts in central Italy and Cyprus. An examination of these exported shafts makes it clear that their notable decorative qualities made them viable products in distant markets. Diagonally streaked columns were also produced in quarries in the Aegean area, and those from Lesbos could appear very similar to shafts from Hippo.

The grey-and-white streaked and spotted marble from Cap de Garde, Algeria, near the ancient city of Hippo Regius has traditionally been termed »Greco scritto«, but the term »Greco striato« or »Grigio striato« seems more fitting (see below). The quarries have been characterised and the distribution of its marble has been tracked based on its distinctive patterns and, where possible, confirmed by analysis of stable isotopes of carbon and oxygen[1]. So far, the pattern of distribution is irregular and somewhat puzzling. In its North African heartland of eastern Algeria and Tunisia (the Roman provinces of Numidia and Africa Proconsularis), the marble is well represented in most cities near the coast. It is also seen in some inland sites close to the Sahara, such as Haïdra and Tebessa, but it is very scarce in other frontier sites, such as Timgad and Lambèse[2]. In Africa, Hippo marble does not seem to have penetrated far beyond this core area. It reached Leptis Magna in western Libya, but it has not been detected in testing farther east at Cyrene[3]. To the west, it does not seem to have reached much beyond Numidia, and it is missing in central Algerian sites, such as Cherchel[4], and far western sites, such as Banasa[5] and Volubilis[6] in Morocco.

Nevertheless, isotopic analysis has confirmed that marble from Hippo was not only used in its core area but also exported to the north across the Mediterranean. Particularly in the form of column shafts, it reached central Italy, especially Rome and Ostia[7].

So far it has not been observed that the successes of this exportation seem to be due to the selection of more attractive material for more or less distant markets. Shafts appearing in distant markets, even within the borders of modern Tunisia and Algeria, seem to have comparatively strong contrasts between light and dark zones and display sharp striations, and, at times, rich undulations. A column fragment converted into a sculpture pedestal in the Palazzo Altemps, Rome, clearly displays the beauty that Hippo marble can have when well-selected pieces are

1 Antonelli et al. 2009; Antonelli – Lazzarini – Cancelliere 2010, 585–588; Attanasio et al. 2012; Tykot et al. 2018.
2 Tykot et al. 2018. 476.
3 Antonelli et al. 2009, fig. 8.
4 Herrmann et al. 2012a, 1321 f. tab. 1 fig. 3; Herrmann et al. 2012b, 305 f.
5 Antonelli et al. 2014, 16–18.
6 Antonelli et al. 2009, fig. 8.
7 Herrmann et al. 2012b.



1 Column shafts in Hippo marble from Cap de Garde (grey-veined marble from Hippo Regius), Algeria. a: Palazzo Altemps, Rome, UGA C1510003 (photo: J. Herrmann). b: Villa dei Quintili, entrance, Rome, UGA 1510002 (photo: A. van den Hoek). c: Carthage Museum, Tunisia, UGA C1409004 (photo: J. Herrmann). d: Old Forum, Khemissa, Algeria, USF 10850. Marble probably from Hippo (photo: A. van den Hoek)

highly polished (fig. 1 a). Dark, slightly undulating diagonal bands alternate with light zones with grey streaks in cloud-like formations. Similar effects are evident in one of the column shafts used in a nymphaeum at the entrance of the grandiose 2nd-century Villa of the Quintili on the Via Appia outside Rome (fig. 1 b)[8]. The shaft's undulating veining had led scholars to classify it under the heading of Cipollino. Several shafts of Hippo marble in the Carthage Museum have the added refinement of reeded flutes, but the contrasting bands and variable striations are still conspicuous features (fig. 1 c). Samples from all three of these shafts proved to have isotopic ratios compatible with Cap de Garde/Hippo and incompatible with other marbles with similar markings (tab. 1; fig. 4).

Many shafts of the local marble preserved at Hippo are less decisive and impressive than these elite examples. White areas often dominate the grey spots and streaks. This is true of a shaft at Khemissa, only about 80 km south of Hippo (fig. 1 d)[9], whose markings are scattered blotches. Isotopically the shaft could be from Mt. Filfila, Algeria or Hasançavuslar, Ephesos, as well as from Hippo. The grain of the shaft – maximum grain size (MGS) 4 mm – is too coarse for Hasançavuslar, whose MGS ranges between 1.45 and 2.1 mm, but it is possible for both of

8 Paris 2000, 20–24. 52 f.: »colonne di marmo cipollino«.

9 Additions to our quarry data make the old identification as Cap de Garde as likely as that of Filfila marble, see Herrmann et al. 2012b, 302 fig. 4.



2 Marble from Cap de Garde (Hippo marble). a: Ostia, Basilica Cristiana, USF 40932. b: Paphos, Saranta Kolones (medieval fort). Eterianos column, UGA 2102067/73. c: Kourion, Roman agora, UGA C21202066/72 (photos: J. Herrmann)

the Algerian sources[10]. The markings of the shaft, which are very similar to those of a column at Hippo[11], favour the Hippo source.

Not all column shafts sent from Cap de Garde to the northern shores of the Mediterranean were impressively ornamental. A small Hippo marble column in the Basilica Cristiana at Ostia, which is probably of 4th-century date, seems poor in both contrasts and in interesting patterning, but its abraded, stained, and lichen-covered condition may conceal its decorative possibilities (tab. 1; fig. 2 a). The Basilica Cristiana makes use of a number of Thasian and Proconnesian column shafts drawn from a nearby depot owned by a certain Volusianus, whose name is inscribed on shafts in the depot and in the basilica itself[12]. A member of the Volusianus family, Rufius Antonius Agrypnius Volusianus, conducted a correspondence with Augustine, bishop of Hippo around 410. The column shafts in the Basilica Cristiana are almost a material embodiment of these close relations between Ostia, Rome, and Hippo Regius.

Another large artefact of Cap de Garde marble, but not a column shaft, has also been identified at Ostia: a threshold or pier with a moulded narrow edge in the Schola del Traiano (east corner) (tab. 1).

The overseas use of Hippo marble column shafts can be greatly extended by a surprising appearance in the Eastern Mediterranean at Cyprus. Groups of Greco striato shafts, that is, with bands of lighter and darker striations, were seen in the Roman agora of Kourion, datable in the

10 Attanasio et al. 2012, tab. 1.
11 Beside the nymphaeum/fountain basin of a house on the ancient seafront, see Lavergne 2005, 135.
12 Pensabene et al. 1999.



3 Piazza Armerina, Villa del Casale, semicircular entry court. a: 2nd column at right, USF 40929, Lesbos limestone. b: 3rd column at right, USF 40930, Lesbos limestone (photos: J. Herrmann)

early 3rd century AD[13], and others were reused in the medieval fort of Saranta Kolones, at Paphos (tab. 1; fig. 2 b–c)[14]. One shaft in Saranta Kolones was inscribed in handsome lettering:

ΚΛΑΥΔΙΑΝΟC | ΕΤΕΡΗΙΑΝΟC | ΙΠΠΙΚΟC
Κλαυδιανὸς Ἑτερηιανὸς ἱππικός

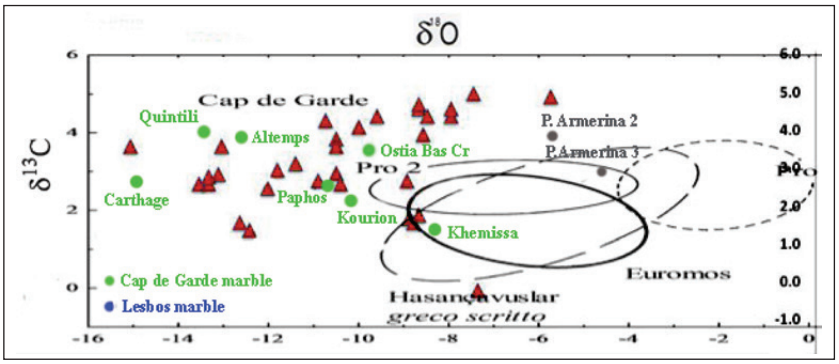
»Klaudianos Eterianos, of the equestrian rank«

This otherwise unknown Klaudianos was presumably the purchaser of the column[15].

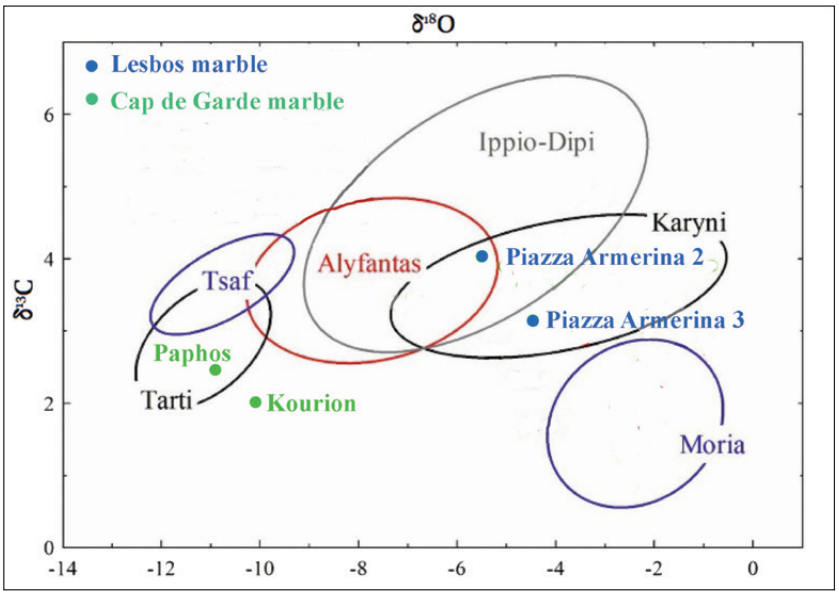
Samples taken from the Klaudianos shaft and the Kourion shaft proved to have isotopic ratios that suited Cap de Garde and cannot be confused with those of other grey-and-white streaked or spotted marbles, such as Euromos, Prokonnesos, or Ephesos/Hasançavuslar (fig. 4). It could, however, be from the quarry of Bigio antico limestone at Tarti on Lesbos (fig. 5)[16], but the shaft appears to be marble not limestone. The appearance of Hippo marble on Cyprus is not unprecedented. Recently a multi-method analysis of inscribed marble plaques in the Sanctuary of Apollo Hylates itself has identified one plaque as Hippo marble[17].

Optical examination has suggested that marble from Cap de Garde was exported to Piazza Armerina in Sicily[18], but our isotopic testing has cast this into question. Two column shafts from the entrance court of the Villa del Casale were sampled, and both are probably stone from Lesbos

13 Karageorghis 2009.
14 Maier – Karageorghis 1984, 304 f. 309 f.: »granite columns«.
15 For the equestrian rank in the later Roman Empire, see Davenport 2012.
16 Bruno et al. 2020; Bianchi et al. 2023.
17 Prochaska et al. 2017, 208–210. 213.
18 Atienza Fuente – Gonzáles de Andrés 2019.



4 Isotopic ratios of column shafts of Cap de Garde marble are plotted against isotopic fields of Greco scritto and similar marbles (after Bruno et al. 2018, fig. 8; graphics: J. Herrmann). The Cap de Garde field has been updated with our complete quarry data (after Herrmann et al. 2015, 739 f.; graphics: J. Herrmann)



5 Column shafts of Lesbos and Cap de Garde marble plotted against quarries of Lesbos. Lesbos quarry diagram after Bianchi et al. 2023 (graphics: J. Herrmann)

(tab. 1; figs. 7–8). The two columns analysed flanked the passageway to the villa's main peristyle. The shaft on the left had the typical appearance of Bigio antico from Lesbos; it was grey and flecked with white spots (fig. 3 a). The shaft to the right of the passageway's entrance, however, had markings that could be better characterised as Greco striato, since striations pass diagonally through the shaft (fig. 3 b). Both Piazza Armerina shafts had isotopic values corresponding to Bigio antico of Lesbos, not to the familiar quarries of shell marble at Moria but to the quarries at Karyni, which have recently been recognised as an important ancient marble source[19]. The samples were tiny flakes, but the MGS of both was fine-grained (1.0 mm; 0.8 mm), like the characteristic MGS of Lesbian Bigio antico[20]. The isotopic values of one shaft (fig. 3 b) also corresponded to Hasançavuslar, Ephesos, but the MGS of Hasançavuslar is coarser (1.45–2.1 mm)[21]. The similar diagonal markings of the shafts from Lesbos, Hippo, and occasionally Hasançavuslar, make it

19 Bruno et al. 2020; Bianchi et al. 2023.
20 Bianchi et al. 2023, 22 fig. 13.
21 Attanasio et al. 2012, tab. 1.

Number	Location	Description	$\delta^{13}C$ (VPDB)	$\delta^{18}O$ (VPDB)
UGA C1409004	Carthage Museum	Fluted and reeded column shaft (fig. 2)	2.9	–15.0
UGA C1510002	Rome, Villa dei Quintili	Nymphaeum on Via Appia, column next to right (fig. 2)	4.0	–13.5
UGA C1510003	Rome, Palazzo Altemps	Pedestal of bust of Lucius Verus (fig. 1)	4.0	–12.7
UGA C2102066	Kourion, Cyprus	Column shaft in Roman agora (fig. 5 c)	2.1	–10.1
UGA C2102072	Kourion, Cyprus	Column shaft in Roman agora (fig. 5 c)	2.1	–10.1
UGA C2102067	Paphos, Cyprus	Inscribed column shaft reused in medieval fort of Saranta Kolones (fig. 5 b)	2.5	–10.8
UGA C2102073	Paphos, Cyprus	Inscribed column shaft reused in medieval fort of Saranta Kolones (fig. 5 b)	2.5	–10.8
UGA 230302	Ostia	Basilica Cristiana, small column shaft in ›side chapel‹ (fig. 5 a)	3.4	–9.6
USF 10850	Khemissa, Algeria	Old Forum, ›boutiques‹, column shaft (fig. 4). MGS 4 mm	1.3	–8.3
USF 40932	Ostia, Schola del Traiano, east corner	Pier/threshold with narrow edge decorated with panelling. 228 × 33 × 22.5 cm	3.8	–12.0
USF 40929	Piazza Armerina, Villa	Entry court, 3rd column at right. MGS 1.0 mm (fig. 6 b)	3.0	–4.5
USF 40930	Piazza Armerina, Villa	Entry court, 2nd column at right. MGS 0.8 mm (fig. 6 a)	3.8	–5.7

Table 1 Isotopic ratios of carbon and oxygen in column shafts analysed at the University of Georgia (UGA) and the University of South Florida (USF)

clear that this had become a widely understood fashion by the 2nd century. They also make it clear how important laboratory analysis is to distinguish the sources of Greco striato.

Efforts to determine the sources of Greco striato/Greco scritto are further complicated by yet another recently discovered source of grey-striated marble. At least one shaft in the entry courtyard at Piazza Armerina macroscopically presents the unmistakable features of Greco dislocato from Euromos in Caria, Türkiye, and this impression was confirmed by isotopic analysis[22]. Another shaft in the villa's main peristyle also seems to be Greco dislocate[23], and several others can be considered Greco striato/Greco scritto, but they are not accessible for close examination, and the specific provenance of their marble is unknown.

So far, the Hippo column shafts overseas do not seem to make up long, uniform colonnades; they seem to be mixed in with other striped grey-and-white or spotted columns. The mixing of shafts with similar spots and striations at Piazza Armerina has just been mentioned. The Hippo marble shaft in the nymphaeum of the Villa dei Quintili is a group with shafts of Cipollino from Karystos and one of Bigio antico from Moria, Lesbos. The agora of Kourion contained one or two more possible Hippo shafts and others that seemed to be Proconnesian, and possibly Bigio antico from Lesbos. This irregularity may reflect reuse of scavenged older material. It could also be a product of lower-budget, non-imperial projects, but it may also reflect a taste for variety and richness of pattern. It has been observed that shafts from Cap de Garde were apparently not used in constructions sponsored by emperors themselves[24]. The shaft at Saranda Kolones on Cyprus, in

22 J. Cox – J. J. Herrmann, Jr. – R. H. Tykot – A. van den Hoek, in this volume, figs. 2 a; 6; tab. 1.
23 J. Cox – J. J. Herrmann, Jr. – R. H. Tykot – A. van den Hoek, in this volume, fig. 2 b.
24 Pensabene 1976; Pensabene 2002; Antonelli et al. 2009.

fact, was inscribed by a member of the equestrian order not the imperial family (fig. 2 c). The Villa dei Quintili, however, was an extravagant high-status project, which was eventually expropriated by the Emperor Commodus (fig. 1 b).

Marble from Cap de Garde has long been considered a type of Greco scritto (»written Greek«), a term used by Roman marble workers of the past to describe marble with short streaks and dots, which suggested unintelligible writing. In recent years, Walter Prochaska and his co-workers have tended to use the category marble »with black specks or convoluted veins«[25]. Hasançavuslar at Ephesos has been shown to be the most important source of Greco scritto[26], Cap de Garde also produces some speckled marble[27], but this seems to be a minor facet of its production. In column shafts, as just described, the marble's markings tend to have diagonal streaks, often in broad bands. If an Italian term is needed (as is traditional in marble studies), Hippo marble may be better characterised by terms used by Patrizio Pensabene, such as Bigio striato (»grey streaked«) or Cipollino grigio (»grey onion marble«), that is, with undulating veins[28]. Some varieties of marble from Lesbos, Hasançavuslar, and perhaps even Euromos fit into this classification as well.

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25 Prochaska et al. 2017, 208.
26 Attanasio et al. 2012.
27 Antonelli et al. 2009, fig. 3; Attanasio et al. 2012, fig. 4.
28 Pensabene 2007, 260 f. 263. 681 f. (Ostia, portico of forum) n. 822; Pensabene 2013, 413–415.

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STONE PROVENANCE OF THE ANTIQUE AND MEDIEVAL MONUMENTS FROM SELECTED SITES IN DALMATIA

Abstract
The paper contains preliminary results of investigation of the limestone varieties used for the antique and medieval monuments in Dalmatia. Until now, petrographic examinations have been carried out mostly for antique monuments, while medieval limestone sculptured works still have to be included in the petrographic research more frequently. In this paper several monuments from very important archaeological sites in Dalmatia are included. The localities are Kapitul near Knin, Rižinice and Hollow Church in Solin, and Split. The selected monuments from each site were manufactured during antiquity and the Middle Ages, so they offer an opportunity to compare the varieties of limestone used in both periods. Because of the small number of analysed samples, the results should be supplemented by numerous petrographic analyses in the future.

INTRODUCTION

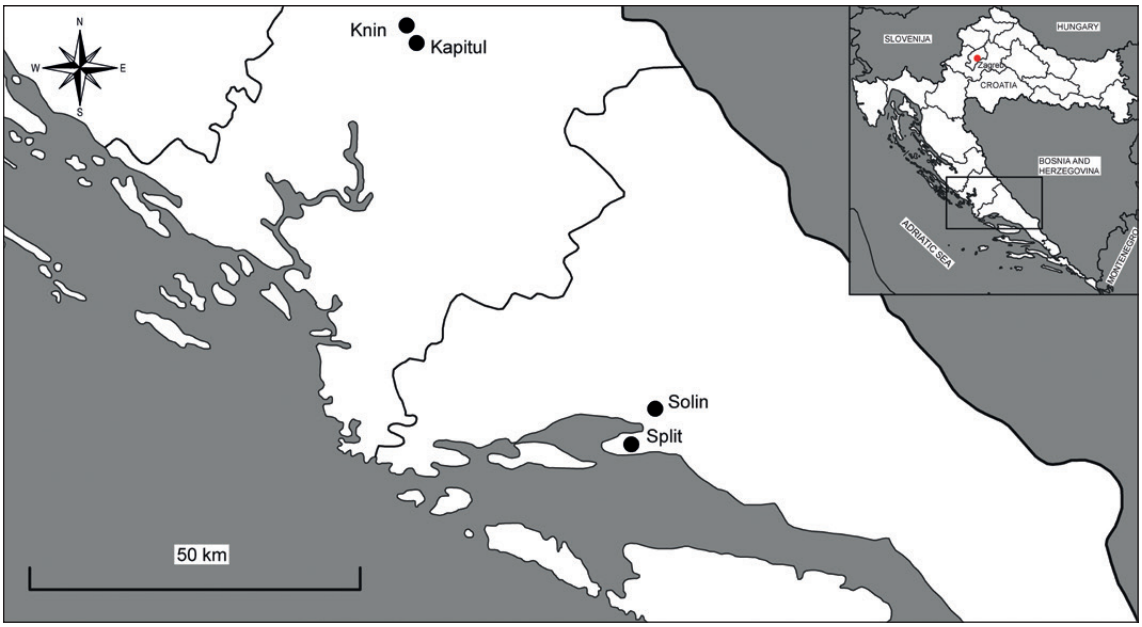
The main goal of the research in the paper is a detailed determination of the limestone varieties used for the selected antique and medieval monuments from Dalmatia. The paper presents data on only a few monuments, so for more complete knowledge on the origins of the limestone used in antiquity and the Middle Ages for stone monuments in Dalmatia (church furniture, inscriptions, sarcophagi), it is necessary to supplement the described results with future new analyses.

To date, petrographic analyses in Croatia have more often been conducted for antique than for medieval monuments. In antiquity there was a significant use of marble, while its appearance in the Middle Ages was limited, but not quite excluded. There are no marble quarries in Croatia, and marble monuments were either imported from foreign workshops or they were made of imported marble blocks in domestic stonemasons' workshops. In Late Antiquity the monuments made of Proconnesian marble are very numerous among the marble works in Dalmatia. Architectonic sculpture, church furniture and sarcophagi were all made of this type of marble[1]. The other sorts of marble, especially that quarried in Greece (Mount Pentelikon) and Italy (Carrara) were also present, but less so than Proconnesian marble[2]. During antiquity, marble monuments were often present in the eastern Adriatic, and in Late Antiquity, marble church furniture and architectonic sculpture were usual in Dalmatia and Istria[3]. However, marble monuments represent only a part of the stonemasons' production in Late Antiquity, and a greater number of monuments were made of local limestone. It is well known that Dalmatia is rich in limestone of good quality, and especially good limestone originates from the island of Brač, where limestone quarries were exploited during antiquity. The Brač limestone was used by the Salonitan stonemason's workshop, the most

1 On the antique marble monuments, see Cambi 2020.

2 Here we can mention marble monuments from the 6th-cent. church from Gata near Omiš. Different sorts of marble, especially Pentelic, have been proved by petrographic analyses, on which, see Crnković 1994. Pentelic marble had a considerable presence in Dalmatia during the earlier Roman times, as attested by numerous Attic sarcophagi. On these sarcophagi, see Cambi 1988.

3 See Ward-Perkins 1975. Of the marble church furniture and architectonic sculpture we can mention, as perhaps the most significant groups, the sculptures from the Eufrasius Basilica and from the Salonitan churches. From the extensive literature see e.g. Terry 1988; Duval et al. 1994.



1 Map of Dalmatia with locations of four archaeological sites: Kapitul near Knin, Rižinice and Hollow Church in Solin, and Split Cathedral (graphics: A. Maričić)

important workshop in Dalmatia[4]. That workshop also used stone from other quarries, e.g. from Seget in the vicinity of Trogir. The petrographic analyses carried out so far proved the use of the Brač and Seget limestone within the Salonitan workshop[5]. Significant production of church furniture and other stone monuments in Late Antiquity also necessitated exploitation of numerous local, less-known quarries throughout Dalmatia. Some petrographic analyses testify to the hinterland quarries as sources of stone material[6].

During the Early Middle Ages, marble monuments are less present than in Late Antiquity. The vast majority of the medieval stone monuments were made of limestone. This is a general observation without confirmation by petrographic analyses that could provide data on limestone varieties[7]. Regarding the medieval stone monuments in Dalmatia, a lack of petrographic analyses is evident, but there are many successful stylistic analyses of the monuments, which represent a great contribution to the study of the workshop origins of the stone sculptures. A greater number of workshop groups have been identified and precisely dated within the framework of a few decades. So, in the Croatian literature, the stone monuments from different stonemasons' workshops from the second half of the 8th to the end of the 11th century have been identified[8]. The artistic style

4 On the Brač quarries and limestone see Marinković – Miliša 2015.

5 For Gata see Crnković 1994; for Srima, where only different varieties of the Brač limestone were used, see Maršić 2005, 74. 117–119; in Bilice the petrographic analysis speaks of Seget limestone, on which, see Jarak – Maričić 2023.

6 E.g. some samples from Gata have been identified as local limestone from the hinterland quarries, see Crnković 1994, 193.

7 In the literature devoted to the medieval stone monuments, the stone is identified only as limestone, without further classification. Regarding this, see numerous syntheses and catalogues of the stone monuments, e.g. Vežić – Lončar 2009; Piteša 2012; Jarak 2017.

8 Here we mention only the most significant stonemasons' workshops: the early pre-Romanesque Split and Zadar workshops from the end of the 8th and early 9th cent., the Trogir workshop from the 1st half of the 9th cent., the workshop of the master of the Koljani Pluteus from the 1st half of the 9th cent., the Kotor workshop from the early 9th cent., the workshop from the time of Duke Trpimir, two workshops from the time of Duke Branimir, the workshop from the time of King Držislav and a greater number of early-Romanesque workshops from the 11th cent. From the extensive literature, see only several works devoted to the mentioned workshops: Petricioli 1960; Rapanić 1987; Burić 1988, 91–117; Jakšić 2015.



2 The four archaeological sites analysed in the paper. a: Aerial view of Kapitul near Knin. b: Aerial view of Rižinice in Solin. c: Aerial view of Hollow Church in Solin (photos: Z. Alajbeg). d: View of Split Cathedral (from Milošević 2011, 165)

and manner of cutting of monuments in particular stonemasons' workshops have been described[9]. In addition to those sculptures that have been matched to a particular workshop, there are many stone monuments that do not fit with any of the described workshops but which can be identified in terms of style and given an approximate dating. In this paper we bring together the results of petrographic analyses for both – those sculptures that have been firmly linked to a workshop and those without a secure attribution to a workshop of origin. The results of the petrographic analysis of a fragment of altar fence pediment that belongs to the stonemason's workshop from the time of the Croatian Duke Trpimir, who reigned in the middle of the 9th century, are of special significance. Another analysed monument, a fragment with palm from Kapitul, possibly also belongs to the same workshop. The monuments related to the time of Duke Trpimir have so far not been petrographically analysed. The monuments from the so-called Trpimir workshop are of a good quality, and it has been supposed that sculptors came from some Dalmatian town and worked at localities in the Croatian hinterland. This paper also contains the results of the petrographic analysis of a fragmentary monument ascribed to the Solin stonemason's workshop from the end of the 8th century that was closely connected to the famous early pre-Romanesque workshop in

9 With regard to quality, the early pre-Romanesque Split workshop, the workshop from the time of the Duke Trpimir, the Benedictine workshop from Duke Branimir's time and several early-Romanesque workshops hold a pre-eminent position.

Split. As for the other data, we present the results of the petrographic analyses of some antique inscriptions from the time of the Roman Empire that have been found at locations with medieval monuments that have also been petrographically analysed. That is done in order to compare the varieties of limestone used during antiquity and the Middle Ages in certain limited regions. The number of analyses in this paper is rather small and only future analyses can provide statistically relevant data. This paper includes only the first, preliminary data on the varieties of limestone used at several very important antique and medieval localities in Dalmatia.

Petrographic analysis of the stone samples is an important tool for determining the possible origin of the stone material or the potential quarry as source material for its exploitation. This paper presents the preliminary results of macroscopic and microscopic analyses of nine stone samples. Three samples were from Kapitul near Knin, while two samples each were taken from Rižinice (Solin), Hollow Church (Solin) and Split Cathedral (figs. 1–2).

CHOSEN LOCALITIES AND MONUMENTS

Kapitul

The archaeological site Kapitul is located around 2 km southeast of Knin Fortress. Kapitul is a small hill next to the river Krka. It has a special place among early medieval localities in Dalmatia based on the fact that it was the first archaeologically investigated site from the Croatian Middle Ages. Archaeological research on the site started in 1886 and resulted in important discoveries including church architecture, Roman and medieval inscriptions, sculpture and medieval graves[10]. During the 1st century AD, at the time of the Roman Empire, a Roman military fort was built at the site. The oldest finds are therefore funerary monuments of the soldiers (*legio XI Claudia Pia Fidelis* and *legio XX Valeria Victrix*)[11]. The site was not known as an important place during Late Antiquity, but it had a very important role in the Middle Ages[12]. The early medieval period is richly attested by numerous archaeological finds, especially by pre-Romanesque stone sculptures and grave-goods. The most numerous stone monuments belong to the second half of the 10th century, to the time of the Croatian King Držislav, whose name, together with the name of his son Svetoslav, is preserved in the inscription on two plutei of the church furniture. With regard to the generally small number of stone monuments from the 10th century in Croatia, in comparison with the numerous monuments from the 9th and 11th centuries, the monuments from Kapitul hold the most important place in the investigations of pre-Romanesque sculpture from the second half of the 10th century in Dalmatia[13]. Stone monuments from Kapitul, made of limestone, belonged to the church of the royal Benedictine monastery that was mentioned in the literary sources from the 11th century, but which was founded much earlier, perhaps during the reign of the Croatian Duke Trpimir in the middle of the 9th century. The earlier foundation of the pre-Romanesque church at Kapitul is attested to especially by stone monuments with features of 9th-century sculpture. One of the monuments from this earlier group of pre-Romanesque sculptures has been petrographically examined. It is, according to T. Burić, a fragment of an abbot's chair from the 9th century[14]. In the 13th century, after the end of the early medieval Croatian State, the new Romanesque Knin Cathedral was built at the site, on the foundation walls of the earlier Benedictine church. Kapitul therefore had a very prominent place in the Late Middle Ages, too. A sarcophagus found at the site in the 20th century, in 1955, also originates from that period. The sarcophagus was moved to the Museum of the Croatian Archaeological Monuments in Split and a sample taken from it has been petrographically analysed. After the small-scale archaeological research during the 20th century,

[10] The results of the first archaeological research at Kapitul were published in the famous book by F. Bulić in 1888.
[11] Bulić 1888, 3; Patsch 1895.
[12] Iveković 1928.
[13] On the early medieval stone sculpture from Kapitul see Burić 1988.
[14] Burić 1988, 100.

new revision investigations started in 2011[15]. To date, there have been several campaigns. During the research in 2016, a fragmentarily preserved funerary inscription of a soldier of the *legio XI Claudia Pia Fidelis* was found[16]. A sample from this early Roman inscription, dated to the 1st century AD, has been petrographically analysed.

Rižinice and Hollow Church

Similarly to Kapitul, Rižinice and Hollow Church are localities with early medieval Benedictine monasteries. These monasteries were also royal foundations, and they had very important roles in Croatian history. The monastery in Rižinice, at the border between Klis and Solin, is known as the first securely dated early medieval monastery in the Croatian State. It was founded by Duke Trpimir in the middle of the 9th century, which is documented by the preserved historical source, the so-called Trpimir Donation. A fragment of the gable, made of limestone, with the inscribed name of Trpimir, was found by chance in 1891. Later, in the course of archaeological research, parts of church furniture and sarcophagi were discovered. The parts of church furnishings are very good sculptural works and they show identical stylistic features. Similar findings of church furnishings have been discovered at around ten archaeological localities in Dalmatia. On the basis of the dated gable from Rižinice, the aforementioned stone sculptures from different localities have been classified as works of the stonemason's workshop from Duke Trpimir's time[17]. The great quality of works speaks in favour of sculptors from some Dalmatian city who were employed at the Croatian court. Another smaller gable fragment, discovered at Rižinice during the archaeological excavations at the end of the 19th century, has the same features as the fragmentary gable bearing the name of Trpimir. The decorative motifs and the manner of execution are the same on both fragments. The smaller pediment fragment has been petrographically analysed. Identification of the limestone used for this gable is very important and has significance for the stonemason's workshop connected to Duke Trpimir. The other monument included in the petrographic research is a fragment of a sarcophagus with remnants of the inscription. The fragment has been dated to the 4th century[18].

Recently, revision archaeological research took place in Rižinice and the new discoveries make it possible to acquire a detailed picture of the monastery and particular objects within the complex. During Late Antiquity, there was an early Christian church and smaller monastery at the site, and before that, in the first centuries AD, a Roman villa rustica existed here[19].

The locality Hollow Church is situated in Solin, beside the river Jadro. Today, there are impressive, conserved architectural remains of the two churches – early Christian and early medieval – at the site. The early medieval church, built in the early-Romanesque style, is visible within the confines of the bigger early Christian building. At the site, there are preserved stone monuments like sarcophagi and capitals. Most of the stone sculptures have been deposited in two museums in Split: the Museum of the Croatian Archaeological Monuments and the Archaeological Museum. The stone monuments date from antiquity, the pre-Romanesque and the early-Romanesque periods. They were made of limestone and marble. The early medieval church has been dated to the 11th century, probably to the middle or the beginning of the second half of the 11th century. It served as the coronation basilica of King Zvonimir and it has been supposed that the church was equipped with plutei, today kept in the Split baptistery but originally parts of the altar screen of some church building. Among the mentioned plutei, one, made of marble, has a figural composition with a king on the throne.

15 On the recent investigations at Kapitul see Jurčević 2020.
16 Demicheli 2018.
17 On the stonemason's workshop from Duke Trpimir's time see Jakšić 2015, 295–314.
18 Gauthier – Marin – Prévot 2010, 952 f. cat. 583.
19 Uroda 2019, 191–195.

After the disappearance of the Croatian kingdom, the monastery complex with the church (that was dedicated to St. Peter and Moses) lost its importance and perished, until it was discovered again in the 20th century.

Two fragmentary monuments from Hollow Church have been petrographically analysed. One of them is a capital from Late Antiquity, dated to the 6th century. It has a stylised form, with smooth leaves at the corners and acanthus between them[20]. The other is a fragmentary impost with a badly preserved diagonal lily cross motif[21]. There are two other limestone impost fragments with the same motif which originate from Hollow Church[22]. The diagonal lily cross is a motif specially connected to the early pre-Romanesque Split workshop. In that famous workshop, the monuments with the lily cross were made of marble and they are of an extraordinarily good quality. They belong to the same category as the works of the so-called Liutprandic Renaissance in Italy. The simple modelling of the limestone imposts from Hollow Church probably followed the prototypes of the Split workshop. In the literature, there is a statement about the possible existence of an early pre-Romanesque workshop in Solin from the same time as the Split workshop[23].

Split Cathedral and Bell-tower

Diocletian's mausoleum, built during the transition years from the 3rd to the 4th century, was adopted for Christian worship, probably at the end of antiquity. During the Early Middle Ages, the building functioned as Split Cathedral. Different monuments from the church furnishings from several medieval phases have been connected with the cathedral. A special place is accorded to marble plutei decorated with a motif of an oblique cross of lilies, works from the early pre-Romanesque workshop in Split from the end of the 8th century. Monuments from earlier and later periods are also known, speaking of the changes in the cathedral's interior. One early-Romanesque fragmentary monument, a fragment of a pilaster, has been petrographically analysed. The fragment has a plant motif that consists of an S-tendril, leaves and a volute[24].

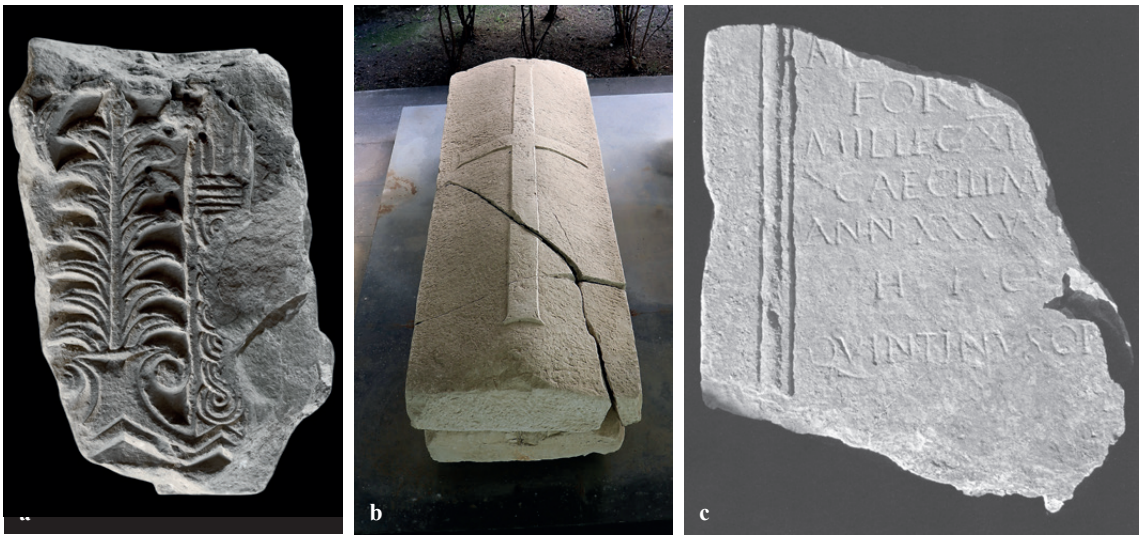
The bell-tower of Split Cathedral is a later addition to the complex. It was built over centuries, from the 13th to the 16th century. Many earlier stone monuments were used as building materials in the bell-tower. They could be connected with the cathedral or originate from other places, probably in the vicinity of the cathedral. For the petrographically analysed inscription, it is difficult to judge its original place. The monument is dated to the antique period[25]. It can testify to the sort of limestone used for antique inscriptions.

PETROGRAPHIC ANALYSIS

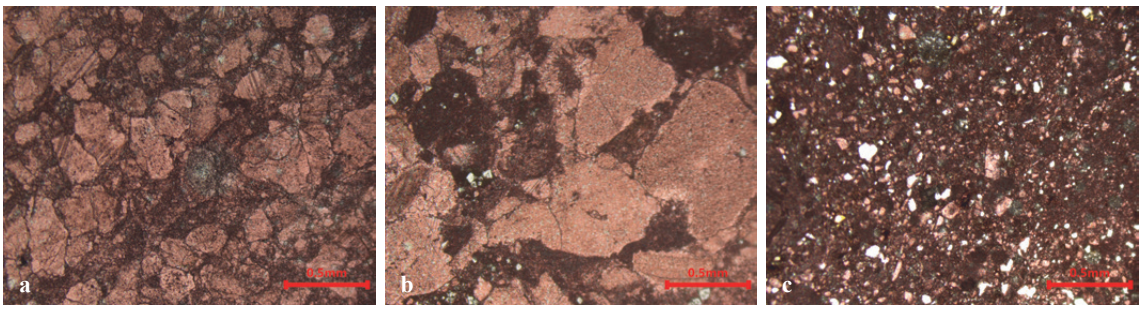
Methodology

Petrographic analysis was conducted at the University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering. Micropetrographic analysis was performed on the thin sections using a petrographic microscope OPTIKA B-1000 with included digital camera for microphotographs. All thin sections were stained with Alizarin red S and K-ferricyanide (according to the procedure proposed by B. D. Evamy and D. J. Shearman), in order to distinguish carbonate minerals, present within them[26]. Classifications after R. J. Dunham with the modifications after A. F. Embry and E. J. Klovan as well as E. Flügel were used for distinguishing and describing various carbonate

[20] Piteša 2012, 145.
[21] Piteša 2012, 150.
[22] Gunjača 1992, 202 f.; Basić 2006, 91; Piteša 2012, 148–150.
[23] Piteša 2012, 137–139.
[24] Piteša 2012, 54–56.
[25] Bulić 1896, 84.
[26] Evamy – Shearman 1962, 102 f.



3 Stone samples from Kapitul. a: Fragment of church furniture (photo: Z. Alajbeg). b: Sarcophagus from the Late Middle Ages (photo: Archives of the Museum of the Croatian Archaeological Monuments, Split). c: Fragment of a military inscription (from Demicheli 2018, 118)



4 Microphotograph of stone samples from Kapitul. a: Fragment of church furniture. b: Sarcophagus. c: Fragment of a military inscription (photos: A. Maričić)

rocks in the field[27]. Classifications after R. L. Folk were applied in the micropetrographic analysis of thin sections[28].

Results

Micropetrographic Analysis of Three Stone Samples from Kapitul

Three stone samples from Kapitul originate from a fragment of church furniture from the Early Middle Ages (fig. 3 a), a sarcophagus from the Late Middle Ages (fig. 3 b) and a military inscription from the Roman Empire (fig. 3 c). According to the macroscopic analysis, all three samples are white to light grey, fine-grained, grain-supported limestones. They have numerous macroscopically visible, densely packed bioclasts. Bioclasts of calcite composition are mostly smaller than 2 mm. With the diluted hydrochloric acid (HCl) solution, the samples react aggressively. All three samples of bioclastic limestones are determined as packstone. In the thin section of all three samples, numerous bioclasts are visible (fig. 4). Among them, numerous fragments of rudist

27 Dunham 1962; Embry – Klovan 1972; Flügel 1982; Flügel 2004.
28 Folk 1959; Folk 1962.

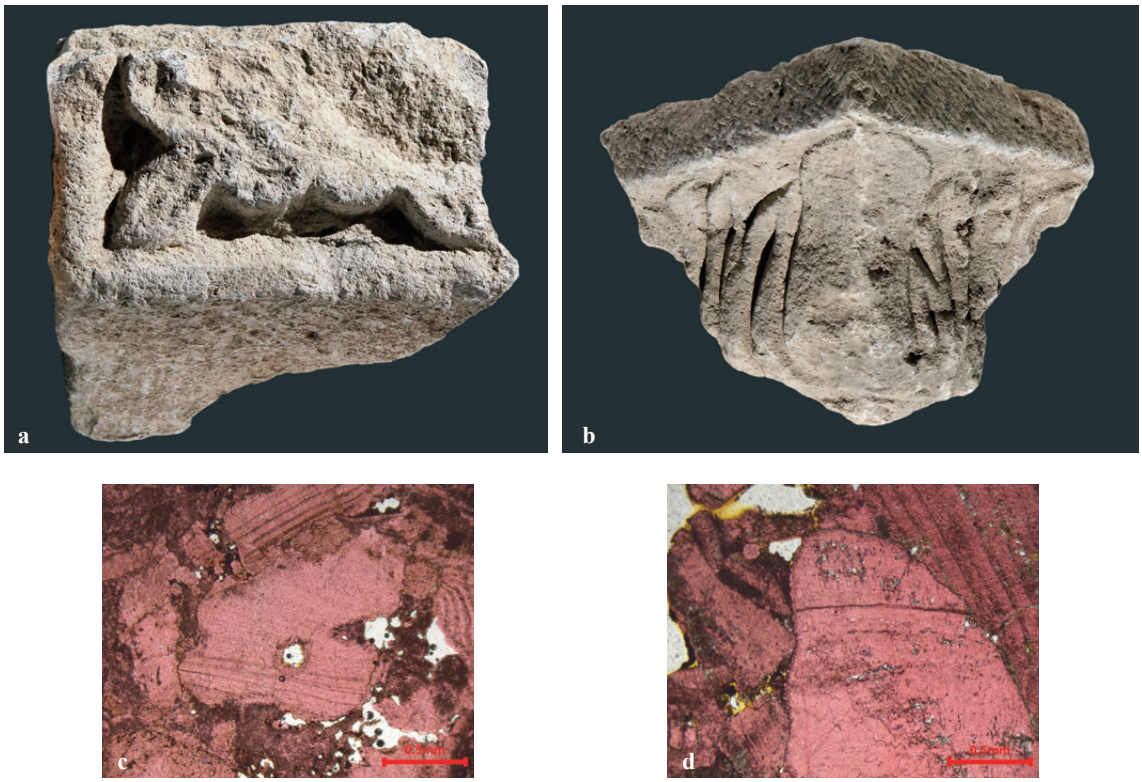


5 Stone samples from Rižinice. a: Fragment of an altar fence pediment. b: Fragment of a sarcophagus (photos: T. Seser). c: Microphotograph of the altar fence pediment. d: Microphotograph of the fragment of a sarcophagus (photos: A. Maričić)

bivalve shells, fragments of echinoids and rare foraminifera tests were present. Bioclasts are relatively well sorted and medium-densely packed, with a range from 0.1–2 mm, while the sample from a fragment of church furniture has bioclasts larger than 2 mm. Bioclasts are bound together with a partially dolomitised micritic matrix. In addition, all samples are porous. According to the micropetrographic analysis, the sample from the church furniture fragment is determined as biomicrite (fig. 4 a), while the sample from the sarcophagus is biomicrudite (fig. 4 b). The sample from a military inscription, besides numerous bioclasts (rudist bivalve shells) in a dolomitised micrite matrix, has terrestrial fragments as quartz grains. The dimensions of the bioclasts are smaller, ranging from 0.1–0.2 mm. They are relatively well sorted and medium-densely packed. According to the analysis, the sample is determined as biomicrite (fig. 4 c).

Micropetrographic Analysis of Two Stone Samples from Rižinice

Two samples from the archaeological locality Rižinice were analysed. The first was a fragment of an altar fence pediment dated to the Middle Ages (fig. 5 a), and the second was a fragment of a sarcophagus from the Roman Empire (fig. 5 b). Both samples are macroscopically similar and determined as white to light-grey limestones that are fine-grained and grain supported. In both samples, numerous macroscopically visible and densely packed alochems (bioclasts) are present. The samples have been identified as grainstone. In the thin sections, there are numerous bioclasts such as fragments of rudists, bryozoans, and foraminifera bound with a micrite matrix and sparite cement. The bioclasts are relatively poorly sorted and medium-densely packed with a range from 0.5–1 mm (rarely larger than 2 cm). Both samples were identified as biomicrite to biosparite limestones (fig. 5 c–d).



6 Stone samples from Hollow Church. a: Impost fragment. b: Capital (photos: T. Seser). c: Microphotograph of the impost fragment. d: Microphotograph of the capital (photos: A. Maričić)

Micropetrographic Analysis of Two Stone Samples from Hollow Church

Two stone samples from Hollow Church in Solin were analysed. The first was an impost fragment from the Middle Ages (fig. 6 a) and the second one is a capital from Late Antiquity (fig. 6 b). Macroscopically both samples are light-grey limestones with numerous macroscopically visible alochems but with no grain support, hence the samples were identified as floatstone. In thin sections, numerous fragments of rudist bivalve shell ranging from 1 to more than 2 mm are visible. In addition, both samples are porous. Both samples have been identified as biomicrudite (fig. 6 c–d).

Micropetrographic Analysis of Two stone Samples from Split Cathedral

Stone samples from Split Cathedral were a fragment of the altar fence from the Early Middle Ages (fig. 7 a) and a sample from the cathedral's bell-tower that is a fragment of an inscription from the Roman Empire (fig. 7 b). Both samples are white to light-grey limestones with grain support with no mud. Numerous macroscopically visible alochems are densely packed. Both stone samples were identified as rudstone. In thin sections, numerous bioclasts comprising rudist bivalve shell fragments, fragments of echinoids, bryozoans and rare foraminifera tests are visible. Bioclasts are relatively poorly sorted, medium-densely packed with a range from 0.5 to more than 2 mm and bound together by a micritic matrix/sparite cement. Both samples have been identified as biomicrudite to biosparrudite (fig. 7 c–d).

DISCUSSION AND CONCLUSION

As a first step in determining the possible origin of the stone material that was used during construction of nine important stone monuments from four different archaeological sites macroscopic and microscopic analysis was undertaken. All nine samples were identified as bioclastic



7 Stone samples from Split Cathedral. a: Pilaster fragment. b: Fragment of a Roman inscription (photos: T. Seser). c: Microphotograph of the pilaster fragment. d: Microphotograph of the fragment of the inscription (photos: A. Maričić)

limestones with numerous bioclasts that are mostly smaller than 2 mm, although some samples have fragments larger than 2 mm. The samples are similar in composition and predominantly consist of rudist fragments bound together by a micrite matrix. Beside rudist fragments, other bioclasts such as echinoids, bryozoans and foraminifera tests are subordinately present. The composition of the stone samples suggests that all samples are of Upper Cretaceous age, which is in accordance with the basic geological map of the Split area[29].

Samples were divided into four groups according to the micropetrographic determination (tab. 1). All three samples from Kapitul show differences in petrographic characteristics. Two are identified as biomicrite (Group 1) and one as biomicrudite (Group 2). The samples from the sarcophagus and church furniture show similarities in bioclast composition and in the ratio of bioclasts to micrite, although the dimensions of bioclasts and their distribution is slightly different. There is a possibility that these two samples were taken from a similar rock formation or quarry, although the monuments are not dated to the same period (Early Middle Ages and Late Middle Ages). The sample taken from the Roman military inscription cannot be fully compared with the other two samples. This sample differs in its petrographic characteristics; therefore, it is assumed that this stone material belongs to another formation or quarry. Both samples from Rižinice differ from the other stone samples and are assigned to Group 3. These samples are similar in their petrographic characteristics, and both are identified as biosparite

[29] Marinčić – Magaš – Borović 1971; Magaš – Marinčić 1973.

Sample	Location	Stone monument	Age	Macropetrographic determination	Micropetrographic determination	Petrographic group
1031	Kapitul	Fragment of church furniture	Early Middle Ages	Packstone	Biomicrite	1
3686	Kapitul	Sarcophagus	Late Middle Ages	Packstone	Biomicrudite	2
4771	Kapitul	Military inscription	Roman Empire – 1st century AD	Packstone	Biomicrite	1
S-90	Rižinice	Fragment of an altar fence pediment	Middle Ages (9th cent.)	Grainstone	Biosparite to biomicrite	3
A-4073	Rižinice	Fragment of a sarcophagus	Roman Empire (4th cent.)	Grainstone	Biosparite to biomicrite	3
38925	Hollow Church	Impost fragment	Middle Ages (end of the 8th or early 9th cent.)	Floatstone	Biomicrudite	2
38943	Hollow Church	Capital	Late Antiquity (6th cent.)	Floatstone	Biomicrudite	2
S-37	Split Cathedral	Fragment of an altar fence pilaster	Early Middle Ages (11th cent.)	Rudstone	Biomicrudite to biosparrudite	4
A-2142	Split Cathedral, bell-tower	Fragment of an inscription	Roman Empire (1st–5th cent.)	Rudstone	Biomicrudite to biosparrudite	4

Table 1 Samples divided into four petrographic groups according to macro- and micropetrographic analysis

to biomicrite, which could suggest that both materials belong to the same formation or quarry, although the monuments are dated to different historic periods (Roman Empire and Middle Ages). The samples from Hollow Church are assigned to Group 2 – biomicrudite. The samples are similar in their petrographic properties and it can be assumed that the origin of the samples is from the same formation or quarry, although the monuments are dated to different periods – Late Antiquity and the Middle Ages. The Split Cathedral samples are assigned to Group 4, as both are determined as biomicrudite to biosparrudite. The samples are similar in composition and petrographic properties, and it can be assumed that they belong to the same formation.

In addition to the determination of macroscopic and microscopic characteristics, further analysis of the samples is planned. To determine more accurately and reliably the origin of the stone material, samples from the surr ounding old quarries will be analysed. In addition, determination of the qualitative and semiquantitative mineral composition and micropalaeontological analysis is planned to gain further knowledge on stone samples from these four important archaeological localities.

With regard to the similarities of the analysed samples from Solin and Split it is possible that certain medival monuments were made of antique spolia, but for a more reliable conclusion new analyses should be done.

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A FIRST MINERO-PETROGRAPHIC AND ISOTOPIC CHARACTERISATION OF MARMOR NUMIDICUM (GIALLO ANTICO) AND OTHER SIMILAR YELLOW STONES

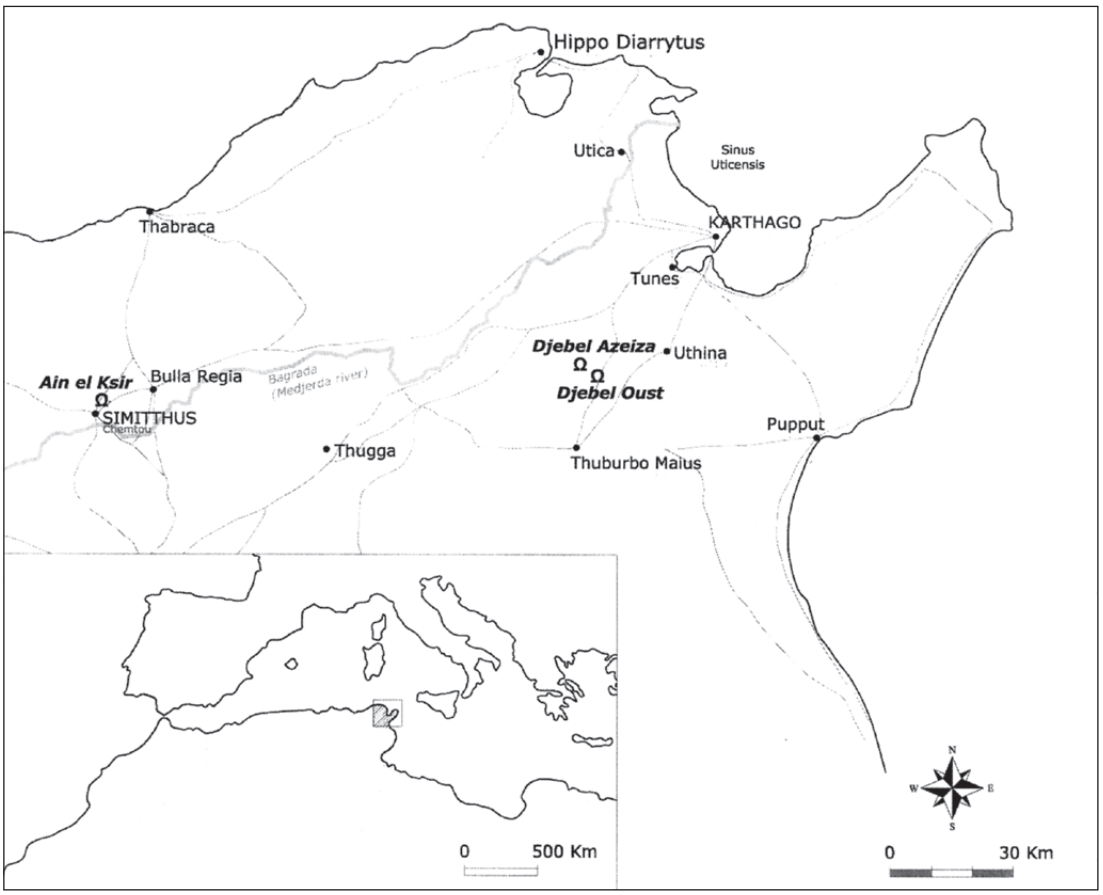
Abstract
Marmor Numidicum, later called Giallo antico, the most beautiful yellow stone used in antiquity, originated from near the town of Simitthus, modern Chemtou in northwestern Tunisia. Its numerous and quite large quarries were already open at the end of the 2nd century BC, increasingly exploited soon after the Roman conquest of Numidia, and later much enlarged in Imperial times up to the 4th century AD. The Imperial period saw a wide Mediterranean distribution of this stone, although it was among the most expensive varieties listed in Diocletian's Edict of 301. After the fall of the Roman Empire, only the reuse of spolia took place, especially in Rome and Italy; a new, limited, exploitation was resumed at the end of the 19th century. Giallo antico was used for architectural elements such as columns and cornices, as well as for flooring slabs and more rarely for carving statues. A first archaeometric investigation X-ray powder diffraction (XRPD, microscopic and microchemical examination of thin sections by polarising optical microscopy [POM], scanning electron microscope coupled with an energy-dispersive spectrometer [SEM+EDS], as well as stable isotopes ratio analysis [SIRA]) of quarry samples and artefacts allowed an initial minero-petrographic and geochemical characterisation, useful for a positive distinction of Giallo antico from some similar (›substitution‹) yellow stones, such as the Algerian Kristel yellow and the Italian Giallo di Siena and Breccia dorata, used contemporarily, or later.

INTRODUCTION AND SHORT HISTORY OF USE

Several black limestones and the most beautiful yellow stone used in antiquity are of Tunisian origin (fig. 1). The Roman name of the yellow stone was Marmor Numidicum, a geographical designation, as Numidia was the ancient name of the region including the town of Simitthus (now Chemtou), where numerous and quite large quarries were open from the 2nd century BC. These, as concluded from detailed studies conducted on-site by several German archaeological missions[1], were increasingly exploited soon after the Roman conquest of Numidia in 146 BC. In Imperial times, they became *patrimonium caesaris* (»property of the emperor«) for centuries[2], and were progressively enlarged up to the 4th century AD. This period, but especially up to AD 100[3], saw a wide Mediterranean (and Central European) distribution of this yellow stone that later spread from Britain to North Africa, and from Iberia to the Near East, in spite of the fact that it was among the most expensive varieties (200 *denarii* per cubic foot) listed in Diocletian's Edict of 301[4]. Later on, only reuse of spolia took place, especially in Rome and Italy, where in the Late Renaissance period, the stone was named Giallo antico. A new, quite limited, exploitation was resumed by a French company at the end of the 19th century, and in the 1960s.

Giallo antico was highly esteemed and very popular in Roman times, as demonstrated by its mention by many historians and writers such as Festus, Pliny the Elder, Sidonius Apollinaris,

1 Rakob 1993.
2 Pensabene 2013, 411.
3 Ardeleanu 2018.
4 Lazzarini 2009, 470; Lazzarini 2010.



1 Map of ancient Tunisia showing the location of Simitthus, where the Giallo antico quarries and those of the Bigio morato black limestones are found (after Rakob 1993, 2 fig.1; graphics: L. Lazzarini)

Isidorus of Sevilla[5], and also Seneca, Suetonius and Statius[6]. It was mostly used in slabs for *opera sectilia*, e.g. for flooring (fig. 2 a) and wall facings, as well as for architectural elements such as columns: the most famous were that dedicated to the memory of Caesar in the Forum Romanum, and those on the two sides of Constantine's Arch; also notable for their size are those of the Capitolium of Carthage at Byrsa[7]. Even more common were cornices, while capitals were rare. Statues of Giallo antico which are known include barbarians (fig. 2 b) (often with black flesh made of Bigi morati = Numidian limestones)[8], and wild African animals, such as lions (fig. 2 d), all with obvious symbolic meanings related to the stone's origin. We also know of an abundant production of small statuettes (such as Bacchus' herms, and depictions of Meleager, fig. 2 c), as well as of vases, both produced throughout the central part of the Roman Empire.

In spite of its utmost historical and artistic importance, Giallo antico has not yet been satisfactorily characterised minero-petrographically and geochemically: such a characterisation is absolutely needed for a positive distinction from macroscopically very similar stones like some Spanish varieties (from Santa Tecla and Buixcarrò, not considered here), the yellow of Kristel (a place a few kilometres northeast of Oran, Algeria[9]) and Giallo di Siena and Breccia dorata from

5 Gnoli 1988, 166–168.
6 Sen. epist. 86, 6; Suet. 85; Stat. silv. 1, 5, 35–36.
7 Younes – Lazzarini 2023.
8 Agus – Cara – Lazzarini 2006; Lazzarini – Agus – Cara 2006.
9 Antonelli – Lazzarini – Cancelliere 2010.



2 a: The *opus sectile* floor of Brescia's Capitolium with slabs of Giallo antico, Africano and Pavonazzetto). b: The »Dace Mattei«, Museo Nazionale Romano, Palazzo Altemps, Rome. c: The hero Meleager, Museo Archeologico Nazionale, Turin. d: The lion in the Musei Vaticani, Rome (photos: L. Lazzarini)

the Montagnola Senese (Early Lias of Tuscany, Italy)[10]. These were all used as ›substitution‹ materials in Roman times, with the Italian ones even more widely used during the Renaissance and Baroque periods. A contribution towards this goal follows.

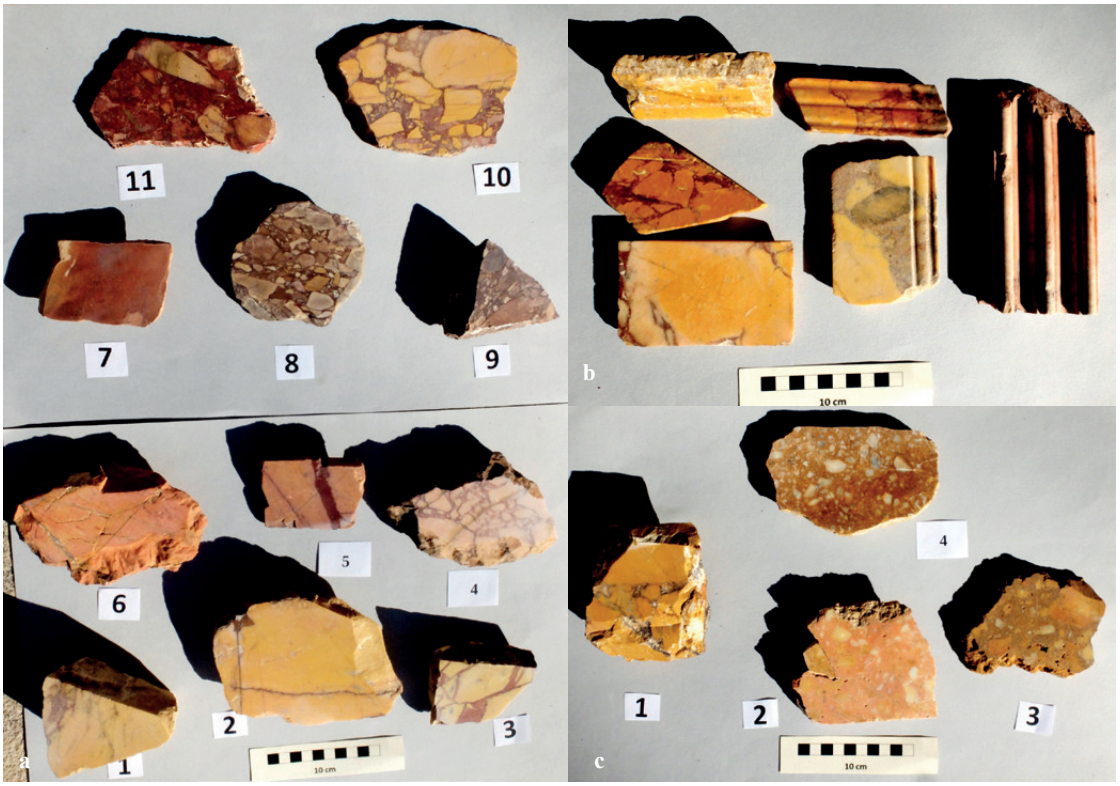
ANALYSIS AND DISCUSSION OF THE RESULTS

Macroscopically Giallo antico looks like a fine-grained compact limestone with a remarkable variability in colours (from almost white to dark yellow, often with red, brown or violet areas/veins) and textures (very often brecciated). It outcrops in the western part of Mount (Jebel) Chemtou

[10] Michelucci et al. 1981; Lazzarini 1998; Bruno – Lazzarini 1999.



3 The Giallo antico debris hill near the quarries of Chemtou (photo: L. Lazzarini)



4 a: The samples taken from the debris hill. b: The samples taken from artefacts. c: The samples of Giallo di Siena and Breccia dorata (photos: L. Lazzarini)

Sample no.	Montmoril-lonite	K-mica	Quartz	Calcite	Albite	Dolomite	Hematite	Goethite
GA 1				+++				
GA 2		±		+++	+			
GA 3				+++				
GA 4		±		+++				
GA 5				+++				
GA 6		±	+	+++				±
GA 7				+++				
GA 8			±	+++			±	
GA 9	±	+		+++				
GA 10				+++				
GA 11		±		+++	±	±		
GA M 1			±	+++				

Table 1 Results of the X-ray diffraction analysis of the samples of Giallo antico examined. +++ very abundant; ++ abundant; + present; ± trace

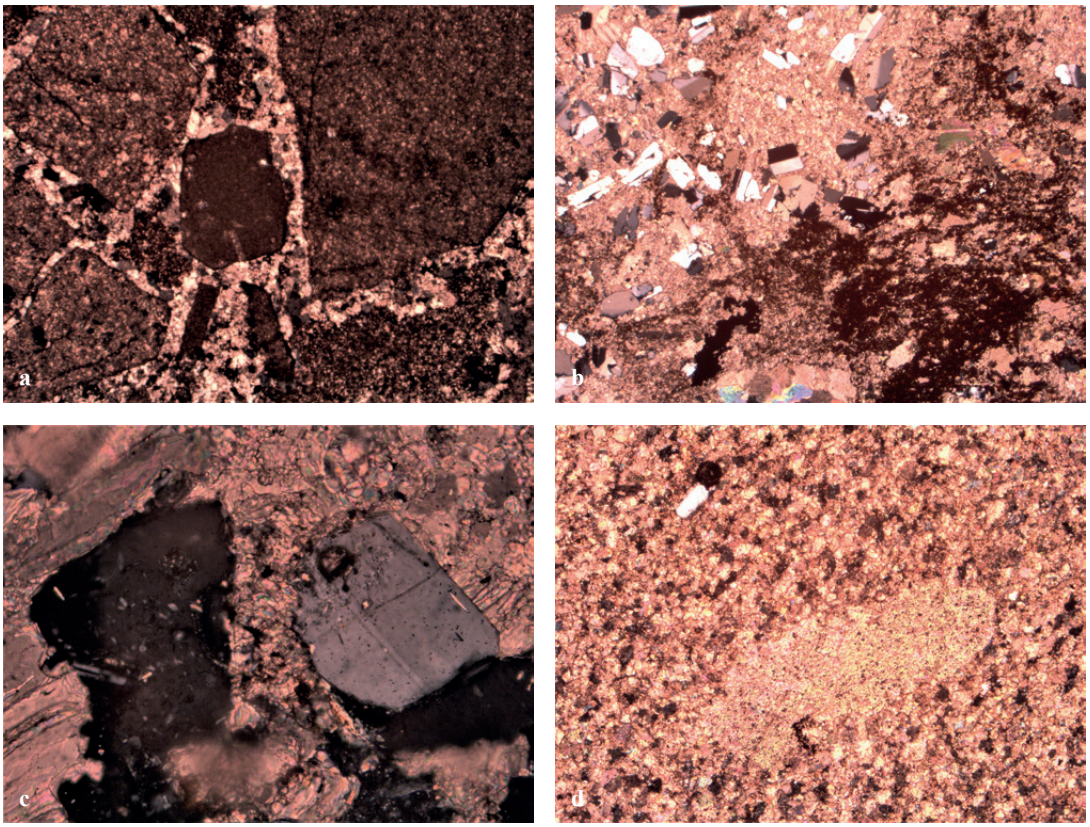
Sample no.	Insoluble residue % (HCl 2 %)	Montmoril-lonite	Illite/Mus-covite	Quartz	Albite	Hematite	Goethite
GA 2	0.31	±	++	+	+++		±
GA 6	0.11	±	++	++	+	+	++
GA 9	6.22	+	++	±	+	+	+
GA 11	3.03	±	++	+	++	+	±

Table 1bis Quantity of the insoluble residue and its mineralogical composition by XRD. +++ very abundant; ++ abundant; + present; ± trace

Lithotype	Sample no.	K-mica	Quartz	Calcite	Albite	Goethite	Hematite
Giallo di Siena Montagnola	GS		+	+++	±	±	
Breccia Dorata holotype, quarry of Montarrenti	BD1	±	+	+++	±	±	
Breccia Dorata allotype, quarry of Tegoia	BD2	±	±	+++			±
Breccia Dorata allotype, quarry of Tegoia	BD3		±	+++			
Breccia Gialla Fibrosa, quarry of Tegoia	BD4		±	+++			
Pavonazzetto Senese, quarry	PS	±	±	+++	±	± Chlorite ± magnetite ±	+

Table 2 iResults of the X-ray diffraction of samples of yellow stones from the Montagnola (province of Siena, Italy)

belonging to the anticline of the el-Hairech massif, and geologically pertains to the Lower Jurassic. A first mineralogical characterisation of both Giallo antico (samples taken from the large artificial hill formed by quarry debris (figs. 3. 4 a), and ancient artefacts (fig. 4 b), and of the other yellow stones mentioned above (only quarry samples, fig. 4 c), was made by X-ray powder diffraction (XRPD, for Giallo antico also of insoluble residues obtained by dissolution in a 2 % hydrochlorid acid [HCl] solution). The petrographic features were determined by polarised microscopy (and some microchemical examination by SEM+EDS) on thin sections; another geochemical analysis performed on all yellows was the standard mass-spectrometric determination of the stable carbon

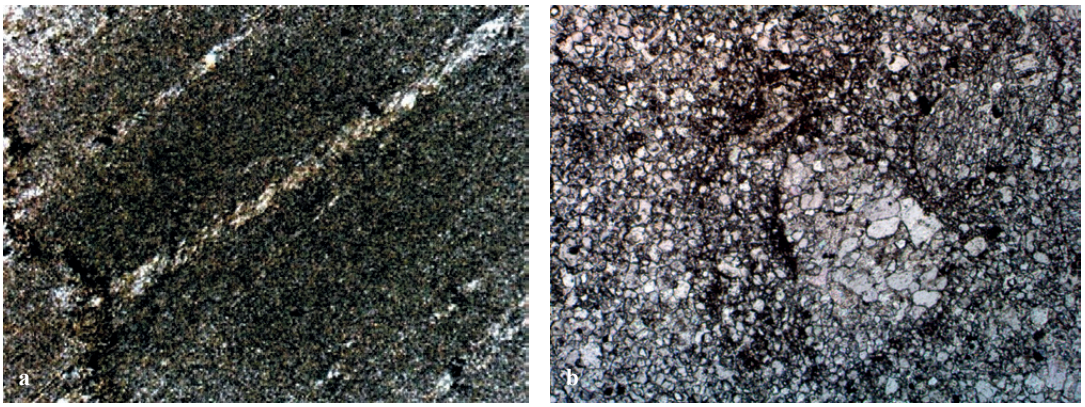


5 a: Photomicrograph of a thin section showing a micro-brecciated fabric formed by micritic clasts, N+, long side = 3.84 mm. b: Presence of abundant twinned albite, quartz individuals and red-brown haematite particles, N+, long side = 3.84 mm. c: Crystal of quartz and one of twinned albite, both with sericite inclusions, N+, long side = 0.95 mm. d: A reworked echinid's plate, N+, long side = 0.95 mm (photos: L. Lazzarini)

(C) and oxygen (O) isotope ratios against a PDB (Pee Dee Belemnites) international standard. The results obtained are summarised below.

- X-ray diffraction of all Giallo antico (tab. 1) indicated calcite as the primary component of the rock; only one sample showed traces of dolomite; the semi-quantitative presence of other accessory minerals in some samples is: traces of montmorillonite; traces to presence of K-mica and quartz; traces to presence of albite; traces of haematite and goethite. The analysis of the insoluble residue of four samples revealed different grades of purity: high for two of them, with values below 1 %, and around 3–6 % for two other samples; its XRD analysis (tab. 1bis) indicated the constant presence of traces of montmorillonite, abundant illite/muscovite, presence of or abundant quartz and albite, presence of haematite and goethite.
- The XRD of the yellow Sienese limestones is reported in table 2: the results showed that calcite is the main mineral, with a constant presence of small amounts of quartz and sometimes traces of K-mica, albite, haematite and goethite; in the Pavonazzetto sample, traces of chlorite and magnetite are also present.
- The petrographic study of a dozen Giallo antico thin sections allowed us to establish that a micro-brecciated fabric is rather common and formed by angular micritic to microsparitic clasts of millimetric to centimetric size in a micritic/microsparitic cement (fig. 5 a)[11]. Most non-brecciated samples show as micrites (fig. 5 b), often with microsparitic

[11] Folk 1959.



6 Photomicrograph of thin sections (N+, long side = 3.84 mm). a: The Kristel yellow showing several isoparallel microsparitic veins in a micritic matrix. b: The Breccia dorata, where rounded clasts are distinguishable from the granoblastic matrix (photos: L. Lazzarini)

to sparitic (recrystallised) areas and veins where the largest calcite crystals may reach 1.2 mm across. Common accessory minerals are:

- albite, quite common, mostly in twinned crystals, sparse or concentrated along veins and/or stylolites: its maximum grain size (MGS) is 0.9 mm
- K-mica in small plates (sometimes forming iso-oriented trains) stylo-cumulated and associated with/included in albite and quartz (fig. 5 c)
- goethite, in very fine yellow-brownish particles, either dispersed or concentrated in the matrix: it is responsible for the yellow colour of the stone
- haematite, in fine reddish-brown powdery dispersed particles, often concentrated in veins or stylolites, more rarely included in sparite
- quartz, usually not abundant, in single, angular/subangular individuals showing a wavy extinction and very small dimensions (around 0.02–5 mm)
- apatite, rare and sometimes included in quartz and plagioclase
- pyrite, very rare, in small opaque rounded particles

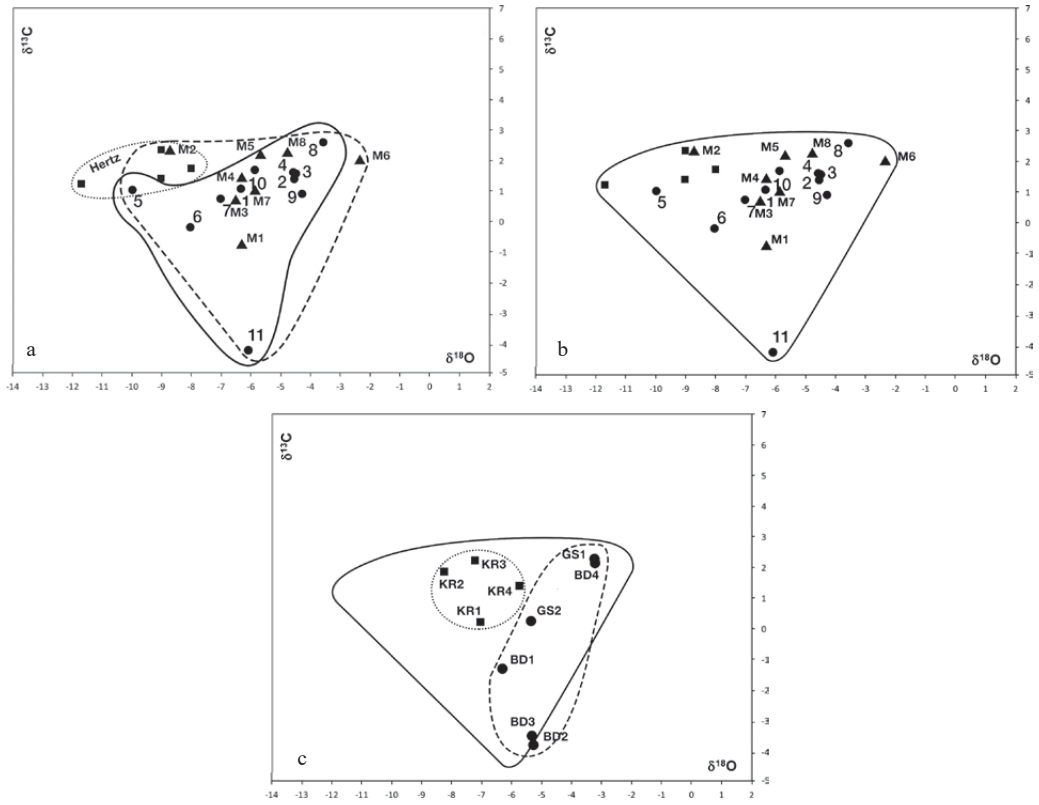
Rare, much reworked bioclasts (of plates of echinids [?]) have occasionally been observed (fig. 5 d).

The thin sections of three samples of the Kristell yellow could be classified as micrites formed by micritic to sparitic crystals of calcite, mostly tending to be idiotopic and equigranular, often showing characteristic isoparallel thin veins of sparite (fig. 6 a), resulting in the unique distinguishing petrographic feature of this limestone from Giallo antico, since the accessory minerals are practically the same as for the latter, although albite and quartz are less abundant, and K-mica, apatite and pyrite were not found.

The study of five thin sections of Giallo di Siena and of the related Breccia dorata allowed us to classify these two lithotypes as true marbles formed after low-grade metamorphism in the greenschist facies of slightly impure limestones. In fact, Giallo di Siena exhibits a granoblastic-homeoblastic fabric formed by a mosaic of calcite crystals, mostly with curved boundaries, and a fine grain (average grain size is about 0.1–0.2 mm; MGS around 0.4 mm). These characteristics are also found in the Breccia dorata's clasts (fig. 6 b); common accessory minerals for both are small amounts of quartz (in this stone with very small rutile inclusions), rare albite, goethite, haematite and K-mica.

As for the isotopic composition of Giallo antico, in 1987 N. Herz published[12] the results of a few analyses of Giallo antico quarry samples (fig. 7 a) that delimited a rather small field, much

[12] Herz 1987.



7 Isotopic diagrams. a: Quarry samples of Giallo antico. b: Quarry and artefact samples. c: All reference samples of Giallo antico as well as a few samples of Kristel and Sienese yellows (graphics: L. Lazzarini)

Sample description	Sample no.	$\delta^{13}C$ (PDB) (+)	$\delta^{18}O$ (PDB) (–)
Fragment of a column of the Augustus' house peristyle (RM)	M 1	–0.90	6.30
Fragment of a pilaster from the Magazzini del Sarno, Pompeii	M 2	2.38	8.79
Erratic tile from a floor of the Villa dei Brutii Praesentes, province of Rieti	M 3	0.80	6.57
Small cornice, as M 3	M 4	1.46	6.23
Fragment of a cornice, storeroom of Santa Maria in Aracoeli (RM)	M 5	2.15	5.79
Erratic tile from an opus sectile of Grumentum	M 6	2.00	2.29
Fragment of a cornice from Uthina (Oudna, Tunisia)	M 7	1.18	5.88
Erratic tile, storeroom of the Villa del Casale, Piazza Armerina	M 8	2.23	4.78

Table 3 Results of the isotopic analysis of the Giallo antico quarry samples

enlarged after the present analyses of eleven samples from the quarry debris hill and of eight samples from various items macroscopically identified as of the same stone (tabs. 3–4; fig. 7 b). In this reference diagram, the few samples of the Kristel and Sienese yellows analysed with the same instrument and methodology have then been plotted (fig. 7 c): their relative fields unfortunately overlap that of Giallo antico.

CONCLUSIONS

Based on the aforementioned results, Giallo antico may be classified as a micritic to microsparitic limestone of marine origin that underwent a weak regional metamorphism in the greenschist

Sample description	Sample no.	$\delta^{13}C$ (PDB) (+)	$\delta^{18}O$ (PDB) (–)
Holotype, light yellow with brown-reddish areas	GA 1	1.06	6.38
Holotype, yellow with a loose net of brown-reddish veins	GA 2	1.44	4.64
Holotype, yellow, brecciated, with a net of tight red veins	GA 3	1.55	4.98
Allotype, yellow, brecciated, with small clasts	GA 4	1.75	4.60
Allotype, reddish-yellow with large dark-red veins	GA 5	0.94	10.16
Allotype, pinkish, brecciated with large clasts	GA 6	–0.25	8.11
Allotype, yellow with red areas, similar to Rosso antico	GA 7	0.75	7.09
Allotype, light-brownish clasts in a dark brown violet matrix	GA 8	2.54	3.73
Allotype, as GA 8, but smaller and yellowish clasts	GA 9	0.98	4.39
Allotype, yellow and well brecciated variety	GA 10	1.71	5.94
Allotype, yellow, brecciated with a dark red cement	GA 11	–4.27	6.06

Table 4 Results of the analysis of the Giallo antico samples taken from artefacts/monuments

facies. Such metamorphism transformed the small amounts of clay of the sometimes slightly marly limestone protolith into quartz, K-mica and albitic plagioclase: the common abundant presence of twinned crystals of the last mineral provides the fingerprint of this rock. Its yellow colour is due to fine particles of goethite and other hydrated iron oxides, mostly dispersed in the calcareous matrix or concentrated into defined areas, often with red patches/stains/veins due to the presence of haematite. In monuments, red chiaroscuro effects were sometimes produced artificially by burning the surface of Giallo antico with concentrated fire, thus dehydrating the yellow iron oxides with the formation of red haematite.

The Algerian Kristel yellow is very similar to the Tunisian one, perhaps pertaining to the same geological formation, although of an even lower metamorphic grade, while the Giallo di Siena and Breccia dorata may be considered low-metamorphic marbles: they can all be distinguished microscopically from Giallo antico to some extent in thin sections, the former through its iso-oriented veins of sparite, the latter through their definitely granoblastic fabric, relatively larger grain size, lower amounts of albite and frequent presence of rutile inclusions in quartz.

Based on the isotopic results gained so far, it seems that it is not possible to obtain a clear distinction between the yellow stones cited above[13].

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THE STONE TESSERAE FROM THE ROMAN MOSAIC FLOORS OF ANCIENT MESSENE

FIRST RESULTS ON MATERIALS CHARACTERISATION AND PROVENANCE

Abstract
This study discusses the first results on characterisation and identification analysis of stone slab fragments and stone tesserae from the *opus sectile* and mosaic floors of ancient Messene dated to the 3rd–4th century AD. Scanning electron microscope coupled with an energy-dispersive spectrometer (SEM-EDS) analysis was employed for the preliminary observations and the external surface morphological examination, whereas the mineralogical analysis was performed by means of optical microscopy and X-ray diffraction (XRD). In addition, this study presents the first results obtained for the provenance of the red stone samples. Red tesserae and *opus sectile* stone slabs were analysed and compared with results from samples of Rosso antico red marble from the Mani Peninsula in the southern Peloponnese, Greece. The red marble of Mani was intensively exploited during Roman times, and for the present research, two of the most well-known quarries were chosen (Profitis Ilias and Paganea). The results obtained so far reveal the use of different types of stones for the formation of stone tesserae and *opus sectile* slab pieces. Furthermore, external surface deterioration phenomena which are possibly connected with different stones' morphological characteristics have been explored.

INTRODUCTION

The artistic value and the durability of Roman mosaics demonstrate that mosaicists reached a high level of artistic skills and technological knowledge. Ancient written sources provide useful information[1] about the manufacturing technology, which is enriched through studies on the iconography of the mosaics and through archaeometric research on material properties employed for their construction[2]. The contribution of analytical techniques underlines the complexity of mosaic floor construction while raising questions about the choice of inorganic raw materials.

Mosaics are architectural structures built with different layers of mortar supporting a surface of numerous tesserae. Taking into consideration the documented mosaic floors, different materials were used to form the tesserae. Among them, coloured stones in cubic shapes were the most predominant, widely used to create simple or more sophisticated decorative designs. The whole process of preparing and applying the materials was carried out manually, with results that were obviously inhomogeneous, but at the same time unique in terms of aesthetic parameters.

Guided by the need for the characterisation of construction materials and the identification of their possible provenance, the present study focuses on the stone tesserae and slab fragments from the Late Roman pavements from the city of ancient Messene (3rd–4th cent. AD) in the southern Peloponnese, Greece. The samples were selected from three mosaic and one *opus sectile*

1 Cf. Vitr. 7; Dunbabin 1999.

2 Cf. Ricca et al. 2014; Arinat – Shiyyab – Al Sekheneh 2020; Casas et al. 2021; Sánchez – Tuñón – Montejo 2021; Miletic et al. 2022; Petrova 2022; Rasmussen et al. 2022.



1 a: The city of ancient Messene from the west with the location of Late Roman Domus 1, Domus 2 and Domus 3, as well as the »Plateia« (Google Earth image; graphics: E. Mantzana). b–c: View of the floors from Domus 2 (photos: Society of Messenian Archaeological Studies). d–e: Stone tesserae and stone slab samples considered in the present study (photos: E. Mantzana)

pavements discovered in three urban *villae*, as well as from a mosaic floor from the open space, the »Plateia« at the west of the meat market complex of the agora (fig. 1). The objectives of the research were to distinguish specific practices related to the use of raw materials in these mosaic floors. For this reason, a preliminary provenance study focused on modern stone samples from the well-known ancient quarries of Rosso antico in the Mani Peninsula, the closest recorded sources of red stones to the city of ancient Messene. The first results obtained reveal specific technological practices regarding the type of stone used for the tesserae and *opus sectile* slabs. There are also signs of deterioration on the external surfaces of the samples, probably due to use and environmental conditions.

ARCHAEOLOGICAL CONTEXT

Ancient Messene is located in the southwestern part of the Peloponnese. The city was founded by the Theban general Epaminondas in 369 BC and was built according to the Hippodamian planning system. From the time of Augustus until the end of the 4th century AD, the city flourished; it

maintained its size and organisation and was characterised by economic growth[3]. Its wealth is reflected in the architectural remains of urban *villae* and public buildings with mosaic floors, dated between the Roman Imperial times and the Late Roman period (3rd–4th cent. AD). These houses, discovered during excavations directed by P. Themelis under the auspices of the Archaeological Society of Athens, are prestigious structures inhabited by the elite during the Late Roman phase of the city of Messene[4].

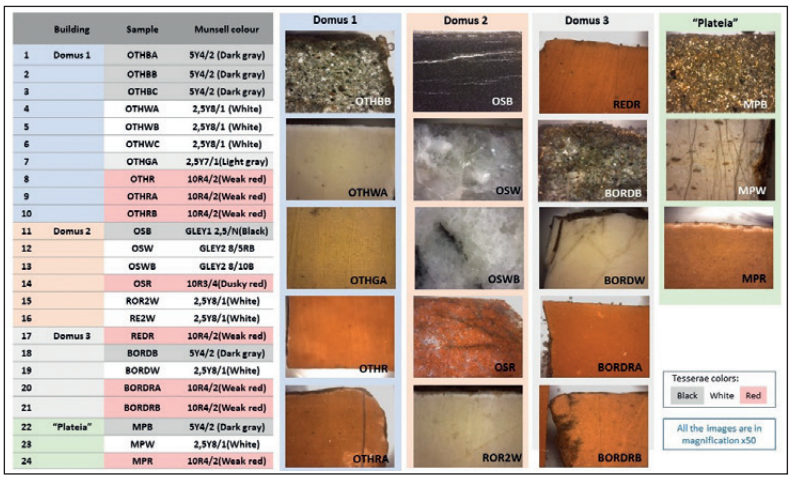
The present study focuses on the stone tesserae from the mosaic floors of three urban *villae*, located in different areas of the city centre, and a public complex to the west of the agora. Domus 1, located to the northwest of the theatre, belongs to a district of houses and is dated between the 3rd and 4th centuries BC. It encompasses mosaic floors with geometrical patterns, floral motifs, and inscriptions. The remains of the second villa (Domus 2), to the east of the Sanctuary of Asclepius, include two main halls decorated with an *opus sectile* and a *tessellatum* mosaic floor (fig. 1). These rooms are considered to be two of the largest in Greece[5], and the presence of an *opus sectile* floor in one of them is a factor that underlines the nobility and prestige of the structure during the Roman period[6]. The mosaic floors of the third urban villa (Domus 3), located to the north of the stadium and gymnasium complex (3rd–4th cent. AD), are smaller in scale and depict enigmatic figurative scenes. The last mosaic floor chosen is from the »Plateia«, the open space on the west side of the agora, where a pavement with geometric patterns has been preserved.

SAMPLES AND METHODOLOGY

Complex geometric patterns are present on every mosaic floor of the selected Roman buildings. White-, red- and black-coloured stones were used to create these patterns. The complexity of the patterns varies, but the size of the tesserae is similar (around 1 cm^3), with the exception of the mosaic of the »Plateia«, which is made up of cubic pieces of double size. The samples were selected from among the scattered tesserae and small mosaic fragments collected during the excavations. It is important to note that the material selected represents the three basic colours used for the geometric patterns of the *tessellatum* and the *opus sectile* pavements. In total, 20 stone samples of white, red and black tesserae from four mosaic floors and four small fragments of stone slabs from the *opus sectile* pavement were analysed during the present study (fig. 2).

The preliminary observations of the samples under an LED optical microscope (FOM/i-scope, Moritex) aimed at categorising the tesserae according to their morphological characteristics. As far as colours and shades are concerned, their determination was carried out using Munsell colour charts (fig. 2). In addition, during the initial study, which was mainly based on the identification of small quantities of mortar remains, it was possible to determine their orientation in relation to the original structure. This initial categorisation of the stone tesserae determined the sampling strategy and guided the selection of representative samples. Questions of availability and the size of the tesserae guided the analytical strategy and the appropriate use of the samples. In this way, the larger tesserae of the »Plateia« group and the *opus sectile* slab samples were selected and prepared as thin sections for petrographic analysis using a polarising microscope (Zeiss AxioScope. A1), with images captured by a digital camera (Jenoptik ProgRes C3). From the initial group, nine samples were analysed using a petrographic microscope. The specific selection was mainly based on preliminary optical microscopic observations and the size of the samples. The group of samples includes the *opus sectile* floor in Domus 2 (OSB, OSW, OSWB, OSR), the cubic tesserae from the »Plateia« mosaic floor, the red stone samples OTHRA (Domus 1) and the sample REDR (Domus 3).

3 Themelis 2016.
4 Tsivikis 2021.
5 Tsivikis 2016.
6 Dunbabin 1999.



	Building	Sample	Munsell colour
1	Domus 1	OTHBA	5Y4/2 (Dark gray)
2		OTHBB	5Y4/2 (Dark gray)
3		OTHBC	5Y4/2 (Dark gray)
4		OTHWA	2,5Y8/1 (White)
5		OTHWB	2,5Y8/1 (White)
6		OTHWC	2,5Y8/1 (White)
7		OTHGA	2,5Y7/1(Light gray)
8		OTHR	10R4/2(Weak red)
9		OTHRA	10R4/2(Weak red)
10		OTHRB	10R4/2(Weak red)
11	Domus 2	OSB	GLEY1 2,5/N(Black)
12		OSW	GLEY2 8/5RB
13		OSWB	GLEY2 8/10B
14		OSR	10R3/4(Dusky red)
15		ROR2W	2,5Y8/1(White)
16		RE2W	2,5Y8/1(White)
17	Domus 3	REDR	10R4/2(Weak red)
18		BORDB	5Y4/2 (Dark gray)
19		BORDW	2,5Y8/1(White)
20		BORDRA	10R4/2(Weak red)
21		BORDRB	10R4/2(Weak red)
22	"Plateia"	MPB	5Y4/2 (Dark gray)
23		MPW	2,5Y8/1(White)
24		MPR	10R4/2(Weak red)

2 Representative optical microscopy photographs of the stone tesserae and slab samples from Domus 1, Domus 2 and Domus 3 and the »Plateia«, their assignment to these establishments and colour name that corresponds to the closest Munsell colour (graphics: E. Mantzana)

From the stone samples, representative surfaces were polished and analysed using a JEOL JSM–6510LV scanning electron microscope coupled with an energy-dispersive spectrometer (SEM-EDS) (OXFORD Instruments EDS Inca Energy 250 X-ct systems) using 20 kV/180 sec as measurement conditions, and the analytical data of elemental composition were evaluated through the accompanying INCA software. For each sample, mean and standard deviation values were calculated after analysis of four different areas, selected depending on the heterogeneity of the surface. In addition, the state of preservation of the external surfaces was investigated by means of secondary electron (SE) and backscattered electron (BSE) imaging. Among the initially selected samples, only those from Domus 1 were chosen with at least five tesserae for each main colour. Three samples of each colour were analysed by SEM-EDS, as well as one light-grey tessera (OTHGA; fig. 2; tab. 1).

The mineralogical analysis was performed on powdered material, obtained after grinding parts of 15 stone samples in an agate mortar, by means of X-ray powder diffraction (XRPD), employing a Bruker D8 Advance diffractometer with nickel-filtered Copper-K-alpha (Cu-Ka) radiation operating at 40 kV/40 mA and equipped with a Bruker LynxEye fast detector. The qualitative mineralogical analysis was performed using the DIFFRACplus EVA software (Bruker-AXS, Madison, WI, USA) based on the International Centre for Diffraction Data (ICDD) Powder Diffraction File (2006 version). Geochemical and mineralogical analysis aim at the characterisation and identification of stone samples, which are considered as the principal steps in provenance studies[7]. The samples for the mineralogical analysis represent all five mosaic pavements. From the samples of Domus 1, only one of each coloured stone tesserae was analysed (OTHRA, OTHBA, OTHWA, OTHGA). From Domus 2 the four stone slabs as well as the white tessera RE2W were included in the analysis programme, and likewise the tesserae samples REDR, BORDB and BORDR from Domus 3. Finally, from the »Plateia«, MPB, MPW and MPR complete the group of samples for the XRPD analysis (tab. 2). For comparative purposes, three more stone samples from the recognised quarries of Rosso antico on the Mani Peninsula were also analysed during the present study. These comprise samples Paganea I & II (PAP1 & PAP2) and Profitis Ilias (PAPI), which were compared with the red stones from the *opus sectile* pavement (fig. 3). Furthermore,

7 Cf. Lazzarini 1990; Lazzarini 2004; Russell 2017.

	Building	Samples	Colour	Values	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	TiO_2	FeO
1	Domus 1	OTHBA	Black	μ	1.33	1.94	7.71	59.52	0.55	nd	0.13	1.60	23.16	0.59	3.85
				s	0.18	0.18	0.76	1.13	0.19	–	–	0.18	2.47	0.15	0.52
2	Domus 1	OTHBB	Black	μ	1.05	1.11	7.70	74.72	0.48	nd	0.17	1.88	10.27	nd	2.98
				s	0.14	0.10	0.38	0.26	0.08	–	–	0.10	0.25	nd	0.33
3	Domus 1	OTHBC	Black	μ	0.90	1.34	8.14	72.82	0.51	nd	nd	1.85	11.21	nd	3.23
				s	0.16	0.09	0.32	1.25	0.27	–	–	0.07	0.47	–	0.26
4	Domus 1	OTHWA	White	μ	nd	1.43	1.03	4.24	nd	0.62	nd	nd	94.12	nd	nd
				s	–	0.34	0.23	0.57	–	–	–	–	0.57	–	–
5	Domus 1	OTHWB	White	μ	0.51	0.58	1.32	7.02	nd	0.59	nd	0.29	90.31	nd	0.71
				s	–	0.13	0.64	0.89	–	–	–	0.06	2.08	–	0.01
6	Domus 1	OTHWC	White	μ	nd	0.57	nd	4.16	nd	nd	nd	nd	95.43	nd	0.5
				s	–	0.14	–	0.45	–	–	–	–	0.94	–	–
7	Domus 1	OTHGA	Light Grey	μ	0.55	0.76	2.21	14.63	0.94	0.61	nd	0.55	77.85	nd	2.49
				s	0.16	0.20	0.17	1.12	0.25	0.13		0.16	0.68		0.18
8	Domus 1	OTHR	Red	μ	nd	0.99	1.89	26.76	nd	0.88	0.35	nd	70.56	nd	nd
				s	–	0.06	0.46	0.74	–	–	–	–	0.86	–	–
9	Domus 1	OTHRA	Red	μ	nd	1.17	0.825	7.84	nd	nd	nd	nd	91.455	nd	nd
				s	–	–	0.09	1.46	–	–	–	–	1.50	–	–
10	Domus 1	OTHRB	Red	μ	nd	0.72	1.43	12.11	nd	nd	nd	0.47	85.45	nd	1.45
				s	–	0.16	0.28	0.80	–	–	–	–	1.47	–	–
11	Domus 2	O5B	Black	μ	0.85	3.14	6.64	37.48	nd	nd	nd	1.61	47.79	nd	2.5
				s	0.62	0.27	0.38	0.40				0.31	1.19	–	0.38
12	Domus 2	O5W	White	μ	nd	7.33	0.99	nd	nd	1.41	nd	nd	93.46	nd	nd
				s	–	6.79	0.28	–	–	–	–	–	6.60	–	–
13	Domus 2	OSWB	White/	μ	nd	1.60	0.90	1.13	nd	nd	nd	nd	98.30	nd	nd
			Black	s	–	0.67	–	–	–	–	–	–	1.27	–	–
14	Domus 2	OSR	Red	μ	1.06	1.60	3.34	7.73	nd	nd	nd	0.41	86.39	nd	nd
				s	0.35	0.29	0.86	1.05				0.16	0.67	–	–
15	Domus 2	ROR2W	White	μ	nd	0.52	0.89	6.90	nd	nd	nd	nd	92.01	nd	0.69
				s	–	0.02	0.19	0.39	–	–	–	–	0.60	–	–
16	Domus 2	RE2W	White	μ	nd	0.46	0.67	3.53	nd	nd	nd	nd	95.34	nd	nd
				s	–	0.16	0.3	0.47	–	–	–	–	0.73	–	–
17	Domus 3	REDR	Red	μ	nd	0.76	1.43	12.88	nd	1.21	nd	0.48	84.61	nd	0.93
				s	–	–	0.27	1.34	–	–	–	–	0.95	–	0.13
18	Domus 3	BORDB	Black	μ	1.03	1.23	5.14	63.42	nd	nd	nd	0.79	24.98	0.75	2.67
				s	0.18	0.31	0.57	5.66	–	–	–	0.20	4.41	0.27	0.42
19	Domus 3	BORDW	White	μ	–	0.91	0.64	3.03	nd	nd	nd	nd	95.62	nd	0.52
				s	–	0.29	0.25	0.23	–	–	–	–	0.42	–	0.07
20	Domus 3	BORDRA	Red	μ	0.42	1.37	6.74	85.07	nd	nd	nd	2.03	0.38	nd	4.00
				s	0.06	0.05	0.28	0.32	–	–	–	0.14	0.04	–	0.08
21	Domus 3	BORDRB	Black	μ	0.66	0.82	1.72	15.60	nd	nd	nd	0.29	80.63	nd	0.79
				s	–	0.20	0.40	1.03	–	–	–	0.14	1.12	–	0.21
22	»Plateia«	MPB	Black	μ	1.08	1.67	8.67	70.07	0.97	nd	nd	1.60	12.81	nd	3.63
				s	0.13	0.46	0.50	1.13	0.01	–	–	0.24	0.92	–	0.27
23	»Plateia«	MPW	White	μ	nd	1.19	0.9	2.27	nd	nd	nd	nd	97.21	nd	nd
				s	–	–	–	0.59	–	–	–	–	1.16	–	–
24	»Plateia«	MPR	Red	μ	nd	1.05	1.18	3.67	nd	1.27	nd	nd	93.93	nd	1.55
				s	–	0.36	0.18	0.46	–	0.49	–	–	1.57	–	–

Table 1 The mean value (μ) and standard deviation (s) of the concentration of the major oxides (wt %) for stone samples using SEM-EDS. The results are the average of four analyses on each sample. The values are normalised to 100 wt % (nd: value not detected)

the upper surface microstructure and the state of their preservation were studied with SEM-EDS and the line scan and elemental mapping tools.



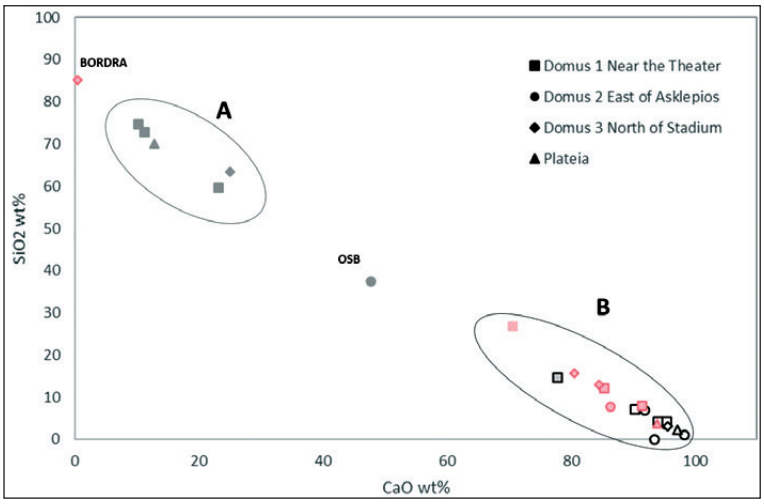
3 Sampling location and hand specimen photographs of Rosso antico from the Mani Peninsula (Google Earth image; graphics: E. Mantzana)

No	Building	Tesserae	Colour	Calcite	Dolomite	Quartz	Albite	Muscovite	Chlorite	Hematite	Halite
1	Domus 1	OTHBA	Black	++	–	++++	+	+	+	–	–
2		OTHGA	White-Gray	++++	–	+	+/tr	–	–	–	–
3		OTHWA	White	++++	–	+		–	–	–	–
4		OTHRA	Red	++++	–	+/++		–	–	–	–
5	Domus 2	OSB	Black	++++	–	+++	tr	+/++	++	–	–
6		osw	White	++++	+	tr		–	–	–	–
7		OSWB	White-black	++++	–	tr		tr			
8		OSR	Red	++++	–	+/tr	tr	+	+/tr		+/tr
9		RE2W	White	++++	–	tr		–	–	–	–
10	Domus 3	REDR	Red	++++	–	++/+++		–	–	–	–
11		BORDB	Black	+/++	–	++++	+	+	+		
12		BORDR	Red	++++	–	++		–	–	–	–
13	»Plateia«	MPB	Black	++	+	++++	+/++	+/++	+		
14		MPW	White	++++	–	+/tr		–	–	–	–
15		MPR	Red	++++	–	tr		–	–	–	–
16	Rosso Antico	PAPI	Red	++++	–	+	+/tr	+	+/tr	tr	
17		PAPl	Red	++++	–	tr	tr	+/++	tr	tr	tr
18		PAP2	Red	++++	–	tr	+/tr	+/++	+/tr	tr	+/tr

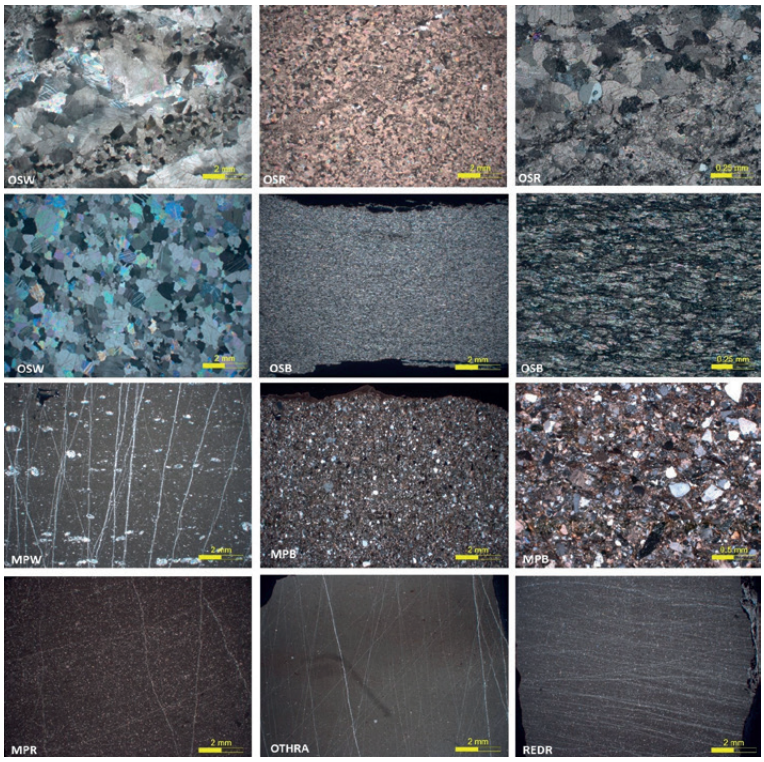
Table 2 Semi-quantitative XRPD results for the mineralogical composition of tesserae samples. The relative abundance is described by the following modifiers; –: not detected; tr: traces; +: few; ++: common; +++: frequent; ++++: dominant

RESULTS AND DISCUSSION

The mean values of major elements from the stone samples were determined via SEM-EDS (tab. 1). The projection of the chemical data in the scatter diagram of SiO_2 versus CaO (wt. %) (fig. 4) reveals the negative correlation between these two elements and highlights the clustering of the majority of the analysed samples into two compositional groups, one rich in SiO_2 (Group A) and a second one rich in CaO content (Group B). In general, the CaO content in the white and red-coloured tesserae is higher compared to the black stone samples, which exhibit a higher percentage of SiO_2. Sample OSB (*opus sectile*) exhibits an intermediate composition between the



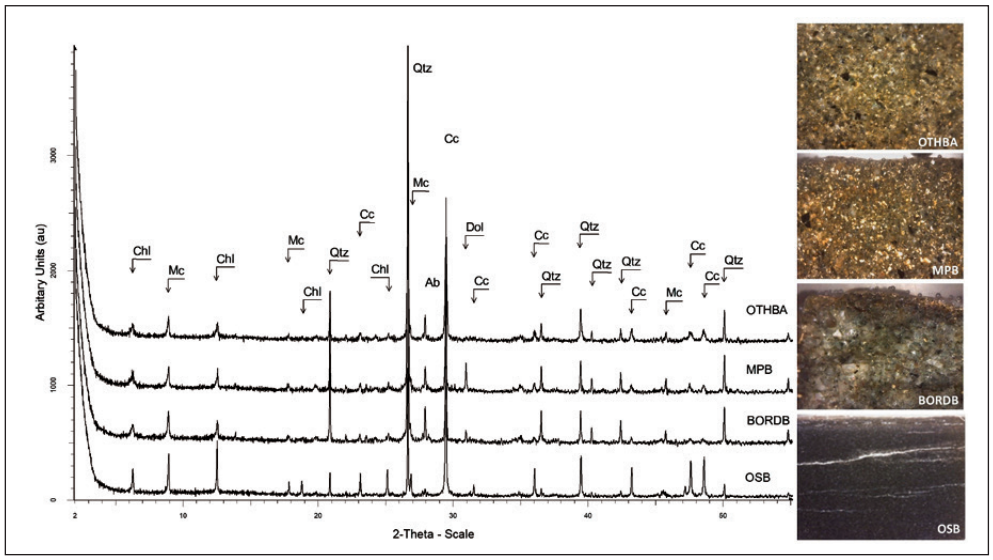
4 Scatter diagram of silicon dioxide (SiO_2) versus calcium oxide (CaO) content for the white, red and black stone samples from Domus 1–3 and the »Plateia« of ancient Messene (graphics: E. Mantzana)



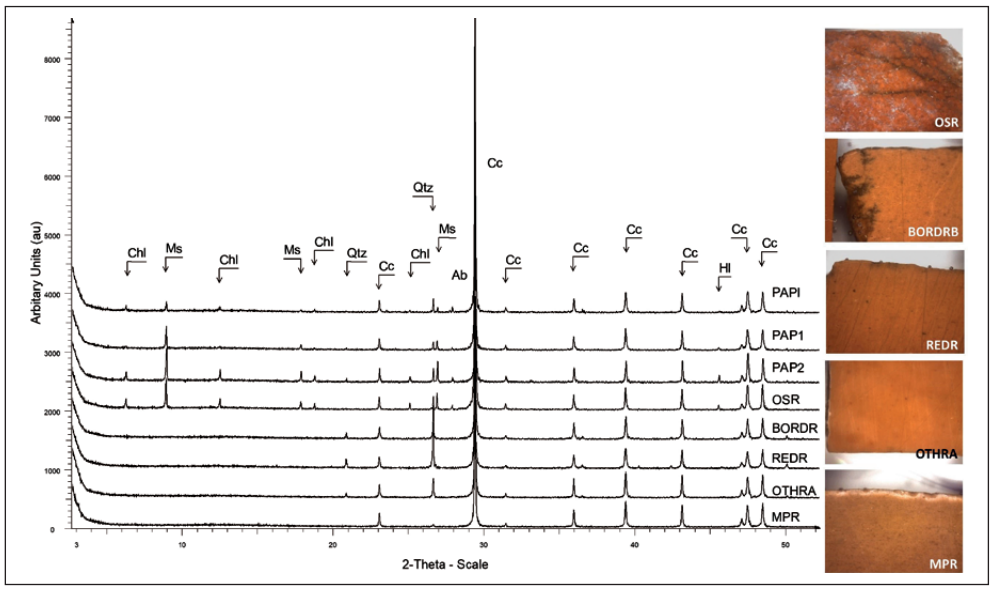
5 Photomicrographs of *opus sectile* stone slab (first and second row) and stone tesserae samples (3rd and 4th row). All images are taken under crossed Nicols (photos: I. Iliopoulos)

two main chemical groups, whereas sample BORDRA (Domus 3) is very poor in CaO and plots marginally to chemical Group A.

The petrographic analysis was primarily focused on the characterisation of stone samples and secondly on their assignment into groups according to their petrographic characteristics. All four *opus sectile* samples examined herein (fig. 5, first and second row) are classified as metamorphic rocks. Samples OSW and OSWB from the *opus sectile* pavement in Domus 2 are coarse-grained white marbles with calcite as the predominant mineral. Some dolomite is present in sample OSW. Sample OSR is a fine-grained red marble with black-coloured veins which comprises sparitic



6 Composite plots of XRPD patterns of black-coloured tesserae samples. Their relevant optical microscopy images are also given on the right of the image. Qtz: quartz, Cc: calcite, Chl: chlorite, Dol: dolomite, Mc: muscovite, Ab: albite (graphics: E. Mantzana)



7 Composite plots of XRPD patterns of red-coloured stone samples (OSR, BORDR, REDR, OTHRA, MPR) and Roman quarry samples from the Mani Peninsula (PAPI, PAP1, PAP2). Representative optical microscopy images of some of the samples are also given on the right of the image. Abbreviations as in fig. 6 (graphics: E. Mantzana)

calcite, quartz, feldspars, chlorite and muscovite, as well as opaque minerals. Sample OSB is a black slate stone rich in calcite with subordinate quartz.

The stone tesserae from the mosaic floor of the »Plateia« (MPW, MPB, MPR) exhibit the same colour variation as those observed in the material examined from the *opus sectile* pavement. The white and red tesserae MPW and MPR are classified as micritic limestone composed mainly of micritic calcite. Bedding is apparent in both samples and their fine calcitic material is cross-cut by numerous veins composed of microsparitic calcite (fig. 5). As far as the black-coloured tesserae and the samples MPB, OTHBA, REDB, BORDB are concerned, optical microscopic analysis presents significant morphological homogeneity. The tesserae sizes are limited, with the sole exception of sample MPB, which was ultimately chosen to represent the sample group in the

petrographic analysis. According to the observation, sample MPB is classified as calcareous sandstone composed of quartz, calcite, muscovite, plagioclase, hornblende and a calcareous cement matrix (fig. 5). From the specific samples, it is clear that exclusively sedimentary rocks have been used for the formation of black cubic tesserae.

Furthermore, the petrographic analysis was focused on the comparison of red stone samples from the floors of Domus 1, Domus 2 and Domus 3 (OSR, OTHRA, REDR) and sample MPR from the »Plateia« mosaic floor. Samples OTHRA and REDR compositionally resemble sample MPR and bear similar calcite veins but exhibit a smaller grain size and lack any observable bedding feature. The compositional characteristics and the textural features observed in these three samples help to unequivocally classify them as sedimentary rocks, in contrast to the metamorphic origin of sample OSR (red marble).

The mineralogical analysis was complemented with the use of XRPD analysis (tab. 2). The results are discussed according to the three main colours observed macroscopically in the analysed samples, in order to underline any similarities and differentiations. The white stone samples include the material from the *opus sectile* and the *tessellatum* mosaics from Domus 1, Domus 2 and Domus 3, as well as the »Plateia« mosaic. The comparison of XRPD results shows the predominance of calcite over other minerals with the only exception being the presence of a small amount of dolomite in sample OSW, a fact that verifies the petrographic observations.

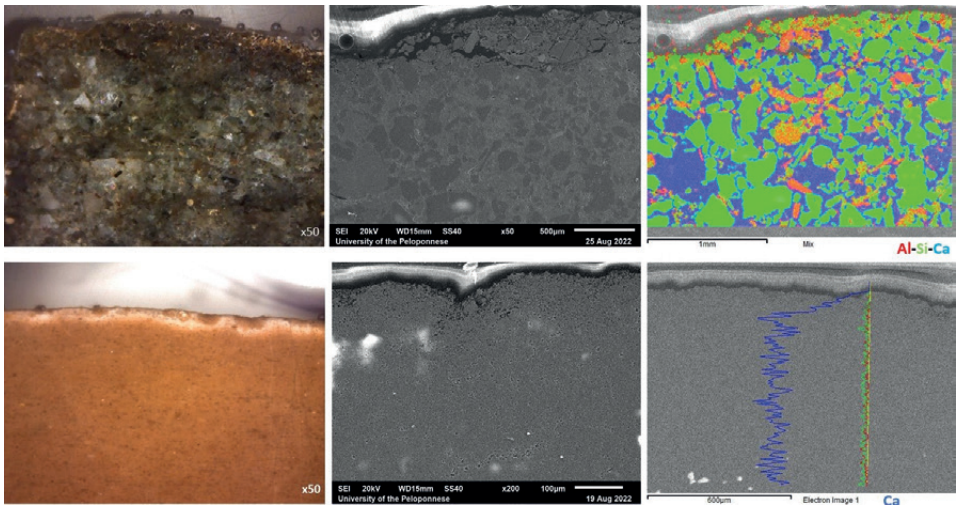
For the group of black stones, four samples were analysed. According to petrographic analysis, samples from the tesserae OTHBA, MPB, and BORDB were characterised as calcitic sandstones. The comparison of their XRPD patterns underlined similarities and the fact that quartz is the predominant mineral, calcite is the second most abundant, and albite, chlorite and muscovite are present in smaller amounts. The XRPD results of sample OSB showed a stone with the same minerals but in different quantities. In that case, calcite is the predominant mineral, followed by quartz. Albite, chlorite, and muscovite are present in greater amounts compared to samples OTHBA, MPB, and BORDB (tab. 2; fig. 6).

As far as the five samples of red stones analysed are concerned, four of them (samples BORDR, REDR, OTHRA, and MPR) exhibit almost identical XRPD patterns with calcite being identified as the predominant mineral, whereas quartz was present only in very small amounts (fig. 7). According to the petrographic analysis (fig. 5), sample MPR is characterised as micritic limestone. The XRPD pattern of sample OSR presents a significant differentiation from the limestone samples. In that case, calcite is also the main mineral, but there are other minerals, like muscovite, chlorite and very small amounts of quartz, albite and halite. The presence of the latter is possibly attributed to the proximity of the sampling location to the sea.

Finally, the XRPD analysis of the Rosso antico stone samples PAPI, PAP1, and PAP2 showed that they are predominantly composed of calcite with only minor quantities of quartz being present. These samples also contain variable amounts of muscovite, chlorite and albite (fig. 7). In particular, the XRPD pattern of sample PAP2 exhibits substantial similarity to that obtained through the analysis of sample OSR, possibly indicating their common provenance.

STATE OF PRESERVATION

Stone tesserae and slab samples had been placed on the top layer of a floor that was in use. Consequently, the external surfaces were likely to have been exposed to anthropogenic and environmental deterioration factors. SEM-EDS line scans and elemental mapping analysis were used to assess the state of preservation of the external surfaces and to characterise the layers of deterioration. Fragmentation and exfoliation were observed in the upper layers of ca. 0.5–1.0 mm, possibly due to mechanical stress. The first case is common in black sandstone tesserae (samples BORDB and MPB). Exfoliations are present on slate stone (sample OSB) and micritic limestone (sample OTHRBA). In figure 8 (upper row), areas of black calcareous sandstone with fragmentation phenomena are noticed. In this case, elemental mapping analysis of SEM-EDS showed a mixture of silica and alumina, probably representing soil substances, to be deposited



8 Optical microscopy and SEM images in combination with EDS elemental mapping analysis and line scan (graphics: E. Mantzana)

on the top surface but also to penetrate into the cavities formed after deterioration. Furthermore, on the top surface of red and white micritic limestone tesserae (sample MPR) (fig. 8, lower row), the decrease in calcium oxide is documented through SEM-EDS line scans. The most characteristic morphological feature of these areas is the expansion of porosity at a depth of 100–200 µm (fig. 8, lower row, central image); these phenomena are possibly connected with the reduction of calcium oxides. By contrast, the internal structure of the tesserae does not seem to be affected by deterioration phenomena, revealing stone materials of good consistency and considerable mechanical strength.

CONCLUSIONS

The present study focuses on the geochemical, petrographic and mineralogical analysis of stone tesserae and *opus sectile* stone slab fragments from the floors of Late Roman *domus* of ancient Messene (3rd–4th cent. AD). As preliminary research, the main aim was the characterisation of white-, black- and red-coloured stone tesserae which had been used for the geometrical designs in the mosaic pavements of ancient Messene. The research will continue with the main themes of figurative scenes and inscriptions, but according to the current results, it is evident that different materials were used for *tessellatum* and *opus sectile* mosaics. In the former, only sedimentary rocks such as micritic limestones and calcareous sandstones were identified, but for the *opus sectile* main theme, the stone slabs are formed only from metamorphic rocks. That differentiation is evident even in floors located within the same villa and sequential rooms, like Domus 2. This preference could be correlated to the specific stones' properties, such as their hardness, porosity, lustre and workability, but also to financial parameters like a low-budget project and the availability of materials. Consequently, for the shaping of cubic tesserae, a sedimentary rock would have been a reasonable choice compared to a metamorphic rock with discontinuities, higher hardness, and possibly a higher price.

The research into the provenance of these stones started with the identification and the mineralogical analysis of Rosso antico red marble. Based on the XRPD results, Paganea samples have a similar mineralogical content to the original Rosso antico sample (OSR). The specific stone was known and popular during the Roman period, but also, its quarries are located at a relatively short distance from the archaeological site. The use of it could be expected, but it seems that the red marble was used only on *opus sectile* floors and not in general for the *tessellatum* mosaic floors. As far as the cubic tesserae are concerned, further provenance studies for the sedimentary rocks will help to answer questions about mosaic constructors during the Late Roman period. Questions

about the organisation and supply of materials could be answered, adding information about how mosaicists worked and managed their commissioned projects.

Furthermore, stone tesserae provenance studies and documentation of their state of preservation will provide necessary information for successful implementation of conservation. Most of the detected deterioration phenomena on the external layers of the tesserae are due to the properties of the materials and to the environmental conditions. The way these stone samples lose their surfaces, through fragmentation, exfoliation, and the dissolution of substances, indicates that mechanical stress is the main reason. The causes of these deterioration phenomena should be taken into consideration not only during the process of designing new conservation materials but also for the development of effective maintenance interventions.

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MOSAIC AS *OPUS SECTILE*

IMITATION OF COLOURED MARBLES ON THE NEVIODUNUM (DRNOVO, SLOVENIA) MOSAIC PAVEMENT

Abstract
During archaeological excavations in Drnovo pri Krškem, Slovenia (Municipium Flavium Latobicorum Neviodunum, Pannonia superior) in 1964, fragments of the mosaic pavement were discovered, dated in the late 2nd to early 3rd centuries. Its central field imitates an *opus sectile* pavement composed of large square plates of coloured marbles. Remains of six plates are preserved, imitating four different types of marble. Three of them show the same schematic design with big ovoid elements accompanied by smaller ones defined by black outlines. They are mostly filled with ochre and white but also with some deep red tesserae in the way Giallo antico brecciato marble (Chemtou) was usually painted in antiquity. Formally similar to this design is another one with the filling in pink, grey, white and some green tesserae, probably showing the pink variant of the Breccia policroma della Vittoria marble (Akrini, Kozani). Another two types of marble are clearly recognisable as Red porphyry (Gebel Dokhan) and Porfido verde antico (Krokea). Mosaic imitations of *opus sectile* pavements are known from at least the early 3rd century onwards as a substitution for precious coloured marbles. The Neviodunum pavement seems to be one of the few such pavements made at the beginning of this fashion.

NEVIODUNUM AND THE DISCOVERY OF THE MOSAIC

Almost 60 years ago, a mosaic with a rare motif was discovered at Drnovo near Krško (Slovenia) during excavations by Peter Petru, then curator of the National Museum of Slovenia. The mosaic is unique in that its central ornamental field, with its patterns and colour scheme, depicts rocks, the colourful ›marbles‹ used in antiquity as floor and wall coverings. In this paper, we will try to identify the rocks depicted in the mosaic technique in order to provide information on trends in the use of certain rocks. By placing it in a broader cultural context, we expect to be able to date the mosaic, which otherwise has rather unreliable research data.

Neviodunum (»New Town«) was a Roman settlement in the area of today's Drnovo in the Krško polje in southeastern Slovenia. The area was settled by the Romans in the last third of the 1st century BC during their conquest of Pannonia. The area's former inhabitants, the Celtic Latobics, were annexed to the Roman Empire through trade, diplomacy and military force. The settlement was initially a military outpost, but later passed into civilian hands. The Emperor Vespasian granted Neviodunum city rights and elevated it to the full name of Municipium Flavium Latobicorum Neviodunum. Its development was influenced by its favourable geographical position on the route between Emona and Siscia, between which road and river trade routes ran[1]. Neviodunum became a port and an important trading centre. Archaeological excavations have uncovered market and storage spaces, brick and pottery workshops, baths, wells, residential buildings, a water supply system and cemeteries[2].

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1 Petru – Petru 1978; Puhar 2013.
2 Petru – Petru 1978.



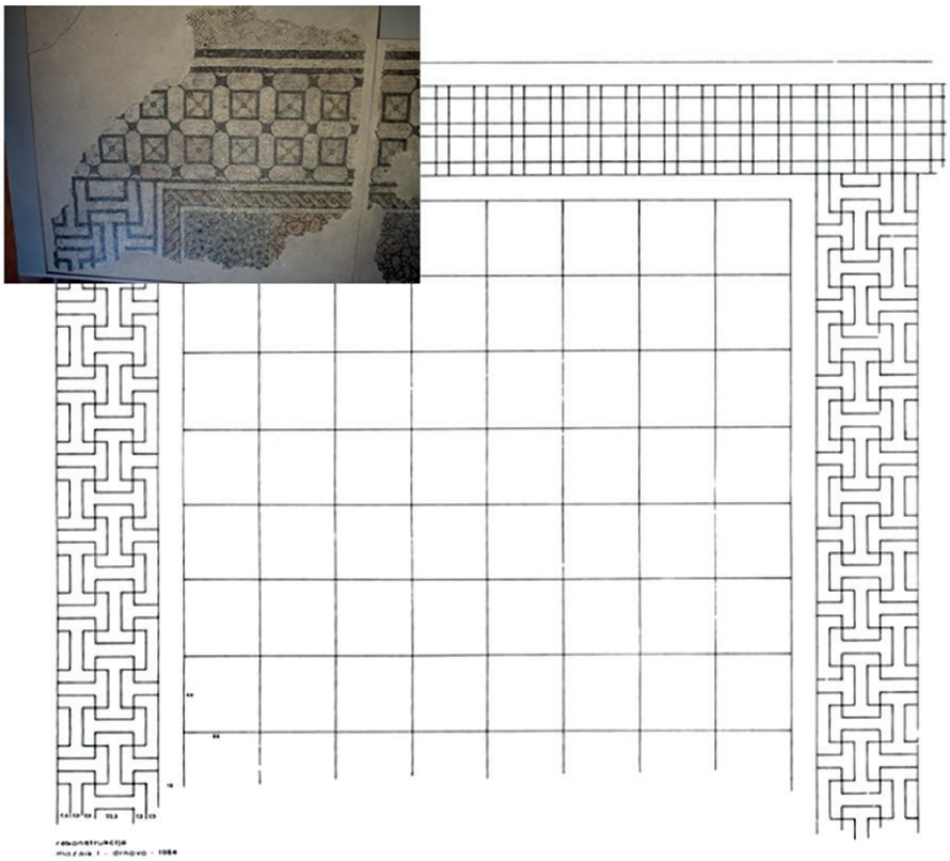
1 Mosaic from Neviodunum (Drnovo, Slovenia), discovered during excavations in 1964 (photo: Archive of the Posavje Museum Brežice)

The excavated remains are preserved by the National Museum of Slovenia and the Posavje Museum Brežice[3]. During excavations between 1961 and 1968, the remains of a mosaic pavement were also discovered in 1964, which were removed and restored[4] and have been part of the collection of the Posavje Museum Brežice since the late 1960s.

Several parts of the mosaic pavement have been preserved. The tesserae, 8–10 mm in size, are black, white, yellow, ochre, red, pink, dark red, green and grey (fig. 1). The mosaic was published in a review of mosaic pavements of Slovenia[5], and a reconstruction (fig. 2) and interpretation of its motif with a detailed description was undertaken.

»The reconstruction made possible by these fragments shows a white frame band of diagonally running *tesserae*, terminated on the inner side by a black narrow frame. The inner ornamental surface is divided into a central, probably square field and a wide, four-part ornamental frame, where two parallel bands have identical ornamental divisions: a meander scheme forming the

3 Puhar 2013, 4.
4 Bogovčič 2011, 13.
5 Djurić 1976/1977.



2 Reconstruction of the mosaic after Djurić 1976/1977 with a photograph of a preserved part of the mosaic (photo: J. Puhar)

motif of a Greek key (BAIEM A 484) on a white base and an orthogonal scheme of two rows of framed squares on a white base, connected by black squares of curved sides (BAIEM A 353). The filling motif of the framing squares is diagonally arranged coloured flowers radiating from a central circle. The central field, surrounded by a bordure of double-stranded braid, is filled with panels of coloured marble imitated in mosaic technique«.[6]

ROCKS REPRESENTED BY MOSAIC

In the central decorative field, as can be seen from the picture (fig. 1), six panels depicting four different types of coloured marbles are partially preserved. On the basis of the patterns and colour schemes depicted, we have attempted to identify the rocks depicted.

Giallo Antico/Giallo Antico Brecciato (Chemtou, Tunisia)

Three of the six fields are filled with a decoration of overlapping floating ornaments in various shades of ochre and deep red (fig. 3). They are interpreted as multicoloured breccia, the so-called Giallo antico or Numidian marble, which is also the most common motif in mosaics imitating ›marble‹. The rock, also called Marmor Numidicum by the Romans, was one of the most popular and expensive in the empire. The stone was quarried near the ancient town of Simmithus, now

6 Djurić 1976/1977, 565 f.



3 Giallo antico on the Neviodunum mosaic (photo: J. Puhar) compared to the rock it depicts (from Lazzarini 2012, 80)



4 Breccia policroma della Vittoria on the Neviodunum mosaic (photo: J. Puhar) compared to the rock it depicts (after <https://phaidra.cab.unipd.it/detail/o:433013?mode=full&tab=63> [30.03.2023])

Chemtou in Tunisia, and the mines were owned by the emperor[7]. The Giallo antico motif has been used in North African mosaics since the first half of the 2nd century, but initially only as a filler in geometric patterns[8]. Numerous early examples of mosaic pavements imitating Giallo antico are known from the sites of Cyrene and Benghazi (Libya), Makhtar (Tunisia), Agrigento (Sicily, Italy) and Nora (Sardinia, Italy)[9]. The Giallo antico thus also represents the first rock to be depicted in mosaic paving in the context of mimicry. Its depiction can be traced back to the end of this fashion in mosaic art in the early 6th century.

Breccia Policroma della Vittoria (Akrini, Kozani, Greece)

Formally similar to the previous motif, the pattern appears in a single field (fig. 4). The pattern shows that it also depicts a breccia, but its colour scheme is different from that of the previous motif. The lenticular ornament is bordered in black and filled with tesserae in shades of pink, grey, white and green. It has been identified by Bojan Djurić and Igor Rižnar[10] as a rock known as Breccia policroma della Vittoria[11], popular in Late Antiquity, from a quarry in Akrini (Kozani, Greece).

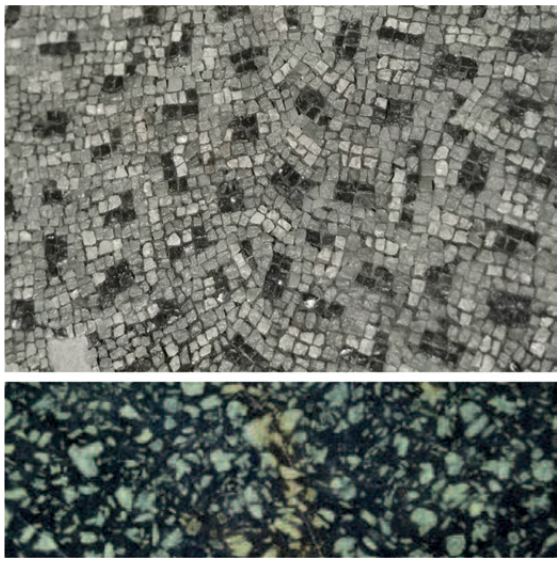
Imperial Red Porphyry (Gebel Dokhan, Egypt)

The almost completely uniform dark-red surface of the mosaic, with minimal variations in the colour scheme, is clearly identifiable as imperial Red porphyry, known in antiquity as *lapis purpureus porphyrites*, which was quarried on Mount Gebel Dokhan (Mons Porphyrites) in the hostile environment of the Eastern Desert (fig. 5). The Red porphyry is usually brownish-purple to dark purple in colour, but often with a mottled or opaque groundmass and with crystals ranging in colour from white to pink. Porphyry mines were exploited as early as the Late Predynastic

7 Lazzarini 2012, 80.
8 Michaelides 1985, 162.
9 Michaelides 1985.
10 Djurić – Rižnar 2017, 139.
11 Lazzarini 2007, 245–252.



5 Imperial Red porphyry on the Neviodunum mosaic (photo: J. Puhar) compared to the rock it depicts (from Lazzarini 2012, 89)



6 Green porphyry depicted in a mosaic (photo: J. Puhar) compared to the rock it depicts (from Lazzarini 2012, 90)

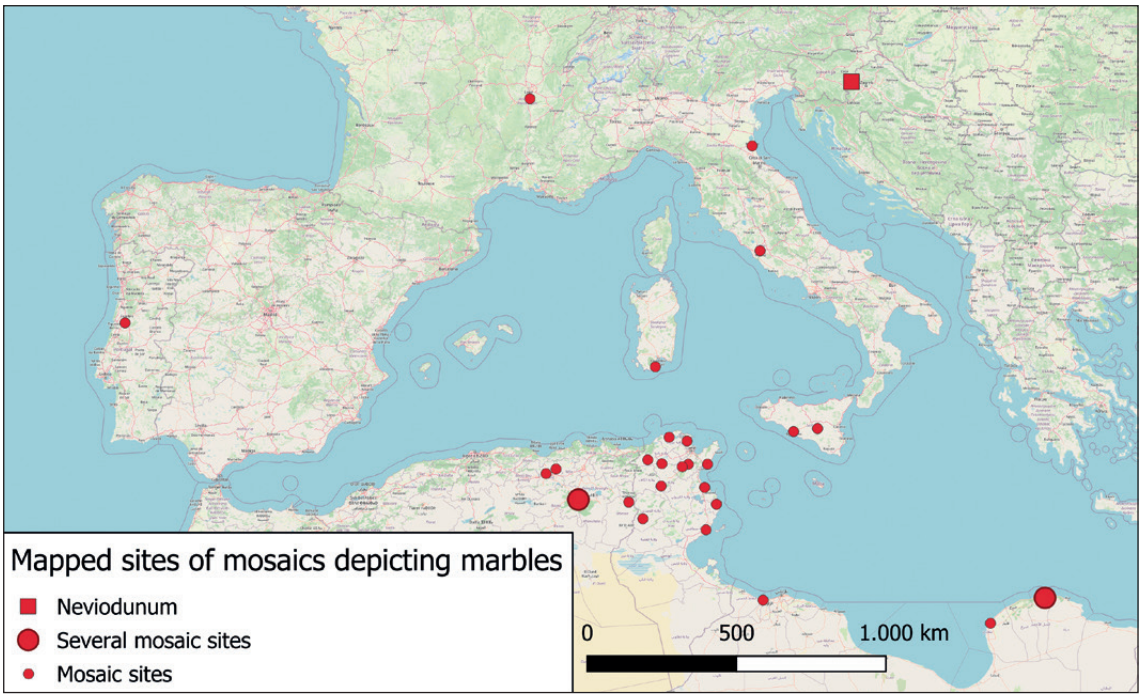
period of Egypt – the Early Old Kingdom and the Ptolemaic period[12]. It was rediscovered in the Roman period, when the quarry started operating from the time of Augustus (31 BC), followed by fluctuations, and was abandoned for a while in the time of Trajan (AD 98–117). It was used again on a large scale in the time of Hadrian (AD 117–138), and the rock reached its greatest popularity in the time of Diocletian (AD 284–305), when the stone was widely available on the market and the purple colour signified the colour of the emperor. The exploitation of the resource continued on a large scale during the reign of Constantine (AD 306–337), especially in the construction of the new capital at Constantinople. It was the most important and expensive stone of antiquity[13].

Green Porphyry/Lapis Lacedaemonius (Krokea, Greece)

The green surface, interspersed with individual elements ranging in colour from yellowish and light to dark green, represents a green porphyry with the characteristic phenocrysts of lighter shades shown (fig. 6). In antiquity it was also called *lapis Lacedaemonius*, Κροκεάτης λίθος or »Spartan basalt« after its only source in the southern Peloponnese at Krokea[14]. Together with imperial Red porphyry, Green porphyry was the most expensive stone in antiquity[15]. We learn a lot about the quarry from Pausanias, an ancient geographer who travelled in Greece and described it in the following words: »As you go down to the sea in the direction of Gythium, you come to the Lacedaemonian village called Croceae. The stone quarries here are not one continuous piece of rock, but stones are dug out of them like river stones, rather difficult to carve, but when they are carved admirably adapted to adorn the temples of the gods, and add very greatly to the beauty of fishponds and ornamental waters. And in front of the village are statues of the gods, as Zeus of Croceae in stone, and at the quarry Castor and Pollux in brass.«[16]

It seems that Green porphyry was quarried from pits dug into the ground until the stone, of various shapes and sizes, emerged. Such pits remained open throughout several periods, with the

12 Lazzarini 2012, 89.
13 Lazzarini 2012, 89.
14 Lazzarini 2012, 90.
15 Deppmeyer – D'Onza 2018, 74.
16 Shiletto 1886, 215.



7 Mapped sites of mosaics depicting marbles (map: T. Pavlin)

most intensive extraction taking place in the first centuries of the Roman Empire, according to the ceramics found on the surface in the surrounding area. Lapis Lacedaemonius was first used in the Middle Minoan period (1700 BC) to make ritual vases and seals. The use of the stone continued into the Mycenaean period, but seems to have ceased in the Classical Age (500–336 BC). In the Roman Age, the use of stone began in the late Republican period in the middle of the 1st century BC until the end of antiquity. As it could not be quarried in large blocks, it was mainly used for *opera sectilia* and *crustae marmoreae*[17].

FROM NORTH AFRICA TO NEVIODUNUM

As Demetrios Michaelides[18] notes, floor coverings made of slabs of precious imported coloured marble – *opus sectile* – became increasingly popular from the beginning of the 3rd century onwards. Due to the cost of extraction and transport, they were considered a luxury commodity. The imitation of marble flooring in the mosaic technique demonstrates the value and appreciation of *opus sectile* flooring. Neviodunum is thus placed on the map of sites with imitation marble pavement mosaics, which are otherwise typical of the Mediterranean and which are prominent in North Africa. At the same time, it is a topical representation of the trend for depicting combinations of different types of ›marble‹ (*opus sectile*), which emerged at the end of the 2nd and beginning of the 3rd century. Michaelides[19], in his inventory of mosaic pavements depicting marbles, managed to list 42 examples, of which 32 come from North Africa, nine from Italy and only one from the Western Provinces. The latter is a lost mosaic discovered in Sainte-Colombe, France, which is preserved only in a drawing and was published by Jean-Pierre Darmon[20]. Later, Miguel

17 Lazzarini 2012, 91.
18 Michaelides 1985, 162.
19 Michaelides 1985.
20 Darmon 2011, 411.

Pessoa[21] added the mosaic from Conímbriga to the list. The mosaic from Neviodunum (Drnovo) has so far not been included in the known inventories of researchers and has been added to the map. On the map (fig. 7) we see how strongly the trend of depicting marbles in mosaic is linked to North Africa and its area of influence – Sicily and Sardinia. Rome and Ravenna stand out from the pattern, and even more markedly, Sainte-Colombe (France) and Neviodunum (Drnovo, Slovenia).

FROM WALL PAINTING TO MOSAIC

To explain the motivation behind the colourful marbles depicted in mosaics, we need to look back and take into account the broader context of the representation of rocks in ancient architecture. The first and most represented artistic expression of stonework in the context of mimicry was undoubtedly wall painting[22]. The first known examples of the imitation of ornamental stone incorporated into wall paintings are associated with the First Pompeian style, characterised by the imitation of *opus sectile* according to Vitruvius. Vitruvius writes that some things are painted in accordance with nature, which is why the colour and use of marble slabs were imitated in wall paintings: »A picture is, in fact, a representation of a thing which really exists or which can exist: for example, a man, a house, a ship, or anything else from whose definite and actual structure copies resembling it can be taken. Consequently the ancients who introduced polished finishings began by representing different kinds of marble slabs in different positions, and then cornices and blocks of yellow ochre arranged in various ways.«[23]

Perhaps the most famous example of a wall painted in the First Pompeian style is from the Samnite House in Herculaneum (now Ercolano), dating from the end of the 2nd century BC[24]. The First Pompeian style, also called the Structural or Incrustation style, was the most popular from 200 BC until 80 or 60 BC. It is characterised by the imitation of marble (marble veneering) with other simulated elements and the use of vibrant colours, both of which are a sign of wealth. This style was a replica of that found in the Ptolemaic palaces of the Near East, where real stones and marble were incorporated into the walls. Even when the First Pompeian style was no longer fashionable, in the 1st century AD, wall paintings were still used to depict rocks; an example is the lararium in the House of the Golden Cupids from Pompeii[25].

Trier, Germany, boasts a wide variety of wall paintings dating from the 1st to the 4th century AD, depicting many rock formations. Korana Deppmeyer and Maria Carmen D'Onza[26] have identified an impressive spectrum of 20 different rock types that can be found in buildings with different functions, among which public buildings predominate. The authors note that the types of rocks depicted cannot be a guide to dating, because the same rocks have been imitated over the centuries and on a supraregional scale[27].

By the first quarter of the 2nd century, marble was also being depicted in a new medium: mosaic paving. Unlike the research on the wall paintings in Trier[28], Michaelides[29], using the example of his inventory of mosaics, concludes that it is possible to identify certain regularities in relation to the motifs in the mosaics and their dating on the basis of the depictions in the mosaic pavement. He notes that by the end of the 2nd century, Giallo antico appears as the exclusive rock in mosaic representations, with only a few exceptions. It is only from the late 2nd or early 3rd century on-

21 Pessoa 2016.
22 Pessoa 2016, 64.
23 Morgan 1960, 210.
24 For the Samnite house of Herculaneum see <https://herculaneumtourguide.com/2013/08/12/the-samnite-house-of-herculaneum/> (29.03.2023).
25 Dennis 2021, 54.
26 Deppmeyer – D'Onza 2018.
27 Deppmeyer – D'Onza 2018, 71.
28 Deppmeyer – D'Onza 2018.
29 Michaelides 1985, 162.

wards, when we know of examples of entire floor surfaces covered with mosaics depicting slabs of different rocks, that we can speak of an imitation of the *opus sectile* pavements. In the 4th century, this fashion reached its peak; the number of rocks depicted increased, and at the same time, we see that the popularity of depicting the *opus sectile* in mosaic technique increased in parallel with the popularity and use of the real *opus sectile*[30].

Perhaps this is also the answer to the question of the dating of the Drnovo mosaic, which has rather unreliable research data. Despite the possible early dating to the 3rd century, at the very beginning of the trend for depicting the *opus sectile* in the mosaic technique, on the basis of the exceptional examples from Benghazi (Libya), Utica (Tunisia), Agrigento and Rome (Italy), a possible comparison with examples from the 4th century must also be considered. The mosaics from Timgad and Djemila (Algeria) and Thuburbo Maius (Tunisia) in the manner of the *opus sectile*, also depict combinations of different types of rock in the manner of slabs, similarly to those at Neviodunum[31]. Following the trend of depicting a variety of rocks that flourished in the 4th century would also coincide with the last flourishing of Neviodunum in the 4th century, which was otherwise already marked by a crisis.

MIMICKING MARBLE: SAVING MONEY OR ENTERING THE VISUAL GAME?

If we have so far focused on identifying the rocks depicted in mosaics and placing the trend in a cultural-historical context, the question also arises as to the reasons for the depiction of rocks in the mosaic technique. The fact is that at the time of the advent of *opus sectile* mosaics, the original *opus sectile* marble slab floors were highly prized and valuable, with examples from imperial palaces and opulent upper class dwellings alike. Red and Green porphyry led the way in popularity and price, followed by Giallo antico[32]. The extraction and use of these rocks was largely linked to the exclusive quarries, which were located in various parts of the empire. The extraction and transport of marble slabs were extremely difficult, expensive and reserved for the wealthiest classes of the population. By depicting this type of pavement in another technique, another medium, whether in wall painting or later in mosaic, the clients were undoubtedly communicating their high appreciation and recognition of marble pavements of *opus sectile*.

Taking these facts into account, it is understandable that the prevailing interpretation among researchers is that the mosaic technique is an imitation, a fake or a reproduction of a (too) expensive and highly valued *opus sectile* pavement. A number of scholars have latched onto this thesis[33], although Michaelides allows that the practice may also have been indicative of a more widely recognised aesthetic[34]. As Rebecca Molholt[35] has shown, however, this economy-based explanation does not account for the simultaneous appearance of both the original *opus sectile* and its imitation in mosaic technique in several luxury buildings and villas in Roman-period Algeria, Tunisia and Libya[36].

Nathan S. Dennis[37] offers the explanation that the mosaic pavements that imitated the *opus sectile* were conceived as »trompe-l'œil« motifs that established a visual dialogue between reality and imagination, encouraging the viewer to question the limits of sense perception and inviting them to embrace the spiritual gaze as a truer form of experiencing the divine. The imitation of

30 Michaelides 1985.
31 Michaelides 1985, pls. 2–5.
32 Lazzarini 2012, 89; Deppmeyer – D'Onza 2018, 70.
33 Michaelides 1985, 162; Pessoa 2016, 64.
34 Michaelides 1985, 162.
35 Molholt 2008, 35–53.
36 See also Dennis 2021, 55–60.
37 Dennis 2021, 56.

marbles in the mosaic technique was thus meant to fundamentally alter the materiality and experience of the imitation stone, effectively blurring the line between imitation and original[38].

Tesserae that fragment the image place the viewer in the active role of the interpreter, the creator of the whole. In its mimetic quality, the mosaic could not, of course, deceive the viewer into believing that it was an original *opus sectile*. Through the awareness of the mimesis, the viewer willingly entered into a visual game that was most probably appreciated in the cultural milieu of the time, if we are to judge from the *asarotos oikos* (»unswept floor«) mosaics, made in a related mimetic tradition, as well as from Pliny the Elder's accounts of the famous painting competition between Parrhasius and Zeuxis, who competed to see who could better deceive the viewer's eye with a realistic depiction[39].

If the claim, for which Dennis[40] does not cite a source, that tesserae are often made from the very same rock they are intended to represent in the motif they create, is true, it might also be worth considering the purely practical explanation that stone deposits were likely to produce large quantities of waste, which, in the case of a valuable raw material, could be used for mosaics, where fragmentation was not a problem. Petrographic analyses have not yet been carried out on the Neviodunum mosaic to provide this information but are planned for the near future. In addition to the precise identification of rock types, I would like to mention the concern of some researchers[41] that it may not be useful to identify rock types in mosaics in great detail, since the ancient mosaicists depicted at least some of the rocks in a more generic way.

In summary, the Neviodunum mosaic joins the trend of depicting *opus sectile* pavements with a variety of coloured rocks which began in the 2nd century in North Africa (the first example from Cyrene) and continued until the end of the 5th century, or, with exceptions such as Ravenna, until the 6th century. On the basis of the comparisons from Timgad, Djemila and Thuburbo Maius from the 4th century, where various rocks are depicted as *opus sectile*, it is worth considering the dating of the Neviodunum mosaic to this time. If it is dated to the 3rd century, the Neviodunum mosaic would be one of the first mosaic pavements with such a variety of depictions of colourful marbles. Given the examples of combinations of *opus sectile* and the mosaic pavements they depict, one may doubt that the imitation of coloured marbles was purely an economic solution. This interesting trend, which developed in North Africa and reached even remote provinces such as Pannonia, certainly had an aesthetic of its own and went beyond mere cheap imitation in terms of meaning.

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TINOS LOST IN TIME ANCIENT SERPENTINITE QUARRY (RAS, CYCLADES, GREECE)

MULTIDISCIPLINARY PRELIMINARY RESULTS

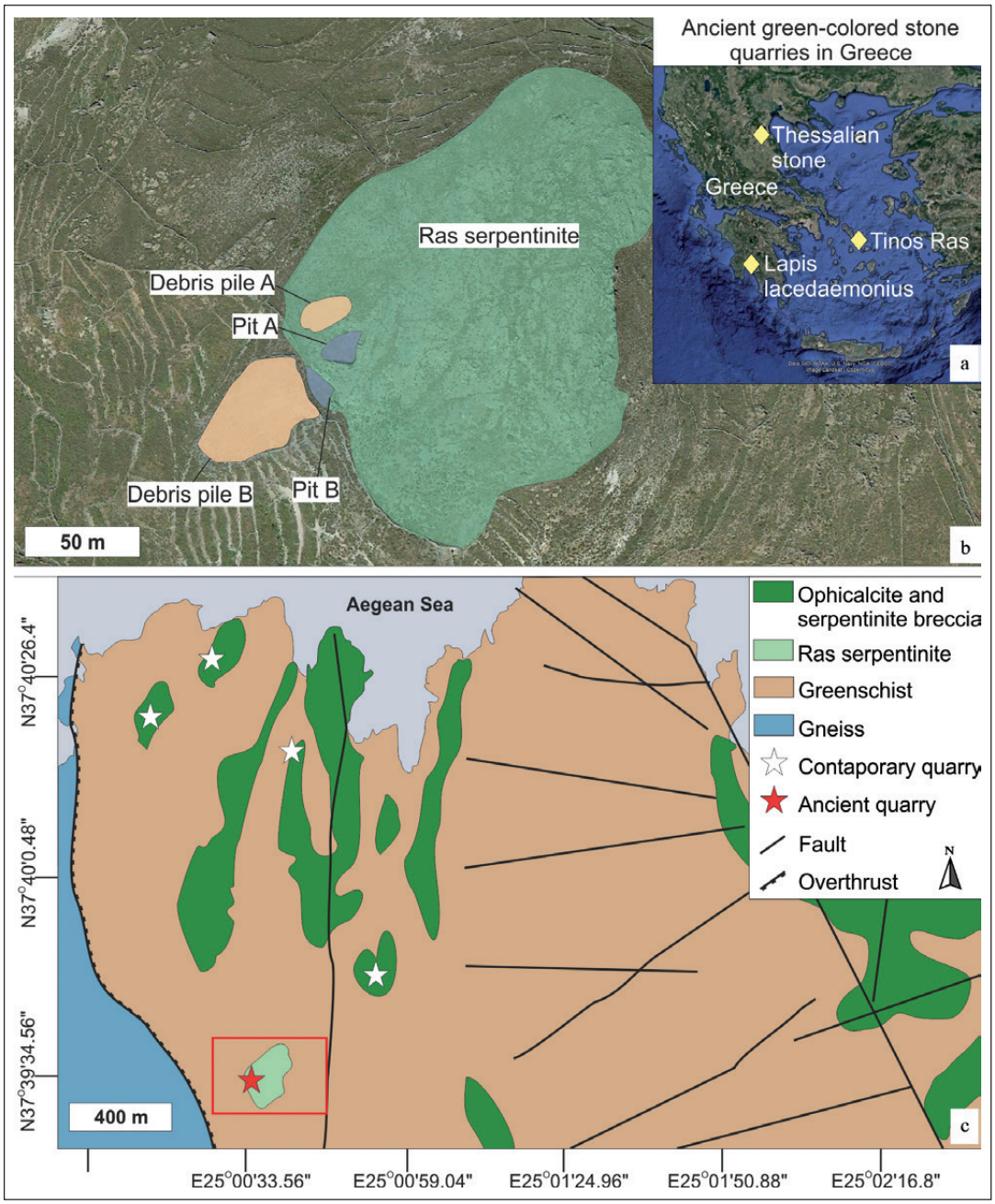
Abstract
In recent years, research has increasingly focused on individual marble production centres of antiquity. However, the commercial term »marble« oftentimes includes rocks with different origins than those described by the geological term i.e. metamorphic carbonate rocks. Recent mining activity in Tinos has focused on ophicalcites, yet the abandoned ancient quarry of Agios Georgios Ras (Ras) comprises a unique serpentinite type devoid of carbonate minerals. The site consists of two small-scale open pits facing north and south, respectively. Characteristic tool-marks and grooves for separating the stone from the parental one, as well as holes for inserting wedges, were noticed. The Ras serpentinite is composed of two serpentine varieties; the darkest is a massive dark-green-coloured serpentinite that is cross-cut by a light-green serpentine network. Small concentrations (< 1 %) of other minerals include talc, chlorite and iron oxides. Research on serpentinite provenance is rather limited and there is a substantial lack of information and data. Therefore, this study is an effort to enrich the present database using a variety of techniques, including XRD, LA-ICP-MS and physicomechanical tests to determine the chemical make-up and strength characteristics of the Ras serpentinite ancient quarry pit. The new geochemical data are interpreted accordingly to depict the environment in which these rocks were formed, such as the unique chemical imprint that will distinguish them from similar occurrences.

INTRODUCTION

In recent years, research has focused on individual marble/stone production centres of antiquity. The ›order‹ and trade process are complex affairs involving the relationship with the quarry, the customer, the location, etc. Different types of marble objects were used by different markets. Needs and types are based on the style and shape required by the customer or society. The large marble production centres were preferred for raw materials, transporting the material to the sculpture workshops; while the process advanced according to the traditional, local decorative designs and motifs of each period.

The importance of coloured stone as a building material and commercial good is undeniable in the field of cultural-historical heritage research, and many studies have been devoted to this topic. Systematic efforts in recent years have led to the discovery of a large number of quarries, which broadens the research to new hypotheses about the use and circulation of decorative stone in each period[1]. In Greece, there are two known occurrences of green-coloured quarries exploited in antiquity (fig. 1 a): the green Thessalian stone (classified as ophicalcite)[2] and the Lapis Lacedaemonius (classified as altered andesite)[3]. In this paper we highlight the existence of a third

1 Lazzarini 2007.
2 Melfos 2008.
3 Koutsovitis et al. 2017.



1 a: Green-coloured stones from the ancient quarries in Greece consisted of the ophicalcite Thessalian stone, the altered andesite Lapis Lacedaemonius and the serpentinite of Ras. b: The studied area of the Ras serpentinite, along with the two open pits (Pit A and Pit B) and the two debris piles (Debris pile A and Debris pile B). c: Simplified geological map of the study area, displaying the modern quarrying activities centred around the ophicalcite and serpentine breccia formations of the northwest of Tinos Island (modified after the Tinos-Yaros sheet [Hellenic Survey of Geology and Mineral Exploration (HSGME) 2003]) (graphics: A. Sideridis)

quarry for green stone, the Ras serpentinite, that along with the two aforementioned cases, is not classified as marble, sensu stricto. Serpentinite (consisting of > 90 vol % of minerals belonging to the serpentine group) is a rock formed due to hydrous metasomatism, namely serpentinisation, of ultramafic lithologies, usually representing parts of the Earth's mantle section[4]. Serpentinite is

[4] Evans – Hattori – Baronnet 2013.

typically massive and green-coloured, having a slippery feel to the touch. According to the geotectonic environment of its formation, it is distinguished into abyssal, mantle wedge and subduction-related serpentinites, each one presenting distinctive geochemical features[5]. It is important to mention that serpentinite is an abundant rock in the Hellenic region, and it was used at a) the Neolithic Avgi settlement for tool production, albeit these rocks were collected rather than quarried[6] and b) Knossos as part of the palatial architecture in limited amounts[7].

Regarding the Tinos Island ›marble‹ study, this focused exclusively on the ancient white marble quarries, providing their physicochemical characteristics[8]. Moreover, no reports in recent literature have referred to the studied Ras serpentinite quarry[9]. To our knowledge, attempts at serpentinite provenance-related studies globally are limited[10], and most importantly, this research is focused on material characterisation, offering no context regarding the geotectonic settings of formation.

White marble production in the Hellenic region, both in antiquity and the present, is more voluminous than green-stone quarrying. The latter may be on a smaller scale, yet use of green stones was sought after, as shown by applications in the Hagia Sophia, in the Basilika Santa Prassede, on St. Peter's Square, etc.

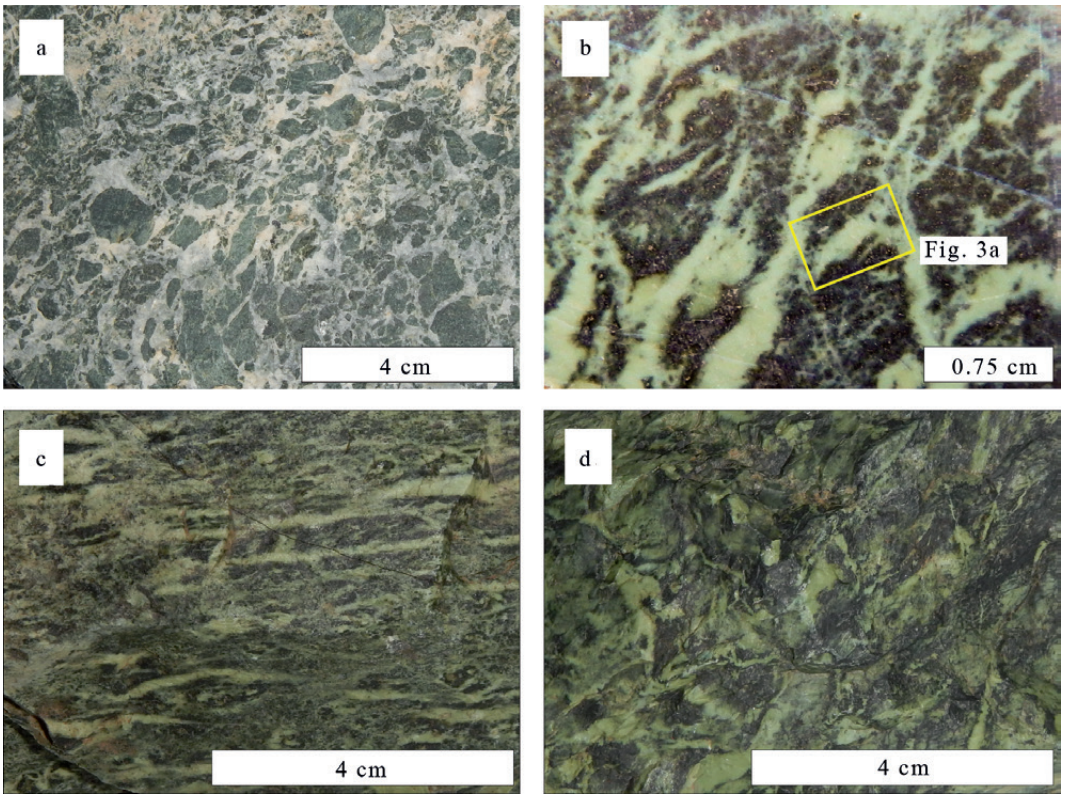
Based on the above, the present research is an interdisciplinary approach aiming: a) to specify the geochemical and geotectonic fingerprint of the Ras serpentinite and define its specific petrographic and mineralogical characteristics; b) to correlate the physical properties of the material with potential uses; c) to characterise the tool-marks and extraction methods, offering insights into the current commercial-historical and archaeological models concerning the trade and exploitation of the coloured stones of antiquity; and d) to shed light into the extent of the know-how of the craftsmen of that time. The interdisciplinary methodology applied to work with the ancient Ras serpentinite quarry may serve as a pilot study for future projects aimed at the provenance of archaeological serpentinite artefacts. Development of the database and implementation of petrographic and geochemical descriptions are of great importance in order to achieve a complete characterisation and classification of the material being studied.

MATERIALS AND METHODOLOGY OF THE INTERDISCIPLINARY APPROACH

The studied geological samples were collected adjacent to the debris piles next to the ancient quarries for the purpose of preliminary study. Samples displaying different textural features were collected to a) evaluate the impact on the texture of physical properties and b) acquire a complete textural image catalogue[11]. Macroscopic photographs of the collected samples were analysed via the Image.J software; representative areas of each sample were selected, and images were transformed into black-and-white scale with adjusted optical parameters so that the distinction between the two serpentine phases is detectable. Then using the threshold option, the two serpentine phases were distinguished and quantified.

The trace and rare earth elements geochemistry of the serpentine group minerals were determined on a polished thin section by a laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) at the NAWI Graz Central Lab for Water, Minerals and Rocks (at the University

5 Deschamps et al. 2011; Deschamps et al. 2013; Sideridis et al. 2022.
6 Bekiaris – Stergiou – Theodoridou 2018; Stergiou et al. 2022.
7 Grammatikakis et al. 2017.
8 Lazzarini – Antonelli 2003.
9 Lazzarini 2007.
10 Navarro et al. 2013; Grammatikakis et al. 2017; Frýbová et al. 2018; Punturo et al. 2018; Keulen – Poulsen – Frei 2022; Stergiou et al. 2022.
11 Following the relevant decision (ΥΠΠΟΑ/ΓΔΑΠΚ/ΔΙΠΚΑ/ΤΕΕΑΕΙΣΘΔΣΟ/232868/24-6-2021) with which the undersigned, together with the Curator of Antiquities of Tinos, Dr. Anastasia Angelopoulou, were permitted to study and publish the ancient quarries of the Late Hellenistic and Roman times in the site of Ras, Tinos Island.



2 Texture macrophotographs of the Tinos lithologies. a: Ophicalcite currently quarried in Tinos; Ras Serpentinite. b: Displaying a non-preferred orientation of light-green serpentine net, the yellow selection represents the photomicrograph of fig. 3 a. c: Demonstrating an oriented subparallel light-green serpentine net with mylonitic texture. d: With augmented and densified light-green serpentine (photos: A. Sideridis; permission granted by the Ephorate of Antiquities of Cyclades)

of Graz and the Graz University of Technology, Austria), with an ESI New Wave 193 excimer laser (193 nm wavelength) coupled to a quadrupole Agilent 7500 CX mass spectrometer. A beam size of 50 µm, with a fluence of ~5 J/cm², helium flow of 0.8 L/min, 25 s gas blank followed by 50 s of ablation and a dwell time of 20 s for each mass were used for the element analyses. The reference material NIST SRM 612 was used for standardisation, and Silicon (Si) as the internal calibration element for serpentine. The USGS reference glass BCR-2G was analysed as a monitoring standard, which could be reproduced within errors. For data reduction, the software GLITTER was used along with the values for NIST SRM 612[12].

Two grams of the whole rock were pulverised along with a selection of pulverised dark-green matrix to be analysed via X-ray diffraction (XRD). XRD patterns were obtained for the samples in a 2θ range of 2° to 60° and at a scanning rate of 2°/min, using an XRD Bruker D8 Advance diffractometer, with nickel-filtered Copper K-alpha (Cu-Kα) radiation (λ = 1.5418 Å)[13]. The average crystal size of serpentine group minerals was deduced via the Scherrer equation:

$$B(2\theta)=K*\frac{\lambda}{L}*\cos\theta$$

where B(2θ) is the peak width; L the crystallite size; the constant K is generally taken as being about 1.0 for spherical nanoparticles; θ is the diffraction angle; and λ is the X-ray wavelength.

12 Jochum et al. 2012.

13 Minerals and Rocks Research Laboratory, Department of Geology, University of Patras.

The mechanical properties of the serpentinite rocks were determined by a point load test (PLT). The PLT is an effective and rapid way to predict the uniaxial compressive strength (UCS) of a rock sample, which is widely recognised as the most important component in any engineering geology project[14]. UCS is a time-consuming and expensive laboratory test, hence many researchers employ indirect methodologies to calculate this parameter[15]. Among the indirect tests, PLT is the most applied test, utilising the Point Load Strength Index $Is_{(50)}$ as an indirect measure of the compressive strength of rock[16]. For this specific study, the PLT laboratory tests were conducted in the Laboratory of Engineering Geology, Department of Geology, University of Patras using the PLT apparatus.

REGIONAL GEOLOGY AND SITE DESCRIPTION

The serpentinite occurrence of Ras is just over 7 acres in size. Two major centres of quarrying activity have been identified: a) the northern open pit (Pit A) covers an area of 228 m² and b) the southern open pit (Pit B), which is rather limited (121 m²) (fig. 1 b). Along with the open pits, there are two distinct debris piles (d. p.); the northern one (D. p. A) covers an area of 456 m², whereas the southern one (D. p. B) is more extensive, reaching 808 m² (fig. 1 b).

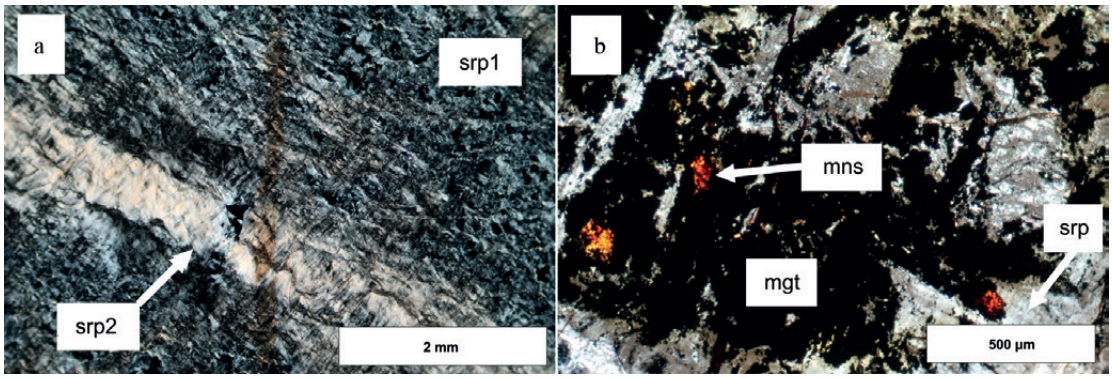
The Ras serpentinite overlies a greenschist formation (fig. 1 c) and it is macroscopically distinctive from the other serpentinite-related occurrences of northwestern Tinos. The currently quarried occurrences comprise a highly brecciated serpentinite in which open spaces are commonly filled with carbonates, and this feature classifies the rock formations as typical ophicalcite (fig. 2 a). The Ras serpentinite, however, lacks deposition of carbonates and instead fractures caused by brecciation are healed as light-green serpentine. This has led to the development of a light-green network. The studied occurrence is characterised by its schistosity, and in places, brittle shear zones occur. The schistosity develops in a northeast-southwest plane dipping to the northwest and the same applies to the shear zones.

PETROGRAPHIC STUDY OF THE RAS SERPENTINITE

The rock texture is unique, with a light-green-coloured serpentine net cross-cutting the massive dark-green-coloured serpentinite. The light-green-coloured net displays different textures depending on deformation. The major textures of the light-green net system identified are a) non-preferably oriented (40.8–45.7 vol %; fig. 2 b), b) an oriented subparallel system and development of mylonitic and pseudo-augen texture (39.4 vol %; fig. 2 c), and c) an augmented and densified net (51.3 vol %; fig. 2 d). It is important to state that there is actually a transition between the aforementioned textures. Macroscopically, no specific description can be given for the dark-green serpentine mass apart from the fact that it is homogeneous.

Under the microscope, the dark-green serpentine is described by its mesh texture, whereas the light-green type is asbestiform (fig. 3 a). Within this mass, skeletal altered magnetite crystals are replaced by chlorite, and the distinctive mineral phase minnesotaite was identifiable as orange-coloured grains in contact with magnetite (fig. 3 b). The light-green net is deprived of any opaque phase. The mode of occurrence of the light-green serpentine, i.e. cross-cutting the main dark-green mass, confirms the fact that it was formed during a later stage of serpentinisation.

[14] Diamantis et al. 2009; Wang et al. 2022.
[15] Kahraman 2014.
[16] Bieniawski 1975.



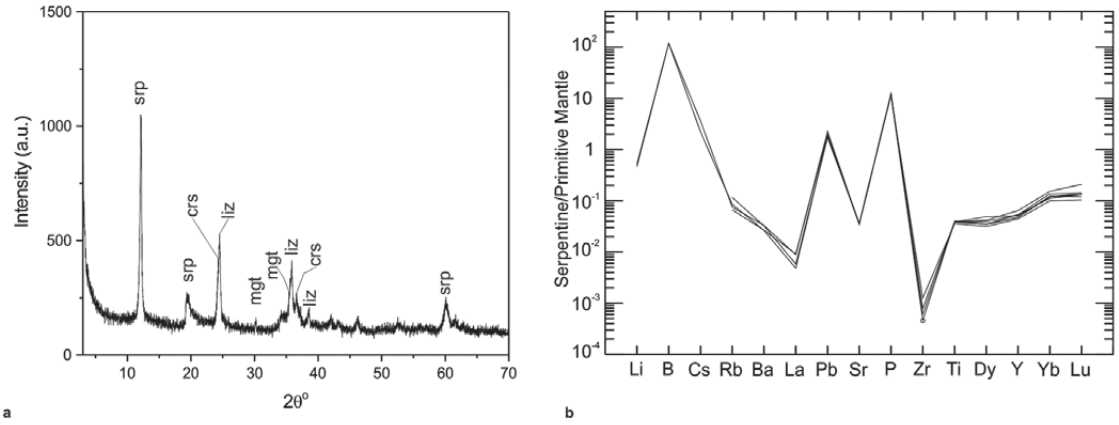
3 Representative photomicrographs of the Ras serpentinite. a: The two serpentine varieties srp1 with mesh and srp2 with an asbestiform texture. b: Magnetite within the serpentine mass and development of orange grains of minnesotaite. Abbreviations: srp = serpentine; mgt = magnetite; mns = minnesotaite (photos: A. Sideridis; permission granted by the Ephorate of Antiquities of Cyclades)

Sample	Point load strength index ($Is_{(50)}$) (MPa)	Strength classification Bieniawski 1974	Indirect determination of uniaxial compressive strength (MPa)	Rock type	Vol % of the serpentine matrix	Net texture	Reference
R1	3.04	Medium strength	66.88	Serpentinite	60.6	Subparallel oriented, development of pseudo-augen texture	This study
R2	2.43	Medium strength	53.46	Serpentinite	54.3	Non-preferably oriented	This study
R3	2.98	Medium strength	65.56	Serpentinite	48.7	Augmented and densified net	This study
R4	2.11	Medium strength	46.42	Serpentinite	59.2	Non-preferably oriented	This study
R5	6.03	High strength	132.66	Ophicalcite	45.9	Carbonated serpentinite breccia	This study
Tinos Green	–	–	100.00*	Ophicalcite	84.3	Carbonated serpentinite breccia	HSGME

Table 1 Laboratory strength test results and sample description of Ras serpentinite and the currently quarried ophicalcite. The uniaxial compressive strength reported for the Tinos Green sample represents direct measurement <https://gaia.igme.gr/portal/apps/opsdashboard/index.html#/de18c9f57cf54843831a0c594bf3ae7c> (15.01.2023) (A. Sideridis)

MINERALOGICAL AND X-RAY ANALYSIS OF THE RAS SERPENTINITE

The X-ray analysis revealed the participation of the following mineral phases: serpentine (var. lizardite and chrysotile) and magnetite (fig. 4 a). The XRD diffractogram of dark-green serpentine (srp1) from Ras serpentinite indicates its trioctahedral structure (e.g., 2θ ~12°, 24.5° and 36° that corresponds to [001], [111], [002] crystalline planes) and belongs to the space group P31 m. It is classified as the lizardite species in the serpentinite subgroup. Lizardite is characterised by strong and sharp diffraction peaks, indicating advanced crystallinity and homogeneity. The average crystal size of its crystallites in respect of their length and width, estimated in terms of the Scherrer equation, is ~72 ± 1 and ~38 ± 1 nm, respectively. Since the dark-green serpentine is classified as lizardite, the chrysotile detected in the X-ray pattern corresponds to the bright-green serpentine variety (srp2). Chrysotile is a serpentine polymorph formed in



4 a: Whole-rock XRD pattern of the Ras serpentinite. b: LA-ICP-MS analyses of serpentine hosted in Ras serpentinite normalised to the primitive mantle (see Sun – McDonough 1989). Abbreviations: srp = serpentine group minerals; liz = lizardite; crs = chrysotile; mgt = magnetite (graphics: A. Sideridis)

conditions of lower pressure and temperature compared to lizardite and mostly represents retrograde metamorphism[17].

PHYSICAL PROPERTIES OF THE RAS SERPENTINITE

According to table 1, the Point Load Strength Index ($Is_{(50)}$) values for samples R1–R4 (Ras serpentinite) range from 2.11 to 3.04 MPa and are characterised as medium strength, while sample R5 (Tinos ophicalcite – Oasis verde) has a calculated value ($Is_{(50)}$) equal to 6.03 MPa and is characterised as high strength[18]. Accordingly, the values of indirect determination of uniaxial compressive strength for samples R1–R4 varied from 46.42 to 66.88 MPa, while sample R5 has a value equal to 132.66 Mpa, similar to those reported by the Hellenic Survey of Geology & Mineral Exploration (HSGME)[19] at 100 MPa (Tinos Green). The ophicalcite is commonly used as a façade, tiles, decorative objects and architectural construction (columns, etc.). Contemporary applications of serpentinite are mostly as a building material for construction and conservation-restoration of the architectonic heritage[20], but the low strength (< 67 MPa indirect UCS) of the Ras serpentinite sets a limit to its potential applications as an architectural element. Moreover, the physicomechanical properties and behaviour of serpentinites is negatively influenced by the degree of their serpentinisation and by the mineralogical and textural characteristics[21].

IN SITU GEOCHEMICAL STUDY ON SERPENTINE GROUP MINERALS

The geochemical study was based on the LA-ICP-MS analysis conducted on mineral phases on a thin section. Whole-rock analyses were not conducted since this is a destructive method requiring the pulverisation of a rock sample or a possible future artefact. LA-ICP-MS however, involves minimum destruction of an area of ~70 μm. The trace and rare earth (REE) elements were identified via the LA-ICP-MS technique. The primitive mantle (PM)-normalised REE

17 Koutsovitis 2017; Colás et al. 2019.
18 Bieniawski 1975.
19 <https://gaia.igme.gr/portal/apps/opsdashboard/index.html#/de18c9f57cf54843831a0c594bf3ae7c> (15.01.2023).
20 Navaro et al. 2018; Nespereira et al. 2019.
21 Diamantis – Gartzos – Migiros 2014; Masoud et al. 2020.



5 a: Measurements of the Pit A façade, where tool-marks have been preserved (graphics: V. Anevlavi; permission granted by the Ephorate of Antiquities of Cyclades). b: Sketch of Pit A and Pit B indicating the place where figs. 5–6 were taken (graphics: A. Sideridis)

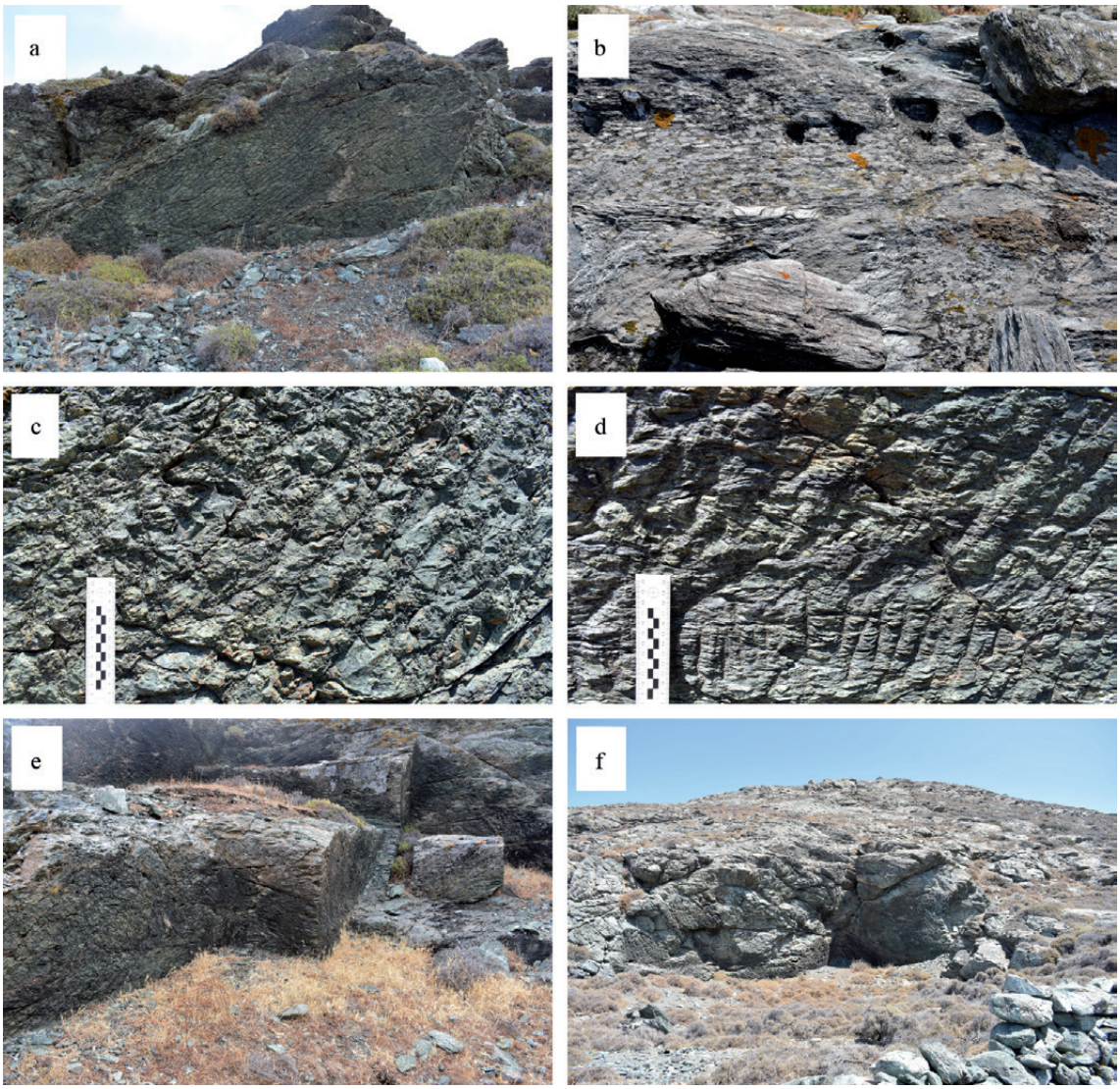
patterns reveal a depletion in light REE (LREE) and middle REE (MREE) and increasing concentrations of terbium (Tb)-lutetium (Lu), but lower than the primitive mantle values. In the PM-normalised multi-elemental diagram (fig. 4 b), one can notice positive boron (B), lead (Pb) and phosphorus (P) anomalies exceeding PM values. Negative anomalies are recorded for strontium (Sr) and zirconium (Zr). These traits coincide with a forearc peridotite protolith (lower than PM level REE abundances) that was serpentinised in a subduction zone (anomalies noted in trace elements)[22].

ARCHAEOLOGICAL ASPECTS AND EXTRACTION METHODS

At this stage, quarrying and stonemasonry activities were becoming central to the community's identity. The main Greek quarries were fully active until the end of the 6th century BC[23]. During the Hellenistic period, no quarries or new technologies evolved and the activities remained on a small scale and local. However, the exceptions that are presented in the geographical map of the period are Pentelikon near Athens and the quarries of Paros. During the Roman period, quarrying continued in large quarries as many more were opened due to the huge demand. These centres continued to be used in conjunction with smaller local quarries for large distribution throughout the Roman Empire[24]. The methods of stone extraction and the tools change depending on the material and its properties, personal preferences, experience and training of the quarries, and the customers' priorities.

The basic organisation of a quarry is the extraction area, debris dump, sliding ramps to the storage platform, storage platform and hoisting machine position, tool repair workshops, a sacred area with a small sanctuary, workers' accommodation, guard tower, and loading area[25]. These characteristics can be changed according to the infrastructure, the locality, and the nature of the quarry, as well as whether the quarry was temporary or permanent[26]. In the case of the Ras quarry, only two pits can be observed and no modern activity can be seen. In the southwestern part of the

22 Deschamps et al. 2011; Deschamps et al. 2013; Koutsovitis 2017; Sideridis et al. 2022.
23 Waelkens – Paepe De – Moens 1988.
24 Clayton – Fant 2008.
25 Kozelj 1988.
26 Kozelj 1988.



6 Representative photographs of the Ras quarry. a: The north wall of Pit A. b: Cylindrical wedges in the upper part of Pit A. c–d: Detailed photo of the pick-marks from Pit A. Note the change in direction of the tool-marks in 6 d (almost vertical) in response to the natural discontinuities in the rock. e: The upper level of Pit A. An unfished square block can be seen *in situ* separated from the parent rock with a trench. 6 f: Pit B, where no tool-marks have been preserved (photos: V. Anevlavi; permission granted by the Ephorate of Antiquities of Cyclades)

pits, stone fences can be noticed. However, these features can be dated back many centuries and dating them is not possible.

Pit A is the larger and it is the one with the surviving tool-marks, which will be mentioned below. Pit B is smaller and no traces of tool-marks can be observed. The difference between these two pits is obvious, due to the disorderly exploitation of the rock. These indications could lead to the hypothesis that the two pits might have been open at different periods. A second hypothesis could be linked with possible different purposes for which the material was to be used, such as different extraction methods for architectural elements or the cutting of tesserae and pieces for mosaics or *opus sectile*. The current absence of archaeological finds means there is nothing to assist us with further hypotheses or results. Two-metre-wide exploratory trenches were also identified at the top of Ras Hill.

At Pit A, two levels can be observed in this part of the quarry: the main level with waste pieces all over the surface, and a smaller part on the northeastern side of the pit with small

extraction imprints. The northeast wall is approx. 12.5 m long and 5.3 m in height (fig. 5 a). While the southern side is approximately the same length, 12.4 m and with a maximum height of 5.6 m, the upper surface of this site is very eroded. A sketch of Pit A and Pit B is included to aid in understanding the position of the pits in the Ras Hill (fig. 5 b). Quarrying was undertaken with the quarry pick and possibly with a point chisel and wedges, as the tool-marks in the north wall of Pit A indicate (fig. 6 a)[27]. At the upper level of Pit A, cylindrical wedges can be seen, placed in a straight line (fig. 6 b). The holes have a length of 3–4 cm and they are approx. 5–6 cm apart from each other.

Extracting the marble block from its parent rock, craftsmen must know and consider the length of the natural cracks, and the right place to introduce the wedges and the levers[28]. The main characteristics of the marble extraction process are the ease or difficulty of splitting the marble in a given direction; knowing how to exploit this quality; the faults hidden within the stone; and the resilience, purity, and responsiveness to precision workmanship[29]. The north façade of Pit A is one of the best-preserved areas with tool-marks in the whole quarry. Based on the field geology, there is a correlation between the tool-mark orientation and the geological discontinuities. There are three main orientational tool lines; the two major ones cut the façade diagonally at 55° with a northeast-southwest trend (most commonly practised; fig. 6 c) and 40° with a northwest-southeast trend, and the third was noticed along a shear zone with almost vertical marks (fig. 6 d). The approximate length of the wall is 10.5 m and the maximum height is 2 m. The line of holes can be observed at approx. 2.5 m from the surface. These marks in the east wall were possibly made for a scaffolding mechanism. These holes are approx. 15–20 cm long, and the distance between them ranges between 20 and 40 cm. A large hole can be seen at the left side in a lower level, which could indicate either another use or fault of the parent rock.

A point chisel and a hammer would be used for defining the soon-to-be extracted block, and large quantities of the unnecessary stone block were then removed. The block would start to acquire a shape[30]. As soon as the trench was cut, shallow holes, round or square, would then be carved out at the bottom of the block, which at this point was still attached to the parent rock. Wedges would be placed into these holes and hammered in, in that way assisting in the extraction of the block[31]. At the upper level of Pit A, an unfinished square block can be seen, while the parent rock and the channel between the block and the parent rock are still clearly visible (fig. 6 e). The dimensions of the block are approx. 45 × 45 × 50 cm, while the line of parent rock and the channel both measure 20 cm; larger and smaller imprints can be seen in the upper lever. However, the extent is not so large: the maximum depth towards the hill is 2 m. This small block could potentially be linked with the medium strength of the Ras serpentinite, which renders it unable to produce larger blocks for more extended architectural features.

The south wall is mostly covered with lichens. No clear tool-marks can be seen. Future research on lichenometric dating will help the study to establish a possible dating profile, since there are not, so far, any known objects related to this source of stone. The northeast façade of Pit A is of special interest, since it is a very well-preserved wall with various marks. The pick-marks run in various directions. The cracks of the parent rock direct the orientation of the picks and ultimately the imprinted marks. This technique shows excellent extraction abilities, since the characteristic of the stone is recognised by the workman, aiming for the removal of the compact block.

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27 Wootton – Russell – Rockwell 2013b.
28 Wootton – Russell – Rockwell 2013a.
29 Korres 2000.
30 Wootton – Russell – Rockwell 2013b.
31 Korres 2000.

Pit B has no ancient marks and the extraction façades are smaller than in Pit A (fig. 6 f). This difference could indicate that these two pits were opened in different periods, since Pit B does not show high-quality extraction skills. One theory could be related to the quality of the stone. It is possible that this side/vein of the stone has a lower, more fragile quality, which led the workmen to search for a better extraction spot.

After the extraction and the first phase of processing the volume (removing the unnecessary material to make the transfer easier), the unfinished object is ready for transport[32]. Two piles of debris can be seen in the southwestern part of the pits. The larger Debris pile B is mainly made of larger parts of waste, while Debris pile A comprises finer pieces of waste material. These observations could suggest two possibilities. Either the two piles are linked with the two different pits, or these piles are related to different stages of the quarrying work. For example, the larger pieces could relate to the primary shaping of the stone blocks and the small pile could indicate a finishing process of the shaping. Only one large block with tool-marks across each surface has survived. It is clear that this block has been left there, during a second extraction phase or during transportation. Nowadays, it has been integrated into the stone wall. Unfortunately, similarly to the quarry situation, this activity cannot be dated.

The transport would be completed by sea or land, depending on whether the material was used on the island or not. The great advantage of quarries that are closer to the sea is that shipping, both long- and short-distance, is cheaper than transport over land[33].

CONCLUSIONS

On Tinos Island, there are two serpentinite-bearing lithologies: the currently quarried ophicalcite (serpentinite clasts welded with carbonates) and the previously unknown Ras serpentinite. The Ras counterpart is distinguished by the development of a bright-green serpentine net (var. chrysotile), developing as a healing fracture within a dark-green serpentine mass (lizardite) during retrograde metamorphism. Among the trace minerals, minnesotaite is an important find, since its rarity could be used for provenance analyses. Serpentine is the major mineral phase in the Ras serpentinite. Lizardite has an average size of ~72 ± 1 and ~38 ± 1 nm, in terms of length and width, respectively. When compared to the ophicalcite, the Ras serpentinite is of lower strength, and this could potentially limit its uses in extended architectural artefacts. This fact, along with the geological discontinuities presented by the serpentine, seems to have had an immediate impact on the quarrying method, which was focused on the extraction of small blocks. Geochemically, the Ras serpentinite has been formed within a subduction zone after the serpentinisation of a forearc peridotite. Craftsmen of the era that this quarry was active had a good understanding of the geological aspects of the material, and they implemented different extraction methods, as seen by the change in the tool-mark orientation along with the clearly visible grooves of separation and the holes for the insertion of wedges.

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[32] Wootton – Russell – Rockwell 2013a.
[33] Wootton – Russell – Rockwell 2013a.

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Sabrina Violante – Paola Quaranta – Domenico Poggi

ZOOMORPHIC SCULPTURES IN ALABASTER FROM THE PALATINE HILL IN ROME

Abstract
Amongst the works in the Imperial Palace on the Palatine Hill, three sculptures were selected for their similar faunal iconography, for the materials used – alabaster and Antique black – and for the unusual inlay technique (*interraso marmore*) which makes these specimens unique for their kind. These are two sculptures, depicting a tiger and a turtle, and a circular support decorated with feline skins, perhaps panthers. Analysis of the marbles indicated that the alabaster used for the realisation of the sculptures, although presenting different macroscopic characteristics, points towards the quarries of Hierapolis, in particular to the Gölemezli extraction site. Based on observations conducted in situ under a stereo microscope, the inserts in an Antique black appear to have a crystalline structure. Isotopic analyses, performed on a single sample taken from the tiger, seem to point to the Göktepe quarries, a hypothesis to be verified through further analysis.

The Palatine Hill, famous for being the location of the legendary founding of the city of Rome and for housing the most sacred Roman places of worship, soon became the residence par excellence of the imperial family. After the building of Octavian Augustus' house on the hill, the area underwent a sudden transformation, from a residential neighbourhood to an imperial residence, with the construction in the Julio-Claudian era of the Domus Tiberiana and the Domus Transitoria, then extended to the Domus Aurea, ending with the Domus Augustiana/Augustana in the Flavian era.

Of the rich sculptural apparatus that once decorated these luxurious residences, only a few artefacts remain today. Part of the material was lost, as it was presumably reused or employed as building material. Other significant evidence has become part of important collections of those who sponsored excavations in the area during the 17th–19th centuries[1]. Despite these difficulties, the Palatine Hill continues to offer relevant testimony, although often fragmentary, to its ancient splendour, starting from Pietro Rosa's[2] excavations up to the present day.

Of the various lines of research conducted, one is certainly worthy of being pursued, and that is identifying the quality of stone used to create what were the sculptures par excellence of the Roman world, finely crafted, relying on the first choice of materials and the best workmanship of the time. Setting trends and symbols related to the imperial propaganda, they were a source of inspiration and a point of reference for all the provinces of the empire.

Amongst the works from the Imperial Palace, some coloured marble sculptures depicting animals are of particular interest[3]. Three sculptures were selected for their similar faunal iconography and, above all, for the materials used – alabaster[4] and Antique black – as well as the unusual inlay technique (*interraso marmore*) which makes these specimens unique for their kind[5].

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1 For the history of the excavations, see Santoro – Sielhorst – Terzi 2022.

2 Tomei 1999.

3 Cf. Spinola 2002.

4 The sculptures presented are part of a large nucleus of fragments in alabaster, all coming from the Palatine, currently under study by the writer.

5 The definition (*verum et interraso marmore vermiculatisque ad effigies rerum et animalium crustis*) is found in Pliny's »Naturalis Historia« (Plin. nat. 35, 2), where the historian attributes this technique, known since antiquity, to Claudius' reign.



1 Palatine Hill. Tiger in alabaster with inlay recesses and a single Antique black insert preserved *in situ*; right side (photo: B. Angeli, Parco archeologico del Colosseo)

THE TIGER

One of the most interesting and valuable sculptures from the Palatine depicts a female tiger in motion, in dimensions slightly smaller than life-size (fig. 1)[6]. Much of the body was preserved; however, the head, limbs and tail are missing. The sculpture is made of a single block of alabaster and retains an original iron pin, inserted to support and anchor the former tail[7]. Along the body are recesses whose function was to hold the leg grafts, as well as circular recesses for inserts (fig. 2). Of particular interest is the presence of internal cavities below the belly related to the geological nature of the alabaster, perhaps discovered by the stoneworker only when the block was worked (fig. 3). The sculpture was unearthed in 2002 during the excavation of an ancient conduit and was found on the western side of the Domus Tiberiana, which faces the Velabro, leaning against a Domitian wall, where it probably ended up when the palace was abandoned.

Another fragment, similar in material and technique, has more recently been identified and is presented here for the first time. It is a fragment of a feline paw in Alabastro fiorito, the characteristics of which seem to trace back to the same specimen or a similar one (fig. 4)[8]. The feline paw, almost life-size, is characterised by deep grooves that mark the surface, namely a long central ridge and a series of smaller oblique grooves on its side. On the anterior sector, a small portion related to the claws remains, while the lower plane of the paw is worked using a tooth chisel. The fractured rear retains part of a circular recess, which is oblique in relation to the laying surface of the paw and suggests the insertion of a pin for anchoring the piece. The object

6 The dimensions of the sculpture, excluding the head, tail and legs, are 92 cm (L) × 36 cm (H) × 32 cm (D) (inv. 475143). The sculpture has been studied by Maria A. Tomei and Riccardo Fusco, see Tomei 2006; Fusco 2014.

7 Restoration conducted by the restorers Luigi Mamone and Debora Papetti of the then Archaeological Superintendence of Rome.

8 The dimensions of the fragment are 8 cm (H) × 7.5 cm (W) × 9 cm (D) (inv. 23.M324-1.1194), and it is similar in size, material and technique to the tiger sculpture inv. 475143. The fragment we identified was recognised as pertaining to a paw by Silvio Costa.



2 Palatine Hill. Tiger, back (photo: B. Angeli, Parco archeologico del Colosseo)



3 Palatine Hill. Tiger, left side (photo: S. Violante, P. Quaranta, Parco archeologico del Colosseo)

was found among the materials unearthed during the archaeological excavation of the central cryptoportico of the Domus Tiberiana, which is a complex system of corridors and underground environments serving the palace above, located near the area where the tiger was found. The feline seems to be striding slowly, as can be seen from the dorsal curvature, the movement of the hips and the preserved part of the right anterior limb. The animal is depicted in the slightest details: the udders, genitals and especially the mantle, characterised by bands of inlay, of which a single black marble piece is preserved in situ, and by a realistic rendering of the hair on the



4 Palatine Hill. Feline paw in alabaster attributed to a tiger (photo: S. Murrone, Parco archeologico del Colosseo)

buttocks, thighs and belly. The realistic portrait of the animal has led to the hypothesis that a very specific species was depicted, such as the Indian *Panthera tigris tigris*, closely connected to the Dionysian cult. There are a series of cavities that can be seen along the body whose function is unclear. However, the idea that some of them were sculpted for the purpose of holding the figure of Dionysus, often represented on the animal's back on his triumphal return from India, is not to be excluded[9].

THE TURTLE

In another recent archaeological excavation, a small sculpture of a life-size turtle made of Alabastro fiorito was unearthed (fig. 5)[10]. The animal's shell is almost entirely preserved and fractured near the head[11]. Listels define the hexagonal shapes on the dorsal area and the pentagonal shapes on the remaining surface. The lateral scutes are recognisable from shallow engraved grooves and are interrupted on each side by a prominent rectangular shape. The latter are divided by a vertical engraving, each one characterised by a small circular embedment in the centre intended to house a marble insert. Of the four holes, only two still retain the original piece of black marble[12]. At the rear of the shell is a cavity intended to house the tail, while on the opposite side, which was originally intended for the head, part of the two recesses formerly holding

9 Fusco 2014. There is extensive literature regarding the iconography of Dionysus riding the tiger that has recently been included in Bottos 2018.

10 The small sculpture was found in 2008 during archaeological excavations conducted by the former Archaeological Superintendence of Rome on Via Nova, the road that crossed the northwestern slope of the Palatine Hill via the House of the Vestal Virgins.

11 The dimensions of the sculpture are 13.3 cm (L) × 11.8 cm (W) × 6.5 cm (H) (inv. 567449).

12 The detachment of one of the inserts allowed us to see the entire shape, cylindrical in the front and with a truncated conical rear end. In addition, the surface has a series of miniscule circular incisions that were probably made on cutting the stone. After examination, no residues of functional substances were detected at the moment the insert was glued (see below).



5 Palatine Hill. Turtle's shell in alabaster with a small Antique black insert (photo: S. Violante, P. Quaranta, Parco archeologico del Colosseo)

the front legs remains, each recess containing a hole to facilitate embedding. These body parts were made separately, perhaps in a different stone or in bronze. The belly of the animal (in Italian »piastrone«) is divided into two parts by a central line that crosses the body longitudinally; the two halves are slightly convex. The part near the tail at the rear end is schematically engraved. The turtle is made of an alabaster whose quality enhances the natural colours of its shell, varying from intense yellow to white-greyish. Even the choice of carving the stone highlighting its texture in circular bands does not seem accidental, recalling the characteristic rings on the carapace, determined by the animal's growth.

It is well known that the animal is sacred to Mercury, who forged the lyre from its carapace, and attributed to Aphrodite as a symbol of fertility. The turtle was also regarded as a connection between Heaven and Earth. It is often used as a decorative element of gardens and fountains, as in the case of the white marble sculpture found in a Pompeian residence[13]. It is likely that with this function, the turtle was part of the sculptural decoration of the imperial palace, constituting a particularly valuable element, given the materials used for its realisation.

THE PANTHERS

To the two sculptures presented so far, made in the round (»a tutto tondo«) and with proportions similar to the real thing, we want to associate a different sculptural element (fig. 6).

It is made of a similar material and uses the same inlay technique to depict the various colours of the animal's coat. It is a small hollow circular support, composed of two fragments

13 See Serpe 2008, 151 (C 47).



6 Palatine Hill. Small circular support decorated with two feline skins, perhaps panthers (photo: B. Angeli, Parco archeologico del Colosseo)

and decorated with two feline skins, perhaps panthers[14]. Unlike the other items, the small size of the two feline heads and their shapes suggest that they were used as ornaments to embellish a piece of furniture. Both animals retain the upper part of the head, with the snout framed by a mane, small ears of a rounded shape, half-closed eyes with an oblique cut and a wide nose, only preserved at the root. Traces of the hanging legs can be noted on the sides. Partly preserved black marble inserts are embedded in the surface in holes of different sizes that might have also housed inserts made of other materials, given the presence of sporadic elements in shades of yellow and red. These inserts, as well as the reddish and brownish oriental alabaster chosen, were used to authentically portray the animal's fur. The exact shape and function of the object has yet to be determined. The larger fragment is flared upwards and ends with a thick lip, while the concave inner surface is roughly sculpted. The second fragment retains only a small portion of the inner surface, sculpted similarly to the previous one; a partially preserved circular recess, connected to a pin, crosses the fragment in height. These characteristics suggest that the artefact was designed to accommodate an overhead element inserted within it.

[14] The fragment, whose dimensions do not exceed 12 cm in height (inv. 52858), is identified in the catalogue as »[…] pelle leonina con due teste« (»lion skin with two heads«), which evidently does not consider the intentional colourful appearance of the coat. The pieces were probably found in the 2nd half of the 19th cent. in an unspecified location on the Palatine Hill, since they seem to relate to the Catalogue of the Palatine Museum drawn up in 1881 by Gherardo Ghirardini, where the 45th sculpture on display reads: »Frammento di sedile di forma circolare, da cui pendono due pelli di pantera. Sono due pezzi che furono riuniti con un perno. Alabastro orientale, altezza m 0.12.« It is likely that the two fragments were mounted on the modern marble base where they still stand today on this occasion. The cleaning and restoration work in which the decorated surface was polished, probably to enhance the tones of the marble, can also be traced back to this period.

ARCHAEOMETRIC ANALYSES

Calcareous Alabaster Artefacts[15]

From a preliminary autoptic examination, the lithotypes used for the realisation of the analysed sculptures, although presenting different macroscopic characteristics, would seem to be attributable to alabasters traditionally known as Alabastro fioriti, listati and dorati originating from the Hierapolis area (Türkiye, Denizli). Even the tiger, which differs slightly from the other artefacts, was made by cutting »al verso« a block of a beautiful golden colour, which shows macroscopic features that could correspond to the rocks cultivated in Hierapolis.

Naturally, due to the strong limitations of the autoptic observations determined by the heterogeneity of these stones and the textural ›convergences‹ that distinguish them[16], in order to try to identify and attribute the provenance of the four artefacts, it was decided to collect powder samples[17] to be subjected to archaeometric analyses, namely, the $^{13}C/^{12}C$ and $^{18}O/^{16}O$ isotopic ratios were determined on the samples then transformed into $\delta^{18}O$ ‰ PDB and $\delta^{13}C$ ‰ PDB units[18].

It was decided to use this methodology taking into account the large database on travertines and alabasters outcropping in the Denizli Basin (Hierapolis), as well as the data relating to North African ›travertine alabasters‹[19].

Table 1 shows the values of the $\delta^{18}O$ ‰ PDB and $\delta^{13}C$ ‰ PDB units calculated from the data obtained by mass spectrometer.

The experimental values were compared with those available in literature, obtained from the analysis of samples collected both inside alabaster quarries and, regarding the Denizli Basin (Türkiye, Hierapolis area), from particular outcrop areas of travertines and ›travertine alabasters‹[20].

Particularly useful for this purpose is the recent work by Ayala Amir and colleagues[21], in which the authors compare the values acquired from the isotopic analyses of samples[22] found inside two caves (Téomin and Natuf caves, Israel) with ancient artefacts, Egyptian alabasters of modern extraction and, above all, with the most recent literature data relating to the ›travertine alabasters‹ of the Mediterranean area.

On the following pages the $\delta^{13}C$ ‰ PDB – $\delta^{18}O$ ‰ PDB isotopic diagram from Amir and colleagues[23] is shown, in which the values of the measurements carried out on the four artefacts under study were also projected (fig. 7). The experimental points fall in an area quite close to the

Artefact	$\delta^{13}C$ ‰ PDB	$\delta^{18}O$ ‰ PDB
Tiger (inv. 475143)	+3.27	–10.97
Paw attributed to the tiger (inv. 23.M324-1.1194)	+2.79	–3.00
Turtle (inv. 567449)	+3.65	–3.81
Panthers (inv. 52858)	+4.09	–12.68

Table 1 Values of the units $\delta^{18}O$ ‰ PDB and $\delta^{13}C$ ‰ PDB determined on alabaster samples (D. Poggi). Accuracy of the measurement system: ±0.2 per thousand

15 »Travertine alabaster« for Anglo-Saxon authors.

16 Barker et al. 2018.

17 For the dual purpose of minimising the damage (UNI EN 16085:2012) and reducing the interference from the material alteration processes which occurred during use and burial, the samples were removed using a drill equipped with a 2 mm steel bit, driving the boreholes to a depth of some millimetres. The sample was selected with the assistance of the restorers Fiorangela Fazio and Massimo Lasco.

18 The isotopic analyses were carried out following the ›classical‹ method proposed by Mc Crea 1950.

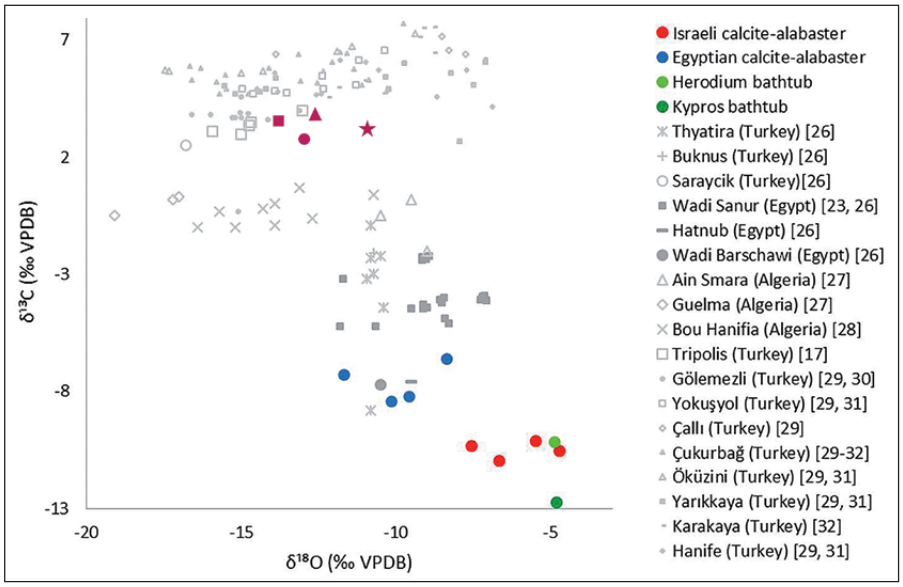
19 Barker et al. 2018; Brilli et al. 2018a; Amir et al. 2022.

20 De Filippis et al. 2012; Özkul et al. 2013; Brilli et al. 2018a.

21 Amir et al. 2022.

22 Samples collected from the alabasters still in place (speleothems), from debris and from rough artefacts.

23 Amir et al. 2022.



7 Projection of the values (in purple) relating to the four alabaster artefacts under study (star: tiger; circle: feline paw; rectangle: turtle; triangle: panthers) in the following $\delta^{13}C$ ‰ PDB – $\delta^{18}O$ ‰ PDB isotopic diagram. In the legend on the right are listed the extraction sites and the bibliographic references of the publications from which the isotopic data were obtained (after Amir et al. 2022, 6 fig. 5)

one which characterises the alabasters quarried in the Denizli Basin (Türkiye), namely areas that are close to those outcropping near Tripolis and Gölemezli.

The relatively high values of carbon ($\delta^{13}C$ ‰ PDB)[24] allow us to classify the alabasters among the *thermogenic* ones (generated by the precipitation of carbonate from CO_2-rich waters of deep origin) rather than among the *meteogenic* ›travertine alabasters‹, characterised by CO_2 of meteoric genesis[25].

The experimental points of $\delta^{13}C$ ‰ PDB range between the following values: +2.79/+4.09 (±0.2); those of $\delta^{18}O$ ‰ PDB are slightly more dispersed: –10.97/–13.81 (±0.2).

The provenance from Gölemezli[26], which until recent studies was believed to be the main quarry of the Hieropolitan alabaster[27] appears even more probable when projecting the experimental data in the $\delta^{13}C$ ‰ PDB – $\delta^{18}O$ ‰ PDB isotopic diagram proposed by Mauro Brilli and colleagues[28].

The tiger is the artefact that differs the most from the others, in terms of the oxygen values alone ($\delta^{18}O$ ‰ PDB). If we consider the databases relating to quarry materials, these are, however, variations that fall within the dispersion inherent in this type of rock.

In particular, the tiger and the paw fragment probably pertaining to it have similar carbon isotopic ratios (+2.79/+3.27 [±0.2]), but they differ significantly in terms of oxygen. It would therefore seem unlikely that the fragment could have been part of a single block, from which the entire tiger would have been obtained. In any case, it is known that the alteration processes acting in the ground, determined by the interaction of the artefacts with aqueous solutions, can easily modify the original isotopic imprint of the stone material, especially with regard to oxygen. Therefore, it cannot be excluded that the paw fragment could originally have been part of the same block and

24 The mean value of $\delta^{13}C$ ‰ PDB calculated for the four samples is slightly lower than the mean cited by Brilli et al. 2018a, 407: 3.45 ‰ compared to 5.7 ‰.

25 Brilli et al. 2018a, 407.

26 Village located about 13 km northwest of Hierapolis.

27 Brilli et al. 2018a, 411.

28 Brilli et al. 2018a.

that due to its smaller size and different post-use history, it may have undergone a more extreme chemical alteration than that of the tiger's body.

In conclusion, it can be stated that the experimental values obtained, compared with those available in literature, point towards the quarries of Hierapolis (fig. 7), in particular to the Gölemezli extraction site, which, until recent studies, was believed to be the main quarry for Hierapolitan alabaster[29].

Artefacts in Antique Black

Both the turtle and the two fragments with panthers are characterised by the presence of some small cylindrical inserts in Antique black introduced inside holes created in the alabaster artefacts. The inserts were made of an Antique black which, despite the limits of the observations conducted in situ by stereo-microscope, appears to have a crystalline structure. This type of structure can be indicative both of proper marbles[30], designated by Patrizio Pensabene and Lorenzo Lazzarini as Bigi antichi, and of some grey-blackish limestones called Bigi morati[31]. In fact, there are some Antique blacks classified among the crystalline limestones or at the limit between very diagenised limestones and proper marbles, in the geological meaning of the term. These are, respectively, the ›blacks‹ extracted in Teos (Türkiye)[32] and at Göktepe, near Ephesos (Türkiye)[33]. Like the blacks of the panthers and the turtle, the only stone insert preserved on the tiger is also characterised by its crystalline structure. From this artefact, which reproduces the stripes of the tiger's fur, the only sample representative of the ›black marbles‹ was removed[34] (fig. 8).



8 Tiger, sampling area of the specimen of the Antique black and small millimetric sliver described by the image captured under the stereo-microscope (the interval between the marks of the metric reference is equal to 1 mm) (photos: D. Poggi)

$\delta^{18}O$ ‰ PDB	$\delta^{13}C$ ‰ PDB
–2.65	+2.42

Table 2 Values of the $\delta^{18}O$ ‰ PDB and $\delta^{13}C$ ‰ PDB units determined on the Antique black sample (D. Poggi). Accuracy of the measurement system: ±0.2 per thousand

29 Scardozzi 2016; Scardozzi 2019.

30 Metamorphic rocks with a crystalline structure, mainly composed of calcite and/or dolomite, deriving from the recrystallisation of limestones and/or dolomite due to the changed conditions of temperature and/or pressure induced by geological causes.

31 Pensabene – Lazzarini 1998; Lazzarini 2007; Lazzarini 2013.

32 Brilli – Giustini – Kadioğlu 2019.

33 Attanasio et al. 2017; Brilli et al. 2018b.

34 At the moment, the other inserts of small size have not been sampled, as they constitute rare evidence of the technique.

The sample, with a weight of about 15 mg (fig. 8) after removal by scalpel of the residues of grouting, was subjected to $^{13}C/^{12}C$ and $^{18}O/^{16}O$ isotopic analyses, the results of which, transformed into δ units, are shown in table 2.

If it is assumed that the Antique black of the tiger inserts was a limestone (Bigio morato sensu Pensabene and Lazzarini)[35], using the diagram proposed by Brilli and colleagues[36], the isotopic data fall within the pertinence field of Göktepe. From a strictly isotopic point of view, by comparing the values of the sample with the reference ones of the most important Bigi antichi proper marbles[37] according to Lazzarini[38], the possible sources would be the following: Göktepe (Türkiye), Moria (Lesbos Island), Mt. Hymettos (Athens, Greece); Cape Tainaron (Mani, Greece); Luna (Carrara, Italy).

Using the diagrams proposed by Ali Bahadır Yavuz and colleagues[39], it is possible to confirm the possible provenance from Göktepe, Lesbos and Carrara (Bardiglio), with the last two being unlikely (the point falls on the limit of the ellipses pertaining to marbles). According to the data of Yavuz[40], it is also possible to consider the use of the marble extracted in Belevi (Türkiye), one of the provenances also reported by Attanasio and colleagues[41]. According to the latter authors, the isotopic imprint of the Antique black of the tiger would also be compatible with the blacks extracted in Göktepe, Vytnia and, less likely, Chios.

In relation to the fine grain of the Antique black of the tiger, among the marbles listed above, the use of Lesbian marble, characterised by a medium to large grain, is considered unlikely.

Since, as it is well known that in order to have a good probability of identifying grey-blackish ›marbles‹ it is necessary to resort to different analytical methodologies, it would be advisable to also proceed to the petrographic analysis and to the determination of the concentration of some elements present in traces, such as, for example, strontium (Sr), useful for the identification of Göktepe marble[42]. In relation to the context, the latter origin could be one of the most probable ones.

CONCLUSIONS

The group of sculptures examined is characterised by the use of alabaster and by the marble inlay technique that finds its ultimate expression between the Julio-Claudian and Hadrianic ages. The technique used with this material leads us to rethink the evolution of the parietal technique of *interraso marmore* mentioned by Pliny[43] and established by the increasingly numerous identifications[44]. As far as we are concerned, it is the first time this technique was applied to sculptures, with a realistic representation of the shape and colours of the subject[45]. The provenance of the sculptures is antique, namely originating from the furnishings of the imperial palace.

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35 Pensabene – Lazzarini 1998.

36 Brilli – Giustini – Kadioğlu 2019.

37 Pensabene – Lazzarini 1998; Yavuz – Bruno – Attanasio 2012; Lazzarini 2013; Attanasio – Bruno – Yavuz 2014; Attanasio et al. 2017; Brilli et al. 2018b; Brilli – Giustini – Kadioğlu 2019.

38 Lazzarini 2013.

39 Yavuz – Bruno – Attanasio 2012.

40 Yavuz – Bruno – Attanasio 2012.

41 Attanasio – Bruno – Yavuz 2014.

42 Attanasio et al. 2017.

43 Plin. nat. 35, 2–3.

44 A summary of the presence of materials elaborated using the inlay technique can be found in Quaranta – Bruto 2006. See also Violante 2013, 154 f.

45 If we exclude the ›jaguar‹ of the Vatican Museums, currently dated to the 18th cent. (Spinola 2002, 358), the example that comes closest to the sculptures in question, and namely to the panthers, is a small 12 cm-tall marble sculpture with a representation of a feline with a mystical cyst between the legs, found on the antiques market (Bertolami FineArt Roman: Marble Panther Holding Cista; <https://auctions.bertolamifinearts.com/en/lot/80471/roman-marble-panther-holding-cista-1st-/> [15.04.2025]), the authenticity of which cannot currently be established.

The physical characteristics of the animals probably led to the choice of a specific and refined alabaster which enhanced the peculiarities of each animal. In the cases of the feline and turtle skins, the small size of the sculptures could have facilitated the choice of a particular alabaster that could reproduce the animal's mantle in a ›realistic‹ way. By contrast, the size of the sculpture representing the tiger made it necessary to find a block of alabaster of greater size that resembled the colours of the animal's coat, with a honey-yellow tone tending to red, emphasised by the wave structure of the stone.

The presence of the black inlay to represent the striations of the fur makes the animal's appearance even more realistic and could lead us, due to the particular technique used for the inlay, to a possible Roman workshop, in line with the parietal evidence[46]. If the manufacture points to a Roman workplace, albeit hypothetically, the origin of the materials seems to suggest a micro-Asian environment, namely the Ieropolitan quarries of Gölemezli for the alabaster and, hypothetically, those of Göktepe for the only Ancient black insert preserved. This last identification is of particular importance, because although still to be verified through further analysis[47], it could suggest a new dating of the tiger, pointing to a later period than the Claudio-Neronian era as last proposed[48].

In accordance with the taste for naturalistic representation, which finds its utmost expressions in the splendid Cipollino marble crocodile from Hadrian's Villa[49], the dating of the tiger can thus be circumscribed between the last Neronian age and, more likely, the Hadrianic age.

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[46] Based on the hypothesis of urban manufacture, cf. Quaranta – Bruto 2006, 7.

[47] The sample taken produced limited results because of its small size.

[48] For more information on the dating of the object to the Claudio-Neronian age, see Fusco 2014. For more information on the use and export of marble from the quarries of Göktepe in Hadrianic times in connection with the workshops of Aphrodisia, see Attanasio et al. 2021.

[49] The sculpture, recently restored and on public display, is made of Karystos marble, whose veinings, enhanced by the processing of the surface, recall the skin of the animal, and above all its relationship with water.

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ASMOSIA XIII presents in two volumes the papers and posters from the regularly organised international conference of the »Association for the Study of Marble and Other Stones in Antiquity«, which took place in Vienna in 2022. The 77 papers of the Viennese symposium reflect the current state of research in the field of archaeometry and provenance of ancient marbles and are dedicated to eight major topics: the different types of marble and their use in architecture and sculpture during antiquity; provenance research on marbles and other types of stone; the development of databases and methodology; geology and quarries, including their organisation; specific properties of stone and the effect of climatic influences on stone and its restoration; pigments and the application of colour to marble and finally, the production and trade of stone and marble in Alpine regions and the Danube provinces. There are also contributions on transport networks, the distribution of various goods, the mobility of workshops and the characterisation of ceramic raw materials and aggregates in order to describe production techniques and the regional distribution of products.

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