

METALLON

The Exploitation of Subsurface
Resources in Ancient Greece

16 Oct.
2025

**M. H. Wiener Laboratory, ASCSA
Conference Room**

54 Souidias Street
Kolonaki, Athens



**Workshop organized
as part of the Innovative
Action of the GPR Human Past**



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Workshop organized by

Julien Gravier

Chloé Chezeaux

As part of the

Innovative Action

of the GPR Human Past

In collaboration with the

M. H. Wiener Laboratory for Archaeological Science,
American School of Classical Studies at Athens

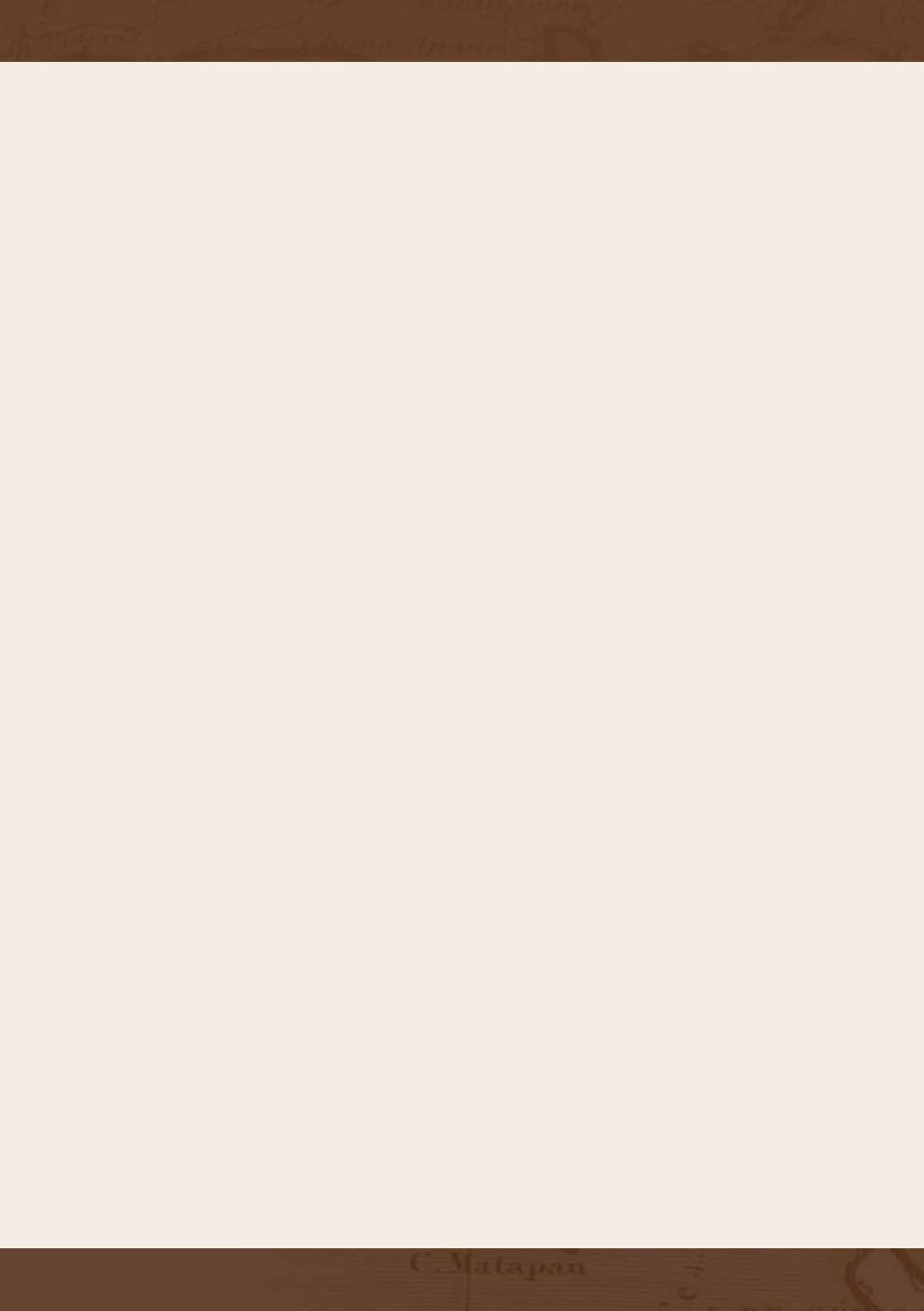


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Workshop Programm

09h00 Welcome

09h30 Opening Words

P. Karkanias (Wiener Laboratory, ASCSA)

09h40 Introduction

C. Chezeaux (University of Lausanne)

J. Gravier (Bordeaux Montaigne University)

09h50 Keynote

E. Filippaki (NCSR Demokritos)

10h20 Techniques and Methods of Extraction

10h25 Archaeometallurgical Research in Northeastern Greece: Case Studies from Prehistory and Antiquity

N. Nerantzis (University of the Peloponnese)

10h50 Coffee Break

11h05 Quarrying of Stones in Ancient Greece: The Case of Limestone Resources

M. de Vals (Sorbonne University)

11h30 Environmental Impact and Landscape Transformations

11h35 Eretria and Its Quarries: Marginal Resources at the Core of Ancient Territorial Dynamics

C. Chezeaux (University of Lausanne)

**12h00 From the Mine to the Forge:
Iron Exploitation across the Eretrian Territory**
J. Gravier (Bordeaux Montaigne University)

12h30 Lunch Break

14h00 Resources, Economy, and Circulation of Materials

**14h05 The Good and the Bad Stone:
An Underground Story**
T. Vettor (Sorbonne University)

**14h30 Retracing Networks of Metal Resources Distribution:
The Case of Argilos**
J. Lefebvre (University of Montreal)

**14h55 Becoming a Rock Star: The Shift from Local Stones to
Serpentinite in Minoan Stone Vase Production**
K. Regnier (Catholic University of Louvain)

15h20 Conclusion of the Workshop

METALLON. The Exploitation of Subsurface Resources in Ancient Greece

J. Gravier, Bordeaux Montaigne University

C. Chezeaux, University of Lausanne

Keywords: Ancient Greece; Aegean world; Raw materials; Extraction; Human-environment interactions; Territorial dynamics; Landscape transformations; Tipping points.

The Greek term *metallon* may refer to either a mine or a quarry, whether used for the extraction of rock, ore, or salt. In this sense, it does not denote the nature of the resources themselves, but rather their shared origin: the subsurface. This common provenance opens the door to a cross-disciplinary reflection on the exploitation and management of such resources in ancient Greece.

In recent decades, the study of the past has seen a growing interest in environmental questions. A key dimension of this research concerns the relationship between ancient societies and their environment: how did human groups interact with their surroundings to meet their needs, build infrastructure, or produce everyday objects? In this field, the rise of interdisciplinary approaches – at the intersection of archaeological sciences and historical inquiry – combined with recent methodological advances, has led to major developments in the field.

The METALLON workshop aims to present the current state of knowledge on the exploitation of subsurface resources in ancient Greece.

Through a variety of approaches and case studies, it seeks to explore the technical, social, and environmental dimensions of these practices. How can we identify and characterize extracted materials – clay, metal, stone – and what can they reveal about the choices made by the societies that utilized them? What extraction methods were employed across different chronological and regional contexts? What can the circulation of these resources tell us about the economic, political, and territorial dynamics of the Aegean world? What impact did these activities have on the environment, and what transformations of the landscape did they generate? Ultimately, temporality is a central thread of this inquiry: how were extractive practices embedded within the *longue durée*, between continuity, rupture, and adaptation?

Archaeometallurgy in Greece through the Lens of Geology

E. Filippaki

Lab of Archaeometry, INN, NCSR “Demokritos”

Keywords: Archaeometallurgy; Geological Processes; Ancient Mining; Mineral Resources; Aegean World.

Shaped by a long and dynamic geological history, Greece possesses an extraordinary richness in rocks and minerals. This geological diversity not only sculpted the landscape but also provided the essential raw materials that underpinned human settlement, and technological innovation across the Aegean world. The complex tectonic and geotectonic evolution of the Hellenic region, driven by the ongoing convergence of the African and Eurasian plates, created a mosaic of metallogenic provinces. These geological processes gave rise to distinct ore-bearing districts, including Laurion in Attica, the Cyclades, Chalkidiki, and Thasos. Such regions sustained metal extraction and production for millennia, supplying copper, lead, silver, gold, and iron that fuelled technological progress and economic power.

This presentation explores how these metallogenic provinces formed through dynamic geological processes such as metamorphism, magmatism, and hydrothermal activity. It also highlights recent and ongoing archaeometallurgical research in Greece, which integrates

geological, mineralogical, and archaeometric approaches to reconstruct ancient metallurgical techniques and the development of early metallurgy in the Greek mainland and the Aegean.

Archaeometallurgical Research in Northeastern Greece: Case Studies from Prehistory and Antiquity

N. Nerantzis

University of the Peloponnese

Keywords: Silver Extraction, Arsenical Copper, Tin Bronze, Iron Working, North Aegean

Northeastern Greece is particularly rich in metal-bearing deposits that have been the focus of extraction since the Late Neolithic period. In the region defined by the rivers Strymon and Nestos, copper production was the first metallurgical application practiced as early as the 5th millennium BCE. Silver extraction was another important technological application in association with lead production, with the earliest evidence found on Thasos in the 4th millennium BCE. Evidence for arsenical copper production during the Early Bronze Age (3200-2600 BCE) emerges at coastal settlements on Thasos and Samothrace. At this early stage, metal production was small-scale, intended to cover the needs of local communities for display items and tools, while procurement of the raw materials was adapted to meet local demand rather than interregional exchange. Evidence for the introduction of tin bronze technology in the 18th century BCE has recently been confirmed through the study of the metallurgical assemblage of Mikro Vouni on Samothrace, providing clues to long-distance connections with Minoan Crete.

From the phase of Greek colonization in the Archaic period (700-480 BCE) up to Roman times (1st century BCE-4th century CE), exploitation of the region's precious metal deposits increased substantially, with higher outputs achieved as the mining and metallurgical processes were progressively being conducted in a more systematic manner. The impact of such activities on the landscape has often been severe, since mining is a highly demanding industry involving large volumes of extracted mineral ores, wood, and charcoal for fuel, as well as infrastructure such as road networks, ore processing facilities, furnaces, and other installations.

The current presentation focuses on a review of the relevant archaeological findings related to mining and metal production and some recent analytical results from archaeometric studies of sampled material from various sites. The case studies discussed include prehistoric copper production on the islands of Thasos and Samothrace, ironworking at Molyvoti in Rhodope and Abdera in Xanthi, and precious metal extraction at Pistyros in Kavala during the Hellenistic period.

Quarrying of Stones in Ancient Greece: The Case of Limestone Resources

M. de Vals
Sorbonne University

Keywords: Limestones, Quarries, Geological Rock Characteristics,
Resource Availability

Rocks have been used for multiple purposes in all times, for small objects – jewelry, vases, weights, sculptures – and for monuments, from private to public architecture. It might not be the most dominant material in construction, but it is the best-preserved one compared to wood, terracotta, or mud bricks, for example. Thus, stone is found in massive quantities in archaeological sites and is the subject of many archaeometric investigations. However, it is usually well-defined and limited resources that have been investigated for provenance or technological study: obsidian, steatite, marble, or fine stones, and more recently granite. These materials already have specific analytical protocols for provenance studies, and quarries mostly have been well identified.

On the other hand, sedimentary stones are the most common resources in Greece, forming more than 70% of the subsurface. In addition, since limestone quarries are not well known, the exploitation of this specific resource remains poorly defined. Limestone studies in archaeological contexts are showing promising results, as they reflect local and regional

trends for the exploitation of stone resources.

In this presentation, I would like to investigate the characteristics of the geological outcrops that were exploited for importation during antiquity. Local limestone outcrops actually produced most of the volume of building stones, but the proximity to the construction site was the main reason behind the choice of these rocks. For exportation and importation, were specific geological formations selected for their physical characteristics, or was the choice determined mainly by availability and topography? Was limestone quarrying a sustainable resource exploited over the long term, or was it only linked to specific construction projects? To address these questions, we will examine different quarries in central Greece and the Peloponnese, the stones exploited, and where they were exported, embedded into their different geological settings.

Eretria and Its Quarries: Marginal Resources at the Core of Ancient Territorial Dynamics

C. Chezeaux
University of Lausanne

Keywords: Ancient Quarries, Eretria (Euboea), Stone Extraction, Landscape Archaeology, GIS Analysis

In the study of subsurface resources in ancient Greece, quarries remain overlooked. Too often regarded as mere sources of raw material, they are rarely integrated into broader archaeological questions or territorial analyses. The case of Eretria, a city in Euboea whose architecture made extensive use of locally sourced materials, clearly illustrates this gap: despite the evident importance of stone in urban development, extraction sites have received little to no systematic investigation.

This study, conducted in collaboration with the Swiss School of Archaeology in Greece (ESAG), offers a micro-regional analysis of ancient quarrying in the Eretrian region. Combining field surveys, remote sensing, morphological analysis of quarry faces, tool-mark recording, and GIS-based spatial modeling, the research has identified, documented, characterized, and analyzed around thirty quarry sites. Their spatial distribution, state of preservation, and immediate environmental context reveal a consistent, structured extraction landscape intricately connected to the city itself.

Beyond technical considerations, this research explores the broader territorial implications of stone quarrying – its impact on rural land use and occupation patterns, and the interplay between urban and rural spheres. Stone extraction was far more than a matter of resource procurement: it actively shaped the material and social landscape. This perspective resonates with ancient conceptions of stone not as an inert substance, but as a living resource – capable, like metals, of regenerating and ‘growing back.’ Such an organic view of the subsoil invites a reassessment of ancient extractive practices over the long term.

By bridging archaeology, historical geography, and spatial analysis, this study advocates for a renewed understanding of ancient quarries as full-fledged archaeological sites – rich in technical, social, and territorial significance.

From the Mine to the Forge: Iron Exploitation across the Eretrian Territory

J. Gravier
Bordeaux Montaigne University

Keywords: Iron metallurgy, Eretria, Chaînes Opératoires, Resource Exploitation, Archaeometry

The exploitation of iron within the territory of the ancient city of Eretria remains understudied, despite the region's wealth of ferruginous deposits. The chaîne opératoire of ancient ironworking – from ore extraction to forging – has, to date, never been the subject of a fully integrated study. However, recent developments in research conducted at a regional scale, and the shift in perspective they entail, now make it possible to adopt a comprehensive approach to the production system, placing it within the broader context of resource exploitation and landscape management in the Eretrian territory.

Between 2023 and 2025, three field campaigns were conducted. The first consisted of an exhaustive inventory of iron-related remains uncovered during the excavations of the Swiss School of Archaeology in Greece and preserved in the Archaeological Museum of Eretria. This work recorded over 1,650 artifacts, including slags, metal scraps, furnace wall fragments, and ore samples. Conducted within an archaeometallurgical

framework, this systematic inventory also enabled the identification of several technological categories and provided a preliminary typology of production activities documented within the urban area.

Following this study, two thematic field surveys were carried out in 2024 and 2025 as part of the Eretria and Amarynthos Survey Project (EASP – ESAG), aiming to broaden the scope of the investigation. Focusing on evidence for ironworking, these surveys identified evidence corresponding to several stages of the production process that were previously absent from urban contexts. Although these indicators are sometimes subtle – particularly due to disturbances caused by modern agricultural practices – their presence across the territory strongly suggests a structured organization of ore exploitation and iron production within the Eretrian chora.

The integration of data from urban contexts with that from rural sites sheds new light on the organization of production. While the former appears to have hosted forging workshops, the latter seem likely to have been dedicated to extraction and primary smelting. This functional complementarity points to the existence of an integrated system, connecting raw material procurement, technological choices, and the distribution of finished products. Through the combined analysis of these various datasets, this research aims to reconstruct the complete chaîne opératoire of ironworking in Eretria, ‘from the mine to the forge.’

The Good and the Bad Stone: An Underground Story

T. Vettor
Sorbonne University

Keywords: Stone Quality, Ancient Quarries, Material Selection, Geological Factors, Mediterranean Architecture

Since Prehistory, humanity has relied on stone for everyday needs —tools, buildings, pigments, ceramics, metallurgy, glass, food preservation, and jewelry. This was possible because rocks were readily available underground. While prehistoric constructions frequently employed local stones, the range of materials expanded rapidly with the development of stone carving.

During antiquity, thousands of stone quarries emerged across the Mediterranean Basin, ranging from small local extractions to large-scale operations, some of which remain active today, such as the Carrara marble quarries. The establishment of new quarries and the distribution of their materials were driven by several factors, foremost among them the quality of the stone.

The required quality of stone varied according to its intended use, with sculptures and prestigious edifices often demanding higher standards than ordinary dwellings. Consequently, depending on the purpose, some stones were deemed suitable while others were not, which led to the

careful selection of quarry sites in antiquity. To better understand the distribution of ancient quarries, the volume of stone they produced, and their specific uses, it is therefore essential to decipher the factors that determine both the qualities and the defects of the material.

Stone properties were shaped by many factors: type of rock, tectonic activity, metamorphic conditions, geochemical changes, and weathering. These factors not only clarify why certain outcrops were specifically selected for quarrying in the past but can also guide the identification of new ancient quarries by predicting where the highest-quality stone may be found in the landscape. These parameters will be examined, discussed, and illustrated through several examples of ancient quarries.

Retracing Networks of Metal Resources Distribution: The Case of Argilos

J. Lefebvre
University of Montréal

Keywords: Argilos, Bronze, Akanthos, Copper Ores, Commercial Networks

In the mid-7th century, Andrian colonists traveled north to establish new settlements. They founded the colonies of Stageira, Akanthos, and Sanè on the easternmost finger of the Chalkidiki peninsula, and, a little further east, the city of Argilos on the coast of the Strymonic Gulf. Shortly after its foundation, Argilos experienced rapid economic growth, partly due to the exploitation of nearby polymetallic resources such as Mount Pangaeon. Access to these resources was facilitated by the Argilians' close relationship with the local Thracian populations, with whom they cohabited for at least a century after the city foundation, who were known to exploit these coveted resources for a long time. Abundant metallurgical remains unearthed at Argilos confirm that production began soon after the city's foundation.

This paper investigates the potential copper sources that fueled Argilian bronze production, drawing on metallographic and ICP-MS analyses of bronze artifacts. The Southern Rhodope Core Complex, a geological formation known since antiquity for its wealth in copper, iron, silver, and

gold, formed the backdrop for Argilian bronze production. It is likely that ores from the Bisaltian mines or Mount Pangaeon supplied this industry. Indeed, both locations yielded abundant traces of ancient activity, in the form of historical accounts, architectural remains, mining galleries, and epigraphic inscriptions. However, recent surveys and archaeometallurgical analyses have not identified copper ore extraction that matches the signatures of Argilian bronze production.

This study therefore considers the possibility that Argilian metal production may have exploited Chalkidian copper ores rather than local sources. Northeastern Chalkidiki, considered by some to rival the Laurion district, has been exploited for its polymetallic resources since antiquity. Shortly after its foundation, Akanthos became a major geopolitical player in the region, likely benefiting from these resources. A large part of its economy seems to have relied on their trade. Archaeological research has revealed a long-standing commercial relationship between Akanthos and Argilos, raising questions about the nature of the commodities exchanged between these two sister colonies. By combining historical, numismatic, and archaeometric evidence, this paper defines the role of Chalkidian copper ores and Akanthian trade in Argilian metal production. This case study contributes to our understanding of Northern Aegean geopolitical dynamics and their impact on the chaîne opératoire of bronze production.

Becoming a Rock Star: The Shift From Local Stones to Serpentinite in Minoan Stone Vase Production

K. Regnier

Catholic University of Louvain

Keywords: Serpentinite, Minoan Crete, Stone Vases, Raw Material Procurement, Petrography

Minoan stone vases constitute a prominent feature of the material culture of Bronze Age Crete. Their production required suitable raw materials. Since the substantial study of P. Warren (1969), scholars have noted a significant shift at the end of the Prepalatial Period (ca. 2300-1900 BCE). At this time, serpentinite began to replace softer stones, such as chlorite and steatite, often available locally, and eventually became the most frequently used material for Cretan stoneware production during the Proto- (ca. 1900–1650 BCE) and Neopalatial (ca. 1650-1425 BCE) periods. This paper first examines two published case studies to evaluate how serpentinite was adopted for stone vase production across different regions of Crete, and to determine whether local procurement practices persisted or were replaced by broader regional strategies.

The first case study, Mochlos in eastern Crete, provides well-published Prepalatial contexts with numerous small stone vases made from different local stones. With the recent publication of the Neopalatial

buildings, it is now clear that serpentinite had become the dominant material for stone vases in the region; a trend also visible at the nearby site of Pseira. Excavators have proposed that most of the Neopalatial serpentinite was sourced from outcrops located less than five kilometers away from Mochlos. This hypothesis is currently under investigation and will be briefly discussed in this contribution. The second case study focuses on southern Crete. It concerns a corpus of stone vases from the Prepalatial tombs in the Asteroussia region and from Protopalatial palatial and domestic contexts at Phaistos, for which petrographic analyses are available. These studies have revealed the use of a wide range of local stones by the Prepalatial communities, from soft stones to hard materials, such as gabbro and diabase. Yet, in Protopalatial contexts at Phaistos, serpentinite stands out, comprising more than 50% of the stone vase assemblage. This region also appears to have yielded a distinctive 'gray serpentine,' a slightly serpentinitized chlorite-rich rock, although it has not yet been petrographically analyzed. This material seems to have fallen out of use after the Protopalatial period.

The paper concludes with a simplified diachronic model of serpentinite procurement strategies. This model extends beyond the two case studies, linking known outcrops across Crete with several archaeological settlements. Drawing on cost-distance analysis, stone vase typologies and preliminary petrographic results, this model aims to provide a preliminary framework for discussing the development of serpentinite circulation networks in Minoan Crete.

METALLON

The Exploitation of Subsurface Resources in Ancient Greece

The Greek term metallon may refer to either a mine or a quarry, whether used for the extraction of rock, ore, or salt. In this sense, it does not denote the nature of the resources themselves, but rather their shared origin: the subsurface. This common provenance opens the door to a cross-disciplinary reflection on the exploitation and management of such resources in ancient Greece.

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Key words: Ancient Greece; Aegean world; Raw materials; Extraction; Human-environment interactions; Territorial dynamics; Landscape transformations; Tipping points.

Organizers: Julien Gravier (Ausonius / Bordeaux Montaigne University)
Chloé Chezeaux (ESAG / University of Lausanne).