14TH INTERNATIONAL CONFERENCE OF THE ASSOCIATION FOR THE STUDY OF MARBLE AND OTHER STONES IN ANTIQUITY

ASMOSIA XIV

15–20 SEPTEMBER 2025 | LJUBLJANA

BOOK OF ABSTRACTS

FF UNIVERSITY OF LJUBLJANA
Faculty of Arts

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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, as related to diagnosis problems, matching of stone fragments and authenticity

Session 7 |
Pigments and Paintings on Marble

Session 8 |
Special Theme Session: Limestones and other rocks of the Alpine-Dinaric-Pannonian area: sources, extraction and use

Poster Session A |
Applications to Specific Archaeological Questions – Use of Marble
Advances in Provenance Techniques, Methodologies and Databases
Stone Properties, Weathering Effects and Restoration, as related to diagnosis problems, matching of stone fragments and authenticity
Limestones and other rocks of the Alpine-Dinaric-Pannonian area: sources, extraction and use

Poster Session B |
Provenance Identification I: Marble
Provenance Identification II: Other Stones
Quarries and Geology (Quarrying Techniques, Organization, Transport of Stones, New Quarries, Stone Carving and Dressing, Hazards to and Preservation of Quarries)

Abstracts

IDENTIFICATION OF LESBOS MARBLE IN ABILA (NORTH JORDAN) WITH SOME CONSIDERATIONS ON ITS PRESENCE IN JORDAN

Khaled Al-Bashaireh
Yarmouk University, Department of Archaeology, Irbid, Jordan

Keywords: Lesbos marble, Abila, Jordan

This work presents an archaeometric characterization of the white marble used for columns found in the Decapolis city of Abila (North Jordan). Proconnesian, Thasian, and Parian white marble varieties from the Turkish and Greek Islands were used to build the site's buildings despite the reuse of architectural elements. The results of the utilized analytical techniques, compared with published research, showed that the columns have similar analytical and characteristic features to Lesbos marble from Karyni quarries. The results introduce the first presence of Lesbos marble in Jordan and shed light on the wide distribution of this marble in the region.

MARBLE SOURCES AND USE FOR SCULPTURE IN JORDAN DURING THE ROMAN AND BYZANTINE PERIOD

Khaled Al-Bashaireh
Yarmouk University, Department of Archaeology, Irbid, Jordan

Keywords: local economy, trade system, marble sculptures

Jordan lacks high-quality white marble sources; therefore, it was imported from various sources to meet the demand for this material for building and sculpture. Many structures including temples, churches, baths, and nymphaea, at several archaeological sites were adorned with white marble sculptures, especially statues. Gerasa, Gadara, Philadelphia, and Petra among other sites are examples of this feature. Archaeometric investigations of white marble sourcing in archaeology have become widely spread in the past decades, and have provided and made available large analytical data about archaeological white marbles used in these sites. The presentation will shed light on these sculptures and categorize them according to their quarry origins and carving and use periods. It will present the results of a

quantitative study of the distribution of the white marble quarries during the Roman and Byzantine periods in these sites based on the available provenance data. The presentation will evaluate the white marble distribution data within a wider socio-economic frame and emphasize the most probable factors that affected this distribution: the marble trade system, changes in cultural practices related to statue erection, marble reuse and recycling, and local economic situation.

(MARBLE) TRACES OF THE MUNICIPIUM TROESMENSIUM (TURCOAIA, ROMANIA)

Cristina-Georgeta Alexandrescu
"Vasile Pârvan" Archaeological Institute, Bucharest, Romania

Keywords: Troesmis, marble imports, municipium

During the Troesmis project, started in 2010, the castra of legio V Macedonica and the canabae, as well as necropoleis and further settlement infrastructure, were localized, mainly using non-invasive research. Epigraphic evidence attests to the Roman army, the early and late Roman period settlements, the civilians and military personnel, and, for the 2nd–3rd century, after the dislocation of the legion to Dacia, to a Roman town with municipium rank. The localization of the latter is still a debated subject. The complex geophysical prospecting campaigns from the last two years highlighted that the initial assumption that the town used the infrastructure of the castra is not confirmed. Furthermore, the mapping of the marble finds, mainly parts of wall cladding, provides a possible hint for the localization of the municipium Troesmensium in the former canabae. Most of the about 300 documented marble objects are concentrated in the center of the civilian settlement to the northeast of the legionary camp. In the camp itself, there were significantly fewer marble finds, even though it can be assumed that the legionary legates and military tribunes represented a higher social class than those in the canabae or municipium. Marble was imported into the northern part of Moesia Inferior/Scythia through the harbour of Tomis. The slab fragments documented are mainly of white marbles, with a few examples of Pavonazetto and the largest collection of Greco Scritto in the north of the province. The analysis is thus of interest also for the study of the export of these materials. A selection of fragments from the group of medium-grained white marbles was analysed. The isotopic analyses (possible at the beginning of the project for about 10 fragments) proved insufficient/inconclusive for the determination of the marble

provenance. Combined methods (petrographic, chemical, and isotopical analyses) were possible for a further 10 samples of white marbles. Based on these results, the macroscopic determination of the lithic material of the other fragments was carried on. The group of the Greco scritto fragments was not yet further investigated to differentiate between the two possible sources, by Ephesos and/or Prokonessos. Various types of marble were used, including Prokonnesos (for architectural elements, paving, and cladding), Pavonazetto from Afyon (for slabs or opus sectile tiles), and Greco Scritto (for cladding and possibly opus sectile). White marble slabs from Prokonnesos, Paros, Thasos, and Herakleia/Miletos were used for sculpture at Troesmis and its surrounding areas.

COLOURED MARBLES FOR ANCIENT TOMIS (CONSTANȚA, ROMANIA)

Cristina-Georgeta Alexandrescu[1] – Irina Sodoleanu[2]
[1] "Vasile Pârvan" Archaeological Institute, Bucharest, Romania
[2] Muzeul de Istorie Naţională şi Arheologie, Constanţa, Romania

Keywords: coloured marbles, Tomis, trade

The cladding elements made of white and coloured marbles from the Late Roman Mosaic-Floored Building (MFB) in Constanţa were uncovered between 1959 and 1966 but remained largely unpublished until 2019, when investigations on the building resumed. A re-evaluation of archival materials provided new insights into the location and context of the marble cladding discovered on the walls of the great mosaic hall. Our investigations aim to accurately identify the materials used, document the shapes and dimensions of the pieces, and, as much as possible, re-contextualize them. The project's results will help establish the provenance of the imported materials, determine their relevance to various phases of the building's operation, and clarify their relationship with the proposed chronology. Additionally, the quality and cost of the materials used for architectural decoration can offer clues about the owner and the building's purpose. Two main categories of marble finds can be distinguished: white marbles and coloured marbles. A selection of relevant lithic materials from museum deposits was sampled to determine the provenance of the marbles. Through petrographic and geochemical analyses, the white marbles were identified as coming from Dokimeion and Prokonnesos. The coloured marbles uncovered in this building, which have been identified so far through macroscopic inspection,

provide insights into the specific technological details of the interior decoration – a style that was quite popular in antiquity but has limited evidence in the Lower Danube region and along the western shores of the Black Sea. Tomis served as the main harbour for northern Moesia and Dacia and was an important Greek and later Roman city, involved in an extensive and complex trade network dating back to the 7th century BC. Coloured marbles are relatively rare in the region. Besides the Late Roman finds from the MFB in Tomis, only isolated finds from Halmyris and Argamum are known, although these lack context. Furthermore, during the Constantinian phase of a notable building in Oescus, some marble cladding made of coloured marbles was recently discovered. Consequently, the assemblage from the MFB in Tomis represents the most complex find, attesting to the trade network of this significant ancient centre. The most likely hub from which the assemblage of over 17 types of coloured marbles – provenanced from Asia Minor, Egypt, Africa, and Greece – was delivered, cut to shape for various wall cladding patterns, is Ephesus.

FROM QUARRY TO CITY: TRACING BUILDING STONE PROVENANCE IN ANCIENT ERETRIA

Jérôme André[1,2,3] – Marilou de Vals[2] – Tommy Vettor[2] – Chloé Chezeaux[1,2]

[1] Lausanne University, Lausanne, Switzerland
[2] Swiss School of Archaeology in Greece, Lausanne, Switzerland
[3] University Lumière Lyon 2, Lyon, France

Keywords: building stone, ancient Greek quarries, stone supply strategies

This presentation outlines the method and preliminary results of the study of the stone materials used in the constructions of the ancient city of Eretria and its main sanctuary at Amarynthos (Euboea, Greece), from the 6th to the 1st century BCE. Initiated in 2024, this multidisciplinary research project investigates the building stones employed in Eretria's monuments, focusing on their provenance and supply networks. By comparing samples from monuments with those collected from quarries in the Eretrian Plain and surrounding regions, the study seeks to answer broader questions about how local environments were exploited for construction projects.
The project encompasses several key components: intensive field surveys to locate quarries, petrographic characterisation of rocks extracted from these sites, and detailed analysis of the stones used in the city's architecture.

Representative samples of both sedimentary rocks and marbles were collected from quarries and buildings for petrographic analyses, including XRD, SEM, and, for marbles, IRMS, ICP-MS, and multivariate statistical analysis.
Preliminary results include a comprehensive database of quarries and sedimentary stone facies specific to the Eretria region. The analysis of the city's architecture highlights a dominant use of local stones sourced from quarries situated within proximity or less than 4 km from construction sites. Slope breccia and hard limestone were particularly prevalent, forming the bulk of the building stone used in Eretria and Amarynthos.
By the late 6th century BCE, the evidence also reveals use, although limited, of allochthonous stones, including imported marbles and sedimentary rocks. These materials were vital for constructing buildings such as temples, whose superstructures were entirely crafted in stone. The local facies were unsuitable for carving the sculpted elements characteristic of these new architectural forms.
This paper provides an initial overview of the stone supply strategies in Eretria from a diachronic perspective, evaluating the results of various archaeometric analyses conducted on quarries and monuments from the city. This study represents the first comprehensive survey of this kind in Eretria, taking into account all rock types and all buildings uncovered to date.

MARBLE FOR THE GODS: NEW PERSPECTIVES ON MARBLE NETWORKS IN ROMAN THRACE FROM THE RECENTLY EXCAVATED SANCTUARY OF APOLLO NEAR AUGUSTA TRAIANA (BULGARIA)

Petya Andreeva
National Archaeological Institute with Museum at the Bulgarian Academy of Sciences, Sofia, Bulgaria

Keywords: sanctuaries, marble sculptures, Roman Thrace

This paper aims to contribute to the discourse on the use and significance of marble in sacred contexts in Roman Thrace, drawing on the recent discoveries at a previously unknown sanctuary of Apollo near Augusta Traiana, one of the major cities of the province. The sanctuary was located 375 meters above sea level, approximately 10 km northeast of the ancient city, within a region rich in limestone deposits. Excavations at the site

revealed a temple used for ritual practices, along with numerous marble ex-votos. Most of the offerings, carved from white marble, include statues, sculptural groups, and votive plaques, featuring depictions of Apollo and other mythological figures associated with him, as well as representations of the Thracian Horseman, whose cult was syncretized with that of Apollo.

The findings from the newly discovered extra-urban sanctuary highlight the extensive use of marble in sculpture, which became a defining feature of Roman-period votive monuments dedicated by local communities in surrounding regions. The use of marble reflects an effort to replicate the visual programs of religious offerings from urban centres.

The study further develops the discussion on the role of local sanctuaries, often dedicated to syncretic cults such as those of Apollo and the Thracian Horseman. These sanctuaries played a crucial role in developing marble networks within the province. It also examines the interaction between foreign and local cults, as evidenced by the incorporation of foreign motifs in marble, illuminating the spread of stylistic trends and the evolving nature of marble production in the region, as well as its influence on extra-urban use. The prominent role of marble in sacred contexts underscores its social significance, providing valuable insights into the organization of workshops and the craftsmen involved in marble production and distribution in Roman Thrace.

HELLENISTIC AND ROMAN FUNERARY RELIEFS FROM THE LOWER STRYMON VALLEY (GREECE) AND THE SOURCE OF THEIR MARBLES

Dimitra Andrianou[1] – Vasiliki Anevlavi[2] – Walter Prochaska[2] – Lorenzo Lazzarini[3] – Thorsten Jakobitsch[2]

[1] National Hellenic Research Foundation, Institute of Historical Research, Athens, Greece
[2] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria
[3] Istituto Veneto di Scienze, Lettere ed Arti, Venice, Italy

Keywords: lower Strymon Valley, archaeometry of funerary reliefs, Hellenistic and Roman period

Aegean Thrace (modern northeastern Greece) has been the subject of extensive historical and archaeological research in recent decades. Studies on the iconography and epigraphical evidence of funerary stelai from the region have significantly advanced our understanding of indigenous Thracians and Greek colonists, their onomasticon, and funerary beliefs. Moreover, analyses of the distribution of these stelai, combined with research into the provenance of their marble, have shed light on the use and transportation of materials from the Archaic to Roman periods. Building on prior research in Aegean Thrace, ongoing investigations in the mainland of ancient Thrace (modern Bulgaria), and Macedonia, our proposed study aims to examine another area known for its settlements of mixed populations, namely the lower Strymon valley (part of ancient Macedonia in the Hellenistic period). The Strymon River is unique as it flows through the ancient lands of Thrace at the border of Macedonia, with its southern (lower) course inhabited by indigenous populations of Thracians and Greek colonists, fostering a blend of both cultures. Our current project focuses on a corpus of 90 marble funerary stelai from the lower Strymon valley, with particular attention to two dominant iconographic themes: the heros equitans and the so-called funerary banquet. The stelai are currently stored in the Archaeological Museum of Serres and date to the Hellenistic and Roman periods. Our study will analyse the iconographic motifs in the context of similar Greek and Thracian monuments, investigate the provenance of their marble through petrographic, isotopic and geochemical analysis, and explore its riverine or overland transportation. Concurrently, ancient local quarries will be examined, and sampling will be conducted to establish a comprehensive database of marble sources. The preliminary white marble provenance results will indicate the use of local sources but also the incorporation of supra-regional marble, shedding light on trade networks and resource distribution in the region. The presentation will showcase the material under investigation, address the key historical and archaeometric questions of the study, and analyse the preliminary findings from the marble provenance and quarry investigations.

THE WHITE MARBLE INVENTORY OF ROMAN AQUAE CALIDAE ON THE BLACK SEA COAST: ARCHAEOMETRIC PROVENANCE RESULTS

Vasiliki Anevlavi[1] – Walter Prochaska[1] – Petya Andreeva[2] – Dimcho Momchilov[3] – Miroslav Klasnakov[3]
[1] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria
[2] National Archaeological Institute with Museum at the Bulgarian Academy of Sciences, Sofia, Bulgaria
[3] Regional Historical Museum of Burgas, Burgas, Bulgaria

Keywords: marble provenance, Roman period, Black Sea coast

Aquae Calidae (warm waters in Latin) was an ancient settlement in the Thracian region, located within the modern boundaries of Burgas, a coastal city on the Black Sea in Bulgaria. Renowned for its natural hot springs, the site developed into a prominent thermal destination in antiquity, centred around thermal baths. The current research focuses on white marble artefacts discovered at the site, primarily dating to the Roman period. These include inscriptions, architectural elements, fragments of sculptures, and votive reliefs. Investigating the provenance of these artefacts in a region lacking local marble deposits provides valuable insights, particularly in the context of the expanding database of Roman marble trade networks. Analytical methods such as stable isotope analysis (C13 and O18), multi-element trace element analysis via ICP-MS, and petrography have been employed to determine their origins. This study offers an opportunity to explore regional marble trade, including the distribution of raw materials and finished products. The site's coastal location, combined with its popularity as a thermal destination and the abundance of archaeological finds, including over 4,000 coins from various periods, underscores its significance as a key hub in the trade network of the Black Sea coast. Evidence of marble sourced from Thasian and Proconnesian quarries, as well as local quarries like the central Asenovgrad, reflects the diversity of material sources and highlights the site's strong connections to both regional and interregional trade networks. Furthermore, discussions of marble provenance are closely linked to the localisation of workshops and the mobility of craftsmen during the Roman period, shedding light on broader patterns of production and exchange.

FROM QUARRY TO NECROPOLIS: THE JOURNEY OF EPHESIAN SARCOPHAGI THROUGH WHITE MARBLE PROVENANCE STUDIES

Vasiliki Anevlavi[1] – Walter Prochaska[1] – Martin Steskal[1] – Doris Bielefeld[2]
[1] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria
[2] Philipps Universität Marburg, Archäologisches Seminar, Marburg, Germany

Keywords: marble provenance, Ephesian sarcophagi, Ab-u Hayat quarry

Ephesos, a prominent city in antiquity, benefited from an abundance of high-quality local marble, which played a central role in its sarcophagus production. This study investigates the provenance of marble used in 72 sarcophagi, employing petrographic and geochemical methods to distinguish between local Ephesian sources and imported materials. Techniques included macroscopic observation, ICP-MS trace element analysis, and stable isotope evaluation ($\delta^{18}O$, $\delta^{13}C$). These findings were compared against an extensive database of approximately 5,500 geological samples from numerous ancient quarrying centres. Analyses of sarcophagi from Ephesos have confirmed that many were crafted from the city's local marbles, primarily Ephesos I and Ephesos II, historically associated with the majority of building construction of the city from its earliest beginnings (e.g., sanctuary of Artemis). Additionally, a smaller local quarry, known as Ab-u Hayat, contributed to sarcophagus production, although on a more modest scale. The study further identified imported pieces created from Prokonnesos, Thasos, and Aphrodisias marbles, indicating strong connections with other leading production centres across the Eastern Mediterranean. Fine-grained marbles commonly found in other regions are notably rare in Ephesos (except for some Attic sarcophagi), reflecting localised preferences or market constraints. These findings illuminate the intricate balance between local resources and imported materials in Ephesos, underlining both economic considerations and cultural choices. They also shed light on the broader significance of marble in funerary customs, as well as on the dynamic trade networks that supplied this renowned urban centre.

INDEPENDENT MARBLE MOULDED ELEMENTS FROM THE DECORATIVE PROGRAM OF THE FRIGIDARIUM OF THE MONUMENTAL THERMAL COMPLEX OF VALERIA (CUENCA, SPAIN)

Javier Atienza Fuente
Independent researcher, Cuenca, Spain

Keywords: Roman decoration, marble mouldings, marble decoration

The archaeological interventions carried out in Valeria between 2015 and 2021 have made it possible to exhume the remains of a monumental public thermal complex that was in continuous operation from the middle of the 1st century AD to the end of the 3rd century AD, in an excellent state of conservation since, after its abandonment, the building was not subject to looting or plundering of its construction materials. Until now, excavations have focused mainly on the different rooms that make up the frigidarium, revealing wall structures that, in some cases, exceed 4 meters in height. These wall structures have numerous holes on their internal facing that are distributed over the surface following regular patterns and which serve to fix and anchor the different elements that were part of the decoration. In addition to the wall structures, several thousand marble elements of different varieties and typologies have been recovered, which were part of the building's decorative program. Most of these marble elements belong to parietal slabs, but a set of around 500 fragments is made up of independent elements that have carved moulding on their surface. In this work, firstly, the different moulded independent marble elements that have been identified are described, from the simplest (listels and torus) to those that present a greater plastic complexity (crowning and transition mouldings). These elements are then studied from a functional point of view, considering their physical characteristics (size, shape, presence or absence of mechanical fixing holes, etc.) to try to determine their precise location within the decorative program. Finally, especially in the case of crowning and transition mouldings, the study has focused on the design of their plastic decoration, trying to find formal parallels in other places in the Roman Empire. This study has not only made it possible to establish with certainty the exact location of some of these marble elements, but also to identify plastic models and designs that had a wide spatial dissemination and a long duration in time.

GEOARCHAEOLOGY OF ROMAN ANCIENT COASTAL QUARRIES AT BIZERTE (TUNISIA)

Maha Bannour
University of Tunis, Faculty of Humanities, Department of History, Laboratory of DIRASET Maghrebine, Tunis, Tunisia

Keywords: geoarchaeology, coastal quarries, Bizerte

Many researchers have carried out archaeological research such as surveys and archaeological excavations in the region, nevertheless, many researchers have carried out yet they didn't pay great attention to ancient quarries. Several coastal quarries have been exploited for systematic urbanization since the Romanization of the Punic Cities in Bizerte (North of Tunisia). During antiquity, the study area corresponds to the northern part of Africa which is known for its strong urbanization since the Punic period (Utica, Thiniza? Hippo Diarrythus etc.) certainly, in addition to the economic role of the presence of the good building stone contributed a lot. Romans had prospected and then exploited coastal quarries which were known for having good stone quality for building their public as well as imperial monuments. Our survey carried out along the coast of the Bizerte region (Hippo Diarrythus) has identified ten quarries between Cap Blanc (Promontorium Candidum) and Cap Ettarf (Promontorium Appolinis). The petrographic and mineralogical study of the materials constituting this quarry shows that they are mainly shell sandstones of eolian origin. Fossil dating of these sandstone levels allows us to attribute a Tyrrhenian age. The Roman quarrymen exploited this quarry in the open air only by applying an extraction by cutting marks which is identical to that applied as well in the ancient quarries of the Tunisian Sahel as in others in Spain, Turkey and France in the quarries of Cap de Couronne.

THE ENIGMA OF THE LATE ARRIVAL OF PORPHYRY AND MONS CLAUDIANUS TO ROME

Simon J. Barker[1] – J. Clayton Fant[2]

[1] University of Warsaw, Faculty of History, Centre for the Research on Ancient Civilizations, Warszawa, Poland
[2] University of Akron, Department of History, Ohio, United States of America

Keywords: porphyry, diorite, Eastern Desert

The arrival in Rome of the great stones of Egypt's Eastern Desert remains imperfectly understood. The Elder Pliny (NH 36.55) mentions stones named for the first emperors: marmor Augusteum, marmor Tibereum, and marmor Claudianum (Mons Claudianus tonalite gneiss). This suggests early imperial involvement and an inscription (AD 18) celebrating the discovery of porphyry reinforces that impression. The paradox prompting our research is that these stones were absent in Rome itself before Nero (AD 54–69). Instead, we see a definite, if modest, diffusion of stones from smaller Egyptian quarries. At Pompeii small pieces of porphyry and m. Claudianum appear mostly post-earthquake (of AD 62), while pieces of the "small" stones, like a large plaque of ophites in a bar at VI.10.1, clearly originate from structures built before the earthquake. Why did no porphyry reach Rome in the decades immediately after its discovery? Why has no archaeological evidence of Claudian activity at his namesake quarries been found? Logistics and documents provide hints. The "small" stones were limited not only in deposits but in the size of extractable blocks or columns. This became an advantage for transport because baggage camels and wagons could negotiate narrow tracks, but columns and large blocks required wide roads with limited gradients. The large quarries needed large labour forces: Mons Claudianus was staffed at about 1000 under Trajan. A new city, Kaine (Qena), was built on the Nile to house the families of skilled labourers. The ophites quarry, by contrast, needed no more than 100, judging by its workers' huts. Secondly, at Rome Augustus' example of modesty and limited powers prevailed into the reign of Claudius, as an anecdote from Pliny (NH 36.57) shows: his prefect of Egypt sent porphyry statues, surely of Claudius himself, to Rome but they met with disapproval, and no precedent was set. With Nero peer pressure was ineffective. He loved purple, the colour of royalty since the Bronze Age. He restricted the sale of Tyrian purple dye. He displayed a purple awning at the Theatre of Pompey picturing himself as a charioteer. His cremated remains were preserved in a porphyry urn. No wonder we see porphyry and other purplish stones in the paving and revetment of the Domus Transitoria. We argue that the late introduction of porphyry to Rome was due to Nero, who pushed the big quarries of the Eastern Desert to supply his appetites.

BEASTS OF BURDEN: ANIMAL LABOUR IN THE STONE TRADE

Simon J. Barker[1] – Ben Russel[2]
[1] University of Warsaw, Faculty of History, Centre for the Research on Ancient Civilizations, Warszawa, Poland
[2] University of Edinburgh, School of History, Classics and Archaeology, Edinburgh, United Kingdom

Keywords: ancient quarries, manpower, animal transport

This contribution focuses on what ancient sources and comparative evidence from later historical periods (especially the sixteenth to nineteenth centuries) reveal about the use of animals in quarrying and stone transport processes. It follows on from previous work presented by B. Russell at ASMOSIA XI, which examined labour organisation and wages at the imperial quarries of Mons Claudians in the Eastern Desert of Egypt and Dokimeion in Phrygia (and published in the conference volume), and by S. Barker and B. Russell at ASMOSIA XIII, which focused on the range of workers (stoneworkers of various specialisms, metal-workers, and other specialists), the composition and size of quarry work-teams, and their organization (published in volume 13 of Ædificare. Revue internationale d'histoire de la construction). The importance of transport for the cost of stone is well-known (estimated by J. DeLaine at over 50 per cent of the total cost in the case of the Baths of Caracalla), but the necessary investment in animal labour, both within quarries and for overland haulage beyond quarries is an underexplored aspect of stone transportation. Our focus here will be on the composition and size of transport-teams, their organisation, the logistical importance of animal-use (about 400 pairs of oxen were employed at the quarries of Carrara for this purpose in the nineteenth century), and the economic impact of their maintenance costs. From antiquity, we will draw on the evidence provided by inscriptions, papyri and ostraca, especially from Greece and Egypt, as well as archaeological evidence from the Eastern Desert (for animal lines and water sources, for example). Historical data from a range of marble and other stone quarries, including Carrara (Italy) and various sites in Britain, will be compared to this ancient evidence. We will also explore what impact animal labour might have had on transport costs and times, using transportation models developed by scholars working on the economic geography of the Roman world.

NOTES ON THE CLASSICAL SPOLIA OF PALERMO (ITALY)

Daniel Becerra Fernández[1] – Valentina Purpura[2]
[1] University of Malaga, Faculty of Philosophy and Letters, Department of Historical Sciences, Málaga, Spain
[2] Independent researcher, Palermo, Italy

Keywords: Palermo, marbles, reuse

The city of Palermo, capital of the Sicilian region, has in its monuments a large content of reused Roman ornamental rocks, many of them coming from the main quarries of the Empire since it is the strategic location of the island of Sicily in the centre of the Mediterranean that allowed it. With this work, we intend to show how civil and religious powers reuse marmora in their main headquarters. The methodology developed has consisted of the bibliographic review and the documentation and cataloguing of the prestigious stone materials present in the different monuments of the historic centre of the city of Palermo. The results show the presence of the main marbles of the Orbis Romanus and other ornamental stones used in Roman times in the Royal Palace, in the Cathedral of Palermo, in San Cataldo, in S. Maria dell'Ammiraglio, in the Loggia dell'Incoronazione and in other points of the city's streets and churches. These materials, valid as functional elements, are reused for their symbolism and their connection with the classical and late antique world, being present in the main spaces of the monuments analysed or to highlight different places. We also note how the use of these marbles and external influences have influenced the later decoration of the city's large buildings, such as the use of the technique known as "mischio".

SECTILIA FROM THE SANCTUARY OF APOLLO PYTHIOS IN GORTYN, CRETE

Jacopo Bonetto[1] – Antonio Bianco[2]
[1] University of Padua, Department of Cultural Heritage, Padua, Italy
[2] University of Pisa, Department of Civilizations and Forms of Knowledge, Pisa, Italy

Keywords: opus sectile, Gortyn, Pythion

Since 2014, the University of Padua and the Italian School of Athens, with the collaboration of the Ephoria of Heraklion, have been conducting excavations and research in the area of the sanctuary of Apollo Pythios in Gortyn of Crete. It is a complex of extraordinary importance which over the years demonstrates how its presence played an indisputable role in the early stages of birth and formation of the urban nucleus in the historical period. The most recent ceramic attestations certify that the area was frequented starting from the 10th century BC and the first monumentalization of the place around the middle of the 7th century BC, followed by rapid growth, as demonstrated by archaic inscriptions. Its transformation during the following centuries demonstrates the care that the Gortynians dedicated to this monument, central to the city s activities, and it is during the Roman imperial period that its renovation shows a new structure of the oikos with the positioning of floors in opus sectile. This presentation, after an introductory part aimed at understanding the different phases of this sanctuary, illustrates in detail the discovery of the marble material which took place in the summer of 2024 and analyses its different aspects: its origin, its possible use and tries to provide a useful dating for the reconstruction of the monument during the last most important transformation, in which it was enriched with a fine flooring, which recalls the richest monuments of imperial Rome.

THE EXPLOITATION OF STONE RESOURCES OF NORTH-EASTERN ITALY AND THEIR USE IN THE ROMAN AGE

Jacopo Bonetto[1] – Caterina Previato[1] – Simone Dilaria[1,2] – Eliana Bridi[3] – Chiara Girotto[1] – Claudio Mazzoli[3]
[1] University of Padua, Department of Cultural Heritage, Padua, Italy
[2] University of Padua, Inter-Departmental Research Centre for the Study of Cement Materials and Hydraulic Binders CIRCe, Padua, Italy
[3] University of Padua, Department of Geosciences, Padua, Italy

Keywords: stone resources, Roman architecture, provenance determination

This contribution aims to present the results of a multidisciplinary research project conducted by the Department of Cultural Heritage in collaboration with the Department of Geosciences of the University of Padua (Italy). The project aims to identify and trace the provenance of the stones used in the Roman Age for the construction of architectural complexes and infrastructures of North-Eastern Italy as well as for the production of

artefacts. The study involves, on the one hand, a detailed analysis of stone structures and artefacts found in the main Roman urban centers of the region, and on the other hand, the identification of their provenance and the mapping of potential quarry sites and basins. The identification of the lithotypes and their source areas is carried out by applying different archaeometrical techniques. The final goal of the project is the reconstruction of the dynamics of selection, extraction, and use of the stone resources of North-Eastern Italy in Roman times. The current research sites include the cities of Oderzo, Concordia Sagittaria, Vicenza, Padova, Verona, Adria, and San Basilio di Ariano nel Polesine. To date, over 400 stone samples have been collected at these sites and are currently undergoing analysis. Preliminary results from the study of samples taken from Roman buildings, architectural elements and artefacts, indicate that the primary extraction areas, mostly located along the Alpine and Pre-Alpine ranges, were heavily exploited during the Roman period. While cities generally sourced stone from nearby outcrops, as seen for example in the cases of Vicenza and Verona, evidence also points out that some stone materials were the object of long-distance trade within the region. This trade was likely facilitated by an extensive waterway network, including the Po River and Adriatic coastal routes.

THE QUARRIES IN THE BELGRADE AREA AND THE ROMAN STONE MONUMENTS ALONG THE DANUBE FROM SINGIDUNUM TO VIMINACIUM (SERBIA)

Katarina Bradić-Milinović[1] – Divna Jovanović[2] – Bojan Djurić[3] – Igor Rižnar[4]
[1] University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia
[2] Geological Survey, Belgrade, Serbia
[3] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia
[4] G. E. Geološke ekspertize Igor Rižnar s.p., Ljubljana, Slovenia

Keywords: Tašmajdan quarry, Viminacium, Neogene limestone

The Roman settlements on the right bank of the Danube in Upper Moesia, from the confluence with the Sava to the Đerdap gorge (Iron Gates), are associated with many monuments of Middle Miocene limestone of Badenian and Sarmatian age. The most numerous among the monuments are funerary stelae and sarcophagi. The favourable transport capacities

along the Danube suggest their quarries should be sought in the area of Singidunum (Belgrade, Serbia). The best known is Tašmajdan, which is a Badenian limestone quarry located 2 km east of the Roman castrum and 2 km south of the Danube. Sarmatian limestone quarries in the vicinity of Belgrade are located at Bele vode, Sremčica, Repište and elsewhere, but none have been confirmed as operating in Roman times. The analysis of the Roman stone monuments comprised fifteen sarcophagi from Singidunum (7) and Viminacium (8), and forty stelae from Singidunum (17), Smederevo (7) and Viminacium (16). The monuments were investigated macroscopically and microscopically applying paleontological, sedimentological and petrological analyses. The results show that the sarcophagi from Singidunum and Viminacium are made of whitish to yellowish massive and well-cemented detritic limestone with characteristic Badenian microfauna with lithotamnium algae, rhodolites, corals, foraminifers and frequently poorly rounded detrital grains. The paleontological analysis shows that red algae from the genus Lithothamnium sp. predominate. This is characteristic of Badenian limestone and the specific lithotype has been identified across the Paratethys, where it is known as Leitha limestone. The same lithotype is also present in the Tašmajdan quarry in Belgrade. Furthermore, the microfossil assemblage of foraminifera exhibits the same species composition as in the limestones sampled from monuments. As for the stelae, analysis shows they are made of Badenian (20) and Sarmatian (20) limestone. Badenian limestone of the sampled stelae corresponds with the microfacies observed in the Tašmajdan quarry. Sarmatian limestone is usually brownish bioclastic packstone with characteristic fossil assemblages of benthic foraminifera and signs of changes in sea salinity, typical of the Sarmatian. The comparison of the samples and the macroscopic observations of the Roman monuments from Singidunum, Smederevo and Viminacium, on the one hand, with the samples taken from the quarries in the Belgrade area, on the other, reveals that part of the stone used for the production of sarcophagi and stelae very likely came from the quarries in the Belgrade area. Quarries of Sarmatian limestone are known along the Danube, but we lack firm evidence of their use in Antiquity.

THE PROVENANCE OF STONE FROM A LATE ROMAN CHURCH IN MILAVIĆI, BOSNIA AND HERZEGOVINA

Rok Brajkovič[1] – Petra Žvab Rožič[2] – Boštjan Rožič[2] – Adisa Lepić[3] – Saša Čaval[4]

[1] Geological survey of Slovenia, Regional Geology, Ljubljana, Slovenia
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia
[3] National Museum of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina
[4] Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia

Keywords: sedimentology, provenance, freshwater limestone

The inner (Dinaric) area of the Roman province of Dalmatia relied heavily on the local supply of stone to produce stone products. The southeastern area of Bosna and Hercegovina (vicinity of the towns of Stolac and Bileča) has been largely unstudied in terms of the Roman use of stone. Our investigations focused on architectural elements (baptismal pool, column fragments) of a newly discovered late Roman church in Milavići. Eleven samples were collected for sedimentological analysis. Lithofacies (LFT) and microfacies types (MFT) were identified. We also identified the lithofacies types of the stelae found in the surrounding settlements. In addition, field geological investigations were carried out. The preliminary identification of stone used to produce the stelae from the area surrounding the excavation site revealed the presumed local supply. However, the architectural elements of the excavated late Roman church present a different picture – we have identified three types of lithofacies: LFT1 – white homogeneous porous micrite limestone (MFT1 – ooid peloid limestone), LFT2 – white to yellow porous micrite limestone with organic matter (MFT2.1 – micrite limestone with organic matter, MFT2.2 – bioturbated micrite limestone with organic matter and MFT2.3 – micrite limestone with rare ooids and organic matter), and calcite tuffa. Sedimentologic identifications point to restrictive near-shore environments of LFT1 and 2 sedimentation. LFT3 – Calcite tuffa was identified in the local environment. The LFT1 and 2 are attributed to the middle Miocene based on identical lithofacies types to known successions of karstic shallow carbonate lakes. The closest outcrops of this type of lithofacies are located 70 km from the excavation site. Further research is ongoing, however also from the current data we can conclude that the architectural element from a late Roman church excavated in Milavići proves for the first time the regional transport of this lithofacies in the Roman province of Dalmatia.

THE USE OF AMETHYST IN DECORATION OF ALTARS: EXAMPLES FROM MILAN AND OTHER ITALIAN TOWNS (17TH–18TH CENTURIES)

Roberto Bugini[1] – Luisa Folli[2]
[1] CNR, Institute of Heritage Science, Milan, Italy
[2] Independent researcher, Lodi, Italy

Keywords: amethyst, altar decoration, Italy

Amethyst, the violet macro-crystalline variety of quartz, is one of the twelve precious stones decorating the walls of New Jerusalem (Revelation 21/20) and is already quoted in Exodus (28/19, 39/12). The mineral is mentioned by ancient (Theofrastus, Pliny), medieval (Isidorus, Marbodus, Albertus Magnus etc.) and modern Authors (Del Riccio, Aldrovandi, De Boot). Other ones (Cardano, Grapaldo) reported its supposed medicinal properties (against drunkenness) or described it in some capricious palaces (Colonna, Marino). Finally, encyclopaedists of the 19th century (Corsi, Quatremère) included Amethyst in their inventories. The origin is related to basaltic volcanites (Melaphyre) whose cavities are filled by Amethyst, Agate, Jasper and Zeolites. The most important European source was located near Idar-Oberstein (Rhineland-Palatinate, Germany), but ancient Authors also reported an unspecified eastern provenance (India). Amethyst, and other gems, were skilfully mounted in gold works and jewellery (necklaces, amulets, regal and liturgical objects etc.) of Egypt, Greece, Rome, Middle Ages (Iron Crown of Lombard Kings, Monza). Amethyst and gems were also the stuff of "intaglio" (carving) in Antiquity and in the Italian Renaissance: i.e. artefacts from different Milanese workshops, quoted by Vasari (late 16th century). Amethyst was also employed in the renowned "commesso di pietre dure" (inlay): a technique, that flourished in Florence (Opificio Pietre Dure, 1588) and in other Italian towns, especially to decorate pieces of furniture (i.e. bunch of grapes – Paris, Louvre, table OA12152). Cutting and polishing enhanced the features (colour, shade, transparency) of Amethyst, which are useful to distinguish the mineral, when it is impossible to carry out any investigation and when archives are vague about the nature or provenance of stone materials. This study considers the works of distinct craftsmen (Garavaglia, Rusnati, Corbarelli, Sacchi etc.), often with sons and relatives, during the 17th and 18th centuries. They employed Amethyst in selected structures of churches (tabernacles, altar-fronts, balustrades etc.) in Milan, Brescia, Vicenza, Rome etc. The mineral was always joined together with other gemstones (Lapis lazuli,

Jasper, Agate etc) and marbles, alabasters, granites etc.; its application concerns thin slabs inserted in decorative patterns, in symbolic designs or visual representations.

THE REUSE OF COLOURED MARBLES IN THE OTTOMAN ARCHITECTURE - THE BUILDINGS OF "MIMĀR SINĀN" (16TH CENTURY)

Roberto Bugini[1] – Luisa Folli[2] – Zeliha Hale Tokay[3]
[1] CNR, Institute of Heritage Science, Milan, Italy
[2] Independent researcher, Lodi, Italy
[3] Mimār Sinān Güzel Sanatlar Üniversitesi, Mimarlık Fakultesi, Restorasyon Bilim Dalı, İstanbul, Turkey

Keywords: Sinan, reuse, coloured marble

The architect Sinan (mimar Sinan Qoğa), one of the most outstanding figures of the Ottoman world, played a leading role in the architecture of the 16th century and beyond. His buildings are predominantly located in İstanbul and surroundings: tombs (türbe), bath houses (hamam), pavilions (köşk), palaces (saray) and small mosques (mescit), but the most significant are some complexes of edifices (külliye) including mosques (cami) with quadrangular courtyards (avlu) and ablution fountains (şadirvan), tall minarets (minar), theological schools (medrese), hospitals (darüşşifa), refectories (imaret) etc. The buildings of Sinan show an innovative conception of the space, mainly in the domed mosques: from basic square plan to hexagonal and octagonal ones; among these the most significant are: Šah-Zade, Süleymaniye and Şemsi Ahmed Paşa (İstanbul); Selimye (Edirne). Sinan duty, as Chief Court Architect, involved, in addition to the design, the choice of stone materials, the displacement to the yards, the working and the execution. A large number of architectural elements, both structural and ornamental, were made of coloured marbles of different origins; masonries, on the contrary, were made of squared blocks of a local limestone (Bakirköy, west of İstanbul). A large group of Sinān buildings was accurately examined to identify each coloured marble; this identification was favoured by the polished surface. The catalogue includes: Cipollino rosso, Granito violetto, Pavonazzetto, Proconnesian (Turkey); Cipollino, Porfido serpentino verde, Verde antico (Greece); Granito rosso, Porfido rosso antico (Egypt); Bianco e Nero antico (France). Coloured stones of local origin were also used, such as the pudding-stone of Hereke (province

of Kocaeli). The employ concerns: upright structural elements (columns and piers; monolithic shafts or superimposed drums); masonry units of arches and vaults (voussoirs and keystones; wedge-shaped blocks); floors and veneers (slabs of different shape, size and thickness). Different coloured marbles were used together, not only in decorative patterns: an alternation of shafts of two or three different marbles is typical of the courtyard. Coloured marbles almost always came from different edifices of Constantinople, built by the Romans and then dismantled by the Byzantines, the Crusaders and the Ottomans (before and after the Conquest – 1453). However, the prevailing presence of Proconnesian, also suggests the use of freshly quarried materials.

LAYERED MEANINGS AND THE CUTTING OF TWO-DIMENSIONAL RELIEFS IN STONE

Patricia A. Butz
University of California at Riverside, Department of Art History,
Riverside, California, United States of America

Keywords: relief carving, Egyptian rock-cut relief, Roman funerary relief

This paper addresses the phenomenon of relief carving in stone surfaces: the opportunities that are presented for the layering of subject matter, how to distinguish between deliberate layering and recutting, and how the stone itself may be influential. The topic is inspired by looking at an Egyptian example: the figural placement of Akhenaten and Nefertiti in two very similar scenes from the rock-cut tombs TA1 and TA2 at Amarna. In both of the scenes, the king and queen are seated in a kiosk, ostensibly receiving tribute. What makes the depiction so noteworthy is that they are seated side-by-side but not in the conventional way a couple is depicted together in Egyptian art. Akhenaten, in fact, blocks Nefertiti almost completely in both cases, but the line drawings from the 1905 Davies publication (Rock Tombs of Amarna II and III) make clear that the queen's feet and shins, for example, are seen extending very subtly beyond the overlap of Akhenaten.

This gives precedent for the actual relief that is the focus for the paper. The specific relief under examination is from the rock-cut temple of Abu Simbel in Upper Egypt where in one particular relief sequence, Ramesses II is shown combatting the Hittites in the Battle of Kadesh. It is the argument of this paper that the king is shown in a layered relief

composition, with Ramesses II fighting beside Amun-Re in a war chariot, each drawing his individual bow simultaneously against the enemy. While not as subtle as Amarna – Amun is more visible – the god is directly on the other side of the king.
The paper explores the meaning behind these depictions and compares them to the conventional 2-D method in Egyptian art, where one figure depicted fully behind the other is understood as the two seated or standing side-by-side. The visual message of "who is in front" is changed. It will be argued that what is seen at Amarna and Abu Simbel significantly embraces optical perspective while still retaining conceptual meaning. The expertise of the stone cutter and the stone proper make this possible.

MARBLE PROVENANCE OF A ROMAN FUNERARY VERSE INSCRIPTION FROM TIBISCUM (ROMANIA)

Chiara Cenati[1] – Vasiliki Anevlavi[2] – Walter Prochaska[2]
[1] University of Vienna, Institute of Ancient History and Classical Studies, Papyrology and Epigraphy, Vienna, Austria
[2] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: Latin epigraphy, Bucova marble, provenance studies

In this contribution, we present a compelling example of the use of high-quality local stone in the production of a funerary monument. The large inscribed slab from Tibiscum (CIL III 1552 = CIL III 8001 = CLE 460; IDR III/1, 157; http://lupa.at/17549) was part of a mausoleum dedicated to a former officer of an auxiliary unit of the Roman army stationed in Tibiscum during the mid-second century AD. The epigraphic field was originally flanked by two reliefs depicting Attis, of which only one survives. The inscription goes beyond a simple funerary text, presenting a poem that reflects on the rest granted in death to the officer after the prolonged hardships of military service. The execution of the reliefs and the palaeography of the text are notably meticulous. Furthermore, the inclusion of a poem in place of a conventional inscription underscores the intention to create a monument that would stand out among its contemporaries.
An analysis of the stone has revealed that this substantial monument was crafted from marble sourced from the Bucova quarries. The sample was analysed via isotopic (oxygen and carbon) and geochemical/trace element

analysis (ICP-MS). The analysis confirms that the artefact is made of local marble from the area of Bucova. In the study made by Müller and Piso, it was observed that Bucova marble was the most commonly used stone for public buildings, honorific monuments and funerary structures in Roman Dacia. Its high quality and ease of transport made it an ideal material for large-scale monuments, including architectural works.
The combined approach of epigraphy and provenance studies proves indispensable in achieving precise historical insights. This particular investigation not only corroborates the initial conclusions of Müller and Piso on the widespread use of Bucova marble in Sarmizegetusa and Tibiscum but also represents a first step towards reconstructing the marble trade routes in the Danube and Balkan regions, including the distribution of semi-finished products.

POROSIMETRIC AND RELATED PETROGRAPHIC CHARACTERISTICS OF GREEK AND MICROASIATIC WHITE MARBLES USED IN ANTIQUITY

Alberto Conventi[1] – Lorenzo Lazzarini[2]
[1] IUAV University of Venice, LAMA Laboratory for the Analysis of Ancient Materials, Venice, Italy
[2] Istituto Veneto di Scienze, Lettere ed Arti, Venice, Italy

Keywords: ancient white marbles, porosimetry, petrography

Porosity is one of the very important physical properties of building materials, greatly controlling their behaviour and durability over time. It is in fact the most important parameter to be evaluated to establish the degree of deterioration of a marble/stone, and to find out the best consolidation material and restoration methodologies. Even from an in-depth research in the specialist literature relative to the pure, white crystalline marbles used for statuary and architecture in antiquity, it appears that data on the primary porosity of such marbles, in spite of its relevance for monuments conservation, are very limited, if not practically non-existent. This is why this paper considers the main porosimetric features measured by Hg-intrusion of major (and some minor) white and grey marbles used in antiquity originating from Greece and Asia Minor. Porosimetric parameters being in direct relation with the genesis of a rock and its petrographic features, are also important in sé, and may be useful for their characterization finalised to provenance determination of an object. In fact,

for marbles they depend from fabric, grain boundaries shapes, average and maximum grain size, all parameters that were here studied in thin section under a polarising microscope. These two analytical methodologies (porosimetric and petrographic) have been applied on a preliminary basis to samples collected in ancient quarries of Mounts Hymettos, Pentelic, of the islands of Paros, Naxos, Thasos, Fourni, and from Aphrodisias, Göktepe, Docimium, Proconnesos, Ephesos, Iasos, Heraclea ad Latmum, Thiounta). The results showed, as expected, a variability of the average porosity mainly related to fabric types (homeo/heteroblastic, mosaic, equilibrium/non equilibrium, mortar, etc.), grain size and crystal boundary types, the lower values having been found on marbles with fine grain, equilibrium fabric and curved-embayed boundaries. The comparison between the various Greek and Microsiatic marbles has been extended to the most common type (ordinario) of Carrara marble.

MARBLE FRAGMENTS FROM THE SUBURBAN COMPLEX (IV, XVII 4) OF OSTIA (ITALY)

Paolo Cremisini[1] – Marcello Turci[2] – Fabrizio Antonelli[3]
[1] Cooperativa Archeologia, Rome, Italy
[2] University of Graz, Graz, Austria
[3] IUAV University of Venice, LAMA Laboratory for the Analysis of Ancient Materials, Venice, Italy

Keywords: marble, Ostia, notae lapidicinarum

This paper will focus on some of the results of the excavation campaign conducted between September and October 2022 at Ostia by the Karl Franzens Universität in Graz, with the participation of Sapienza University of Rome, as part of the larger research program launched in 2018 by the Centre Camille Jullian directed by Marcello Turci in collaboration with CEREGE, MAP-CNRS, CICRP, GEOPS, and LIVE of Strasbourg.
The excavation uncovered two sectors of a large building (surface area of approximately 15,000 m^2), the Suburban Complex IV, XVII 4, in the neighborhood outside Porta Marina, whose presence was partly already known through aerial images and limited archaeological trench excavations conducted by M. Heinzelmann in 2001. Among the materials that emerged in this context, there was a large quantity of architectural and coating marble fragments in the layers of the building's dismantling. Precisely because of their quantity and features, a study specifically addressing them was needed.

The paper will present these results, after a process of inventorying, classifying, and computing typological and metric data. Through these stages, a reconstruction of the marble decorative apparatus and the way it changed over different phases has been proposed. After reviewing the main lithotypes and fragment typologies, three major points will then be addressed:

- The presence of a room upholstered with Spanish broccatello dated to the Trajan era – an early case of employment of broccatello outside of Spain – whose known occurrences in Rome and the rest of Italy date from the Severan age onward.
- The discovery of a column base in white marble bearing a quarry inscription on its lower surface with a standard Apuan marble formula. Petrographic analyses, however, exclude the base's provenance from Apuan quarries.
- The finding of Asiatic Corinthian capitals fragments that are comparable to a capital from the Baths of Porta Marina (Squarciapino excavations 1971–1975), dated back to the second half of the 3rd century AD. Their measurements prove to be compatible with the above base, thus both fragments probably belonged to the same colonnade. From the base it is also possible to reconstruct the height of the column and get an idea of the height development of the building, which is otherwise completely unknown.

TRACING THE ORIGIN OF COPTIC LIMESTONE RELIEFS IN THE MUSEUM OF FINE ARTS IN BOSTON. THE QUESTION OF QUARRIES

Georgia Delli[1] – Anastasia Christophilopoulou[2]
[1] National and Kapodistrian University of Athens, Athens, Greece
[2] Museum of Fine Arts, George D. and Margo Behrakis Chair of Art of Ancient Greece & Rome Department, Boston, Massachusetts, United States of America

Keywords: limestone, Coptic reliefs, quarries

The Early Christian Coptic society was prosperous, numerous, vibrant and left behind a small artistic legacy interwoven in the byzantine history of Egypt. From this legacy the most famous are the funerary reliefs and portraits. The conquest of Egypt by the Arabs in 639 brought an end to

this production. Nowadays the few excavations in Egypt focusing on this period have brought to light several painted portraits, known as portraits of Fayoum, but very few sculptured reliefs from the provincial capital, bishopric side and important religious center, Oxyrhynchus. Only a few Coptic reliefs are found in the collections of the Museum of Fine Arts in Boston, coming mainly from Esna (Latopolis) and Kom Abu Billo. From the examination of those, however, new research questions arise. Aside from the stylistic and archaeological discussion, the problem of attributing the limestone artefacts to the quarries from whence they originated from, has not been examined thoroughly yet and calls for further scholarly discussion. The site of Kom Abu Billo, for example, is close to a quarry bearing the same name, and even though a relief sample from the area exists, research has not been conducted to relate those two. The present abstract and the forthcoming poster aim to present the known data deriving from the reliefs and the Late Antique known limestone quarries and pose further research questions. Hopefully, future interest will include an archaeometric research perspective which will answer the research problematics by taking samples from reliefs and quarries alike and by identifying the origin of the Coptic limestone reliefs of the Museum of Fine Arts in Boston.

MARBLE SCULPTURES IN MAGNA GRAECIA: STRATEGIES AND TECHNOLOGY

Fabiano Fiorello Di Bella
Scuola Superiore Meridionale, Area of Archaeology and Cultures of the Ancient Mediterranean, Naples, Italy

Keywords: Magna Graecia, marble sculpture, Greek archaeology

The absence of marble quarries in Magna Graecia has been repeatedly emphasised in the history of research, although exclusively for stylistic considerations, in order to ascribe the marble sculptures found in Magna Graecia to Greek sculptural traditions. This prevailing tendency, which can be traced back to Ernst Langlotz's Die Kunst der Westgriechen im Sizilien und Unteritalien (1963), denies any technical skill of the Western Greek artisan in the marble processing.
This contribution aims to analyse the specific strategies used by local workshops to optimise the available marble, imported from Greece and processed locally.

The methodology used takes into account the autopsy carried out on published and unpublished sculptures. The working process is clear in unfinished sculptures, such as a statue of a kore from Taranto or the Archaic and Classical sculptures of Metapontum, which show numerous signs of marble piecing, metal attachments, repairs and joints. Nevertheless, the frequent use of acrolithic and pseudo-acrolithic techniques is also distinctive of areas where marble is lacking.
The outcome reveals a richer scenario for marble sculpture in Magna Graecia, less anchored to the motherland and more autonomous in the choice of functional solutions and technologies employed, which constitute the most authentic mark of local workshops.

THE EXTRACTIVE LANDSCAPE OF THE CITY OF ROME IN ANTIQUITY AS SEEN ARCHAEOLOGICALLY AND GEOLOGICALLY

Daniel P. Diffendale
Scuola Normale Superiore, Classe di Lettere e Filosofia, Pisa, Italy

Keywords: Rome, volcanic tuff provenance, quarries

Provenance studies of local stones differ from those of prestige materials like marble. An emblematic example is the city of Rome with its numerous quarries of volcanic tuff, which have served the city's architectural needs from the 7th century BCE until the present day. Recent studies have demonstrated the potential of trace-element analysis using inductively-coupled plasma mass spectrometry (ICP-MS) together with petrographic analysis to discriminate between the products of different volcanic deposits around Rome, as well as to distinguish broad areas of extraction within the same deposit (for example, between the Anio and Monteverde extraction areas of Tufo Lionato). Given the blanketing of the landscape by quarries and the nature of the distribution of trace elements in tuff, it is not yet possible to securely identify the products of specific ancient quarries. Drawing on the data of quarries made available by SITAR (the Sistema Informativo Territoriale Archeologico di Roma), studied under the auspices of the project "The INscribed city: urban structures and interaction in imperial ROME" (IN-ROME; European Research Council grant GA 101054143), it is possible to sketch an image of the ancient urban and suburban extractive landscape. Comparing this more fine-grained picture with the coarser one derived from the geochemical data allows us to better

understand the current limitations of tuff provenance studies and to identify lines of future research, such as the need for a much more extensive program of sampling and analysis.

NEW INSIGHTS ON ANCIENT QUARRYING OF VOLCANIC STONE MATERIALS AND POZZOLANS IN THE EUGANEAN MAGMATIC DISTRICT, NORTHERN ITALY

Simone Dilaria[1] – Michele Secco[1] – Jacopo Bonetto[1] – Caterina Previato[1] – Chiara Girotto[1] – Milo Katerin Pilgrim[2] – Luigi Germinario[3] – Claudio Mazzoli[3]
[1] University of Padua, Department of Cultural Heritage, Padua, Italy
[2] University of Texas at Austin, Department of Art and Art History, Austin, United States of America
[3] University of Padua, Department of Geosciences, Padua, Italy

Keywords: geochemistry of volcanic rocks, discriminant analysis, Euganean Hills

A research project led by the Department of Cultural Heritage and the Department of Geosciences of the University of Padua explores the exploitation and use of volcanic stone resources of the Euganean magmatic district of the Veneto region. This area, historically significant for its extensive utilization of trachyte, consists of a series of independent volcanic outcrops, formed after a major eruptive phase of differentiated mainly subvolcanic rocks dating back to the Lower Oligocene. The project involves systematic sampling of historical and abandoned quarry sites within the Euganean district, including trachyte formations and lesser-known lithotypes such as rhyolites, latites, and breccias from explosive diatreme outcrops. An updated database comprising around 250 reference samples, fully characterized through Optical Microscopy (OM), X-ray Fluorescence (XRF), and X-ray Powder Diffraction (XRPD), has been created. This comprehensive database has been crucial to define the exact provenance of compatible stones samples collected from different archaeological sites of the region. More than 400 samples comprising both stones and mortars were collected from buildings and structures of several ancient towns in the Veneto region, including Padua, Vicenza, Adria, Oderzo, Concordia, and Montegrotto. The archaeological samples were analysed using the same protocols and subjected to multivariate statistical analyses, including Principal Component Analysis (PCA) and Discriminant Analysis (DA).

These methods enabled precise matching of archaeological samples with their corresponding geological references, thereby identifying, in most cases, their exact quarrying origins. In addition to the extensive use of trachyte, the research uncovered unusual practices involving the quarrying and use of other volcanic materials from minor extraction sites that were notably employed as pozzolanic additives in mortar and concrete production. In conclusion, by leveraging a structured database containing geochemical and petro-mineralogical data from various outcrops of Euganean volcanic rocks, and employing a rigorous analytical protocol combined with statistical data processing, it has been possible to achieve a high-resolution provenance determination. This approach has provided fresh insights into the craftsmanship of ancient artisans and has enabled a deeper exploration of the transportation, distribution, and trade of materials from the Euganean quarries in north-eastern Italy.

PROVENANCE STUDY OF MARBLE USED IN ROMAN SCULPTURES FROM PERGE, TURKEY

Murat Dirican[1] – Vasiliki Anevlavi[2] – Walter Prochaska[2] – Süleyman Atalay[3] – Gül Işın[4]
[1] Leiden University, Faculty of Archaeology, Leiden, Nederlands
[2] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria
[3] Antalya Museum, Antalya, Turkey
[4] Akdeniz University, Department of Archaeology, Antalya, Turkey

Keywords: Perge, marble, provenance

The ancient city of Perge is one of the most significant settlements of the Pamphylian cultural region. Distinguished by its hundreds of original sculptural finds dating to the Roman Imperial Period, Perge is situated 18 kilometers east of Antalya (Turkey), nestled between the rivers Kestros (present-day Aksu River) and Katarraktes (present-day Düden River), on a fertile plain.
Excavations in the ancient city of Perge have been ongoing since 1946. Numerous sculptures have been unearthed during excavations carried out in various monumental structures across the city. These sculptures, primarily made of marble, comprise Roman Imperial period portrait sculptures as well as copies of Classical and Hellenistic period works. Some

of these findings have been published and introduced to the academic community.
However, no research to date has provided concrete data regarding the material, production, and workshop-related issues of these artefacts. The identification of the materials from which the sculptures were made has been limited to visual inspection, and it has been suggested that only fine-grained examples may be composed of Dokimeion marble.
For the first time, this study presents petrographic, geochemical, and isotopic analyses of 27 marble samples, most of which are associated with the sculptural finds from the Northwest Nymphaeum (F5) of Perge. The aim is to contribute concrete data to the discussion concerning the material, production, and workshop characteristics of the Perge sculptures.
According to the archaeometric data obtained, while some of the analysed samples are linked to the Dokimeion source area, a few dolomitic examples may be associated with the Thasian quarry of Vathi. The remaining samples are thought to be potentially related to various quarry sites in Asia Minor. The results could indicate that Roman Perge, which constituted a sculptural school of sorts, imported marble from different regions – an expected outcome considering the city's socio-economic relations and cultural sophistication.

LIMESTONE AND ITS QUARRIES FOR COLONIA ULPIA TRAIANA POETOVIO (PTUJ, SLOVENIA)

Bojan Djurić[1] – Katarina Bradić Milinović[2] – Iva Ciglar[3] – Igor Rižnar[4]
[1] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia
[2] University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia
[3] Regional Museum Ptuj-Ormož, Ptuj, Slovenia
[4] G. E. Geološke ekspertize Igor Rižnar s.p., Ljubljana, Slovenia

Keywords: Poetovio, Slovenske gorice, Neogene limestone

The general impression concerning the use of stone in the Roman colony of Poetovio, now Ptuj in northeastern Slovenia, is one dominated by white marble used for the monumentalisation of the city and its cemeteries. However, the city reveals an almost complete lack of masonry structures preserved above their foundations, hence offering a very limited knowledge of the construction stone, which was never marble. The relatively few surviving architectural elements (column capitals, shafts and bases) and

some new discoveries of in situ architectural remains show that Neogene limestone was used for these and several other purposes.
Two main types of Neogene limestone have been identified in the architecture and architectural members, as well as in the sepulchral and other monuments. One is Lower Badenian, whitish to yellowish bioclastic limestone with more or less quartz and quartzite grains derived from the pre-Neogene basement, used for column shafts and capitals, sarcophagi and altars. The other is yellowish and porous ooid limestone of Sarmatian age, employed in the construction of the city walls.
As for their source, a series of Neogene rocks is exposed east of the Pohorje Mts, in the hills of Slovenske Gorice between the Drava and Mura Rivers. A narrow, roughly 4 km wide belt of Badenian and Sarmatian strata, with a southwestern-northeastern orientation, is cropping out east of Maribor between the Drava and Pesnica Rivers. Within this belt, a thick Badenian limestone horizon is located between Kamenščak and Hrastovec, while a thinner horizon of Sarmatian limestone is exposed at Rebrca above the Spodnji Duplek village and continues due northeast. A sudden turn in the course of the Drava between Ptuj and Maribor is an erosional effect caused by more resistant limestone horizons in the Neogene succession in comparison with the less resistant Neogene clastites in the surrounding area.
The quarries of Badenian and Sarmatian limestones that have been recognised within this belt some 13 km upstream from Poetovio seem to be the optimal choice considering the transport possibilities along the Drava. More precisely, Badenian limestone was quarried on the Kamenščak hill, southeast of Maribor, and Sarmatian limestone on the Rebrca hill, some 3.5 km further east, both at the Drava.

PROVENANCE OF BLACK AND WHITE TESSERAE FROM SELECTED ROMAN MOSAICS IN SLOVENIA

Sabina Dolenec[1,2] – Judita Lux[3] – Bernarda Županek[4] – Snježana Miletić[5] – Maja Gutman Levstik[6] – Katharina Zanier[7] – Andrej Šmuc[8]
[1] Slovenian National Building and Civil Engineering Institute, Ljubljana, Slovenia
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia
[3] Institute for the Protection of Cultural Heritage of Slovenia, Development Service, Ljubljana, Slovenia
[4] Museum and Galleries of Ljubljana, Ljubljana, Slovenia

[5] Geological Survey of Slovenia, Ljubljana, Slovenia
[6] Institute for the Protection of Cultural Heritage of Slovenia, Conservation Centre, Restoration Centre, Ljubljana, Slovenia
[7] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia
[8] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia

Keywords: mosaics, provenance, Roman period

Mosaics represent one of the best-preserved and most widespread archaeological artefacts from Roman times. In Slovenia, they have been found in many larger Roman towns (e.g., Emona/Ljubljana, Celeia/Celje and Poetovio/Ptuj), smaller towns and villages (e.g. Neviodunum/Drnovo and Črnomelj), and in suburban, rural (e.g. Mošnje and Šentpavel) and maritime villas (e.g. Izola). All mosaics as found in Slovenia are floor mosaics crafted using the opus tessellatum technique, generally covering floor surfaces in richly decorated public buildings, town houses and villas, mainly in dining rooms, baths and other representative spaces. While most mosaic studies focus on stylistic grouping, design development, and art history, provenance studies of tesserae are less common in archaeometric research, especially those using microfacies analyses of stone tesserae. This contribution presents the microfacies characterization of white and black tesserae from selected Roman floor mosaics in Slovenia, with the aim of defining their provenance. We studied tesserae from different mosaics from the Roman towns of Emona and Celeia (present day Ljubljana and Celje), a villa maritima in Izola and a villa rustica near Mošnje. The mosaics usually contain simple black and white geometrical and/or vegetative or animal motifs and are mainly made of white and black stones (tesserae), while coloured ones are less common. They are dated from the Early Roman (late 1st century BC) to the late Roman/Early Christian period (late 4th and 5th century AD). To be able to focus on a wide range of questions about tesserae supply, quarries, fluctuations in supply and demand through time etc. only archaeologically well documented and chronologically determined mosaics were included in this analysis. Samples of stone tesserae were studied using a stereomicroscope (for macroscopic sedimentary features) and optical microscopy (to analyse the mineral and bioclastic composition, as well as the structural and textural properties of tesserae). Results showed that all white and black tesserae consisted of limestone with several microfacies identified. In both black and white tesserae the microfacies

types are quite diverse. Most of the identified facies can be found in the Cretaceous successions of the Dinaric Carbonate Platform in south-western Slovenia, north-eastern Italy and south-eastern Croatia, suggesting a regional or imported origin of the tesserae. In the case of the mosaic tesserae from Izola, a regional provenance is assumed, while for Emona, Celeia and especially Mošnje, the tesserae are considered to be imported.

ROMAN QUERNSTONES FROM EMONA (LJUBLJANA, SLOVENIA): PETROGRAPHIC AND GEOCHEMICAL CHARACTERISTICS

Sabina Dolenec[1,2] – Bernarda Županek[3] – Luka Križanič[2] – Doroteja Muhić[2] – Matej Dolenec[2] – Nastja Rogan Šmuc[2]
[1] Slovenian National Building and Civil Engineering Institute, Ljubljana, Slovenia
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of geology, Ljubljana, Slovenia
[3] Museums and galleries of Ljubljana, Ljubljana, Slovenia

Keywords: Roman quern stones, petrographic and geochemical analysis, Emona

The archaeometric examination of grinding tools, which were frequently found at Roman excavation sites in the Mediterranean region, could provide information about the production sites of these artefacts and shed light on the ancient trade routes. In the Roman period, millstones and quern stones were produced on a large scale and exported in large quantities to and from various provinces of the Roman Empire.
The City Museum of Ljubljana houses 37 fragments of cross-stones from Roman contexts. They were found in Emona and its surroundings. Most of them are small or large fragments, provisionally dated to the 1st to mid-5th century AD. In this contribution we present the results of mineralogical-petrographic and geochemical analyses of 21 quern stones found in Emona and preserved in the City Museum of Ljubljana. With the applied analyses, we have tried to clarify the question of which rocks these querns were made of and where they originate from.
The samples were analysed by optical microscopy, X-ray powder diffraction and chemical analysis by ICP-OES. The research results show that the Emona quern stones belong to the various igneous (extrusive) and sedimentary rocks. The area of origin was determined for most of the quern

stones examined, with the various extrusive rocks coming mainly from Italy (Orvieto, Monte Vulture and Sicily) as well as Spain or France. The sedimentary rocks from which some of Emona's quern stones were made most likely originated from the local region. Emona was supplied by quarries that were relatively easily accessible and located in the immediate vicinity of the city.

FROM LIMESTONE TO LANDMARK: RECONSTRUCTING ROMAN IMPERIAL WORKFLOWS OF QUARRYING, TRANSPORT AND CARVING IN THE TAURUS MOUNTAINS, SOUTH-WESTERN ANATOLIA

Frans Doperé – Bas Beaujean
KU Leuven, Faculty of Arts, Department of Archaeology, Leuven, Belgium

Keywords: quarry, stone carving, transport

The archaeological site of Sagalassos (Turkey), located in the Taurus Mountains of south-western Anatolia, lies in proximity to high-quality limestone deposits that were crucial for its Roman Imperial building projects. Over four decades of research by the Sagalassos Archaeological Research Project and the Pisidia Survey Project have documented the extraction and processing of cut stone blocks. Quarries have been identified within the urban centre, necropoleis, and at two key locations approximately 5 kilometers north-west of the settlement: the Ağlasun Dağları Pass and Sarıkaya.

Archaeometric analyses confirm that most ashlars used in Roman Imperial structures were sourced from local quarries, as well as those at the Ağlasun Dağları Pass. Earlier assessments suggested that these quarries could not fully account for the volume of ashlars used. However, recent investigations revealed an extraction trench 20 meters above the modern walking level at the Ağlasun Dağları Pass, indicating sustained quarrying activities. This new evidence highlights the pivotal role of these quarries during the late 1st century BCE to early 3rd century CE, a period when Sagalassos emerged as a prominent regional center.

Recent follow-up surveys around the Ağlasun Dağları Pass documented additional quarrying traces and abandoned, half-finished artefacts such as ashlars and other profiled architectural elements. The distribution of these artefacts, along with their positioning along routes leading toward Sagalassos, points to the existence of a quarry road that facilitated transport

across the rugged Taurus terrain. Furthermore, similarities in carving tools used to finish building blocks from different quarries suggest that final processing of building elements occurred near the construction sites.
To complement these new findings, a GIS-based cost surface model was developed to reconstruct the most plausible transport routes and methods. The integration of archaeological evidence and GIS modeling allows for a detailed understanding of the workflow involved in quarrying, pre-processing, transport, and final finishing of building materials for Roman Imperial Sagalassos. This multidisciplinary study provides detailed and archaeologically substantiated insights into the logistics of large-scale construction in the Roman world.

GRANITE PROVENANCE AND IDENTIFICATION OF JINSHAN AND JIAOSHAN STONES FROM SUZHOU, CHINA: PRELIMINARY INSIGHTS AND IMPLICATIONS FOR ARCHITECTURAL HERITAGE RESEARCH

Qian Du – Wei Zhao
Shanghai Jiao Tong University, School of Design, Department of Architecture, Shanghai, China

Keywords: granite, provenance, Suzhou

This study focuses on the origin, current status, and identification of Jinshan and Jiaoshan stones, aiming to provide crucial evidence for the historical and chronological research of architectural heritage. Jinshan stone, sourced from Suzhou, China, is one of the most significant granite sources in the Shanghai and Tai Lake region. According to the Yingzao Fashi (Treatise on Architecture), Suzhou has two granite-producing mountains: Jinshan and Jiaoshan. Jinshan stone is characterized by its hardness, fine texture, slight brittleness, and a colour ranging from white with a hint of blue to pale red, with few black spots. In contrast, Jiaoshan stone is softer, with coarser grain, more black spots, a yellowish tint, and small voids. Both types of stone were used in the construction of walls, columns, steps, and other architectural elements.
This study examines the origins and current status of Jinshan and Jiaoshan stones through the investigation and sampling of granite mining areas and existing quarries, including those in Mudu, Tianchi, Dajiao, and Tianping. Local stone processing factories were also visited to understand traditional quarrying techniques.

The study reveals that large-scale extraction of Jinshan stone ended in the latter half of the 20th century, with small-scale quarrying now primarily serving landscape features, such as railings, pavements, and sculptures. Significant variations exist in the stone's characteristics across different quarries within the same region. Even within a single quarry, the quality of the extracted stone can vary significantly. Relying solely on historical descriptions, it is easy to confuse Jinshan stone with Jiaoshan stone, especially since the Jinshan area includes stones with characteristics similar to those of Jiaoshan. Therefore, the integration of petrographic and geochemical analysis is essential for more accurate identification of stones from the Jinshan region, laying the groundwork for future provenance studies and database development.

AUGUSTUS AND THE OBELISKS

J. Clayton Fant
University of Akron, Department of History, Akron, Ohio, United States of America

Keywords: Roman emperor, Aswan granite, obelisk

Octavian spent only five months in Egypt after defeating Antony and Cleopatra in 30 BC. But in that time he not only formulated his approach to governing Egypt but also seized upon its resources to glorify Rome and himself as its new leader. Central to this were obelisks. Octavian immediately appreciated their great visual and propaganda impact. The timing is clear from the Latin inscription on an obelisk first brought to Alexandria and later to Rome: "on the order of [Octavian], Cornelius Gallus, praefectus fabrum (chief of engineers), built the Forum Julium" in Alexandria. When Octavian left Egypt in January of 29 BC, Gallus' title became Prefect of Egypt; therefore Octavian must have given that order soon after his arrival, and by then he had already learned that disused obelisks were available among the ruins of Heliopolis nearby. The best known obelisks of Augustus (his title after 27 BC), are the two large obelisks brought from Alexandria to Rome in 13 BC. One was installed in the Circus Maximus, the other as the pointer of a solar pavement in the Campus Martius. They have been the focus of much interest recently, but often without context other than urbanistic. But they were not Rome's first obelisks but part of a discourse originating in the Forum Iulium where the first obelisk now announced Egypt's subjugation to Rome and the Caesars.

In two of Augustus' earliest monuments obelisks repeated this message. In the Mausoleum DeVos noted a depiction of the double crown of Egypt adorning a ceiling coffer; and two obelisks flanked the entrance, recalling Egyptian tradition but now serving a Roman monument. Together they link Augustus to the kingship of Egypt and to the king as avatar of Amon-Re, the sun god. In the Temple of Palatine Apollo, vowed before the battle of Actium, Pensabene has recognized the remains of two obelisks anchored to the cella walls at the entrance; they were reminders of the Egyptian queen's defeat. The obelisks of the Campus Martius and the Circus in 13 BC became focal points of much larger Roman landscapes, but their core message remained the same, explicit in the identical inscriptions of their bases: Augustus "dedicated (them) as a gift to Sol because of Egypt's subjugation." Only the Pharaoh could dedicate obelisks, and as Bowersock pointed out, here Augustus as dedicator supplanted the Egyptian king, just as the Latin Sol displaced Amon-Re.

FROM QUARRY TO MARKET: TRACING THE ROMAN STATUARY PRODUCTION IN THE INLAND BALKANS

Ines Ferjan
University of Edinburgh, College of Arts, Humanities and Social Sciences, School of History, Classics and Archaeology, Edinburgh, United Kingdom

Keywords: statuary production, workshop organisation, marble provenance

The socio-economic dynamics shaped organisation and trade networks involved in statuary production in the Balkan hinterland during the Roman period. Building on previous studies, this work enhances our understanding of the logistical processes behind statuary production and offers a comprehensive analysis of regional variations in marble use and artistic practices.

This research examines production stages between the quarry and customer, developing production models that emphasize the varying roles of workshops based on their location – whether near quarries or closer to markets. These models are supported by statues with previously studied provenance, including part-worked examples that illuminate the operational challenges workshops faced. By focusing on representative statues from the study area, the research reconstructs the lifecycle of these statues, tracing their journey from quarrying to final display. The analysis of part-worked statues reveals presumed intermediate production stages and

highlights challenges such as material flaws and logistical constraints. The findings demonstrate how local geology influenced the diversity of statues in the inland Balkans and explore the socio-economic factors driving the choice between imported marble and locally sourced stone. In the northern inland Balkans, marble imports were significant, although local commissioning of lower-quality stone remained viable. A key distinction between Mediterranean and Eastern Alpine marble imports lies in their carving stages: the former were often transported as finished or near-finished statues, demonstrating high craftsmanship and catering to the upper strata of society, while the latter were occasionally shipped as raw blocks or part-worked pieces for local completion. In contrast, the southern inland Balkans, abundant in high-quality marble suitable for statuary, predominantly relied on local production, with only occasional external commissioning. Together, these production models reveal the interplay of logistics, craftsmanship, and consumer preferences, underscoring the economic complexity that underpinned ancient sculptural production.
All of this contributes to a deeper understanding of statuary production stages, revealing regional adaptations in material use, workshop practices, and trade networks within the Roman Empire. While the analysis primarily relies on statues with previously studied material provenance, it identifies a methodological gap in the limited application of chemical testing for Roman statuary in the Balkans and advocates for future interdisciplinary research for more refined insights into Roman craftsmanship.

MAPPING MARBLE: GIS INSIGHTS INTO WHITE MARBLE IMPORT NETWORKS IN SOUTHERN PANNONIA DURING THE ROMAN PERIOD

Ines Ferjan
University of Edinburgh, College of Arts, Humanities and Social Sciences, School of History, Classics and Archaeology, Edinburgh, United Kingdom

Keywords: marble trade, Roman transport networks, GIS analysis

Southern Pannonia, which lacked local marble resources, relied entirely on imports during the Roman period, necessitating efficient logistical solutions for stone transportation. The viability of these transport networks depended on topographical constraints and economic considerations. While previous studies have explored stone trade routes in this region to some extent, geospatial models have not yet been applied to reconstruct potential trade routes.

This study employs advanced geospatial modelling techniques, specifically Circuit Theory, Least Cost Path, and Cost Corridors, to analyse potential Roman trade routes for marble. These tools facilitate an investigation of the decision-making processes involved in selecting specific routes, including conditions under which overland transport might be favoured over fluvial routes. The research focuses on marble imports into southern Pannonia, categorised into two main groups: Eastern Alpine marble and Mediterranean marble. While Eastern Alpine marble was transported via overland and fluvial routes, Mediterranean marble traversed seas before reaching distant Roman settlement. Although sea navigation is excluded from this geospatial analysis, the role of major ports in transshipment and onward movement of imports is examined. The Circuit Theory analysis proves particularly valuable by identifying alternative routes that might otherwise be overlooked and offering fresh perspectives on the complexity of the Roman stone trade network. The findings highlight the importance of economic factors and logistical challenges in determining optimal modes of long-distance transport. However, the study acknowledges limitations in the geospatial models, particularly their inability to fully account for maritime navigation and upstream or downstream travel, necessitating complementary archaeological evidence.
This research demonstrates the potential of modern analytical approaches to advance the archaeological understanding of Roman trade networks. By proposing plausible transport routes and identifying gaps for further investigation, it contributes to understanding of the logistical frameworks underlying the Roman marble trade.

THE MARBLE REVETMENTS IN THE THERMAL SPACES IN THE HISPANIA CITERIOR PROVINCE: COLOUR AND AESTHETICS

Laura Galán Palomares
Catalan Institute of Classical Archaeology, Archaeometric Studies Unit, Tarragona, Spain

Keywords: Hispania Citerior, thermae, marble revetments

The paper explores the use of decorative marmora in the Hispania Citerior province through an in-depth study of the wall marble revetments in thermal spaces. Detailed analysis of examples from this province reveals that marmora revetment schemes – ranging from monochromatic designs

to complex polychrome compositions – were carefully crafted to shape and enhance the atmosphere of each room. These schemes also functioned to establish hierarchies between different spaces within a building.
Not only did the decoration serve as a marker of use, but the marmora themselves – with their colour, brilliance, veins, and strips – also fulfilled this role. In this regard, it is important to highlight the concept of «stoniness» – the aesthetics of ornamental rocks – and emphasize that its perception is not fixed, but varies depending on the observer and the landscape, which encompasses not only natural scenery but also urban and architectural settings.
My doctoral research has demonstrated that this dynamic was particularly evident in the thermal complexes of Hispania Citerior, where the selection of marmor varieties was deliberately guided by their colour and visual impact. In this regard, the selection of specific marble lithotypes – apparently guided more by their visual characteristics than their origin – for particular purposes invites reconsideration of the value and potential meaning attributed to colours, thereby enriching our understanding of ancient visual aesthetics.
Colour was evidently associated with notions of luxury, and the polychromy of the coverings served effectively this ostentatious purpose. Interestingly, the choice of marble lithotypes and their combinations seems to have been influenced primarily by workshops, which followed prevailing trends set by the likes of the metropoli, rather than by the personal preferences of building patrons. Patrons typically confined their decisions to commissioning marble for specific rooms, with the functionality of these spaces often dictating the organization and design of the marble revetments. This pattern is consistently observed in the thermal spaces of Hispania Citerior, where the use of marble was carefully curated to mark the function expected by the room that housed it.

TOWARD A SYSTEMATIC OVERVIEW OF FUNCTIONAL MARBLE FURNISHINGS IN ROMAN HISPANIA

Laura Galán Palomares – Begoña Soler Huertas
Catalan Institute of Classical Archaeology, Archaeometric Studies Unit, Tarragona, Spain

Keywords: marble furniture, production, trade

Among the various avenues of research into the use of marmor in Hispania, one of the most fruitful focuses on the production of portable marble objects. Though typically subsumed under the category of decorative sculpture, earlier studies have tended to center on typological and stylistic classification. Candelabra, fountains, vases, tables, wellheads, reliefs, and sculptures are commonly referred to as "marble furnishings" in the scholarly literature. These objects are closely linked to the notion of privata luxuria, which gained prominence at the end of the Republican era, though they are also found in select public and occasionally funerary contexts.

The body of research devoted to these productions in Hispania is substantial. Since A. Balil's foundational examinations, numerous contributions have enriched our understanding (E. Koopel, I. Rodá and F. Arasa for the province of Citerior Tarraconensis; P. Leon, P. Rodríguez Oliva, and P. Beltrán on Baetica; and T. Nogales's in Lusitania). Inquiries into specific categories have likewise emerged, such as Mª Luisa Loza's investigations of fountain-statues, Antonio Peña's focused analyses of small-scale hermae, A. Morillo and J. Salido on the impact of Hispania-based labra, or J. Bonnin's comprehensive corpus of Roman sundials.

From these varied contributions, one can sketch an initial classification that distinguishes objects with explicit utilitarian functions—such as tables, wellheads, and fountains—from those intended chiefly for ornamentation, including oscilla, pinakes, and other forms of decorative sculpture. However, the breadth of these categories, coupled with the absence of dedicated monographs on certain types, has created a gap in our understanding of the mechanisms that drove their production and circulation, as well as the origins of the workshops responsible.

In this proposal, we propose a preliminary framework for cataloging the functional marble furnishings attested in Hispania, with a focus on items specifically designed for everyday use—candelabra, thymateria, trapezophoroi, and labra, among others. The conclusions drawn from this study shed new light on the provenance of these objects, largely determined by the varieties of marble employed. In addition, the spatial distribution of certain decorative models reinforces the idea that specific fashions and practices took root in defined regions or within chronological horizons. Finally, to further the debate, we examine additional points of interest, ranging from technological expertise to the circulation of decorative motifs, as well as the way these objects were disseminated throughout the province, based on the extant evidence gathered to date.

ARCHITECTURAL MARBLES IN THE CAMPI FLEGREI (BAY OF NAPLES, ITALY): PROVENANCE IDENTIFICATION WITH ISOTOPIC AND PORTABLE X-RAY FLUORESCENCE ANALYSIS

Eleonora Gasparini[1] – Enrico Gallocchio[2] – John J. Herrmann, Jr.[3] – Robert H. Tykot[4] – Annewies van den Hoek[5]
[1] Università degli Studi della Campania Luigi Vanvitelli, Naples, Italy
[2] Parco Archeologico dei Campi Flegrei, Pozzuoli, Italy
[3] Museum of Fine Arts, Boston, Massachusetts, United States of America
[4] University of South Florida, Department of Anthropology, Tampa, Florida, United States of America
[5] Harvard University, Harvard Museum of the Ancient Near East, Cambridge, Massachusetts, United States of America

Keywords: Roman architectural decoration, marble identification, C and O isotopic analysis

The Parco Archeologico dei Campi Flegrei presents a scattering of architectural marbles, which represent only a small fraction of what originally must have appeared in the splendid Roman Imperial constructions of the area, but the various pieces seem to offer a rich variety of materials. Identification is often hampered by the dark surface discoloration, probably caused by ancient fire damage. Sampling of 18 pieces has been approved in order to determine the marble's provenance, and laboratory analysis will take place at the University of South Florida. The techniques used will be analysis with isotopes of carbon and oxygen and with a portable X-ray fluorescence spectrometer.
The Campi Flegrei contained ports and resorts important for the city of Rome, but the area also lay on the northern border of the strongly Hellenized regions of southern Italy. Its material culture is likely to have been cosmopolitan, and its architectural elements in white marble seem to show typologies and styles from widespread sources. Several Ionic capitals are the simple mainland Greek type, without the foliate decoration and decorated necks often seen at Rome, and their marble could be from Mt. Pentelicon near Athens. There are examples of mass-produced Corinthian capitals of Western Roman type probably in Carrara marble and others of Asiatic type of second century date, probably Lesbian or Proconnesian marble. A lotus capital is an Attic type, probably in Pentelic marble. Two especially beautiful capitals, an Asiatic Corinthian of Augustan date and a second-century decorated Asiatic-type Ionic, are a fine-grained

brilliant white marble that could be either Pentelic or Phrygian marble from Afyon, Turkey. A pair of late Roman composite capitals seem to be (calcitic) marble from the Greek island of Thasos. Some modest composite capitals of uncertain marble are an unusual mixture of Asiatic and Western Roman typologies.
The many architectural elements recovered from the submerged Severan constructions in the port of Pozzuoli could be from a variety of sources, and their identification may make it possible to associate these elements with different structures.
The results of the analyses should resolve many ambiguities and shed important light on this distinctive mixture of ancient architectural elements, apparently of diverse typological, stylistic, and material origins.

EVALUATION OF THE EXTRACTION OF PODPEČ LIMESTONE FROM THE PODPEČ QUARRY (SLOVENIA) FROM THE ROMAN PERIOD TO THE CLOSURE OF THE QUARRY

Mateja Golež[1] – Viktor Kmetec[2] – Rok Vezočnik[3]
[1] Slovenian National Building and Civil Engineering Institute, Department of Materials, Ljubljana, Slovenia
[2] GEO Viktor Kmetec s.p., Vrhnika, Slovenia
[3] Slovenian National Building and Civil Engineering Institute, Department of Geotechnics and Infrastructures, Ljubljana, Slovenia

Keywords: 3D model, Podpeč quarry, limestone

The Podpeč quarry is a relatively well-known natural stone deposit in the Slovenian area, which, with the placement of Plečnik's architectural heritage on the UNESCO heritage list, has also acquired internationally recognizable dimensions. In recent years, the Podpeč limestone and the Podpeč quarry have received a lot of additional research attention from both the geological profession, as well as archeology and urban planning The specific facies types associated with the lithological development of the Podpeč limestone have been identified. Additionally, a quarry dating back to the Roman period, although slightly older, is relevant to a proposed urban solution aimed at improving the navigability of the Ljubljanica River, which includes the establishment of a port in Podpeč.Added to the new findings is a 3D model of the quarry in Podpeč, which is located at the northwestern foot of St Anna hill, to estimate the amount of Podpeč limestone taken from

the time of the Roman era until the quarry in Podpeč was closed in 1973. This LIDAR model represents the basis for estimating the volume of natural stone taken, which was used for construction, decorative purposes and for burning lime. Based on the changes in the relief of the Podpeč quarry, the estimated material excavated is between 500 and 600 thousand m^3, which has not yet been assessed. The presented method of evaluating the extracted natural stone with the help of a 3D model gives a clearer picture of the significance of limestone as a building and decorative material, and which will be further improved in the future, because the method will be used to evaluate the entire landscape of the quarries on St Anna.

Accurate mapping of stone buildings, objects and archival material, which is still waiting for researchers in the future, can significantly contribute to improving the result of evaluating the used material from the quarry in Podpeč.

DECORATIVE AGGREGATE IN OPUS SIGNINUM PAVEMENTS FROM ROMAN EMONA (LJUBLJANA, SLOVENIA)

Maja Gutman Levstik[1] – Matevž Novak[2] – Bernarda Županek[3] – Jelka Kuret[1] – Matej Dolenec[4] – Sabina Dolenec[4,5]

[1] Institute for the Protection of Cultural Heritage of Slovenia, Restoration Centre, Ljubljana, Slovenia

[2] Geological Survey of Slovenia, Ljubljana, Slovenia

[3] Museum and Galleries of Ljubljana, Ljubljana, Slovenia

[4] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia

[5] Slovenian National Building and Civil Engineering Institute, Ljubljana, Slovenia

Keywords: opus signinum, Emona, aggregate

This study investigates the decorative aggregate of five pavements from the 1st to 4th century AD, located in insulae XIII and XVII of the Roman colony of Emona (modern Ljubljana, Slovenia). Four of the pavements from the insula XIII were excavated in 2016 (at the site on Slovenska cesta), while the pavement from the neighbouring insula XVII was excavated in 1963 (at the site on Aškerčeva cesta/NUK 2). The pavements were constructed using the opus signinum technique. This paving method was widely used throughout the Roman Empire in various rooms of private houses and public buildings, alongside the more renowned and costly

mosaic pavements. The investigated pavements varied in colour and type of aggregate used. The decorative elements included irregularly shaped ceramic pieces and a variety of stones, which were inserted randomly rather than following a geometric pattern. Before undergoing conservation-restoration processes, a sampling of aggregate from the pavements was conducted for optical microscopy analysis. The analysis, focusing particularly on the stone, revealed that black stones were identified as micrite and biomicrite mudstones to wackestones, which were present in all pavements. The yellow rock was identified as an ooid grainstone to packstone. The green stones were identified as a type of tuff known as pietra verde. The grey pebble was identified as micaceous quartz siltstone, while the dark red rock was determined to be red quartz sandstone. It is noteworthy that pavements of the opus signinum type are relatively common in Emona; however, they have received less attention compared to mosaic pavements, as they were considered less significant and less informative.

STONE FOR MOGONTIACUM (MAINZ, GERMANY). STUDIES ON THE REGIONAL PROVENANCE OF SANDSTONE IN GERMANIA SUPERIOR

Thomas Heide[1] – Christian Soder[2]
[1] Johannes-Gutenberg-Universität Mainz, Institute for Ancient Studies / Classical Archaeology, Mainz, Germany
[2] Institut für Steinkonservierung e.V., Mainz, Germany

Keywords: sandstone provenance, quarries, methodology

The Roman province of Germania Superior, lacking high-quality marble or limestone deposits in its immediate vicinity, heavily relied on alternative stone materials for elaborate stone products. While the initial period of Roman occupation saw the import of limestone from distant sources in Lorraine, local sandstone soon became the preferred material due to its widespread availability and ease of transportation along fluvial routes. Despite its ubiquity, sandstone remains an under-examined subject in the archaeological provenance research of the region.
This paper presents the first results of an ongoing interdisciplinary study that seeks to develop a methodological framework for the identification and classification of sandstone varieties used in the local Roman stone

industry. By integrating archaeological and geological approaches, the project aims to establish a comprehensive reference database for sandstone types found in Germania Superior and their respective sourcing areas. The project combines traditional quarry site documentation with advanced petrographic, geochemical, and isotopic analyses to refine provenance attribution. The integration of these approaches into the archaeological examination of stone objects seeks to improve our understanding of regional quarrying networks, material selection criteria and chronological sequencing.
Two distinct sandstone varieties (1. coloured sandstone; 2. sandstone of the Rotliegend group) been selected as test cases to evaluate the analytic techniques and the workflow used in this project to define provenance. The selection is based on their distinctive visual and structural characteristics, which facilitate their identification. A significant proportion of stone workings in Mogontiacum (modern Mainz, the provincial capital) are composed of these varieties, which are supposedly quarried in the surrounding areas. The objective of this paper is to determine the provenance of these materials and establish a chronological framework for their exploitation.
By introducing a new analytical toolset and expanding the available dataset, this research contributes to a more nuanced appreciation of sandstone's role in Roman material culture. The study's broader implications extend beyond Germania Superior, offering methodological insights applicable to provenance research in other regions.

NORTHERN GREEK WORKMANSHIP IN A DOLOMITIC MARBLE SCULPTURE IN THE MUSEI CAPITOLINI, ROME

John J. Herrmann, Jr.
Museum of Fine Arts, Boston, Massachusetts, United States of America

Keywords: EPR, Thasian dolomitic marble, Pergamon

In 2002 sculptures in Thasian-looking marble in the Centrale Montemartini at Rome were analysed with XRF by Richard Newman, and in 2012 a round of sampling was conducted in the Capitoline Museums for analysis by Donato Attanasio with EPR. The sculptures

chosen were coarse-grained, spotless white marble. Demonstrating that they are also dolomitic makes it clear that the material comes from the Cape Vathy area on Thasos. 31 sculptures proved to be Thasian marble, but none are typical products of Thasian workshops. All seem to be by sculptors well integrated into Roman workshops or well adapted to Roman standards. The use of Thasian marble, however, suggests the possibility that some of these works could have been produced by "Romanized" Thasians or northern Greeks, and a few sculptures have characteristics that stand out as potentially Thasian, or at any rate northern Greek. Here a Thasian marble figure in the courtyard of the Palazzo dei Conservatori (CD13) is advanced as a sophisticated but somewhat abnormal work probably by a northern Greek artist.

The sculpture, a colossal torso, has been identified as Dionysos but is more likely to be Herakles. Its modelling is unusually simple, with the rib cage and waistline scarcely indicated. The work has been considered poor quality ("The forms of the body are weak and superficially modelled" after Stuart Jones). The simplified treatment of anatomy, however, finds parallels in high quality sculpture of the Roman period in Pergamon. The primary sculptural marble at Pergamon is Parian, but a few dolomitic Thasian marble sculptures can be identified in the museum there (a Hellenistic cuirass from a victory monument and a headless statue of the Small Herculaneum Woman type). A large Hellenistic torso of dolomitic Thasian marble in the Vatican also appears to be carved by a Pergamene sculptor, and a similar treatment to the Herakles/Dionysos torso can also be found in a large table support with a figure of Dionysos in the Thasos Museum storage. The torso's unusually gentle treatment may well be due to the sculptor's provincial origin.

The treatment of the massive Capitoline torso may not be unique to works on Thasos or in Thasian marble, but the use of Thasian marble in this case tends to favor an attribution to a northeastern Greek sculptor. The case shows that identification of the marble source can shed useful light on the origin of the sculptor who worked it.

A THASIAN DOLOMITIC MARBLE ROMAN PORTRAIT FROM THE SANCTUARY OF ESHMUN, SIDON, LEBANON

John J. Herrmann, Jr.
Museum of Fine Arts, Boston, Massachusetts, United States of America

Keywords: Thessaloniki, provincial style, fizz test

A Roman marble portrait of a man with a short beard was excavated at the Temple of Eshmun in Sidon and then stolen during the Lebanese civil war in 1981. The portrait turned up on the art market in New York, where the dealer was informed of its illicit provenance. The dealer, Dr. Jerome M. Eisenberg, attempted to contact the Lebanese authorities but received no answer, and the head sat for years at the back of his gallery. It was eventually identified again and this time returned to Lebanon with considerable recrimination.

While in Eisenberg's gallery, the head, which appeared to be dolomitic marble from Thasos, was given a "fizz test" by applying muriatic acid (HCl) to the surface. Since there was no reaction (fizz), the head was confirmed as dolomitic rather than calcitic marble.

In his catalogue of sculpture from the Eshmun site, Rolf Stucky did not comment on the material and attributed the portrait to Asia Minor. It is, however, not only Thasian marble, but its workmanship also seems to be Thasian or, at any rate, northern Greek. The head is notable for its symmetry and its sharp, linear workmanship, with only a minimal use of the drill. The hair arrangement, in which rigidly parallel strands of hair form an arch over the forehead with a central fork, is a type known from the time of Nero in Rome and continues to be worn throughout the empire until well into the second century. These features are all familiar from the lower-quality portraiture of Thessaloniki and Macedonia in general and difficult to find all together in works in the Levant. The portrait's unusual beard, which passes under the chin and an absence of incision in the eyes, indicates a date in the time of Trajan or Hadrian (ca. 100–130 AD). The schematic character of the head brands it as provincial, but it is higher quality than usual, and its strong and relatively rich modeling connects it with the finest portraiture of Roman times on Thasos itself.

The sculpture is a clear case of craftsmanship having the same origin as the marble while reaching a distant location during Roman Imperial times. The marble was not used purely as raw material, and its identification is an important index to the origin of the sculptor.

DOLOMITIC MARBLE FROM THASOS IN THE CAMPI FLEGREI (BAY OF NAPLES, ITALY)

John J. Herrmann, Jr.[1] – Eleonora Gasparini[2] – Enrico Gallocchio[3] – Robert H. Tykot[4] – Annewies van den Hoek[5]
[1] Museum of Fine Arts, Boston, Massachusetts, United States of America
[2] Università degli Studi della Campania Luigi Vanvitelli, Naples, Italy
[3] Parco Archeologico dei Campi Flegrei, Pozzuoli, Italy
[4] University of South Florida, Department of Anthropology, Tampa, Florida, United States of America
[5] Harvard University, Harvard Museum of the Ancient Near East, Cambridge, Massachusetts, United States of America

Keywords: Thasian dolomitic marble, portable X-ray fluorescence, Baia

On a macroscopic basis 16 figural sculptures in the Parco Archeologico dei Campi Flegrei have been identified as white, coarse-grained marble from the Greek island of Thasos. The sculptures are located in the Castello di Baia and in the bathing complex at Baia. A preliminary survey has been made with portable Xray fluorescence (XRF), and 15 of the 16 revealed a component of magnesium, which indicates that they are dolomitic marble and hence from Thasos. Sampling is underway to determine in laboratory conditions whether this first diagnosis is correct.
The multitude of sculptures suggests that the sculptural workshop located in the Sosandra Baths at Baia may have had a particular fondness for Thasian marble.
A portrait of the Emperor Claudius (41–54 AD) may be the earliest firmly datable Thasian sculpture in Italy. Literary sources attest that Thasian marble was a notable novelty in the time of his adopted son and successor Nero, and the Claudius could be a work of that time or a pioneering work of Claudius' own time.
A few of the Campi Flegrei sculptures have echoes of works in the Thasos Museum, and the Athens National Museum. These parallels will be presented, and the question of Thasian and Athenian workmanship on the Bay of Naples will be explored.

THE DIMONCE ANDESITIC TUFF QUARRY AND ITS ROLE IN THE CONSTRUCTION OF GOLEMO GRADIŠTE, KONJUH (NORTH MACEDONIA)

Radomir Ivanović
Archaeological museum of the Republic of North Macedonia, Skopje, North Macedonia

Keywords: Andesitic tuff, quarries, Golemo Gradište

The archaeological site of Golemo Gradište, located in Konjuh, northeastern North Macedonia, within the municipality of Kratovo, is one of the largest Late Roman towns in the region, spanning 17 hectares. Strategically situated at the intersection of the Late Roman provinces of Dardania, Dacia Mediterranea, and Macedonia Secunda, the site flourished during the 6th century AD. Its prosperity was driven by its advantageous location in a mining region, a well-connected road network, and defensible fortifications. Although earlier phases of occupation are evident, the primary urban development occurred in the Late Roman period.
The construction of a settlement of this scale required vast amounts of building materials and skilled masons. Analysis of the stone used at Golemo Gradište reveals that andesitic tuff was the primary building material. This stone was largely quarried from the acropolis and its slopes, but the Dimonce quarry, located 800 meters from the northern terrace of the site, served as the primary source. This open quarry, covering 19 hectares, supplied andesitic tuff for structural and architectural elements and decorative liturgical features. Other stones, including white marble, coloured limestone, cipollino verde, and sandstone, were used primarily for sculptural and decorative purposes. While some of these materials were locally sourced, others were imported or reused as spolia, demonstrating a mix of local resources and external influences.

MODERN FLORAS OF ANCIENT QUARRIES

Thorsten Jakobitsch – Vasiliki Anevlavi
Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: modern vegetation, quarries, ecological studies

Quarry landscapes represent significant anthropogenic disturbances to the environment, where vegetation cover is stripped away to expose and extract the underlying rock of interest. This process creates a new landscape that, upon quarry abandonment, can evolve into an ecological niche for specialized species – plants and animals adapted to inhabit rocky surfaces. Consequently, abandoned quarries have the potential to enhance regional biodiversity. While extensive research has been conducted on vegetation in modern or recently abandoned quarries, the study of ancient stone extraction sites has been largely overlooked. These ancient quarry landscapes, long abandoned, are often covered by climax vegetation, making them invaluable for understanding the long-term development of plant communities. By examining these plant assemblages, researchers can gain insights beneficial for restoring modern quarries in renaturation projects and enhancing their ecological potential. Moreover, vegetation can play a pivotal role in field studies of quarries. Plants, with their specific requirements for soil pH, can act as bioindicators, helping to identify hidden boundaries of ancient quarries that are no longer visible. This paper highlights the relevance of plant studies in quarry research through case studies from Greece, demonstrating their utility in uncovering historical quarry landscapes and informing contemporary ecological restoration efforts.

SILICA-RICH SEMIPRECIOUS STONES IN PIETRA DURA TECHNIQUE: LINKING VISUAL AND COMPOSITIONAL VARIABILITY TO PROVENANCE ANALYSIS

Štěpán Jaroměřský[1] – Richard Přikryl[1] – Martin Racek[2] – Adam Culka[1] – Filip Košek[1] – Ivana Novotná[3]
[1] Charles University in Prague, Faculty of Science, Institute of Geochemistry, Mineralogy and Mineral Resources, Prague, Czech Republic
[2] Charles University in Prague, Faculty of Science, Institute of Petrology and Structural Geology, Prague, Czech Republic
[3] National Technical Museum, Prague, Czech Republic

Keywords: dolostone, eastern Baltic, provenance

Pietra dura technique, originally linked to 16th century. Florence and later spread to several important centres in Europe (e.g., Prague, Bohemia), represents the trickiest development of antique art of mosaics. The technique is known for combination of endless varieties of polishable hard

stones of extraordinary visual quality (combining colours and textures), cut in thin slabs, and assembled in in a way resembling paintings depicting landscape, veduta, or still life. Concerning stone types, numerous types of polishable limestones, known in antiquity, were combined with specific varieties of silica-rich precious stones including SiO_2 varieties such as amethyst, opal, agate, jasper, quartz, or silicates such as lapis lazuli. Jasper-like variety of silica belongs to the most popular materials due to its vivid colours. Although the origin of limestone used in the pietra dura technique has been extensively studied in the past, the provenance of its silica-based materials has largely been overlooked or described in a vague and superficial manner. The recent research therefore focuses on complex investigation of siliceous materials of the pietra dura technique from the point of view of their composition, resources, source area determination, and art period and/or regional preference of utilisation. The study benefits from the possibility of sampling and analyses of historically known localities such as Kozákov hill in NE Bohemia (one of the localities exploited since at least medieval times, and known to semiprecious stone collectors in the whole Europe) and some others in Bohemia (Czech Republic), Rheinland-Pfalz (Germany), etc. Due to variable genetic environments and phase composition of jasper-like materials, their multimethod laboratory study by optical microscopy, SEM/EDS, powder X-ray diffraction, spectroscopic techniques (Raman, Mössbauer) allows for finding significant fingerprinting difference. From non-destructive techniques, fluorescence under short-wave and long-wave UV radiation together with portable Raman spectroscopy provide powerful results applicable also for pietra dura artworks as well.

ROMAN STELE FROM THE CATHEDRAL OF ST TERESA OF ÁVILA IN BJELOVAR (CROATIA)

Ivan Jengić[1] – Martina Ivanuš[2]
[1] Croatian Conservation Institute, Department for Stone Sculpture, Zagreb, Croatia
[2] Croatian Conservation Institute, Section for Training, Professional Development and International Cooperation, Zagreb, Croatia

Keywords: Roman stele, restoration, stone

A fragment of a Roman stele with figurative depictions, embedded above the entrance to the Cathedral of St Teresa of Ávila in Bjelovar, was first

mentioned in archaeological literature in 1901. Built into the church upside down because it had an 18th century dedicatory inscription carved on the back, the relief was hidden until renovations at the end of the 19th century when it was photographed and briefly visible before being built back into the wall and covered with plaster. The stele was removed from the façade during the restoration of the cathedral in 2020, and made accessible for study once again. A significant portion of the upper part of the stele has been preserved, including the rectangular relief field and the triangular pediment above it. Unfortunately, the inscription and the lower section (inset) used to secure to the base have not been preserved. However, the preserved section does not generally deviate from the established features of Noric-Pannonian stelae suggesting that the monument was likely produced in one of the regional workshops. The head of Medusa is at the centre of the triangular pediment, and the highly damaged acroteria show traces of reclining lion figure. The foreground of the relief field is dominated by a female figure in a chiton with a cloak (himation) draped over her shoulders, and the figure of a man dressed only in a subligaculum and draped with a cloak. It is presumed that the stele depicts the escape of Iphigenia from Tauris. Based on stylistic characteristics, particularly the woman's hairstyle, the stele can be dated to the second half of the 2nd century or the very beginning of the 3rd century. In 2021, experts from the Croatian Conservation Institute conducted conservation and restoration of the stone stele to preserve it and prepare it to be displayed in a museum. This fragment of a Roman funerary monument is made of marble. The comprehensive restoration began with laboratory analyses, which guided the choice of the most suitable methods and restoration materials. Considering the numerous previously identified contaminations and damages to the stone, various cleaning and surface consolidation methods were employed along with minor reconstructions of missing parts of the stone relief, minimal sculptural retouching, and final chemical treatments for consolidation and protection of the stone. Upon completion of the restoration, the fragment of the stele was displayed in the future Diocesan Museum of the Diocese of Bjelovar-Križevci.

SCHAIDBERG MARBLE – A BY–PRODUCT OF THE SEVERAN ROAD CONSTRUCTION OVER THE RADSTÄDTER TAUERN (AUSTRIA)

Stephan Karl[1] – Astrid Stollnberger[2] – Raimund Kastler[3]
[1] Archaeogon, Bayer & Karl GesbR, Graz, Austria
[2] University of Salzburg, Department of Ancient Studies, Salzburg, Austria
[3] State of Salzburg, Department 2/03, Folk Culture, Cultural Heritage and Museums, Salzburg, Austria

Keywords: Roman road, milestones, Schaidberg marble

Schaidberg marble is a fine-grained, highly translucent, white to yellowish metamorphic rock with yellow veining. It exhibits strong foliation and, in certain regions, has transformed into hard mylonites. Historically quarried at around 1600 m a.s.l. near the Schaidberg Tauernhaus in the Radstädter Tauern Pass (Salzburg, Austria), this deposit was reassessed as part of a research project on the Roman road across the pass.
Initially thought to be Roman, the visible quarries have been reinterpreted as post-antique. The most significant extraction occurred during the Baroque period, as seen in church pavements in Althofen, Mariapfarr, and Tamsweg, coinciding with road construction between 1747 and 1749. Features once attributed to Roman quarrying are now recognized as karst formations resulting from post-glacial weathering.
Nevertheless, clear evidence indicates that the marble deposit was already exploited during Roman times, in the course of the construction of the Roman road in 201 AD under Emperor Septimius Severus. Most milestones from this period are made of Schaidberg marble, and their exact extraction site may still be identifiable.
During Roman times, Schaidberg marble was used only locally, primarily within the Lungau district, including Immurium (modern-day Moosham). Unlike marble sources opened for architecture, grave buildings and other purposes, this deposit was discovered incidentally during road construction, leading to limited and short-lived quarrying activities.

IMPERIAL PATRONAGE AND DISTRIBUTION MODELS FOR THE LATE ANTIQUE MARBLE TRADE REVISITED

Allison B. Kidd
The British Museum, Department of Greece and Rome, London, United Kingdom

Keywords: Marzamemi, Late Antiquity, stone trade

The late Roman ship that sank off the coast of Marzamemi, Sicily carried 100 tons of partially prefabricated architectural and decorative elements – columns, capitals, bases, and various ecclesiastical furnishings in white and grey-streaked marble and green breccia – from quarries in Greece and Asia Minor. During initial excavations of the wreck from the 1960s-1970s by Gerhard Kapitän, only the best-preserved elements were raised from the seabed. Given the overall number, decorative styles, and scale of the artefacts recovered at the time, Kapitän and subsequent scholars have concluded that the cargo was sent by Emperor Justinian for the construction of a basilica in North Africa or Sicily to celebrate his reconquest of the region. This argument underpins persistent assertions that the late antique stone trade depended on imperial mediation. The results of the wreck's complete excavation from 2013–2019 by the Marzamemi Maritime Heritage Project have called Kapitän's ideological and political explanations into question. To start, a secondary cargo of amphoras and galley wares from the ship points to a ca. AD 520 date for the wreck. That the assemblage could predate Justinian's reign is substantiated by the architectural elements' styles, which are attested as early as Anastasius' reign. The bulk of these elements comprises approximately 30 matching bases, columns, and capitals and 16 chancel screens and pier colonnettes carved from white marble. Such a number exceeds what was required of other large-scale ecclesiastical construction projects, such as the Basilica of Sant'Apollinare Nuovo, yet the elements' sculptural details are not of a level one would expect of a privileged, imperially-funded project. Other elements one would envisage in such an initiative, like impost blocks, are missing. What is more, stable isotope analysis across the assemblage, presented here for the first time, suggests that the white marble was not sourced from Prokonnesos alone. The only truly exceptional artefact that points to imperial intervention is the ambo, carved in a green breccia from Thessaly. Given our project's new results, this paper advances an alternative explanation for the wreck. Rather than a commission entirely of imperial patronage destined for North Africa or

Sicily, the Marzamemi cargo constitutes part of a sizeable order from a bishop, urban prefect, or other civic leader for one or more construction projects supported by a single imperial gift, destined somewhere along the Adriatic coast. Such a conclusion demands a reevaluation of standard distribution models for the late antique stone trade.

MICROBIOLOGICAL AND GENETIC EVALUATION OF THE DETERIORATION SYMPTOMS ON THE SPECTATIUS FAMILY TOMB – THE LARGEST MONUMENT OF THE ROMAN NECROPOLIS IN ŠEMPETER, SLOVENIA

Janez Kosel[1] – Nejc Tomšič[1] – Mojca Mlakar[1] – Nina Žbona[2] – Polonca Ropret[1,3]
[1] Institute for the Protection of Cultural Heritage of Slovenia, Conservation Centre, Research Institute, Ljubljana, Slovenia
[2] Institute for the Protection of Cultural Heritage of Slovenia, Restoration centre, Department for stone and stuccowork, Ljubljana, Slovenia
[3] University of Ljubljana, Faculty of Chemistry and Chemical Technology, Ljubljana, Slovenia

Keywords: biodeterioration, Roman masterpiece, stone tomb monument

Our objective, as part of the planned conservation work, was to characterise biofilms related to the formation of various deterioration symptoms occurring on the Spectatius family tomb, the largest monument of the Roman Necropolis in Šempeter, Slovenia. By using fluorescent microscopy, microbial cultivation methods and standard DNA sequencing, we were able to identify 34 fungal isolates, 28 being filamentous moulds, primarily dominated by xerophilic Cladosporium spp. (mainly Cladosporium langeronii RN 28) and some Alternaria and Mycoceros species; and 6 yeast or yeast-like species, namely Tremella dirinariae, Torula fici, Filobasidium wieringae, Rhodotorula babjevae and Blastobotrys peoriensis. Interestingly, locations on the tomb, which are well sheltered against rainfall, contained higher concentrations of xerophilic fungi than those, which are completely or partially exposed to rain. The black fungal species of Cladosporium spp. and Alternaria spp. formed the bulk of the black-greyish patina present on the bottom reliefs and within the cracks of the inner dome of the Spectacius tomb. Moreover, a biofilm of the red coloured yeast Rhodotorula babjevae caused thick red stains right under the top roof of the monument's left side. The obtained results indicated that not only moulds but also yeasts

can cause significant biodeterioration. Lastly, we isolated indigenous mycoparasitic stains of Filobasidium wieringae (RN 37 and RN 38) that could potentially be used in biocontrol formulations applicable in situ for the sustainable preservation of the Spectatius family tomb monument.

ASOMATA (GREECE): A CASE STUDY IN ANCIENT QUARRYING: INSIGHTS, CHALLENGES, AND PERSPECTIVES

Angeliki Koukouvou
Archaeological Museum of Thessaloniki, Publications & Digital Applications Directorate, Thessaloniki, Greece

Keywords: building stone quarries, quarrying techniques, ancient Macedonia

In 2001, the rescue excavation of three ancient quarries near the settlement of Asomata (Macedonia, Greece) marked a turning point in the study of ancient quarrying in Greece. The Asomata quarries, the first of their kind to be systematically excavated and studied in Greece, provided invaluable insights into extraction techniques, tools, dating, and the overall organization of quarrying processes.
Despite significant advancements in recent years, systematic studies of ancient quarries remain limited, with a strong bias towards marble. Quarries of other stones, such as medium-hard to soft sedimentary limestones (referred to as poros or porolith in ancient sources), have been largely neglected by scholars. This oversight is significant, considering that common building stone was the primary material used in ancient architecture, especially for monumental constructions.
This presentation will focus on the data obtained from the excavation of the Asomata quarries. This includes layers of rubble filling the quarry pits, stone chips, blocks dumped in situ, unfinished blocks still attached to the bedrock, and numerous tool marks preserved in excellent condition on the quarry faces and beds. Their study shed light on the strategies employed to overcome challenges encountered during the extraction and ensure the smooth and successful operation. Quarry 2, in particular, provides crucial information on extraction techniques specifically tailored to medium-hard to soft rock and offers reliable chronological data.
The location of Asomata quarries in this region of the Old Macedonian Kingdom presents a unique opportunity to investigate the profound impact of quarrying on urban growth and expansion during the Late Classical and

Hellenistic periods, and the broader socio-economic landscape. These quarries would undoubtedly have served the ambitious building programmes of the Macedonian kings during times of prosperity and political dominance. Archaeometric provenance research strongly suggests that the stone extracted from the Asomata quarries was utilized in the monuments of ancient Aigeai, the old capital of the Macedonian Kingdom. The study of ancient quarries offers a fertile ground for interdisciplinary research, integrating insights from natural sciences, social sciences, and humanities to explore broader theoretical questions.

THE QUARRIES OF THE ANCIENT CITYWALL IN THASOS (GREECE)

Tony Kozelj – Manuela Wurch–Kozelj
Independent researcher Thasos, Greece

Keywords: Thasos, marble, gneiss

The Thasos rampart was built between 494 and 491 BC, consisting of two facings of marble and gneiss blocks, filled with cuttings of all sizes, mixed with earth. A rough calculation indicates around 55,000 m3 of cut material. It seems clear that several quarries contributed to the supply of blocks. Some of these quarries were located close to the line of the rampart, thus limiting transport, while others, a little further away, still made their contribution.
The characteristics (colour, quality, grain size, etc.) of the marbles used enable us to identify their origin. Glyptographic marks bear witness to the production, distribution and even application of the blocks.
The technical process involved in building such a fortification will be discussed, e.g. the judicious distribution of marble and gneiss courses to contribute to the stability of the construction; and the traces of extraction on the blocks, which allow us to recognize the techniques employed, and consequently to indicate the period of activity, construction, repairs, or even reconstructions of certain sectors of the rampart (e.g. in the 4th century BC, during the major town-planning program, modification of a town entrance, addition of 16 towers).

ROMAN MARBLE QUARRIES IN VICINITY OF VITANJE (SLOVENIA)

Jure Krajšek[1] – Rafko Urankar[2]
[1] Celje Regional museum, Celje, Slovenia
[2] PJP d.o.o., Slovenska Bistrica, Slovenia

Keywords: Roman, marble, quarries

Already in the 19th century, Roman marble quarries in Hudinja, just north of Vitanje, were mentioned byFranz Ferk alongside the other marble quarries from the southern Pohorje mountain. Also, there were numerous mentions of the quarries in Hudinja in the second half of the 20th century, but no specific/exact location was ever given. A topographic investigation of the area started in spring 2021 and it is not finished yet in 2025. Due to the specific geological and geographical conditions and transformation of slopes due to intensive agriculture use in the last thirty years, the remains of Roman marble quarries are not easily recognizable. Combination of topographic survey, intense study of old maps and cadastral plans and analyse of lidar images enabled us to detect a complex of marble quarries with the connection roads and main road leading from the quarry complex in to the valley; from the valley a closest and direct way leaded alongside the Hudinja river in the direction of the Municipium Claudium Celeia.

THE HEDJRET ENNOUS GRANITOID IN NORTH–WESTERN ALGERIA: A MAJOR SOURCE OF SHAFTS AND BLOCKS FOR THE ANCIENT MONUMENTS OF TWO COASTAL CITIES IN MAURETANIA CAESARIENSIS: CAESAREA (CHERCHELL) AND TIPASA DEMONSTRATED BY NONDESTRUCTIVE INVESTIGATIONS

Atmane Lamali[1,2] – Touatia Amraoui[3] – Pierre Rochette[4] – Lamine Hamai[1,2] – Zoubir Chatti[2] – Salah Eddine Bentridi[2] – Nacer Merabet[1]
[1] Research Center in Astronomy, Astrophysics and Geophysics, Algiers, Algeria
[2] University of Khemis Miliana, Laboratory of Energy and Intelligent Systems, Khemis Milian, Algeria
[3] Aix-Marseille Université, CNRS, Centre Camille Jullian, Aix-en-Provence, France
[4] Aix-Marseille Université, CEREGE, Aix en Provence, France
Keywords: Hedjret Ennous, Caesarea, Tipasa

Using the combination of visual examinations and magnetic susceptibility measurements, several previous studies focused on the detection and characterization of Roman shafts with the aim of classifying them into different groups based on their physical and chemical properties to identify their provenance. Our study is focused on the granitoid from the quarry of Hedjret Ennous (ex "Fontaine du Génie") located near Caesarea, the ancient capital of Juba II's Mauretanian Kingdom and the future Roman province of Mauretania Caesariensis. In the field, our work was carried out in two main areas, starting at the quarry to characterize the materials, then at the archaeological sites of Cherchell and Tipasa (World Heritage Site), to measure the magnetic susceptibility of granite shafts and blocks found locally.

Thanks to the fieldwork conducted on the quarry (in particular as part of the ARCHEoPHY-Tipasa project), both magnetic susceptibility measurements and petrography analyses were performed on local rocks and remnants of antique column shafts still present on site.

Ancient excavations in Cherchell and Tipasa have uncovered dozens of column shafts and blocks, most of which come from ancient public monuments, including the great Christian basilica in Tipasa and the "Hundred Columns Mosque" in Cherchell. The latter was built reusing ancient columns from an undetermined Roman monument. Most of these shafts have been examined for visual petrological features and magnetic susceptibility measurements. Based on these investigations, the main classes of columns were revealed. Remarkably, the first class, which represents the most abundant group in this study, was from the Hedjret Ennous granitoid rocks. But analyses also revealed the presence of shafts from other Mediterranean regions, such as Italy and Turkey. These new data highlight both the dynamism and maritime connections of Mauretania Caesariensis through its commercial ports open to Mediterranean networks, as well as the use of a local resource deemed of sufficiently high quality. It was therefore used for the adornment and monumentalisation of the provincial capital and neighbouring towns.

ORNAMENTAL LITHIC MATERIALS FROM THE ROMAN SITE OF EL FORAU DE LA TUTA (ARTIEDA, JACETANIA, ZARAGOZA, SPAIN)

María Pilar Lapuente Mercadal[1,2] – José Antonio Cuchí Oterino[1] – Paula Uribe Agudo[1] – Jorge Angás Pajas[1] – José Ángel Asensio Esteban[3] – Lara Iñiguez Berrozpe[1]
[1] University of Zaragoza, Faculty of Sciences, Department of Earth Sciences, Zaragoza, Spain
[2] Catalan Institute of Classical Archaeology, Tarragona, Spain
[3] Ausonius Institute, Huesca, Spain

Keywords: marble, provenance, archaeometry

The recent archaeological interventions carried out in the Roman site of El Forau de la Tuta, a place located in the pre-Pyrenean area of the Hispanic conventus caesaraugustanus, are revealing the dimensions and characteristics of this urban settlement. Despite being placed relatively far from its capital, Caesaraugusta, (about 160 km), and therefore away from its central axis crossed by the Ebro river, its privileged location in the corridor of one of its tributaries, the Aragon River, along with the good road communications in the territory, certainly facilitated trade activities with neighbouring regions.

The discrete group of white and coloured marbles, found up to now, associated to the Roman imperial phase (1st–2nd century AD), is part of the decorative elements mainly of its thermal complexes. These marbles, together with the two-colour black and white mosaics in various rooms, are evidence of the use of different regional limestones, but also of the consumption of more ostentatious materials for slabs and small listels for architectural decoration. They are white, white and grey marbles and different well-known multi-coloured breccias originally from the other side of the Pyrenees, as well as various marmora from the Hispanic Mediterranean coast.

The archaeometric study of provenance carried out has followed the usual analytical protocol: petrography, cathodoluminescence and C and O isotopes. It has revealed the trans-Pyrenean importation of marble from the French regions of Gave d'Ossau (Louvie-Soubiron) as well as from territories further away as Saint-Béat district (Haute-Garonne), including the Roman breccia of Lez, and the multi-coloured cipollino mandolato from Campan. On the other hand, the use of two varieties of Brocatello from Tortosa (at the mouth of the Ebro) and Santa Tecla stone from

Tarraco, highlight the commercial relationship with the provincial capital. This Mediterranean influence, favoured by the navigation of the Ebro, was completed with the importation of other classical marble with a sculptural character, Luni-Carrara attested also by archaeometric studies.
Finally, the combination of ornamental materials with sources of different origins is a common and widespread phenomenon observed in other archaeological sites of the Caesaraugustan conventus.

GÖKTEPE MARBLE IN HISPANIA. STATE OF ART

María Pilar Lapuente Mercadal[1,2] – Trinidad Nogales Basarrate[3] – José Miguel Noguera Celdrán[4] – Isabel Rodà de Llanza[2,5]
[1] University of Zaragoza, Faculty of Sciences, Department of Earth Sciences, Zaragoza, Spain
[2] Catalan Institute of Classical Archaeology, Tarragona, Spain
[3] Roman Art National Museum, Mérida, Badajoz, Spain
[4] University of Murcia, Facultad de Letras, Departamento de Prehistoria, Arqueología, Historia Antigua, Historia Medieval y Ciencias y Técnicas Historiográficas, Murcia, Spain
[5] Autonomous University of Barcelona, Faculty of Arts and Humanities, Barcelona, Spain

Keywords: Göktepe marble, Hispania, archaeometry

In order to provide a more accurate picture of the role played by the Carian marble of Göktepe in the Westernmost provinces of the Roman Empire, this archaeometric contribution presents the current state of knowledge on the identification of this marble in Hispania.
The study is supported by the usual analytical protocol of sequential step-by-step determination, comprising in this order: petrography (macro and microscopic), cathodoluminescence and stable isotopes of C and O, to which are added additional parameters such as elemental content (Sr, Mn) and occasionally other complementary such as Sr isotope ratios.
Based on the analytical parameters detected as discriminants of the sculptural varieties of Göktepe (white, grey, black), established in samples from quarries and their comparison in sculptural pieces from Villa Adriana in Tivoli, in recent years we have been carrying out a series of provenance studies analysing new Hispanic finds and re-evaluating previously studied cases that had been erroneously identified as Carrara.

With this analytical standpoint, focused on two sculptural formats, imperial portraits and late antique ideal and mythological pieces commonly associated with Hispanic rural villas, we aim to provide a perspective on what has been done and what remains to be studied, in order to approach the moment of the introduction of Göktepe and to better understand its dispersion in Hispania.

TWENTY YEARS OF «MARMORA»: FOSTERING MARBLE STUDIES

Lorenzo Lazzarini[1] – Alessandro Poggio[2] – Silvia Gazzoli[3] – Elena Pontelli[2] – Alberto Pizzigati[4]
[1] Istituto Veneto di Scienze, Lettere ed Arti, Venice, Italy
[2] Scuola IMT Alti Studi Lucca, LYNX – Center for the Interdisciplinary Analysis of Images, Contexts, Cultural Heritage, Lucca, Italy
[3] Scuola Normale Superiore, Pisa, Italy
[4] Fabrizio Serra editore, Pisa, Italy

Keywords: marble studies, academic journal, interdisciplinarity

Twenty years ago, the first issue of «MARMORA. An International Journal for Archaeology, History and Archaeometry of Marbles and Stones» appeared. The journal, founded by Lorenzo Lazzarini and published by Fabrizio Serra Editore, intended to become a reference point for those who study marbles and stone materials.
Over the years, the interest in the journal has not waned. Until now more than 130 articles have been published in «Marmora» focusing on several topics related to the world of marbles and stone materials: quarries, transportation, archaeological and art historical investigations, archaeometric characterization of stone materials, museum issues and more. Such a variety of themes, encompassing the entire Mediterranean basin, reveals, on the one hand, the vitality of the field of study, on the other hand testifies to the marked interdisciplinary inclination of the journal.
The ASMOSIA conference, which periodically marks the advancements in the field, is the ideal place to present the milestones of the journal's life that are relevant to the entire community. The poster will show statistics and data related to the articles published until now: topics, methodologies, geographies, and chronologies. Moreover, it will highlight relevant case studies published over the years.

The final aim of this poster is to assess the main tendencies in the studies related to marbles and stone materials, and more generally to materiality, stimulating a reflection on recent acquisitions and potential perspectives in the field.

OPUS SECTILE FROM THE THERMAL COMPLEX TERME TAURINE IN CIVITAVECCHIA (ITALY)

Tjaša Levec
University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia

Keywords: Terme Taurine, opus sectile, polychrome marble

The Terme Taurine, also known as the Bagni di Traiano, are located 4 km east of Civitavecchia, near a hydrothermal spring. The thermal baths consist of around 80 rooms covering an area of approximately 20,000 m^2. The most revealing excavations were carried out by Raniero Mengarelli (1912–1923) and Salvatore Bastianelli (1927–1933). The Taurine Baths were probably built in the late Republican or Augustan period and later renovated, extended and decorated with opus sectile during the reign of Hadrian. Examples of opus sectile are preserved in situ in the archeological park, while others are kept in the National Archeological Museum of Civitavecchia and were analysed in this study. These artefacts, mainly floor tiles, have been attributed to the 2nd century AD, i.e. to the time of Hadrian's renovation. Their original location cannot be determined, as we have no precise information from the excavation reports. Possibly originating from the caldarium or the now-lost upper floor, 11 square modules featuring the QOrQ motif according to Federico Guidobaldi's typology, have been preserved. Two types of marble are used for this motif, marmo africano and giallo antico, sometimes combined with breccia corallina. One type is used for four rectangles, the other for the central square and the surrounding triangles. The combinations alternate, creating a chessboard-like pattern. Each module measures one Roman foot. Presumably originating from the biblioteca 28 fragments of the opus sectile were analysed. These feature geometric shapes such as triangles, trapezoids and rectangles, and are mainly made of giallo antico, portasanta and pavonazzetto marble. Their original arrangement could not be reconstructed, although we can conclude that several pieces were once part of square floor modules, while some others probably belong to a wall

decoration. As part of the study, all fragments were documented, measured and photographed. The material was identified through autoptic analysis, and further typological and modular analysis was carried out to hypothesize original patterns. Historical research was carried out on the development of the site and comparative studies of the QOrQ motif were conducted using parallels from other Roman sites.

NEW INSIGHTS ON THE ARCHAIC MARBLE QUARRIES OF NAXOS, GREECE: PROCESS, TRANSPORT, AND PROVENANCE

Rebecca Levitan[1] – Evan I. Levine[2] – Jessica Paga[3] – Jean Vanden Broeck-Parant[4] – Rosie Campbell[4] – Vasiliki Anevlavi[5]
[1] King's College London, Classics Department, London, United Kingdom
[2] University of Copenhagen, Faculty of Theology, Copenhagen, Denmark
[3] College of William & Mary, Department of Classical Studies, Williamsburg, United States of America
[4] Catholic University of Louvain, Institute of Civilisations, Arts and Letters, Louvain-la-Neuve, Belgium
[5] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: Naxos, quarries, landscape

In the early history of marble working in the Mediterranean, few locations were more influential than Naxos, an island at the center of the interconnected Cyclades and home to several sources of exceptionally vibrant large-grained white marble. This paper presents the results of fieldwork by the Naxos Quarry Project (NQP) at Melanes and Apollonas: the two most notable ancient marble quarries on the island. This interdisciplinary project combines geological sampling with drone lidar survey, architectural and sculptural study, ecological modeling, and regional archaeological survey. This integrated approach offers unparalleled insight into the archaeological evidence for diachronic marble extraction on Naxos and the relationship between this practice and the landscapes within which it was located.
In this paper, we focus on three major outputs from this study. The first concerns evidence for ancient stoneworking processes. Our work reveals that Naxian marble workers were innovators who pioneered new site-specific techniques to harness and exploit their native natural resources.

The second output focuses on evidence for the transport of marble blocks and the re-use of quarrying byproducts. Within the quarried landscapes on Naxos, we isolated several stretches of preserved slipways made from marble lapilli and other debitage from the quarrying process. Documenting, mapping, and modeling these slipways sheds new light on the overland transport of the large slabs and blocks for which the Naxian quarries were famous. Finally, we present preliminary results from our geochemical, isotopic, and petrographic analysis of geological samples from Apollonas and Melanes. This extended sampling effort includes previously undocumented areas of quarrying, enhancing our understanding of their material characteristics. Juxtaposing these results with the comprehensive marble database developed by the Austrian Archaeological Institute (ÖAW) highlights potential correlations with a diachronic assemblage of Naxian artefacts and greatly contributes to provenance studies for Cycladic marble. Our focus on the technical aspects of quarrying (especially facture and transport) and the results of analytical testing sheds new light on some of the best known sites of quarrying in the Archaic Mediterranean. In so doing, we offer new perspectives on the chronological range of marble working on Naxos and the diffusion of artwork and architecture sourced from these quarries.

NOVEL METHOD OF PROVENANCING ANCIENT MARBLES: FRACTAL AND COMPLEXITY MEASURES

Ioannis Liritzis[1] – Ion Andronache[1] – Lluís Casas[2] – Roberta Di Febo[2] – Anna Anglisano[3]
[1] Alma Mater Europaea University, Maribor, Slovenia
[2] Autonomous University of Barcelona, Faculty of Sciences, Department of Geology, Barcelona, Spain
[3] Girona University, Department of Environmental Sciences, Girona, Spain

Keywords: complexity, fractal, marble provenance

A high demand for marble stimulated the formation of quarries in the ancient Mediterranean area, from the Near East through Greece, Italy, to Spain. Current studies focus on the distinction of marbles with similar petrographic characteristics as well as diversification within their extraction sites. Several archaeometric methods are used for this purpose. The provenance can be determined using a well-established multi-technique approach. The interdisciplinary aspect of ancient marble provenance

necessitates collaboration among experts from different disciplines (e.g. art, archaeology, archaeometry, conservation, geosciences). The degree of distinctiveness in provenance studies of ancient marbles should be a very important "standard" during the verification of methods used in archaeometric studies. Here, complexity measures and fractal analysis are used to study the organizational complexity of the images. They offer an alternative cost-efficient, fast and accurate approach compared to existing techniques. Four groups of algorithmic measures are used:

- Gray Level Co-occurrence Matrix (GLCM) with 12 indices,
- Head/Tail analysis with 4 indices,
- Normalized Kolmogorov complexity with 2 indices, and,
- Fractal analysis with 14 indices.

The approach revealed to be efficient in identifying the appropriate index for the current images. Forty-two marble pieces were selected from quarries and archaeological samples. They come from the two quarries of Gualba (Spain) and Ceret (France), and from the archaeological sites Montsoriu (Gothic castle (10th–14th centuries)), Breda (11th century monastery reused), and Girona (Roman era). Sampling was made on different parts/locations of samples (quarries, archaeological samples) for representativeness and including any intra-sample inhomogeneities (18 from Guelba, 8 from Ceret, 6 from Breda, 10 from Montsoriu and 2 from Girona). Thin sectioned images (at a few mm scale) taken at Crossed Polarized Light (XPL) and Plain PL (PPL) images were analysed. Using heatmaps, the compatible indices found amongst the 4 algorithmic groups are Contrast, Dissimilarity (from GLCM), and Kolmogorov, as best suited for PPL and XPL data. The archaeological samples were attributed mainly to Gualba, and this is aligned with the main conclusion made by Lluís Casas and others in 2023. Only three cases from Breda, Montsoriu and Girona seem to originate from Ceret. Our methodology has been confirmed on 7 × 5 mm scale images from Paros, Penteli, Proconnesos and Carrara, well known ancient Mediterranean quarries.

The results of provenance are discussed amongst all indices and compared to earlier archaeometric work and archaeological estimations. Without needing expensive instrumentation, a construction of a database may offer a solution to marble provenance studies.

METAGENOMIC ANALYSIS OF DETERIORATION SYMPTOMS ON THE LIMESTONE ROŽANEC MITHRAEUM MONUMENT, SLOVENIA

Milica Ljaljević Grbić[1] – Ivica Dimkić[1] – Tamara Jankiev[1] – Janez Kosel[2] –Črtomir Tavzes[2] – Slađana Popović[1] – Aleksandar Knežević[1] – Lea Legan[2] – Klara Retko[2] – Polonca Ropret[2,3] – Nina Žbona[4] – Nikola Unković[1]
[1] University of Belgrade, Faculty of Biology, Belgrade, Serbia
[2] Institute for the Protection of Cultural Heritage of Slovenia, Conservation Centre, Research Institute, Ljubljana, Slovenia
[3] University of Ljubljana, Faculty of Chemistry and Chemical Technology, Ljubljana, Slovenia
[4] Institute for the Protection of Cultural Heritage of Slovenia, Restoration centre, Department for stone and stuccowork, Ljubljana, Slovenia

Keywords: biofilm, Roman masterpiece, stone relief

The primary purpose of the study was to uncover all aspects of autochthonous biofilm pertaining to the formation of numerous deterioration symptoms occurring on the limestone Rožanec Mithraeum monument in Slovenia. Using state-of-the-art sequencing technologies, combining mycobiome data with observations made via numerous light- and spectroscopic (FTIR and Raman) microscopy analyses pointed out epilithic lichen Gyalecta jenensis and its photobiont, carotenoid-rich Trentepohlia aurea, as the origin of salmon-hued pigmented alterations of limestone surface. Furthermore, the development of the main deterioration symptom on the monument, i.e., biopitting, was instigated by the formation of typical endolithic thalli and ascomata of representative Verrucariaceae family (Verrucaria sp.) in conjunction with the oxalic acid-mediated dissolution of limestone. The domination of lichenized fungi, as the main deterioration agents, both on the relief and surrounding limestone, was additionally supported by the high relative abundance of lichenized and symbiotroph groups in FUNguild analysis. Obtained results not only upgraded knowledge of this frequently occurring but often overlooked group of extremophilic stone heritage deteriogens, but also provided a necessary groundwork for the development of efficient biocontrol formulation applicable in situ for the preservation of similarly affected limestone monuments.

THE LIMESTONE OF RODADERO DE LOS LOBOS – CORTIJO PIQUÍN (CÓRDOBA, SPAIN): USES AND DISPERSION IN ROMAN TIMES

María Luisa Loza[1] – José Beltrán Fortes[2] – Esther Ontiveros[1] – Juan de Dios Borrego de la Paz[3] – Daniel Becerra Fernández[4]
[1] Andalusian Institute of Historic Heritage, Seville, Spain
[2] University of Seville, Faculty de Geographic and History, Department of Prehistory and Archaeology, Seville, Spain
[3] University of Cordoba, Cordoba, Spain
[4] University of Malaga, Faculty of Philosophy and Letters, Department of Historical Sciences, Málaga, Spain

Keywords: Roman quarries, Rodadero de Lobos, archaeometry

In the municipality of the city of Córdoba (Andalusia, Spain), we found a stone material known as Rodadero de los Lobos, from the Sierra de Córdoba, together with other types of lithics used as ornamental stones in Roman times and in other later periods.
The presence of this ornamental stone, according to visual research, in a large number of supports in the city of Cordoba and the south of ancient Hispania has led us to carry out work with two objectives: a) the documentation of the supports for which this marmor was used, and b) its diffusion, with emphasis on its use in the ancient city of Colonia Patricia (Corduba), now Cordoba, and its subsequent reuse in the city from Late Antiquity to the present day. It also focuses on the production of Rodadero de los lobos, which is present in other cities and which we have documented so far.
The methodology used consisted of a bibliographical study of the subject and the study and cataloguing of pieces made from this type of stone. All this has made it possible to document a significant distribution throughout the province of Vlterior Baetica and its use in different types of supports: epigraphic supports, shafts, mouldings, etc., as well as the use of pieces made from this material, i.e. as spolia material.
This work deals with very important aspects of the limestone of Rodadero de los Lobos and is part of the project to study the ancient Roman quarries in the Cordoba mountains.

GENII PROJECT (J6-4609): REVOLUTIONIZING ROMAN STONE RESEARCH THROUGH EOLITH DATABASE INTEGRATION

Edisa Lozić
Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia

Keywords: database, EOLITH, Roman quarries

The GENII project presents a transformative approach to studying Roman stone materials through the EOLITH database – a state-of-the-art geospatial and lithological platform designed to revolutionize data integration and analysis. EOLITH combines newly collected data with AI-driven tools, including a groundbreaking chatbot that offers intuitive, real-time interaction with the database. This tool empowers researchers to explore, search, and correlate data on Roman stone materials with unparalleled ease and precision.

Focusing on the Dolenjska region, a vital part of the Roman province of Pannonia during the 1st to 3rd centuries AD, the project leverages advanced technologies such as AI for automated stone classification, predictive modelling, and LiDAR for geospatial analysis. These cutting-edge methods enable the precise identification of Roman quarry sites and their connections to artefacts, including funerary monuments and altars, while revealing the intricate logistics of Roman stone distribution and regional construction practices.

This poster showcases the EOLITH database's capabilities as a revolutionary research tool. It highlights its potential to transform how scholars document quarry locations, analyse geological properties, and establish connections between artefacts and their sources. By integrating geological analyses, site locations, and transportation networks with Roman city data, the GENII project bridges traditionally isolated research domains, creating a comprehensive understanding of Roman quarrying practices.

Through the integration of newly gathered data and case studies from the Dolenjska region, the findings demonstrate EOLITH's unparalleled potential to reshape our understanding of Roman stone economics. By connecting artefacts to their quarry origins, the database opens new frontiers for comparative analysis, offering a nuanced exploration of regional production systems and the socio-economic dynamics of Roman Pannonia. This project exemplifies how innovative technology can elevate archaeological research to unprecedented levels, leaving a lasting impact on the field.

MISREADING THE RED STONE: A FRESH LOOK AT VITRUVIUS' RUBRIS LAPIDICINIS

Christopher J. Lyes
University of Oxford, School of Archaeology, Oxford, United Kingdom

Keywords: quarries, tuff, Vitruvius

"I have spoken of lime and sand, both of what varieties they are and what virtues they possess. Next in order comes the description of the quarries from which both squared stone and supplies of rubble are taken and furnished for buildings. Now these are found to be of unequal and unlike virtues. For some are soft, as they are in the neighbourhood of the city at Grotta Rossa, Palla, Fidenae and Alba; others are medium, as at Tivoli, Amiternum, Soracte, and those which are of these kinds; some hard, like lava"(Vitr. 2.7.1).
Thus, Vitruvius begins his discussion of the building stones of Rome and their source quarries. These volcanic stones formed the linchpin of construction in the Urbs from the Archaic period down to the widespread adoption of opus caementicium and ceramic building materials in the Late Republic. Vitruvius' treatise is fundamental in explaining how these stones were quarried, sourced, and integrated into Roman architecture. However, his reference to the so-called lapidicinis Rubris, which he locates in Saxa Rubra (Grottarossa), has often been dismissed or misread, particularly by scholars who focus primarily on geological surveys while overlooking the potential insights yielded by archaeological investigation. This paper re-examines the relevant Vitruvian passages in tandem with new, on-the-ground archaeological evaluation – part of a five-year project examining over 300 ancient stone quarries across the Roman Campagna – to demonstrate that multiple, significant extraction sites do indeed exist in the Grottarossa area. By carefully analysing the in-situ evidence, together with associated habitation and production debris, this study shows that local quarrying activity was considerably more extensive than traditionally assumed, offering a fuller perspective on Roman building stone exploitation. By foregrounding this fresh evidence, it becomes clear that the so-called red stone quarries played a significant role in Roman building practices, broadening our knowledge of the dynamic interplay between the City's architectural needs and its available resources. Far from constituting a minor episode in Rome's construction history, the quarries at Grottarossa invite renewed scrutiny, confirming that textual sources, when coupled with sustained archaeological fieldwork, can deepen our understanding of

Roman resource strategies and shed fresh light on the ancient built environment.

EXTRACTION AND STONE CUTTING AT THUGGA-DOUGGA: TRANSPOSITION OF HARD ROCK PROCESSING TECHNIQUES TO LIMESTONE PROCESSING

Yvan Maligorne[1] – Chloé Damay[2,3]
[1] University of Western Brittany, Faculty of Arts and Humanities, Centre for Breton and Celtic Research, Brest, France
[2] University of Rennes 2, Archaeosciences and History, Research Center in Archaeology, Rennes, France
[3] Sorbonne University, Paris, France

Keywords: quarries, limestone, marble

The construction of the Numidian and Roman monuments at Dougga essentially used local limestones, extracted from the outcrops to the north and north-west of the town, which are the subject of a research program (ToPiC, Tombes, pierre, cirque) supported by the Maison des sciences de l'homme de Bretagne (Rennes) and authorized by the Institut du Patrimoine (Tunis).
Several of these extraction sites have preserved very clear traces, which enable us to reconstruct the chain of operations and, above all, can be compared with traces found on blocks used in epigraphically dated monuments.
These outcrops were exploited over a long period, leaving a variety of traces, some very unusual. Some have precise parallels in the quarries of harder rocks, mainly marble and granite. This observation is in line with observations made on architectural blocks: on the forum, in its Antonine-period form, some limestone entablature blocks also display cutting techniques frequently found in marble. As the columns in the forum are made of marble, we suggest that teams of craftsmen (quarrymen and stonemasons) familiar with marble came to Dougga, probably from Carthage, whose Antonine programs provided the models for column capitals, and employed and transmitted to local stonemasons the techniques with which they were familiar.
Technical examination of the limestone statues also reveals close similarities with the design of marble sculptures. The operational chain, the choice of tools, colour application techniques and the selection of statuary formats

and layouts all point to the transposition of the marble techniques to another stone. Certainly initiated by the arrival of sculptors specialized in marble at Dougga on the occasion of exceptional statuary commissions in the 2nd century, this adaptation is attested from time to time until the 3rd century.
The paper will briefly describe the outcrops, the extraction techniques used before focusing on the know-how skills that seem to have been borrowed from marble working, in an approach that will take into account the quarries, the monuments and the statues from the third quarter of the 2nd century onwards.

THE STONE QUARRIES IN THE NORTHWEST OF THE SEA OF GALILEE (ISRAEL) AND THEIR ASSOCIATION TO THE ARCHAEOLOGICAL SITES

Haim Mamalya[1,2] – Dror Segal[3] – Yossi Stefanski[1]
[1] Israel Antiquities Authority, Hazor, Israel
[2] Ashkelon Academic College, Department of Land of Israel Studies, Ashkelon, Israel
[3] Archaeology Museum, Gan Hashlosha National Park, Israel

Keywords: quarries, limestone, basalt

The northeastern shores of the Sea of Galilee host significant ancient sites. Including Tel Raqqat and Tel Kinnrot (ancient Kinneret) from the Bronze and Iron Ages (4th–1st millennium BCE), and Tiberias, Magdala and Capernaum from the Classical Periods (Hellenistic-Roman-Byzantine, 3rd century BCE–7th century CE).
A large quantity of building stones was needed for their construction, which were widely used by the Roman-Byzantine cities and villages as settlements expanded. The study below will examine lithological trends in the selection of stones for construction vis-à-vis the supply of the bedrock mapped on the slopes of the Lower Galilee and Korazim Plateau facing the Kinneret basin.
A detailed map of thousands of building stones used in the research of the settlements, mainly from the Roman-Byzantine periods, enables the classification of these stones based on their rock types. This information helps estimate trends in the use of different rocks for building stones at the sites. The data shows more Basalt stones were used than Limestone, with limited use of other stones like Conglomerates, Granite, and Marble.

The identified stone quarries on the Lower Galilee slopes facing the Sea of Galilee are mostly of Limestone, with fewer of Basalt. The lithology rock analysis shows that Limestone has just as much potential for building stones as Basalt. However, there are trends in construction that do not match this potential, such as less Limestone use in Tiberias and Magdala despite abundant limestone sources. In Capernaum, limestone is widely used, even though its source is relatively far away.
It seems that in ancient times, the use of different rocks in this area for building stones was based on several factors, likely in the following order: building traditions, available materials, and decorative or engineering needs, sometimes constructing with stone material in secondary use (as was most probably done at Capernaum). Additionally, maritime transport was an easy way to transport stone from quarries or ruins (spolia) to construction sites, as may be surmised by the discovery of stone piers along the Sea of Galilee shores for docking heavy cargo barges.

VIERBLATTKAPITELLE – IMPORTED MARBLE CAPITALS AND LOCAL SALONITAN PRODUCTION IN LIMESTONE

Daniela Matetić Poljak
University of Split, Arts Academy, Department of Visual Culture and Fine Arts, Split, Croatia

Keywords: Salona, Vierblattkapitell, local workshops

The research carried out on the corpus of capitals from Salona (capital of the Roman Dalmatia) at the Arts Academy in Split covers the wider area of the Salonitan ager. Bordered by the cities of Trogir and Stobreč (Roman Traugurion and Epetion), the Salonitan ager has been a unique area from Antiquity to the present day, in which stone material was coming from the common local quarries (such as Sv. Ilija above Trogir or the quarries of the island of Brač, etc.) and the products from the same local workshops were distributed. It is also an area in which, over the centuries, the elements of sculptures and architectural decoration were relocated from one site to another, mostly as spolia.
The catalogue of capitals reveals some interesting data. For a significant number of capitals, the original buildings they belonged to are unknown. Most of the capitals, based on how the acanthus leaves (and other elements) are stylized, are of the Asiatic type. They are made of marble and represent

imports from the eastern provinces of the Empire. The large number of imported capitals is not surprising, given Salona's position as a port on the trade route from the eastern provinces to the northern Adriatic and Apennine peninsula. Since there is no marble in the region, the most cost-effective way of their importation was via maritime trade routes.
In the corpus of Salonitan capitals, only a small number of Asiatic capitals are made of local limestone, and they are presumably products of local workshops. Unfortunately, it is rare to find multiple examples of the same capital type that could give us an insight into the characteristics of the local interpretation of the imported models.
The capitals with four acanthus leaves in crowns, the so-called Vierblattkapitell type, represent an exception. Rudolf Kautzsch analysed most of the Salonitan examples in his Kapitellstudien, dividing them into subtypes. Some of them are impossible to trace, but in recent times, some unpublished examples have come to light. The Vierblatt capitals are today located in Manastirine and the Archaeological Museum in Split. Several of them were probably used as spolia for the construction of the medieval belfry of Split. The Salonitan Vierblattkapitells offer a unique opportunity for the study of the relationship between the imported marble models and the local products in limestone.

MARBLE, MOSAICS AND BUILDING STONES USED IN CELEIA

Snježana Miletić[1] – Mirijam Vrabec[2] – Bojan Djurić[3]
[1] Geological Survey of Slovenia, Mineral resources and geochemistry department, Ljubljana, Slovenia
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia
[3] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia

Keywords: marble, mosaic, Celeia

Studies about stone, its use and provenance reveal the economic picture, including the supply and trade of stone material. A challenge appears when the discrimination characteristics of the same type of stone are not clear, which is the case with the white Eastern Alpine marble. The main problems of this marble, regionally highly prized in antiquity, are its lack of specific structural and textural features and its wide geographical occurrence.

Rocks in archaeological stone can be examined using geological methods to pinpoint their provenance. With this goal, we examined three archaeological sites in and around Roman Celeia: the tomb of Ennii in Šempeter, three mosaics and the remains of a Roman villa in Celje.
The tomb of Ennii is made of Middle Miocene Eastern Alpine marble. Using standard geological methods, we analysed marble samples from two locations – Pohorje and Gummern. A specific method of fluid inclusion analysis was tested, and some optimizations were proposed, particularly regarding the time for homogenisation and measuring. Results were supplemented by published data on Pohorje, Gummern and Treffen marbles, and discriminant analysis showed possible provenance of 6 archaeological samples (4 from Pohorje, 2 from Treffen).
The mosaic tesserae were examined by mineralogical and geochemical methods. The results showed that the tesserae are made of: black, mostly laminated limestones and white miliolid limestones, appearing in the Karst Upper Cretaceous layers; red Upper Cretaceous-Pliocene limestones, deposited in Istria and northern Italy; yellow sparitic limestone, presumably from Chemtou (Tunisia); green andesite tuff from the Oligocene Smrekovec volcanism in the vicinity of Celje; and white rhyolitic tuff, presumably from the Italian Tertiary volcanism.
The stones from the Roman villa were tracked according to mineralogical composition in the vicinity of the villa. Grey recrystallized Triassic limestones were found on the Grajski hrib in Celje, volcaniclastic Triassic and Oligocene rocks appear near Celje, and Oligocene quartz tectonic breccias can be found in the Savinja River.
Results showed a wide range of sources of natural and building stones in Celeia.

INDICATIONS OF EARLY STONEMASONRY IN THE EASTERN SUBURBS OF COLONIA IULIA EMONA (LJUBLJANA, SLOVENIA)

Danica Mitrova[1] – Rok Brajkovič[2] – Matej Draksler[3]
[1] University of Ljubljana Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia
[2] Geological Survey of Slovenia, Ljubljana, Slovenia
[3] Skupina STIK, Ljubljana, Slovenia

Keywords: Emona, stonemason workshop, laminated micritic limestone

As part of the reconstruction project for the Križanke Summer Theatre auditorium in Ljubljana (Slovenia), rescue archaeological excavations were

conducted in 2018 by the Museum and Galleries of Ljubljana and ARKLJ. The site is situated between the eastern defensive wall of Colonia Iulia Emona and the Ljubljanica River, near a crossing point on a gentle slope below the edge of a Pleistocene terrace. The excavations revealed nearly continuous use of the area from the Mid or Late Augustan period until the decline of organised life in Emona.

This contribution focuses on the earliest phase of suburban activities, marked by a multi-room wooden building constructed just east of the city defences. Preliminarily dated to shortly after the founding of Emona, the building featured sunken foundations and floors composed of clay and mortar. It retained a consistent room layout throughout successive renovation phases until its abandonment, likely before the Flavian period. Notable quantities of waste rubble, including stone debris, stone tiles and mortar crafted from the same stone material, suggest the building was associated with stonemasonry activities.

Petrographic and sedimentological analyses were carried out on the recovered finds. The stone debris consisted mainly of pebbles of carbonate and clastic origin. Based on sedimentological clast analysis, comparable lithofacies types can be found in the alluvial deposits of the Sava River. These deposits, which also form the bedrock at the Križanke site, could have been extracted locally. The stone blocks, finished products, and waste rubble consisted of laminated micritic limestone, which sedimentological analysis associates with a sedimentary environment with poorly ventilated conditions. Comparisons with existing data indicate that these litho- and microfacies types were used in Emona for producing tesserae.

The dating of the building's stratigraphic layers suggests that its existence may have been tied to the demand for stonemasonry during the early phases of Emona's urban development. Current evidence implies that this development was not executed as a single, coordinated effort; rather, the construction of some insulae appears to have extended into the Claudian period. Analyses from the Križanke site further indicate that the stone blocks were transported regionally and processed on-site to meet the colony's construction needs.

CHALLENGES IN EXAMINATION AND CONSERVATION–RESTORATION OF A ROMAN MARBLE SEPULCHRAL STELA: THE ORPHEUS MONUMENT IN PTUJ, SLOVENIA

Aleksandra Nestorović[1] – Nina Mertik[1] – Sabina Dolenec[2,3] – Ana Brunčič[3] – Janez Kosel[4] – Nina Žbona[5]
[1] Regional Museum Ptuj-Ormož, Ptuj, Slovenia
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana
[3] Slovenian National Building and Civil Engineering Institute, Ljubljana, Slovenia
[4] Institute for the Protection of Cultural Heritage of Slovenia, Research Institute, Ljubljana, Slovenia
[5] Institute for the Protection of Cultural Heritage of Slovenia, Restoration center, Department for stone and stuccowork, Ljubljana, Slovenia

Keywords: Roman sepulchral stela, relocation of a monument, marble

In 2024, the Slovene Ministry of Culture launched the Žitnica / Granary project on Ptuj Castle Hill (Slovenia), establishing a new facility dedicated to archaeology. This initiative allows the Regional Museum Ptuj-Ormož to relocate the largest monolithic monument ever found in the Roman province of Upper Pannonia in order to prevent its further degradation. The museum is leading the effort to move this decaying monument to the future exhibition area.

Due to the technical complexity of the proposed interventions and the exceptional heritage significance of the Orpheus Monument, an Expert Commission was appointed by the Institute for the Protection of Cultural Heritage of Slovenia. The long-term conservation of the monument can only be achieved by relocating it to a controlled, air-conditioned environment within the new section of the museum, where it can be appropriately displayed to the public. A copy of the monument will be erected at Slovenski trg in its original location.

This major conservation-restoration project that raises increasingly complex questions, which are discussed in this contribution:

- Technical measures to protect the monument prior to lifting it from the ground, including lifting and transportation considerations due to the size and fragility of the monolithic marble slab.

- Archaeological excavations around the monument before the relocation.
- Creating a copy of the monument, selecting a suitable material that resembles the original and is resistant to weathering.
- Conducting marble analyses, studies and planning the conservation-restoration work on the monument, as well as investigating previous interventions.
- Planning the space for an appropriate presentation of the monument in the new lapidarium.

Additionally, the results of microbiological analysis of long, mouldy grey stripes covering most of the reliefs are presented, along with non-destructive testing method such us ground-penetrating radar (GPR) measurements and ultrasonic velocity measurements (USV) to assess the condition of the marble monolith.

AUGUSTA EMERITA: RECEIVING AND DISSEMINATING CENTRE OF MARBLES IN LUSITANIA

Trinidad Nogales Basarrate[1] – Pilar Lapuente Mercadal[2,3] – Nova Barrero Martín[1]
[1] National Museum of Roman Art, Mérida, Spain
[2] University of Zaragoza, Faculty of Sciences, Department of Earth Sciences, Zaragoza, Spain
[3] Catalan Institute of Classical Archaeology, Tarragona, Spain

Keywords: Augusta Emerita, Lusitania, regional marbles

Marble was not used in the west of the Iberian Peninsula until the full conquest and Romanisation of the territory, the future province of Lusitania, with its capital in the colony Augusta Emerita (present-day city of Mérida). The inland geography of this new city made it difficult to access marble imported from Rome, which did reach other cities such as Tarraco, Carthago Nova, Hispalis or Corduba.
During the first provincial years, under the reign of Augustus (27 BC–14 AD), local stones and bronze were used as architectural-decorative and epigraphic materials, although the regional marble quarries were known thanks to the efficient work of Agrippa. In the reign of Tiberius (14–37 AD), a systematic exploitation of the regional quarries began, especially the marbles of the anticline of Estremoz, which continued in the 1st and 2nd

centuries AD, under the close supervision of an illustrious Lusitanian, L. Cornelius Bocchus.
The quality of Lusitanian marbles determined their massive use, as their varieties were adapted to the building and decorative needs: white marbles for architecture and sculpture, grey and brecciated marbles for plaques and epigraphs, paving and other secondary uses. The white marbles, due to their quality, came to be confused with Carrara. The archaeometric analyses carried out since the 1990s and the knowledge of the regional quarries have favoured the recognition of these regional varieties even beyond their regional context, which were widely disseminated throughout the Iberian Peninsula and North Africa.
Augusta Emerita, a political and administrative centre, became a centre for receiving and disseminating materials, workshops and models, in close connection with Rome. Thus, despite its inland location, archaeometric studies have been revealing the particular import of the most prized marbles for emblematic pieces.

MARMORA FROM THE PRAETORIUM OF COLONIA CLAUDIA ARA AGRIPPINENSIUM (COLOGNE, GERMANY)

Leonie Nolte[1] – Vilma Ruppienė[1] – Sebastian Ristow[2] – Franziska Bartz[3] – Michael Wiehen[3]
[1] Ruhr–University of Bochum, Institute of Archaeological Sciences, Bochum, Germany
[2] Jewish Museum in the Archaeological Quarter Cologne, Cologne, Germany
[3] Archaeological Zone – City of Cologne, Cologne, Germany

Keywords: Cologne, praetorium, incrustations

A praetorium served as the political and administrative centre and the official residence of the emperor's deputy in a Roman province. Remains of such an extensive complex were also excavated in Cologne, the capital of the Roman province of Germania Inferior, established under Emperor Domitian around 85 AD.
During excavations conducted in 1953, 1960–1970, and since 2007, numerous fragments of former wall and floor revetments have been uncovered. Approximately 1700 of these fragments, originating from the areas of the southern baths, the apsidal hall, and the area in the north of the apsidal hall, are being analysed as part of a master's thesis. The study

aims to provide new insights into the variety and provenance of marmora used in different parts of the building and into the former appearance of the interior decoration.
All incrustation fragments were examined macroscopically in detail. For fragments where the rock type and origin could not be reliably identified macroscopically, representative samples were subjected to petrographic analysis using a polarization microscope and isotopic analysis (C and O isotopes).
The study reveals that both in the praetorium baths and the apsidal hall, local and Mediterranean stones were employed for wall and floor decoration. Southern baths: Of 200 incrustation fragments investigated, approximately half are marmora of local or regional origin (e.g., black, grey, and red Belgian limestones and marble from the Odenwald). The other half consists of imported stones from Mediterranean sources, with Pentelic and Carrara marble being the most common. Varieties such as Cipollino verde, Fior di pesco, Breccia di Sciro, and Verde antico were only identified in small quantities.
Apsidal hall: The largest number of incrustation fragments (540) comes from this area, which likely functioned as a representative reception hall. Here, a significantly greater diversity of stone types (25) was identified compared to the southern baths (15). The coloured marmora were sourced from quarries in Greece, Turkey, Egypt, Tunisia, and France. The most common white marble types are Pentelic, Carrara, and Proconnesian marble. Also, the range of regional materials is more diverse. Notable examples include Granito verde a erbetta from Trier and diorite from Felsberg (Odenwald). These two, along with Granito bianco e nero and Cipollino mandolato from the Pyrenees, were increasingly used during Late Antiquity, suggesting that the apsidal hall was decorated or renovated during this period.

UNVEILING QUARRYING PRACTICES IN THE EUGANEAN HILLS, ITALY: INSIGHTS FROM UAV LIDAR AND GIS ANALYSIS

Josiah Olah[1] – Michele Secco[1] – Cristiano Miele[2] – Filippo Carraro[3] – Simone Dilaria[1] – Jacopo Turchetto[1]
[1] University of Padua, Department of Cultural Heritage, Paduaa, Italy
[2] Archetipo S.r.l., Padua, Italy
[3] Independent researcher, Padua, Italy

Keywords: LiDAR, quarried landscapes, roman quarries

This research investigates the historic quarrying landscape of the Euganean Hills, Veneto, Italy – a series of volcanic hills known for their unique geochemical and mineralogical composition, which have made the region a prominent source of stone materials for over 2,500 years. High-resolution UAV LiDAR surveys and GIS-based analysis targeted survey areas based on topographical and geological parameters, supplemented by insights from lower-resolution LiDAR datasets. The study focused on volcanic breccia deposits as part of ongoing provenance research into the pozzolanic additives of Roman mortars in northern Italy. Digital terrain models (DTMs) covering 8.5 square kilometers were produced, achieving 25 times the resolution of regional aerial LiDAR datasets. From this data, 89 potential quarry sites were identified and evaluated through targeted field surveys.

The analysis enabled the precise detection and 3D modelling of anthropogenic features within forested landscapes. Statistical analysis of 50 sites distinguished historic quarries from modern ones, which revealed patterns related to morphology, spatial layout, and inferred extraction techniques. Two potential Roman-period breccia quarry complexes were identified and documented through spatial analysis and field surveys. These sites exhibited distinctive physical attributes, transportation pathways, and functional organization, suggesting shared extraction methodologies and logistical systems. The extent of material extracted further indicates their likely role as key sources for pozzolanic aggregates.

This study highlights the value of high-resolution UAV LiDAR in detecting and analysing quarry landscapes, particularly in densely vegetated terrains. By integrating remote sensing, GIS-based spatial analysis, and targeted field validation, the research provides new insights into quarrying techniques, site organization, and the cultural and economic significance of ancient stone extraction. The findings contribute to the regional documentation of new sites and detailed site-specific analyses, while ongoing archaeometric research aims to deepen our understanding of pozzolanic aggregate use and provenance in northern Italy.

LOCATION AND CHARACTERISATION OF THE QUARRIES OF RODADERO DE LOS LOBOS - CORTIJO PIQUÍN (CORDOBA, SPAIN)

Esther Ontiveros Ortega[1] – José Beltrán Fortes[2] – María Luisa Loza[1] – Antonio Monterroso Checa[3] – Massimo Gasparini[4] – Juan Carlos Moreno Escribano[5] – Juan de Dios Borrego de la Paz[3] – Daniel Becerra Fernández[6]
[1] Andalusian Institute of Historic Heritage, Seville, Spain
[2] University of Seville, Faculty de Geographic and History, Department of Prehistory and Archaeology, Seville, Spain
[3] University of Córdoba, Faculty of Geography and History, Department of Art, Archeology and Musique, Córdoba, Spain
[4] University of Córdoba, Research, Innovation, and Competitiveness Unit for the Heritage Environment, Córdoba, Spain
[5] National Geographic Institute, Madrid, Spain
[6] University of Malaga, Faculty of Philosophy and Letters, Department of Historical Sciences, Málaga, Spain

Keywords: prospection, Roman quarries, marmor

In the Sierra de Córdoba (Córdoba, Andalusia, Spain), we find a significant number of stone types that were used as ornamental stones in Roman times, both in the city of Córdoba and other cities in the south of the Iberian Peninsula. All this has led us to propose a study of one of the stone typologies from this mountain range, the ornamental rock known as Rodadero de los Lobos. This work focuses on the study of the different extraction fronts of this stone material, specifically on the private property of the Piquín farmhouse and its comparative study with archaeological pieces from the Roman Theatre of Córdoba. This study will allow us to deepen our knowledge of the quarries in this mountain range, the characterisation of the material, the local use and the approximation of the possible exit routes for the blocks obtained from these quarries.
The methodology used has combined surface prospection and the use of drones with a LiDAR sensor. The use of both techniques has allowed us to obtain very interesting results. Various archaeometric techniques – thin-film petrographic analysis, X-ray fluorescence and X-ray diffraction – were also applied to the quarry samples obtained. We have been able to identify and document various loci in the study area, as well as possible transport routes for the material. The material has been characterised using

petrographic and physico-chemical techniques, defining this important Cordovan ornamental stone.
Finally, it deepens the knowledge of one of the most important ornamental rocks extracted in the region of Cordoba, along with the Piedra de Mina, various types of granite and the white marble of the Trasierra.

NOVEL METHOD OF DOCUMENTATION OF ROMAN QUARRIES BY USE OF LIDAR TECHNOLOGY

Milorad Ostojić[1] – Jesenko Hadžihasanović[2] – Adnan Kaljanac[2]
[1] Narodna biblioteka i muzejska zbirka Zvornik, Zvornik, Bosnia and Herzegovina
[2] University of Sarajevo, Faculty of Philosophy, Department of Archaeology, Sarajevo, Bosnia and Herzegovina

Keywords: LiDAR, Dardagani, survey

The galleries of the Roman underground limestone quarry, at the site named "Sige" in Dardagani near Zvornik, were first recorded in 1965. During 1966 and 1968, only archaeological reconnaissances were carried out, while in 2008 more detailed investigations of stone and both vast complex of opencast and underground quarries in the surrounding area were carried out, when it was determined that Sige and other surrounding quarries were primary source of stones of Sirmium from 2nd until 5th century AD. Till today, the following finds from the site have been recorded: the remains of stone sarcophagi and pillars, Roman ceramics and iron tools, a crossbow fibula, coins of Emperor Valentinian I, and a Mithras relief.
During 2024, a number of surveys of the underground quarry and the external part of the site "Sige" were carried out using LiDAR, adapted and specialized for archaeological surveys, with the aim of demonstrating the potential use of this technology for the purpose of creating detailed archaeological documentation, and mapping the accurate, and previously unknown, complete three-dimensional presentation of the Roman quarry site in Dardagani.
One of the examples of the potential use of archaeological documentation made with adapted and specialized LiDAR is the possibility of obtaining three-dimensional representation of various mining galleries, done in short period and low light conditions, versus the traditional methods of photography or drawing which would require much more time and lighting for documentation of same area of the quarry. Also, by recording with

adapted and specialized LiDAR, it is possible to obtain data on galleries whose dimensions are obtained on a scale of 1:1, which then enables the measurement of individual carved blocks of stone, as well as the depressions that would remain after the extraction of individual blocks. This data provides the possibility to estimate, based on the average size and volume of the carved blocks, the approximate number of extracted stone blocks that could have been exported to Sirmium during the time the Dardagani quarry was active in the Roman period.
Data obtained from LiDAR survey could serve as an opportunity to further the existing practice of the local community for future research activities, as well as the cornerstone of any future conservation effort and put this archaeological site into function for the scientific community and the public alike.

THE EARLY IMPERIAL MARBLE ASSEMBLAGE OF THE VACONE VILLA BATHHOUSE (LAZIO, ITALY)

James Page[1] – Garney Farney[2] – Candace M. Rice[3] – Tyler Franconi[3] – Dylan Bloy[4]
[1] Barcelona Supercomputing Centre, Centre for Humanities and Social Sciences, Barcelona, Spain
[2] Rutgers University, Department of History, Newark, New Jersey, United States of America
[3] Brown University, Joukowsky Institute for Archaeology and the Ancient World, Providence, Rhode Island, United States of America
[4] University of Tennessee, Department of Classics, Knoxville, Tennessee, United States of America

Keywords: Roman villas, bathhouses, greco scritto

The Roman villa at Vacone was founded during the late second century BC on the slopes of Monte Cosce, approximately 40 km north of Rome. The villa was substantially reorganized and renovated during the Early Imperial period (perhaps during the reigns of Augustus or Tiberius), with a lavish new bathhouse featuring extensive marble decoration added to the structure. This poster presents the quantified marble assemblage of the villa in its archaeological context, exploring the interplay between necessity and choice in the decoration of the villa.
The decorative stone and marble elements at the Vacone villa utilised a range of lithotypes, drawn from both local deposits and from further

afield. The assemblage mainly consisted of white, grey, or off-white marble extracted from within the Italian Peninsula, with the most common lithotypes identified as Lunense Bardiglio and Lunense Bianco. However, a significant quantity of Greco Scritto was also present. Greco Scritto, while used in a diverse range of contexts across the Roman world, seems to have had a strong association with water. During the first century AD, its most widespread applications were in fountains, nymphaea, and bathing complexes (both public and private). Chronologically, Greco Scritto is thought to have been primarily used in architectural assemblages between the late first century AD and the mid-second century AD, although earlier examples exist within Italy and elsewhere in the Roman Empire. An Augustan-Tiberian date for the Imperial remodelling of the Vacone villa would make its assemblage of Greco Scritto one of the earliest in Roman Italy, with its use in the bathhouse reinforcing the lithotype's association with water.

Alongside the lithotypes mentioned above, a diverse selection of polychrome marbles were present at Vacone in limited numbers. The expense of coloured marbles (especially for private consumers during this early period) limited their use throughout the villa to certain contexts and locations. In contrast to the white and off-white marbles used for revetment, imported coloured marble was used for cornicing or opus sectile flooring, with their deployment across the residential area representing a balance between practicality and a desire to impress in the villa's decorative composition.

MARBLE MADE MEASUREMENT TOOLS FROM CARIAN IASOS (TURKEY)

Diego Peirano
Italian Ministry of Education, Universities and Research, Turin, Italy

Keywords: marble, mensa ponderaria, mastoid weights

During the campaigns led by the Italian Archaeological Mission in Carian Iasos, a number of marble measurement tools were returned by excavations, mainly in agora, data that confirm the trade and craft vitality in this part of the city along the centuries. Firstly, a fragmentary mensa ponderaria (sekoma) conserving part of a cavity, while a second one is barely visible, then 17 mastoid weights, two provided of scratched letters and two with figural decorations. One of these seems to depict in place of breasts two heads, similar in that to a weight found in the sanctuary of Demeter and

Persephone in Knidos, but also to clay loom weights. These references should confirm the feminine imagery of these weights, used – according to Kroll and Stefanaki – by women, with all likenesses for weighing wool. A second weight was indeed found in a marketplace, maybe it was used here to weight, or was in waiting to be reused, having been found with hundreds of reused marble parts. Another weight was decorated with a bird (a dove?) on a hemisphere, and with a fish (a dolphin?) on another one. Being items of a certain value, it has been observed how sometimes these were offered to female deity sanctuaries: in Iasos a weight was found in the east stoa of a temple recently associated with Aphrodite. These weights are in average small; probably for this reason are not provided of handles: only a fragment conserves traces of a handle termination. With all likelihood, these weights were placed on a scale pan instead to be hanged to a hook. With regard to the materials, two of these weights are made of Iasian marble, so were locally made; with regard to those decorated, it should be observed how the dove and the dolphin are well documented in local craft, consequently, at least large part of these weights, also those made of grey and white marbles, should have been made locally.

THE MARBLE ARTEFACTS FROM AGIOS GEORGIOS, GREVENA (WESTERN MACEDONIA, GREECE): PROVENANCE, CARVING AND USES

Simona Perna[1,2] – Marie-Claire Savin[1,3] – Owain Morris[1] – Mar Sánchez Hernández[4]
[1] Catalan Institute of Classical Archaeology, Tarragona, Spain
[2] Autonomous University of Barcelona, Faculty of Arts and Humanities, Department of Art and Musicology, Barcelona, Spain
[3] Autonomous University of Barcelona, Faculty of Arts and Humanities, Department of Antiquity and Medieval Studies, Barcelona, Spain
[4] Universitat Rovira i Virgili, Tarragona, Spain

Keywords: white marble, architecture, marble trade

The region surrounding the Agios Georgios village (Grevena) has long been overlooked in archaeological studies. Recent investigations, however, reveal a significant archaeological record that sheds light on the region's cultural and historical role during antiquity, particularly in the Roman period. Between 2022 and 2024, a notable concentration of marble artefacts came to light in the Arsalia fields, located approximately 2 km from the

village. The marble finds, all bearing tool marks, result from the bulk-shaping and roughing out of larger blocks while several fragments present relief decoration suggesting the presence of a marble-processing workshop within a larger structure, potentially a Roman villa rustica. Despite marble being a rare commodity in Greek villas, the finds from Arsalia suggest that stone-working could have been an activity alongside agricultural production. These marble fragments might be remnants of architectural features or decorations, or they could represent reused material. Such finds complete and integrate a set of unpublished marble artefacts from Agios Georgios dating from the Hellenistic to the Roman period, housed in the local Ephorate of Antiquities. These include several reliefs depicting human ears, likely associated with healing and divine listening; inscriptions and fragments of architectural elements and sculpture, such as the lower part of a female statue, which may pertain to religious and funerary contexts. These marble artefacts may contribute to the broader understanding of resource exploitation, trade, and architectural practices in Roman Macedonia.

The objectives of this poster are to present and discuss the origin and function of the Arsalia marble artefacts and to determine the role of this material in the broader regional economy. Preliminary observations reveal two primary marble varieties: an ivory-white, fine-grained calcitic type and a sparkly white, fine-grained calcitic type used in both architectural elements and mosaic tesserae. Initial surveys and quarry samples obtained through collaboration with local operators have confirmed visual similarities between the archaeological marble and local geological sources. Macroscopic and autoptic analyses indicate a probable provenance from Mount Vermion, Vourinos, or Vounasa mountains in the Kozani area. Additionally, local greyish limestones were utilized for mosaic tesserae, suggesting a diversified resource utilization strategy. This research underscores the potential to illuminate underexplored aspects of ancient marble production and distribution networks in Roman Greece.

USE AND ORIGIN OF WHITE MARBLES IN ROMAN AQUITAINE

Isabelle Pianet[1] – Graziella Tendron[2] – Laura Barataud[3] – Marie-Claire Savin[4,5]
[1] Bordeaux Montaigne University, Archeosciences Bordeaux laboratory, Pessac, France
[2] Éveha, Biard, France
[3] Bordeaux Montaigne University, The Ausonius Joint Research Unit, Pessac, France
[4] Catalan Institute of Classical Archaeology, Tarragona, Spain
[5] Autonomous University of Barcelona, Faculty of Arts and Humanities, Department of Antiquity and Medieval Studies, Barcelona, Spain

Keywords: marbles, provenance, archaeometry

This research aims to determine the provenance of white marbles used for decorative purposes in key Roman Aquitaine sites constructed at different periods of the Roman Empire. These sites include Cassinomagus in Chassenon (early 2nd century CE), the Saint-Germain baths in Poitiers (late 2nd century CE), the Saint-Saloine baths in Saintes (late 2nd century CE or early 3rd century CE), and the Gleyzia villa in Saint-Sever (4th century CE). A total of 44 samples were collected, primarily from applied decorations, and analysed using a protocol combining geological methods (petrography, cathodoluminescence) and chemical analyses (isotopic analysis, trace elements, and NMR spectroscopy). This combination enabled identification through a process of progressive elimination.
The capitals of the Saint-Saloine baths in Saintes exhibit characteristics consistent with marble from the Pyrenees, likely extracted from the Saint-Béat region (Haute-Garonne), specifically the Rapp quarry, active during the period of these decorations. Similarly, the ornamentation of the Saint-Germain baths in Poitiers predominantly utilized Pyrenean resources, particularly from Saint-Béat. However, one Attic base stands out due to its petrographic features, isotopic signature, and chemical composition, likely attributable to its brecciated nature.
The materials analysed from the Chassenon site exhibit homogeneous brecciated facies of unknown origin, due to the lack of a corresponding geological reference.
Finally, analyses of the decorations from the Gleyzia villa in Saint-Sever confirm the Pyrenean origin of the materials used. However, they chal-

lenge the initial interpretation that identified the marble as originating from Saint-Béat. Instead, the petrographic features, trace elements, and NMR spectroscopy align more closely with observations of marbles from the Ossau Valley.
In conclusion, the predominance of Gallic marbles is undeniable. This trend parallels findings from studies on the supply of coloured marbles in the Picton territory, which revealed a marked preference for Gallic marbles, with Pyrenean stones taking center stage. In this part of Gaul (Nothern Aquitaine) their use is attested as early as the 2nd century BC in the decorations of the Saint-Saloine and Saint-Germain baths and continued throughout Late Antiquity, as evidenced by the capital extracted from the Charente riverbed in Saintes and the decorations of the Gleyzia villa.

GEOSPATIAL PATTERNS IN PENTELIC MARBLE AND THE PARTHENON: LINKING ISOTOPIC AND PETROGRAPHIC VARIABILITY TO GEOLOGY AND MARBLE USE

Scott Pike[1] – Spencer Chase[1] – Heather Kitada Smalley[2]
[1] Willamette University, Department of Environmental Science and Archaeology, Salem, Oregon, United States of America
[2] Willamette University, School of Data Science, Salem, Oregon, United States of America

Keywords: Pentelic marble, provenance, Parthenon

Pentelic marble, renowned for its use in ancient Greek and Roman sculpture and architecture, exhibits spatial variability in stable isotope composition and to a lesser degree texture. This paper presents a statistical spatial analysis of these variables, linking their distribution to underlying geologic formations. Using machine learning with a geostatistical approach, we examine isotopic signatures ($\delta^{13}C$ and $\delta^{18}O$) and maximum grain size variation across the ancient quarry field, identifying spatial patterns likely influenced by differences in limestone protolith, metamorphic gradients, and localized hydrothermal activity. The integration of spatial interpolation methods with petrographic and geochemical data reveals significant correlations between geologic setting and material heterogeneity and allows for increased precision in identifying source quarries for different architectural and sculptural elements of the Parthenon. Our findings emphasize the necessity of incorporating local geology

into provenance studies, challenging assumptions of isotopic homogeneity of some other marble regions. This interdisciplinary study provides archaeologists, scientists, and art historians with a refined framework for sourcing marble artefacts, demonstrating how geological context directly informs material variability and provenance attribution.

PORPHYROGENITURE AND THE PORPHYRA: A LOST ROMAN PORPHYRY MONUMENT OF CONSTANTINOPLE OR A BYZANTINISTS' MISUNDERSTANDING?

George Pinkerton
University of Edinburgh, School of History, Classics, and Archaeology, Department of Classics, Edinburgh, United Kingdom

Keywords: porphyry, porphyrogenitus, Porphyra

In the Middle Byzantine period, Roman emperors and their family members sometimes had the title porphyrogenitus. In Antiquity, the concept of porphyrogeniture – or to be "born in the purple" – was applied to offspring of a ruling monarch. This idea is known from Greek, Latin, Syriac, and Armenian texts, but only in the 8th century does evidence of the specific epithet porphyrogenitus emerge. Mediaeval texts have been used to suggest an etymology connecting this epithet with imperial porphyry – the hardest, rarest, and most precious of stones the Roman Empire could access and which in the Middle Ages could be sourced only from spolia.

Liutprand of Cremona says the "porphyrogeniti" had to be born in a "domus" in Constantinople called "Porphyra", built by no less than Constantine the Great. In her Alexiad, Anna Comnena – herself "born in the purple" – hazards her opinion that this "Porphyra" was so named because porphyry decorated its walls and floor. Early Byzantinists like Charles Dufresne Ducange combined this scant evidence into an attractive picture of a monumental all-porphyry palace set aside for the births of imperial offspring. This has become a well-known piece of information repeated by later Byzantinists. Were they right?

No trace of such a "Porphyra" has ever been found in Istanbul. Ducange himself changed his mind shortly before his death, arguing that in the Middle Ages porphyrogenitus meant that a person had been born to reigning ruler, rather than in a porphyry palace. So too did Johann Jakob

Reiske, who dismissed the idea as a "trifle of the Greeks". However, Reiske buried his comment in a footnote to his edition of a dense Byzantine text. Posthumous editors of Ducange's Greek Glossarium undid his late retraction by recycling and expanding on his earlier opinion from the Latin Glossarium and his proto-archaeological Historia Byzantina.

By the 20th century, wholly fictitious maps had been prepared speculating on the location, appearance, and symbolic significance of the Porphyra and its pyramidal roof. Two monographs on porphyry by Richard Delbrueck and Dario del Bufalo accepted the idea uncritically, translators began to insert references to the Porphyra where Byzantine texts mention imperial purple (porphyra). "Born in the purple" became "born in the Porphyra".

This calls for reappraisal. The concept of birth "in the purple" pre-dates Constantinople's porphyry-decorated Great Palace. Paraetymology and over-reliance on mediaeval sources continues to lead scholars astray. Porphyry may have nothing to do with porphyrogeniture.

THE ROMAN SARCOPHAGUS FROM SIRMIUM IN THE KUNSTHISTORISCHE MUSEUM VIENNA: MARBLE AND COLOUR

Georg Plattner[1] – Vasiliki Anevlavi[2] – Walter Prochaska[2] – Gabrielle Kremer[2] – Robert Krickl[2] – Robert Linke[3]

[1] Kunsthistorisches Museum Vienna, Vienna, Austria

[2] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

[3] Federal Monuments Authority, Vienna, Austria

Keywords: sarcophagus, polychromy, marble

The Roman sarcophagus with depictions of Amor and Psyche was found in 1865 in Sirmium (Sremska Mitrovica, Serbia) and acquired 1867 for the Viennese Imperial collections (inv. no. I 162). Since the opening of the Kunsthistorisches Museum, it has been on display at the side entrance of the building.

Within two projects the sarcophagus is in the focus of research: in cooperation with the Austrian Archaeological Institute, the Kunsthistorisches Museum did a series of marble provenance analysis, including isotopic and geochemical methods. The marble from the Sirmium sarcophagus was analysed and can be classified as Pohorje marble.

In the framework of the PolychroMon project, an interdisciplinary research project on the polychromy of Roman provincial stone artefacts in selected areas of the Danube provinces, funded by the Austrian Academy of Sciences (Heritage Science Austria) since 2021, the sarcophagus was intensively analysed to understand the still visible remnants of colour and to find out about possible traces not any more visible to the naked eye. The interdisciplinary methods applied include non-invasive means as visual inspection, digital microscopy, macro-photography and comprehensive multiband imaging to identify pigment phases and uncover remnants not visible to the naked eye and X-ray fluorescence analyses for chemical information. In addition, small samples were taken with a scalpel, to understand the stratigraphy on cross-sections and gain information regarding the pigments, the painting technique or the alteration of pigments due to degradation phenomena via light- and scanning electron microscopy. The analysis of organic components was achieved by gas chromatography–mass spectrometry, conducted in the Conservation Science Department of the Kunsthistorisches Museum Vienna.
First result show spectacular detailed paintings especially on the small sides of the sarcophagus, where the leaf masks and the felids are painted with red, yellow, and blue pigments, with precise and detailed contour lines in black and with small remnants of applied gold on the surface.

A HELLENISTIC RELIEF IN LUCCA (ITALY): ARCHAEOLOGICAL AND ARCHAEOMETRIC DATA

Alessandro Poggio[1] – Lorenzo Lazzarini[2]
[1] Scuola IMT Alti Studi Lucca, LYNX – Center for the Interdisciplinary Analysis of Images, Contexts, Cultural Heritage, Lucca, Italy
[2] Istituto Veneto di Scienze, Lettere ed Arti, Venice, Italy

Keywords: Hellenistic period, funerary relief, marble provenance

The paper intends to investigate a marble relief in the archaeological collection of the National Museum of Villa Guinigi in Lucca (inv. A.1) through the combination of archaeological and archaeometric (petrographic and isotopic analyses) data. The relief, a Hellenistic artefact, was found reused in the Pieve of Vallecchia (Pietrasanta), located in the area known as Versilia (north-west of Tuscany). It represents a banquet with three figures: the protagonist is a male figure lying on a kline and raising a rhyton with a majestic gesture; he is surrounded by two female figures. The

production of this artefact, which belongs to a well-known typology of funerary reliefs, can be referred to the Aegean-Anatolian area, very distant from the finding place. Scholars don't agree when the relief reached the Tyrrhenian coast, either in Antiquity or in post-antique times.
The goal of this paper is two-fold: on the one hand, it aims to reassess the main archaeological and art historical issues related to this artefact considering the most recent studies on this typology of reliefs; on the other hand, the first-ever archaeometric analysis of this artefact, promoted specifically for the present research, will bring the provenance of the white marble used for the relief into discussion.
The combination of these data will improve our knowledge of the complex biography of this artefact, contributing to the valorisation of this "out-of-context" artefact.

ARCHAEOMETRIC APPROACH TO IDENTIFYING THE PROVENANCE OF MARBLE DECORATIVE ELEMENTS FOUND IN AQUINCUM (BUDAPEST, HUNGARY)

Anita Polgár-Nyerges[1] – Judit Zöldföldi[2] – Bernadett Bajnóczi[3]
[1] Budapest History Museum, Aquincum Museum, Department of Ancient History, Budapest, Hungary
[2] University of Stuttgart, Materials Testing Institute, Building Protection and Restoration of Historical Monuments, Stuttgart, Germany
[3] HUN-REN Research Centre for Astronomy and Earth Science, Institute for Geological and Geochemical Research, Budapest, Hungary

Keywords: Aquincum, marble, provenance

Aquincum, the provincial capital of Pannonia Inferior (from AD 106), was situated at the most important crossing point of the Pannonian Danube frontier. The civil settlement to the north of the legionary fortress was elevated to town status by Hadrian. The civil town flourished until around the middle of the 3rd century AD; several richly decorated public and private buildings are known from the 2nd and 3rd centuries. In addition to the use of mosaic floors to decorate buildings, expensive marble slabs were also used to enhance the splendour of the interiors. Imitations of this decoration often appear on the plinths of wall paintings.
The studied fragments of marble used to decorate buildings can be found in the collection of the Aquincum Museum (Budapest). The finds show a varied picture, with fragments of different shapes and colours. We were

able to separate fragments of large slabs, small and coloured framing fragments, and fragments of profiled door and window frames. The aim of the research was to identify the possible provenance of the raw materials and to compare the results with those of previous investigations conducted in Aquincum and Pannonia. The research have been provided valuable data and additional information for on the study of Roman marble quarrying, working and transport. Some of the white marbles came from the eastern Alps in the direction of Noricum. There is also a large presence of white (e.g. Proconnessos, Thasos, Paros) and polychrome marbles (e.g. cipollino verde, verde antico, breccia corallina, pavonazetto, greco scritto) from the Mediterranean region, which clearly shows that Aquincum had access to the main marble trade networks of the 2nd–3rd centuries AD.
To determine the exact sources of the raw materials, in addition to non-destructive in situ measurements (MGS /Maximum Grain Size/, Raman spectroscopy, XRF /X-ray fluorescence spectroscopy/), thin section petrographic and stable isotope analyses were carried out.

RECONSIDERING THE 'TIBERIUS RELIEF': RECARVED OR NOT?

John Pollini
University of Southern California, Department of Art History, Los Angeles, California, United States of America

Keywords: Tiberius, Roman, relief

In my 2012 book, From Republic to Empire: Rhetoric, Religion, and Power in the Visual Culture of Ancient Rome, I published for the first time an exceptional 90-cm-high historical relief from the collection of A. Moya Morena in Seville and now on loan to the Getty Villa. This high-quality relief, which is said to be from Spain, represents the personification Concordia introducing the emperor Tiberius to the Genius of the People, which I had assumed was that of either Colonia Emerita Augusta (modern Mérida) or Colonia Patricia (modern Córdoba). Because of the relief's height, it probably once formed part of the revetment for a statue base or altar connected with imperial cult worship.
As discussed further in an article in Interdisciplinary Studies on Ancient Stone, Proceedings of the XI International Conference of ASMOSIA, which I published jointly in 2018 with my colleague Pilar Lapuente, with assistance and input from Trinidad Nogales Basarrate and Jerry Podany, it

was determined scientifically that the marble of this relief was from the quarries of Luni-Carrara. Based on a study of Roman sculptures in Spain, it was also established that Luni-Carrara marble was imported into Spain, especially in provincial capitals, because of its symbolic and prestigious value, particularly for images associated with imperial cult worship.

In a recent article in 2022 in the Xth Reunión, Escultura Romana en Hispania,it was argued that the portrait head in this relief did not represent Tiberius but rather Augustus or his Genius recut from a portrait of Caligula after his memory was damned. It was further argued that the head of the personified Concordia was recut from a portrait of an "empress, a sister of Caligula" and that the relief was carved in a workshop in Rome. In my presentation for this ASMOSIA conference, I shall endeavour to show why I do not agree with this newly posited interpretation of the relief as recut and why my original identifications of these two figures are correct. My arguments are based on my own recent careful re-examination of the carving techniques employed on this and other Roman "historical" reliefs that were not recarved. In addition, because of the type of Luni-Carrara marble used for the relief, I shall reconsider the question of whether such a relief might have been carved in Rome or in one of the colonial capitals of Roman Spain.

THE STONE-MARBLE FACE OF DEULTUM (BULGARIA)

Hristo Preshlenov[1] – Nikolay Gospodinov[2]
[1] Bulgarian Academy of Sciences, National Institute of Archaeology and Museum, Sofia, Bulgaria
[2] Independent researcher, Topolovgrad, Bulgaria

Keywords: Deultum, building, stone

The study is focused on building stone and marble materials – elements of architectural order and interior decoration from Roman temples and residential domus, street pavement, porticoes and colonnades, and fortification constructions in the urban area of Deultum in Bulgaria. In the last quarter of the 1st century AD the wooden-brick (pre)Trajan dwellings are built in the colony. In the pre-Hadrian construction urbanization, especially in the temple of Minerva, the regional rock types predominate. The marble "Hadrian-face" of the colony still are presented by the street colonnades. In the late Roman period the elements of the Roman marble

streets colonnades have been reused on purpose, but the builders have moved away from the canon - the bricks cover the marble floor of the temple of the nymphae. The water tradition still remains - the early Byzantine fountain has reused the place and the marble elements of the Roman nymphaeum. Marble reused flags cover the Roman sewer manholes and the Early Byzantine city gates. The Roman and early Byzantine stone and marble spoliae has been also used in the early Byzantine residential buildings. The studies register a high density and intensity of construction, reconstruction and upgrading of buildings with different functional purposes - temples, nymphaeum, public bath, residential-administrative complex (domus), streets with porticoes, late Roman and early Byzantine fortifications. In the constructions, the stone from volcanogenic (andesite, andesite tuffs, basalt and andesite basalt) and volcanogenic-sedimentary (sandstones, tuff sandstones, breccias) rocks from deposits in the city territory, from the Eastern Sredna gora and the Eastern Balkan Mountain, predominates. The marbles have a massive (white, light grey, grey brown) or striped (light grey, reddish) texture, uneven structure and the main rock-forming mineral calcite, originating from Strandzha (Malko Tarnovo region) and the Eastern Rhodope (Ivaylovgrad region) deposits. Layered marble is predominantly used for flooring and cladding, and massive marble is preferred for making structural architectural elements (bases, columns, capitals). During the Byzantine period, in the conditions of a declining standard of living, construction materials from welded and/or destroyed Roman and late Roman buildings and facilities have been reused, including marble architectural elements and linings. The provision of rock types, their processing and (re)use as the main building material in the functional-spatial arrangement and formation of the monumental-representative stone-marble face is tracked, as an indicator of the dynamics of development of the urbanized environment, the ups and downs of its social community.

THE ANCIENT STONE QUARRIES OF POPULONIA (PIMBINO, ITALY): EXPLOITATION DYNAMICS AND QUARRYING TECHNIQUES AT LE GROTTE SITE

Caterina Previato – Emanuela Faresin – Alessandro Mazzariol
University of Padua, Department of Cultural Heritage, Padua, Italy

Keywords: Populonia, ancient stone quarries, extraction techniques

Since 2024 the Department of Cultural Heritage of the University of Padua has been conducting a research project aimed at the study of the ancient stone quarries of the Etruscan-Roman site of Populonia (Piombino, Italy), which were exploited from the early settlement period (9th century BC) through the Roman Age. In the area surrounding the city in fact there are a number of quarries, whose location is known, albeit approximately, but which have never been studied in detail, with only a few exceptions.

The focus is currently on the largest quarry in the city's suburb, sited in the locality of Le Grotte. The site is of extreme interest considering the significant extension of the extraction area (approximately 5 hectares) and the excellent state of preservation of the traces of ancient quarrying activity, such as pick and wedge marks, separation trenches between blocks, semi-extracted blocks, etc.

The project aims to analyse the quarry in detail, to reconstruct the dynamics of its exploitation and the tools and techniques used by the quarrymen, and to quantify the material extracted from it. To this end, the project envisages the application of a multidisciplinary approach: study of archival documents, 2D and 3D geometric survey (by applying different techniques together: total station survey, field and aerial photogrammetry, laser-scanning and manual survey), documentation of the extraction marks, archaeometric analyses to characterize the material outcropping in the quarry.

This contribution will present the first results of the research, offering a comprehensive analysis of the quarry's features, the extraction techniques employed, and the overall exploitation dynamics, and comparing these findings with those from other quarries in the territory of Populonia.

A GIS FOR MAPPING AND STUDYING THE EXPLOITATION AND USE OF THE STONE RESOURCES OF THE REGIO X – VENETIA ET HISTRIA

Caterina Previato – Paolo Kirschner – Jacopo Bonetto – Arturo Zara
University of Padua, Department of Cultural Heritage, Padua, Italy

Keywords: GIS, ancient stone quarries, stone use and trade

In recent years, the Department of Cultural Heritage in collaboration with the Department of Geosciences of the University of Padua has been conducting a research project on the exploitation and use of the stone resources of the Regio X – Venetia et Histria in the Roman Age. The project involves the archaeometrical study of samples taken from Roman buildings and artefacts from the urban centers of the region to determine the lithotypes used and their provenance, and the mapping and analysis of the quarries exploited in historical times. Over the years, a large amount of both archaeological and geological and archaeometric data has been collected, which were firstly inserted in a database connected to a Geographic Information System published by Previato and Zara in ASMOSIA XI Proceedings. In the last months a more complex GIS project was realized by using the open source software QGIS. The GIS structure permits to integrate and relate data from different sources. It contains georeferenced information on historical quarries, and on the geological features of the outcropping rocks. In addition, it includes the results of archaeometric analyses conducted on stone samples taken in the quarries but also from buildings and artefacts from archaeological contexts, making it possible to connect them to their basin of origin. Through the integration of geological data and the results of sample analyses, the GIS makes it possible to reconstruct the exploitation dynamics of stone resources, identify connections between quarries and sites of use, and map trade routes or possible supply routes for stone. Furthermore, it offers a useful tool for spatial analysis and visualization of information related to the distribution and use of stones, contributing to the understanding of the processes of selection, extraction and transport of resources in ancient periods.
This poster aims to present the potential of the GIS structure, which is intended as a multidisciplinary research tool that combines historical, geological and archaeometric data. The project foresees that the GIS will be made freely available online in the future, thus becoming a useful tool for other scholars interested in conducting both historical and geological studies.

DEVELOPMENT OF THE METHODOLOGY FOR PROVENANCE DETERMINATION OF DOLOSTONES USED IN MEDIEVAL ARTWORKS IN THE EASTERN BALTIC

Richard Přikryl[1] – Madara Rasina[1] – Martin Racek[2] – Aneta Kuchařová[1] – Jakub Trubač[1] – Daniela Řimnáčová[3]
[1] Charles University, Faculty of Science, Institute of Geochemistry, Mineralogy and Mineral Resources, Prague, Czech Republic
[2] Charles University, Faculty of Science, Institute of Petrology and Structural Geology, Prague, Czech Republic
[3] Academy of Sciences of the Czech Republic, Institute of Rock Structure and Mechanics, Prague, Czech Republic

Keywords: dolostone, eastern Baltic, provenance

Study of dolostone provenance from artworks received negligible interest from the scientific community in the past. This might be related to the fact that this rock type is restricted to less extensive occurrences in contrast to calcitic limestones (both sedimentary and metamorphic), and its use in architecture or sculpture is thus much more limited as well. However, certain parts of Europe (e.g. some regions in Spain, but namely Eastern Baltic) host numerous dolostone beds which have been employed as durable material for buildings, architecture, and sculpture. Current study focuses on Palaeozoic dolostones from the Eastern Baltic (Latvia, Estonia), the region unified under a political entity called Livonia in medieval times. Despite complex political history, many dolostone artworks survived until nowadays, and study of their origin and efforts of their protection for future generations present challenging tasks. As there was missing any complex strategy on the investigation of dolostone provenancing in the scientific literature, the authors attempted to fill this gap in knowledge and to develop a multimethod approach applicable for this rock type. The material used for the study covered specimens taken from various artworks from Latvian and Estonian heritage objects (important buildings, their architectural elements, tombstones, reliefs, and sculptures) dated from 13th to 18th century, and from selected historical quarries or quarry areas known to be active in medieval times. The laboratory study encompassed microscopic methods (optical microscopy, scanning electron microscopy, cathodoluminescence), image processing methods (petrographic image analysis), insoluble fraction phase study by X-ray diffraction, petrophysical methods (mercury intrusion porosimetry), geochemical methods (C and O stable isotopes study). Combination of these methods allowed for linking

most of the studied artefacts to either certain lithostratigraphic units or even to historical quarries and/or even to specific stone varieties within one quarry in some cases.

POLYCHROMY VS. DECAY SURFACE LAYERS ON OPUKA STONE – THE PROMINENT NATURAL STONE VARIETY USED IN MEDIEVAL ARTWORK IN CENTRAL EUROPE

Jiřina Přikrylová[1,4] – Richard Přikryl[2] – Martin Racek[3] – Irena Kučerová[1,4]

[1] Academy of Fine Art in Prague, Prague, Czech Republic

[2] Charles University, Faculty of Science, Institute of Geochemistry, Mineralogy and Mineral Resources, Prague, Czech Republic

[3] Charles University, Faculty of Science, Institute of Petrology and Structural Geology, Prague, Czech Republic

[4] Institute of Chemical Technology in Prague, Prague, Czech Republic

Keywords: polychromy, opuka stone, central Europe

Opuka belongs to the most widely used types of natural stone in the Central Europe since pre-Christian times. Since early medieval times, it was favoured for finely carved architectural elements and for sculptures. During the late Gothic, it made almost exclusive stone for richly polychromous Beautiful style Madonna and/or Pieta sculptures. The still unfinished debate of purpose of the application of polychromy (aesthetic-artistic vs. practical-protective) requires much deeper research of surface layers formed on opuka stone – either those unintentional related to weathering or intentional ones – related either to polychromy (original or later) or to conservation (effects of cleaning, removal of later polychromy layers). As previous studies focused more on the study of opuka stone itself or on the interactions between stone substrate and mortars or weathering environment, the comprehensive study of surface layers of variable origin and their contribution to stone durability are still missing. Opuka stone is extremely fine-grained sedimentary rock composed predominantly of amorphous to cryptocrystalline forms of silica being accompanied with micritic calcite and minor clay minerals and silt-sized clastic component. Very complex pore space dominated by adsorbent- and capillary-types of pores makes it prone to numerous decay processes; a fact that was recognised even during Medieval times and thus providing one of the clues for the extensive use of polychromy even indoors. Current study is based on microscopic and analytical analyses of

a wide set of specimens taken from sculptural artworks mainly in Bohemia, and from architectural elements and from natural outcrops in Central Europe. The interpretation of results aims not only in the identification of composition of the surface layers, but also focuses on the aspects related to the sequence of development of various surface layers, decay phenomena and/or uses of conservation agents. The results of the study should help in a more gentle conservation approach of this stone type in the future.

MARBLE QUARRIES IN THRACE (BULGARIA) AND THE USE OF MARBLE FROM ARCHAIC TO ROMAN TIMES

Walter Prochaska – Vasiliki Anevlavi
Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: marble chemistry, marble provenance, database

Marble use and trade in the region of Thrace took place extensively already before it became Roman province in 46 AD. Within this territory some of the most prominent and renowned marble sources of antiquity are located (e.g. Proconnesos or Thasos). The coastal regions at the Aegean, Marmara, and Black Sea, as well as the islands, were shaped by Greek culture and these marbles were widely exported throughout the empire. Accordingly, the marble trade in these coastal or island regions was always connected to the international commerce. Recent extensive studies in the course of the project "Fingerprinting White Marbles – Quarries and Cities of Roman Thrace, 1st–3rd century AD" (Austrian Science Fund) revealed that these marbles also were extensively used not only in the coastal areas but moreover in the larger inland cities of Thrace. In contrast to these renowned international marbles, the numerous marble deposits in the interior, in particular in today's Bulgaria, have received far less attention, however, as will be shown in this paper, they were of considerable economic importance. Therefore more than 1400 samples from ancient quarries in Thrace and samples from artefacts in the museums all over the region were analysed by a combination of different methods in order to assign the marble of a given artefact to a corresponding quarry or quarry area.
Evidence of Roman marble production during urbanization of the province in the inland territory of Thrace is known in different areas: The most important geologic unit for economic marble production is the Rhodope

Mountains with high-grade marble deposits. In the eastern parts of the Sredna Gora region further marble deposits occur with different metamorphic grades. Furthermore, in greenschist facies series of the NW Balkan Mountains near the town of Berkovitsa fine-grained marbles occur. Initial analyses indicate that these marbles were not only employed in the province itself, but were also exported. Furthermore, architecture and sculpture in the province of Thrace reveal striking connections to Asia Minor. By means of a sampling of the Thracian quarries on one hand and of Roman artefacts throughout the province on the other hand, the question regarding marble trade as well as the cultural and technological transfer will be discussed in the presentation.

WANDERER BETWEEN THE WORLDS – LIMESTONE OR MARBLE

Walter Prochaska – Vasiliki Anevlavi
Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: metamorphic recrystallization, petrography, texture

In stone-mason industry and in art-history the terms "limestone" and "marble" are in general not specifically differentiated in terminology. The stone industry is much more interested in the properties of the specific rock, particularly with regard to the capability of its surface to take a polish. This is in contrast to the scientific, petrographic nomenclature. Here the term "marble" is clearly assigned to metamorphic rocks, while "limestone" is a not metamorphosed sedimentary rock and, in the case of metamorphic overprint, is transformed to marble. For years the view on the diagenesis-metamorphic boundary is heavily debated. It seems that the opinion on this topic is depending on very different parameters and is also relying to a large degree whether it is discussed by a sedimentologist or metamorphic petrologist. In this respect it is also of great importance to discriminate between neoformation of minerals during diagenesis and those which can be attributed to metamorphism. Presented in this contribution is a number of well known "marbles" which, when carefully investigated with the petrographic microscope, still show more or less clearly the features of a sedimentary precursor rock. The start of a metamorphic recrystallization of a carbonatic sediment very much depends on many different characteristics like porosity, fluid content, presence of silicate minerals, organic

content, etc. On the basis of several examples from renowned ancient marble quarries it will be shown that the degree of metamorphic recrystallization in a given rock sample may vary on a very small scale. Surfaces of artefacts of these types of rocks (weathered of fresh breakage) may be easily confused with "real" marbles when the examination of the microscopic slide or at least a polished surface is not available. Inter alia, examples from the following locations will be presented in this contribution: different locations from Mani peninsular respectively from the Peloponnese, Lesbos, Göktepe, and Rhodes.

EXPLORING POLYCHROMY'S DECORATIVE AND PROTECTIVE FUNCTIONS ON DOLOSTONE IN LATVIA'S MEDIEVAL AND BAROQUE ARCHITECTURE

Madara Rasiņa[1] – Jiřina Přikrylova[2,3] – Richard Přikryl[1] – Martin Racek[3]

[1] Charles University, Faculty of Science, Institute of Geochemistry, Mineralogy and Mineral Resources, Prague, Czech Republic

[2] Academy of Fine Art in Prague, Prague, Czech Republic

[3] Institute of Chemical Technology in Prague, Prague, Czech Republic

[4] Charles University, Faculty of Science, Institute of Petrology and Structural Geology, Prague, Czech Republic

Keywords: polychromy, natural stone, NE Baltic region

Painted finishes of the carved surface of sculptural or architectural stone make one of the most widespread approaches on how to protect porous natural stone from rapid decay and on how to extend visual acceptance of respective artworks. In contrast to numerous studies on polychromy layers on sandstones or marbles, dolostones were examined very rarely. Current study focused on several artworks, located in the Eastern Baltic, specifically in Latvia. The whole Eastern Baltic is known occurrences of dolostones that were widely used in construction and for carving of architectural elements and sculptors since early medieval times. Namely in the case of architectural elements and sculptors, sometimes exposed outdoors, use of polychromy was very common until the Baroque times. In order to show historical development of the application of polychromy on carved dolostone surfaces, two typical examples were selected for this study:

- architectural elements – consoles and columns – in the Chapel and Refectory constructed during the 14th – 16th century period, and

- a Baroque (17th century) relief from the St Matthew Church in Matisi in northeastern Latvia, a region known as Swedish Livonia.

In the first case, lime-based colours with gentle shades were used; but for the younger example, vibrant oil-based paints were documented. The analyses of the composition of these polychromous layers by several analytical techniques (optical microscopy, scanning electron microscopy, FTIR and Raman spectroscopy) also allowed for understanding of original approach in stone substrate preparation and on the stratigraphical development of original painting and later re-painting in some cases. Along with this, the study also focused on the current state of polychromy preservation and on the selection of the appropriate strategy of their restoration.

A NON-DESTRUCTIVE MULTI-METHOD APPROACH TO THE ARCHAEOMETRIC STUDY OF MINOAN SERPENTINITE VASES (BRONZE AGE CRETE, 2650-1450 BCE)

Killian Regnier[1,2] – Antoine Triantafyllou[2] – Charlotte Langohr[1] – Gilles Montagnac[3] – Jean-Philippe Perrillat[2] – Delphine Bosch[4]
[1] Université catholique de Louvain, Faculty of Philosophy, Arts and Letter, Department of Archaeology, Louvain-la-Neuve, Belgium
[2] Université Claude Bernard Lyon I, Laboratory of Geology, Lyon, France
[3] École normale supérieure de Lyon, Université Claude Bernard Lyon I, Laboratory of Geology, Lyon, France
[4] Université de Montpellier, Geosciences Montpellier, Montpellier, France

Keywords: serpentinite, non-destructive analysis, Minoan Crete

Minoan material culture (Bronze Age Crete, 3100–1150 BCE) is characterized by an important production of stone vases showcasing advanced craftsmanship and regional variation in production techniques and stylistic preferences. A particularly wide variety of raw materials was used, with serpentinite, chloritite, and limestone being among the predominant types of stone employed in vase production. The geological characterisation of Minoan stone vases thus provides unique insights into the strategies of material selection and use in Aegean Bronze Age societies.
The project involves the non-destructive archaeometric analysis of different Minoan objects produced in serpentinite. Geochemical data were obtained using portable X-ray fluorescence (pXRF), while crystallography was examined through handheld portable Raman spectroscopy (HH-Raman). Since serpentinisation is typically associated with the formation of ferromagnetic

minerals, a portable magnetic susceptibility meter (pMS) has also been used to measure the magnetic response level. The analysis of archaeological material has then been compared to a field sampling of the different known Cretan serpentinite outcrops, which have been characterized by solution-ICP-MS for whole-rock geochemistry and pXRF calibration, XRD for semi-quantitative mineralogy, and μ-Raman of polished samples for in situ mineralogical characterization.

To date, the project has completed its pilot phase with the study of a protopalatial artisans's Quarter at Malia (Quartier Mu, 1800–1700 BCE). While precise provenance determination remains challenging at this stage, the results offer new perspectives on the factors influencing material selection, including local availability, physical properties, and symbolic value. Preliminary results from the analysis of Quartier Mu at Malia have suggested the use of a more talc-rich serpentinite rock than that previously defined by the researchers, and our initial conclusions suggest that these talc-rich rocks were selected for their greater tenderness, and therefore ease of exploitation. Furthermore, our study has highlighted specific craft production techniques, as well as documenting possible skeuomorphic inspirations between the various craftsmen of this quarter.

The presentation will also include a comparative analysis of Quartier Mu and other Minoan sites (spanning 2650–1450 BCE), based on forthcoming studies planned for March 2025, to further explore patterns of raw material procurement and potential exchange networks in Minoan Crete.

This presentation finally seeks to foster discussions on the non-destructive characterization of serpentinite, which is known to be poor in distinctive characteristics between outcrops, and on the complexities of establishing artefact provenance in the absence of documented quarries.

EXCLUSIVE USE OF FLUORITE IN INCRUSTATION ART OF VILLA FROITZHEIM, GERMANY

Michael Reinert – Vilma Ruppienė
Ruhr-University of Bochum, Institute of Archaeological Sciences, Bochum, Germany

Keywords: Roman villas, incrustations, fluorite

The aim of the PhD project, funded by the German Research Foundation (DFG), is to investigate the use of ornamental stones for incrustations in

the decoration of Roman villas and vici. The finds originate from 21 sites located in the Moselle and Rhine regions.

The majority of the incrustation fragments analysed in this project (2087 from 4826 fragments) originate from the Roman villa near Froitzheim. This villa rustica, likely in use from the mid-3rd to the late 4th century AD, is situated approximately 40 kilometers southwest of Cologne. Most of the incrustation fragments from this villa are unstratified surface finds, with only a few originating from excavations conducted in 1963/64. Among these finds are remains of former wall and floor revetments made of various marmora from regional sources (red, gray, and black Belgian limestones, granito verde a erbetta from Trier) as well as stones from Mediterranean quarries (cipollino verde, fior di pesco, breccia di Sciro, verde antico, pavonazzetto, porfido rosso, porfido verde, and others).

Particularly noteworthy are 14 fragments of fluorite, which include both irregularly broken pieces and fragments of worked slabs. The colours of the fluorite fragments range from white, light green, and green to pink and violet. The green, pink, and violet areas consist of fluorite, while the white zones are quartz veins. Some fragments display clear traces of working, including one or two polished surfaces. The slab fragments measure 2–3 centimeters in thickness, corresponding to the average thickness of Roman stone incrustations.

It remains unclear whether the fluorite finds from Villa Froitzheim were originally part of the villa's interior decoration (wall or floor incrustations, inlays for furniture) or served as raw material for the production of fluorite gemstones, as testified, for instance, in the Gallo-Roman settlement at Blot (France). However, the presence of polished surfaces on both sides of some fragments suggests the exclusive use of fluorite in incrustation art.

The origin of the fluorite is not yet determined. The colour combination of green and violet with white quartz veins does not match known sources in Belgium, England, or Spain. A potential origin in French deposits (La Barre in the vicinity of Aubière), where fluorites with similar colours have been described, is currently being investigated.

INCRUSTATIONS IN ROMAN VILLAS IN THE RHINE AND MOSELLE REGION

Michael Reinert – Vilma Ruppienė
Ruhr-University of Bochum, Institute of Archaeological Sciences, Bochum, Germany

Keywords: Roman villas, incrustations, Augusta Treverorum

The PHD project "Incrustations in Roman Villas in the Rhine and Moselle Region: Investigations on the Provenance of the Ornamental Stones and Their Use" (financed by German Research Foundation) is researching the use of marmora for wall and floor revetments during Roman times in the private contexts. In this context, 21 Roman villas and vici (2nd to 5th century AD) from the Moselle region (Konz, Mehring, Pfalzel, Mertert), the Eifel (Froitzheim, Oberweis, Leudersdorf, Dalheim, Diekirch, Altrier, Walferdange, Bertrange, Echternach, Schieren, Aspelt, Contern, Goeblingen, Andernach, Ahrweiler, Vichten) and the Hunsrück (Bad Kreuznach) have been investigated so far, with 4,826 incrustation fragments being recorded.

The aim of the project is to systematically document all significant sites featuring marmor incrustations within an area of approximately 20,000 km² across the Roman provinces of Germania Inferior, Germania Superior, and Belgica. This comprehensive inventory seeks to provide insights into the possibilities and limitations faced by villa owners when decorating their residences with costly marbles. Additionally, the data gathered contributes to the identification of trade networks, as well as the distribution of both locally sourced and long-distance traded stones.

All artefacts were measured, weighed, photographed, described, and indicative finds also drawn. The provenance of stones was largely determined macroscopically. For some fragments, petrographic analyses using a polarizing microscope were also conducted, and for white marbles, oxygen/carbon isotope analysis was additionally carried out.

Analysis of the data reveals the presence of both regional stones and Mediterranean imports in most of the villas investigated. The most common regional stones include red, grey, and black Belgian limestones, Odenwald marble, and Granito verde a erbetta (=Diabase from Trier), while the most frequently encountered Mediterranean stones are Cipollino verde, Giallo antico, Breccia di Sciro, Fior di pesco, Verde antico, and various types of white marble. However, the extent and distribution of

these materials vary significantly across sites, making it impossible to determine a clear preference for either imported goods or regional quarries. This variability can be attributed not only to incomplete preservation (e.g., spolia, lime kilns) but also to differences in excavation methodology (survey, partial excavation, complete excavation) and the scope of the original decorative schemes. Notably, certain stone types exhibit regional trends: for instance, red Belgian limestone is predominant in the Eifel (Germania Inferior), rare in the Moselle region (Belgica), and absent in the Hunsrück (Germania Superior). In contrast, black and grey Belgian limestone is found throughout the study area.

NICOTERA (CALABRIA, ITALY) GRANITE QUARRY AND ITS WIDE DIFFUSION

Pierre Rochette[1] – Valérie Andrieu[1] – Rosolino Cirrincione[2] – Francesco Cuteri[3] – Patrizia Fiannacca[2] – Andreas Hartmann-Virnich[4] – Patrizia Macrì[5] – Giuseppe Montana[6] – Rosalda Punturo[2] – Simona Raneri[7] – Claudia Sciuto[8]

[1] Aix-Marseille Université, CEREGE, Aix en Provence, France

[2] University of Catania, Department of Biological, Geological, Environmental Sciences, Catania, Italy

[3] Accademia di Belle Arti di Catanzaro, Catanzaro, Italy

[4] Aix-Marseille Université, Le Laboratoire d Archéologie Médiévale et Moderne en Méditerranée, Aix en Provence, France

[5] Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

[6] Università degli Studi di Palermo, Dipartimento di Scienze della Terra e del Mare, Palermo, Italy

[7] University of Florence, Department of Earth Sciences, Florence, Italy

[8] University of Pisa, Department of Civilizations and Forms of Knowledge, MAPPA laboratory, Pisa, Italy

Keywords: granite, Nicotera, Roman quarry

A Roman quarry of granite shafts in Nicotera (Calabria) is already known, but its diffusion has been deemed to be only local. Moreover, its discrimination with respect to the similar looking Mons Claudianus granite has been quoted as "very difficult". We have shown that magnetic susceptibility, yielding an order of magnitude difference between the two sources, is a straightforward technique to solve this difficulty.

Through a revisit of the quarry, where tens of semi-elaborated shafts can be observed, and systematic surveys in France, Italy and Tunisia we demonstrate that the shafts from Nicotera, besides diffusion in Calabria (14 shafts observed in Mileto, Vibo Valentia and Lamezia Terme), have been widely exported in western Mediterranean.
In Italy outside Calabria, we have so far identified 23 shafts or slabs, in the following regions by order of abundance: Sicily (Palermo, Monreale, Catania), Latium (Roma, Ostia), Campania (Amalfi, Salerno) and Toscana (Pisa, Siena). Palermo cathedral alone counts 9 shafts. Almost all occurrences are in medieval context. We also identified four shafts or fragments in Tunisia (Carthage and Kairouan). The Nicotera granite shafts thus appear geographically spread almost as much as the granite shafts from Corsica and Sardinia: Nicotera is absent from France but Corsica and Sardinia shafts are absent from Sicily. Contrary to the Corsica and Sardinia quarries, where numerous large shafts – up to 115 cm diameter – have been extracted, the Nicotera quarry seems to have specialized in the 30–45 cm diameter range. Diameters in the 70–80 cm range are exceptional and not exported (we found one in the quarry, two in Mileto). Taking into account the yet unknow occurrences, the shafts remaining in the quarry and the lost material, it is likely that the production of Nicotera quarry exceeded a hundred shafts, making it a significant source in the context of Roman granite trade in the western Mediterranean, despite its more complex accessibility compared to Corsica and Sardinia quarries, linked to much more abrupt coastal morphology. Accordingly, the total number of shafts quarried in Nicotera is likely less than for Corsica or Sardinia quarries.

ALGAJOLA GRANITE QUARRY IN NORTH-WESTERN CORSICA: EVIDENCE FOR ITS USE AND DIFFUSION PRIOR TO THE MODERN PERIOD

Pierre Rochette[1] – Valérie Andrieu[1] – Patrizia Macrì[2] – Jérôme Gattacceca[1] – Eric Ferré[3] – Simona Raneri[4]
[1] Aix-Marseille Université, CEREGE, Aix en Provence, France
[2] Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
[3] New Mexico State University, Department of Geological Sciences, Las Cruces, New Mexico, United States of America
[4] University of Florence, Department of Earth Science, Florence, Italy

Keywords: granite, Corsica, quarry

A remarkable type of granitoid rock has been quarried in modern time in NW Corsica, in Algajola, 5 km W of l'Ile Rousse. Its facies is characterized by large (up to 4 cm) purple feldspar, in a black and white coarse grained matrix. It is a quartz monzonite, rich in Mg and K. It somehow reminds the Troad quartz monzonite but its phenocrysts are larger and stockier, and its matrix is coarser and darker. It is also remarkable by the presence of large honey-coloured crystals of titanite.

This granite has been used in Florence by the Medici family likely starting from the 17th century. A 17 m long monolithic column, carved in the 19th century, was left in the quarry. In the early 20th century, it has been used in various monument in France, e.g. the monument to the Dixmude airship catastrophe in Pierrefeu (Var) or monuments in Paris. We have encountered a macroscopically similar lithotype in two rectangular slabs 30 × 50 cm included in the cosmatesque pavement of the Salerno (Campania) cathedral of the Norman period, i.e. 12th century, as well as in a 28 cm diameter shaft hosted in Autun (Burgundy) museum. The magnetic susceptibility of these pieces is identical to the one of the geological samples from Algajola and to the Dixmude monument, in the 10-13 10^{-3} SI range. This departs from the range observed on Troad granite: 25-40 10^{-3} SI. No antique usage of this Algajola facies had been previously reported, but it may have been visually mixed up with Troad. The slabs recognized in Salerno are associated with roundels of black porphyry, Sede di San Lorenzo and Mons Claudianus, pointing toward the choice of especially rare materials. It is likely that they were cut out of Roman spolia rather than directly obtained from Corsica in the 12th century. The column in Autun, given its small diameter and high length over diameter ratio, should come from a medieval monument. Still, Autun is a major Roman city. Thus, its origin as a Roman spolia is also likely.

MARBLE PROVENANCE OF THE CLASSICAL SCULPTURE COLLECTION OF LUDWIG POLLAK IN THE MUSÉE D'ART ET D'HISTOIRE, GENEVA

Irene Bald Romano[1] – Béatrice Blandin[2] – Vasiliki Anevlavi[3] – Walter Prochaska[3]

[1] University of Arizona, School of Art/School of Anthropology, Tucson, Arizona, United States of America

[2] Musée d'Art et d'Histoire, Domaine Archéologie, Geneva, Switzerland

[3] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: Ludwig Pollak, marble, sculpture

This presentation is focused on the marble provenance of the Greek and Roman sculptures collected by Ludwig Pollak (1868–1943) housed in the Musée d'Art et d'Histoire in Geneva. Pollak was one of the most important connoisseurs of ancient classical sculpture in the late 19th and first decades of the 20th centuries – a collector, dealer, and museum director in Rome. As a Jew feeling the increasing pressure of Fascist and Nazi anti-Semitic policies in Italy in the 1930s and 1940s, Pollak dispersed his collection, sending eleven Greek and Roman sculptures to the Musée d'Art et d'Histoire for safekeeping in 1940. Pollak and his family were rounded up with Roman Jews in October 1943 and murdered at Auschwitz-Birkenau. The museum was given some of the sculptures and purchased others from Pollak's heir. They have never been examined as a group with reference to the collector, their ancient context, how and where Pollak acquired them, and why Pollak chose these particular sculptures to safeguard. The Pollak collection comprises some important pieces that are often cited in handbooks on Greek and Roman sculpture, including a Roman copy of a seated maenad/nymph adjusting her sandal from a famous 2nd century BC group composition; a Roman variation of the Aphrodite Ourania by Pheidias; a life-sized 2nd century AD statue of the god Silvanus, probably from Campania; a Roman genre statuette of a seated girl; a colossal head of a bearded god; a Hellenistic female head from a collection in Venice; a 1st century AD copy of a Hellenistic portrait of a philosopher; a Roman private portrait of the period of Septimius Severus; a 3rd century AD bust of a young man, inscribed "Myron Fecit." Stable isotopic analysis of the marble of some of these sculptures was conducted in the 1980s by Karl Ramseyer and Danielle Decrouez, with presentations at early ASMOSIA conferences. Given the advances in the identification of white marbles since that time and questions raised by these scientists themselves, it was decided to restudy the marbles using multiple approaches. In 2023 Vasiliki Anevlavi and Walter Prochaska examined nine sculptures using microscopy, stable isotopic analysis, and trace element analysis and employing multivariate discrimination analysis for statistical evaluation. The results have clarified the chronology of certain sculptures (two of Göktepe marble), identified at least one as a pastiche, likely assembled in the early 20th. century, and confirmed the authenticity of one assumed to be a fake.

GIALLO ANTICO FROM CHEMTOU AS A SCULPTURAL MATERIAL: THE CASE OF THE IBERIAN PENINSULA

Julio C. Ruiz
Society of Applied Archaeometry to Cultural Heritage, Madrid, Spain

Keywords: Roman sculpture, Iberian Peninsula, stone trade

The famous yellowish limestone from Simmithus (Chemtou, Tunisia) is one of the most valued and widely distributed stone materials of the Roman era, particularly in the western regions of the Empire. Recently, in the context of ASMOSIA Conferences, its distribution has been thoroughly examined by St. Ardeleanu, while L. Lazzarini has conducted a systematization of its analytical parameters. This backdrop offers an excellent opportunity to further analyse and reassess its usage and diffusion in the Iberian Peninsula, a geographical area rich in archaeological evidence of the use of giallo antico. As for its distribution and circulation in Hispania, several studies by M. Mayer have explored this subject, with one specifically focusing on sculptural production. This latter work is the basis for the research presented here, which aims to provide an updated overview of the use of giallo antico in sculptural manufacturing in Hispania, incorporating the latest findings, studies, and discoveries. To achieve this, all evidence of small- to medium/large-format sculptures has been compiled from available publications, along with the study of previously unpublished pieces I have identified in various Spanish archaeological collections. The comprehensive review of these sculptures supports the hypothesis that most of them were part of the sculptural decoration of domus and villae. Therefore, it can be concluded that their primary commissioners were the owners of these residences. Concerning their production, it is highly plausible, as previously suggested by various researchers, that they were crafted in workshops situated near the quarries in Chemtou.

LOCAL STONE RESOURCES OF TARRACO (TARRAGONA, SPAIN) IN THE SCULPTURAL RECORD (I): MIOCENE BIOCALCARENITES

Julio C. Ruiz
Society of Applied Archaeometry to Cultural Heritage, Madrid, Spain

Keywords: Roman sculpture, biocalcarenites, local artisans

The Miocene biocalcarenites, abundant in the surroundings of ancient Tarraco, were extensively used as construction materials during the Roman period. These stones, primarily extracted from the "El Mèdol" quarry, exhibit distinctive yellow-orange hues, high porosity, and significant bioclast content, including large shell fragments. The variety of soldó features smaller bioclasts, is more compact, and contains a micritic matrix with quartz inclusions. Petrographic analysis highlights their heterogeneous composition, which contributed to their versatility in architectural and sculptural applications. This study focuses on the characterization and historical exploitation of these biocalcarenites, emphasizing their role in Roman artistic production. Through macroscopic and microscopic analyses of preserved quarry materials and archaeological specimens, including statues, reliefs, and other architectural elements, the properties of the stones are linked to specific extraction sites. Notably, the 'El Mèdol' stone dominates among the identified materials, though occasional use of soldó and calcisiltites from smaller quarries, such as 'Punta de la Creueta' and 'Coves de la Pedrera', is documented. The findings demonstrate a clear intentionality in material selection by Roman artisans, tailored to the functional and aesthetic requirements of each project. Chronological data suggest that biocalcarenites were most widely used from the late 1st century BCE to the early 1st century CE, with a gradual decline in use for sculptural purposes after the 3rd century CE. Despite their rarity in later periods, the enduring significance of these materials is evident in their extensive application across diverse monumental contexts, including funerary and public edifices. This comprehensive review integrates geological, archaeological, and historical evidence, offering new insights into the logistical and cultural frameworks underpinning the exploitation of Miocene limestone in Roman Tarraco. The study underscores the necessity for further petrographic analysis to refine the attribution of materials to specific quarries and elucidate the broader trade networks of lithic resources in the Roman Empire.

LOCAL STONE RESOURCES OF TARRACO (TARRAGONA, SPAIN) IN THE SCULPTURAL RECORD (II): CRETACIC LIMESTONES

Julio C. Ruiz
Society of Applied Archaeometry to Cultural Heritage, Madrid, Spain

Keywords: Roman sculpture, limestones, local artisans

The Cretaceous limestones of Tarraco were an essential material for Roman architecture and sculpture, sourced from local quarries such as El Llorito and La Salut. This study examines two main facies: the piedra de Santa Tecla and llisós. Piedra de Santa Tecla is characterized by yellowish to pinkish tones, with recrystallized calcite veins and stylolites of hematite, and is identified microscopically as pseudo-microsparitic limestone. In contrast, llisós exhibits greyish and brownish hues with visible bivalve shells filled with calcite, being predominantly a biomicritic limestone. Hybrid varieties between these facies were also observed. These materials, initially used as ornamental stones, gained prominence between the late 1st and mid-2nd centuries AD. Their use extended beyond epigraphy to sculptural reliefs, particularly funerary monuments such as sarcophagi, cippi, and altars. Notably, llisós was preferred for its greater workability, resulting in more elaborate reliefs compared to the limited figurative uses of piedra de Santa Tecla. Despite this, the latter is associated with notable examples, including inscriptions referring to the stone as marmor and a unique hand-shaped pestle likely used in mortar production. Macroscopic and petrographic analyses confirm that these limestones were crucial to local production systems, with evidence of widespread distribution across northeastern Hispania. Chronologically, their sculptural application spanned from the Augustan period to the early 4th century AD, reflecting evolving tastes in funerary art and resource exploitation. This research highlights the interplay between material properties, artistic practices, and socio-economic factors shaping the sculptural heritage of Tarraco.

PRELIMINARY RESULTS ON THE INTERIOR DECOR OF THE BARBARA BATHS IN AUGUSTA TREVERORUM (TRIER, GERMANY)

Vilma Ruppienė – Michael Reinert – Victoria Monique Scharlau
Ruhr-University of Bochum, Institute of Archaeological Sciences, Bochum, Germany

Keywords: Roman baths, incrustations, Augusta Treverorum

The so-called Barbarathermen (Barbara Baths) in Trier (Roman Augusta Treverorum), named after their proximity to the medieval church of St Barbara, were constructed in the mid-2nd century AD. At the time of their completion, they represented the second-largest bathing complex in the Roman Empire. Initial investigations between 1822 and 1825, and the first

systematic excavations conducted from 1877 to 1885, uncovered a wealth of artefacts, including marble sculptures and incrustations, which attest to the exceptionally rich sculptural and decorative furnishings of the baths. Subsequent excavations throughout the 20th and early 21st centuries yielded further significant finds of a similar nature; all these findes have not yet been systematically investigated and published. Since 2022, annual archaeological internship conducted with students from Ruhr-University Bochum has focused on cataloging these finds systematically. So far, around a fifth of the estimated 9,000 incrustation finds have been examined. The project aims to generate new insights into the baths' original decorative program and the diversity of marble types (both white and polychrome marmora) employed in their construction. Preliminary results suggest that the baths were predominantly adorned with Mediterranean marmora (90 % of documented fragments) and featured not only qualitative marble floors but also intricately decorated wall systems and an extensive sculptural program. The most frequently used stone types are: fior di pesco, breccia di Sciro, cipollino verde, pavonazzetto, proconnesian, pentelic and Carrara marble. The most common regional stones include black Belgian limestone and coarse-grained marble from the Odenwald region in Germany. Numerous profiled veneer fragments with various motifs as well as remains of wall pilasters, bases and capitals indicate a complex wall system. The exceptional scale and opulence of Barbara-Baths underscore the prominent status of Augusta Treverorum as early as the 2nd century AD, a status that culminated in Trier's designation as an imperial residence during Late Antiquity. Comparable elaborate incrustations in late antique structures, such as the so-called Konstantinbasilika (Imperial Audience Hall) and the Quadratbau of Trier's early Christian cathedral, can be directly linked to imperial building initiatives within the city. It is highly plausible that the construction and lavish decoration of the earlier Barbara-Baths also reflect the patronage of the imperial administration.

SIZE MATTERS: MEASURING MARBLE IN ANTIQUITY AND LATER

Ben Russell[1] – Simon J. Barker[2]
[1] University of Edinburgh, School of History, Classics, and Archaeology, Edinburgh, United Kingdom
[2] University of Warsaw, Faculty of History, Centre for the Research on Ancient Civilizations, Warszawa, Poland

Keywords: ancient quarries, marble carving, measurements

How was marble measured in antiquity? And what can later sources reveal about how quantities of marble were recorded and communicated? The only written source to survive from antiquity that appears to document the cost of different types of marble is the Edict of Maximum Prices promulgated by the emperor Diocletian in AD 301. This document has, therefore, received considerable attention from scholars working on the ancient stone trade. However, as has been well discussed, the exact units of these marbles is unclear. The text simply lists marbles by the 'foot' (pedem), and not whether this is a linear, square, or cubic foot. Corcoran and DeLaine, and B. Russell have argued that the measurements must refer to square feet – in other words to flat panels of stone – but others have argued for these numbers as cubic feet and have applied them accordingly. Additionally, ostraka from Mons Claudianus in the Eastern Desert record inventories of blocks of different dimensions, some of which note three dimensions and others just by two; while columns at the site, on the other hand, are recorded by their length. The key point here, as P. Rockwell put it, is that 'a stoneworker's view of his material is concerned with its use.' Accordingly, the way in which they measurements are taken will also be conditioned by the use to which it is to be put and the nature of the project. Here, later evidence, notably that provided by nineteenth-century building manuals, make it clear that a foot of marble can refer to linear, squared, or cubic measurement depending on what is being described – i.e. whether a line of moulding, a section of paving, or a column shaft. Peacock and Maxfield, in their work on Mons Claudianus, noted the same thing: 'it seems probable that a foot would have the same meaning as it does among modern quarrymen: i.e. it could indicate linear, a real or cubic measure and the context would indicate what was intended'. This poster will gather the extant evidence for different systems of measurement as they were applied to marble and consider how these can be understood with the help of comparative sources from later periods. This will provide insights into how information about marble orders was communicated and quantities of stone bought and sold.

UNVEILING ANCIENT HANDCRAFT: IDENTIFYING AND SOURCING CARBONATE INCLUSIONS IN ARCHAEOLOGICAL MATERIALS

Petra Šajna[1,2] – Maja Gutman Levstik[3] – Judita Lux[6] – Manca Vinazza[4] – Martin Šala[5] – Mirijam Vrabec[2] – Sabina Dolenec[1,2]

[1] Slovenian National Building and Civil Engineering Institute, Ljubljana, Slovenia
[2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia
[3] Institute for the Protection of Cultural Heritage of Slovenia, Restoration Centre, Ljubljana, Slovenia
[4] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia
[5] National Institute of Chemistry, Department of Analytical Chemistry, Ljubljana, Slovenia
[6] Institute for the Protection of Cultural Heritage of Slovenia, Ljubljana, Slovenia

Keywords: carbonate inclusions, mortars and ceramics, provenance

Carbonate inclusions have played a significant role in archaeological materials, providing insight into ancient manufacturing techniques and material sourcing. Usually in Roman wall painting mortars and ceramics, carbonate inclusions such as crushed limestone, calcite, marble, speleothem and dolomite were added to improve the material's properties. In mortars, carbonates enhanced polishing effects, creating a mirror-like sheen, while in ceramics, they served as temper, reducing clay plasticity, preventing shrinkage during drying and firing, and improving durability against thermal shock in vessels used for cooking. This practice, well-documented across archaeological periods, reveals the technological sophistication of ancient handcrafts. In this study, artefacts with carbonate inclusions from various archaeological sites across Slovenia were analysed, including Roman wall painting mortars or plasters and ceramics dating from the Neolithic to the middle Ages (13th century), with a focus on fragments from different Roman periods. The research aims to identify the types of carbonate used, distinguishing between coarse-grained calcite, marble, limestone, etc., and to evaluate differences in carbonate grains between samples. Additionally, the study investigates the provenance of the materials, assessing whether they were locally sourced or imported. Methods employed in this research included polarizing optical microscopy, scanning electron microscopy (SEM) coupled with energy dispersive spectroscopy (EDS), and laser ablation. Optical microscopy allowed for the identification of carbonate particles, their size, shape, and deformation features, including reaction rims. SEM/EDS provided detailed information on the microstructure, determined the presence of micro-inclusions, and analysed the elemental

composition of the carbonate inclusions, offering insights into their provenance, while laser ablation enabled the determination of trace element profiles, further distinguishing material sources. Differences in the carbonate inclusions were observed in grain type, structure, degree of deformation, shape, and size, indicating distinct sourcing and processing techniques. These variations were evident both across archaeological sites from different time periods as well as within the same site, suggesting the use of carbonate materials from multiple sourcing locations. This analysis provides detailed insight into the selection, sourcing, and processing methods.

THE MARBLE DÉCOR OF THE TEMPLE OF MERCURY ON PUY-DE-DÔME (AUVERGNE, FRANCE): ANCIENT DISCOVERIES, NEW LENS

Marie-Claire Savin[1,2] – Anna Gutiérrez Garcia-Moreno[2] – Bertrand Dousteyssier[3]
[1] Autonomous University of Barcelona, Faculty of Arts and Humanities, Department of Antiquity and Medieval Studies, Barcelona, Spain
[2] Catalan Institute of Classical Archaeology, Tarragona, Spain
[3] Université Clermont-Ferrand, Maison des Sciences de l Homme, France

Keywords: mountainous environment, religious architectural decoration, Arverni

Perched atop the Puy de Dôme near the Roman city of Augustonemetum (modern Clermont-Ferrand, France), the Temple of Mercury ranks among the most significant sites in the western provinces of the Roman Empire. Constructed in the mid-2nd century CE, it stands as one of the largest Roman mountain sanctuaries.
While hundreds of fragments unearthed in the 19th century are preserved at the Bargoin Museum in Clermont-Ferrand, no comprehensive study has been conducted. The present work offers an overall assessment of the material from these early excavations, as well as fragments uncovered during surveys carried out in the early 2000s. This revision includes prospections of local outcrops, a macroscopic examination of all the fragments, and the archaeometric analysis of some of them.
Among the regional marbles, apart from the previously proposed use of marble from the Châtelperron quarries located 80 km northeast of the site,

the objective is to investigate whether other smaller, closer geological outcrops were utilised. The study thus examines the small marble lenses of the Chavanon series located approximately 50 km southwest of the site (in the present-day communes of Messeix, Savennes, and Merlines), as well as those of the Aix series 90 km east of the site (in the communes of Champoly, Grézolles, and Saint-Thurin), and the grey limestone outcrops of Ferrières-sur-Sichon.
The examined material also revealed the use of numerous imported stones, including red and green porphyry, giallo antico, pavonazzetto, rosso antico of several varieties, africano, verde antico, cipollino verde and breccia corallina. More unexpectedly, stones such as the nuvolata variety of the breccia corallina, alabastro fiorito and gabbro eufotide were also identified. In addition to the investigation of the regional or distant provenance of the stones used, we will also present some hypotheses regarding the arrangement of the decoration, as well as the glyptographs and attachment marks observed. Even at this early stage of research, the richness and exceptional characteristics of this assemblage promise to be a key element in advancing the study of this remarkable site and the people who built and worshipped there.

NEW DATA ON ROMAN STELAE FROM AQUILEIA (ITALY)

Luca Scalco[1] – Claudio Mazzoli[2] – Chiara Girotto[1] – Monica Salvadori[1] – Caterina Previato[1]
[1] University of Padua, Department of Cultural Heritage, Padua, Italy
[2] University of Padua, Department of Geosciences, Padua, Italy

Keywords: Aquileia, Aurisina limestone, Roman tombstones

The University of Padua has undertaken a research project on decorative motifs and sculpture techniques, focusing on the Roman stelae of Aquileia. A significant aspect of this research involved the analysis of the lithotype utilised by stonemasons during the production of tombstones from the Imperial age. The research approach entailed a comprehensive bibliographic and archival review, complemented by a direct examination of the materials, which involved autoptic recognition of the stone used. A total of 40 stelae were then selected (approximately 25% of the known total), from which samples were obtained in the form of small chips for subsequent analysis under optical microscope. This analysis enabled the identification of the type of sedimentary rock according to texture and fossil assemblage. Stelae to be sampled were selected in order to encompass the entire period of use (Augustean-Constantinian age, including re-worked stelae), the different

attested types (aediculae, framed and plain stelae), along with their decorative elements (primarily portraits, dolphins, and rosettes).
The investigations revealed that the absolute majority of the stelae are composed of limestone from the Aurisina quarries, though not all of them. Even considering the Aurisina sample, the material exhibits significant heterogeneity: various facies have been identified, ranging from Grainstone (Aurisina Granitello) to Rudstone (Aurisina Fiorito). Chronological and functional peculiarities in the utilisation of these distinct facies suggest a deliberate selection by the stonecutters. However, given the substantial similarity of the material under consideration, the overall picture is quite homogeneous, thereby highlighting the capability and flexibility of local sculptors in managing Aurisina limestone to create their products.

PROVENANCE STUDY ON OBSIDIAN FRAGMENTS FROM THE GRUTTI 'E ACQUA COMPLEX (SARDINIA)

Victoria Scharlau – Constance von Rüden
Ruhr-University of Bochum, Institute of Archaeological Sciences, Bochum, Germany

Keywords: obsidian, pXRF, nuragic Sardinia

As a small part of the DFG (German Research Foundation) funded "Making Landscape" Project, which is aimed at determining the Nuragic settlement structure (bronze age culture in Sardinia) within the Canai plain (Sant'Antioco, Sardinia), the obsidian fragments, found during the excavations from 2017 to 2024 and the survey in 2022, were examined via portable XRF as well as typologically.
Within the scope of a BA thesis, the investigation focuses on whether the differences in the chemical composition of various obsidian deposits – particularly the varying concentrations of trace elements such as Mn, Ti, Rb, Zn, and Sr – can be used to determine the provenance of the obsidian fragments.
As part of this study, it will be examined whether exclusively obsidian from Monte Arci was used, as it is geographically the closest obsidian source in the western Mediterranean and within Sardinia there is so far no known prehistoric usage of the other Mediterranean obsidian sources.
Furthermore, it is of interest whether and to which extent the individual sub-sources of Monte Arci obsidian SA, SB1, SB2 and SC, as located and characterised by various scientific studies between the 1960s and 1990s,

are represented within the spread of obsidian artefacts from the Grutti'e Acqua complex and whether there is a notable difference when compared to the surface finds from the 2022 survey surrounding the area of a suspected Neolithic settlement. It is noteworthy that, in contrast to Neolithic or Chalcolithic obsidian, only limited scientific studies have been conducted on Bronze Age obsidian in Sardinia.

A LOOK AT THE WORK AND OPERATION OF THE STONE QUARRIES, FROM A SOCIAL AND HUMAN SOCIOLOGICAL ANGLE

Dror Segal
Archaeology Museum, Gan-Hashlosha National Park, Israel

Keywords: Mauthausen quarry, Terezin camp, Mount Gilboa quarry

Usually, we research, sample and survey stone quarries, with the scientific approach of a geologist, archaeologist and historian. The type of rock, the method of quarrying, transportation and trade, the construction site and the origin of the stone, the dating of the quarry, the amount of material quarried and more are checked.
Here I want to refer more and more to the human and social side of the quarries' workers, who created them with their own hands, with their bent backs, their well-seasoned hands and worked a lot of sweat and blood in them. Even if we do not have enough information, about the social structure and what was done in ancient Egypt, the Roman world or the construction of the pyramids in Egypt and Central America, we must assume that slavery and forced labor of conquered peoples and the common people existed there as well. Every pyramid, temple and theater that was built, its construction also involved a lot of human suffering.
The picture is different in the twentieth century. So, we know much more, and there is written and photographed historical evidence, about what happened, including forced labor in the quarries, which was sometimes also deliberate punishment and abuse for the sake of it.
Here I would like to present to you three cases, different in essence, geographically and some also chronologically. Some of them also concern my family and the area where I live.
The first case is: the Mauthausen quarry in the famous concentration camp. The second case is in the Terezin camp. The third case is the prisoners' quarry in the Gilboa Mountains.

In all cultures since time immemorial, people have been employed in hard and exhausting physical work in quarries. For the most part these were slaves, members of conquered nations, soldiers and the common people. Quarry work was sometimes used as a tool for forced and penal labor, hard labor. The owners and operators of the quarries won a constant supply of cheap and exploited labor, without elementary social conditions. It was only in the middle of the twentieth century that new mechanical technology, tractors and heavy equipment, came in, which financially stopped most manual labor.
In the study of ancient quarries, it is useful to remember and refer to this human angle as well.

UNVEILING ANCIENT POLYCHROMY IN PANNONIAN SARCOPHAGI FROM SIRMIUM (SREMSKA MITROVICA, SERBIA). PRELIMINARY RESULTS

Eliana Siotto[1] – Jasmina Davidović[2] – Bojan Djurić[3]
[1] CNR, Institute of Information Science and Technologies "A. Faedo", Visual Computing Lab, Pisa, Italy
[2] Museum of Srem, Sremska Mitrovica, Serbia
[3] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia

Keywords: ancient polychromy, Pannonian sarcophagi, Roman sepulchral art

In the course of examining the provenance of stone and the workshop origins of Roman sepulchral monuments in Pannonia, our research has uncovered traces of ancient polychromy on sarcophagi from Sremska Mitrovica (ancient Sirmium). These sarcophagi, primarily dating to the 3rd century AD, reflect a period of peak cultural and artistic activity in Roman Sirmium and are now preserved in various European museums.
Crafted from all materials identified across Pannonia – including Eastern Alpine marble, travertine, Neogene limestone, and green volcaniclastic rock – local artisans finished these sarcophagi. The preserved traces of colour on these artefacts provide a rare opportunity to investigate the materials, techniques, and pictorial styles used in their decoration, as well as to interpret the artists' intentions. This research will soon shed light on the interplay between material choices, economic considerations, and the aesthetics, as well as cultural values of ancient Sirmium, offering a deeper understanding of this significant production.

A comparative analysis of marble sarcophagi with polychrome evidence produced in Rome between the 2nd and 4th centuries AD aims to identify affinities and differences between these two prominent production centres. This approach will contribute to a richer understanding of the artistic and cultural landscape of both Sirmium and Rome.

MICROPETROGRAPHY AS A TOOL FOR PROVENANCE ANALYSIS: A CASE STUDY IN ROMAN ISTRIA (CROATIA)

Katarina Šprem[1] – Davor Bulić[2] – Candace M. Rice[3] – Andrew McLean[4]
[1] Independent researcher, Pula, Croatia
[2] Juraj Dobrila University of Pula, Faculty of Humanities, Department of Archaeology, Pula, Croatia
[3] Brown University, Joukowsky Institute for Archaeology and the Ancient World, Providence, Rhode Island, United States of America
[4] Catalan Institute of Classical Archaeology, Tarragona, Spain

Keywords: micropetrography, limestone, Roman Istria

The Istrian peninsula in western Croatia is characterized by rich carbonate surface deposits exploited intensely under Roman rule, as attested by dozens of quarries documented throughout the peninsula. Stone was used for everything from foundations of private houses to funerary monuments and public buildings. Micropetrography can be used to determine the geological age of the stone used in these structures, to then compare the results with a geological database of Roman quarries. As multiple quarries exploited deposits of the same age, however, micropetrography alone is insufficient to determine provenance, so it must be supplemented by transport and profitability analysis. This can be seen in the Pješčana uvala and Vinkuran (Cave Romane) quarries near Pola which are situated on Cenomanian limestone deposits of a very similar lithotype which makes them almost impossible to distinguish. Our presentation will showcase the results of micropetrographic analysis of several funerary and profane limestone monuments from Parentium and Pola, as well as the preliminary results of functional parts of the largest Roman olive oil mill in the Mediterranean area from the 1st to the 3rd century AD at the site of Barbariga. Most of the funerary monuments from Pola are made from the before mentioned Cenomanian limestone from Pješčana uvala or Vinkuran, while two were made from a lithotype exploited in a quarry further away. Sampled monuments from Parentium showed us the limitations of

micropetrographic analysis: recrystallized samples and samples with no distinguishable microfossils. Micropetrographic analysis of samples from Barbariga is underway, therefore we will present the current state of research.

INTRODUCING OPEN SCIENCE SOLUTIONS IN PROVENANCE DETERMINATION OF WHITE MARBLES USING MULTIMETHOD TECHNIQUES

Balázs Székely[1] – Judit Zöldföldi[2] – Péter Hegedüs[3]
[1] Eötvös Loránd University, Department of Geophysics and Space Science, Budapest, Hungary
[2] University of Stuttgart, Materials Testing Institute, Building Protection and Restoration of Historical Monuments, Stuttgart, Germany
[3] Independent software engineer, Bóly, Hungary

Keywords: white marble, provenance analysis, database

Provenance determination of white marble is an important aspect of archaeological research as it contributes to the reconstruction of ancient trade routes, artistic traditions and historical quarrying practices. The integration of multi-methods – including mineralogy, petrography, grain size, stable and radiogenic isotope analysis – has significantly improved the accuracy and reliability of marble provenance studies. However, the effectiveness of these methods would be greatly enhanced by the principles of open science, which promote data transparency, reproducibility and collaboration in the production of raw data.
Open access databases of petrographic and geochemical reference datasets allow comparative analyses and reduce uncertainties in the attribution of marble deposits. Publication of analytical raw data and detailed methods promotes reproducibility and cross-validation. Open Science also facilitates interdisciplinary collaboration between experts in materials science, archaeology and art history.
Several data integration initiatives are underway. The MissMarble project, launched two decades ago, now contains thousands of validated data from hundreds of quarries and numerous authors. In addition to data integration, the project is also introducing some innovations in data structures. However, from an open science perspective, there are still gaps and challenges. Developments have been made to address these challenges in terms of FAIR principle (Findability, Accessibility, Interoperability, Reusability).

The most common applications of databases are data searching and querying large amounts of data for comparative and dissemination studies. The latter requires the use of appropriate built-in query interfaces or a query language module. Both applications can be served if the system is equipped with a standardised interface that can be embedded in widely used solutions such as the Python environment.
There are advantages to this development: Without additional visualisation or data mining tools, trained users can process and display specific query results in their customised system. This ensures greater data security, enables tracking of data usage, and supports open source analytics tools and machine learning applications.
Easy-to-understand sample data access and query code ensures reusability. As the database grows, they can easily be re-run. Multi-dimensional queries (e.g. isotope and grain size data) are also possible. Results can be filtered by geological unit (Eastern Alps), geographical location (e.g. Proconnesos), archaeological excavation (e.g. Troia), sample type (artefact/quarry) or any other individual property. Data gaps (e.g. missing strontium isotope data) can also be easily identified.
These methods ensure that provenance studies remain transparent, reproducible and accessible, minimising bias and increasing the reliability of historical material use analyses.

MARBLE ROUTES IN NORTHERN ITALY: PROVENANCE STUDIES OF LATE ANTIQUE RAVENNA AND CLASSE

Helena Tůmová[1] – Aneta Kuchařová[2] – Alena Černíková[3] – Enrico Cirelli[4]
[1] Charles University, Faculty of Arts, Institute of Classical Archaeology, Prague, Czech Republic
[2] Charles University, Faculty of Science, Institute of Geochemistry, Mineralogy and Mineral Resources, Prague, Czech Republic
[3] Charles University, Faculty of Science, Institute of Applied Mathematics and Information Technologies, Prague, Czech Republic
[4] University of Bologna, Faculty of Arts, Department of History and Culture, Bologna, Italy

Keywords: marble, provenance, Ravenna

The paper examines the provenance of white marble artefacts and architectural elements from Late Antique Ravenna (Italy), shedding light on the material culture of the city as a sedes imperii of the Western Roman

Empire after 402 AD. Using a multidisciplinary approach – integrating archaeological, geochemical, petrographic and statistical analyses – the study offers new insights into the origin and distribution of marble artefacts within the wider Late Antique Mediterranean koiné.
Preliminary results of the Czech-Italian scientific collaboration show that many key objects of the 5th and 6th centuries, including sarcophagi and architectural decorations, originated mainly from the island of Marmara (Proconnesos), but also from other ancient quarries. These findings challenge previous assumptions and suggest that Ravenna's access to Constantinople and other Mediterranean centres via its port at Classe played a crucial role in sustaining the city's rapid building activity and demand for prestigious materials. These findings underline the city's central role as a hub for the distribution of luxury materials, responding to the surge in building activity that followed its designation as imperial capital.
The study highlights Ravenna's centrality in Late Antique Mediterranean artistic and commercial networks, enriching the understanding of interregional exchange networks and their impact on material culture during a transformative period from Late Antiquity to the Early Middle Ages.
Fifteen marble fragments from the archaeological site of the basilica of San Severo in Classe (Ravenna) were analysed by mineralogical-petrographic (polarising, CL and electron microscopy; powder X-ray diffraction) and geochemical (C-O stable isotope analysis, ICP-MS) methods. The multimethod approach, based on the combination of petrographic criteria including quantitative evaluation (maximum grain size, fabric, mineralogical composition, characteristics of cathodomicrofacies) with C and O isotope data and trace element contents, was used to determine the provenance of marble fragments. The ICP-MS and stable C and O isotope data were processed by discriminant analysis in order to compare the artefacts studied with the database of the main Mediterranean marble localities in Antiquity. Most of the calcitic fragments were classified as Proconnesian marble. Aphrodisias and Docimeion were identified as probable sources of two marble fragments. Two dolomitic fragments probably came from Thasos (Thasos-3).

PREHISTORIC OBSIDIAN USE IN THE NORTHERN ADRIATIC: ITALY, CROATIA, AND SLOVENIA?

Robert H. Tykot
University of South Florida, Department of Anthropology, Tampa, Florida, United States of America

Keywords: obsidian, trade, long-distance

In the central Mediterranean, obsidian from the islands of Lipari, Palmarola, Pantelleria, and Sardinia was acquired starting in the Early Neolithic (ca. 6000 BCE) and distributed a distance of >750 km northward thru the Adriatic Sea toward the Alps, Slovenia, and Croatia. Obsidian from Carpathian sources in Slovakia, about the same distance, also has been found in the northern Adriatic region. While likely to have been used in prehistoric Slovenia, I am not aware of any archaeological reports on obsidian artefact finds. Yet in the northeastern-most regions of Italy, obsidian artefacts have been identified at >40 different prehistoric sites, and >1400 artefacts have been analysed to determine their geological origins. Nearly 400 obsidian artefacts from 18 sites in Croatia also have been analysed. These include those discovered at sites in the Emilia-Romagna, Veneto, and Friuli-Venezia Giulia regions of Italy, and Istria, Dalmatia and Croatia proper.

This study used a non-destructive portable X-ray fluorescence spectrometer to conduct analyses in northern Italy and Croatia. The trace elements measured using a portable X-ray fluorescence (pXRF) spectrometer, including Rb, Sr, Y, Zr, and Nb, distinguish at least twenty different source groups and subgroups in Europe and the Mediterranean. Previous studies demonstrated that obsidian from these sources traveled great distances, raising questions about quantity and frequency from each and how they may have changed over five millennia. This research has significantly increased the number of archaeological sites and artefacts tested, allowing comparisons between time periods and sites and provides some interpretations for the socioeconomic factors involved. Along with mostly small blades, obsidian cores have been found at some sites far from their geological source, confirming the local production of final tools.

The initial use of obsidian began with the introduction of agriculture, most likely traveling from east to west in the same routes within the Cardial Impressed Ware network. The land-based distribution of obsidian from the Carpathian sources, including over the mountainous Dinaric Alps, is compared with the maritime routes taken by Lipari and Palmarola obsidian along and across the Adriatic. The combined data are integrated with the data available for chronology, early village sites, domesticated plants and animals, and ceramics.

THE MARMORA OF THE TRICLINIUM OF THE LATE ROMAN VILLA OF NOHEDA (CUENCA, SPAIN)

Miguel Ángel Valero Tévar[1] – Nelia Valverde Gascueña[2] – Pilar Lapuente Mercadal[3,4] – Isabel Rodà de Llanza[4,5]
[1] University of Castilla-La Mancha, Faculty of Education and Humanities, Department of History, Cuenca, Spain
[2] University of Castilla-La Mancha, Polytechnic School of Cuenca, Department of Civil Engineering and Construction, Cuenca, Spain
[3] University of Zaragoza, Faculty of Sciences, Department of Earth Sciences, Zaragoza, Spain
[4] Catalan Institute of Classical Archaeology, Tarragona, Spain
[5]Autonomous University of Barcelona, Faculty of Arts and Humanities, Barcelona, Spain

Keywords: marmora, Roman villa, ornamental programme

The Roman villa of Noheda is a site located in the interior of Hispania that has a wide sequence of occupation, although undoubtedly, it will be the stage dated in the Late Antiquity the most outstanding. The enclave is mainly known for its famous mosaics, although all the elements that make up the rural area are remarkable. Thus, the existence of several buildings -many of which have large dimensions-, is a relevant fact. But it is not less, the presence of a rich set of marmora from all over the Empire and that in recent years have been classified and studied.
Part of this research has focused on the villa's triclinium, providing new data about the construction systems used in the imposing trichora room, as well as its ornamentation. And it is in this aspect that the archaeometric analyses of the marbles found, as well as their morphological and constructional study, allow to advance the knowledge of the building processes of the whole, described the rich decorative programs that lined the walls, and simultaneously investigated the commercial networks of marbles that reached the interior of the Iberian Peninsula at the end of the Empire.

THE STONES OF ANCIENT ITANOS (CRETE): LOGISTICS AND SOCIO-ECONOMIC ASPECTS OF LOCAL QUARRYING

Jean Vanden Broeck-Parant[1] – Vasiliki Anevlavi[2]
[1] Université catholique de Louvain, Institut des Civilisations, Arts et Lettres, Louvain-la-Neuve, Belgium
[2] Austrian Academy of Sciences, Austrian Archaeological Institute, Vienna, Austria

Keywords: landscape, quarry, local

The ancient town of Itanos, in Eastern Crete, was founded around the 9th century BCE and developed into a trade-oriented city, with its harbour advantageously located at a crossroad of maritime routes. Aspects of its local economy have been lesser studied, especially the ancient exploitation of its geological substrate. We present here the results of the first two campaigns (2024 and 2025) of the Itanos Quarry Project, which aims to better understand the material and socio-economic aspects of the quarrying activity in relation to the development of the city of Itanos. A number of ancient quarries have been identified within the boundaries of its territory (which are quite well known for the Hellenistic period), but, until recently, few of them had been studied thoroughly, while some have only been located for the first time in 2024 and 2025. An accurate mapping of the quarry fronts, slipways and other features, as well as the recording and interpretation of tool marks, allows reconstructing the practical organization of quarrying activities in the vicinity of the ancient town. The proximity of the sandstone (ammoudopetra) and grey limestone (sideropetra) quarries, combined with the evidence from the town itself, points to a local and extensive exploitation of these stones for the construction of buildings, tombs and funerary monuments in the area, with an intensification during the Hellenistic period regarding sandstone. From a wider perspective, the survey of areas of interest, drawing on legacy data, aims to reconstruct the general "quarryscape" of the Itanos' ancient territory and its shifting strategies to exploit its resources in accordance with its changing needs. Several of these changes can be pointed out, notably in the extraction and shipping of coloured stone (breccia) from Vai, in contrast with the strictly local use of sandstone and grey limestone. In addition, the identification and characterisation of the various stones found in the quarries and in the constructions of the ancient town and necropolis, for which datings have been proposed, allows tracing their uses

and the magnitude of their exploitation through time. Overall, a whole sector of the economy of Itanos is reconstructed, providing insights into local stone quarrying in ancient Greece.

ARTEFACTS, SITES AND LANDSCAPES: EXPLORING THE USE OF MARBLE IN WESTERN LUSITANIA (PORTUGAL) DURING THE ROMAN PERIOD

Gil Vilarinho
University of Évora, Center for Art History and Artistic Research, HERCULES Laboratory, Évora, Portugal

Keywords: marble, Roman Lusitania, Portugal

Employing stone materials for building and decorative purposes is one of the most recognisable features of the Roman world. Indeed, though stone materials were widely used for building purposes in earlier periods, the so-called Romanisation process brought a different, often monumental use of distinct types of stone, particularly marble, which was to become a sign of Roman-ness. Though situated in the western-most area of the Roman world and therefore distant from the main Mediterranean marble quarries, the province of Lusitania (roughly present-day Portugal and Spanish Extremadura) was, nevertheless, endowed with several good quality marble sources that were actively exploited in the imperial period. However, the use of these resources remains a comparatively poorly explored topic in this peripheral territory and, until recently, significant archaeological evidence lingered unstudied.
Emerging within the wider framework of the ongoing MARMORAT research project, this study aims to synthesise and assess the use of stone for aesthetically enhancing purposes in the area of Roman Lusitania presently corresponding to the Portuguese territory. In particular, drawing on the available published data and new evidence from ongoing research on museum collections, archaeological sites and landscapes, this paper provides an extensive analysis of how different types of stone were used in this peripheral provincial framework, assessing how this usage evolved over the imperial period and how it changed according to different factors, such as geography, typology, topography and geological setting. The results obtained denote the common use of white marble, local and imported, for sculpture and a wider variety of materials for architectural features. At the same time, inscriptions revealed a widespread production pattern out of locally available materials. This paper presents the first comprehensive and

systematic assessment of the use of marble and other decorative stones in this part of the Roman world, while also ultimately stressing the need for further research on this topic in Portuguese archaeology.

OPUS SECTILE AND OTHER DECORATION ELEMENTS FROM THE THERMAL COMPLEX OF INSULA XXXIX IN EMONA (LJUBLJANA, SLOVENIA). PRELIMINARY CONSIDERATIONS

Tai Vrečko Cindrić – Katharina Zanier
University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia

Keywords: Emona, thermal complex, opus sectile

This research aims to offer a preliminary preliminary presentation of opus sectile tiles and other decoration elements, found in the recent excavations of the former Šumi factory in the city centre of Ljubljana (carried out in 2004/2005, 2007/2008 and 2018/2019). The excavations interested three different insulae of the Roman colony of Emona, insulae XXXIX, XXXIII and XLII, which as such evolved in different building phases from around 15 AD until the end of the fourth century AD and were then heavily damaged and transformed in later periods. During the second half of the second century AD, a thermal complex covered the northern part of insula XXXIX. Scattered on the area of insula XXXIX and the surrounding area, 196 fragments of marble tiles and other stone decoration elements were discovered. They were likely part of the furnishings of the thermal complex, where some elements were also found in situ as part of the pool cladding. The fragments were autoptically assessed. They consist mainly of opus sectile tiles of different shapes and dimensions, frequently made of white marbles, but also of cipollino, greco scritto, marmor styrium, lumachella nera and others. Also some fragments of sculptural decoration where identified. Especially for the white marbles, the autoptical assessment offers of course only very preliminary information. But, as the material is until now completely unpublished (not even mentioned in any publication), also this preliminary assessment offers new insights into the furnishings of the thermal complex and draws attention to this rich context of marble and opus sectile finds, which are not very frequent in the archaeological excavations of Ljubljana. The research is also aimed to offer a better understanding of the two main phases of the thermal complex, also through the comparison with other thermal complexes in Emona and in other Roman sites.

IDENTIFYING THE ORIGIN OF MARBLE ARTEFACTS FROM SYRIAN MUSEUMS

Dagmara Wielgosz-Rondolino[1] – Sara Mandera[2]
[1] University of Warsaw, Faculty of Archaeology, Warsaw, Poland
[2] Nicolaus Copernicus University, Institute of Archaeology, Toruń, Poland

Keywords: marble provenance, sculpture, Syria

A comprehensive archaeometric analysis has been conducted on hundreds of marble artefacts housed in Syrian museums as part of the European Commission-funded project "Marmor: The Graeco-Roman Marble Artefacts from Syria. Their Archaeometric Identification, Archaeological and Art" (Marie Curie Intra-European Fellowship). These artefacts include fragments of sarcophagi, public statues, mythological sculptures, and architectural elements, many of which remain unpublished and are presented here for the first time. The collections studied originate from museums in Damascus, Latakia, Tartus, Aleppo, Hama, and Homs. While some artefacts lack specific provenance, others were found in key sites such as Antioch-on-the-Orontes, a major Seleucid foundation from the late 4th century BCE, and smaller towns like Arethusa.
The study aimed to identify the quarry sources of the marble used in these objects by employing petrographic analyses of thin sections, including optical and cathodoluminescence microscopy, complemented by stable carbon and oxygen isotope analyses.
The findings reveal that the marble originated from various quarry sources, including Proconnesos, Docimeion, Mount Pentelicon, and Paros. These results not only enhance our knowledge of ancient trade networks and material distribution in the Graeco-Roman period but also provide new insights into the artistic and architectural choices in ancient Syrian cities. The research contributes to the broader field of archaeometric studies in the Graeco-Roman Eastern Mediterranean region.

THE ORGANISATION OF ANCIENT MARBLE QUARRYING IN THASOS (GREECE)

Manuela Wurch-Kozelj – Tony Kozelj
Independent researchers, Thasos, Greece

Keywords: Thasos, quarry, ecosystems

We always describe the traces in the quarries, those of the extraction, the working of the tools, the transport of the extracted blocks, etc., which are the traces left by the men (quarrymen, stonemasons, sculptors, carpenters, blacksmiths, etc.) who made the exploitation work. But they couldn't work if they didn't have the materials to do their job – metal for tools, wood for hoist machines, hemp for ropes, etc. – and if they weren't housed, fed and watered.
Many archaeological remains can be associated with quarrying exploitation, whether they were linked to mining, and agriculture activities (farms, fields), but also with isolated or enlarged settlements and cult-places (depending on the period: caves, sanctuaries or basilicas). Towers were often associated with quarrying exploitation to ensure the activities: protect the workers and the extracted products ready to leave the quarries.
The aim here is not to present a catalogue of all the types of remains on the island of Thasos, but to highlight some of them that are directly related to the quarries and that allow us to glimpse part of the spatial organization of the exploitations, to propose schematic-organigrams (interweaving of elements) and, by extrapolation, to distinguish different eco-systems, from the "detached unit" corresponding to the exploitation of a temporary quarry to the "specific system of supervised intensive work" relating to the complex exploitation of the quarries in the South of the Island of Thasos. These ecosystems are not all synchronous (contemporary with each other) and the interest is also in showing the evolution of the systems over time.

CONSIDERATIONS ON THE STONE SUPPLY IN THE ROMAN MUNICIPIUM OF NEVIODUNUM (DRNOVO, SLOVENIA)

Katharina Zanier[1] – Rok Brajkovič[2]
[1] University of Ljubljana, Faculty of Arts, Department of Archaeology, Ljubljana, Slovenia
[2] Geological Survey of Slovenia, Ljubljana, Slovenia

Keywords: Stone products, Roman period, limestones, provenance

The paper presents the lithologies used in the stone products of Neviodunum (today's Drnovo in Slovenia), a Roman municipium in southwestern Pannonia. In different research stages, overall 100 stone monuments from the area of the Roman town and different parts of its ager were assessed. They consist of inscribed honorary, votive and

especially sepulchral monuments, architectural elements and decoration, as well as walls and milestones. The artefacts date mostly to the 2nd and 3rd century AD. Only a few pieces could still be dated within the 1st century AD, and almost no monument could be clearly dated to the 4th century.
Petrographic and biostratigraphic analyses were carried out on selected archaeological and geological samples. Besides some rare exception, stone products are made of locally sourced limestones. Mostly they refer to the following lithostratigraphic units: the Middle Miocene "Lithothamnium" Limestone Member of the Laško Formation, the Upper Cretaceous Krško Formation and the Early Jurassic Krka Limestone Member of the Podbukovje Formation. In the monuments of the town the use of all three rock types appears to be coeval. In the northern half of the ager mostly two lithostratigraphic units are attested. "Lithothamnium" Limestone Member is used in its central and eastern part, the Krka Limestone Member is used in its western and central part up to the town of Neviodunum. The southern part of the ager, where only rare and small settlements were located, was supplied by strictly local stone material. For now, we can add a new source, namely at least one stele is made from the Early Cretaceous (Aptian–Albian) Rudist limestone, the outcrops of which are located in the immediate vicinity of Črnomelj (less than 1 km air distance).
Besides mentioned main lithologies, some others were identified, but within the assessed material they appear to be used for few or singular artefacts. These are pebbles most likely of the Drnovo Alloformation (used as masonry building material), white marble (in some rare, mostly funerary and votive monuments from the town and ager) as well as calcite tufa (possibly used as marble surrogate).

ANCIENT OUTDOOR MONUMENTS IN SLOVENIA: CURRENT STATE AND PERSPECTIVES

Nina Žbona[1] – Saša Stržinar Sterle[1] – Sabina Dolenec[2,3] – Špela Govže[1] – Maja Gutman Levstik[4]
[1] Institute for the Protection of Cultural Heritage of Slovenia, Restoration Centre, Department for Stone and Stucco Conservation, Ljubljana, Slovenia
[2] Slovenian National Building and Civil Engineering Institute, Laboratory for Cements, Mortars and Ceramics, Ljubljana, Slovenia
[3] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Ljubljana, Slovenia
[4] Institute for the Protection of Cultural Heritage of Slovenia, Restoration Centre, Department of Natural Sciences Research, Ljubljana, Slovenia

Keywords: monuments, conservation, restoration

This contribution aims to present the current state of the most significant stone monuments in Slovenia that remain displayed outdoors due to various circumstances. Slovenia boasts a rich and diverse heritage of Roman stone monuments. In the northeast of the country, where Slovenia's only marble deposits are located, numerous monuments have been preserved, situated in prominent urban settings.

Among the most iconic is the Orpheus Monument in Ptuj, a monolithic marble piece standing 4.94 meters high. Despite seasonal winter protection, the condition of the monument is deteriorating alarmingly due to year-round exposure to environmental elements, which resulted in the loss of original material. The professional community has identified dismantling and relocating the monument to a lapidarium as the most viable solution to prevent further degradation.

For monuments such as the Ancient Mithraeum in Rožanec, composed of grey biomicritic thick-bedded limestone, and Dedec in Staje near Ig, carved from micritic limestone, there are no standardized guidelines for long-term preservation. Nonetheless, regular monitoring and maintenance are critical components of their conservation strategies.

Recent efforts have also focused on the Roman Necropolis in Šempeter, specifically on planning conservation-restoration interventions. Larger tombs, such as the Spectatius tomb, are constructed from marble, while other monuments consist of sandstone with volcanic clasts. The proposed renovation of the necropolis aims to provide permanent protection for these monuments and create more favorable conditions for their long-term preservation.

Several years ago, a conservation-restoration project was completed on the wall remains of the Claustra Alpium Iuliarum, a late Roman defence system. Since then, the Restoration Centre has, as a part of the regular programme, consistently monitored the condition of the work at four key sites. These efforts underscore the critical importance of raising awareness about the necessity of regular maintenance, particularly for monuments situated in extreme environmental conditions. Unfortunately, this practice has not yet been fully adopted, either by the professional community or by monument owners.

The conservation of open-air ancient monuments largely depends on the intrinsic properties of the artefacts themselves. Close interdisciplinary collaboration is essential for conducting precise assessments and ongoing monitoring of their condition. This approach is indispensable for planning

effective interventions aimed at preserving monuments that will remain exposed to outdoor environments. Despite the extensive research conducted thus far, many questions remain unanswered. These include determining the exact provenance of stone materials, as exemplified by the monuments in Ptuj, and developing specialized conservation approaches, as seen with the ancient Mithraeum in Rožanec.

THE MARBLE WASTE AT THE EARLY MEDIEVAL CONSTRUCTION SITE OF THE DUBROVNIK CATHEDRAL (CROATIA). INNOVATION IN THE RECYCLING PRACTICE?

Maja Zeman[1] – Suzana Damiani[2]
[1] University of Zagreb, Faculty of Humanities and Social Sciences, Department of Art History, Zagreb, Croatia
[2] University of Zagreb, Academy of Fine Arts, Department for Conservation and Restoration of Artworks, Zagreb, Croatia

Keywords: marble waste, recycling, Dubrovnik cathedral

During the archaeological research of the oldest church in the underground of Dubrovnik Cathedral, in the 1980s, a large quantity of offcuts of various kinds of ancient marble was found. The offcuts took up a wider surface in the lower layers of the church, including the area of the dome-crossing and the church nave. The researchers considered the findings to be only the remains of stone masonry activities from the time of furnishing the church in the early Middle Ages. However, through a more detailed reading of the unpublished notes, we found that the "layer of marble offcuts" was laid on a fill of red loamy soil and fine-grained sand, which still occupies the entire surface of the investigated church. Although these findings would indicate the customary bedding of load-bearing elements, our attention was drawn by the fact that the masons decided to use marble offcuts instead of pebbles or gravel.
Namely, as revealed by contemporary research in the field of utilization of marble waste in the construction sector, if used in the load-bearing layer, marble cuttings could increase not only the compressive strength, but primarily the flexural strength. We consider this notion relevant since Dubrovnik is situated in the earthquake fault area. In addition, our research has shown that the oldest church was preceded by an earlier, late antique complex that at one time possibly underwent demolition, followed by

extensive material recycling. The church itself has gone through several adaptations, with a significant reconstruction dated to the 9th–10th centuries, when vaults and a dome were introduced. Such an intervention required strong pillars at the intersection of the dome and in the nave. Therefore, questions arise whether the early medieval builders advisedly introduced marble offcuts into the bedding of loamy soil and sand in order to obtain better resistance to the thrust of the dome and vaults, at the same time to achieve seismic reinforcement of the building; and whether this was already a known and proven practice or an innovative solution, driven by the need to recycle marble waste at the construction site.
Additionally highlighting some similar findings from the wider area of the eastern Adriatic and the Mediterranean, the intention is to open a discussion on a topic that would contribute to the research of ancient marble recycling methods and innovations in construction technologies in the past.

PROVENANCE OF MARBLE FROM NORTHERN ITALY AND ISTRIA (CROATIA) AS EVIDENCE OF INTERCONNECTIONS BETWEEN EAST AND WEST IN LATE ANTIQUITY

Judit Zöldföldi[1] – Helena Tumova[2] – Enrico Cirelli[3] – Balázs Székely[4]
[1] University of Stuttgart, Materials Testing Institute, Building Protection and Restoration of Historical Monuments, Stuttgart, Germany
[2] Charles University, Faculty of Arts, Institute of Classical Archaeology, Prague, Czech Republic
[3] University of Bologna, Faculty of Arts, Department of History and Culture, Bologna, Italy
[4] Eötvös Loránd University, Department of Geophysics and Space Science, Budapest, Hungary

Keywords: white marble, provenance analysis, non-destructive and minimal-invasive techniques

This article discusses the results of the international and interdisciplinary research project "Provenance of Marble from Northern Italy and Istria as Evidence of Interconnections between East and West in Late Antiquity" on the origin of the white marble used in late antique sarcophagi and architectural elements from ancient Ravenna and its surroundings between the 5th and 8th centuries. It challenges the long-held assumption that most of the marble came from the quarries of Proconnesos (Marmara Island, Turkey) in the eastern Mediterranean. While previous studies have relied

mainly on stylistic, typological analysis and historical conjecture, the research of this project uses a combination of in situ non-destructive and minimally invasive methods, including macroscopic and microscopic examination, grain size analysis using a handheld and mobile polarised microscope, portable Raman spectroscopy, portable X-ray fluorescence spectroscopy, and small amounts of powder samples for $\delta^{18}O$ and $\delta^{13}C$ stable isotopes and $^{87}Sr/^{86}Sr$ radiogenic isotope ratios. In some cases, thin section and cathodoluminescence analyses were also carried out. Analysis of sarcophagi from the basilicas at Ravenna and Classe shows that different types of marble were used, with some sarcophagi showing a combination of marbles from different quarries. The results of the analyses suggest that, in addition to marble from Proconnesos, material from quarries on Thasos and Paros was also used in the Ravenna area. Comparative research was also carried out on finds from the Porec and Novigrad excavations. This study contributes to a broader understanding of trade networks in the Mediterranean and artistic production in Late Antiquity, and also highlights the need for further research into the marble trade in the northern Adriatic.

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Authors

1	Al-Bashaireh Khaled	khaledsm@arizona.edu
2	Alexandrescu Cristina-Georgeta	cgetalexandrescu@gmail.com
3	Amraoui Touatia	touatia.amraoui@univ-amu.fr
4	André Jérôme	jerome.andre@unil.ch
5	Andreeva Petya	petya_letters@abv.bg
6	Andrianou Dimitra	dandr@eie.gr
7	Andrieu Valérie	andrieu@cerege.fr
8	Andronache Ion	andronacheion@email.su
9	Anevlavi Vasiliki	vasiliki.anevlavi@oeaw.ac.at
10	Angás Pajas Jorge	j.angas@unizar.es
11	Anglisano Anna	anna.ar.93@gmail.com
12	Antonelli Fabrizio	fabria@iuav.it
13	Asensio Esteban José Ángel	joseangelasensio@yahoo.es
14	Atalay Süleyman	suleyman.atalay@ktb.gov.tr
15	Atienza Fuente Javier	arkeografia@gmail.com
16	Bajnóczi Bernadett	bajnoczi.bernadett@csfk.org
17	Bald Romano Irene	ireneromano@arizona.edu
18	Bannour Maha	bannourhamzamaha@gmail.com
19	Barataud Laura	barataudlaura@gmail.com
20	Barker Simon J.	s.barker@uw.edu.pl
21	Barrero Martín Nova	nova.barrero@cultura.gob.es
22	Bartz Franziska	franziska.bartz@stadt-koeln.de
23	Beaujean Bas	bas.beaujean@kuleuven.be
24	Becerra Fernández Daniel	dbecerra@uma.es
25	Beltrán Fortes José	jbeltran@us.es
26	Bianco Antonio	antonio.bianco@phd.unipi.it

27 Bielefeld Doris	bielefel@staff.uni-marburg.de
28 Blandin Béatrice	beatrice.blandin@geneve.ch
29 Bloy Dylan	dbloy@utk.edu
30 Bonetto Jacopo	jacopo.bonetto@unipd.it
31 Borrego de la Paz Juan de Dios	juandepost@hotmail.com
32 Bosch Delphine	delphine.bosch@umontpellier.fr
33 Bradić-Milinović Katarina	katarina.bradic.milinovic@rgf.bg.ac.rs
34 Brajkovič Rok	rok.brajkovic@geo-zs.si
35 Bridi Eliana	eliana.bridi@unipd.it
36 Brunčič Ana	ana.bruncic@zag.si
37 Bugini Roberto	robertobugini3@gmail.com
38 Bulić Davor	davor.bulic@unipu.hr
39 Butz Patricia A.	patricia.butz@csun.edu
40 Campbell Rosie	evc27@cam.ac.uk
41 Carraro Filippo	carraro.fil@gmail.com
42 Casas Lluís	lluis.casas@uab.cat
43 Čaval Saša	scaval@stanford.edu
44 Cenati Chiara	chiara.cenati@univie.ac.at
45 Černíková Alena	alena.cernikova@natur.cuni.cz
46 Chase Spencer	smchase@willamette.edu
47 Chatti Zoubir	zoubir.chatti@univ-dbkm.dz
48 Chezeaux Chloé	chloe.chezeaux@unil.ch
49 Christophilopoulou Anastasia	achristophilopoulou@mfa.org
50 Ciglar Iva	iva.ciglar@pmpo.si
51 Cindrić TaI	taicindric@gmail.com
52 Cirelli Enrico	enrico.cirelli2@unibo.it
53 Cirrincione Rosolino	r.cirrincione@unict.it
54 Conventi Alberto	alberto.conventi@iuav.it

55 Cremisini Paolo	cremisinip@protonmail.com
56 Cuchí Oterino José Antonio	cuchi@unizar.es
57 Culka Adam	adam.culka@natur.cuni.cz
58 Cuteri Francesco	francesco.cuteri@libero.it
59 Damay Chloé	chloedamay@gmail.com
60 Damiani Suzana	suzanadamiani65@gmail.com
61 Davidović Jasmina	jasnadavidovic@gmail.com
62 de Vals Marilou	mmdevals@gmail.com
63 Delli Georgia	delligeorgia991@gmail.com
64 Di Bella Fabiano Fiorello	f.dibella@ssmeridionale.it
65 Di Febo Roberta	roberta.difebo@uab.cat
66 Diffendale Daniel P.	daniel.diffendale@sns.it
67 Dilaria Simone	simone.dilaria@unipd.it
68 Dimkić Ivica	ivicad@bio.bg.ac.rs
69 Dirican Murat	m.dirican@arch.leidenuniv.nl
70 Djurić Bojan	bojan.djuric@gmail.com
71 Dolenec Matej	matej.dolenec@ntf.uni-lj.si
72 Dolenec Sabina	sabina.dolenec@zag.si
73 Doperé Frans	frans.dopere@kuleuven.be
74 Dousteyssier Bertrand	bertrand.dousteyssier@uca.fr
75 Draksler Matej	draksler.matej@gmail.com
76 Du Qian	qian.du@sjtu.edu.cn
77 Eddine Bentridi Salah	s.bentridi@univ-dbkm.dz
78 Fant J. Clayton	cfant@uakron.edu
79 Faresin Emanuela	emanuela.faresin@unipd.it
80 Farney Garney	gfarney@rutgers.edu
81 Ferjan Ines	ines.ferjan@ed.ac.uk
82 Ferré Eric	eferre@nmsu.edu

83	Fiannacca Patrizia	patrizia.fiannacca@unict.it
84	Folli Luisa	lufolli@gmail.com
85	Franconi Tyler	tyler_franconi@brown.edu
86	Galán Palomares Laura	lgalan@icac.cat
87	Gallocchio Enrico	enricogallocchio@gmail.com
88	Gasparini Eleonora	eleonoragasparini@gmail.com
89	Gasparini Massimo	aa2gagam@uco.es
90	Gattacceca Jérôme	gattacceca@cerege.fr
91	Gazzoli Silvia	silvia.gazzoli@sns.it
92	Germinario Luigi	luigi.germinario@unipd.it
93	Girotto Chiara	chiara.girotto.3@phd.unipd.it
94	Golež Mateja	mateja.golez@zag.si
95	Gospodinov Nikolay	nikolay_tg2@abv.bg
96	Govže Špela	spela.govze@rescen.si
97	Gutiérrez Garcia-Moreno Anna	agutierrez@icac.cat
98	Gutman Levstik Maja	maja.gutman@zvkds.si
99	Hadžihasanović Jesenko	hadzihasanovic.j@gmail.com
100	Hamai Lamine	lamine.hamai@gmail.com
101	Hartmann-Virnich Andreas	andreas.hartmann-virnich@univ-amu.fr
102	Hegedüs Péter	hpetair@gmail.com
103	Heide Thomas	heidetho@uni-mainz.de
104	Herrmann, Jr. John J.	jherrmannjr@gmail.com
105	Iñiguez Berrozpe Lara	laraib@unizar.es
106	Işın Gül	gulisin@akdeniz.edu.tr
107	Ivanović Radomir	ivanovicradomir@gmail.com
108	Ivanuš Martina	mivanus@hrz.hr
109	Jakobitsch Thorsten	thorsten.jakobitsch@oeaw.ac.at
110	Jankiev Tamara	tamara.janakiev@bio.bg.ac.rs

111 Jaroměřský Štěpán	
112 Jengić Ivan	ijengic@hrz.hr
113 Jovanović Divna	djdivna@gmail.com
114 Kaljanac Adnan	kaljanackaljanac@gmail.com
115 Karl Stephan	stephan.karl@chello.at
116 Kastler Raimund	raimund.kastler@salzburg.gv.at
117 Katerin Pilgrim Milo	milo.pilgrim@utexas.edu
118 Kidd Allison B.	akidd@britishmuseum.org
119 Kirschner Paolo	paolo.kirschner@unipd.it
120 Kitada Smalley Heather	hsmalley@willamette.edu
121 Klasnakov Miroslav	miro_klasnakov@abv.bg
122 Kmetec Viktor	viktor.kmetec1@gmail.com
123 Knežević Aleksandar	knezevica@bio.bg.ac.rs
124 Košek Filip	filip.kosek@natur.cuni.cz
125 Kosel Janez	janez.kosel@zvkds.si
126 Koukouvou Angeliki	akoukouvou@culture.gr
127 Kozelj Tony	tonykozelj@hotmail.com
128 Krajšek Jure	jure.krajsek@pokmuz-ce.si
129 Kremer Gabrielle	gabrielle.kremer@oeaw.ac.at
130 Krickl Robert	robert.krickl@oeaw.ac.at
131 Križanič Luka	lukak3944@gmail.com
132 Kučerová Irena	Irena.Kucerova@vscht.cz
133 Kuchařová Aneta	aneta.stastna@natur.cuni.cz
134 Kuret Jelka	jelka.kuret@rescen.si
135 Lamali Atmane	lamali_atmane@yahoo.fr
136 Langohr Charlotte	charlotte.langohr@uclouvain.be
137 Lapuente Mercadal Pilar	plapuent@unizar.es
138 Lazzarini Lorenzo	lorenzo@iuav.it

139 Legan Lea	lea.legan@zvkds.si
140 Lepić Adisa	adisa.lebic@zemaljskimuzej.ba
141 Levec Tjaša	tjasa.levec@gmail.com
142 Levine Evan I.	evl@teol.ku.dk
143 Levitan Rebecca	rebecca.levitan@kcl.ac.uk
144 Linke Robert	robert.linke@bda.gv.at
145 Liritzis Ioannis	liritzis@aegean.gr
146 Ljaljević Grbić Milica	jmilica@bio.bg.ac.rs
147 Loza María Luisa	marial.loza@juntadeandalucia.es
148 Lozić Edisa	edisa.lozic@zrc-sazu.si
149 Lux Judita	judita.lux@zvkds.si
150 Lyes Christopher J.	jesu3703@ox.ac.uk
151 Macri Patrizia	patrizia.macri@ingv.it
152 Maligorne Yvan	yvan.maligorne@yahoo.fr
153 Mandera Sara	sarmander@doktorant.umk.pl
154 Matetić Poljak Daniela	daniela.matetic-poljak@umas.hr
155 Mazzariol Alessandro	alessandro.mazzariol@unipd.it
156 Mazzoli Claudio	claudio.mazzoli@unipd.it
157 McLean Andrew	amclean6787@protonmail.com
158 Merabet Nacer	n.merabet@craag.dz
159 Mertik Nina	nina.mertik@pmpo.si
160 Miele Cristiano	cristiano.miele@archetipo-srl.com
161 Miletić Snježana	snjezana.miletic@geo-zs.si
162 Mitrova Danica	danica.mitrova@ff.uni-lj.si
163 Mlakar Mojca	mm72124@student.uni-lj.si
164 Momchilov Dimcho	d.momchilov@abv.bg
165 Montagnac Gilles	gilles.montagnac@ens-lyon.fr
166 Montana Giuseppe	giuseppe.montana@unipa.it

167 Monterroso Checa Antonio	amonterroso@uco.es
168 Moreno Escribano Juan Carlos	jcmescribano@transportes.gob.es
169 Morris Owain	owain.morris1@gmail.com
170 Muhić Doroteja	dora.muhic@gmail.com
171 Nestorović Aleksandra	aleksandra.nestorovic@pmpo.si
172 Nogales Basarrate Trinidad	trinidad.nogales@cultura.gob.es
173 Noguera Celdrán José Miguel	noguera@um.es
174 Nolte Leonie	leonie.nolte@ruhr-uni-bochum.de
175 Novak Matevž	matevz.novak@geo-zs.si
176 Novotná Ivana	
177 Olah Josiah	josiah.olah@studenti.unipd.it
178 Ontiveros Esther	esther.ontiveros@juntadeandalucia.es
179 Ostojić Milorad	mil.ost@hotmail.com
180 Paga Jessica	jpaga@wm.edu
181 Page James	jpag1@bsc.es
182 Peirano Diego	diego.peirano@scuola.istruzione.it
183 Perna Simona	sperna@icac.cat
184 Perrillat Jean-Philippe	jean-philippe.perrillat@univ-lyon1.fr
185 Pianet Isabelle	isabelle.pianet@u-bordeaux-montaigne.fr
186 Pike Scott	spike@willamette.edu
187 Pinkerton George	s1007905@sms.ed.ac.uk
188 Pizzigati Alberto	alberto.pizzigati@libraweb.net
189 Plattner Georg	georg.plattner@khm.at
190 Poggio Alessandro	poggio.alessandro@gmail.com
191 Polgár-Nyerges Anita	polgar-nyerges.anita@aquincum.hu
192 Pollini John	pollini@usc.edu
193 Pontelli Elena	elena.pontelli@imtlucca.it
194 Popović Slađana	sladjana.popovic@bio.bg.ac.rs

195 Preshlenov Hristo	hristo.preshlenov@abv.bg
196 Previato Caterina	caterina.previato@unipd.it
197 Přikryl Richard	richard.prikryl@natur.cuni.cz
198 Přikrylová Jiřina	jirina.prikrylova@avu.cz
199 Prochaska Walter	walter.prochaska@oeaw.ac.at
200 Punturo Rosalda	rosalda.punturo@unict.it
201 Purpura Valentina	valentina.purpura80@gmail.com
202 Racek Martin	martin.racek@natur.cuni.cz
203 Raneri Simona	simona.raneri@unifi.it
204 Rasiņa Madara	rasina.madara@gmail.com
205 Regnier Killian	Killian.regnier@uclouvain.be
206 Reinert Michael	michael.reinert@ruhr-uni-bochum.de
207 Retko Klara	klara.retko@zvkds.si
208 Rice Candace M.	candace_rice@brown.edu
209 Řimnáčová Daniela	rimnacova@irsm.cas.cz
210 Ristow Sebastian	sebastian.ristow@lvr.de
211 Rižnar Igor	igor.riznar@telemach.net
212 Rochette Pierre	rochette@cerege.fr
213 Rodà de Llanza Isabel	iroda@icac.net
214 Rogan Šmuc Nastja	nastja.rogan@ntf.uni-lj.si
215 Ropret Polonca	polona.ropret@zvkds.si
216 Rožič Boštjan	bostjan.rozic@ntf.uni-lj.si
217 Ruiz Julio C.	julioruiz92@hotmail.es
218 Ruppienė Vilma	vilma.ruppiene@rub.de
219 Russell Ben	ben.russell@ed.ac.uk
220 Šajna Petra	petra.sajna@zag.si
221 Šala Martin	martin.sala@ki.si
222 Salvadori Monica	monica.salvadori@unipd.it

223 Sánchez Hernández Mar	mar.sanchez@estudiants.urv.cat
224 Savin Marie-Claire	msavin@icac.cat
225 Scalco Luca	luca.scalco@unipd.it
226 Scharlau Victoria Monique	victoria.scharlau@ruhr-uni-bochum.de
227 Sciuto Claudia	claudia.sciuto@unipi.it
228 Secco Michele	michele.secco@unipd.it
229 Segal Dror	DrorS@npa.org.il
230 Siotto Eliana	eliana.siotto@isti.cnr.it
231 Šmuc Andrej	andrej.smuc@geo.ntf.uni-lj.si
232 Soder Christian	soder@ifs-mainz.de
233 Sodoleanu Irina	irina.sodoleanu@gmail.com
234 Soler Huertas Begoña	bsoler@icac.cat
235 Šprem Katarina	katarina.sprem7@gmail.com
236 Stefanski Yossi	stepansky.yosef@gmail.com
237 Steskal Martin	martin.steskal@oeaw.ac.at
238 Stollnberger Astrid	astrid.stollnberger@plus.ac.at
239 Stržinar Sterle Saša	sasa.strzinar.sterle@zvkds.si
240 Székely Balázs	balazs.szekely@ttk.elte.hu
241 Tavzes Črtomir	crtomir.tavzes@zvkds.si
242 Tendron Graziella	graziella.tendron@eveha.fr
243 Tokay Hale	zeliha.hale.tokay@msgsu.edu.tr
244 Tomšič Nejc	nt12619@student.uni-lj.si
245 Triantafyllou Antoine	antoine.triantafyllou@univ-lyon1.fr
246 Trubač Jakub	jakub.trubac@natur.cuni.cz
247 Tumova Helena	helena.tumova@ff.cuni.cz
248 Turchetto Jacopo	jacopo.turchetto@unipd.it
249 Turci Marcello	marcello.turci@gmail.com
250 Tykot Robert H.	rtykot@usf.edu

251 Unković Nikola	unkovicn@bio.bg.ac.rs
252 Urankar Rafko	rafko.urankar@guest.arnes.si
253 Uribe Agudo Paula	uribe@unizar.es
254 Valero Tévar Miguel Ángel	miguelangel.valero@uclm.es
255 Valverde Gascueña Nelia	nelia.valverde@uclm.es
256 van den Hoek Annewies	annewies_vandenhoek@harvard.edu
257 Vanden Broeck-Parant Jean	jean.vandenbroeck@uclouvain.be
258 Vettor Tommy	tommyvettor@gmail.com
259 Vezočnik Rok	rok.vezocnik@zag.si
260 Vilarinho Gil	gil.vilarinho@uevora.pt
261 Vinazza Manca	manca.vinazza@ff.uni-lj.si
262 von Rüden Constance	constance.vonrueden@ruhr-uni-bochum.de
263 Vrabec Mirijam	mirijam.vrabec@ntf.uni-lj.si
264 Wiehen Michael	michael.wiehen@stadt-koeln.de
265 Wielgosz-Rondolino Dagmara	dagmara.wielgosz@uw.edu.pl
266 Wurch-Kozelj Manuela	manuela_wk@hotmail.com
267 Zanier Katharina	katharina.zanier@ff.uni-lj.si
268 Zara Arturo	arturo.zara@unipd.it
269 Žbona Nina	nina.zbona@zvkds.si
270 Zeman Maja	mzeman@ffzg.unizg.hr
271 Zhao Wei	cementzhao@sjtu.edu.cn
272 Zöldföldi Judit	judit.zoeldfoeldi@mpa.uni-stuttgart.de
273 Županek Bernarda	bernarda.zupanek@mgml.si
274 Žvab Rožič Petra	petra.zvabrozic@ntf.uni-lj.si

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Notes

ASMOSIA XIV

15–20 SEPTEMBER 2025 | LJUBLJANA

UNIVERSITY OF LJUBLJANA FF Faculty of Arts

GeoZS Geološki zavod Slovenije

MESTNI MUZEJ LJUBLJANA CITY MUSEUM OF LJUBLJANA

Zavod za varstvo kulturne dediščine Slovenije
Institute for the Protection of Cultural Heritage of Slovenia

SLOVENSKO GEOLOŠKO DRUŠTVO