EXPLORING HUMAN-MINERAL INTERACTIONS

Techno-functional approaches to extracting and processing mineral resources – International Symposium

Date

Friday 17th - Saturday 18th November 2023

Place

Institut für Archäologien
Ágnes-Heller-Haus
4th Floor, Room 04M100
Innrain No.52a
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Keynotes

Prof. Cristina Lemorini; La Sapienza – Università di Roma
Prof. Thomas Stöllner; Ruhr-Universität Bochum

Organisers

Dr. Aydin Abar
Institut für Archäologien
University of Innsbruck

Dr. Isabella Caricola
The Zinman Institute of Archaeology
University of Haifa

Supported by

Time schedule, Friday 17th

8:30-9:00 Welcome and introduction by organisers

Keynote

9:00-9:30 Cristina Lemorini

Exploring the intangible: the role of traces and residues analyses in reconstructing human interaction with quarry/mine resources in Prehistory

Material analysis in the focus

9:30-10:00 Peter Tropper & Roman Lamprecht

Hardness matters: Petrological and petrophysical characterization of the Bronze and Iron Age Stone Tools from the zLower Inn Valley

10:00-10:30 Pratik Pandey

presentation cancelled

10:30-11:00 Coffee Break

Extracting mineral resources

11:00-11:30 Hanna Arndt & Guntram Gassmann

Neolithic Hematite Mining in the Southern Black Forest

11:30-12:00 Andrea Terziani, Nicoletta Volante & Cecilia Viti

Macrolithic Tools from the Neolithic Cinnabar Mine of Spaccasasso Southern Tuscany, Italy): Preliminary Results from the Techno-Functional Analysis and Petrographic Characterization

12:00-12:30 Francesco Breglia, Isabella Caricola & Felice Larocca

Exploring Ancient Mines: A Review of Groundstone Tools from Southern Italy

12:30-14:00 Lunch

14:00-14:30 Mark A. Hunt Ortiz & Johan Ling

Stone Tools in the Bronze Age Iberian Peninsula Copper Mining. Las Minillas Mine (Granja de Torrehermosa, Badajoz, Spain)

14:30-15:00 Olga Zagorodnia & Harriet White

Mining and Ore-Processing Bone Tools from Great Orme Copper Mines

15:00-15:30 Xavier Terradas, Clara Fernández, David Ortega & Carles Roqué

The Mining Tools From the Prehistoric Quarries of Serra Llarga (NE Iberia): Preliminary Results From Lithological, Techno-Morphological and Functional Approaches

15:30-16:00 Coffee Break

16:00-16:30 Discussion

19:45 Dinner

Time schedule, Saturday 18th

Keynote

8:30-9:00 Thomas Stöllner

Materialized practices in mining: The sensorial background of knowledge networks in Prehistory

Processing Mineral Resources

9:00-9:30 Daniela Eugenia Rosso, Clodoaldo Rodlán García, Sonia Murcia Mascarós & Valentin Villaverde Bonilla

Processing Ochre in the Upper Palaeolithic: The Parpalló Cave Record

9:30-10:00 Aydin Abar & Elena Silvestri

Between Stone & Metal: Fracture Patterns and other Traces on Macrolithic Flakes from the Late/Final Bronze Age Mining/Ore Beneficiation Site of Vetriolo (Comune di Levico, TN, Italy)

10:00-10:30 Diego Capra, Isabella Caricola, Giuseppina Mutri, Giulio Lucarini, Michael Boyd & Colin Renfrew

Ochre and hide working during the Bronze Age at Dhaskalio, Southern Cyclades: First Insights from Use-Wear Analysis

10:30-11:00 Coffee Break

Recycling Mineral Resources

11:00-11:30 Julia Haas & Roman Lamprecht

Investigating Prehistoric Slag Tempered Ceramics: Experiments on Slag Processing with Ground Stone Tools and Pottery Production

11:30-12:30 Final Discussion

12:30-14:00 Lunch

14:00-18:00 Excursion

Exploring the intangible: The Role of Traces and Residue Analyses in Reconstructing Human Interaction with Quarry/Mine Resources in Prehistory

Cristina Lemorini

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Besides bronze tools, stone tools are probably the most important group of materials used in prehistoric copper mining. A large number of different types of tools were used in Bronze and Iron Age mining, whereby it can be assumed that most of the tools were used for ore refining. According to this, mallets as well as hammer stones were used for ore separation and grinding stones for fine processing. Statistical evaluations of the rocks used indicate that certain materials were deliberately used. Accordingly, particularly hard and tough rocks such as eclogite or garnet amphibolite were especially suitable for mallets, while rocks with a high abrasive capacity such as gneisses were readily used for grinding processes.
In nature, there are three types of rocks: igneous, metamorphic and sedimentary rocks. Depending on the formation process, the rocks have different mechanical properties. Petrology, is the study of the formation, properties and use of rocks. It is a branch of geosciences and represents the transitional area between mineralogy, which deals with the constituents of rocks (minerals), and geology, which places the rocks in larger spatial and temporal contexts. In the course of this presentation, the mineralogy of the relevant rocks is described in their thin sections. The relationship between mineralogy and metamorphic conditions (pressure and temperature) and mechanical material parameters (porosity, hardness, fracture behavior, uniaxial compressive strength, etc.) will also be discussed. Based on literature data, a positive correlation between the degree of metamorphism, the degree of compaction and brittle fracture can already be observed, as well as the reduction of porosity with increasing metamorphism.

The harder the better: Petrological and Petrophysical Characterization of Bronze Age and Iron Age Stone-Tools from the Lower Inn Valley

Peter Tropper[1] & Roman Lamprecht[2]

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Evaluating the Source Attribution of Chert and its Impact on Techno-Typological Variability of Microblade Technology in Mandakini Basin, India

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Microblade technology in the Indian subcontinent has been observed as a marker of early modern human arrival. Microblade technology requires specific reduction strategies and cognitive and dexterous skills to manufacture. Due to the absence of required hominin fossil remains in the subcontinent, the study of these lithic tools provides crucial information about Prehistoric people, their behaviour, cognitive development and technological skills. The current research aims to access technological changes in Microblade production to understand the behavioural pattern of early modern humans across time and space in the Mandakini basin. Here the stratified microblade industry of Banke Sidha has been considered to understand evolutionary features and compared with the surrounding sites to see inter and intra-site variability in terms of microblade production and raw preferences. Within the Mandakini basin, the microblade industry of six different sites has been used for the comparative analysis. Among these sites, Chert has been identified as a preferential raw material for microblade production. Techno-typological transition in microblade and the reason for raw preferences of prehistoric community has been observed throughout the schematics and qualitative analysis including experimental knapping on local material. We employed a multidisciplinary approach, combining petrographic analysis, geochemical sourcing techniques, and typological examination of raw material to determine the prehistoric chert quarries and possible mobility patterns of prehistoric populations. We use portable X-ray fluorescence (p-EDXRF), Thin section and Raman spectroscopy to analyse the elemental concentration of the geological and archaeological samples. The result of this analysis helps in understanding whether the differential raw preference varies according to the distance between the Microblade sites and raw material sources (chert quarries).

Neolithic Hematite Mining in the Southern Black Forest

Hanna Arndt[1] & Gruntram Gassmann[2]

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The Southern Black Forest is characterized by its eponymous dense forests and its abundance of mineral deposits. Recent surveys and excavations are focusing on a large-scale surface extraction of hematite lenses at the early neolithic ages in the vicinity of Sulzburg and Münstertal.
Over a length of more than 2.5 kilometres, there is a several meters thick ore vein containing quartzite, barite, and scattered hematite. The hematite was extracted utilizing diverse hammerstones and possibly other tools made from perishable materials that can no longer be detected. During the mining process some rocks were broadly removed, while in other cases, deep niches were carved out to access the hematite. This was achieved through crushing and hammering mining techniques employing specialized stone tools, which likely deteriorated rapidly due to the extreme strain, leading to their abundant abandonment. The quantity of hammerstones and fragments is immense, so the extraction and the associated effort must have been extensive as well.
The hematite likely served as a deep red pigment, possibly for body painting. It appears primarily in the Neolithic burial context, where it has been proven to have been scattered over the deceased. The reason why it was extracted with considerable effort in the heart of the Black Forest remains entirely unresolved. Certainly there are more accessible deposits in other regions.
There is currently no concrete evidence regarding the location of associated settlements. It is likely that seasonal extraction took place and related settlements were situated in the fertile loess areas of the Upper Rhine. The question of whether there were also temporary campsites in the Black Forest is indeed valid and should be investigated in the future.

Macrolithic toos from the Neolithic Cinnabar Mine of Spaccasasso (Southern Tuscany, Italy): Preliminary Results from the Techno-Functional Analysis and Petrographic Characterization

Andrea Terziani[1], Nicoletta Volante[2] & Cecilia Viti[3]

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Spaccasasso is a neolithic cinnabar mine, in the Maremma Regional Park. The site is unique in the archaeological field, as at the moment is the only prehistoric cinnabar mine under investigation. Due to its excellent preservation the site is revealing an unusual mining exploitation technique carried out by means of fire setting.
This contribution aims to illustrate the preliminary results from the techno-functional and petrographic analyses conducted on some mining stone tools that come from this particular mining context.
Macroscopic observations associated with a low-magnification approach allowed us to highlight technological traces, i.e. connected with the shaping of the tools and with their hafting, as well as other traces related to their use during the mining activities. These preliminary results revealed little or no investment in their manufacturing and their use or reuse according to different kinematics. On the other hand, petrographic analyses have made it possible to identify one of the lithotypes mostly used in the manufacture of these percussion tools. The raw material is microgabbro, an allochthonous igneous rock that was probably retrieved from the near Ombrone River.
Finally, a second raw material was classified thanks to stereomicroscope observations associated with a comparison collection. This lithotype is anagenite, a local sedimentary rock that was exploited in order to shape other types of mining tools, probably involved in the first phase of the extraction process.

Exploring Ancient Mines: A Review of Groundstone Tools from Southern Italy

Francesco Breglia[1,4], Isabella Caricola[2,4], Felice Larocca[3,4]

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In this communication, we focused on groundstone tools found in important mineral-rich areas in Southern Italy. Notably, in particular the discovery of groundstone tools from Grotta della Monaca and Grotta del Tesauro mines in Calabria, well-known for the exploitation of iron and copper minerals, from the Neolithic to the Copper Age. We conducted a comprehensive use-wear analysis of the prehistoric groundstone tools, including grinding stones and hammerstones, using both low and high-power approach. Through this rigorous examination, we reconstructed the chaine opératoire of extraction and processing of iron and copper ores. Moreover, the exploitation of mineral resources in these contexts persisted into historical periods, with a transition in extraction methods, involving the introduction of metal tools and innovative technological approaches.

We conducted use-wear analysis on numerous other groundstone tools from Southern Italy, which are housed within museum collections, including those from Sardinia, Calabria, and Sicily. Some of these artifacts exhibit wear patterns similar to items found in other prehistoric mining sites. This prompts us to consider how technologies related to mineral extraction might have spread within the wider western Mediterranean Basin. However, the use-wear analysis also revealed that artifacts like grooved stone tools, commonly regarded as indicators of mining activity, were actually employed for different purposes. This challenges traditional interpretations and enhances our understanding of their functions.

Stone Tools in the Bronze Age Iberian Peninsula Copper Mining. Las Minillas Mine (Granja de Torrehermosa, Badajoz Spain)

Mark A. Hunt Ortiz[1] & Johan Ling[2]

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In the Iberian Peninsula, until the last decades, apart from the Chinflón mine, there had been no archaeological excavations in prehistoric metallic mines. Thus, the prehistoric character of the mines was inferred from the surface discoveries associated with the mining debris and, in general, with the ancient workings.
These superficial findings consist basically of stone hammers (quite frequently with a transversalgroove), dated generically to Prehistory or, with a more precise guess, considered as a model of the very first metallic mining technology, to the Chalcolithic period, the first metal roducingculture which emerged in the late 4th millennium B.C.
In the framework of the Maritime Encounters Project, https://www.gu.se/en/research/maritime-encounters, the recent archaeological excavations that have been carried out in the Las Minillas mine, in the municipality of Granja de Torrehermosa, province of Badajoz, SW of the Iberian Peninsula, discovered a clear example of the challenges presented in the archaeological research of a prehistoric copper mineralization, exploited in various phases, during Prehistory and historical times. One of the most characteristic features of this mine, also exploited in Roman and contemporary times, is the presence of an outstanding number of stone tools, which makes it one of the mines with the largest number of lithic mining tools in the Iberian Peninsula and Europe. And this fact, despite the enormous effects that the prehistoric mine remains suffered by later phases of exploitation and both due to biotic post-depositional factors and later phases of exploitation, and the recent use of mining debris for ballast, hydraulic use and also the continuous plowing.

Here, the results of the archaeological excavation campaigns carried out in Las Minillas are presented. It was possible to define three functional areas: habitation area, with the remains of very badly preserved huts; metallurgical area with furnace remains and slag nodules and, finally, the trench-type mining work, which have been dated to the Bronze Age. Associated with the mining works, near 900 lithic tools have been documented, which have been described, registered, geo-positioned and integrated in a GIS.

Mining and Ore-Processing Bone Tools from Great Orme Copper Mines

Olga Zagorodnia[1] & Harriet White[2]

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We present the preliminary results of a functional analysis of bone tools from the Bronze Age copper mine on Great Orme (North Wales, UK). The peak of active exploitation of the mine falls within 16-1300 BC. Over 35,000 bone tools, their fragments and manufacturing waste were unearthed since excavations began in 1987. 150 relatively well preserved examples were studied. The research methodology included visual examination of the tools in order to reconstruct their manufacturing technologies, the observation of manufacturing and use-wear traces using optical microscopy, and recording traces using a scanning electron microscope. Use-wear observations were confirmed by experimental data. The categories of tools considered here were those used for mining and ore-processing:

- Wedges made from tubular bones and might have been used for splitting particularly soft rock.
- Scoops made from animal scapulae and pelvic bones thought to be used for raking ore.
- Bone tools made mostly from ribs and tubular bones that were used for stirring and sweeping ore pieces in gravita tional processing.
- Tools made from tubular bones, blades and scapulae that were not directly involved in mining or ore-processing were identified as awls.

It can be argued that, along with stone and bronze tools used for copper mining and ore-processing, ancient miners actively selected bone for tools. The main qualities of bone blanks (shape and hardness) were well suited to certain operations. Similar types of bone tools have also been found in the other Bronze Age mining areas in Europe – Kartamysh (East of Ukraine), Kargaly (the Urals, Russia), and Schwaz/Brixlegg (North Tyrol, Austria). These findings show for the first time activities such as gravitational ore processing were carried out within the vicinity of the copper mine on Great Orme.

The Mining Tools from the Prehistoric Quarries of Serra Llarga (NE Iberia): Preliminary Results from Lithological, Techno-Morphological and Functional Approaches

Xavier Terradas[1], Clara Fernández[1], David Ortega[1] & Carles Roqué[2]

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The Montvell quarries are an archaeologicalsite specialized in the procurement of flint nodules for the production of knapped lithic tools. Excavations and studies carried out so far suggest an exploitation based on the recurrence of discrete episodes throughout Mesolithic and Neolithic times. These quarries are not an isolated case, but the surveys carried out along the entire length of Serra Llarga mountain range have allowed us to document a large number of quarries, registering more than 100 extraction fronts. The similarity of their formal characteristics and the type of associated mining tools lead us to propose a prehistoric chronology for the entire exploitation. All these discoveries highlight the importance of this mining complex in the supply of flint throughout prehistory in the Iberian northeast.

During the work carried out since 2015 we have recovered a significant number of mining tools (n=70), both on the surface and associated with the stratigraphic units of the area intervened archaeologically. The blanks of these tools are cobbles, without any type of modification, obtained from alluvial deposits outcropping near the slopes of Serra Llarga. The choice of blanks was based on their lithology, weight and morphology. Its lithologies correspond to tenacious rocks, mainly quartz, granite and metamorphic rocks such as hornfels and quartzite. A first morpho-technical approach reveals two types of tools according to their morphology and weight. Some could be identified as hammers linked to the heavier work of dismantling the calcareous strata that contain the flint nodules, whereas the others could correspond to lighter hammers used to detach the remains of limestone adhered to the surface of flint nodules.

We present here the results of the lithological, techno-morphological and functional study of these mining tools, as well as the data derived from an experimental program aimed at testing the hypotheses related to its use.

Processing Ochre in the Upper Palaeolithic: The Parpalló Cave Record

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Systematic use of colour, such as ochre, is a recurrent feature in Palaeolithic sites and is often regarded as evidence for complex behaviour. In Upper Palaeolithic contexts, numerous studies have focused on the geochemical characterisation of ochre related to cave art. However, only a few sites have been the object of comprehensive studies encompassing other functional or symbolic uses of ochre and aiming to reconstruct the technical steps involved in the acquisition, production, and use of this material. For instance, artefacts related to the production of colouring materials, such as ochre processing tools, ochre containers, and other ochre-stained artefacts from Upper Palaeolithic contexts have rarely been the primary focus of systematic studies. In this study, we present the first results of the technological analysis of ochre processing tools and ochre pieces found at Parpalló Cave, Gandía, Spain. This site has yielded one of the most important collections of Palaeolithic portable art, consisting of more than 5000 painted and engraved limestone plaquettes, virtually spanning the entire Upper Palaeolithic. Some of these plaquettes exhibit clear evidence for ochre processing. A collection of more than 200 ochre pieces, featuring a variety of modifications such as striations produced by grinding and scoring, was also found in the same levels. These findings provide an exceptional opportunity to gain insight into the technical processes involved in the production of ochre and the evolution of these cultural practices over time.

Fracture Patterns and other Traces on Macrolithic Tools from the Late/Final Bronze Age Mining/Ore Beneficiation Site of Vetriolo (Commune di Levico, TN, Italy).

Aydin Abar[1] & Elena Silvestri[2]

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Since 2020, the UMSt, soprintendenza per i beni e le attività culturali, Trento, the Ruhr-Universität Bochum and recently also the University of Innsbruck have been carrying out excavations in the mining/ore beneficiation site of Vetriolo (Commune di Levico, TN). First results allow the hypothesis that in the selected area, copper ores were mined and processed in the Late Bronze Age (Laugen-Melaun Period). Several dumps were identified in the area, which are connected to ore beneficiation.
Among the numerous finds from the excavations along the dumps, more than 200 records belong to the category of macrolithic tools, mostly crushing plates and both mobile and static parts of grinding tools. About 60 datasets are larger and smaller pieces of such stone implements.
The following questions will be addressed in the presentation: Which stone tools are present at the site and which are completely missing so far? What traces can be observed on the objects and what conclusions can be drawn from analysing the traces of use of the objects in the context of ore processing? During the lecture, the basic approach and an initial macroscopic examination of the finds will be presented for discussion.

Ochre and Hide Working during the Bronze Age at Dhaskalio, Southern Cyclades: First Insights from Use-Wear Analysis

Diego Capra[1,2], Isabella Caricola[3], Giulio Lucarini[4], Giuseppina Mutrie[5,6,7], Michael Boyd[8,9], Colin Renfrew[9]

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Dhaskalio is a small and steep-sided islet, 90 metres off-shore, at the western end of the island of Keros, in the southern Cyclades. Excavations, carried out between 2006-2008 and 2016- 2018, brought to the light the remains of extensive architecture on Dhaskalio, and a ritual centre of major importance in the Kavos area of Keros, both dated to the mid-third millennium BCE. Finds include a macro-lithic tool assemblage, including more than 1000 stone artefacts made from several rock types. In this study, we focus on a small set of stone tools found in Trenches A and C during the 2016-2018 field seasons. Macro-use wear analysis allows us to define them as multiple-use tools. The preliminary result of an ongoing use-wearstudy suggests that within the examined items, artefacts pertinent to mineral processing (crushing and grinding) may be identified, the mineral in question broadly classified as ochre. Furthermore, among certain stone artefacts, a correlation between ochre and hide processing was observed (i.e., hide in a soft-medium state). Use-wear patterns were identified through the presence of micro-polish observed under a metallographic microscope, set at magnifications ranging from 50x to 200x. Additionally, residues of red ochre are still present on the grinding stone tools. The results are important as they refine our understanding of the range of craft- processing activities undertaken at the site of Dhaskalio, which may have acted as a specialised centre for craft activity in the region.

Investigating Prehistoric Tempered Ceramics: Experiments on Slag Processing with Ground Stone Tools and Pottery Production

Julia Haas[1] & Roman Lamprecht[1]

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Slag tempered ceramics can be found in many Bronze Age/Older Iron Age sites in North and East Tyrol as well as Salzburg. This inner alpine phenomenon can be observed in different archaeological contexts like settlements, burial sites and areas associated with metallurgy, which can be interpreted as a cross-craft interaction between pottery production and copper mining.
Slag as a by-product of copper smelting was either further processed or deposited on the heap. While processing, different kinds of stone tools like hammerstones, anvil stones and lower/upper grindstones were used. The resulting traces of wear can be found on archaeological finds. To better understand these characteristic marks, experiments on crushing and grinding slag were carried out. In prehistory, the resulting slag sand was consequently used as temper for ceramics, which has been intensively discussed in literature. On the one hand, tempering with slag sand is seen as an identity feature of the mining community - on the other hand, it was given several functional aspects like the improvement of thermal shock resistance. Among crucibles, tuyères and casting moulds, predominantly cooking pots were tempered with slag sand, which in turn would not need extensive heat resistance during their usage. Although, non-functional identity aspects are widely considered nonessential, functional aspects have generally been proven in first experiments.
To address these theories and to further extend the already carried out studies, slag tempered ceramics were experimentally produced and tested under different conditions. The aim of this study was to better understand slag-processing using stone tools and the corresponding use-wear and the benefits of slag tempered ceramics.