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**NARNIA**

NEW ARCHAEOLOGICAL RESEARCH NETWORK FOR  
INTEGRATING APPROACHES TO ANCIENT MATERIAL STUDIES



University of Cyprus

Archaeological Research Unit

INTERNATIONAL CONFERENCE

**INTERDISCIPLINARY STUDIES  
OF ANCIENT MATERIALS  
FROM THE MEDITERRANEAN**

Nicosia, 17-19 September 2014

University of Cyprus



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**A B S T R A C T S**

The international conference *Interdisciplinary Studies of Ancient Materials from the Mediterranean* is the concluding act of the multi-partner, interdisciplinary research network entitled *New Archaeological Research Network of Integrating Approaches to ancient material studies (NARNIA)*. NARNIA is a Marie Curie Initial Training Network which falls under the People programme of FP7 (Grant agreement no.: 265010). The project provided the ground for the collaboration of six academic institutions, one research centre and two enterprises. These are the University of Cyprus, which is the coordinating institution, Vrije Universiteit Brussel, Université Paris-Ouest, Hashemite University, University College London, University of Sheffield, the National Centre for Scientific Research “Demokritos”, G. M. EuroCy Innovations Ltd and Thetis Authentics Ltd. The NARNIA network is a collaboration of researchers who are engaged in the holistic study of ancient materials to facilitate a better understanding of the strategies associated with the production and the consumption of material culture and its impact on the historic and ancient environment. The *raison d'être* of this well-structured research network was to improve the career prospects for employment of our twenty fellows by enabling them to develop lab-based skills needed for the study of ancient materials. At the same time the NARNIA network has been contributing to the history and archaeology of the eastern Mediterranean basin, a region of great historical, cultural and geopolitical significance.

In order to achieve this aim, the partner institutions have organised an impressive series of research and training activities. During its four-year lifespan, NARNIA offered 26 training courses in six different countries (Belgium, Cyprus, France, Greece, Jordan and the UK), on the interdisciplinary study of ancient pottery, glass, metals, architectural decoration and building materials, as well as dating and the palaeo-environment, and the application of portable X-ray fluorescence spectroscopy in the field of archaeology. All NARNIA training courses were open to researchers outside the network, and the 16 Early Stage Researchers and four Experienced Researchers recruited by the NARNIA partnership had the opportunity to communicate and interact with scholars and researchers from different disciplines and research backgrounds.

This has been an adventurous and memorable journey for us, and we cannot think of a better way to complete it than the organisation of this international conference, where we can present our work outside our network and meet old and new friends for the establishment of future contacts. We hope that this will be an important occasion for new and established researchers to share their research in an international forum and to exchange ideas on the latest interdisciplinary approaches, analytical techniques and methodologies for the integrated study of ancient materials, technologies and the environment.

Professor Vasiliki Kassianidou,  
NARNIA Project Coordinator  
&  
Dr Maria Dikomitou-Eliadou  
NARNIA Project Manager

Archaeological Research Unit, University of Cyprus  
Nicosia, September 2014



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## Organising committee

Prof. Vasiliki Kassianidou (NARNIA project coordinator)  
Archaeological Research Unit, University of Cyprus

&

Dr Maria Dikomitou-Eliadou (NARNIA project manager)  
Archaeological Research Unit, University of Cyprus

## Scientific Committee

Dr Eleni Aloupi-Siotis, Thetis Authentics Ltd, Greece

Dr Fadi Balaawi, Hashemite University, Jordan

Dr Yannis Bassiakos, National Centre for Scientific Research “Demokritos”, Greece

Dr Peter Day, University of Sheffield, UK

Dr Maria Dikomitou-Eliadou, University of Cyprus, Cyprus

Dr Roger Doonan, University of Sheffield, UK

Dr Demetrios Eliades, G.M. EuroCy Innovations Ltd, Cyprus

Prof. Anne-Marie Guimier-Sorbets, Universite Paris-Ouest, France

Prof. Vasiliki Kassianidou, University of Cyprus, Cyprus

Dr Vassilis Kilikoglou, National Centre for Scientific Research “Demokritos”, Greece

Prof. Marcos Martín-Torres, University College London, UK

Prof. Demetrios Michaelides, University of Cyprus, Cyprus

Mr George Milis, G.M. EuroCy Innovations Ltd, Cyprus

Prof. Karin Nys, Vrije Universiteit Brussel, Belgium

Dr George Papasavvas, University of Cyprus, Cyprus

Prof. Thilo Rehren, University College London Qatar, Qatar

*Abstracts  
for Oral Presentations*



**Annita ANTONIADOU**

School of Geography, Archaeology and Palaeoecology

Queen's University Belfast

UK

Email: aantoniadou01@qub.ac.uk

### **Geoarchaeology or how to set the archaeological story straight**

Geoarchaeology is a fairly new and growing science which integrates archaeology, geoscience, and environmental approaches to spatial patterning in the evaluation of the archaeological record. Until recently, archaeological research in the Mediterranean Basin has been anthropological and historical in orientation, focusing on cultural history, cultural evolution, and cultural processes. During the past decade however, there has been increasing collaboration between archaeologists and earth scientists. Though for areas such as North Africa, the emergence of geoarchaeology has not really impinged on archaeological investigations, and despite the advances in dating, and other scientific techniques assisting in gathering the maximum possible information, there are many intriguing riddles still waiting to be solved.

This paper presents examples of reconstructed Palaeolithic sites in Libya, using geoarchaeology. Robust chronological frameworks are fundamental to our understanding of past events and processes and the rates at which these occurred especially when they linked geological events to human activity. The author's latest research has revealed and dated a wide distribution of *Homo sapiens* across the Libyan coast, during the Quaternary. The work focused on determining the chronological contexts of these sites and their content, understanding site formation and reconstructing paleolandscapes. Uranium-series and Radiocarbon dating along with micromorphological and palynological analysis provided high-precision age estimates that permitted correlation of mineral formation with sub-stage climate episodes in the area early humans were operating in. The paper aims to demonstrate the importance of geoarchaeology for tracing environmental change through the interpretation of site formation processes and set a chronological background.



**Lydia AVLONITOU\***

Maison Archéologie et Ethnologie René Ginouvès  
Université Paris-Ouest Nanterre la Défense  
France  
Email: lydia.avlonitou@mae.u-paris10.fr

### **Pigments and colourants:**

#### **An inside look at the painted decoration of the Macedonian funerary monuments**

The funerary monuments located in the area of ancient Macedonia (northern Greece), namely the famous Macedonian tombs, as well as decorated chamber and cist tombs, form a remarkable source of evidence on late Classical and Hellenistic painting, since they preserve simple or more intricate compositions executed in the techniques formulated at the end of the 5<sup>th</sup> and during the 4<sup>th</sup> century BC.

In the framework of the NARNIA ITN Project, an integrated approach to the study of the painted decoration of these tombs, combining archaeological and archaeometric research, has been conducted. The two main objectives of this research project are the study of the vegetal and geometric decorative patterns, and the physicochemical investigation of the materials and techniques employed in their creation.

In order to decrypt the synthesis of a wall painting, various analytical methods of examination have been applied. In particular, the surface and the stratigraphy of the samples were examined with optical polarised light and scanning electron microscopy, while the combined application of micro-chemical tests,  $\mu$ -XRF Spectroscopy, EDS, XRD and FTIR spectroscopy resulted in the identification of the various materials that comprise the consecutive layers.

In this paper, the focus is given primarily on the palette of the ancient painter, namely the pigments and colorants used. The information obtained both by the analysis and the bibliography is interpreted in order to reveal their variety along with the differences in their application and occurrence in the monuments.

\* NARNIA Project Early Stage Researcher

**Kathleen BENNALLACK**

Department of Anthropology  
University of California San Diego  
USA  
Email: kbennall@gmail.com

**pXRF analysis of flint tools changing through time  
in a single Neolithic neighborhood**

XRF trace-element sourcing of archaeological flint tools is still in its infancy, and is generally still considered largely unreliable, although some researchers have had success. However, little work has been attempted on tracking change through time in lithic makeup, though it has been noted repeatedly that later flint tools tend to be made on inferior materials. We attempt to quantify this difference and determine whether it may have more than simply functional significance (such as the commonly-suggested depletion of ideal sources over the centuries.)

This study is the first phase in an attempt to chemically characterize the Neolithic (c. 10,000-7000 BP) tool assemblages of three sites in southern Jordan. The three sites – Wadi Fidan 1, 61, and 51 date roughly to the Middle and Late Pre-Pottery Neolithic B, early Pottery Neolithic, and late Pottery Neolithic/Early Chalcolithic, respectively, and are located within a few minutes' walk of one another. There is quite probably some overlap in their occupational timelines. Among them they span at least 2,000 years of history, and possibly more. They also exhibit marked differences in the makeups of their tool assemblages; not only in tool types, but in flints chosen for knapping. Rather than attempting to directly source the flint, we attempt to answer the question of whether the flints are significantly chemically different from one another, whether their intra- or inter-site variation (if any) is greater, and what purpose, functionality, and meaning this may have had for the people who made and used them.

**Olivier BONNEROT\***

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: bonnerot.olivier@ucy.ac.cy

### **Technology of the Early Christian wall mosaics of Cyprus**

Early Christian churches and basilicas in Cyprus, and the eastern Mediterranean region in general, used to be richly adorned with costly floor and wall-mosaics. The latter constituted of fine square pieces called tesserae, which were set in a plaster attached to the wall. Few wall mosaics have survived in a good preservation state like the one in the Angeloktisti church at Kiti (Larnaca district), but fragments and detached tesserae are found in many sites, such as Kourion, Kalavassos, Polis Chrysochous, Amathous, and Yeroskipou. The fact that the majority of the tesserae are made of coloured and opacified glass, bears ample testimony to the perfection in craftsmanship achieved by ancient glassmakers, and gives insight into the trade of raw materials in the eastern Mediterranean region. The plaster is crucial for the good conservation of the mosaic and had to be adapted depending on the local weathering factors (humidity, variation of temperatures) and the locally available materials. The study of both artificial materials allows the description of the organisation of mosaic production in Early Christian Cyprus. Comparison with other objects made from similar materials show the use of an original technology, similar to what is found in other sites of the eastern Mediterranean region.

\* NARNIA Project Early Stage Researcher

**Andrea CEGLIA\***

Department of Applied Physics and Photonics  
Vrije Universiteit Brussel  
Belgium  
Email: aceglia@vub.ac.be

**Peter COSYNS**

Department of Art Sciences and Archaeology  
Vrije Universiteit Brussel  
Belgium  
Email: pcosyns@vub.ac.be

**Wendy MEULEBROECK**

Department of Applied Physics and Photonics  
Vrije Universiteit Brussel  
Belgium

**Karin NYS**

Department of Art Sciences and Archaeology  
Vrije Universiteit Brussel  
Belgium  
Email: Karin.Nys@vub.ac.be

**Herman TERRYN**

Department of Electrochemical and Surface Engineering  
Vrije Universiteit Brussel  
Belgium  
Email: hterryn@vub.ac.be

**Hugo THIENPONT**

Department of Applied Physics and Photonics  
Vrije Universiteit Brussel  
Belgium  
Email: hthienpo@vub.ac.be

**Shedding light onto Cypriot glass industry: Consumption and distribution patterns**

In this work, the glass composition of the material excavated in three different Cypriot Early Christian basilicas is presented. The basilicas under study are Agioi Pente in Yeroskipou, Agios Nikolaos in Maroni Petrera and the three basilicas at Kalavastos Kopetra. Early

\* NARNIA Project Early Stage Researcher

Christian basilicas provide a well-defined time window between the 4<sup>th</sup> century and mid-7<sup>th</sup> century, when Cyprus got ravaged by waves of Arab invasions. During this period, glass industry was organised in a multi-leveled structural organisation. There were large production facilities in the Levant and Egypt, which are normally called “primary workshops”. Glassmakers were able to produce 8-20 tons of glass per batch. This glass was then broken into rough cut blocks and shipped towards the entire Empire to supply the secondary workshops where it was remelted and shaped into consumers’ goods for the market. Cyprus owes its strategic position in the eastern Mediterranean to the proximity to the coast of Syria, Palestine and Egypt and the predominant sea currents in the eastern Mediterranean. The island is therefore an excellent research area from which to approach a deeper insight into glass distribution and consumption patterns in the eastern Mediterranean antiquity. The results of this study provide new evidences on the compositions of the glass circulating in Late Antique Cypriot sites.

**Andreas CHARALAMBOUS\***

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: anchar@ucy.ac.cy

### **A diachronic study of Cypriot copper alloy artefacts**

A significant number of copper alloy artefacts coming from the Late Bronze Age sites of Limassol and Pyla *Kokkinokremos*, the Early Iron Age cemetery of Palaepaphos *Skales* and the Iron Age Necropolis of Salamis, was analysed using a portable handheld XRF for the determination of the alloy types used.

The results indicate the abundance and the gradual increase of tin in the alloy used to produce weapons in the case of Limassol, the shortage of tin and the use of scrap metal in the case of Pyla *Kokkinokremos*, the abundance of tin in Palaepaphos in the Early Iron Age, and its use in some cases in a higher percentage in order to produce objects whose colour imitates that of gold artefacts, and finally, the extensive use of tin for the production of a large number of various types of objects in the case of the Necropolis of Salamis.

Furthermore, it is clear that lead was added deliberately into the alloys to improve their cast ability. The presence of arsenic in a number of artefacts is interpreted as evidence for the use of recycled metal deriving from artefacts dating to previous periods. Iron and zinc are believed to be non-intentional additions to the alloys, resulting from the smelting process and originating either in the copper ores or in the flux. Finally, in the case of Salamis, the chemical analysis revealed the existence of a very limited number of early brass (alloy of copper and zinc) artefacts.

\* NARNIA Project Experienced Researcher

**Elisavet CHARALAMBOUS\***

G.M. EuroCy Innovations Ltd, and  
Department of Electrical and Computer Engineering  
University of Cyprus  
Cyprus  
Email: charalambous.elisavet@ucy.ac.cy

### **Un-dusting the foundations of compositional analysis approaches of ceramic archaeological data**

The use of multivariate compositional data in archaeology obtained from various analytical methods is extensive. Archaeological data is notoriously complicated and often comes in multiple forms and types; with compositional data being one of the main types. This paper focuses on the analysis of compositional ceramic archaeological data. It is essential to consider the characteristics of heterogeneity in order to utilise the greatest amount of information possible. With this consideration in mind, we explore the utilisation of trace elements in data analysis considering that, generally, the highly varying elements have the greatest of the impacts on the multivariate data ensemble; these elements do not necessarily depict elements with high concentrations.

Compositional data are closed relative data where information is given by the ratios between components. Therefore, chemical elements do not vary independently, and concentration based approaches to data analysis may lead to faulty conclusions. Mathematically, chemical compositions define points in the Aitchison geometry on the simplex, and not in the usual Euclidean space for which copious classical statistical methods are designed. Calculations which explicitly or implicitly are based on Euclidean distances may give misleading results; including simple calculations like the computations of mean or standard deviation. Fortunately, appropriate log-ratio methods manage to overcome this problem by transforming the multivariate data from the simplex to the usual Euclidean space. Within the context of this paper we also discuss the effectiveness of the additive, centred and isometric log ratio techniques. For comparison purposes the same real archaeological data is used.

\* NARNIA Project Early Stage Researcher

**Artemi CHAVIARA\***

THETIS Authentics Ltd  
Greece  
Email: chaviaraa@gmail.com

**Eleni ALOUPI-SIOTIS**

THETIS Authentics Ltd  
Greece  
Email: aloupie@thetis.gr

### **The story of a soil that became a glaze: Chemical and macroscopic fingerprints**

The study addresses the longstanding archaeological question concerning the identification of clay sources in Attica, adequate for the production of the “clay-paint” used for the black glaze (BG) decoration of Attic pottery. The first stage of the project focused on the direct analytical comparison of archaeological BG ceramic sherds from recent excavations at the Acropolis and at Keramikos with modern BG specimens, produced in the laboratory following the original process of the iron-reduction technique. The laboratory BG specimens were produced from 36 clay-soil samples collected from various locations in Attica (Panakton, Parnes, Hymettus, Mesogaia, Laurion, and Athens). The applied research methodology, which includes  $\mu$ -PIXE, XRF and SEM/EDX, has led so far to the identification of four clay deposits that seem to be compatible with the ancient BG samples in terms of macroscopic appearance, micromorphology and chemical composition.

Nevertheless certain special features of the ancient BG samples, such as the characteristic micro-cracks and colour shades, observed also on specimens in prominent museum exhibits, seem to correlate with specific clay deposits. In addition, a correlation was observed in trace element comparison between modern and ancient BG samples. In order to study further these differentiating features, a group of ~100 geometric, archaic and classical decorated sherds from the 19<sup>th</sup> century Acropolis excavations documented by Graef and Langlotz (*Die antiken Vasen von der Akropolis zu Athen*, Berlin 1909–1933), and now held at the National Archaeological Museum of Athens, were analysed in-situ with the use of a Bruker handheld-XRF system. The combined comparison of macroscopic and trace element features between ancient and modern BG samples offers a new tool for the understanding of the organisation of pottery production in ancient Attica.

\* NARNIA Project Early Stage Researcher



**Anastasia CHOLAKOVA\***

Institute of Archaeology  
University College London  
UK, and  
National Institute of Archaeology with Museum  
Bulgarian Academy of Sciences  
Bulgaria  
Email: a.cholakova@ucl.ac.uk

**Composition, distribution, and use of glass in the 6<sup>th</sup> century AD in the Lower Danube region: Recognising changes – understanding the change**

This paper stems from a project conducted within the NARNIA research network, aiming at an integrated archaeological and scientific study of glass vessels from the Balkan territories of the Late Roman and Early Byzantine Empire. Based on well dated assemblages within a particular regional setting, the present research is able to identify a range of changes in different aspects of glass production and consumption, which took place in the early 6<sup>th</sup> century AD. The intention of this presentation is to explore these phenomena in an attempt to interpret them within the overall socio-cultural and economic processes of Late Antiquity.

The multidisciplinary approach allows the recognition of changes at different ‘levels’ of the inquiry. The chemical analyses of glass demonstrate the introduction of a new compositional group in the region which marks both changes of the raw materials procurement/ location of production, and changes of the glassmaking recipes. Moreover, this group is strongly prevailing in the studied assemblages, in contrast to the evidence for the 5<sup>th</sup> century diversified glass supplies. The repertoire of the vessel shapes is quite restricted, pointing at a shift in the usage, and techniques of manufacture seem rather standardised. Although a detailed study can define all these changes, merging their meanings into the general narrative of the late antique transformation still may be elusive.

\* NARNIA Project Early Stage Researcher

**John CHRISTODOULAKIS\***

Laboratory of Archaeometry, Institute of Nanoscience and Nanotechnology (INN),  
National Centre for Scientific Research “Demokritos”

Greece

Email: physjohn@yahoo.gr, christoi@ims.demokritos.gr

### **Luminescence dating and the palaeo-environment in SW Peloponnesus**

South Peloponnesus, and specifically Mani peninsula, located at southwestern Greece is considered among the most challenging areas for studying past environmental changes, especially during the Upper Quaternary. This is because of its long and complex coastal zone, its active local tectonic regime, as well as its nodal position between three continents. Rich sequences of terrestrial and marine sediments classified by the stratigraphic sense are found in the area. These sedimentary deposits, fluvial or coastal, are an excellent repository of environmental changes that have occurred during the past 170,000 years at least, thus offering the possibility of extensive and in-depth study of these changes.

Here, we present dating results obtained by employing optically stimulated luminescence dating technique, combined with the single-aliquot regenerative dose protocol. These results concern samples collected by a fluvial deposit, situated at an area called Diros where known caves are found. Specifically, seven layers of this stratigraphic deposit were dated and they revealed ages extending from 65,000 to 165,000 years ago. An unforeseen result was that these ages do not follow the stratigraphy of the deposit. Instead, a type of reversion is revealed.

In addition, we attempt a reconstruction of atmospheric circulation patterns over the Late Quaternary, by considering the contribution of airborne dust transferred from distant areas to the local sedimentary record. To the best of our knowledge, it is the first time in the literature that such an attempt is made. Our results are hereby presented and discussed.

\* NARNIA Project Early Stage Researcher

**Sara E. COLE**

Department of History

Yale University

USA

Email: sara.cole@yale.edu

**Miniature glass portrait sculpture in the ancient Mediterranean:  
Egyptian origins and Graeco-Roman developments**

During the Roman Empire, the genre of miniature glass portrait sculpture (i.e. sculpture in the round of either humans or deities, measuring approximately 2-8cm in height) enjoyed a significant resurgence in popularity. In my talk, I will argue that to best understand this resurgence we must fully appreciate the inspiration that Roman glassmakers derived from Egypt's New Kingdom in the mid 2<sup>nd</sup> millennium BC, where miniature glass portraits first appeared in the Mediterranean. In particular, these New Kingdom portraits (which were probably attached to small bodies, unfortunately non-extant today) were characterised by their idealised manner of depicting rulers and gods, and it is this tendency that most shows through in the Roman period where we find, for example, miniature glass portraits of the emperor Augustus, some of which were likely made in Egypt itself.

My talk will focus in particular on the epoch that served as the key bridge between the glass portrait artists of these two periods - the Ptolemaic dynasty (ca. 323-30 BC). At the end of Egypt's New Kingdom (ca. 1070 BC) glassmaking in the Mediterranean went into sharp decline, and for the next several hundred years no miniature glass portraiture is known. During Egypt's Late Period, in the 1<sup>st</sup> millennium BC, miniature glass portrait sculpture reappears in small numbers, but it was under the Ptolemies that this genre experienced the crucial revival – as evidenced by a small number of examples – that would link ancient Egyptian glassmaking to that of Imperial Rome.

**Aurélie CUÉNOD**

School of Archaeology and Ancient History  
University of Leicester  
UK  
Email: ac565@le.ac.uk

**David J. MATTINGLY**

School of Archaeology and Ancient History  
University of Leicester  
UK  
Email: djm7@le.ac.uk

### **Copper in the pre-Islamic Sahara – a Mediterranean provenance?**

Excavations and surveys in the Libyan Sahara have shown that the Garamantian civilisation (a complex society pre-dating the expansion of Islam) produced and consumed metals from the last centuries of the first millennium BC, if not earlier. Both copper and iron artefacts, mostly small fragments of ornaments, sheets, pins, etc., have been recovered from settlement sites and, to a lesser extent, burials. Metalworking activities are also attested from at least two sites, Old Jarma, the Garamantian capital, and Saniat Jibril, one of its satellite settlements, in the form of slag, hearths and ingot moulds. However, there is so far no evidence of smelting activities and the source of the metal used by the Garamantes is unknown.

While contacts and trade between the Mediterranean and the Garamantes is now clearly established, notably by the abundance of Roman ceramics in Garamantian levels, it is not known whether metals followed the same routes. This paper will present the initial results of an analytical program launched as part of the Trans-Sahara Project to assess the provenance of the Garamantian metal. Chemical and isotopic analyses of the copper artefacts are underway to establish the signature of the Garamantian metal. In parallel, a database of available chemical data from North and West Africa is being assembled, which, when compared to the Garamantian metal, should help understand metal movement in the region. In particular, we are trying to assess whether some of the copper used by the Garamantes may have been recycled Roman metal.

**Peter M. DAY**

Department of Archaeology

University of Sheffield

UK

Email: p.m.day@sheffield.ac.uk

### **Ceramic Analysis and Critical Mass:**

#### **New evidence for longevity of major pottery production centres in the Aegean**

The last 50 years in Aegean ceramic analysis have witnessed radical changes. We might cite the move from an almost exclusive interest in provenance to a concentration on the reconstruction of technological practice. In addition, as researchers have reached further back into the past, ideas such as ‘complexity’ become less well defined. Those attempting to compare the existence of ‘specialisation’ with a simpler progenitor have often been surprised by the nucleated production of pottery and its wide exchange from the very earliest pottery in the Aegean.

Such changes are not only context-specific; instead they reveal general conclusions that require our attention. As ceramic analysis, especially petrographic approaches, become increasingly an accepted part of the archaeological process, some new patterns are emerging: the existence of production centres which have a very long history, often over millennia. Such centres have been identified recently in Crete, the Cyclades and the Mainland of Greece.

The longevity of these production centres, identified mainly by their repeated use and manipulation of characteristic raw materials, challenges us to define what is *different* about the ceramic system over time, when the same production centres are dominant. The longevity provokes a reconsideration of the importance of consumption processes, the scales of production, multiple levels of pottery distribution and the way in which the landscape is incorporated into everyday life.

**Maria DIKOMITOU-ELIADOU**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: m.dikom@ucy.ac.cy

**Artemis GEORGIYOU**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: artemis.georgiou@ymail.com

**Athanasios K. VIONIS**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: vionis@ucy.ac.cy

**Cooking fabric recipes:**

**An interdisciplinary study of Cypriot cooking pots of the Late Bronze Age**

This paper discusses the first results of a large-scale interdisciplinary research project initiated in 2011 on ancient cooking pots from Cyprus, as an indispensable source of information for approaching the ancient society that used them, and cooking pot technological and socioeconomic change. Late Bronze Age cooking pots from the urban centre of Kalavassos *Ayios Dhimitrios*, and the contemporary, short-lived settlements of Pyla *Kokkinokremos* and Maa *Palaeokastro* are examined comparatively vis-a-vis typological classifications, fabric composition and the technology of their production. To that end, ceramic petrography is employed as the principal method for the mineralogical and technological characterisation of the cooking pot samples under study.

The inter-type and inter-site compositional and technological variability and similarities are presented in an attempt to associate them with regional geology, the production and distribution of cooking pots, the character of the settlements, possible links among these settlements and other regional centres, and the historical and social processes at the final

stages of the Late Bronze Age. This is a novel attempt to study cooking pot fabrics and the technology of cooking pot production, contextualising this ceramic corpus within their social and historical milieu.

**Chloë N. DUCKWORTH**

School of Archaeology and Ancient History  
University of Leicester  
UK  
Email: cd227@le.ac.uk

**David J. MATTINGLY**

School of Archaeology and Ancient History  
University of Leicester  
UK  
Email: djm7@le.ac.uk

**From the Mediterranean to the Libyan Sahara. Chemical analyses  
of Garamantian glass.**

This paper will present the preliminary results of the chemical analysis of Roman and Islamic glasses recovered from settlement, production and burial contexts in the Wadi al-Ajal oases of the Libyan Sahara. The material includes a number of objects from excavation and survey of Jarma and surrounding sites. Jarma, the capital of the Garamantes, lay outside the Roman Empire but imported vast quantities of luxury goods from it (the diagnostic glass fragments recovered from the area number in their thousands, including a significant proportion of complete vessels). Also included in the analysis is a small amount of comparative material from two sites in Roman Libya (Ghirza and Sabratha).

The material includes possible frits and glass production waste; beads (including semi-finished beads or wasters), vessel glass (mostly Roman and found in burial contexts), mirrors and bangles (Islamic). Of these glasses, 142 samples are being subjected to SEM and LA-ICP-MS, and 12 complete objects to non-destructive  $\mu$ XRF. The evidence obtained so far indicates that localised recycling and secondary glass production was occurring from as early as the Classic Garamantian period (1<sup>st</sup>-4<sup>th</sup> centuries AD). Possible evidence for primary production is less apparent, but it is worth noting that the area boasted significant natron deposits, which may have been exported, if not used for glassmaking locally. Furthermore, the results obtained thus far for the Post-Garamantian and Islamic periods add to the growing body of evidence for a Maghrebian-Iberian association with lead-silica and lead-soda-silica glasses, previously thought to be extremely rare.



**Adi ELIYAHU-BEHAR**

Bar-Ilan University, and  
Kimmel Center for Archaeological Sciences, Weizmann Institute of Science  
Israel  
Email: Adi.Behar@weizmann.ac.il

**The transition from bronze to iron:  
A view from a smith's hoard from Early Iron Age Megiddo**

Utilitarian iron use began in the Levant during the Iron Age I (late 12<sup>th</sup> - 11<sup>th</sup> century BC), and intensified in the following centuries, as is clearly indicated by the growing number of iron objects. Recently, evidence for iron production was identified in several settlement sites. Relative and absolute dates all relate to the Iron Age IIA, which is when iron finally became dominant. There is no direct evidence for iron production during the Iron Age I. This may be due to the contingency of excavation, or alternatively suggests that iron production did not take place within the settlement sites at this time. Indirect evidence supports the earlier conclusion.

During the 2012 excavation season at Megiddo, an Iron Age I hoard was unearthed. The hoard was comprised, *inter alia*, of bronze and iron objects as well as bi-metallic knives. The latter were subjected to microstructure and lead isotope analysis of the bronze rivets. The contents and context of this hoard suggest that the hoard belonged to a local metal smith engaged in the production of both iron and bronze during this time.

### **Tzila ESHEL**

Department of Archaeology  
University of Haifa  
Israel  
Email: tzillaeshel@gmail.com

### **Ayelet GILBOA**

The Zinman Institute of Archaeology  
University of Haifa  
Email: agilboa@research.haifa.ac.il

### **Sariel SHALEV**

Institute of Marine Studies  
University of Haifa  
Israel  
Email: sariel.shalev@univ.haifa.ac.il

### **Naama YAHALOM-MACK**

Institute of Earth Sciences and Institute of Archaeology  
The Hebrew University of Jerusalem  
Email: naama.yahalom@mail.huji.ac.il

## **Iron Age silver hoards from southern Phoenicia: Surface analysis using pXRF**

Over one hundred silver items belonging to four Iron Age silver hoards from southern Phoenicia (Tell Keisan, Tel Dor, Acco and Ein Hofez) were analyzed using pXRF. The results indicate that the items were composed of silver with varying amounts of copper, gold, and lead as well as traces of iron, bismuth and nickel. Each hoard can be characterized based on its chemical composition: The hoard from Tell Keisan is relatively rich in copper; The Ein Hofez hoard is relatively rich in lead and bismuth yet low in copper, while the hoards from Acco and Tel Dor are quite similar in composition. All four hoards contain relatively high levels of gold.

The metallurgical results have been combined with a comprehensive study of the typology and context of the hoards. Recent studies have tried to interpret the Iron Age silver hoards as representing a pre-monetary economy, based on 'hacksilber' and scrap. This interdisciplinary study offers new perspectives on questions regarding the use of silver in the pre-monetary economy: It emphasizes the importance of the quality and purity of the silver,

and raises new possibilities as to how the silver standard was managed. The study contributes to the attempts to locate the silver ores exploited by the Phoenicians. Moreover, a comparison between the hoards reflects a chronological development in the availability and value of silver in Phoenicia throughout the Iron Age.

**John GAIT**

Fitch Laboratory  
British School at Athens  
Greece  
Email: flpetrology@bsa.ac.uk

**Re-examining the late Neolithic – early Bronze Age transition in Lower Nubia (Egypt)  
through integrated ceramic petrology and technology studies**

Lower Nubia extends across the modern political borders of Egypt and Sudan, and through much of its history formed a major cultural and political boarder between Egypt and the Mediterranean world to the north, and Sub-Saharan Africa to the south. The conventional prevailing interpretation of the transition between the Late Neolithic and Early Bronze Age periods has relied on a culture-historical framework of extinction, abandonment and immigration, according to which the A-Group culture came to an end as the result of Egyptian military activity during the Early Dynastic Period in Egypt (c.2800 BC), leaving Lower Nubia devoid of indigenous Nubian occupation for approximately 500 years until the immigration of a culturally distinct C-Group population during the 6<sup>th</sup> Dynasty (c.2300 BC).

Through a detailed comparative analysis of A-Group and C-Group pottery production strategies, integrating both petrographic and macroscopic data with archaeological evidence of how pottery was used, important new insights have been gained into this period that challenge the validity of the traditional cultural-historical model. These results have demonstrated that production strategies were more complicated during the A-Group than previously envisage and were closely entwined with regional and social factors. Furthermore, the numerous technological and stylistic similarities identified between the A-Group and C-Group provide further evidence in support of a direct cultural and historical continuity between the Neolithic and Bronze Age.

**Mainardo GAUDENZI ASINELLI\***

Institute of Archaeology  
University College London  
UK  
Email: m.asinelli@ucl.ac.uk

**Marcos MARTINÓN-TORRES**

Institute of Archaeology  
University College London  
UK  
Email: m.martinon-torres@ucl.ac.uk

### **Copper alloy consumption in a Tyrrhenian medieval town: The case of Leopoli-Cencelle (Italy)**

This study focuses on the provision and use of copper alloys during the Middle Ages in the Tyrrhenian town of Leopoli-Cencelle (Italy), and explores the technical aspects and sociocultural implications of metal consumption. Located in the Tuscia region within the main trade routes linking Rome to the northern Tuscan powers of Pisa and Siena, Leopoli-Cencelle was an active town up to the 14<sup>th</sup> century, which was also facilitated by the proximity of the Tolfa Hills mining district and the important harbour of Corneto.

This research concentrates on the technological and compositional study of copper alloy artefacts such as everyday life objects, dress accessories, work instruments, jewellery, and structural and decorative items. The analytical approach included pXRF, optical microscopy and SEM-EDS, so as to acquire information on copper-alloy composition and manufacturing processes; EPMA and lead isotope analyses by ICP-MS, were used to identify minor and trace element patterns and isotopic signatures useful for the determination of the provenance of metal. The data obtained allows comparisons with medieval sources, as well as an assessment of the nature of the local workshops, their skill and level of specialisation. Some interesting aspects are the relative scarcity of tin bronzes, which are almost exclusively reserved for bell casting, and the presence of gilded or silvered brasses, which denote influences from the eastern Mediterranean world. A comparative approach with assemblages from other regional and interregional contexts was used in order to understand further aspects of the technological, socio-cultural, economic and political factors affecting the manufacture and use of metal in this small town.

\* NARNIA Project Early Stage Researcher

**Konstantinos GIANNAKOS**

Department of Civil Engineering

University of Thessaly

Greece

Email: k.giannakos@on.gr, kyannak@uth.gr

### **The technology of structures in Cyprus during the LBA and possible historical implications**

Technology and its "products", when unearthed by archaeologists, are irrefutable witnesses of the technological level of each era and place. Evaluation of archaeological finds in relation to the advanced technology of each era and compared to the ancient literature, could infer conclusions regarding the nature of relations between different civilizations. Metallurgy, boar's tusk helmets, construction technology and know-how (buildings, flood-control works, bridges etc.), production and exchange of precious metals, silver and iron, as very rare metals, constituted "*cutting-edge technology*" for the Late Bronze Age.

The world of the eastern Mediterranean and the Aegean Sea during the Late Bronze Age was not formed by "isolated" states, but exchanges of any kind were taking place. Thus, the investigation of the (international) relations, wars or alliances and exchanges, recorded in literature and in archaeological finds for peaceful and warlike activities, as well as the cross-traffic/infusion of technological know-how helps us in deriving rational conclusions about the real facts of each era.

In the present study, a combination of the archaeological evidence (both material and textual) of the technological level in constructions – especially in Cyprus – and metal production, the ancient literature, the linguistic analysis of the epics and the Linear B language, is attempted, in order to infer conclusions for possible relations and exchanges among Minoan Crete and/or Mycenaean Greeks - Δαναοί / Ἀχαιοί as Homer calls them - with Cyprus, Egypt, the land of Hatti and partly Levant, specifically during the era of the Attarissiya's raids in Asia Minor and Cyprus/ Alasiya (ca. 1400 BC).

**Ayelet GILBOA**

Zinman Institute of Archaeology  
University of Haifa  
Israel  
Email: gilboaaa@zahav.net.il

**Yuval GOREN**

Institute of Archaeology  
Tel Aviv University  
Israel  
Email: ygoren@post.tau.ac.il

**Mapping Early Iron Age Cypro-Phoenician networks:  
An optical mineralogy study of Phoenician Bichrome Ware in Cyprus**

Phoenician Bichrome ware has long been regarded as the main proxy for tracing early Phoenician mercantile endeavours. Its main distribution outside Phoenicia is in Cypro-Geometric Cyprus. We contend that in order to understand Phoenician mercantile activities in the early Iron Age and their possible connection to later westbound Phoenician trade, an attempt should be made to differentiate between the spheres of interactions of the *different* Phoenician polities. This is possible, inter alia, by determining the exact provenance of ceramics shipped overseas. Here we present, therefore, the first provenience analysis of Phoenician Bichrome ware — the first systematic analysis of this ware anywhere. We, then, interpret the results in a broader context — other evidence for Cypro-Phoenician interaction in this period, the contexts in which these vessels 'operate' and the meaning of their very specific shapes and decorations. Some of the Phoenician polities involved in this trade indeed had a leading role in later Phoenician 'expansion' while others did not. We try to explain this difference by looking at general economic and political trajectories in the Levant in the Iron Age.

**William GILSTRAP\***

Department of Archaeology  
University of Sheffield  
UK  
Email: w.gilstrap@sheffield.ac.uk

**Peter M. DAY**

Department of Archaeology  
University of Sheffield  
UK  
Email: p.m.day@sheffield.ac.uk

### **Production, exchange and consumption of pottery from LH IIIB to LH IIIC early periods in the Saronic Gulf**

Earlier analyses of ceramic material from Kanakia on the island of Salamis have shown that the entirety of the pottery assemblage from the acropolis has been imported. Through a direct comparison of material from excavations at ten other sites from around the Saronic Gulf, we were able to suggest that nearly a quarter of the Kanakia assemblage has an origin in the region of Attica, while the rest appear to have been made in Aegina, the Argolid, Corinthia and Crete. With the subsequent discovery of a craft production installation at the site of Kontopigado, Alimos, approximately 5 km south of the Athenian Acropolis, a wealth of new evidence has been brought to light. This includes kiln wasters and part of a potter's wheel suggesting the manufacture of a range of ceramic vessel types similar to those identified at Kanakia to be of an Attic origin. Examination through thin-section petrography coupled with traditional typological fabric analysis indicates that the pottery produced at Kontopigado includes specialised vessel types such as fine tablewares, cooking vessels and tubs in a range of sizes with a wide distribution of entire assemblages reaching at least as far as Thorikos in southeast Attica, Ayios Konstantinos in Methana to the west and perhaps farther into the Aegean world during the LH IIIB – LH IIIC early periods.

This paper argues that the integration of traditional and scientific methods of analysis are an effective means of situating pottery production and consumption within the wider context of Mycenaean society and economy. In looking at closely contemporary ceramic assemblages from sites in and around the region of the Saronic Gulf at least three regional production centres have been identified and the distribution of their products have been mapped. Both technological and provenance based data have been synthesised to reveal

\* NARNIA Project Early Stage Researcher



unprecedented patterns of pottery consumption and social interaction at the local, regional and interregional levels during a period of prehistory when craft production and distribution is usually considered to have been centrally controlled by local palatial centres.

**Alessandra GIUMLIA-MAIR**

AGM Archeoanalisi  
Italy  
Email: giumlia@yahoo.it

**Susan C. FERRENCE**

INSTAP Academic Press  
USA  
Email: susanferrence@instapress.com

**Philip P. BETANCOURT**

Tyler School of Art  
Temple University  
USA  
Email: ppbcourt1@aol.com

**James D. MUHLY**

University of Pennsylvania  
USA  
Email: jimmuhly@yahoo.com

**XRF analysis of silver alloys from the EM I - MM IIA cemetery of Petras, Crete**

In the course of research on the metal finds from the Early Minoan I - Middle Minoan IIA cemetery of rock shelters and house tombs at Petras, Crete, a large number of objects has been analysed by XRF. The majority of the burials in the cemetery are secondary deposits, the nature of which hinders secure dating. Any information gleaned from the visual (macro- and microscopic) examination and scientific analysis of the objects regarding their style, manufacture, and composition is vitally important to understand the technology employed by the people who used the cemetery.

The equipment employed for the analyses is transportable and consists of several parts: an XRF-source on a tripod, a transformer, a stabilizer and a computer with dedicated software. The characteristics of the equipment and its various devices, the dedicated software and a suitable number of standards, produced *ad hoc* by AGM Archeoanalisi, greatly enhance the precision of the system.

Among the analysed items there is a group of silver pieces, such as for instance bracelets, pendants, and the caps of large decorative rivets that are applied to various items. The

analyses have shown that for these objects different alloys have been employed, and that many of them show a surprising and distinctive composition. The various silver alloys and their metallurgical properties will be discussed in this paper.

Lena HAKULIN

University of Helsinki

Finland

Email: lena.hakulin@kolumbus.fi

### **A new approach for investigating the role of metals in Late Bronze Age Societies on Crete**

The importance of metals in the LBA Minoan and Mycenaean societies on Crete has been a generally accepted view, but up to now no one has focused directly on this topic. The study aims to analyse the social aspects of metals and metal-working in these societies through a new metal-centred approach with the aim to test whether a systematic analysis of the quantity and quality of the metal finds dating to LBA could lead to a better understanding of the political economy, social values and cultural habits in the society.

Due to the apparent scarcity of scientific data on metalwork from LBA Crete three appropriate archaeological parameters for the metal finds and three selected aspects of the metal assemblages were employed as the basis of the analytical approach. The approach is new in three ways: the metal-centred focus for studying Aegean societies, the holistic view comprising all types of copper-based metal finds, and the quantification of the metal finds by weight.

By applying the approach to the metal records from the Minoan and Mycenaean societies separately for East, Central and West Crete, changes and variations between periods and regions in the use and distribution of metal could clearly be detected, reflecting the differences and variations in the periods and the three regions, which other archaeologists detect through other manifestations of the ancient material culture. The different role of metals for the Minoan and Mycenaean palatial societies on Crete were clearly visualised by the metal cycles.

**Halford HASKELL**

Department of Classics  
Southwestern University  
USA

Email: [haskell@southwestern.edu](mailto:haskell@southwestern.edu)

**An interdisciplinary and integrative study of ancient ceramics:  
Aegean transport stirrup jars**

The publication by Haskell, Jones, Day & Killen, *Transport Stirrup Jars of the Bronze Age Aegean and East Mediterranean* (Philadelphia 2011), presents results of a large-scale, interdisciplinary study of transport stirrup jars (TSJs). This holistic research project integrated typological, chemical, petrographic, and epigraphic approaches. While fabric analyses by chemistry alone had not been able to confirm the production and dissemination of the form, together with petrography and the "soft" sciences of typology and epigraphy the authors were able to clarify issues of provenance, technology, and distribution. Chemical analysis when employed within a holistic study remains a viable technique.

While a small fraction of TSJs bear Linear B inscriptions and had received the bulk of scholarly attention, this latest study aimed at assessing a representative sample of all TSJs. TSJs are found in greatest numbers at Aegean sites. While a few pieces are found in the west (Sardinia, Sicily), more significant numbers occur on Cyprus and in the Levant. Our results indicate that virtually all TSJs intended for transport are most closely associated with technological traditions in central and west Crete and they document overseas connections of the late 14<sup>th</sup> through the 13<sup>th</sup> centuries (and perhaps later) between Crete and the eastern Mediterranean.

Furthermore, given the desirability of sharing the extensive data generated by the typological, chemical, petrographic, and epigraphic studies, this project invites discussion of how best to disseminate those data beyond what can be included in a traditional print publication. Possibilities range from completely open access to moderated dissemination.

**Anno HEIN**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: hein@ims.demokritos.gr

**Vassilis KILIKOGLU**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: kilikog@ims.demokritos.gr

**Sustainable data management in the study of ancient materials**

Archaeological material studies complement pure archaeological research and contribute to our knowledge on material culture, in terms of production technology, origin, movement and utilisation. Furthermore, they provide information towards restoration and conservation. On the other hand analytical studies always imply an intrusion in the integrity of an archaeological object even if the applied methods are non-invasive or non-destructive. A major concern of any analytical study should be the reduction of this intrusion to a minimum. Beyond that, the analytical data which can be generated from the selected method should be able to answer specific questions set by the research design. In realistic terms this is rare and usually combined data from more than one technique may provide partial answers. Subsequent to the actual analysis, the data have to be processed and placed in a general context of reference and comparative data. Sustainable data management avoids additional and unnecessary analyses, and effectively becomes non-invasive after all. The present paper provides an overview over data treatment, data management and data availability using the example of integrated studies of archaeological ceramics in the Eastern Mediterranean.

**Anna Kathrin HODGKINSON**

UK

Email: hodgkinson.anna@gmail.com

**A spatial analysis of the socio-economics  
of the production of luxury goods at Amarna**

This paper presents some of the results of a recent spatial analysis undertaken for the New Kingdom Egyptian settlement of Amarna. The analysis focussed on a selection of high-status industries and the production of luxury goods, especially glass, faience, but also metals and sculpture, aiming to establish a working model applicable to the socio-economics of industrial activities across settlement sites dating to the New Kingdom in ancient Egypt.

For her PhD, the author catalogued those artefacts from Amarna that have been identified as evidence of industrial activity for each of the categories listed above. The same has been done for the finished products of the glass-, metal- and sculpture-industries across Amarna. Using GIS software, density analyses were undertaken for each dataset, and distribution patterns were detected. While each category of production evidence and finished products was analysed separately, it was also possible to compare distribution maps. At the same time, while the artefact distributions were studied across the settlement site as a whole, the sizes of the buildings and other archaeological contexts, where the objects were found, were also taken into account. In addition to the spatial analysis, the social context of excavated workshops, both as a production site and a domestic house were considered.

Based on the results of the spatial and archaeological analyses, organisational models were established. These incorporate archaeological evidence reflecting a high level of elite control over raw materials and finished produce, as well as an insight into workshop organisation.

**Demetrios IOANNIDES\***

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: demetrio@ucy.ac.cy

### **Examining the metallurgical ceramics from Late Bronze Age Kition**

The development of metallurgy has been associated with the selection of adequate materials for the production of pyrotechnical tools and their adaption for use in high temperatures. The impeccable function of heat resistant tools, such as furnaces, tuyères, moulds and crucibles, was necessary for effective processing of the metal ores and metals. Ceramics were the most common materials used for the production of metallurgical tools due to their high thermal capacity and heat resistance at considerably high temperatures.

In the case of Late Bronze Age Kition, technical ceramics were found in the sacred precinct demonstrating the presence of metallurgical activity. Unlike the material evidence from Poltiko *Phorades*, which is considered as a primary smelting workshop, the material remains of Kition present similarities in terms of shape and size with those coming from the workshops of the urban centre of Enkomi. In addition, the limited number of slag fragments found might indicate secondary processes of copper production such as refining, melting, and casting.

Therefore, the metallurgical ceramics will be studied and assessed for their compositional and technological characteristics. Primary issues to be addressed is their level of refractoriness, the processes in which they had been used and thereby the social and cultural organization of the site. To answer that, a number of techniques will be employed to investigate various aspects of ceramic production and metallurgical technology.

\* NARNIA Project Early Stage Researcher



**Anthi KALDELI**

Department of Antiquities  
Cyprus  
Email: a.kaldeli@gmail.com

**Vassilis KILIKOGLU**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: kilikog@ims.demokritos.gr

**Anno HEIN**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: hein@ims.demokritos.gr

**Demetrios MICHAELIDES**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: d.michaelides@ucy.ac.cy

**David WILLIAMS**

Department of Archaeology  
University of Southampton  
UK  
Email: dfw@soton.ac.uk

**Late Roman amphorae from Cyprus:  
Investigating production and distribution in the eastern Mediterranean**

Previous studies have increased our understanding concerning the amphora types produced and circulated in the eastern Mediterranean in the Late Roman period, thus enabling an insight into economic organisation, particularly in relation to the Early and Middle Roman periods. Yet, the recent application of scientific methods to the study of these ceramic containers from Cyprus has provided new evidence on their origins and character of production, while it has encouraged inferences on related issues, such as the scale and modes

of production, as well as the nature of intra- and inter-regional trade and exchange networks. This paper aims at presenting these data in order to address the aforementioned aspects and the complexity involved in the period's commercial endeavours. Most importantly, it will demonstrate the necessity for the application of a concrete methodological and theoretical framework, encompassing an interdisciplinary approach, for the adequate examination of economic aspects within the broader socio-economic and political framework. As it will become apparent, this line of enquiry, in conjunction with the centrality of the island in the maritime exchange networks operating in the eastern Mediterranean, offers an insight into little-known issues, which are nevertheless at the core of the study of the Roman economy. Such key-issues are, for example, specialisation of production, value, the phenomenon of imitation, and the market forces of supply and demand.

**Maria KAZANTZAKI**

School of Mining and Metallurgical Engineering  
National Technical University of Athens  
Greece  
Email: kazantzaki.mar@gmail.com

**Yannis BASSIAKOS**

Institute of Nanoscience and Nanotechnology  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: bassiakos@ims.demokritos.gr

**Theodora RONDOYANNI**

School of Mining and Metallurgical Engineering  
National Technical University of Athens  
Greece  
Email: rondo@central.ntua.gr

**Evangelos TSAKALOS\***

Institute of Nanoscience and Nanotechnology  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: tsakalos@ims.demokritos.gr

**John CHRISTODOULAKIS\***

Institute of Nanoscience and Nanotechnology  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: physjohn@yahoo.gr

**Luminescence chronology of Quaternary coastal deposits  
of North Evoikos Gulf (Central Greece)**

North Evoikos Gulf represents an extended basin characterised by intense seismicity and significant climate changes that took place during the Quaternary period. The coastal zone of the Gulf has not only been affected by tectonic activity, but also repeated sea-level changes and volcanic activity, the traces of which have been encoded on the coastal sediments of the area. The ultimate purpose of the research is the reconstruction of the different paleoenvironmental phases of the Quaternary period and their relation to the geodynamics of the

\* NARNIA Project Early Stage Researcher

coastal areas of Evoikos Gulf. The main idea is based on the fact that luminescence dating techniques provide a means to examine sedimentary environments. This is achieved by the minerals found in sediments which act as “dosimeters” and used to determine the time that particular events of the past took place.

Dating results derived for the coastal deposits of North Evoikos Gulf using a number of Luminescence dating techniques, namely optically stimulated luminescence, isothermal thermoluminescence from quartz and post-infrared infrared stimulated luminescence from feldspars. Ages obtained suggest that the main depositional processes in the area took place during the Early Pleistocene. The proposed research is based on an interdisciplinary approach which is innovative for the study area, the significance of which lies on the fact that little literature is available so far.

**Evangelia KIRIATZI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: fldirector@bsa.ac.uk

**Myrto GEORGAKOPOULOU**

UCL Qatar  
Qatar  
Email: m.georgakopoulou@ucl.ac.uk

**Chemical and petrographic interactions:  
A micro-scale investigation of local pottery production on Bronze Age Kythera**

The current paper discusses the further development and application of methodology for the study of pottery from excavations and field surveys through the integrated use of petrographic and chemical analysis (with wavelength dispersive x-ray fluorescence), contributing to understanding the history of a Mediterranean ceramic landscape.

Based on the systematic macroscopic study of pottery from the British School at Athens excavations at the coastal site of Kastri and the Kythera Island Project field survey, around three hundred samples were selected representing all major categories in use during the Bronze Age. In parallel, a large scale geological prospection and sampling was undertaken across the island aiming to locate and characterise all locally available potential raw materials for pottery manufacture and provide the basis for experimental replication of ancient local pottery fabrics.

All pottery and geological samples were initially examined through petrographic analysis with thin sections. A series of coarse and medium grained fabrics were defined and associated with locally available raw materials and technological choices reflecting the continuous transformation of local traditions under the influence of technological knowledge transferred from neighbouring regions in the north and the south. Subsequently, targeted application of chemical analysis was undertaken through wavelength dispersive x-ray fluorescence spectroscopy, that has shed more light mainly on the local production of fines wares and contributed to a deeper understanding of the transformations observed in the local potting industries from the mid third millennium BC to the end of the Bronze age. Overall, the combination of the two analytical techniques, and the constant feedback between the two, has provided a much clearer and holistic view of pottery production and circulation across

the island's landscape and the potential for a better understanding of changes observed in local technological traditions in the context of both local and wider social and economic transformations.

**Francesca LICENZIATI\***

UMR 7041 ArScAn (Archéologies et Sciences de l'Antiquité)

Université Paris Ouest

France

Email: francesca.licenziati@mae.u-paris10.fr

**Thomas CALLIGARO**

Centre de Recherche et de Restauration des Musées de France (C2RMF)

France

Email: thomas.calligaro@culture.gouv.fr

### **The combined application of Raman and portable X-ray fluorescence spectroscopy for the study of mosaic glass *tesserae* from Delos, Greece**

The present work reports on a compositional and technical study of glass *tesserae* in the mosaics of Delos (Greece). The results were obtained using two complementary non-invasive techniques, Raman and portable X-ray fluorescence spectroscopy carried out *in situ*.

The three hundred and fifty mosaics from the island of Delos (130 to 88 BC) constitute one of the most important mosaic corpuses of the Hellenistic period. They were manufactured using various techniques such as *tessellatum*, *vermiculatum*, *chip* and *pebble mosaic*. Beyond their large number and the high quality of many of them, these mosaics stand out because of the large use of artificial materials, in particular glass and faience, which is remarkable for that period.

The principal aim of this research is to investigate the glass *tesserae* in order to identify the raw materials and the glassmaking techniques employed for their production. Since glass *tesserae* are generally coloured, opaque or translucent, the study mainly focused on the characterisation of the colouring and opacifying agents employed. This archaeometric research addresses archaeological issues about mosaic production at Delos, such as the glass supply and the processing of *tesserae* and, possibly, the identification of mosaic workshops operating on the island.

\* NARNIA Project Early Stage Researcher

**Louis Olivier LORTIE**

Department of Archaeology  
University of Sheffield  
UK  
Email: lolortie@gmail.com

**Derek PITMAN**

Department of Archaeology  
University of Sheffield  
UK  
Email: d.pitman@sheffield.ac.uk

**Roger DOONAN**

Department of Archaeology  
University of Sheffield  
UK  
Email: R.Doonan@sheffield.ac.uk

**Scientific studies and the archaeological process:  
The implications of science in the field**

Craft production and exchange are often undertaken as discreet studies within archaeology. This has resulted in instances where whole economic systems have been reconstructed with little discussion of production strategies and conversely detailed technological studies undertaken which fail to consider economy. The co-dependence of these study areas should be clear to most modern archaeologists yet trying to explain this apparent isolation can be challenging. Differing theoretical perspectives of researchers or the suitability of an assemblage to a specific set of questions are likely explanations yet this paper proposes that it is more the result of how the archaeological process is organised and how archaeologists connect with their material.

With reference to ongoing excavations at Wytch Farm, Poole Harbour, Dorset this paper looks at how the reorganisation of scientific material analysis within the archaeological process might impact on the way technology and exchange are studied. Poole Harbour is one of the most important ports of trade in the British Iron Age and has produced extensive evidence for craft production including shale working, iron working and smelting, salt production alongside the well documented pottery production areas.



In this paper we discuss how in-situ scientific analyses, geochemical, material composition and geophysics, can be used to direct excavation, field survey and sampling strategies on a day by day basis. The implications for how research designs are constructed are discussed.

**Christina MAKARONA\***

Department of Analytical, Environmental and Geochemistry  
Vrije Universiteit Brussel  
Belgium  
Email: cmakaron@vub.ac.be

**Priscilla KESWANI**

USA  
Email: pkeswani@comcast.net

**Eleni NODAROU**

INSTAP Study Center for East Crete  
Crete  
Email: enodarou@yahoo.gr

**Ariane JACOBS**

Department of Art Sciences and Archaeology  
Vrije Universiteit Brussel  
Belgium  
Email: Ariane.Jacobs@vub.ac.be

**Nadine MATTIELLI**

Department of Earth and Environmental Sciences  
Université Libre de Bruxelles  
Belgium  
Email: nmattiel@ulb.ac.be

**Karin NYS**

Department of Art Sciences and Archaeology  
Vrije Universiteit Brussel  
Belgium  
Email: Karin.Nys@vub.ac.be

**Philippe CLAEYS**

Department of Geology  
Vrije Universiteit Brussel  
Belgium  
Email: phclaeys@vub.ac.be

## Leave no mudstone unturned: Geochemical provenancing reveals potters' choices and interactions in Late Bronze Age Cyprus

Ceramic fabrics bearing mudstone inclusions (either naturally existing in the clay or added as temper) are attested in several Late Bronze Age sites in South-Western Cyprus (1450-1100 BC). Recent petrographic research revealed that fabrics like these exist in both calcareous and non-calcareous clay matrix variants and are represented in a variety of vessel shapes (storage pithoi, Plain White Wheel-made II jugs, Base Ring juglets), indicating the existence of an on-going tradition.

Mudstone sources can be recognised within specific geological units of Cyprus, associated either with the Mammonia terrane (radiolarian mudstones of the Ayios Fotios formation or within the Kathikas mélange) or with the Troodos ophiolite (within the Perapedhi formation or the Moni mélange). Petrographic and elemental data were as of now unable to provenance the mudstone inclusions and, therefore, could not unambiguously link sherds to specific sources. The distinct nature and geological evolution of the mudstone outcrops, however, makes this an ideal case for the application of alternative techniques, such as isotopic analysis, in order to distinguish between them.

In this study, we analysed ceramic sherds representing different fabrics from the assemblages of *Alassa Pano Mandilaris*, *Alassa Paliotaverna*, *Episkopi Bamboula* and *Palaeaphos Marchello*. Non mudstone-bearing samples were included as references for the local clays used at each site. Moreover, geological samples from relevant clay-bearing formations around the sites and possible mudstone sources were analysed as well. Sr and Pb isotopic data for this sample set are interpreted alongside previously conducted petrographic and elemental analysis in an attempt to trace the provenance of the mudstone inclusions and clay sources. The results shed light on the choices potters were making regarding raw material acquisition, as well as on possible interactions between the sites within the region.

**Aurélia MASSON-BERGHOFF**

Department Greece and Rome

British Museum

UK

Email: [amasson-berghoff@thebritishmuseum.ac.uk](mailto:amasson-berghoff@thebritishmuseum.ac.uk)

### **Votive bronzes in Late Period Egypt: Where did the raw metals come from?**

To date, scholarship on copper mining and trade in Egypt has focused primarily on the Bronze Age, the period between the Old and New Kingdoms. However, copper was still a very important metal during the Iron Age, used in the production of a wide range of commodities. The mass-production of votive bronzes during the Late Period must have required not only a steady supply of copper, but also of lead which formed a high percentage of their alloy. In comparison to the wealth of information available for the Bronze Age, our knowledge of the source(s) for copper and lead appears surprisingly limited for Late Period Egypt. It has nonetheless noticeably improved over the last decade and this is what this paper proposes to investigate.

In addition to the few written sources referring to the trade of metal, recent and on-going surveys and excavations provide new insights into the exploitation of mines in Egypt and elsewhere during the Iron Age. Discoveries of ingots in Late Period contexts bear testimony to the import of metal in Egypt. Analyses tackling the provenance of ores are scarce for objects dated to the Late Period. Even if the identification of a particular mine as a source is not possible through lead isotope analyses, it is easy to differentiate 'local' ores (from Sinai and in the eastern desert along the Red Sea coast) from imported ones (from Cyprus for example). Their results will be discussed and compared to analyses carried out on Late Bronze Age objects.

**Roberta MENTESANA\***

Department of Archaeology  
University of Sheffield  
UK  
Email: r.mentesana@sheffield.ac.uk

**Peter M. DAY**

Department of Archaeology  
University of Sheffield  
UK  
Email: p.m.day@sheffield.ac.uk

**Vassilis KILIKOGLOU**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: kilikog@ims.demokritos.gr

**Simona TODARO**

Dipartimento di Scienze Umanistiche  
Università di Catania  
Italy  
Email: svtodaro@unict.it

**Exploring pottery technological variability and its significance during the Final Neolithic - Early Bronze Age transition at Phaistos, Crete.**

The site of Phaistos in Southern Crete offers great potential for examining the Final Neolithic - Early Bronze Age transition in Crete and assessing the degree of continuity and change, on account of the completeness of its stratigraphy, as well as the abundance and the sheer quality of material. This period has been considered in Crete as ‘transitional’ due to the emergence of new settlement patterns and related material culture, which presage the social changes of later phase.

This paper adopts a ‘bottom-up’ approach to explore the dynamics of technological and social change. It starts with the investigation of technological variation within the ceramic assemblages across the period under study, which shows distinctive adoption of different surface treatments and paste recipes. The aim of the paper is twofold. By integrating macroscopic observation, petrographic examination and SEM analysis, it reconstructs the

\* NARNIA Project Early Stage Researcher

operational sequence of pottery manufacture, informing a view of manufacturing procedures over time.

The analytical study is intertwined with the contexts of consumption of the site in order to understand their relationship with artefact manufacture. By examining the significance of technological choices in pottery making within the context of Phaistos, the study demonstrates a complex picture of continuity and change over the period of study, which belies recent conjecture of a single-phase transformation at the beginning of the Early Bronze Age.

**Noémi S. MÜLLER\***

Fitch Laboratory  
British School at Athens  
Greece  
Email: flchemistry@bsa.ac.uk

**George VEKINIS**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: gvekinis@ims.demokritos.gr

**Vassilis KILIKOGLOU**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: kilikog@ims.demokritos.gr

### **Impact resistance of archaeological ceramics: The influence of firing and temper**

The ability of archaeological ceramics to withstand mechanical stresses is thought particularly important for utilitarian vessels and building materials, and in many instances believed to be the underlying reason for particular manufacturing choices observed in these types of ceramics. Much work on the mechanical properties of clay-based ceramics has centred on the behaviour of the material under slow bending, providing information about how a material will react when exposed to a static load. In addition to static loads, however, impact can play a role. Impact is a dynamic event and forces a ceramic material to absorb energy quickly. Ceramics, which are frequently subjected to impact, include transport vessels, but resistance to impact is equally important for construction ceramics such as tiles or pipes.

In order to understand the influence of technological parameters on ceramic performance under impact and how this compares to its behaviour under static stress, we prepared a systematic series of experimental briquettes, with varying firing temperature and amount of aplastic inclusions. Using an instrumented pendulum tester, these model ceramics were tested for their behaviour under impact, and both initiation and propagation fracture energies were assessed. We discuss the influence of manufacturing parameters on the impact resistance of archaeological ceramics, based on the materials’ composition and microstructure, and examine mechanisms involved. Furthermore, the results are compared to data

\* NARNIA Project Experienced Researcher

from measurements under slow loading conditions, which are more routinely performed on traditional and archaeological ceramics. Finally, the implications of the results for technological studies of archaeological ceramics are discussed.



### **Nerantzis NERANTZIS**

31<sup>st</sup> Ephorate of Prehistoric and Classical Antiquities  
Greece  
Email: nnerantzis2001@yahoo.co.uk

### **Yannis BASSIAKOS**

Institute of Nanoscience and Nanotechnology  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: bassiakos@ims.demokritos.gr

### **Stratis PAPADOPOULOS**

18<sup>th</sup> Ephorate of Prehistoric and Classical Antiquities  
Greece  
Email: epapadopoulos@culture.gr

## **Copper metallurgy of the Early Bronze Age in Thassos, North Aegean**

Archaeometallurgical research of the last decade has added valuable information on copper metallurgy practiced in the Bronze Age coastal settlements on Thassos in the North Aegean. The presence of mineral ores in the island’s geology has been suggested as a determining factor for early silver and lead extraction from the respective indigenous sources. Yet up to date no solid archaeological evidence for mining in the Bronze Age has come to light whereas Archaic, Classical and Hellenistic large scale mining, gold and silver extraction and iron production have been confirmed.

Despite the absence of information on prehistoric mining, smelting residues such as crucibles, tuyères and slag pieces, casting implements namely clay moulds, and artefacts of copper-based alloys were found in Early Bronze Age Limenaria, Aghios Antonios and Skala Sotiros. Recent slag analyses revealed increased levels of Ba and Zn, which are diagnostic elements of the Thassian deposits, hinting to the exploitation of local raw materials at an early stage.

In addition to the metallurgical finds, arsenical-copper and bronze objects were found in the former sites and also at Aghios Ioannis and Kastri but their provenance has not been established so far. The present paper aims to present the evidence for Thassian copper metallurgy during the Bronze Age through analysis of raw materials (copper-bearing ores), metallurgical residues (crucibles, slag) and finished objects and to provide a preliminary

interpretation of the findings. For the first time local production of arsenical copper in the north Aegean has been confirmed at Aghios Antonios and its similarities to Cycladic examples suggest technological sophistication and the establishment of far-reaching exchange networks active during the Early Bronze Age.

**Eleni NODAROU**

INSTAP Study Center for East Crete

Crete

Email: enodarou@yahoo.gr

**Priscilla KESWANI**

USA

Email: pkeswani@comcast.net

**Regional variation in Late Cypriot pithos production:  
Preliminary results from the petrographic analysis**

Large storage vessels are ubiquitous in settlement sites of the Late Cypriot (1650-1050 BC) Bronze Age. In many cases they are associated with ashlar masonry and storage facilities with capacities far exceeding individual household requirements, thus attesting to elite strategies of resource accumulation, staple finance, and redistribution of agricultural commodities. Ethnographic studies in both the Aegean and Cyprus have shown that pithos production necessitates considerable skill and specialised labour.

Building on Keswani's research on the extensive assemblages of pithoi from Kalavassos and Alassa, the authors have developed an analytical program to explore recipes of manufacture and firing technologies for pithos production in south-central and southwestern Cyprus during the Late Bronze Age. A comparative study incorporating samples from six sites taken from storage vessels varying in size, macroscopic fabric characteristics, and surface treatment/decoration is now underway. Petrographic analysis is the main tool of analysis, and it has been complemented by pXRF and geological sampling of raw materials. This presentation discusses the preliminary results of this combined project and their implications for regional patterns of pithos production as well as possible boundaries between Cypriot communities.

## **Sandrine PAGÈS - CAMAGNA**

Centre de Recherche et de Restauration des Musées de France –  
UMR8247 IRCP PCMTH  
Ministry of Culture  
France  
Email: sandrine.pages@culture.gouv.fr

## **Dietrich RAUE**

Ägyptisches Museum - Georg Steindorff  
Universität Leipzig  
Germany  
Email: dietrich.raue@uni-leipzig.de

### **Coloured materials used in Elephantine: Evolution and permanence from the Old Kingdom until the Roman Period**

Since the first French and German archaeological investigations at the beginning of the 20<sup>th</sup> century, and the Egyptian excavations in the 1930s and 1940s, during which the shrine of Heqaib with its considerable collection of private statues from the Middle Kingdom was unearthed, there have been 30 campaigns of the German Archaeological Institute in co-operation with the Swiss Institute for architectural and archaeological research in Egypt.

According to the traces of settlement dating to the Predynastic Period (as of 3300 BC) and to the oldest sanctuary on the island, the temple of Satet from c. 3200 BC onwards, the area of settlement was fortified by a city wall. Up to the Graeco-Roman period the religious centres of the city were continuously renewed and extended. The main goal of the excavation in Elephantine is to gain a comprehensive picture of an ancient Egyptian town as a whole. This encompasses living, commercial quarters, shrines and administrative buildings throughout the duration of their historic development.

The colours preserved on the various building phases of the Temples enable the understanding of the evolution through the time of colours and pigments used. During the excavations of the houses, raw materials, perfectly dated, were discovered and recorded.

Portable Raman and UV-visible spectrometers were taken on the island in order to distinguish the pigments and precious stones, such as garnet, lapis, ochre, Egyptian blue, calcite, huntite, etc. The analyses, performed between 2009 and 2010 with optical fibres, permitted the investigators to propose a chronological evolution of the materials used for the decoration of the official and private buildings.

## **Ilana PETERS**

Department of Archaeology and Ancient Near Eastern Cultures  
Tel Aviv University  
Israel  
Email: ilanapeters@yahoo.com

## **Erez BEN-YOSEF**

Department of Archaeology and Ancient Near Eastern Cultures  
Tel Aviv University  
Israel  
Email: ebenyose@post.tau.ac.il

## **Lisa TAUXE**

Scripps Institution of Oceanography  
University of California San Diego  
USA  
Email: ltauxe@ucsd.edu

### **An archaeomagnetic study of major slag deposits in the central Timna valley**

Archaeomagnetic experiments on slag samples from Site 34 ("Slaves' Hill") and 30a were conducted in order to further constrain the age of the copper smelting activity at these sites as part of Tel Aviv University's Central Timna Valley Project. The experiments focused on dating different slag deposits by reconstructing ancient geomagnetic intensities as recorded by individual slag samples at the time of their formation (using a Thellier-Thellier based protocol at the Palaeomagnetic laboratory of Scripps Institution of Oceanography, San Diego). The intensity values were compared to the regional archaeomagnetic reference curve and to published values from other sites at the Timna Valley and its vicinity.

The results show that while the slag mounds deposited at the unprotected foothill of Site 34 are not from the Late Bronze or Iron Ages, the slag mounds on the hilltop of Site 34 and the naturally protected Site 30a demonstrate copper production during the early Iron Age (11<sup>th</sup> – 10<sup>th</sup> centuries BC). The correlation between the location setting of the slag mounds and date reflects the varying socio-economic and political dynamics of the region in which Iron Age production took place only in protected contexts. Furthermore, comparing the new data with previous archaeomagnetic studies from the nearby Site 30 corroborates Beno Rothenberg's assertion of simultaneity of production of all these sites (34, 30a and 30), and together with the new refined dating gives further support to the claim of intense smelting in the central Timna Valley during the early Iron Age.

**Anastasia PORTARI**

University of Thessaly

Greece

Email: portarianastasia@yahoo.gr

**Ceramic workshops in BA mainland Greece:  
A preliminary study of the archaeological record**

This paper aims to contribute to the study of ancient ceramic technology and production by providing an overview and a quantitative interpretation of what has been recovered from the BA ceramic workshops in mainland Greece. It answers a longstanding need for a diachronic study of the technological practices and the archaeological remains of BA ceramic workshops in mainland Greece, considering the lack of systematic, analytical documentation, study and interpretation of workshop remains and an updated catalogue of pottery kilns.

This paper is based on an analytical and systematic recording of the published archaeological remains from the Peloponnese in the south, to Macedonia in the north. The remains have been recorded in a database by geographical location and date, including a detailed description of their context, features and the extant bibliography.

The quantitative evaluation of the chronological and geographical distribution of pottery kilns and their typology during the EBA, MBA and LBA will be presented in the first part of the paper, along with quantitative data on extant tools and other built features related to the kilns and indicating the existence of ceramic workshops.

It will be followed by an attempt to trace and assess the technological changes and developments in the context of economic and socio-political changes, as they can be deduced in the archaeological record, as well as changes in the scale of production, its extent and the emerging evidence concerning palatial involvement in ceramic production. The third and last section of the paper will discuss the recent archaeometric research on BA pottery workshops of mainland Greece and the overall perspectives of the current research.

**Benoit PROULX**

Department of Archaeology  
University of Sheffield  
UK  
Email: BProulx1@sheffield.ac.uk

**Roger DOONAN**

Department of Archaeology  
University of Sheffield  
UK  
Email: R.Doonan@sheffield.ac.uk

**New methods and technology for space exploration:  
The use of HHPXRF geochemical data in technological studies**

The last two decades have seen a reinvigoration of material culture and technology studies in light of the broader theoretical discussions in archaeology. A number of new perspectives have been developed for the study of ancient metallurgy, especially the role of space. This focus has emerged from the theory of the agency and parallels many studies in landscape and settlement archaeology. In these cases archaeologists have looked to enclosure and architecture to scrutinize how space is used but such opportunities are not always available to those studying ancient technology.

This study reports on the ability of HHPXRF to produce geochemical data that might inform spatial studies on ancient technology, specifically the production of copper. Through the use of archaeological and experimental case studies this paper will demonstrate how space, once a missing dimension in archaeometallurgical studies, can now be integrated to better allow an understanding of agency in technological contexts.

**Frederik RADEMAKERS\***

Institute of Archaeology  
University College London  
U.K.  
Email: frederik.rademakers@gmail.com

**Thilo REHREN**

UCL Qatar  
Qatar  
Email: th.rehren@ucl.ac.uk

### **Seeing the forest for the trees:**

#### **Assessing technological variability in ancient metallurgical crucible assemblages**

Metallurgical crucible remains have been found in many archaeological contexts and in varying degrees of preservation. The reconstruction of metallurgical activity through the study of these remains, by means of optical and chemical analysis, is undertaken with the aims of understanding technological choices of ancient craftspeople, their use of different raw materials and, by extension, the organisation of production and trade. When large assemblages are available for study, an intra-site comparison of technology and material use within different contexts and throughout time offers interesting perspectives.

Complete crucible examples are rarely found and it is often difficult to reconstruct full crucible profiles based on the fragmented remains. This in turn means that process variability within a single crucible can be hard to assess. Crucible slag is often highly heterogeneous, even within single fragments, enticing analysts to lose themselves in details. Furthermore, the abundance of remains is highly variable, depending on the scale of activity, as well as archaeological recovery and preservation, while technological variation within an assemblage can only be detected through study of multiple samples.

Drawing on the analysis of several crucible assemblages (as part of ongoing PhD research), some difficulties and opportunities for technological reconstructions are discussed. Issues related to crucible heterogeneity and inherent process variability are illustrated and a number of interpretative problems arising therefrom are examined. Following a deconstruction of these interpretative issues, some examples are given of how, despite methodological difficulties, archaeologically relevant results are obtained where one tries to see the forest for the trees.

\* NARNIA Project Early Stage Researcher



**Daniela ROSENOW**

Institute of Archaeology  
University College London  
UK  
Email: d.rosenow@ucl.ac.uk

**Thilo REHREN**

UCL Qatar  
Qatar  
Email: th.rehren@ucl.ac.uk

*Fruits seem more beautiful than they actually are if they are floating in a glass bowl* (Plinius)  
**Egyptian glass of the first millennium AD: An archaeological and scientific approach**

The organisation of Roman, Byzantine and Early Islamic glass production and trade is a focus of current research, with archaeological discoveries and the scientific analyses revealing that glass was produced on a large scale in the eastern Mediterranean. Much of the glass used and traded throughout northern Africa, the western Mediterranean and northern Europe originated in the eastern Mediterranean, particularly Egypt and the Levant. Through chemical analysis, six major compositional groups (Roman blue/green; HIMT; Levantine I and II; Egyptian I and II) have been identified, of which three can be linked to Egyptian production centres. However, Egypt's key role in glass production is still poorly understood; significant questions surround the location/change of primary production centres, regional supply patterns and the impact of political developments (e.g. Roman decline and the Arab invasion) on Egyptian glass production, distribution and trade.

Drawing upon material housed in UK collections and from fieldwork in Egypt, this paper will elucidate Egypt's position in first millennium AD glass production, drawing upon archaeological (contextual and chronological) data and scientific analyses (pXRF, EPMA). Questions concerning primary production sites, production methods, choice of raw ingredients, chronological issues and the aspect of recycling will be addressed. Preliminary findings confirm the existence of established compositional groups, but additional primary (sub? ) groups must also be considered. Secondary production sites in Egypt seem to consistently favour the use of raw glass produced in Egypt.

**Maria ROUMPOU**

Department of Dietetics and Nutritional Science  
Harokopio University of Athens, and  
Fitch Laboratory  
British School at Athens  
Greece  
Email: mroumpou@gmail.com

**Evangelia KIRIATZI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: fldirector@bsa.ac.uk

**Noémi S. MÜLLER\***

Fitch Laboratory  
British School at Athens  
Greece  
Email: flchemistry@bsa.ac.uk

**Antonis KOTSONAS**

Department of Archaeology  
University of Edinburg  
UK  
Email: A.Kotsonas@ed.ac.uk

**Manthos BESSIOS**

27th Ephorate of Prehistoric and Classical Antiquities  
Greece

**An interdisciplinary study of 8<sup>th</sup> - 7<sup>th</sup> c. BC transport amphorae:  
New light on early Greek commerce**

The use of amphorae in the eastern Mediterranean for transport, trade and exchange is well attested from the late prehistory to the medieval times. This renders transport amphorae an important resource for the study of ancient trade networks and economy. In this paper we focus on transport amphorae from Methone, known as the earliest Greek colony in northern Aegean, in the Thermaic Gulf. The rich assemblage of inscribed transport amphorae from Methone is the earliest known large assemblage of Greek transport amphorae and indicates

\* NARNIA Project Experienced Researcher

the widespread use of these vessels in the Aegean already in the late 8<sup>th</sup> century BC. The assemblage has recently been the subject of an interdisciplinary research project aiming at exploring holistically the issues of content, provenance and technology of transport amphorae. Organic residue analysis was combined with petrographic and elemental (WD-XRF) analyses and the results have been discussed in the light of epigraphic evidence and the traditional study of ceramic typology. Comparable projects on transport amphorae in the Aegean remain rare and analytical work is still limited. The content of these vessels in particular has hardly been thoroughly assessed, with any existing assumptions relying on ancient literature.

A total of 75 samples were selected from transport amphorae; 45 samples were submitted for organic residue analysis, whilst all 75 samples were the subject of petrographic analysis with thin sections and most of them also to WD-XRF analysis. This paper concerns the first overall presentation of the project outcomes that shed light on some early amphora production centres mainly in northern and eastern Aegean. Emphasis will be placed on the results on organic residues, which indicate good residue preservation in the majority of samples. A variety of natural materials has been identified, including beeswax, resins and plant/animal lipids. These results are considered with reference to macroscopic assessments and petrographic analysis, providing many novel insights on trade and economy in the Aegean of c. 700 BC.

**Damir RUMENJAK**

Ministry of Environmental and Nature Protection

Croatia

Email: rumenjak.damir@gmail.com

**Some aspects of copper production in antiquity  
considering the furnace types and production techniques**

The techniques for copper production in the past obviously depended on the types of furnaces used for the production. Questions that still remain open in archaeometallurgy relate to the relation between the production of ceramics (which could be of longer duration than hitherto supposed), the types of furnace used in copper metallurgy, the ways of production of copper from various minerals (oxides or sulphides), co-reduction, the production of copper with or without matte phase, roasting, carbothermic smelting etc. The experimental work in archaeometallurgy, even the most recent examples, is mostly based on very simple devices which do not offer solutions to all of the questions.

The ideas about solutions are scattered in the vast amount of literature and some unification through discussion is needed. The author believes that a discussion on the types of furnaces used or possibly used in antiquity, as a one of the methodological tools, could give solutions to some of those questions. The results of such discussion could also help in planning new archaeometallurgical experiments.

**Katharina SCHMIDT**

Graduate School “Distant Worlds“  
Ludwig-Maximilians-Universität München  
Germany  
Email: schmidtkatharina@hotmail.de

### **Glass production in the Neo-Assyrian Empire**

Many glass objects of the first half of the 1<sup>st</sup> millennium in Mesopotamia were found in Nimrud, Assur, and Niniveh, the capitals of the Neo-Assyrian Empire. In this regard glass vessels are of particular interest as this is the first time that colourless, translucent and transparent, often paper-thin glass occurs within this corpus. The emergence of these technological innovations indicate highly developed glass workshops, which appear to some extent in the cuneiform texts, but which have not been identified until now in the archaeological record. Furthermore, a close relationship to ‘Syrian workshops’ situated on the Levantine coast is often assumed. This could be the outcome of close economic relationship in terms of trade or the exchange of knowledge. A number of archaeometric analyses have been carried out for this region and time-span, but an overall comparison of the Neo-Assyrian glass objects has yet to be presented. For example, previous analytical results of cobalt-coloured glass from Nimrud support the idea of a possible cobalt source outside of Egypt. This is only one example of many which shows that the study of the ancient material glass can be successfully carried out only with the integration of different disciplines, in this case archaeometry, archaeology, and philology. The paper will present glass objects and glass production sites of the Neo-Assyrian period and in this regard will also take archaeometric data into account. Furthermore the range of production techniques that occur in that time will be discussed. Different concepts of exchange will be integrated.

**Craig SMITHERAM**

Department of Archaeology and Ancient Near Eastern Cultures  
Tel Aviv University  
Israel  
Email: craig.smitheram.ii@gmail.com

**Erez BEN-YOSEF**

Department of Archaeology and Ancient Near Eastern Cultures  
Tel Aviv University  
Israel  
Email: ebenyose@post.tau.ac.il

**Naomi PORAT**

Geological Survey of Israel  
Israel  
Email: naomi.porat@gsi.gov.il

**Galina FAERSHTEIN**

Geological Survey of Israel  
Israel  
Email: galafaer@gmail.com

**Optically stimulated luminescence of Timna mines:  
A method for dating ancient mining activity**

Timna valley, Israel is a major source of copper ore and was the location for the pioneering research into the archaeometallurgy and mining archaeology of the Ancient Near East. A fundamental issue in mining archaeology is the challenge of dating, as datable materials are usually rare. During the Central Timna Valley (CTV) Project 2013 and 2014 seasons, research was conducted in order to address the dating of ancient mining activity. As part of the research, we systematically investigated two basic types of mining technology identified in Timna Valley by the Arava Expedition of Beno Rothenberg: open-pit (*placer*) mines (Merkavot 1 of the CTV) and 'plate-like' blocked shaft mines (Merkavot 2 of the CTV).

The results of our excavations confirm Rothenberg's typology and provide new insights regarding mining technology and post-depositional processes, including the important observations of reuse of mining technologies in later periods and deliberate filling of the 'plate-like' shaft mines by the miners as part of the mining process. Furthermore, to address

this long-standing question, we applied optically stimulated luminescence dating to the fine-sand quartz grains of the mine fills and tailings. Together with preliminary results of previous research in the Faynan copper ore district, we demonstrate the potential of this method as a tool to provide age constraints on ancient mining activity.

**Marta TENCONI\***

Queen Rania Institute of Tourism and Heritage  
Hashemite University  
Email: marta.tenconi@gmail.com

**Fadi BALA'AWI**

Queen Rania Institute of Tourism and Heritage  
Hashemite University  
Email: fadi.balaawi@hu.edu.jo

### **State of conservation of the architectural structures and mortars characterisation of the castle of Azraq, Jordan**

The current contribution is part of a research project which aims to assess and quantify the damage level of the stone masonry of the fort of Azraq (Jordan) and to understand the cause of their deterioration, in order to develop a conservation and management plan. The research will be carried out through the integration of *in situ* observations, historical data and scientific investigation. Moreover, the project will also try to understand the building techniques used through time by means of the building materials characterisation.

Previous archaeological surveys have shown that the actual building is a medieval reconstruction of a Roman *castellum* that in the past underwent numerous rebuildings and modifications; however, it probably still reflects the original structure. Through time, the site has undergone mechanical damage whose main effects are the partial absence of plaster on the wall surfaces and the collapse of part of the stone masonry.

Several samples of mortars from the external and internal stone masonry were selected for the archaeometric analyses. The materials will be characterised from a petrographic, textural, mineralogical and chemical point of view through a multianalytical approach including petrographic examinations, particle size distribution studies, XRPD, and microchemical and microstructural studies by SEM-EDS. On those samples in which salt contamination will be detected through XRPD, IC and ICP analyses will be performed. Finally, an environmental monitoring program has been undertaken through a detailed microclimate investigation, in order to obtain more precise information on the salt type.

\* NARNIA Project Experienced Researcher



**Lenore THOMPSON**

Department of Archaeology  
University of Sheffield  
UK  
Email: lthompson3@sheffield.ac.uk

**Roger DOONAN**

Department of Archaeology  
University of Sheffield  
UK  
Email: R.Doonan@sheffield.ac.uk

**Writing artefact biographies:  
The contribution of high frequency non-destructive HHpXRF analyses**

The large body of material culture theory that has emerged over the last two decades provides a rich perspective from which to develop novel research designs that benefit from recent developments in analytical instrumentation. In this paper we examine the potential of HHpXRF studies to inform biographical approaches to archaeological artefacts.

Through the use of an appropriate case study this paper outlines a methodology that integrates identification of fabrication, repair, and maintenance strategies of copper alloy objects with high frequency compositional analysis that would not be feasible with conventional instrumentation. It is suggested that artefact biographies when furnished with high frequency compositional data offer a realistic methodological alternative to conventional typologically based compositional studies.

**Evangelos TSAKALOS\***

Institute of Nanoscience and Nanotechnology  
National Centre for Scientific Research “Demokritos”  
Greece  
E-mail: tsakalos@ims.demokritos.gr

### **Luminescence Dating and the Palaeoenvironment in SE Cyprus**

The coastal zone of southern Cyprus is of great palaeoenvironmental interest and archaeological significance. Specifically, repeated fluctuations of the global sea level during the Quaternary (last 2.5 million years) have created distinctive formations which now appear as geomorphological features along the coastal areas of Cyprus.

In addition to the palaeoenvironmental interest, the coastal areas of southern Cyprus have a rich cultural ‘archive’. Archaeological surveys have identified human activity, the oldest of which dates back to Late Epipalaeolithic (ca. 11.000-10.000 cal BC), while systematic habitation appears to occur in subsequent periods. Permanent settlement of the island by farmers occurs in subsequent periods, namely the Pre-Pottery Neolithic A. Traces of prehistoric human activity in coastal areas of Cyprus are evident among others, and in those geological formations which reflect the aforementioned palaeo-environmental changes.

The investigation of the sedimentological / lithological characteristics of the sedimentary formations containing human activity, gives an excellent opportunity to understand the palaeo-context in which prehistoric activity in southern Cyprus took place. However, the study of palaeo-conditions can be better understood when we are able to provide the time-frame of these events.

This study focuses on the analysis of the different palaeoenvironmental phases/episodes of the coastal areas of southern Cyprus that took place during the Quaternary through an interdisciplinary approach. For this reason various processes including field geomorphological/geological reconnaissance as well as laboratory based analyses have been undertaken. Techniques employed included grain size analysis, polarizing microscopy, XRD phase identification, XRF analysis, ICP-MS analysis as well as SEM/EDS. Special focus has been given on employing up-to-date luminescence dating techniques for uncovering sediments depositional history and provide comments on the late Quaternary environmental change.

\* NARNIA Project Early Stage Researcher

**Lente VAN BREMPT\***

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: van-brempt.lente@ucy.ac.cy

### **Copper production on the South coast of Late Bronze Age Cyprus**

During the Late Bronze Age (ca. 1650-1100 BC) Cyprus played a principal role in the eastern Mediterranean trading networks as a dominating producer and exporter of copper. By the 13<sup>th</sup> century BC Cyprus likely existed as a collection of regional economical and socio-political networks that may have been defined by the transshipment of copper from the mining villages to the primary coastal sites. Evidence of large-scale production to be expected of a principal copper-exporting agent is basically missing, with the sole exception of Enkomi. Nevertheless at nearly every known Late Cypriot site some remains of metal production have been found. This includes the major sites within the southern Vasilikos and Maroni River valleys where metallurgical debris has been found, with a high variability in quantity, distribution, context and type among and within the sites.

As metallurgical remains do conceal the wide range of technological choices made by ancient craftsmen during the production of metals, this project aims to reconstruct not only the multi-phase production process but also its social and spatial organisation within the sites and the region. By means of a variety of analytical methods like optical microscopy, SEM-EDS and XRF the complete metallurgical assemblages found at Kalavassos *Ayios Dimitrios* and Maroni *Tsaroukkas* have been examined and have been compared to the published results for Maroni *Vournes*. The results of this comparative study will hopefully reveal the function played by these major sites within their regional network, and contribute to a further understanding of the copper production on Late Bronze Age Cyprus.

\* NARNIA Project Early Stage Researcher

**Naama YAHALOM-MACK**

Institute of Earth Sciences and Institute of Archaeology

The Hebrew University of Jerusalem

Israel

Email: naama.yahalom@mail.huji.ac.il

### **Egyptian bronzeworking practices in Late Bronze Age Canaan**

During the excavations of Tel Rehov in the Beth Shean Valley, a canal was exposed in a 13<sup>th</sup> BC courtyard. A crucible found inside the canal and numerous prills and other bronzeworking debris found in its vicinity, suggested that the canal had been used for the production of bronze. Its function was to contain the crucible, similar to the set-up in a contemporary industrial quarter at Qantir/Pi-Ramesses in the Egyptian Delta, where it was called a 'melting canal'. Copper alloying and bronze re-melting were conducted inside an open crucible in both regions, although in Canaan, the crucible was usually placed in a simple pit or a circle of stones while in Qantir, it was placed in a canal. The use of a canal, rather than a pit, reflects a stylistic rather than a technological difference, as there is no marked advantage to the former over the latter.

Significantly, at two additional sites, Tel Mor and Tell Qasile, canals were incorporated into installations related to bronzeworking in slightly later contexts. Following the identification of the Tel Rehov canal, and in light of the reconstruction of the melting activities at Qantir, the function of these enigmatic installations in the sites can now be reassessed. The canal at Tel Rehov existed at a time when an Egyptian garrison was stationed at nearby Beth Shean. An Egyptian affinity is most certainly assumed for the canals found at Tel Mor, where Egyptian occupation during the 20<sup>th</sup> Dynasty is well evidenced.



*Abstracts*  
*for Poster Presentations*



**Eleni ASDERAKI-TZOUMERKIOTI**

University College London Qatar

Qatar

Email: e.asderaki@gmail.com

**Evangelia SKAFIDA**

13th Ephorate of Prehistoric and Classical Antiquities

Greece

Email: eskafida@gmail.com

**Metal workshops at the settlement of Kastro-Palaia, Volos, Greece:  
Tin bronze versus arsenical copper**

The excavations at the settlement of Kastro-Palaia (Iolkos' area) on the bay of Volos, Greece, have revealed evidence of metallurgical activities which were performed diachronically from the Early Bronze Age to the Early Iron Age. The continuous habitation of the area has destroyed a lot of evidence from the workshops themselves and hence the archaeological investigation was limited. Nevertheless, evidence of metallurgical activities still exists, i.e. fragments of crucibles, slags, tools, etc. These have been studied in detail.

The results of that study prompted us to continue our research with the analyses of the metal artefacts found in the area. Forty two copper alloy objects have been examined so far with optical microscope, XRF, and SEM-EDS and eight samples have been selected for lead isotope analyses in order to identify the provenance of the metal used.

From the analyses conducted so far we were able to understand the microstructure of the samples - whether the artefacts were hammered or cast, their corrosion degree as well as the chemical composition of the alloy used for their manufacture. The results constitute a valuable contribution to the study of ancient metallurgy in Kastro-Palaia, as they allow us to better comprehend the use of this particular area of the settlement, and the trade connections between Kastro-Palaia and the rest of the world, and especially with Balkans. In addition, we can now understand how metalwork was developed in the area from the EBA to LBA, and the copper ores from which the metal originated. Finally, the use of tin bronze at the settlement of Kastro-Palaia during the EBA, is an important issue, which is discussed in this work and we attempt to understand if there is any connection with the tin bronzes found in the Neolithic settlement of Mikrothives' junction or even to early stannites used in the Balkans.



**Maria Rosaria BELGIORNO**  
ITABC-CNR  
Italy  
Email: mariarosaria.belgiorno@cnr.it

**The Early - Middle Bronze Age basalt anvils of Pyrgos *Mavroraki*:  
Their use, context and related tools**

One of the centres of early development of copper metallurgy in Cyprus is Pyrgos *Mavroraki* in Limassol, a site which dates to the end of the third and the first half of the second millennium BC. Most arguments about the importance of its metalworking evidence derive from ground stone tools found still *in situ*. Among these, the shaped and curated anvils have allowed to identify the final stages of metallurgical production. The observation of features and traces related to metalworking on these instruments reveals the sequence of operations to make knives and blades. The functional analysis of these tools and their spatial distribution discloses important aspects of the social organization of the process of metal production.

### **Thomas EDWARD BIRCH**

Institut für Archäologische Wissenschaften  
Goethe-Universität (Frankfurt am Main)  
Germany  
Email: birch@em.uni-frankfurt.de

### **Fleur KEMMERS**

Institut für Archäologische Wissenschaften  
Goethe-Universität (Frankfurt am Main)  
Germany  
Email: kemmers[at]em.uni-frankfurt.de

### **Sabine KLEIN**

Institut für Geowissenschaften  
Goethe-Universität (Frankfurt am Main)  
Germany  
Email: sabine.klein@kristall.uni-frankfurt.de

### **Michael SEITZ**

Institut für Geowissenschaften  
Goethe-Universität (Frankfurt am Main)  
Germany  
Email: h.m.seitz@em.uni-frankfurt.de

### **Heidi HÖFER**

Institut für Geowissenschaften  
Goethe-Universität (Frankfurt am Main)  
Germany  
Email: hoefer@em.uni-frankfurt.de

### **Greek coinage in context: The characterisation and provenance of silver from Greek colonies in the western Mediterranean 5<sup>th</sup>-3<sup>rd</sup> centuries BC**

Over 100 coin series have been targeted for analysis as part of the research project, *Coinage and the Dynamics of Power: The western Mediterranean 500-100 BC*, representing some 300 coin samples from different cultural spheres (Greek, Punic, Etruscan, Roman). The research involves determining the provenance of some of the first silver and bronze coinages. The project has also been designed to monitor the continuity and change of bullion sources over

time, as well as focusing on key historical and numismatic developments (i.e. changing alliances of Sicily, Spain and North Africa during the Punic Wars).

This paper delivers results from Greek silver coinage studied from city states in Sicily and South Italy, monitoring the development in silver sources at individual mints (Tarentum, Metapontum, Sybaris/Thurium and Syracuse). The presentation will discuss the sources of silver being used to mint Greek coinage in the colonies, and how this relates to power relations in the geopolitical arena. Within this framework, the paper will place special emphasis on aspects of the methodology and reference materials developed.

The coins presented were sampled from the University of Tübingen collection using 0.5-0.8mm diameter drillings. The bulk metal and trace element compositions were analysed by EPMA and LA- ICP-MS. The provenance of the coins was determined by their lead and copper isotope signatures using MC-ICP-MS. The results were rigorously investigated using multivariate methods that incorporate both the compositional and isotopic data, using a script developed in 'R statistics'. The analytical protocol incorporated newly developed silver-alloy reference materials in conjunction with pure silver CRM's available from the London Bullion Metal Association. The custom-made matrix matched standards were produced as part of a collaborative effort between five academic institutions, initiated by this project, to promote the reliability and comparability of silver analyses.

**Xenia CHARALAMBIDOU**

Fitch Laboratory  
British School at Athens  
Greece  
Email: xenia.charalambidou@gmail.com

**Evangelia KIRIATZI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: fldirector@bsa.ac.uk

**Noémi S. MÜLLER\***

Fitch Laboratory  
British School at Athens  
Greece  
Email: flchemistry@bsa.ac.uk

**Myrto GEORGAKOPOULOU**

UCL Qatar  
Qatar  
Email: m.georgakopoulou@ucl.ac.uk

**Sylvie MÜLLER ÇELKA**

CNRS, Universite Lyon  
France  
Email: sylvie.muller-celka@mom.fr

**Tobias KRAPF**

University of Basel  
Switzerland  
Email: tobias.krapf@unibas.ch

**Eretrian ceramic products through time:  
Investigating the early history of a Greek metropolis**

The current project concerns a scientific research programme undertaken by the Fitch Laboratory of the British School at Athens, in collaboration with the Swiss School of Archaeology in Greece. It incorporates macroscopic, petrographic and chemical (WD-XRF)

\* NARNIA Project Experienced Researcher

analyses in the investigation of pottery production in Eretria throughout the Bronze Age – from Early Helladic II-III to the Middle Helladic period – and the characterisation of interactions among the community of Eretria and other sites. The focus of the research rests on the analysis of Bronze Age ceramic material from Bouratsas plot (G/10) and the ancient acropolis of Eretria (F/100-F/200), including more than hundred fifty archaeological and geological samples.

Eretria is among the major Euboean sites during the Bronze Age and the Iron Age and its socio-economic role is of primary importance in the Aegean and the Mediterranean. The identification of Bronze Age local pottery products that has been defined through the current analytical work and concerns coarse, medium and fine wares sheds light on the character of early Eretrian production, the technological choices that Eretrian potters made and the reproduction of local potting traditions through time. Furthermore, the identification of other non-local fabric groups (coarse, medium and fine) among the assemblage from Eretria indicates the circulation of different products in Eretria for various uses and provides information on the role that Eretria played in the local and regional networks in the Aegean.

**Maria DIKOMITOU-ELIADOU**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: m.dikom@ucy.ac.cy

**Giorgos PAPANTONIOU**

Department of Classics  
Trinity College Dublin  
Ireland  
Email: papantog@tcd.ie

**Vassilis KILIKOGLOU**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: kilikog@ims.demokritos.gr

**Eleni ALOUPI-SIOTIS**

THETIS Authentics Ltd  
Greece  
Email: aloupie@thetis.gr

**Demetrios MICHAELIDES**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: d.michaelides@ucy.ac.cy

**Moulding expressions of culture:**

**A technological and compositional study of the Hellenistic and Roman terracotta figurines from the House of Orpheus in Nea Paphos, Cyprus**

The terracotta figurines from the House of Orpheus in Nea Paphos, Cyprus form a significant collection of high-quality statuettes, all recovered in a well-stratified, domestic environment. They provide an important opportunity to study the technology of their production and assess technological variability through time, within an assemblage coming

from one single household. pXRF and NAA were both used for the chemical characterisation of the terracotta figurines, in order to address compositional variability within the assemblage. The initial analysis of the entire terracotta figurine assemblage by pXRF and their fast sorting into chemical clusters was followed by the selection of a representative sample for NAA. Beyond the testing of the correlation between the two elemental datasets, as well as the identified morphological groupings, the two analytical methods offered the opportunity to assess fabric variability and develop further arguments regarding the production and distribution of various types represented in the assemblage. In correlation with macroscopic observations and 3-dimensional reconstructions of the terracotta figurines, a holistic approach was employed, one that aims at an enhanced understanding of the various stages of the production of the terracotta figurines, from the selection of the raw materials, the shaping of the clay body, to firing and the application of pigments and slips for the decoration, and how these differ in time and/or among contemporary workshops.

**Luisa DALLAI**

Department of Historical Sciences and Cultural Heritage  
University of Siena  
Italy  
Email: [luisa.dallai@unisi.it](mailto:luisa.dallai@unisi.it)

**Alessandro DONATI**

Department of Biotechnology, Chemistry and Pharmacy  
University of Siena  
Italy  
Email: [alessandro.donati@unisi.it](mailto:alessandro.donati@unisi.it)

### **AR.CHI.MIN.: A multidisciplinary project for the study of the ancient mining heritage**

The Ar.Chi.Min. project derives from an established collaboration between archaeologists and chemists of the University of Siena. It implies the comprehensive study of ancient mining and smelting sites, combining classic historical and archaeological observations with physical and chemical measurements and statistical methods.

A high output of analytical data was obtained by portable XRF, GF-AAS and ICP-MS techniques. Results were merged in a GIS application, producing a large data-base relevant for environmental, historical, archaeological and technological issues.

This approach was applied to the investigation of “Colline Metallifere”, a wide territory located in the south-west of Tuscany. It is characterized by the presence of strong arsenic and heavy metals contamination associated with a relevant and long-standing tradition of ore mining and processing. The great development of mining activity in this area was due to the presence of a large mineral deposit, mainly constituted by mixed sulfide ores that were exploited since the Eneolithic age for the production of copper, silver, lead and iron. Beside this, considerable alunite deposits were systematically exploited from the Late Middle Ages to the early 19<sup>th</sup> century. Here, archeological research has been developed since 1980 through excavations and surveys, covering a territory of more than 145 km<sup>2</sup>, recording and describing over 2500 sites (about 50% of these were ancient mining and/or smelting sites).

Recent data revealed that mixed sulfide ores deposits, were exploited for various productive aims according to different historical periods and technological skills. Moreover important evidences emerged about the alum production cycles.



**Adi ELIYAHU-BEHAR**

Bar-Ilan University and Kimmel Center for Archaeological Sciences  
Weizmann Institute of Science  
Israel  
Email: [Adi.Behar@weizmann.ac.il](mailto:Adi.Behar@weizmann.ac.il)

**Analysis of faience beads from Early Bronze Age contexts  
at Tell es-Safi/Gath, southern Levant**

Several beads securely dated to the Early Bronze Age at Tell es-Safi/Gath were identified as made of faience. The beads were found spread in various rooms and buildings, associated with leaving surfaces and in some cases together with other important artefacts, such as a cylinder seal. To the best of our knowledge this is the earliest assemblage of faience beads so far studied that originates from well stratified domestic contexts dated to the Early Bronze Age III (ca. 2900-2500 BC) in the Levant. In order to infer on technological issues, such as the method of formation and the use of raw materials and pigments, the beads were subject to chemical and microstructure analysis using SEM-EDS, infra-red spectroscopy and pXRF analysis. The results of the analyses shed light on the production of early vitreous material during this period.

**John GAIT**

Fitch Laboratory  
British School at Athens  
Greece  
Email: flpetrology@bsa.ac.uk

**Evangelia KIRIATZI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: fldirector@bsa.ac.uk

**Noémi S. MÜLLER\***

Fitch Laboratory  
British School at Athens  
Greece  
Email: flchemistry@bsa.ac.uk

**Carl KNAPPETT**

Department of Art  
University of Toronto  
Email: carl.knappett@utoronto.ca

**A diachronic study of pottery production and supply  
at the Bronze Age town of Palaikastro, East Crete**

The site of Palaikastro in eastern Crete has a long history of occupation in antiquity, from the Early Bronze Age through to the Roman sanctuary of Diktation Zeus, and during the 2<sup>nd</sup> millennium BC it was the location of a substantial Minoan town. The British School at Athens has been associated with the site for over 100 years, from its initial investigation in 1902 through to the present excavations run in collaboration with the Universities of Toronto, Bristol (N. Mommigliano), and Nottingham (A. Livarda).

The wealth of material now available from the site, recovered from well documented stratigraphic levels, allows the investigation of important long term diachronic questions, specifically with regard to changing patterns of social, economic, and political interaction between the Minoan town and other contemporaneous sites on the island, as well as the chronological development of a non-palatial town site.

\* NARNIA Project Experienced Researcher

In order to investigate these issues, the Fitch Laboratory has begun a detailed scientific study of the composition and manufacturing technology of pottery from the town from Middle Minoan IIA through to Late Minoan IIIA2. Using petrographic and chemical analysis (WD-XRF) combined with extensive prospection for potential raw materials and their comparative analysis, this project aims to characterise the composition and techniques of manufacture of both local and imported coarse and fine wares, and identify and understand changes over time. These results will, in turn, contribute to the information known from other sites and help to place the Minoan town at Palaikastro within a wider regional and historical context.

**Amir GOLANI**

Israel Antiquities Authority

Israel

Email: golani@israntique.org.il; amirgolani77@gmail.com

**Precious metals in the eastern Mediterranean  
as a measure of changing economic and political realities**

In the passage from the Bronze to the Iron Age in the eastern Mediterranean, a distinct pattern may be observed in the shifting relations between gold and silver. While both metals are in use in jewelry manufacture and for economic transactions as early as the EB if not earlier, gold, probably originating from Egypt, is more commonly found in use throughout the Bronze Age.

This situation gradually changes in the transition to the Iron Age when use of silver gradually becomes more common. The cataclysmic events affecting the eastern Mediterranean c. 1200 BC are also reflected in the use of precious metals and jewelry manufacture. As the supply of Egyptian gold diminishes, the circulation of gold decreases and the use of silver becomes predominant. The reasons for this are probably rooted in changing political and economic realities that not only caused a drying up of the major sources of gold but also created a preference for silver, evident in jewelry manufacture and the increased hoarding and use of silver.

These factors, along with Assyrian textual sources, suggest that with the rapid expansion of the Neo-Assyrian Empire in the Iron Age II period, silver was in high demand for various economic transactions and the payment of taxes, effectively becoming a form of currency.

**Andrew J. KOH**

Department of Classical Studies  
Brandeis University  
USA  
Email: akoh@brandeis.edu

**Philip P. BETANCOURT**

Tyler School of Art  
Temple University  
USA  
Email: ppbcourt1@aol.com

**Marie Nicole PAREJA**

Tyler School of Art  
Temple University  
USA  
Email: marienicolepareja@gmail.com

**Thomas BROGAN**

INSTAP Study Center for East Crete  
Greece  
Email: tombrogan@instapstudycenter.net

**Vili APOSTOLAKOU**

24<sup>th</sup> Ephorate of Prehistoric and Classical Antiquities  
Greece

**Organic residue analysis of pottery from the dye workshop  
at Alatsomouri-Pefka, Crete**

The analysis of residues in pottery by Gas Chromatography to identify their contents has been highly successful in several efforts to identify ancient vessel contents by their absorbed chemistry. This methodology has recently been applied to pottery from the excavations at Alatsomouri-Pefka in northeast Crete by a team of collaborators from the 24<sup>th</sup> Ephorate of Classical and Prehistoric Archaeology in Greece, Brandeis University, the Tyler School of Art of Temple University, and the INSTAP Study Center for East Crete.

The archaeological site at Alatsomouri-Pefka was excavated under the direction of Vili Apostolakou on behalf of the 24<sup>th</sup> Ephorate of Classical and Prehistoric Archaeology. The site

is located near the village of Pacheia Ammos near the coast in northeast Crete. It was a workshop engaged in manufacturing dyes during Middle Minoan IIB. It consists of a group of rock-cut vats, a deep well excavated into bedrock, and remains of buildings. Finds include murex shells, stone pounders and other tools, a sealstone, large quantities of pottery, and other items.

The non-destructive analysis, which has taken place under a permit issued by the Greek government, involves analysis of degraded residues removed from the pottery with solvents. It has identified several of the dyes that were being manufactured in the workshop, including royal purple (confirmed by the presence of crushed shells of the murex species *Hexaplex trunculus*), madder (which yielded a red colour), and weld (which yielded a yellow hue). Lanolin, the oil that is removed from wool before it is dyed, has also been identified.

**Georgia KORDATZAKI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: gkordat@gmail.com

**Evangelia KIRIATZI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: fldirector@bsa.ac.uk

**Noémi S. MÜLLER\***

Fitch Laboratory  
British School at Athens  
Greece  
Email: flchemistry@bsa.ac.uk

**Mary E. VOYATZIS**

School of Anthropology  
University of Arizona  
USA  
Email: mev@email.arizona.edu

**David G. ROMANO**

School of Anthropology  
University of Arizona  
USA  
Email: davidgilmanromano@gmail.com

**Susan PETRAKIS**

Albuquerque  
USA  
Email: susan.petrakis4@gmail.com

**Jeannette FORSEN**

University of Gothenburg  
Sweden  
Email: jeannetteforsen@hotmail.co.uk

## **Gullog NORDQUIST**

University of Uppsala

Sweden

Email: gullog.nordquist@arkeologi.uu.se

## **Emilio RODRIGUEZ-ALVAREZ**

University of Arizona

Email: emiliorodriguez@email.arizona.edu

## **Sarah LINN**

Graduate Group in Art and Archaeology of the Mediterranean World

University of Pennsylvania

Email: slinn@sas.upenn.edu

### **A diachronic investigation of 'local' pottery production and supply at the sanctuary of Zeus, Mount Lykaion, Arcadia-Peloponnese**

A technological and provenance study was undertaken by the Fitch Laboratory on a pottery assemblage recovered during the excavation of the altar of the sanctuary of Zeus, Mount Lykaion, Arcadia, Peloponnese. One hundred samples have been selected to represent all main pottery types spanning in date from the end of the Neolithic through to the Early Iron Age. Petrographic analysis combined with refiring tests and chemical analysis through wavelength dispersive X-ray fluorescence spectrometry were undertaken to address questions of provenance and technology. Moreover, systematic geological sampling was carried out at targeted loci within the wider area of the site to explore the compatibility and locality of the pottery fabrics.

The pottery fabrics of the earlier periods (Neolithic and Early Bronze Age), although compatible with the 'local' geology, are characterised by significant micro-variability, indicating most probably small-scale production and/or non systematic exploitation of local raw material sources. Novel pottery fabrics and more consistently applied pottery recipes appear during the Middle Helladic period. Despite the typological standardisation of the Late Helladic through Early Iron Age pottery assemblage, unpredictable technological variability was confirmed through petrographic and chemical analyses. The interpretation of the above data on pottery provenance and manufacturing technology, combined with the available evidence on the function and use of the recovered pottery, will shed light on the early history of the site, its character, and its role in local and regional networks throughout the prehistoric and historical times.



**Mohamed MAROUF**

Faculty of Arts

Sohag University

Egypt

Email: Mohamed\_marouf30@yahoo.com

**Deteriorating effects of the metal threads on embroideries.  
Technical and analytical study on archaeological textiles**

Embroideries are considered one of the most important complex textiles which are distinguished with a raised pattern by using additional threads called extra yarns. They are generally thicker than the original warp and weft threads. Usually, they are made of metal threads. These metal threads usually are made of gold, silver, copper and/or their alloys as well as gilt and silvered fiber. Although, this technique gives rich surface for aspect of textile, it usually causes a lot of damage as a result of exposure to corrosion of metal threads.

The main objectives of this research are the identification of embroideries, the investigation of the morphological structure of metal threads, and the study of the mechanisms of degradation of metal threads. Another important aim is to explain the deteriorating effects of metal threads on the natural fibers (silk, wool, cotton and linen) that are found in embroideries whether as a fibrous core or as a basic textile.

Many investigation and analytical methods were applied to record the degradation affects; scanning electron microscope and stereo microscope, as well as an energy dispersive X-ray analysis system and X-ray diffraction were used. The study introduces many important results that led to the detection of the aspects of harmful effects of the metal threads. In addition, it explains the relationship between the nature of chemical composition of metal threads and mechanism of their degradation as well as the mechanism of degradation of natural fibers via corroded metal threads.

**Sergios MENELAOU**

Department of Archaeology  
University of Sheffield  
UK  
Email: sergioslim89@hotmail.com

**Ourania KOUKA**

Archaeological Research Unit  
Department of History and Archaeology  
University of Cyprus  
Cyprus  
Email: ouraniak@ucy.ac.cy

**Peter M. DAY**

Department of Archaeology  
University of Sheffield  
UK  
Email: p.m.day@sheffield.ac.uk

**Pottery production and exchange at the Heraion, Samos, during the late third millennium BC: First steps in the study of technology and provenance**

This paper discusses the results of a pilot fabric study carried out on pottery from the Early Bronze Age II late-III (ca. 2500-2000 BC) levels at the Heraion settlement on the island of Samos. This is a time not only of marked social change, but also of an increasing body of evidence, which indicates the widespread movement of pottery within the Aegean and the coast of Asia Minor. The site of the Heraion is important in a reconsideration of this period, as a centre with a local tradition of ceramic production, as well as being a key player in exchange networks within the eastern Aegean.

In a first appraisal of the ceramic assemblage, a total of 44 coarse, medium and fine fabric ceramic samples were selected from the pottery assemblage for microscopic analysis, representing a range of local pottery and suspected imports. Petrographic analysis complemented macroscopic observations and typological-stylistic evaluations, and allowed a detailed characterisation of the samples with respect to textural and mineralogical data. The analytical results reveal information regarding issues of technology, geological and/or geographical provenance of local and suspected imports, forming a firm basis for future analyses of pottery recovered from new excavations at this important site.

**Noémi S. MÜLLER\***

Fitch Laboratory  
British School at Athens  
Greece  
Email: flchemistry@bsa.ac.uk

**Anno HEIN**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: hein@ims.demokritos.gr

**Myrto GEORGAKOPOULOU**

UCL Qatar  
Qatar  
Email: m.georgakopoulou@ucl.ac.uk

**Evangelia KIRIATZI**

Fitch Laboratory  
British School at Athens  
Greece  
Email: fldirector@bsa.ac.uk

**Vassilis KILIKOGLOU**

Institute of Materials Science  
National Centre for Scientific Research “Demokritos”  
Greece  
Email: kilikog@ims.demokritos.gr

**Integrating chemical data of archaeological ceramics into existing databases:  
The new WD-XRF facility at the Fitch Laboratory of the British School at Athens**

Provenance studies of archaeological ceramics, based on their chemical composition, date back more than 50 years. From the very beginning, the eastern Mediterranean region attracted much attention, and over the years a vast amount of data has been collected. The Fitch Laboratory of the British School at Athens has long played a central role in ceramic analyses in the region, employing different methods to retrieve chemical data, and integrating chemical and petrographic analysis under one roof. Recently, a new WD-XRF facility was set

\* NARNIA Project Early Stage Researcher

up at the Fitch Laboratory and an analytical routine dedicated to the analysis of archaeological ceramics was established.

An important issue is comparability of newly acquired data with existing reference data. Much chemical analysis work on pottery from the region was also undertaken with NAA. The recently established *ceraDAT* database, developed at N.C.S.R. “Demokritos”, comprises more than 7000 records of NAA data from archaeological pottery and clays from the eastern Mediterranean region, and provides calibration factors which allow comparison of data from different laboratories collected in the database. With aim to ultimately integrate and compare chemical data acquired with the new WD-XRF facility to the existing *ceraDAT* database records, we have determined calibration factors, analysing reference materials. Cretan clays, previously analysed by NAA, were measured by WD-XRF to explore inter-method comparability.

The integration of chemical data is of particular importance due to the largely shared geographical and chronological foci of studies which make use of the two different methods, both published and ongoing. The outcome of this study is thus expected to ensure inter-laboratory comparability and contribute to longevity of data.

**Pantelitsa MYLONA**

Muséum National d'Histoire Naturelle Paris

France

Email: pantelitsa.mylona@gmail.com

**Site formation processes and use of space  
at PPNA village of Ayios Tychonas- *Klimonas* in Cyprus:  
Micromorphology of mudbrick materials construction, a geoarchaeological approach**

The site of Klimonas is very important to the Cypriot Neolithic Period. During the excavations carried out at the site, a circular building was found. This kind of building reminds us the collective PPNA buildings of Near East. Two other PPNA buildings have been identified in the circular one.

The micromorphological analysis carried out on the filling of this structure, aims to define the technology of the use of earthen balls in the construction of walls. It also aims to specify the process of the formation of the layers and to reconstruct the use of space. As the results show, the material used for the construction of earthen balls comes from the site and its environment. The technical procedure remains the same during the three phases of the occupation although the material becomes more and more anthropogenic.

Two types of sediment were found: the slab and the constructed floor. According to the information concluded after the micromorphological research, the occupation of the site had been continuous but with several variations in what concerns the use of space in each phase. For example there were cases where there was a surface with trampling marks and other cases where there were not any (for example: places for storage etc). Moreover, we can confirm that the third building was used for domestic reasons. More information about the paleo-environment of the site will be collected during the forthcoming fieldwork and analysis.

**Ines OBERHOLLENZER**

Technical University of Berlin

Germany

Email: inesoberhollenzer@live.de

**Rusafa – Sergiupolis / Rusafat - Hisham, Syria:**

**The decoration systems of churches and palaces in the Late Antique and Early Islamic periods, 5<sup>th</sup> to 9<sup>th</sup> century AD: Material, technology and design**

This poster presents the preliminary results of a research project on the technical aspects of the decoration systems of Resafa/Sergiupolis – Rusafat/Hisham in Syria. The Resafa expedition is a project of the German Archaeological Institute (DAI), conducted by Dorothee Sack (TU-Berlin) and Muhammad Sarhan (DGAM Raqqa). Research on the monuments of Rusafa/Sergiupolis - Rusafat Hisham and the construction of their architectonic form would not be complete without a study of their architectural surfaces. The poster will first consider the large Late Antique buildings within the city walls, as well as the buildings of the Umayyad residence outside.

The changes in architectural ornament between the Late Antique and Early Islamic period are especially clear in Basilica A, which contained the grave of Saint Sergius. The lengthy history of this pilgrimage site's use stretches from the 5<sup>th</sup> to the 13<sup>th</sup> century. During this time, the basilica was expanded and parts were converted for use as a congregational mosque. In its apse, traces of several programs of ornament overlaying one another are evident at first glance. Each of these layers indicates a different taste in architectural ornament and a different desired aesthetic effect. The various decorations were made using different techniques, several of which are still evident today. One can see, for example, the effacing of the stone architectural ornament dating from the time of the building's construction, the scoring of the surface to be employed as a base for mosaics that would cover the cupola of the apse, anchoring holes for the attachment of stone-incrustation panels and, finally, metal clamps used as reinforcements for an Abbasid-period stucco frieze applied to the now smooth plastered recess of the apse.

The poster will show how several phases of decoration can be identified on the basis of information regarding the materials and craft techniques employed. This information will be further used to place in order the respective phases of the city's use.

## **Olga PAPADOPOULOU**

Laboratory of Physical Chemistry  
School of Chemical Engineering  
National Technical University of Athens  
Greece  
Email: [olpap@central.ntua.gr](mailto:olpap@central.ntua.gr)

## **Panayiota VASSILIOU**

Laboratory of Physical Chemistry  
School of Chemical Engineering  
National Technical University of Athens  
Greece  
Email: [pvas@orfeas.chemeng.ntua.gr](mailto:pvas@orfeas.chemeng.ntua.gr)

### **Metallographic characterisation of two ancient Roman copper-based metal fragments**

Two ancient copper-based fragments were among the finds recovered during technical works at the riverbed of Tiber in Italy. Both objects are naturally corroded - covered with thick stable patinas - and maintain a metal core. The good preservation condition allows a detailed examination of the metallurgical characteristics and the corrosion layer stratification as well.

The metallographic cross-sections of the objects were studied by optical microscopy in bright field and under polarised light. Chemical analyses, on metal cores and corrosion products, were performed by scanning electron microscopy coupled with energy dispersive spectroscopy. The metal substrates were chemically etched in order to observe the phase distribution and the grain sizes and boundaries in each case. Both alloys were produced by casting. The alloy chemical composition of the first sample is Cu 84.4, Zn 12.7, Pb 2.2, Fe 0.7% weight. The other object is under investigation. Deformed crystals with twins, corroded slip lines and intergranular corrosion phenomena are some of the most interesting findings.

This work is part of an extensive study which, in combination with a literature review of the ancient metallurgical techniques of the Mediterranean, attempts to give answers about the period and the place of origin of these objects as well as the manufacturing techniques employed to produce them.

**Victoria A. SAINSBURY**

Research Laboratory for Archaeology and the History of Art

University of Oxford

UK

Email:victoria.sainsbury@arch.ox.ac.uk

**Reusing, repairing, remelting: Reconsidering ancient glass recycling  
and what that means for material analyses**

Many compositional studies of archaeological glass are frustrated by the well-acknowledged practice of recycling. However, the recycling of glass is not necessarily an obstacle but may also be seen as an opportunity for archaeologists and archaeological scientists alike. Recycled glass is an important source of new material, with social and industrial ramifications. Recycling is not a single practice, but a broad range of different behaviours of reusing, repairing and remelting, each of which has important implications for the significance of glass as a material, trade, as well as the resultant artefacts' place in a social world. It can be a matter of cost, availability, or, particularly in the case of reuse, more complex social ideas, and different forms of recycling will cause different chemical changes to the resultant glass.

In no small part due to both archaeometric analyses and shipwreck excavations, the extensive trade of glass ingots across the Mediterranean in the Roman period is well known, as is the contemporaneous trade in glass cullet. However, the implications of such recycling are often dismissed in discussions of glass composition and trade. By separating out the different forms of recycling and understanding their likely compositional affects, glasses that are likely to have been recycled can be more easily identified. Using a legacy data approach to look at broad compositional trends, particularly the use of colourants and decolourants, proportions of recycled glass in specific assemblages can begin to be discussed, which feeds into larger discussions of glass trade.



**Gláucio MACHADO SANTOS**

Department of Spectacle Techniques  
Theater School  
Federal University of Bahia  
Brazil  
Email:glaucio.machado.santos@gmail.com

**Towards an ancient technological heritage in theater: Exploring links between the Abydos Mysteries (Egypt) and the Great Dionysia (Greece)**

The conjectures here presented are directly influenced by the work of Pearson and Shanks, and are also composed in dialogue with the work of Inomata and Coben. The principal motive for the investigation is the enormous development of scenery and of scene artifacts that occurred during the Great Dionysia in Ancient Greece. In this period, the evidence indicates the increased utilisation of naval structures, suspensions of high weight, and others. This indication allows an inference that some theatrical practices could have been born at the Abydos Mysteries and have been brought to Greece, in the course of a predominantly handicraft tradition: the organisation of a scene. Thus, this work intends to discuss the possibility of Egyptians – priests, philosophers, or even choreographers and scene directors – working as *didascaloi* in Ancient Greek theater.

For this paper, the main source of study was the architectural decoration developed for theater spaces in Greece, taking in consideration the large utilisation of magical effects in the scenes of Ancient Egypt, as referred to by Gillam. Finally, it should be emphasised that this is an embryonic thought of a theater professor, which is offered as a stimulus for the beginning of a collective work. This paper is a mere provocation that intends to invite other colleagues for an interdisciplinary collaborative study, using the knowledge of theater practices, especially staging and scenery, and archaeological data to new possible interpretations of the ancient materials from the Mediterranean.

**Melina SMIRNIOU**

University College London Qatar

Qatar

Email: m.smirniou@ucl.ac.uk

**Polyxeni ARACHOVITI**

13th Ephorate of Prehistoric and Classical Antiquities

Greece

Email:

**Eleni ASDERAKI-TZOUMERKIOTI**

University College London Qatar

Qatar

Email: e.asderaki@gmail.com

### **Compositional analysis of Late Bronze Age glass from Pherai in Thessaly**

Pherai, situated 20km west of the city of Volos, is one of the most significant sites in Thessaly (northern Greece) with continuous and uninterrupted occupation from the Late Neolithic period to modern times. Systematic and rescue excavations of the area since 1976 have yielded substantial information providing a clear understanding of the settlement development from prehistoric through the Late Byzantine period. During Late Bronze Age the settlement reached one of its peaks as suggested by a considerable amount of excavated material. Among the variety of finds there is a large amount of glass mainly from funerary contexts.

The present study examines several glass beads and plaques found in various Mycenaean chamber tombs at Pherai dated from LHIIA (1500-1400 BC) to LHIIIA (1400-1300 BC). Analytical techniques such as XRF and LA-ICP-MS were used to determine the samples' chemical compositions, to characterise the trace elemental content in glass and to identify their raw materials and place of origin. By characterising the glass from Pherai in Thessaly, the present paper examines where the glass was produced and whether it was internationally traded and exchanged looking at similarities and differences on the various regional chemical signatures.

Totko STOYANOV

Department of Archaeology

University of Sofia

Bulgaria

Email: totko@mail.bg

### **Amphorae production in Early Hellenistic Mesambria Pontica**

The poster reviews investigations that have been conducted during the last decades on amphora stamps from Thrace, attributed primarily to the “Parmeniskos group” as defined by V. Grace. Examining amphora stamps of Kabyle, L. Getov suggested that two more names *Ἀντίφιλος* and *Μελσέων* are to be added to the Parmeniskos group. He presumed that their production centre should be traced within the West Pontic area and inland Thrace.

An amphora stamp of *Ματρόβιος* from the Getic city, in the Sboryanovo locality, NE Bulgaria, seemingly related to Parmeniskos group, led to a series of studies by the author. The juxtaposition with a stamp found in Mesambria Pontica, and the numismatic and epigraphic data from that *polis*, provoked the hypothesis that the amphorae with stamps of *Ματρόβιος* are both of indigenous origin and part of the *Antiphilos / Melseon* group.

With a view to test the hypothesis of the local production 74 amphora samples from Bulgaria have been analysed using INAA. One of the results beyond doubt was the differentiation of the stamps in question from the stamps of Parmeniskos group.

Field surveys conducted in 2007 and 2008, in the hinterland of Mesambria, have been undertaken aiming at the collection of samples from local clay beds and their comparison to local production in ancient times. Tests with silicate and element analysis and the comparison with roof-tiles and pottery of established Mesambrian origin confirmed the thesis in favour of local production of the amphorae with the stamps of the group under discussion. After the publication of the results, new stamps belonging to the group appeared.

**Daniela STOYANOVA**

Department of Archaeology

University of Sofia

Bulgaria

Email: daniela.stoyanova.su@gmail.com

### **Archaeological and archaeometric data about the *Moschos*' production of roof-tiles and architectural terracotta on the West Pontic Coast**

The production of *Moschos* is evidenced by stamps found on flat tiles, front cover tiles with an Ionian cima, as well as simas with palmettes and heads of nymphs. Flat tiles with the stamp of ΜΟΣΧΟ were found in Apollonia Pontica, Odessos, Dionysopolis and Olvia. A front cover tile with an Ionian cima with a stamp was found in Messambria. In addition, simas with a stamp of *Moschos* were found in Messambria and Odessos. The specific features of the clay provide the opportunity to identify cover tiles as well as front flat and cover tiles as ΜΟΣΧΟ's production. The accumulated information reveals that the production of *Moschos* was very popular along the West and Northwest Pontic coast.

The published architectural terracotta from Messambria is related to the known stamps of ΜΟΣΧΟ on flat tiles from Olvia. The magistrate ΜΟΣΧΙ is known from Olvian coins dated back in the time span between 350 and 340-335 BC and 330-323 BC. He is related to the same ΜΟΣΧΟ whose stamp was evidenced on the tiles. An attempt is made to specify his status and activity as an architect in Olvia, who also performed magisterial functions related to the control on the *polis*, an activity which does not exclude the possibility of being a pottery/tile workshop's owner as well.

The study on the constructional and stylistic typical features of the *Moschos*' production is complemented by archaeometric analyses: geological evidence, ICP AES – elemental analysis, XRD and microscopic optical analyses. They provide the opportunity to discuss further the production of roof-tiles and architectural terracotta in Messambria and its territory.

**Marshall WOODWORTH**

Research Laboratory for Archaeology and the History of Art  
University of Oxford  
Email: marshall.woodworth@arch.ox.ac.uk

### **Organic residue analysis of Roman amphorae excavated in Beirut, Lebanon**

The residue of the original contents of ceramic vessels has the potential to survive for millennia after the vessel's use and deposition into the archaeological record. Such organic remains rarely survive as visible residues on the pottery's surface but exist in minute quantities that have been absorbed and retained within the ceramic itself. Gas chromatography-mass spectrometry has been proven as a highly selective and specific means for the analysis of such absorbed residues in archaeological material and the identification of a vessel's content. The application of absorbed residue analysis is complementary to material studies concerning ceramic provenancing, providing a better picture of a vessel's content and origin. This paper focuses on amphorae as containers for long-distance trade excavated in Beirut, Lebanon in a process of determining types of commodities (such as wine and olive oil) imported into Beirut during the Late Roman and Early Byzantine periods.