



29 May 2015, Friday

- 09.00-09.30** Registration
- 09.40-09.50** Assist. Prof. Dr. İ.Murat KUŞOĞLU, Director, ARKEM, DEU
- 09.50-10.00** Prof. Dr. Halil KÖSE, Vice Rector, DEU

I. Sessison : EPHEOS

- Chairman :** **Duygu AKAR TANRIVER**
- 10.00-10.30** “Archaeometry in Ephesos: Retrospection and Current Issues of Research”,
Speaker : **Sabine Ladstätter**, (Excavation Leader of Ephesus)
- 10.30-10.50** “Archaic Pottery from Ephesos. Potential and Limitations of Archaeometric Applications for the Reconstruction of the Ionian Ceramic Landscape”.
Speaker : **Lisa Peloschek** (Austrian Archaeological Institute)
- 10:50-11:10** “Late Hellenistic to Late Antique Kitchen Ware of Ephesos: First Petrographic Results”
Speaker : **Jessica Erci**, (Austrian Archaeological Institute)
- 11.10-11.30** Coffee break
- 11.30-12.00** “Scientific characterisation of glass from Ephesos: evidence for regional production?”
Speaker : **Julian Henderson**, (University of Nottingham)
- 12.00-12.20** “Future Perspectives for Ephesos”
- 12.30-13.20** **Lunch in Torbali Vocational School**

II. Session : MILETUS

- Chairman :** **Ali Kazım ÖZ**
- 13.30-14.00** “Archaeometry in Miletus: Retrospection and Current Issues of Research”
Speaker : **Philipp Niewöhner**, (Excavation Leader of Miletus)
- 14.00-14.30** “Archaeometric Methodology on Provenance Analysis of Ancient Marbles in Aegean Region”
Speaker : **Walter Prochaska**, (University of Leoben)
- 14.30-15.00** “The Potential of the Analysis of the Organic Residues in Ceramics for the Study of the Ancient Economy”
Speaker : **Silvia Polla**, (Free University of Berlin)
- 15.00-15.30** “Future Perspectives for Miletus”
- 15:40-17:00** Technical visit to Ephesus Excavation House



Address : Dokuz Eylül University, Torbali Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbali Campus, TR-35860, Torbali, izmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





30 May 2015, Saturday

III. Sessison : SMYRNA AGORA

Chairman : **Nilhan Kızıldağ**

10.00-10.45 “Archaeometry in Smyrna: Retrospection and Current Issues of Research”

Speaker : **Akın ERSOY**, Excavation Leader of Smyrna

10.45-11.15 “First Archaeometric Results of Mortars used in Smyrna Agora”

Speaker : **Burak FELEKOĞLU**, (University of Dokuz Eylül)

11.15-11.45 “Classification of Oxidized Metal artefacts from Smyrna Agora by Portable XRF ”

Speaker : **İ. Murat KUŞOĞLU**, (University of Dokuz Eylül)

11.45-12.15 “Future Perspectives for Archaeometry in Smyrna Agora”

12.15-13.20 **Lunch in Torbali Vocational School**

IV. Session : METROPOLIS

Chairman : **Aygün EKİN MERİÇ**

13.30-14.00 “Archaeometry in Metropolis: Retrospection and Current Issues of Research”

Speaker : **Serdar AYBEK**, (Excavation Leader of Metropolis)

14.00-14.30 “Archaeometry in Gemstone Glyptics for Ionia”

Speaker : **Murat HATİPOĞLU**, (University of Dokuz Eylül)

14.30-15.00 “Future Perspectives for Archaeometry in Metropolis”

V. Session : UNDERWATER of AEGEAN SHORES

15.00-16.00 “Archaeometric Potential of Aegean Shores and Current Issues of Research”

Speaker : **Harun ÖZDAŞ**, (DEU, Institute of Marine Science and Technology)

16:00-16:30 **Closing discussions**

17:30-18:30 **Technical visit to Smyrna-Agora**



Address : Dokuz Eylül University, Torbali Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbali Campus, TR-35860, Torbali, izmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Organizing Comitee

Assist. Prof. Dr. I. Murat KUŞOĞLU, Director of ARKEM
Assoc. Prof. Dr. Sabine Ladstätter, Director of ÖAI
Assist. Prof. Dr. Akin ERSOY, Excavation Leader of Smyrna
Assoc. Prof. Dr. Serdar AYBEK, Excavation Leader of Metropolis
Assoc. Prof. Dr. Philipp Niewohner, Excavation Leader of Miletus
Assist. Prof. Dr. Harun Özdaş, Underwater Archaeology Chair of DEU

Scientific Comitee

Assoc. Prof. Dr. Sabine Ladstätter, Austrian Archaeological Institute
Dr. Lisa Peloschek, Austrian Archaeological Institute
Prof. Dr. Walter Prochaska, University of Leoben
Assist. Prof. Dr. İ. Murat Kuşoğlu, University of Dokuz Eylul
Assoc. Prof. Dr. Philipp Niewöhner, Universität Göttingen
Prof. Dr. Ünsal Yalçın, German Mining Museum
Prof. Dr. Julian Henderson, University of Nottingham
Prof. Dr. Binnur Gürler, University of Dokuz Eylul
Prof. Dr. Sacit Özer, University of Dokuz Eylul
Assist. Prof. Dr. Duygu S. Akar Tanrıver, University of Dokuz Eylul
Assist. Prof. Dr. Aygün Ekin Meriç, University of Dokuz Eylul
Assoc. Prof. Dr. Burak Felekoğlu, University of Dokuz Eylul
Assist. Prof. Dr. Altuğ Hasözbeğ, University of Dokuz Eylul
Assist. Prof. Dr. İlker Özkan, University of Dokuz Eylul



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, izmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Preface

Aegean region of Turkey has hosted several civilizations during the migration and settlements of communities in history. There are lots of proofs for their daily life, knowledge and technological developments and tools for material production and shaping. In this case archaeometry takes place to identify the objects found in excavated archaeological sites for a better understanding of ancient people culture and interactions with each other by using archaeological questions and analytical techniques and investigations of reverse engineering.

Since DEU ARKEM (Dokuz Eylul University, Archaeometry Application & Research Center) has founded in Izmir on March 2014, organization focused to the archaeometric potential and possible scientific investigations in the archaeological sites around Izmir. It is found that cooperations between the running archaeological sites with the assistance of archaeometry will result in a better historical conceptions. In this vision, ÖAI (Austrian Archaeological Institute) which continues excavations and restorations in Ephesos; found the idea of this expectations and would like to organize an international workshop with DEU ARKEM which focus to possible cooperations between running archaeological sites. As a foresight, centering the archaeometric investigations in DEU ARKEM, Izmir may result with the "living excavations" to gain more knowledge in a shorter time with directing the cooperations between sites around Izmir during running excavations.

In this workshop it is aimed to start discussions of the archaeometric presentations from different archaeological sites around Izmir as Smyrna-Agora, Ephesos, Miletus and Metropolis and additionally underwater archaeology team of Marine Science and Technology Institute of Dokuz Eylul University, which will evaluate the possibilities of cooperations between the running archaeological sites reflecting the Aegean ancient civilizations, their cultures and interactions with each other.

We would like to thank DEU ARKEM, ÖAI, Torbali Vocational School of DEU and Dokuz Eylul University for their partnership and supports in this scientific activity for enlarging global cooperations of social and natural sciences to enlighten the history by using archaeology and archaeometry.

Director of DEU ARKEM
İ. Murat KUŞOĞLU



Address : Dokuz Eylül University, Torbali Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbali Campus, TR-35860, Torbali, Izmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Archaic Pottery from Ephesos. Potential and Limitations of Archaeometric Applications for the Reconstruction of the Ionian Ceramic Landscape

Lisa Peloschek

*Austrian Archaeological Institute, Franz Klein-Gasse 1, 1190 Vienna, Austria
e-mail : lisa.peloschek@oeai.at*

Abstract

In Ephesos of the Archaic period, a wide range of locally produced and imported ceramic vessels had been uncovered, particularly in the area of the later Tetragonos-agera. Local production is, most importantly, evidenced through the existence of a pottery kiln containing fragments that might have been constituted the original load of the kiln. Petrographic analyses of selected coarse- and fine wares allowed to further differentiate clay pastes geologically relating to Ephesos' environs. The range of local clay pastes will be highlighted.

Similarly, imported wares will be identified, which are primarily characterised by the presence of volcanic rocks of intermediate composition. They correspond broadly to the area of modern Izmir spanning in the north towards Phocaea/Pergamon. The focus of the presentation lies on the problem related to the attribution of ceramics to individual production sites in the above-mentioned area, as reference data is scarce. Another point that will be discussed is the complexity of determining a provenance for fine wares based on thin-section analyses alone. The aplastic constituents of the clay pastes are defined by an extraordinary fineness lacking any coarse rock fragments essential for a sound interpretation, as examples excavated in Ephesos will illustrate, making the application of geochemical analyses necessary.

It is intended to stress the significance of multidisciplinary research and the need to supplement existing geochemical investigations on ceramics, which have been performed quite comprehensively in Central Western Asia Minor, by petrographic approaches.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Late Hellenistic to Late Antique Kitchen Ware of Ephesos: First Petrographic Results

Jessica Erci

*Austrian Archaeological Institute, Franz Klein-Gasse 1, 1190 Vienna, Austria
e-mail : jessica.erci@oeai.at*

Abstract

Late Hellenistic to Late Antique kitchen wares from Ephesos excavated in prominent sacral, profane and public building complexes such as “Terrace Houses 2”, “Lukasgrab”, “Vediusgymnasium”, “Well on the State Agora” and “Late Antique residence south of the Church of Mary” have been investigated through integrated archaeometric analyses. The selected pottery represents the time span between the 1st century BC and 6th century AD focusing on closed and well stratified archaeological contexts.

The aim of this presentation is to discuss preliminary results of the petrographic investigations of the certainly locally produced cooking pottery of Ephesos. However, it has to be noted that besides Ephesian productions a high amount of petrographic fabrics studied can be regarded as imports, pointing towards an origin from the area around Phocaea. As comparable petrographic data on ceramics from Western Asian Minor so far is scarce this is a fundamental investigation.

Different clay recipes of the local kitchen ware are examined in order to determine how the pottery had been manufactured. One main research objective is, whether the potter had added intentionally temper to the paste in order to facilitate appropriate thermal conductivity of the pots when being in use. Furthermore, a correlation of vessel shapes with petrofabrics is implemented in the aim to reconstruct cooking practices. This study covers different vessel shapes such as cooking pots and their lids, casseroles or cooking pans, which have been exposed in varying way to open fire. In addition, bowls, jugs, vessels with inserted strainers, cups, plates and trefoil jugs have been analysed, which form integral part in ancient food preparation processes. Combining archaeometric and archaeological approaches, new insights into the Ephesian kitchen and dining culture, but also modes of production on the crafts sector, can be gained.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Scientific characterisation of glass from Ephesos: evidence for regional production?

Julian Henderson

*Department of Archaeology, University of Nottingham, University Park, Nottingham NG7 2RD, UK
e-mail: julian.henderson@nottingham.ac.uk*

The scientific analysis of ancient glass from Turkey is still an under-researched field. Therefore the scientific investigation of nearly 100 samples of glass recovered from 2 sites in Ephesos of different periods provides a new window into the use of different glass technologies and their potential provenances. The glass samples were derived from the Byzantine Verulanus Halls and the 'medieval' ('Abbasid?', Seljuq and Ottoman) Turbe Artemesion. The glass from these 2 sites is very different both in terms of its preservation and the types of glass vessels that have been discovered. The glass from the Verulanus Halls is generally better preserved and includes a large amount of window glass fragments.

The contrast in preservation is a clear indication that different glass technologies were involved in the two periods involving the use of different raw materials. Scientific analysis has been carried out using an electron microprobe so as to determine major and minor components and inductively coupled plasma mass spectrometry to determine trace elements. This talk will focus on the interpretation of the electron microprobe analyses and in particular:

- The different compositional types of glass discovered;
- The raw materials used to make the glasses;
- Evidence of recycling;
- The possible provenance for the glasses (where the glasses were fused from raw materials);
- Potential indications for the manufacture of glass in Turkey

The microprobe results have provided evidence for the expected use of natron glass and plant ash glass with these two different glass technologies being correlated with the Byzantine and 'medieval' glasses respectively (Henderson 2013). These 2 basic technologies will be discussed and defined.

However, amongst the later glasses, in particular, but also amongst the Byzantine glasses, the chemical compositions show that there are clear divergences from the expected natron and plant ash glass technologies and this raises questions about the likely different raw materials used to make such glasses and also where they were fused from raw materials. Some of these exceptions contain high levels of magnesium oxide (a possible indicator of a Persian provenance) and others high levels of alumina (a possible indicator of either an Indian/ south-east Asian provenance or a Turkish one). These glass compositions will be compared with published data so as to try to elucidate whether indeed glass was manufactured in Turkey during the Byzantine, Seljuq and Ottoman periods.

References :

Henderson, J. 2013. *Ancient Glass: an interdisciplinary exploration*. New York and Cambridge: Cambridge University Press.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Archaeometry in Miletus: Retrospection and Current Issues of Research

Philipp Niewöhner¹, Reyhan Şahin²

¹Universitaet Göttingen, Christliche Archäologie und Byzantinische Kunstgeschichte, Göttingen

²Uludag University, Department of Archaeology, 16120, Bursa

e-mail : reyhansahin@uludag.edu.tr

Abstract

The expansive investigations in 80's and 90's were focussed on the Archaic settlement in Miletus. The excavations were carried out mainly on the southern slope of the Kalabaktepe. The Sanctuary of Aphrodite Oikous at Zeytintepe was identified and excavated in 1990 to 1991. Through the excavations from 1994 a number of evidence verified the presence of Minoan culture.

Recent geophysical surveys reveal a detailed city plan. One of the main objective of the current researches is to verify different architectural phases in Miletus. In Accordance with this purpose the urban area has been investigated through the drillings. At Humeitepe, which is located in the norteastern of the ancient city center, the surface surveys have been carried out since 2014. The available findings are expected to be supported by the ceramic evidences (Berns & Huy 2014). Current researches also aim to focus on the daily life/living conditions in Miletus after the Archaic Period. For this purpose the housing contexts at Humeitepe are planned to be excavated.

Through the georadar surveying on the Theater hill some architectural ruins from late Byzantine Period are identified, which show divergence from the regular street system and reach out landwärts. (Niewöhner et al. 2013: 208-210, Abb. 79, 82-83). During the excavation season in 2013 it came out that, the cave under the theater belong to an ancient sanctuary. Also some other architectural ruins are defined, which are also clearly belong to this sanctuary For this reason in 2014 season geophysical suveys in the same sanctuary, in front of the cave was carried out.

Archaeometric analysis constitute an important episode of the investigations in Miletus. Chemical analyses shed light on the origin of the ceramics. Accordingly it became definite that Fikellura pottery from Miletus, on the whole, was produced in Milesian workshops. On the other hand imported pottery from different production centers were also identified clearly (Akurgal et al. 2002; Schlotzhauer 2006; Waschek 2008). These findings inform us about the trade relations of the city.

S. Polla's current Project in collaboration with N. Schwerdt "The potential of the analysis of the organic residues for study of Roman and Late Antique Economy" must also be mentioned in this content. The main objective of the analysis is to define the economic aspects of traded coarse and cooking wares and relationship between pottery and regional eating habits. Within the framework of this project, samples of late Antique amphorae and cooking wares from Miletus have been sampled in 2014.

The provenance analysis of the marmor fragments (by W. Prochaska), from the early Byzantine column capitals reveal some results about the variety of their origins. Accordingly a group of available samples can be assigned to local marmor quarries from Bafa (Latmos) Lake. A second group shows the characteristics of the Prokonnessian marmor. The origin of the third group, which is attested among the finds, could not be identified,



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Referances

- Akurgal et al. 2002, Akurgal, M., Kerschner, M., Mommsen, H., Niemeier, W.D., Töpferzentren in der Ostägäis, Archäometrische und archäologische Untersuchungen zur mykenischen geometrischen und archaischen Keramik aus Fundorten in Westkleinasien, Wien.
- Berns/ Huy 2014, Berns, Ch./Huy, S., 2014 Milet 2014 - Survey auf dem Humeitepe. Jahresbericht des Instituts für Archäologische Wissenschaften für das Akademische Jahr 2013-2014, Bochum, 66-68.
- Niewöhner et al. 2013, Niewöhner, Ph., Neue spät- und nachantike Monumente von Milet und der mittelbyzantinische Zerfall des anatolischen Städtewesens, Archäologischer Anzeiger, 165-233.
- Schlottzhauer 2006, Schlottzhauer, U., Some Observations on Milesian Pottery. In: A. Villing & U. Schlottzhauer, Naukratis: Diversity in Egypt. Studies on Greek Pottery and Exchange in the Eastern Mediterranean, London, 133-144.
- Waschek 2008, Waschek, F., Fikellura-Amphoren und -Amphoriskoi von Milet. Ein Gefäßlager am Kalabaktepe? Archäologischer Anzeiger 2, 47-81.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Archaeometric Methodology on Provenance Analysis of Ancient Marbles in the Aegean Region

Walter Prochaska

*Department of Applied Geological Sciences and Geophysics, University of Leoben, Austria
e-mail : walter.prochaska@unileoben.ac.at*

Abstract

A series of methods for tracing the origin of white marbles used in antiquity have been applied so far during the last decades. To pinpoint the place of origin of the marble to an area or even to a special quarry may be of appreciable importance in investigating ancient trading routes and trade relations. A material-specific classification can be conducive to understand if the workshops of an area used marbles of acceptable quality from a local quarry or quarrying areas or if they used imported marbles in or without combination with local ones. Furthermore during restoration activities the knowledge of the origin of the marbles used in architecture may be of importance for supplying more or less original types of marbles. Information on the provenance of the used material may also be of interest for evaluating the authenticity of an artefact.

Petrographic investigations: The characteristic textures and microfabrics of marbles can be used to some extent to characterize and discriminate white marbles of different provenance. Especially the maximum grain-size (MGS) and the average grain-size (AGS) are analyzed. However the number of the different textural elements is limited and for a sound discrimination of white marbles further variables are necessary.

Chemical composition of white marbles: Mg, Fe, Mn, and Sr are incorporated in the carbonate lattice and turned out to be valuable parameters for the chemical characterization of white marbles and have successfully been used by different authors. Especially Mn is an important variable when analyzing white marbles and the content ranges from about 10ppm e.g. in Prokonnesian marbles to a few 100 ppm. Similarly Sr is substituting Ca in the carbonate lattice and covers a wide span.

Stable isotope characteristics of white marbles: A landmark in the investigation of white marbles by means of instrumental analysis was the paper by Craig & Craig (1972) where they published the first stable isotope date on marbles from the Greek mainland and Greek islands with the intention to assign these marbles to their quarries. Up to now thousands of analyses have been published and this analytical method still is the most important and most widely used analytical approach in the investigation of white marbles.

Fluid inclusions in rocks: Different types of microinclusions are ubiquitous in practically all kinds of minerals and rocks. The inclusions which can be found in calcite or dolomite crystals of these rocks represents the volatile phase present during the formation of the rock which is generally the peak of the metamorphic event in the case of marbles. Recently this method was developed to obtain additional analytical parameters in cases when other methods fail to pinpoint the origin of white marbles.

Within the course of this presentation a series of marble provenance studies in the Aegean region will be presented, specifically examples from Ephesos, and the surrounding area. Furthermore the use of aphrodisian marbles and especially the discovery and the wide use of the recently discovered Göktepe marbles will be discussed.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





The potential of the analysis of the organic residues for study of Roman and Late Antique Economy

Silvia Polla¹, Reyhan Şahin²

¹Freie Universität Berlin, Institute of Classical Archaeology, Berlin

²Uludag University, Department of Archaeology, 16120, Bursa

e-mail : silvia.polla@fu-berlin.de

Abstract

A new established research program focusing on Late Antique Urban Economies (conducted by Silvia Polla at the FU Berlin) aims at using the potential of the analysis of organic residues in amphorae and cooking wares for the study of both transmarine and regional trade and urban consumption patterns.

On the one hand, trade and consumption of foodstuff will be studied by examining the contents of the amphorae from several urban excavation contexts. The analysis of the organic residues for the determination of the traded products can provide new information on Late Antique economic change to be compared to the traditional assumption related for example to the agricultural vocation of the amphorae production regions. As an example, the content of spatheia have been recently reassessed and its multifunctional nature hypothesized (Pecci et al. 2010).

On the other hand, socio-economic issues related to the regional trade patterns and use of cooking wares will be considered. Late Antique/Early Byzantine regional foodways (Arthur 2007) will be studied by analysing the organic residues absorbed by material belonging to imported and local cooking wares at different regional contexts. By doing so we aim at shading new light on the economic aspects of traded coarse and cooking wares and on the relationship between pottery and regional eating habits.

Within the framework of this project samples of Late Antique amphorae and cooking wares from Miletus have been sampled in 2014 in collaboration with Nico Schwerdt. The analysis of the absorbed organic residues are in course using GC-MS at the Institute of Chemistry of the Freie Universität Berlin.

References :

Arthur P. (2007a), Pots and boundaries. On cultural and economic areas between LateAntiquity and Early Middle Ages, in LRCW2 Late Roman Coarse, Cooking Wares and Amphorae in the Mediterranean, , BAR Int. Ser. 1662 (I), Oxford, 15-28

Pecci et al. (2010), Pecci A., Salvini L., Cirelli E., Augenti A., Castor oil at Classe (Ravenna- Italy): Residue analysis of some Late Roman Amphorae coming from the port, in LRCW3 Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry. Comparison between western and eastern Mediterranean. BAR International Series 2185 (II) Volume II, 617-622



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Archaeometry in Smyrna: Retrospection and Current Issues of Research

Akın Ersoy

Dokuz Eylül University, Department of Archaeology, 35390, Buca, Izmir
e-mail : akin.ersoy@deu.edu.tr

Abstract

New/Nea Smyrna has been relocated to the area between Kadifekale and Kemeraltı axis after Alexander the Great at the end of the 4. Century B.C., beginning of the 3.century B.C. Findings about the ancient city of Smyrna under the modern city of Izmir can be accessed through a few select locations inside the city; these important spots are the Agora of Smyrna, Kadifekale and Basmane-Altınpark areas.

These locations have been unearthed within the framework of Ancient City of Smyrna Excavation, Research and Restoration Project since 2007 conducted on behalf of Ministry of Culture and Tourism and Dokuz Eylül University. Interdisciplinary studies conducted since the beginning of the project has allowed us to evaluate the different aspects of the city in a complementary way. Within the scope of this understanding, Archaeometry, within archaeology allows us to unveil the abstract model and understand the function and interoperability of the structural framework of Smyrna. Bouleuterion and the Roman Bath, their excavations still ongoing and the previously identified Agora Basilica, West Stoa and the Mosaic Hall has been evaluated with the mentioned method; area and material construct has been styled with the findings through this study.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, izmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





First Archaeometric Results of Plaster and Mortars used in Smyrna Agora

Burak Felekoğlu¹, Eren Gödek¹, Akın Ersoy², İ.Murat Kuşoğlu³, Altuğ Hasözbeğ³

¹Dokuz Eylül University, Engineering Faculty, Department of Civil Engineering, 35390, Buca, İzmir

²Dokuz Eylül University, Faculty of Letter, Department of Archeology, 35390, Buca, İzmir

³Dokuz Eylül University, Archaeometry Application & Research Center, 35860, mTorbalı, İzmir
e-mail : burak.felekoglu@deu.edu.tr

Abstract

“New/Nea” Smyrna has been founded on the slopes of Kadifekale towards Kemeraltı after Aleander the Great. Basilica, comprising one of the biggest graffiti collections of ancient world, is composed of 4 galleries on the basement and 3 galleries on the ground level. These graffitis are giving us extensive information about the ancient world preserved on 2 separate layers of plaster on the walls of the basement. Furthermore, the Bouleuterion which is located beyond the Western Stoa/Portico of the courtyard shows Roman structural features and is thought to be built at the end of the 2nd century.

Lime based plaster and mortar specimens from three different locations of Smyrna Agora excavations have been investigated within the scope of this study. A two-layer graffito plaster from Basilica (P1 inner layer, P2 outer layer) and two distinctive mortars from Bouleuterion were collected from the site. While one of the Bouleuterion mortars was masonry mortar from walls (BWM), other one was from the floor blockade (BBM – porous mortar).

Physical and mechanical properties of plaster and mortar specimens such as water absorption, density and surface hardness and compressive strength have been determined. Thin section analyses were performed for mineralogical investigations. Specimens were gently ground in an agate mortar for the characterization of the binder and aggregate. Aggregate particle size distribution of both plaster and mortar specimens were determined by sieve analysis. The fraction passing through 0.063 mm sieve was considered as the binder. Powder fractions of 0-0.063 mm and 0.063-0.125 mm were used in X-ray Diffraction (XRD) analysis for the comparison and characterization of binder and aggregate crystal structure respectively. The chemical composition of polished sections of plaster and mortar specimens were also investigated by Scanning Electron Microscope equipped with an Energy Dispersive Spectrometer (SEM-EDS).

Physical and mechanical test results showed that outer plaster layer (P2) is denser, harder and exhibited higher strength compared to inner plaster layer P1. This strength difference can be attributed to the possibly low water/lime ratio of P2 plaster in order to finish the outer surface of plaster by pressurized troweling. By this way, it is possible to obtain a smooth surface suitable for graffito applications. Carbonation reactions may also contribute to the strength of outer layer P2 plaster. High compressive strength and surface hardness of Bouleuterion wall mortars (BWM) is due to the presence of crushed brick particles as aggregates which provides a good aggregate-matrix bonding. Dense matrix structure is also responsible for the relatively high mechanical performance of BWM. On the other hand, porous structure of floor blockade mortar located between stones results with low strength and hardness.

Microstructural analysis indicated that graffito plaster layers from Basilica are mainly composed of lime-based mortars. On the other hand, Bouleuterion wall mortars (BWM) are composed of hydraulic lime-based mortars strengthened with crushed brick powder and particles.



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Classification of Oxidized Metal artefacts from Smyrna Agora by Portable XRF

İhsan Murat Kuşoğlu¹, Duygu Akar Tanrıver²

¹Dokuz Eylül University, Archaeometry Application & Research Center, 35860, Torbali, Izmir

²Dokuz Eylül University, Department of Archaeology, 35390, Buca, Izmir

e-mail : murat.kusoglu@deu.edu.tr

Abstract

During the excavations between 2007-2014 in Smyrna Agora and surrounding sectors such as Altınpark, Basmane and Kadifekale, 337 pieces of metal artefacts were classified. In an archaeological manner, most of the findings are classified as copper, bronze and brass and with a less amount of gold, silver, lead and iron based metals. Smyrna is standing under the city center of Izmir. That is why it is not easy to dated metal objects with the help of sterilized archaeological layers. It is tried to dated them according to their shape and typology. Smyrna area is used between Hellenistic to Ottoman period and it is decided that most of the metal artefacts are used in Byzantine and later periods. Very less amount of artefacts are thought to be used in Hellenistic period.

Archaeometallurgy is dealing with provenance analysis of metal artefacts. To produce a metal artefact local or traded metals ores have to be reduced with burning charcoal or wood with the effect of heat. Also the ores of alloying elements have to be used to produce several metal alloys. The knowledge, technology and the trading possibilities of the civilizations change the elemental composition and structural properties of ancient metal artefacts. While copper is a metal, it can be alloyed by tin, zinc, lead, nickel to produce bronze and brass. On the other hand minor elements in the metal ores are the fingerprints reflecting their periods of production and civilization cultures.

In this study, the elemental composition results of 33 oxidized metal artefacts were determined by portable XRF (Olympus Innov-X Delta Premium) to understand how oxide layers can reflect the metal alloy compositions. The oxidation kinetic of elements in the metal alloys and their interior and exterior oxidation mechanisms can change the elemental amounts in the oxide layers than its unoxidized alloy.

It is found that p-XRF is very helpful as a fast classifier during running excavations for oxidized metal artefacts and may reflect their production periods. On the other hand, it can also be used to choose the right metal artefacts for further analysis in clean laboratories.



Address : Dokuz Eylül University, Torbali Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbali Campus, TR-35860, Torbali, Izmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





Archaeometry in Gemstone Glyptics for Ionia

Murat Hatipoğlu

*Dokuz Eylül University, Izmir Multidisciplinary Vocational School, Gemology and Jewelry Program.
Dokuz Eylül University, The graduate School of Natural and Applied Sciences, Natural Building and Gemstones Program
e-mail: murat.hatipoglu@deu.edu.tr*

Abstract

The paper aims an archaeometric study regarding to the mineral origin artefacts with the art of gem carving which have been come out by the archaeological excavations in the Aegean region of western Anatolia since 1940's. Therefore, the gemstone glyptics (seal and ceremonial stones) including both cameos and intaglios in the Izmir Archaeological Museum are identified using the non-destructive (gemological) material identification methods (Pretola, 2001) (such as FT-IR, hydrostatic balance, refractometre, gemmoscope, immersionoscope, polariscope, and UV lamb), and declared as cultural heritage.

In fact, the artefacts made of various gemstones very early became associated with folklore and superstition. Without an understanding of mineral formation or chemical composition of gems, ancient people developed myths as a way to explain the colors of gemstones. In many civilizations worldwide, individual gemstone colors and varieties were believed to have magical influence over the lives of humans. They could bring health or sickness, luck or misfortune, depending on the type of stone, in addition were also important cultural indicators of social rank, profession, and religious belief (Rapp, 2009). This usage way was also accepted by the various civilizations established in western Anatolia in history.

The gemmological material investigation in the Museum reveals that the seal and ceremonial artefacts made by the various civilizations in western Anatolia in history were mainly cut and engraved from the quartz mineral varieties having crystalline, microcrystalline and amorphous structure. Those of crystalline structure are mainly amethyst and rock crystal. Those of microcrystalline structure are mainly blue chalcedony, various agates, carnelian, sard, sardonic, onyx, chrysoprase, and jasper as well as fire and common opals (Table 1). In addition, the archaeological investigation of ancient figures drawn on these artefacts shows about 41 samples of a total 228 samples were cut and engraved by the master craftsmen during the Ionia Period (700BC to the Battle of Lade in 494BC), that balance the Greek and Anatolian cultural influences in this important period of the history (Crielaard, 2009; Greaves, 2010) (Fig. 1), even if the art of gem carving had been dated at least back to the 7th millennium BCE in the Indus Valley (Rapp, 2009).

As a result, it can be stated that the most popular gem materials for glyptic seal manufacture were quartz mineral varieties. Although crystalline structured quartzes were more difficult to carve than microcrystalline structured quartzes, the resulting product was quite durable. Ancient Aegean lapidariers must have understood that a very hard material, such as emery ore widely deposited in the Aegean region, was required to shape or engrave quartz. It should be noted that the enhancement of optical properties in the gemstone artefacts was not well understood until relatively recently. Ancient lapidariers often polished these artefacts or hollowed out the back in order to encourage the transmission of light through the stone, but faceting was not developed until the medieval era. On the other hand, it is obviously that due to the variability and richness of the



Address : Dokuz Eylül University, Torbalı Vocational School, Conference Hall,
7 Eylül Mah. 5562 S. No: 9, Torbalı Campus, TR-35860, Torbalı, İzmir
Tel.: (0090) 232 853 1826 e-mail: arkem@deu.edu.tr
website : www.arkem.deu.edu.tr





geological structure of the Anatolian land, the artefact manufacture from gemstones has been carried out in Anatolia since prehistoric times.

Table 1. Statistical chart of the mineral origin artefacts (seal and ceremonial stones), conserved in the Izmir Archaeological Museum.

Mineral species and variety	Gemstone glyptic form	Usage	Ionia Period (A total of 41)	Sample (A total of 228)
Amethyst	Cameo	Ceremonial stone	1	1
Rock crystal	Cameo and Intaglio	Seal and ceremonial stones	1	8
Agate	Cameo and Intaglio	Seal stone	4	24
Jasper	Cameo and Intaglio	Seal stone	3	37
Carnelian	Intaglio	Seal stone	7	39
Chrysoprase	Cameo and Intaglio	Seal stone	1	4
Blue chalcedony	Cameo and Intaglio	Seal stone	9	22
Sard	Cameo and Intaglio	Seal and ceremonial stones	8	33
Sardonyx	Cameo and Intaglio	Seal and ceremonial stones	3	26
Fire opal	Intaglio	Seal stone	1	20
Dendritic opal	Cameo	Seal stone	1	1
Common opal	Cameo and Intaglio	Seal stone	2	13



Fig. 1. Some mineral origin artefacts (seal and ceremonial stones), conserved in the Izmir Archaeological Museum. Amethyst cameo (003.080), sard intaglio (013.346), common opal cameo (013.496), jasper intaglio (013.499), fire opal intaglio (013.583), blue chalcedony cameo (003.353), sardonyx cameo (13589), agate intaglio (013.523), and rock crystal (010.042).

References

- Crielaard, J.P. (2009). "The Ionians in the Archaic period: Shifting identities in a changing world," in Ton Derks, Nico Roymans (ed.), *Ethnic Constructs in Antiquity: The Role of Power and Tradition*. Amsterdam University Press, 37-84.
- Greaves, A.M. (2010). *The land of Ionia: Society and economy in the Archaic Period*. Wiley-Blackwell, Chichester/Malden, MA.
- Pretola, J.P. (2001). A feasibility study using silica polymorph ratios for sourcing chert and chalcedony lithic materials, *Journal of Archaeological Science*, 28, 721-739.
- Rapp, G., (2009). *Archaeomineralogy*. 2nd Ed., (Editors; Herrmann, B., Wagner, G. A.), Springer-Verlag Berlin Heidelberg, Berlin.