ÖAW AUSTRIAN ACADEMY OF SCIENCES

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AUSTRIAN ACADEMY
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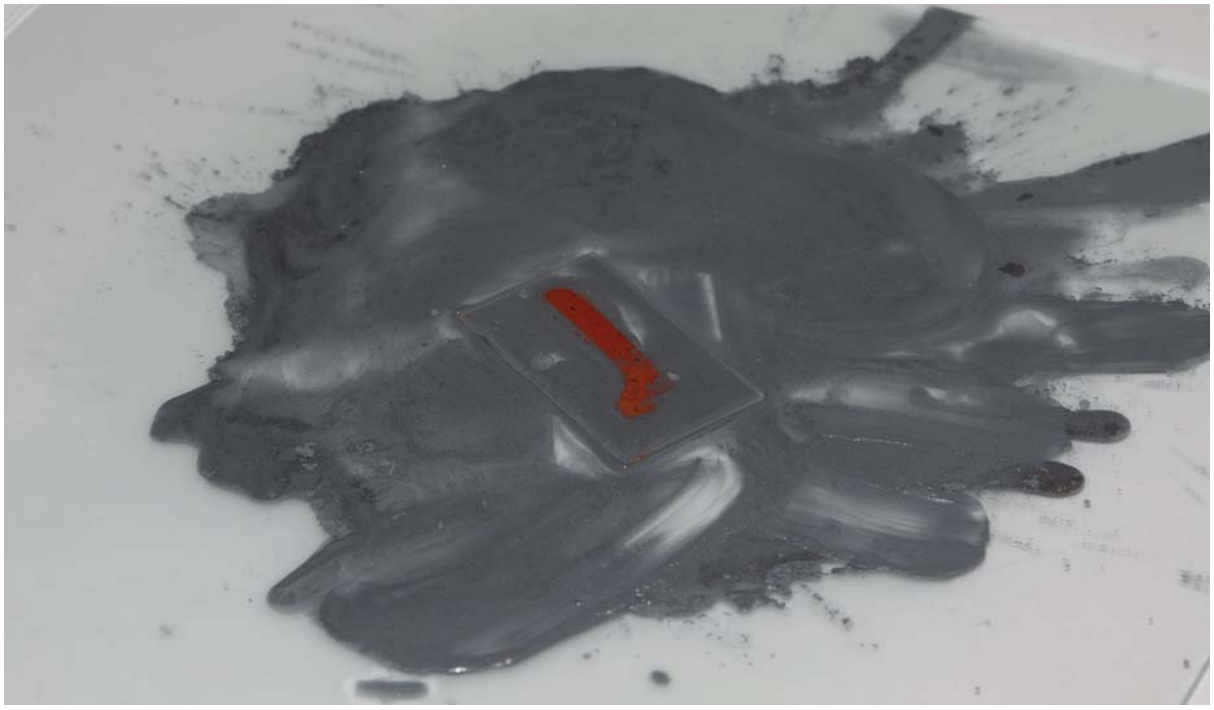

KICK-OFF WORKSHOP

ARCHAEOMETRY IN HISTORICAL ARCHAEOLOGY

PROVENANCE, TECHNOLOGY AND CONSERVATION

ABSTRACTS

Supported by
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ÖAI

ARCHAEOLOGICAL MORTAR, RENDERS AND WALL PAINTINGS: THE ADVANTAGES OF COMPREHENSIVE, IMAGE-BASED ANALYSIS

Johannes Weber – Anthony Baragona | Institute For Art And Technology/Conservation Science, University For Applied Arts, Vienna

Mortars, renders and plasters are some of the most widely studied materials when examining an archeological or historical building. Not only are they durable and ubiquitous, but they demonstrate many aspects of a society's material culture and technological development, such as access to certain materials and relative proficiency of technique. Mortars are compound materials; while their macro properties such as the bulk physic-mechanical, chemical and mineralogical parameters may be relevant to answer certain questions, they are greater than the sum of their parts. Therefore it is important to study not just the mortar's binder, aggregate, and additives but also the structural context between them. Moreover, each of these components has a story to tell, e.g. about the source materials, their processing, mixing and application, and the alteration they have experienced over time

While a wide variety of analytical methods exist to characterize a mortar, the most important of these preserve the spatial relationships between mortar constituents. Comprehensive, image-based analysis combines the power of petrography by polarizing light microscopy and scanning electron microscopy with micro-chemical phase analysis (SEM-EDX) with digital image analysis, all of which can be performed on the same polished thin section. Polished thin sections allow the study of the compositional and micro-structural inhomogeneities in both the layered structure of a mortar as well as within its constituent parts. In this way the artisanship of a wall painting, its binder and aggregate materials, and how the entire system has altered over time can be studied simultaneously. While this presentation focuses on these techniques, valuable information and confirmation can be gained by the use of additional topographic methods, demonstrated here with scanning FTIR.

This approach is illustrated here by its application to a number of mortars from Roman Antiquity. Included are multi-layer, painted wall plasters, Opus caementitium and waterproofing mortars, demonstrating that these techniques yield interesting results on both decorative and non-decorative, structural mortars.

ARCHAEOMETRIC STUDIES ON ANCIENT POTTERY: PRODUCTION SITES IN THE SELE RIVER PLAIN (SOUTHERN ITALY) FROM THE 7TH – 3RD C. BC.

Alberto De Bonis – Verena Gassner – Theodoros Ntaflos | University of Vienna
Franz Ottner | University of Natural Resources and Life Sciences (BOKU) Vienna

The Sele River plain is one of the most important archaeological areas in southern Italy and includes the Greek-Lucanian colony of Poseidonia/Paestum and the Etruscan-Italic sites of Pontecagnano and Fratte. The study of material culture provides important clues to explore the intercultural and socio-economic system of this area as it makes it possible to follow the circulation of products, trading and other contacts inside and outside the study area.

This work shows the first results of the archaeometric investigation of ancient ceramics and raw materials carried out for the Lise Meitner (FWF -Austrian Science Fund) research project. The aim of the project is the study of the provenance and technology of the ceramic production of the Sele plain from the 7th to the 3rd century BC, through an interdisciplinary approach between geologists and archaeologists of institutions from Austria (Universität Wien,

Universität für Bodenkultur Wien) and Italy (Parco Archeologico di Paestum, Museo Archeologico Nazionale di Pontecagnano, Università degli Studi di Napoli Federico II, Università degli Studi di Salerno, Università degli Studi del Sannio).
In the course of the project more than 350 ceramic samples from the major (Paestum, Pontecagnano, and Fratte) and minor sites in the territory (e.g., sacred areas) have been investigated via mineralogical-petrographic techniques. Samples of clays were also collected and analysed in order to find possible clay resources exploited in antiquity in the plain of Paestum and its surroundings.

THE ORGANIZATION OF THE LATE BRONZE AGE TO IRON AGE POTTERY PRODUCTION AT ARSLANTEPE (MALATYA) THROUGH ARCHAEOMETRIC ANALYSES

Pamela Fragnoli | Austrian Archaeological Institute, Austrian Academy of Sciences

The transition from the Late Bronze to the Iron Age in western Asia, i.e. the last centuries of the 2nd millennium BCE, is marked by one of the most dramatic crisis in the pre-classical eastern Mediterranean that led to the downfall of the Hittite empire in Central Anatolia. Despite the disappearance of the Hittite authority a number of neo-Hittite kingdoms emerged in eastern Anatolia and northern Syria and testify to an attempt by the new ruling class to preserve a cultural continuation with the imperial (LBA) Hittite tradition. In the last years, the excavation of these phases have been resumed at the site of Arslantepe in eastern Anatolia, ancient Malitiya/Meliddu, to inquire this transition and the neo-Hittite levels, mostly known through a series of monumental gates and buildings and the famous reliefs. This research is highlighting a strong continuity and internal developments in the ceramic production, as well as in other elements of the material culture.
86 ceramic samples of all main wares and types dated to the Late Bronze Age and Iron Age layers (1600-712 BCE) have been analysed through thin section petrography and XRFWDS geochemistry. When a neo-Hittite urban centre developed at Arslantepe in the Early Iron Age (1100 BCE), the raw material procurement patterns and the paste preparation modes drastically changed in contrast to the continuity suggested by typological data. The most common wares were produced with new recipes and southern metamorphic units started being extensively exploited besides the more traditional ones located east to the site.
From the Iron Age 2 (1000-850 BCE), there is an increase of foreign wares that recall traditions from eastern and western Anatolia, the Aegean, Cyprus, the Levant, Cilicia and Syria. However, most of these samples result locally produced using a few specialized recipes that belong to a long tradition of paste preparation dating back to the Late Chalcolithic and Early Bronze Age. These local imitations differ from the few imported exemplars also in the paste preparation, finishing and firing procedures. Contrary to the foreign wares, which exhibit well-finished and decorated surfaces, the more common ones show a high variety of recipes prepared with local raw materials independently from the functional shapes. The absence of peculiar pastes for cooking pots represents the greatest break with respect to the previous thousand-year long tradition at Arslantepe.

TWO IRON AGE BARREL BRACELETS. INVESTIGATION, TECHNOLOGY AND CONSERVATION

Irina Huller – Gabriela Krist – Kathrin Schmidt – Marta Anghelone | Institute of Conservation, University of Applied Arts Vienna

In fall 2012, two Iron Age barrel bracelets, named after their bulbous shape, were found together with 130 other prehistoric metal objects alongside a prehistoric route in the municipal area of Ehrwald, in the district Reutte, Tyrol (Austria). These bracelets are a product of the late Hallstatt period, around 600 BC. They are made out of an embossed bronze sheet with a lateral opening and mainly repousséd, punched and engraved patterns.
The bracelets were found in a unique condition; they had been intertwined through their lateral openings. Thanks to this, the overlapped areas are better preserved, whereas the remaining exterior surface is heavily corroded, fragile, slightly deformed and suffered more material losses.
The aim of the conservation treatment is the prevention of further material loss and the preparation of the objects for exhibition. It was chosen not to separate the two bracelets, since they are very fragile, and they stabilize each other in the current position.
In order to gain information useful for developing a proper conservation strategy the bracelets were investigated by X-ray diffraction (XRD) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX).
The corrosion products were identified as mushistonite ($CuSn(OH)_6$), copper-tin-hydroxides with traces of brochantite ($Cu_4(SO_4)OH_6$).
The surface was cleaned with deionized water, ethanol-wetted cotton swabs and mechanically with fine tools. To secure the corroded surface and fragile edges of the bronze sheet, an acrylic resin (Paraloid™ B44) was selected and applied in different concentrations. Additionally, silk fabric (Crepeline) and glass fibers were used to support the exposed edges and re-attached pieces.
After the successful conservation treatment the bracelets will be presented in an exhibition in Ehrwald.

MECHANICAL AND THERMAL PROPERTIES OF ARCHAEOLOGICAL POTTERY AS TOOLS FOR STUDYING FUNCTIONALITY

Vassilis Kilikoglou | Institute of Nanoscience and Nanotechnology, N.C.S.R. Demokritos

Archaeological – functional - pottery (i.e. transport or cooking vessels) come in a large variety of shapes and clay pastes as well as technologies of manufacture. The effect of the above parameters on material mechanical and thermal properties has received considerable attention in the archaeological literature, in attempt to explain functional limitations or pottery affordances. Indeed, the presence of specialized paste recipes for particular classes of pottery has frequently been related to the specific demands placed on cooking pots, metallurgical ceramics or transport amphorae. The most important parameters of the ceramic matrix that affect pottery performance are the presence of non-plastic inclusions and the miscrostructure developed, the latter being controlled by firing temperature and porosity. Furthermore, the shape and the dimensional characteristics of a ceramic vessel are as important as the matrix properties in its performance and for this reason it has always to be included in the relevant studies.
In this presentation all the above aspects will be discussed and their importance will be demonstrated with data on series of laboratory experimental specimens as well as computer simulations on archaeological pottery.

SCIENTIFIC INVESTIGATIONS ON LATE ROMAN MURAL PAINTINGS FROM LAURIACUM (ENNS)

Robert Linke – Farkas Pintér – Markus Santner | Bundesdenkmalamt

Archaeological rescue excavations carried out by the Federal Monuments Authority Austria in Enns (Upper Austria) revealed remains of a Roman villa from the 3rd cent. A.D. Due to a pressure of time, a number of render fragments were salvaged en bloc. In total, the find contained more than 2000 fragments of plaster. Conservation and restoration work, which was carried out in the Conservation Department showed mural paintings from four different time periods and of very high quality. Finally, an interdisciplinary project, which involved more than 25 archaeologists, conservators, scientists, art historians, curators and five different institutions gave interesting insights into cultural, social as well as technological and artistic aspects of that period.
This presentation focuses on the construction technique of the building as well as on the art technology of the mural decor. Microscopic analyses of the mortar show a sophisticated system of a combination of loam and lime binders. Further investigations identified pigments such as ochre, green earth, umbra and carbon black, which were applied in secco technique. For economic reasons, more expensive pigments, such as cinnabar and Egyptian blue, were used with a red base coat or with an organic binder. Comparisons with murals from Carnuntum, Saalfelden and Magdalensberg emphasize the high artistic quality of the paintings and widen the knowledge on painting technology of that time.
In 2017/2018 the fragments were on display at the Kunsthistorisches Museum and are now presented in the Museum Lauriacum in Enns.

ARCHAEOMETALLURGY - LIMITS AND POSSIBILITIES: INVESTIGATIONS ON EARLY MEDIEVAL METALWORK AND TRADE

Mathias Mehofer | Vienna Institute for Archaeological Science

Der Forschungsbereich Archäometallurgie des interdisziplinären Forschungsinstituts für Archäologie (VIAS) der Universität Wien betreibt intensive Forschungen im Bereich der archäometrischen Analyse an archäologischen Fundobjekten. Ziel ist die Beschreibung einer vollständigen Technologiekette vom Rohmaterial über die Verarbeitung zum Fertigprodukt, der Nachbehandlung und der möglichen Wiederverwendung bis hin zur Dokumentation der Veränderungen durch die Deponierung oder Bodenlagerung. Anhand ausgewählter frühmittelalterlich datierter Fallbeispiele zur Buntmetallverarbeitung und den daraus rekonstruierbaren Metallkreisläufen oder zur Eisentechnologie sollen verschiedene Fragestellungen zur technologischen Entwicklung während des Mittelalters in Ostösterreich beleuchtet werden. So lassen die umfangreichen rasterelektronenmikroskopischen Untersuchungen zahlreicher Scheibenfibeln und anderer Artefakte aus Buntmetall erkennen, dass es zwischen dem 8. - 9. Jh. n. Chr. zu einem Wechsel in den Versorgungsmöglichkeiten mit den Rohstoffen – Kupfer, Zinn, Zink und Blei – kam. Die archäometallurgischen Analysen sind dabei bestens geeignet, diese Resultate mit kulturhistorischen Ereignissen in Verbindung zu bringen.

FOOD PRODUCTION AND CONSUMPTION. THE ORGANIC RESIDUE ANALYSIS OF ARCHAEOLOGICAL MATERIALS

Alessandra Pecci | ERAAUB, Departamento de Historia i Arqueologia, Universitat de Barcelona

Archaeology provides important data on food practices in ancient times, both when written documents are present and when they are not enough or do not exist at all. Ceramic vessels, fireplaces, production installations for food, animal bones, botanic remains preserved in the archeological record can be recovered and studied in order to understand the food produced and consumed. Organic residue analysis provides further data on the theme. In fact, organic residues are preserved trapped in the matrix of archaeological porous materials. This is true both for ceramic vessels and the plastered surfaces of archaeological floors or vats of production installations. Also earthen floors absorb the substances that came in contact with them and preserve them for centuries and millennia. Thanks to the chemical analysis it is possible to identify the substances that fallon the floors or were contained in ceramic vessels and therefore understand the contents of ceramic vessels, their use and function; understand the use of space and the presence of activity areas in rooms and buildings, and establish whether production installations were for wine, oil or other organic substances.
I will show examples of the application of this research to archaeological sites in the framework of an interdisciplinary approach that integrates archaeology, organic residue analysis, and other researchers such as archaeozolology, and archaeobotany, to obtain a global vision of the food produced, consumed and transported at the sites, from the pre Roman to the Medieval period.

PROVENANCE ANALYSIS OF ANCIENT MARBLES - METHODS, CASE STUDIES AND RECENT INVESTIGATIONS

W. Prochaska and V.Anevlavi | Montanuniversität Leoben

The presentation focuses on fingerprinting techniques on ancient marbles and on our current activities in this field. Different analytical methods have been applied in the past to pinpoint the origin of marbles, however they often do not discriminate in sufficient detail between marbles of different provenance. Therefor we use a combination of different analytical methods and a statistical, multivariate evaluation of the data obtained. A material-specific classification can be conducive to understand if the workshops of an area used marbles of acceptable quality from a local quarry or quarrying areas or if they used imported marbles in or without combination with local ones.
Our approach using a combination of the well-established Isotope analysis with trace element analysis of a series of trace elements analyzed by AAS or ICP-MS and the analysis of micro inclusions of the marbles will be demonstrated by means of selected examples. Recent methodological developments will be discussed as well as future analytical possibilities.
A recently started project (Provenance Matters - A multi-proxy Approach for the Determination of White Marbles in the Roman East) concerning marble production and trade during urbanization on the Roman East will be presented. Recent fieldwork and sampling was conducted so far in the SE Rhodopes of Bulgaria where the Roman Villa Armira (1st 4th century) is one target of investigation within this project.

EXAMINATION OF A LATE ANTIQUE STONE RELIQUARY

Roman Sauer | University of Applied Arts Vienna
Daniel Oberndorfer | Austrian Archaeological Institute, Austrian Academy of Sciences

As part of a multidisciplinary project focusing on a late antique pilgrimage sanctuary, fragments of a stone reliquary were examined in terms of manufacturing technique, composition and provenance. The reliquary was found below the altar of one of the five churches of the pilgrimage sanctuary on the Hemmaberg during an excavation in 1992. The first part of the lecture is centred on the examination of the manufacturing technique and the design of the reliquary. Since remains of painted plaster were found next to the stone fragments during the excavation, the assumption was obvious that these may have been an ornamental part of the reliquary. In order to reassess this theory, thin sections of the mortar fragments were prepared in order to subsequently examine the structure and composition by microscopic methods.
The characterisation and provenance interpretation of the rock used for the reliquary as well the results of the petrografical plaster analyses are the topics of the second part of the lecture. Finally our conclusions based on both, analysing the manufacturing technique and thin sections, will be discussed.

NON-DESTRUCTIVE AND NON-INVASIVE MATERIAL ANALYSIS OF ARCHAEOLOGICAL FINDINGS FROM EPHESOS

Manfred Schreiner | Institute of Science and Technology in Art, Academy of Fine Arts and Institute of Chemical Technologies and Analytics, Technische Universität Wien

In the last decades a particular collaboration between historical, philological and cultural studies on one side and natural sciences on the other side has been developed and a close co-operation between e.g. archaeology, art history, or conservation-restoration with physics, chemistry or biology seems fairly well established. The investigations of the physical properties and the material composition is used increasingly in addition to the visual and stylistic analysis, in order to allocate an object to a particular historic or prehistoric context, to determine the correctness or incorrectness of the claimed provenance or to explore the technology used for manufacturing an object. The base therefore is to find out, when new materials, techniques or technologies have been introduced or others came out of use. However, the analysis of a great number of dated or precisely dateable artefacts is necessary and enables us to set up a »terminus post quem« or a »terminus ante quem« for e.g. pigments used for paintings or metal alloys for coins and also for methods developed or even invented for materials processing or fabrication.

In the presentation the applicability of so-called non-destructive/non-invasive analytical techniques such as X-ray fluorescence analysis (XRF), reflection infrared (FTIR) and Raman spectroscopy to archaeological glass and coins from Ephesos will be discussed and results obtained in various projects in cooperation with the ÖAI and the Austrian Academy of Sciences presented:

- Hanghaus 1 in Ephesos – Die Gläser, B. Czurda-Ruth. Verlag der Österreichischen Akademie der Wissenschaften, Wien 2007
- Der Münzschatz von Becin, R.H. Ünal, F. Krinzinger, M. Alram, S.Pfeifer-Tas. Verlag der Österreichischen Akademie der Wissenschaften, Wien 2010
- Sylloge Nummorum Sasanidarium Paris-Berlin-Wien. Verlag der Österreichischen Akademie der Wissenschaften, Wien, Bd. I (M. Alram, R. Gyselen), 2003; Bd. II (2012), Bd. III/1 und 2 (N. Schindel), 2004.

- Die Frühzeit des Friesacher Pfennigs, M. Alram, R. Härtel, M. Schreiner. Verlag der Österreichischen Akademie der Wissenschaften, Wien 2002.

Furthermore, the Centre of Image and Material Analysis in Cultural Heritage (CIMA)[1] will be introduced, which could be founded in 2014within the HRSM-project of the Ministry of Science, Research and Economy.

NEUTRON ACTIVATION ANALYSIS FOR PROVENANCING AT THE ATOMINSTITUT, TU WIEN

Johannes Sterba | TU Wien

For more than 50 years, the TRIGA Mk II nuclear reactor at the Atominstitut has been in operation as a research reactor. Neutron Activation Analysis (NAA) has been one of the research topics under investigation from the very beginning of the institute. During the SFB SCIEM2000, a large database of chemical fingerprints of volcanic material has been accumulated at the Atominstitut, leading to the successful provenancing of over 500 pieces of pumice from archaeological excavations in the Mediterranean. In the last 8 years, the focus of provenancing studies at the Atominstitut has been widened to include ceramics. In close cooperation with Prof. Mommsen the statistical data evaluation of chemical fingerprints has been refined. A case study of currently analysed data will be presented.

[1] https://hrsm.cvl.tuwien.ac.at/