7th Balkan Symposium on Archaeometry

University of West Attica

Hellenic Society of Archaeometry

Non-Profit Organization *Perrevia Network*

Book of Abstracts

Athens, 22-25 September 2020

7th Balkan Symposium on Archaeometry

University of West Attica | Hellenic Society of Archaeometry | Non-Profit Organization *Perrevia Network*

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The University of West Attica is pleased to announce the dates for the 7th Balkan Symposium on Archaeometry. The Symposium will take place between 22-25 September 2020 in the premises of the University of West Attica in Athens. This international symposium aims to highlight recent advances in the archaeometric applications to archaeology and cultural heritage in the wide area of the Balkan countries and to provide an international academic forum for dissemination of results of current research in these fields in the region. The Symposium is addressed to the international scientific community of archaeologists, archaeological and heritage scientists, and researchers. The main theme of the Symposium is: “Science and Heritage” and it will focus on interdisciplinary research projects on cultural heritage of the Balkan countries. The Symposium is organized by the University of West Attica, The Hellenic Society for Archaeometry (HSA) and the Second-level Non-Profit Organisation “Diktio Perrevia” (Perrevia Network). Papers on all aspects of research on archaeometrical applications to archaeology and cultural heritage in the Balkan region are welcome. The results of long-term research projects, evaluation of new and past methodologies, as well as problem oriented and comparative studies are welcome. The geographical scope of the workshop is inclusive, encompassing the Balkan countries and the Black sea, while the chronological scope ranges from the earliest prehistory to medieval and historical periods.

Athens, 22-25 September 2020

7th Balkan Symposium on Archaeometry

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Program

~~**DAY 1 | 22 September (Tuesday)**~~

~~17:00 – 19:00 Registration - Welcome cocktail~~ *Canceled*

DAY 2 | 23 September (Wednesday)

~~09.00 – 10.00: Registration~~ *Canceled*

9.00 – 10.00: Welcome Ceremony and Talks

Session: *Analytical Techniques* | Chairs: *Prof. T. Ganetsos and Prof. S. Akuz*

10.00 – 10.20: Peter Vandenabeele, Anastasia Rousaki, "*Mobile Raman Spectroscopy in Archaeometry Research"*

10.20 – 10.40: Theodore Ganetsos, Efi Tsitsa, George-Michael Sisamakis, "*Tracing the 'evidence' of Minoan painters In Relief wall paintings of Knossos"*

10.40 – 11.00: Nerantzis Nerantzis, Effie Photos-Jones, "*Which ore to smelt? Cultural shifts and changes in raw materials acquisition for the iron bloomeries of Thasos"*

11.00 – 11.20: Eirini Christopoulou, Theodoros Ganetsos, Nikolaos Laskaris, "*Non-destructive XRF and Raman spectroscopy analysis in pigment identification of wall paintings of the painter Nikiforos Lytras from the church of Agios Georgios, Haidari, Athens"*

11:20 – 11:40: Nikolaos Daskalakis, Theodoros Ganetsos, Daniel Moraetis, Eleni Papadopoulou, Iris Tzachili, "*Study and analyses of stone artifacts and vessels from the Peak Sanctuary at Vrysinas (Rethymnon, Crete) applying spectroscopy techniques"*

11.40 – 12.20: Coffee Break

Chairs: *Prof. P. Vandenabeele and Dr. A. Rousaki*

12.20 – 12.40: Konstantina Romantzi, Dionysia Giakoumi, Theodore Ganetsos, "*G.I. Katsigras Museum: in situ measurements in paintings by G. Gounaro"*

12.40 – 13.00: Sevim Akyuz, Sefa Celik, Aysen E. Ozel, Gulnur Kurap, Sait Basaran, "*Analyses of Some Archaeological Potteries and Clays unearthed from Enez Excavation by Variable Analytical and Chemometric Methods"*

13.00 – 13.20: Maria I. Papageorgiou, Theodore Ganetsos, *"The Kouroi of Atalanti: Funerary limestone (poros) statues and grave stelai from the ancient cemetery of Opounta, preliminary presentation, analysis, and investigation of the composition, diversity and possible sources of limestone"*

13.20 – 13.40: Lamprini Malletzidou, Triantafyllia T. Zorba, Dimitrios Karfaridis, George Vourlias, Eleni Pavlidou and Konstantinos M. Paraskevopoulos, "*The dome of Rotunda, Thessaloniki: Characterization analysis of the multi-pictorial phase wall-painting"*

13.40 – 14.00: Ole Christian Aslaksen, Tobias Krapf, Maja Gori, Lena Vasileiou, "*A pXRF survey of Late Bronze Age and Early Iron Age pottery in central Epirus (Ioannina Prefecture) and Southern Albania (Korçë Prefecture)"*

14.00 – 15.00: Lunch Break

15.00 – 17.00: Poster session **| Chairs:** *Dr. A. Oikonomou and Dr. N. Laskaris*

1. **Sevim Akyuz,** *"Investigations of Duloz and EmpireIssues of Ottoman Empire Postage Stamps by Vibrational Spectroscopic and Energy Dispersive X-Ray Fluorescence (EDXRF) Methods"*
2. **Konstantinos Chartomatzidis, Paul Konstantinidis, Lamprini Malletzidou, Ioanna K. Sfampa, George Kitis**, *"Thermoluminescence properties of calcium sulfates of various hydration levels"*
3. **George S. Polymeris, Lamprini Malletzidou, Triantafyllia T. Zorba, Eleni Kouloumpi, Konstantinos M. Paraskevopoulos, George Kitis,** *"Investigating the possibility of age assessment using pigments and dyes; Preliminary luminescence and UV-VIS measurements"*

4. **Meropi Katsantoni, Theodore Ganetsos, Carmela Crescenzi, Foteini Stringari**, *"Study of pigments in Etruscan tombs in Sorano of Italy"*
5. **Fostriropoulou Arentona, Karatzani Anna**, *"Study and Conservation of a pair of women's shoes dated to 1905"*
6. **Maria Ntougka, Theodore Ganetsos, Stella Chrisoulaki**, *"Pigments on Terracotta Figurines of the Hellenistic Period from Piraeus: Non-Destructive Chemical Analysis with XRF and Raman Spectroscopy"*
7. **Pavlos Fovakis, Theodore Ganetsos, Nikolaos Daskalakis**, *"Study and analyses of pigments in minoan larnax from the peripheral unit of Rethymnon (Crete) applying non-destructive techniques."*
8. **Vasiliki Iliakopoulou**, *"Objects, routes with multiple narratives, Digital compositions (Photo collages)"*
9. **Efthalia Patsiatzi, Lamptini Malletzidou, Triantafyllia T. Zorba, Pavlos Beinas, Vassiliki Touli, Konstantinos Chrissafis, E. Pavlidou, G. Vourlias, K.M. Paraskevopoulos,** *"Physicochemical characterization of late post-Byzantine wall paintings, Monastery of the Ascension, Elassona, Mount Olympus, Greece"*
10. **Stylianos Kioumourtzoglou, Paul Konstantinidis, George S. Polymeris, George Kitis,** *"Extension of age limits by fitting TL/OSL dose response curves using analytical expressions from physical models"*
11. **Evmorfia Kasimi, Adamantia Panagopoulou, Christos Karydis**, *"A preliminary study of copper navel phiales from the Louvre Museum and the National Archaeological Museum of Athens with non destructive physicochemical analysis and non-invasive conservation"*
12. **Theodore Ganetsos, Igor Lukacevic, Ante Matanic, Nikolaos Laskaris** *"Pigment identification in paintings by from J. F. Mücke, using Raman spectroscopy: an arts/science project."*
13. **Georgios P. Mastrotheodoros, Eleni Filippaki, Yorgos Facorellis, Konstantinos G. Beltsios, Varvara Papadopoulou**, *"Revisiting the wall paintings of St Demetrios church in Klimatia village (Epirus, NW Greece)"*
14. **Asimina Vafiadou, George S. Polymeris, Ioanna K. Sfamba, Valeria Giannoulatou, George Kitis, Ioannis Liritzis**, *"A comparative luminescence study on several limestone samples of various origins"*

DAY 3 | 24 September (Thursday)

~~**9.00 – 10.00:** Registration~~ *Canceled*

Session: *Analytical Techniques* | Chairs: *Dr. G. Polymeris and prof. Th. Ganetsos*

10.00 – 10.20: Vassiliki Kokla, Anthimia Batrinou, Spyros Papatheodorou, Dimitra Houhoula, George Panagiaris, Agamemnon Tselikas, *"Non-invasive and biological analysis on pigments used in the nineteenth century manuscript"*

10.20 – 10.40: Smit Ziga, *"Can IBA compete with newer analytical methods in archaeometry?"*

10.40 – 11.00: Jan-Michael C. Cayme, Aila Shaine V. Sambo, and Leee Anthony M. Neri, *"Preliminary Analysis of Mortars Excavated at the Calumat Open Site in Alubijid, Philippines"*

11.00 – 11.20: Anastasios Asvestas, Georgios P. Mastrotheodoros, Anastasia Tzima, Konstantinos G. Beltsios, Dimitrios F. Anagnostopoulos, *"Investigation of paintings by scanning xrf"*

11.30 – 12.00: Coffee Break

Session: *Conservation* | Chairs: *Prof. E. Nobilakis and Ass. Prof. Y. Facorellis*

12.00 – 12.20: Anastasia Rousaki, Luc Moens, Peter Vandenabeele, *"Probing into the Painters' Materials and Techniques"*

12.20 – 12.40: Nikoleta Tasiouli, Stamatis Boyatzis, Anna Karatzani, Andreas G. Karydas, *"Study and conservation of a 19 th century printed silk scarf from the collection of the National Historical Museum of Greece"*

12.40 – 14.00: Lunch Break

Session*: Open* | Chairs: *prof. Th. Ganetsos and Dr. G. Mastrotheodoros*

14.00 – 14.20: Argyro Kontogianni, Theodore Ganetsos, Nikolaos Zacharis, Panagiotis Kousoulis, and Evangelos C. Papakitsos, *"A Detailed Study about Egyptian-Coptic and Software Engineering"*

14.20 – 14.40: Vergou Maria, *"Protection and Repatriation of Cultural Treasures - The Acropolis Sculptures"*

14.40 – 15.00: Jelena Živković, *"Ceramic production on northern edges of the Balkans in the Ottoman period"*

15.00 – 15.20: Koutouvaki Eirini, *"Clayey sediments and pottery fabrics in the wider Ierapetra area"*

15.30 – 16.00 Coffee break

Session*: Open* | Chairs: *Prof N. Zacharias and Dr. E. Kouloumpi*

16.00 – 16.20: Ourania Kordali, Artemios Oikonomou, Georgia Pliakou, Nikolaos Zacharias, *"A preliminary study of early Roman glass from Ioannina, Greece"*

16.20 – 16.40: Peter I. Stavroulakis, Karim Sadr, Konstantinos Naseb, Theodore Ganetsos, Nikolaos Laskaris, *"Digital preservation and accurate 3D reproduction of rare archaeological San skull specimen"*

16.40 – 17.00: Vayia V. Panagiotidis, Vasiliki Valantou, Christofilis Maggidis, Nikolaos Zacharias, *"Tracing environmental patterns and human activities via the chemical synthesis of soil stratigraphy: The MY.SPE.AR archaeological project"*

19.00: Social Diner

DAY 4 | 25 September (Friday)

Conservation Session and Dating Session **| Chairs:** *Prof. I. Liritzis and Prof. Th. Ganetsos*

9.40 – 10.00: Ioannis Karapanagiotis, Panagiotis Spathis, "*Superhydrophobic coatings for the protection of calcareous stone"*

10.00 – 10.20: Vasile Bercu, Liviu Tugulan, Mihail Secu, Mihalis Cotrubinis, Octavian G. Duliu, "*Agreement between ESR and TL ages for a recent Romanian Plane deposit"*

10.20 – 10.40: Vasile Bercu, Cătălin Lazăr, Gabriel Popescu, Bogdan Manea, Viorel Fugaru, Octavian G. Duliu, "*ESR study of ceramic fragments collected from several archaeological sites in Romania"*

10.40 – 11.00: Lamprini Malletzidou, George S. Polymeris, Ioanna K. Sfampa, Triantafyllia T. Zorba, Stylianos Stoulos, Konstantinos M. Paraskevopoulos, George Kitis, "*Exploring the potential of calcium sulfates as luminescence dating dosimeters"*

11.20 – 12.00: Coffee Break

12.00: Symposium Results / Best Poster award / New members of Balkan Symposium /

13.00: Announcement of next city of the 8th Balkan Symposium on Archaeometry

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Mobile Raman Spectroscopy in Archaeometry Research

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2. Archaeometry Research Group, Department of Archaeology, Ghent University, Sint-Pietersnieuwstraat 35, B-9000 Ghent (Belgium).

Since a couple of years, Raman spectroscopy is becoming increasingly important in archaeometry research. The technique can be applied in a non-destructive way and is compatible with a broad range of artefacts. The technique provides relatively quickly some information on the molecular and crystallographic composition of the objects under study. Moreover, the technique is frequently applied by using mobile instrumentation. This way, it is possible to bring the equipment on site and the (low power) laser beam is directly focused on the artefact. Thus, sampling is avoided and it is possible to obtain the required molecular information.

Although this approach seems straightforward, some limitations may hamper the applicability. Stable position equipment is of the utmost importance, as correct focusing is of the utmost importance to obtain high quality Raman spectra. Related to this approach, the stability and accessibility of the artefact Is important. Moreover, as Raman spectroscopy is a weak physical phenomenon, interference from background radiation should be avoided. Moreover, when irradiating the object with a laser beam, it is possible that some fluorescence radiation appears – a physical process that might overwhelm the Raman spectrum. Therefore, some approaches have been developed to avoid this interference, which is of extreme help in archaeometry.

Acknowledgments
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Tracing the 'evidence' of Minoan painters

In Relief wall paintings of Knossos

Ganetsos Theodore [1], Efi Tsitsa [2] Sisamakis George-Michael [3]

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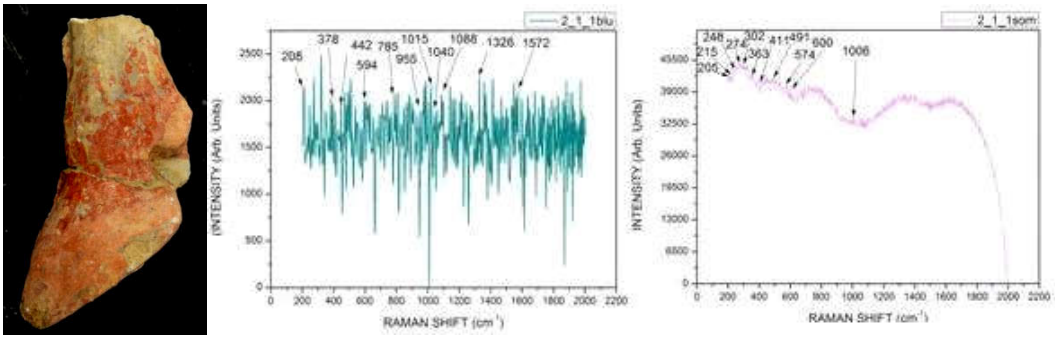
(2) Archaeological Museum of Heraklion, Crete
(3) Student, University of West Attica.

Abstract

Relief wall painting fragments from Knossos were carefully examined, initially under a digital microscope, where different layers and pigments were revealed. During the examination of 'difficult areas' the exact point that the spectroscopy analysis would take place was determined. Raman spectroscopy was selected, as a non-destructive analysis method. New evidence came to light, revealing the complex way that Minoans used and mixed the pigments in order to achieve a certain hue.

The implementation of 3D on relief fragments, gave access to hidden areas and offered a fuller perception even in details. The 3D model allows viewing from all sides and contributes to better understanding of technical applications, enhancing the interpretative framework.

The parallel use of different methods of examination was vital, in order to locate the 'invisible' traces left by Minoan creators. The combination of Raman spectroscopy, digital microscope and 3D applications, gave us today the tools to reveal these techniques that produced unique relief masterpieces from plaster and limited number of pigments.



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Which ore to smelt? Cultural shifts and changes in raw materials acquisition for the iron bloomeries of Thasos

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Abstract

The exploitation of mineral deposits for the extraction of metals on the island of Thasos, N Greece can be traced to the late fourth millennium BC. Archaeological evidence from the EBA onwards suggests that small communities lived largely in coastal settlements on the south of the island and extracted copper, lead and silver for the manufacture of small tools and objects of display.

The 'advent' of an indigenous iron metallurgy, sometime between 900 and 700 BC, is manifested for the first time within a different landscape, namely the central uplands and at the site of Kastri. The Kastri settlement (1200-700 BC) emerges as the dominant settlement already from the LBA with access to trade networks, manifested by imports including precious items in amber, blue glass and metal. Analyses on slag from copper and iron production recovered primarily from the cemeteries show that the local hematite/limonite deposits rich in barite were utilized during this period. But around 700 BC Kastri is abandoned in favour of another location, further north on the coast, at the site of modern day Limenas/Thasos. It is that Thracian settlement that the Parian colonists encounter in c. 670 BC and it is out of that 'meeting' of the Greek and Thracian elements that the powerful city state of Thasos emerges in the late Archaic period with its urban economy and large-scale building projects. All of the above created an increased demand for iron and the bloomeries that sustained it. The above information derives from excavated sites scattered throughout the island. However small-scale surveys across the south have revealed the remains of small bloomeries (manifested as slag remains) of possibly Byzantine/Ottoman period but perhaps even earlier. These bloomeries are characterized by the use of a different source of iron, rich in titanium, the raw materials most probably derived from the freely available magnetite sands found on the island's southern shores. By following these shifts in raw materials acquisition and exploitation through the analysis of metallurgical finds this paper aims to clarify the culturally determined value attachments on resources among the prehistoric indigenous population, the Greek colonists of the urban centre and later still the rural Byzantine communities.

Since the coexistence of rich iron ores and timber is not a rare occasion, Thasos is used here as a model that could be relevant in similar island settings elsewhere when issues of cultural shifts and resource perceptions are under study.

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Non-destructive XRF and Raman spectroscopy analysis in pigment identification of wall paintings of the painter Nikiforos Lytras from the church of Agios Georgios, Haidari, Athens.

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ABSTRACT

The church of Agios Georgios which is dated in 16th century by the wall painting of Humiliation at the niche of intention in the sanctuary that is dated in that period, is famous for the wall paintings which decorate multiple points of the church's interior. All these wall paintings are dated in the second half of 19th century and two of them were painted with certainty by the painter Nikiforos Lytras while the rest of them are probably works of the same artist too. It is about the two wall paintings of Nikiforos Lytras which are situated in the north and the south wall with representations of the Beheading of John the Baptist and Saint George on horseback killing the dragon, three wall paintings situated in the iconostasion of the temple with represantations of Christ ,Virgin Mary and Saint Paraskevi and the wall painting of the niche of the sanctuary with the representation of Platytera(Virgin Mary holding Jesus Christ child) which probably is painted by the painter Nikiforos Lytras maybe in collaboration with the painter Nikolaos Gyzis. [1-3]. The present study is focused on the wall painting of Platytera at the niche of the sanctuary of the church of Agios Georgios (19th century) and is part of doctoral thesis with subject Application of non-destructive spectroscopic techniques for pigments identification and reconstruction of the color pallet in Nikiforos Lytras and Nikolaos Gyzis paintings. For the purpose of this study were carried out in-situ measurements using non-destructive pXRF and pRaman spectroscopic techniques in order to identify the pigments.[4] The results of this study which are extracted based on the collaboration of the two techniques,are of high importance since they are compared with pigments of that period and pigments of other paintings of the same painter in order to fruitful conclusions are drawn as to whether the work was created by Nikiforos Lytras in collaboration with Nikolaos Gyzis as reported or not.

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[1] Dictionary of Greek Artists, item Nikiforos Lytras, MELISSA publications, p.440

[2] PANATHINAIA Magazine volume 269-270(15-31/12/1911)

[3] Nina Athanasiou, Greek Painters, MELISSA publications, 1973

[4] Eirini Christopoulou, Nikolaos Laskaris and Theodoros Ganetsos,2020, Pigment identification of two post-byzantine icons of Theodoros Poulakis by pXRF and pRaman spectroscopies, Scientific culture, Vol. 6 No. 2,(2020) pp.65-72.

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Study and analyses of stone artifacts and vessels from the Peak Sanctuary at Vrysinas (Rethymnon, Crete) applying spectroscopy techniques.

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Abstract

The aim of the paper is to present the first results of the mineralogical and geochemical study of stone artifacts excavated in the biggest Peak Sanctuary in west Crete (Rethymnon), at the Minoan site of Vrysinas (ca. 2000-1550 B.C.E.). For the study and analysis of stone artifacts applied spectroscopy techniques, such as XRF, RAMAN and XRD to confirm a range of various lithologies in the stone vessels and tools from Peak Sanctuary at Vrysinas. The analyzes were carried out in the Laboratory of the archaeological museum of Rethymnon and at the Technical University of Crete. Most of the stone artifacts and vessels ascertain that were made of serpentinite, but also other rocks such as limestone, marble, gabbro, quartz, flint etc were identified. The most of these rock-types are related to various geological formations occurring in Crete such as ophiolite nappes. The results of this paper add another lost link to the ancient technology of Minoan civilization and surprise us with the use of a variety of raw materials, both domestic and imported for the construction of stone artifacts.

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G.I. Katsigras Museum: in-situ measurements in paintings by *G. Gounaro*

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Abstract

George Gounaropoulos (1889-1977) was one of the early 20th century artists who introduced modern art in Greece. Following his academic studies at the School of Fine Arts in Athens, he studied and worked in Paris, where in the 1920s he developed his personal artistic style.

The Municipal Art Gallery of Larissa, G.I. Katsigras Museum owns ten works by Gounaropoulos. George Katsigras (1914 – 1998) was a doctor and significant art collector who subsequently donated his collection to the Municipality of Larissa. He was a close friend of Gounaropoulos from early on which explains why the Katsigra collection contains some rare examples of the artist's early and experimental painting.

Therefore, we had the opportunity to examine six oil paintings, comprising of a self- portrait from 1912, four works from the early to mid-1920s and one from around 1927-29. We also examined three charcoal and pencil drawings from the 1950s and a 1970s charcoal and crayon painting.

The paintings' study is going to be carried out with the valuable help of new technologies. Two non-destructive methods, XRF and Raman Spectroscopy are going to be used. The combination of those methods will give the most accurate results, capable of creating a database that could be used to identify other unknown paintings of the artist or to authenticate paintings that do not bear his signature. The research's main objective is the reconstruction of the artist's color palette. Moreover, the in-situ study will not affect the paintings' condition. The needed measurements can easily be taken, even without taking the artworks down.

Fig.1 a) "Blonde Nude" 1924 – 1925 and b) In-situ measurements in paintings using XRF and Raman

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Analyses of Some Archaeological Potteries and Clays unearthed from Enez Excavation by Variable Analytical and Chemometric Methods

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Abstract

Potteries are the most abundant findings among the archeological artifacts. These findings, whose main raw material is clay, give important information about the civilization, culture, technology and trade of that period. Clay minerals undergo chemical and structural changes during the firing; e.g. during thermal treatment the structural collapse due to loss of structural hydroxyls, transformation to different mineral structures due to reaction with calcite in the structure and phase changes. For this reason, investigation of the mineral structures of the ancient potteries gives information about the firing temperature and firing conditions. Since XRD provides information mineral phases only in crystalline state, in combination to XRD the FTIR and Raman spectroscopic investigations and the determination of elemental contents by EDXRF allow us to determine the firing- temperature and -conditions in more detail.

In this study, pottery fragments belonging to 4th-6th Century BC, excavated in Enez-Turkey, were analyzed by different analytical techniques, in comparison with a local clay unearthed during the excavations. In order to determine the firing temperature of the pottery shreds, thermal simulations were performed by using ceramic tablets, prepared in different temperatures from the local clay, unearthed during the excavations. Moreover to estimate the upper limit of the firing temperature of the pottery fragments, the specimens were re-fired up to 850°C. Comparison of the second derivative profiles of the IR spectra of original and corresponding re-fired pottery fragments indicated that potteries were fired less than 850°C. **The comparative FTIR and micro-Raman spectroscopic, EDXRF and XRD analyzes of the terracotta remains allowed to determine the chemical and mineralogical contents of the ceramic fragments.** Chemometric analysis of the IR data was also performed for revealing distinct groups. Principal component analysis and cluster analysis techniques were used.

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The Kouroi of Atalanti: Funerary Limestone (poros) Statues and Grave stelai from the Cemetery of Ancient Opous, Preliminary Presentation, Analysis, and Investigation of the Composition, Diversity and Possible Sources of Limestone

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Abstract

Of exceptional importance for Central Greece and for the art of Archaic sculpture in general, considering their scarcity, are the funerary limestone statues that came to light by the Ephorate of Antiquities of Phthiotida and Evrytania at the east fringes of Atalanti, at the end of 2018.

Statues are only part of the wider monumental landscape of the unknown organized ancient cemetery, a small part of which was unearthed at the east edge of Opous (Atalanti), the capital of ancient Locris. Additionally, during the excavation, which is still in progress, 13 undisturbed tombs have been investigated. These contained single burials, accompanied by plentiful and significant artefacts, such as terracotta figurines, bronze vessels and mirrors, as well as silver and glass jewels, dated from the 6th to the 2nd century B.C. The cemetery is still under study, yet unpublished, and the current article is the first preliminary report for the mainly life-sized limestone statues and grave stelai. The exceptional and innovative stylistic features of the statues and the unique way of their standing indicates that they were created by an unknown Locrian Sculpture Workshop that was active in the region –according to our current knowledge- from the 6th to the mid.- 5th century B.C.

Analyses have been carried out in order to investigate the diversity of the limestone composition from which sculptures and grave stelai were made, to identify further distinct groups with different chemical composition and finally to locate possible quarries or regions of East Locris that functioned as the sources of limestone extraction.

New technology equipment applied in order to identify specific characteristics of the limestone statues and grave stelai. The 3D measurements of the statues were performed on a Shining 3D Einscan 2X 3D Scanner. The scanner was set up to acquire in, Feature-only Rapid Mode with a resolution of 0.2mm. For post processing, quality option was selected.

Fig. 1 Archaic sculpture and 3d scan image

XRF in-situ measurements were carried out in order to investigate the diversity of the limestone composition from which sculptures and grave stelai were made. We identified distinct groups with different chemical composition and after a useful comparison with XRF data from 9 different regions of East Locris we found the possible provenance of the sources of limestone extraction.

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The dome of Rotunda, Thessaloniki: Characterization analysis of the multi-pictorial phase wall-painting

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Abstract

Constructed in the early 4th century AC, as a part of the Galerian Palace Complex in Thessaloniki, Rotunda is a monumental circular domed structure decorated with marvellous mosaics. The wall-painting under study was created in the late 19th century by the Italian artist S. Rosi, in order to replace the eastern missing part of the dome's mosaic composition. The applied painting techniques, the previous pictorial phases, the existence of overpaintings and the restoration problems of the Rossi wall painting are matters which have concerned conservators, archaeologists and scholars.

Samples collected from the lower area of the Rosi wall painting were examined by means of microscopic, spectroscopic and crystallographic techniques, in order to investigate the applied pigments and materials, the microstratigraphy of the samples and the wall-painting's state of preservation.

The S. Rosi pictorial phase -imitating the lost tesserae- is an oil painting which consists of a false gilding background, while Prussian blue, green earth, emerald green, ultramarine and ferrous pigments (ochres and umbers) were identified within the painting layers, along with ZnO and $BaSO_4$. At least two more pictorial phases also exist below the S. Rosi wall painting and of different painting techniques. The first one -attributed to the Byzantine era- shows indications of the use of *fresco* technique, along with the presence of green earth and bone black. The second pictorial phase is an egg tempera of the Ottoman period, while red lead and lead white are the identified pigments.

The dark hue of the S. Rosi pictorial phase is attributed to the natural ageing of the applied materials and to the surrounding mosaics' preservation state at the time of the painting's completion. Finally, the existence of overpaintings was not supported by means of characterization, at least not by the samples under examination.

Acknowledgements

The authors acknowledge to the Ephorate of Antiquities of Thessaloniki City for the permissions of this work and especially M. Kyranoudi, Director of the Department of Conservation of Antiquities and Works of Art. This work was supported by the Hellenic Foundation for Research and Innovation (HFRI) and the General Secretariat for Research and Technology (GSRT) for the HFRI PhD Fellowship grant (Grand Number: 22).

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A pXRF survey of Late Bronze Age and Early Iron Age pottery in central Epirus (Ioannina Prefecture) and Southern Albania (Korçë Prefecture).

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Abstract

In this paper we discuss the results of a survey of pottery from Bronze and Early Iron Age from southern Albania (mainly Sovjan) and central Epirus (mainly Krya and Liatovouni) conducted with the means of portable X-Ray Fluorescence (pXRF) scanning. In addition, a survey of clays from the Korçë Basin (Albania) was pursued to get a basic knowledge of the chemical composition of raw materials in the area. Both undecorated and decorated pottery from different periods were analyzed and compared to discern tendencies of clustering or the lack thereof. Materials from central Epirus, and southern Albania were studied separately, but following the same approach and aims. In this way local technological practices and the impact of new decorative styles on local communities can be understood by looking at types and the usage of raw materials.

A Thermo Niton XLT-3 GOLDD+ energy dispersive portable XRF was used for the study. The device has a main, high, low and light filter which together ran for a total of 380 seconds on the instrument's Mining Cu/Zn setting. Several spots were analyzed on each sherd to avoid the effect of inclusions (following Bergman & Lindahl 2016).

At Sovjan, *the results indicate that* the later material is more diverse in composition than the earlier albeit this is the case for both the unpainted and painted pottery. For the material from Liatovouni it may seem as if late orange-red fine ware pottery differs from other wares. The materials from Krya was less uniform than that from Liatovouni. Concerning the paints, the material from central Epirus and southern Albania showed some differences concerning the relative amounts of for example Fe and Cr, which is generally more abundant at painted spots than unpainted spots in Albania. The local technological variation may hint at the movement of knowledge and aesthetic taste rather than pots and materials even if similar styles and pottery types are found at the sites in question (e.g. the matt-painted pottery of the Late Bronze Age and mainly Early Iron Age).

*The research here presented was conducted while employed at the Univ. of Gothenburg, and was financed by the Bank of Sweden Tercentenary Foundation.

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Investigations of Duloz and Empire Issues of Ottoman Empire Postage Stamps by Vibrational Spectroscopic and Energy Dispersive X-Ray Fluorescence (EDXRF) Methods

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Abstract

The first postage stamp use in the world started in 1840. In 1875, the Universal Postal Union was established to coordinate many postal services spread around the world, and the Ottoman Empire was a founding member. The aim was to combine proportions, weights, and acceptance requirements. The following year, the Ottomans launched a new set of stamps known as the Imperial series. From then on until the end of the Ottoman Empire a variety of stamps were issued. The Duloz series of stamps were printed between 1865-1882. Afterwards, Empire stamps had been printed Ottomans after being a member of Universal Postal Union. Unlike the previous Duloz series postage stamps, Empire stamps had been bear the name of the country in Western characters and values.

In this study, Duloz and Empire issues of Ottoman Empire postage stamps, printed in 1865-1913, have been analyzed for the first time, non-destructively using Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR), Raman and Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry methods. The merging of data coming from analytical techniques has allowed the characterization of the pigments used on the surface of each stamp and dispersed between the paper fibers. Lead chromate, Prussian blue, vermillion, calcium carbonate, gypsum, cellulose and oil were identified. Moreover, the oxidative and hydrolytic degradation the cellulose due to aging paper of the stamps was also analyzed.

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Thermoluminescence properties of calcium sulfates of various hydration levels

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Abstract

Calcium sulfate is found in three different hydration levels, namely anhydrate, hemihydrate and dihydrate. The study of their thermoluminescence (TL) properties is essential for potentially using them as dosimeters, especially for archeological and geological dating methods. In this experiment, we used natural and commercial samples. The irradiations were applied through a $^{90}Sr/^{90}Y$ beta source, and the TL measurements were carried out using a Harshaw-3500 TLD-Reader, in a nitrogen atmosphere. The following experiments were applied to each sample. a) Sensitivity test, where the effect of repetitive measurements on the TL intensity was examined. The protocol included a measurement of the natural TL signal, followed by an irradiation dose of 3.8 Gy with a record of the TL glow curve up to 400 °C. This procedure was repeated 4 times. b) Dose response experiment, including the irradiation with doses of 1.9, 3.8 and 5.7 Gy and the record of the TL glow curve up to 400 °C. c) Inspection whether the TL glow curves change with various heating rates.

Representative figures of dihydrate calcium sulfate show an excessive increase on the TL intensity after each successive cycle of irradiation-measurement (Fig. 1a), while a linear correlation was observed between the dose and the TL intensity in all samples (Fig. 1b). Finally, the inspection regarding the different heating rates shows a different fluctuation of the TL intensity for each sample.

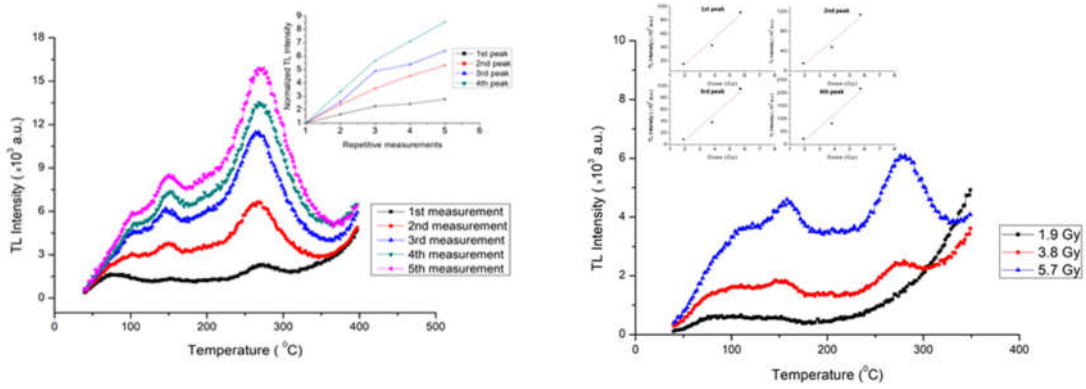

Fig1: a) Sensitivity test on the dihydrate calcium sulfate, b) Dose Response of the dihydrate calcium sulfate

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Investigating the possibility of age assessment using pigments and dyes; Preliminary luminescence and UV-VIS measurements

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Abstract

Direct and absolute dating of paintings becomes an important task which is related not only to archaeometry, but also, to authenticity testing. As the main constituent of a typical painting stratigraphy, the painting layers include mostly pigments and dyes. Even though the ground layer could be a very helpful tool for indirect dating, recently specific ground materials have been reported as very promising towards direct dating by luminescence techniques. The present study presents preliminary thermoluminescence (TL) and optically/infrared stimulated luminescence (OSL/IRSL respectively) measurements on pigments and dyes, traditionally used for paintings since antiquity. Over thirty different materials were studied; the majority of these were of inorganic nature, consisting of silicates, aluminosilicates and inorganic carbonate content. Basic TL/OSL features excluding dose response features were studied. The chemical composition of these colour pigments, in combination with their wide spread use in artistic laboratories throughout centuries, constitute two powerful motivations for further investigation of these materials for luminescent dating purposes.

The majority of the pigments/dyes, including all ochres, umbers, Persian red and Egyptian blue, present features that correspond to natural quartz, a luminescent material already established for dating applications. These features include (a) typical SiO_2 TL peaks (110 °C and 325 °C) along with (b) a sensitization pattern, due to which, predose effect could be effective towards dating, (c) a fast OSL component and (d) quite effective bleaching ability. In the case of black dyes (Ivory and Bone black) the luminescence signal is dominated by apatite, along with carbonitic traces. Green Verona samples indicate that the dominant mineral is calcium sulphate. For the cases of blue pigments, such as Lapis Lazuli and ultramarines, the TL glow curve indicates the presence of a feldspathic shape without the presence of obvious TL peaks; the signal originates from lazurite. Finally, for Alizarin and Indigo, being of organic content, only OSL at room temperature was measured. For each pigment/dye, UV-VIS spectrophotometry was applied in order to calculate the optical energy gap of the dominant mineral. Besides the quartz-based pigments, our results indicate that all blue pigments stand as very promising candidates towards luminescence dating of paintings.

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Study of pigments in Etruscan tombs in Sorano of Italy

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This research work presents the study of pigments in the Necropolis of San Rocco in Sorano, Italy. The necropolis is noteworthy not so much for its enormous size, but for the many different types of tombs it contains. The research was carried out in the Etruscan monolithic tombs, dating from 3rd - 2nd century B.C. The most important Etruscan tombs in Sorano which were studied are the Tomb Hildebrand and the Tomb of the winged demons.

The method which was used to identify pigments is a portable non-destructive technique: μXRF [1]. This technique has been chosen because it is impossible for part of the frescoes to be transferred to the laboratory and they cannot be sampled, which is a destructive method. The operating principle of XRF is the X-ray fluoresce spectroscopy and it is used for both qualitative and quantitative elemental analysis of solids, gases and liquids samples. The results of the measurements in the Etruscan tombs in Sorano showed that consist of the pigments: yellow ochre, red ochre and carbon black. Corresponding pigments, according to the literature, have been used in the necropolis of Cerveteri [2] and the tomb Dell 'Orco in the necropolis of Tarquinia [3].

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Study and Conservation of a pair of women's shoes dated to 1905

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Abstract

The project involves the analytical investigation and conservation treatment of a pair of women's shoes (slippers) from Pyrgi of Chios, which is part of the collection of the *Lykeion ton Hellenidon* of Athens.

The shoes are dated to 1905 and were typically used on festive occasions. They are made of velvet fabric decorated with red tassels and embroidered with metal threads and sequins and they are flat with leather outsole. They are both misshaped and the leather outsole is worn off. The velvet fabric is in good condition but the metal threads are corroded and some sequins and tassels are missing.

Shoes are composite objects with a complex construction and decorative elements and as such they pose difficulties to conservators. The published information on methods developed for the conservation treatment of shoes is limited. They mostly deal with leather archaeological shoes (Peacock 1983, Kite and Thomson 2006), while shoes are briefly discussed in textile conservation texts (Landi 1992, O'Connor and Brooks 2007).

Shoes from that time are only rarely found in collections in Greece, and their study will provide technological knowledge and information about the value and significance of such objects during the early 20th century. Similarities with Eastern shoes will be explored due to the geographic location of the island and to the possible trade routes of the period produced (Görünür, 2014). To provide answers to these questions and for developing an appropriate treatment proposal a more in depth study of their construction, the materials used and their state of preservation was performed.

Optical Microscopy, Scanning Electron Microscopy coupled with Energy Dispersive Spectroscopy, Fourier Transformed Infrared Spectroscopy, X-radiography and X-Ray Computed Tomography were used for the study and documentation of the shoes.

This methodology provided details of the construction technology related to the successive layers of the sole (leather and supporting materials), their morphology and thickness and the joining techniques used. The velvet part and the supporting layers together with the metal threads and the stitching used to secure it at the leather insole were also recorded. The fibres of the velvet and the tassels were identified as well as the metals and the core threads of the metal threads and the sequins. Based on the results obtained treatment options were explored in order to clean, reshape and stabilize all their individual parts.

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Pigments on Terracotta Figurines of the Hellenistic Period from Piraeus: Non-Destructive Chemical Analysis with XRF and Raman Spectroscopy

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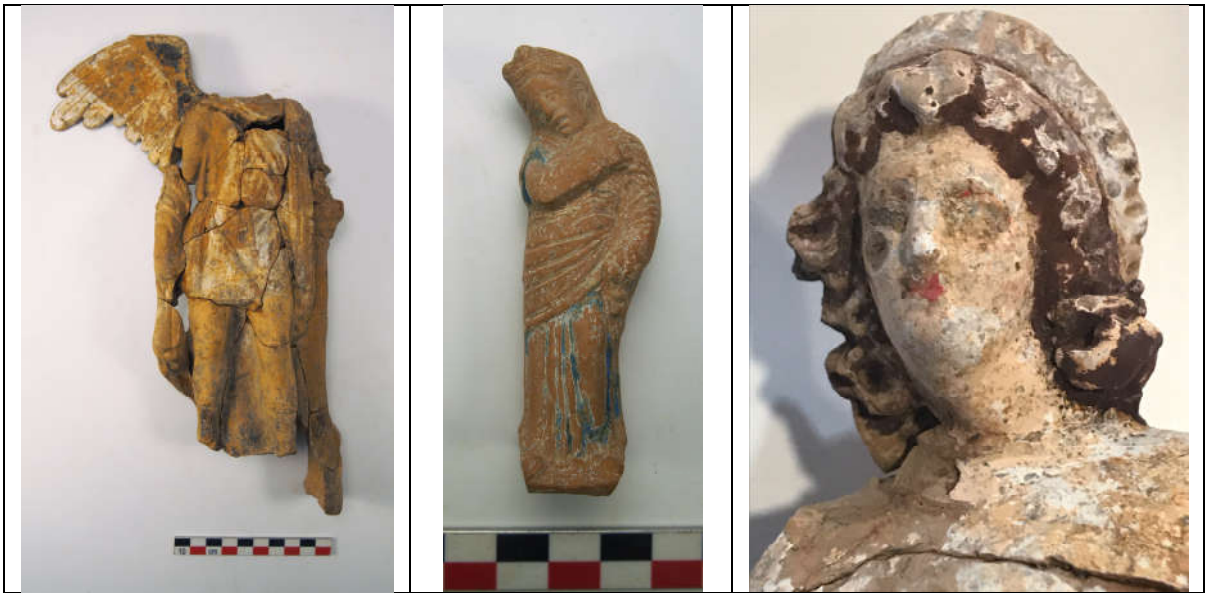
Abstract

In this research work we present our preliminary results on the investigation of pigment identification using non-destructive and portable spectroscopic methods on ten fragmentary Hellenistic figurines from the Metro excavation of Piraeus. The figurines were chosen based on the preservation of their pigments, the range of colours and the patterning of colours between different workshops or even different types of figurines. Initial measurements were taken with an X-ray florescence spectroscopic portable instrument to detect chemical elements. Subsequent measurements were carried out with a portable Raman apparatus to identify the chemical composition of each pigment. Spectragryph software was used to analyze the Raman and XRF spectra and then, we cross-referenced them to the ones found in the international pigments' databases. Also, measurements were performed on the unpainted interior of the figurines to ensure that the measurements of the painted exterior register pigment and not a clay spectrum. The analysis revealed, as expected, mainly inorganic pigments. Additionally, considerable indications of organic pigments were revealed as well, and thus it will be important to corroborate this by using more specialized techniques. The broad pallete of pigments includes: two different types of white pigment namely gypsum and lead white, copper-based blues, red lead, red ochre and cinnabar, a mixture of red ochre and red madder to create a pink colour, and yellow ochre. The presence of carbon black was assumed as it could not be identified as another pigment.



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Study and analyses of pigments in minoan larnax from the peripheral unit of Rethymnon (Crete) applying non-destructive techniques.

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Poster

Abstract

The aim of the paper is to present the first results of the study and the analysis of the pigments, which were used for the decoration of the larnax from the peripheral unit of Rethymnon, dating back to the Late Bronze Age, specifically in the LM III period (1300-1100 BC).
For the analysis and the identification of the pigments on the coloured surfaces of the larnax were used the non-destructive spectroscopic methods XRF and RAMAN. Due to the large number of the larnax and their extraordinarily high archaeological value, which makes it impossible to transport them, the use of portable Raman and XRF spectrometers for the analyzes carried out in the warehouse of the Rethymno Ephorate of Antiquities, as well as in the old Archaeological Museum and in the contemporary exhibition of the new Archaeological Museum of Rethymnon.
The analysis revealed the use of a variety of pigments, both organic and inorganic, which appear in the majority of the larnax, as basic paints or as random admixtures or as oxidation of mineral paints. In particular, were found and identified inorganic pigments such as lead white, white chalk, gypsum white, white bone, yellow ocher, orpiment, red ocher, red lead, realgar, vermillion, black carbon and bone, azurites, lazurites, Egyptian blue, riebeckite, malachite etc, as well as inorganic pigments, such as purpurine, berberine and saffron.
The results of this paper add another lost link to the ancient technology of Minoan civilization and surprise us with the use of unknown –until now- raw materials, both domestic and imported, such as the realgar, vermillion, Egyptian blue etc.

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Fig. 1 Painted LM Larnax from the Armenoi necropolis, Rethymnon, Crete

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Objects, routes with multiple narratives, Digital compositions (Photo collages)

Iliakopoulou Vassiliki
Painter, Engraver, Graphic Designer Msc.lighting designer

In the present thematic research, at the first level, the Head of Hermes is chosen as the study object of special interest. The head of Hermes is part of the well-known work of ancient Greek sculptor, Praxitelis, and dates back to around 340 B.C. The statue, due to its harmony and beauty, is the ideal image of classical beauty in sculpture which resulted to become known throughout the world within a short time of its discovery.

The artist (author) chose this specific creation, an exact copy of the original, because it belongs to her personal collection and because of both its ideal proportion (analogy) and its purity of the shapes. It has been photographed from different positions, so that the change of lighting environment and angle of view affect the way the viewer perceives it. The aim of photography is to convey both the theatricality-drama and the emotional charge that it causes to the viewer, thus rendering elements such as calmness, contemplation, oppression and arrogance.

In the second level of this research work, digital compositions are created using some of the artist's (author's) paintings and photographs. The main goal of the research is to highlight the composition of photographic material in a work completely different from the original. The whole process of this exercise was implemented with many test preparations in order to success the final result. The main elements were: Museum – city-monument: Objects, routes with multiple narratives.

Keywords: arrogance, contemplation, oppression, calmness.

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Physicochemical characterization of late post-Byzantine wall paintings, Monastery of the Ascension, Elassona, Mount Olympus, Greece

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Abstract

In order to maintain cultural identity, it is crucial to search thoroughly cultural heritage materials. The Monastery of Ascension is located in Sykea, a village of Elassona town near Mount Olympus, with a great significance charitable and cultural contribution in the area ("Ιερά Μονή Αναλήψεως Του Σωτήρος Συκέας," 2007). Its catholicon was constructed and painted in about the mid-17th century, while the iconographer remains unknown. The purpose of this study is the characterization of catholicon wall-paintings and the identification of the painting technique that were used at that period of time, as it is the critical moment between the old and the new techniques.

The collected samples -including plaster and painting layers- were analyzed by means of optical microscopy, Fourier Transform Infrared spectroscopy (FTIR), Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS), X-ray Diffractometry (XRD) and Thermogravimetry (TG-DTA). The combined spectroscopic and microstratigraphic results indicate the use of fresco technique; calcite with quartz and wooden fibers were used for the plaster layer (Regazzoni *et al.*, 2018). The artist's palette is quite simple, as the painting layers consist of red, yellow and brown ferrous pigments, malachite and carbon black. This study is a part of a general project concerning the documentation of the late post-Byzantine artistic workshops which acted in Central and Northern Greece (Malletzidou et al., 2019).

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Extension of age limits by fitting TL/OSL dose response curves using analytical expressions from physical models

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Abstract

Nowadays, both Thermoluminescence (TL) and Optically Stimulated Luminescence (OSL) are widely used in archaeometry, especially for the age determination of different samples and materials. The lower and upper age limits of TL and OSL are set by the TL and OSL response to natural dose. In routine dating applications, it is highly desirable that the dependence of TL and OSL on the dose is linear. On the other hand, there are several cases of non-linear such response. The possibility to use the entire TL/OSL dose response curve and not only the linear part, is expected to result in a significant extension of the age that can is calculated. However, for this to be applicable, exact analytical equations describing the TL/OSL as a function of dose are required.

Recently, Pagonis *et al*., (2020) suggested a new analytical equation for the TL versus dose; the use of this equation enabled the fitting of the whole TL dose response behavior. In this study, the analytical TL dose response of Pagonis *et al*., (2020) is extensively investigated in several experimental TL/OSL curves of both synthetic and natural materials. The results showed that the newly proposed equations fit excellently experimental TL/OSL dose response curves, allowing thus to estimate much larger, than usual, equivalent doses and significantly extending the upper limits of TL and OSL dating techniques.

In the aforementioned study, there are two models describing the phenomena: a) the simplest model, namely One Trap One Recombination (OTOR) and b) the more complex one, named Two Traps One Recombination (TTOR). The new analytical equations for the dose response of dosimetric materials were created with the use of the well-known Lambert W function. We managed to recreate these expressions in an Excel spreadsheet, for a more practical use. Also, using the same Lambert W function, two other spreadsheets were constructed, describing the continuous wave optically stimulated luminescence (CW-OSL), as well as the standard TL deconvolution model.

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A preliminary study of copper navel *phiales* from the Louvre Museum, France and the National Archaeological Museum of Athens, Greece with non-destructive physicochemical analysis and preventive conservation

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Abstract

The first metals known to humans were those that were relatively abundant in the environment and those that required little or no effort to obtain them. Copper is considered, according to archaeologists, the first metal used by man to make utensils, tools and weapons due to its hardness and since it does not require a special metallurgical process. In ancient Greece, metallurgy was evolving into an art, giving the special classical value to both quality metallurgy and shaping metallurgy.

This study presents the type of navel vial with copper as the basic material, and the decoration of radiant leaves that comes from the Achaemenid Empire as it is then certified in Greece in the 6th and 5th century BC. The production technology and the decoration of the bottles were investigated based on 2 copper bottles from France and Athens. The objects came from the Louvre Museum and the Archaeological Museum of Athens and date back to the 4-5th century and 6-7th century BC.

The subject of the present case study is the chemical analysis and manufacturing technology of these vials. The present research is important, as the results of the current study allow us to determine whether the Louvre vial (BR29890), the Archaeological Museum of Athens (16193) and the vial from the sanctuary of Hercules (BE 46152) in Sesklo of Volos in Greece (Stamelou et all, 2018) have common technology construction or origin.

More specifically, the structural analysis refers to the non-destructive physicochemical analysis of the copper vials studied, using special equipment and methods: Optical microscopy, Ultraviolet fluorescence - ultraviolet light and X-ray fluorescence spectroscopy. Chemical analysis with non-invasive XRF energy dispersion provided information for the identification of chemical elements such as copper (Cu), tin (Sn) and lead (Pb). However, in order to better identify issues related to technology (such as the exact method of construction and conditions) or questions regarding the origin of the raw material and to better understand the state of conservation, more specialized

destructive research should be conducted. Laboratory analysis techniques, as the microstructure must be examined to answer such questions.

Equally important preventive preservation plays an important role in deceleration and preventing damage by achieving optimal conditions for good preservation of vials. Preventive maintenance includes the procedures for safe handling and usage, transport, storage, and exposure. In addition, it aims to preserve the object to protect further erosion such as: environmental control of relative humidity RH (45 -55%) and temperature (18 ± 2 ° C), lighting (150-200 lux) and intensity of ultraviolet radiation at 60-80 Mw / lumen, as well as their storage so that they are kept in the best possible condition without causing changes in their physical state.

		
Image 1: Phiale from Perachora, Archaeological museum of Athens (16193)	Image 2: Phiale from temple of Hercules, Sesklo, Volos (BE 46152)	Image 3: Phiale, Louvre museum, Paris (BR 2980)

Acknowledgments

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Pigment identification in paintings by from J. F. Mücke, using Raman spectroscopy: an arts/science project.

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Abstract

"Vukovar landscapes" is a series of oil on canvas paintings made in mid-19th century by an unknown author. Only one of the landscapes is signed, by Joseph Franz Mücke, a royal painter of Habsburg dynasty, presumably ordered by Count Emmerich Josef Eltz as a decoration for his Manor in Vukovar, Croatia. Of all candidate authors, Mücke is the only one who was known to live in Vukovar in the period the landscapes were made. One of the clues toward the discovery or confirmation of the true author could be given by comparing the painting pigments used in signed and unsigned landscapes.

Raman spectroscopy with 785nm laser is used to identify the pigments used for the signed painting "The Gardens". Raman analysis reveals the author's palette. For blue colours indigo pigment was found with addition of calcite for lighter hues. Green colours contain malachite with possible mixture of other earth pigments, like terre-verte. Orange-brown colours are obtained using either a mixture of red lead, red earth and yellow earth pigments or terra umbra. All earth pigments contain traces of quartz. Elemental analysis, such as XRF, is proposed for complete characterization of Mücke's palette.

Figure 1. Raman experiment of "Vukovar landscapes" painting in Eltz Manor, Vukovar, Croatia.

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Revisiting the wall paintings of St Demetrios church in Klimatia village (Epirus, NW Greece)

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Abstract

The major part of the Greek territories was seized by the Ottoman Turks by the end of the 15th century AD. Nevertheless, the Greek religious painting received a boost during the 16th century, and many monuments were then embellished with splendid wall paintings. In the area of Epirus (NW Greece) the local artistic creation shows some rather idiomorphic characteristics that allow for its differentiation from other contemporary trends; therefore it has been designated as the "NW Greece School of Painting" (Αχειμάστου-Ποταμιάνου 1992). The Filanthropinon monastery church (Ioannina lake islet) is regarded as the birthplace of this painting idiom and was recently investigated by means of analytical techniques (Mastrotheodoros et al 2019a, 2019b). Archaeologists attribute part of the Filanthropinon wall paintings to the painters Georgios and Frangos Kontaris who are regarded as prominent artists of the NW Greece School of painting (Δεληγιάννη-Δώρη 1999). The St Nikolaos church (Krapsi village, Epirus) wall paintings and part of the Varlaam monastery (Meteora monasteries complex) katholikon decoration are signed works of the Kontaris brothers, while Frangos Kontaris painted alone the interior of the Transfiguration church in Klimatia village (Epirus). The St Demetrios church that is also located in the latter village bears wall paintings that are claimed –on the bases of stylistic considerations- to have been painted by the Kontaris brothers as well (Δεληγιάννη-Δώρη 1999).

In this work we report on the analytical investigation of the St Demetrios wall paintings that aimed primarily at identifying the employed materials and techniques. In this framework, several microsamples were studied through optical microscopy (OM), scanning electron microscopy (SEM-EDX), μ-Raman and FTIR. The analytical data are critically assessed in the light of a previous pertinent study (Facorellis et al 2011) and other archaeometric investigations of NW Greece School of painting wall paintings (Mastrotheodoros et al. 2018; 2019a; 2019b).

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A comparative luminescence study on several limestone samples of various origins

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Abstract

Limestone is a sedimentary rock composed largely of the minerals calcite and aragonite, which are different crystal forms of calcium carbonate ($CaCO_3$). Many limestones are composed from skeletal fragments of marine organisms such as coral or foraminifera. Limestone makes up about 10% of the total volume of all sedimentary rocks.

Limestone is very common in architecture, especially in Europe and North America. Many landmarks across the world, including the Great Pyramid and its associated complex in Giza, Egypt, are made of limestone.

Dating of monuments constructed by limestones as well as sedimentary rocks consisting of limestones is restricted to applying thermoluminescence (TL) (Liritzis, 2000, 2010, 2011, Liritzis et al., 1997, 2008) since there is a strong disbelief regarding whether limestone does show useful optically stimulated luminescence (OSL, Galloway, 2002).

In the present work several properties of different limestone samples of various origins are studied and compared. Subsequent collection, the samples were kept in the dark and measured after several months using mostly TL. Several properties, such as the response to artificial beta irradiation, the shape of TL curves and the number of the TL peaks, repeatability, sensitivity changes, anomalous fading were studied. There is also an attempt to retrieve OSL signal from the limestone samples; while natural OSL is almost flat and useless for dating, OSL following artificial irradiation indicates a decaying shape. The structure of all samples was studied by XRD. For some among the samples the XRD showed the presence of quartz minerals, which would yield the 110°C peak in TL and the fast component in OSL, characteristics identifiable in the curves. Finally, another interesting topic was the study of OSL resulting from very deep traps (Polymeris and Kitis, 2012) which would also be a very useful signal towards absolute dating (Kitis et al., 2010). The comparative study of all the aforementioned luminescence features could provide with hints towards the usefulness of limestone as a material for provenance studies.

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Non-invasive and biological analysis on pigments used in the nineteenth century manuscript

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Abstract

The application of innovative techniques such as imaging spectroscopy using high resolution cameras and DNA analysis can reveal important elements of the preservation status of ancient manuscripts.

The aim of this research was to assess the preservation condition of a nineteenth century manuscript by an interdisciplinary approach which combined the analysis of the pigments and inks, as well as the analysis of the causative agent of biological attack of the manuscript.

Imaging spectroscopy techniques and SEM/EDS analysis were applied to the inks and the pigments in order to study the nature of these materials and DNA molecular analysis (PCR and sequencing) was performed to investigate the unknown fungus found on the pigments of manuscript.

Using both approaches, the location of the developing of the biological attack was determined on spots where the red pigments had been placed on the decoration and the components of the pigments and the inks were recognized. Moreover, the unknown fungi were identified to the species level as *Chaetomiun globosum* which is a cellulolytic mold.

The development and the combined use of new technologies in diverse scientific fields can provide useful information in the analysis of ancient manuscripts especially on the inks and the pigments as well as the type of biological factors found in the manuscript. The results of this study have led to the identification of the specific fungus and by tracing the type and the extent of the biological attack, appropriate treatments could be applied to minimize the damage and improve the preservation conditions of the manuscript.

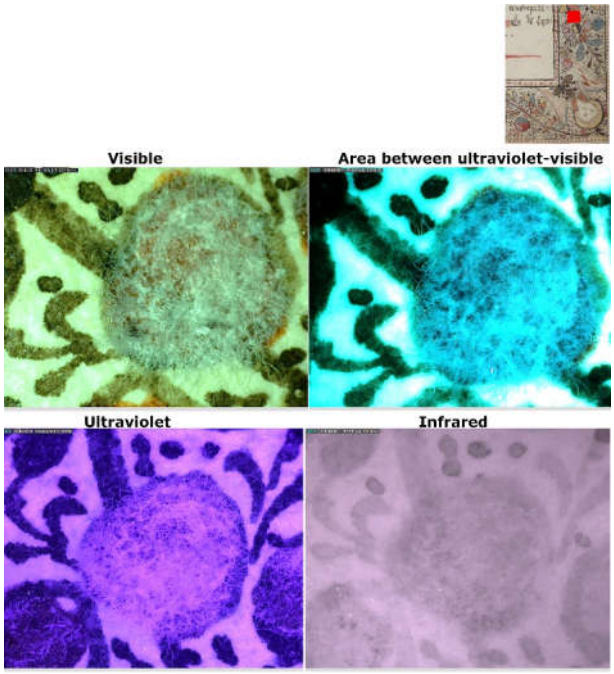

Figure 1. Biological attack on the red pigment that have been used in the decoration of the manuscript

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7th Balkan Symposium on Archaeometry

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Can IBA compete with newer analytical methods in archaeometry?

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Abstract

Ion beam analysis (IBA, which includes methods such as PIXE, PIGE, RBS, NRA) is bound to the use of electrostatic particle accelerator, which, due to their price, can be afforded by a few research centres per state. In recent decades several hand-held and table-top devices came into use that are much easily affordable and at the same time qualified with good analytical properties. It is then a challenging question in which fields IBA methods may still have the leading role.

1. Archaeological materials: metals, glass, pigments. The analytical methods have to be assessed according to their sensitivity, elemental range, ability to analyze bulk material and deterioration of the sample. PIXE, which is the most used IBA analytical methods, still excels for its elemental range and easy manipulation with the samples at using external beams, but its sensitivity is inferior to LA ICP MS by a factor of 1000. It is surface sensitive, but less then SEM, so surface impurity layers <1 µm need not be cleaned off. Neutrons, gamma rays and charged particle with energies above 10 MeV can provide activation analysis deep in the sample, but they are sensitive to a much smaller range of elements. For glass, the main advantage of IBA is non-destructive character of measurements, as finished object of high artistic values can be probed in situ; disadvantage is, however, lower sensitivity in comparison with LA ICP MS (Šmit et al., 2020). Radiation damage inflicted with focused beams becomes problematic at pigment analysis, so XRF methods are rather used instead.

2. Combined IBA approach. An IBA research station using external beam is typically equipped with different detectors that allow simultaneous application of different analytical methods: for PIXE, simultaneous detection of light and heavy elements in combination with special techniques such as differential PIXE, which can roughly provide concentration profiles. Gamma-rays induced in light elements reach much deeper into the sample that the corresponding soft X-rays. Rutherford backscattering can be done in vacuum or in helium atmosphere.

3. Combination with other methods. PIXE can provide additional information on elemental composition applied together with neutron-based methods, such as PGAA (Šmit et al, 2020).

4. Further improvements: In-air proton beam can provide mapping with a resolution below 100 µm, introduction of new techniques such as MeV SIMS extends the field of application into organic chemistry.

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Preliminary Analysis of Mortars Excavated at the Calumat Open Site in Alubijid, Philippines

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Abstract

This study presents the preliminary results of the chemical analysis of mortars found in a structure at the Calumat Open Site in Alubijid, Misamis Oriental, Mindanao, Philippines. The site has an extensive oral history linking its purpose as a fortress (*Ilihan*) that served as a refuge for the community from marauding pirates and the possible location site where the fortress of the nephew (Raja Mongkai) of a well-known local chieftain (Sultan Kudarat) in the Philippines once stood. The structure may have been part of an old church according to the Jesuit religious order accounts of the town of Alubijid. It used to be a mission area of the Recollects religious order before the supervision was eventually transferred to the Jesuits (Arcilla, 2000; Neri, 2011).

The mortar samples were collected from different trenches and subjected to sieve analysis, Fourier transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA). Sieve analysis shows that the mortars collected are well graded and composed of coarse to medium sand as aggregates. The FTIR spectra have characteristic absorbance peaks assigned to calcium carbonate (lime) and silicates from sand (Cayme and Asor, Jr. 2017). Mortars are generally manufactured by combining the binder or lime with the aggregates, which is usually sand. Based on the TGA, the mortars are classified as hydraulic and have the typical decomposition pattern of calcium carbonate at a temperature of about 650°C to 750°C (Cayme and Asor, Jr. 2016). This preliminary chemical analysis would facilitate the understanding of the construction and conservation of lime stone mortar building and structures in the Philippines. Results of this study will also give valuable insight on the manufacturing of mortars in the Calumat Open Site.

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INVESTIGATION OF PAINTINGS BY SCANNING XRF

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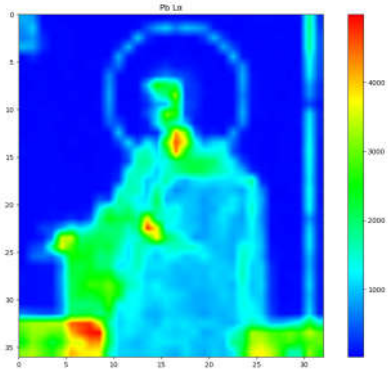
Abstract

X-Ray Fluorescence (XRF) is considered as an ideal analytical technique for the technical investigation of artworks, as it allows for the non-destructive analysis of cultural heritage objects. However, paintings are often characterized by heterogeneous multi-elemental composition and exhibit a complex layered structure as well. Consequently, application of XRF at a single spot could provide misleading information. To overcome this problem, study of paintings is performed using a conventional micro-XRF spectrometer equipped with a programmable motorized x-y-z sample stage, allowing scanning. The target movement in the x-y direction (target's surface plane) enables line scans and area measurements of XRF spectra, while the elemental distribution visualization is achieved through the proper analysis of the spectra. The possibilities of this method were exploited through the investigation of a miniature religious panel painting (icon). The studied item dates to the late 19th century and measures approximately 11×8 cm. The contribution of set-up parameters to the quality of the measured spectra are examined, while the impact of the beam spot and the scanning step size on spatial resolution are also discussed. Beam spot size is determined applying different size pinholes. The use of pinholes results to lower intensity rates compared to spectrometers utilizing polycapillaries, yet it improves considerably the sensitivity for the K transitions of heavy elements (e.g. silver, antimony, barium). The spectral analysis and the elemental distribution visualization are performed using the open source PyMca code [1].



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Probing Into the Painters' Materials and Techniques

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The investigation and identification of the components used by the artists gives a deep insight not only on their palette but also on the degradation processes and weathering through time. Raman spectroscopy is considered as a core stone technique when it comes to the characterization of the inorganic and organic constituents of the complex art layers. A major breakthrough of the technique is that it produces solid results when it is applied *in situ* and directly on the artefact.

Traditionally, when an art piece needs to be studied, micro-samples have to be extracted in order to be investigated in the laboratory, often with a benchtop Raman system. With the latter approach, stratigraphic analysis is only possible when embedding a cross section in appropriate resins. If sampling is not allowed, then mobile Raman spectrometers can be used, allowing the characterization of the top layers of the work of art. The penetration depth of the radiation used by the Raman instruments is restricted to few micrometers (according to the laser used and the focusing).

The combination of using a Raman system non-invasively (without sampling) and simultaneously acquiring information from deeper than the surface created the concept of microspatially offset Raman spectroscopy (micro-SORS) [1,2]. By separating the excitation laser from the collection zone, information of the layers hidden under a turbid one can be revealed. In this study, we thoroughly investigate and compare the different modes of micro-SORS by underlining the new perspectives of the non-invasive stratigraphic analysis.

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Superhydrophobic coatings for the protection of calcareous stone

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Aging of natural stone in historic artworks and monuments is induced by atmospheric water, air pollution, biodeterioration and other environmental factors. In particular, liquid water can cause severe damages in calcareous stones as it can penetrate deep into the pore network of the porous stones, dissolving water-soluble components, breaking stones through the freeze/thaw cycles and depositing salts and pollutants. The effects of the deteriorative activity of liquid water can be dramatic for materials with poor cohesion, as it is for example the soft limestone used in the buildings of the archaeological site of Pella. For this reason, the scientific project “Open Lab for the study & preservation of Pella's buildings and palace” which is supported by the General Secretariat for Research and Technology aims at developing sustainable strategies for the preservation of the local limestone using nanomaterials.

Biomimetics, superhydrophobic and water repellent coatings can, in principle, offer good protection against the activity of liquid water. An easy method to produce and deposit superhydrophobic coatings on large stone surfaces has been developed in 2007 (Manoudis et al., 2007): nanoparticles are dispersed in solutions of organic materials which are used for the conservation of stone, such as organosilicon materials, acrylic polymers or fluoropolymers. The dispersion is deposited onto the stone. Nanoparticles form clusters which enhance the roughness of the polymer surface at the micrometer/nanometer scale leading to non-wetting. The aforementioned method has been adopted and modified by several researchers who demonstrated that water repellent coatings accompanied by the self-cleaning property can clean the dirt and dust and may have antibacterial properties thus offering protection against biodeterioration (Cao et al., 2020). The goal of this paper is to provide an overview of the progress achieved in the production of superhydrophobic nanomaterials which have been suggested for the protection of cultural heritage.

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Study and conservation of a 19th century printed silk scarf from the collection of the National Historical Museum of Greece

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Abstract

Aiming at an optimal gel-based methodology for the selective removal of stains on a 19th c. ink-printed silk scarf (566mm × 633mm), depicting the temple of Holy Trinity Church of Vienna, from the collection of the National Historical Museum of Greece, its biography and preservation condition was traced with the help of optical microscopy, UVF imaging, gloss and pH measurements, colorimetry, X-ray Fluorescence (XRF) and Fourier Transform Infrared (FTIR) spectroscopy (Manso, 2011; Ferrero, 2004; Romero, 1999). Emphasis was given on non-invasiveness, and selectivity, as zeroing, or minimizing the effect from the cleaning methodology on the base material (silk) and the print (oil binder-based carbon black), (Figure 1).

Implementation of non-invasive methodology (XRF, ATR-FTIR) provided significant information about the qualitative differentiation as well as elemental and molecular characterization of stains, glue residues and deposits of the historical silk object (Luo, 2012; Karydas, 2005). Data collection concerning the application and evaluation of selective cleaning of silk with gel systems is of great importance due to the lack of bibliography on this field. The use of a 75% biodegradable, environmentally safe, green solvent (diethyl carbonate, DEC) applied on silk cleaning procedures. The issue of enzyme, chelator and gel residues after cleaning applications is also investigated by means of the analytical methodology.

Non-invasive methodology, including technical examination on Vis, UVF and implementation of multispectral imaging system in combination with analytical elemental analytical methods was employed

to investigate, record and evaluate the condition of the silk object (Albertin, 2018; Dyer, 2013; Cook, 2012). Based on the above analytical results, a pilot study was implemented aiming at studying and documenting the effect of simultaneous thermal and photo-oxidation ageing on silk, residues, spots, and stains, on specially developed printed silk mock–ups; these were previously artificially aged to simulate the pathology and condition of the printed scarf (Vilaplana, 2015; Li, 2013; Luxford, 2011; Nilsson, 2010). The pilot study also allowed an Arrhenius chemical kinetics analysis of the silk mock-up ageing rate. Colorimetry, gloss and pH measurements completed the assessment of mock-ups properties alteration induced by accelerated aging and gel applications. The results led to the selection of appropriate gel systems for the selective cleaning of the printed scarf: agar and gellan gum aqueous gel systems for deposits and oxidized acrylic glue residues, DEC-based PMMA and NEVEK organogels for the various tape backing detachment and adhesive removal from purpose made mock-ups (Trabace, 2017). As enzymes (lipase), chelating factors (EDTA, DTPA) and viscosity gel regulator (calcium acetate) were included in the gel formulations, their residues after cleaning applications was studied with infrared spectroscopy (ATR-FTIR) and UV-induced visible fluorescence colour photography (Bertasa, 2017; Cremonesi, 2016; Iannuccelli, 2010; Bellucci, 1999).

The examination and documentation techniques provided information on the construction technology of the historical silk object and allowed the characterization and qualitative differentiation of stains, residues, deposits, silk deterioration and guided the subsequent conservation treatment methodology. Moreover, the conservation treatment of the scarf, including removal of the old backing fabric, selective stain and glue residues removal (Figure 2), application of new support fabric, preparation of the mounting system for the safe display of the object are also discussed (CCI, 2009).

Finally, the use of gels in both the mock-ups and the object is discussed in order to stress the possibilities, limits and limitations of the application of complex gel systems in the cleaning of historical protein substrate (silk) with minimal effects and in the conservation of cultural heritage objects which require alternative conservation treatments.

Figure 1: examined areas of great interest

ATR-FTIR, XRF spots *Fibre sampling points*

Etching on silk depicting the Temple of the Holy Trinity Church of Vienna, National Historical Museum of Greece, Import directory

Figure 2: After conservation treatment

Athens, 22-25 September 2020

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A Detailed Study about Egyptian-Coptic and Software Engineering

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Abstract

The ancient Egyptian is one of the oldest world's languages, with the hieroglyphic writing demonstrating its existence since the 33rd century BC. Its final stage, the Coptic language, began in the 1st century AD, with Old Coptic, and extends until the 16th century AD, creating a continuous of written sources in Egyptian language of almost 5000 years. The transliteration of Egyptian-Coptic starts with the alphabetization of written Egyptian on the basis of the Greek script and it is one of the greatest proofs of the cultural interaction of the two cultures. Coptic was the language of the monks and the gospels, the scriptures, the letters and other transactions, leaving us a written wealth. Another proof of the unsurpassed cultural relationship between the two populations is the large number of Coptic texts and objects on display or at archives in Greek museums and libraries. It is also noteworthy that Coptic survives today as the liturgical language of the Coptic Orthodox Church. However, the lack of interactive computational tools makes it difficult for researchers to study the language in depth and allows various misinterpretations. Especially for Greek scholars, digital resources are even more limited.

In this present work we try to present Coptic material that exists in Greece, the huge volume and the undisputable value of the Coptic language in the diachronical history of languages but also the incapacity of digital resources to meet the needs of researchers and scholars of Coptic. This will highlight the need to create a software tool that will fill in the gaps and the weaknesses of other tools, a software application that will make it easier for the user to study and learn Coptic, and finally an application that will help to preserve this language over the centuries. This software tool will be based on a pre-existing model of ancient languages processing, which was successfully implemented in the case of Linear B, aiming at both educational and research use for any kind of Coptic artifact.

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Protection and Repatriation of Cultural Treasures - The Acropolis Sculptures

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Abstract

States worldwide have used all possible legal instruments and diplomacy to show their belief that cultural treasures must be protected and returned to their country and people of origin who created them and consider them as a part of their proper identity.

Cultural Treasures have been victims of destruction and illicit trafficking during Wars and armed conflicts since the Antiquity. According to the official elements of UNESCO *"…Together with the trafficking in drugs and arms, the black market of antiquities and culture constitutes one of the most persistent illegal trades in the world"*.

From illegal excavation to final sale, the value of the most beautiful masterpieces increases 100 fold, a greater growth than that of drugs.

As for the online purchases, it is estimated that 80 percent of the 100,000 antiquities available online at any given moment have no recorded provenance—which means they are probably looted or fake. These objects have a combined total asking price of more than $10 million.

The ISIS looting across the Middle East in recent years, bringing a wave of illicit objects into the marketplace and the easy access to the antiquities through Facebook, WhatsApp, eBay, and Amazon, have contributed to the increase of fake and looted antiquities

The State practice on the Repatriation of Cultural Treasures is evident from the number of International and Bilateral Conventions and Protocols adopted, as completed by soft law rules and guidelines, the administrative acts or attitudes, in particular in the diplomatic field, the national legislations and the

judicial acts. This practice, already stable and uniform, is confirmed by the explosion of the repatriation of antiquities during the last years.

The most famous and still pending case before the UNESCO's Intergovernmental Committee for Promoting the Return of Cultural Property to its Countries of Origin or its Restitution in case of Illicit Appropriation (ICPRCP) concerns the Hellenic Government's demand for the return by the United Kingdom of the Parthenon Sculptures.

According to international law there is:

- Duty of Repatriation of cultural treasures – symbols of cultural and historic heritage
- Duty of Unification of Monuments
- Duty of Repatriation of Cultural Treasures wrongfully acquired during war, occupation or colonization.

These principles apply to the case of the Acropolis Sculptures that must be repatriated in the name of Justice and Truth.

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Ceramic production on northern edges of the Balkans in the Ottoman period

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Abstract

This paper discusses the production technology of common pottery from Belgrade (Serbia) dated to the Ottoman period (the 16th - the 17th centuries). Some of wares included in the study, such as Monochrome Glazed Ware and Slip-Painted Ware, were widely distributed across the Balkans and the Eastern Mediterranean in the Ottoman period, but technologies of their production have not been sufficiently explored. This study is based on the in-depth scientific analysis of 159 samples of both glazed and unglazed wares. Ceramic petrography and Wavelength Dispersive X-Ray Fluorescence (WD-XRF) analysis were used for the characterisation of ceramic bodies while Scanning Electron Microscopy with Energy Dispersive Spectrometer (SEM-EDS) was used for the study of slips and glazes. The provenance determination was addressed with ceramic petrography in combination with geological maps of Belgrade.

The results show that Belgrade's ceramics can be classified into three groups defined by technological characteristics of ceramic bodies, slips and glazes. The largest group of pottery, consisting of Monochrome Glazed Ware, Slip-Painted Ware and unglazed coarse wares, was made of locally available low-calcareous and micaceous clays. The *chaînes opératoires* of local ceramics reveal a complex mixture of technological choices despite relatively standardised shapes and sizes of vessels. This is well-visible in the plurality of choices applied in the preparation of ceramic pastes and slips. All glazes are of the high-lead type, but there are differences in methods of their preparation. The provenance of other two Belgrade's groups could not be positively determined, but they substantially differ to the local pottery in almost all segments of production.

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Clayey sediments and pottery fabrics in the wider Ierapetra area

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Ierapetra and its wider region has caught the attention of Minoan archaeology much less than other areas on Crete, due to the sparsity of finds and the lack of impressive Minoan. It was only in the last decade that a series of new excavation projects started to shed light on the Bronze Age history of the area. There are, however, many gaps in our knowledge, particularly concerning the raw materials and the production of the pottery found in the new sites excavated so far in the area.

This project contributes to this problem by exploring the two most frequently attested Minoan pottery fabrics in the southern part of the isthmus of Ierapetra, namely the granodiorite and the ophiolitic. The provenance of these fabrics had been taken for granted in Minoan literature: the Mirabello fabric is connected to the granodioritic outcrops at Gournia-Kalo Chorio area and the South Coast fabric is connected mostly to the ophiolitic series/flysch mélange between Myrtos and the Asterousia-Messara area. However, most recent studies[1] have cast doubts to these ideas and show that, taking into account the repetitive geological structure of the island, this provenance is not a solid fact, particularly because ophiolitic lithologies and granodiorite outcrops have been attested in the southern part of Ierapetra isthmus as well, on the plain and the surrounding hills of the Ierapetra plain.

In order to clarify this issue, clay prospection was carried out in the wider Ierapetra area. The samples were studied through petrographic analysis, and the purpose was to define a) the mineralogical composition of the clayey sediments and the role of the rock suite for their formation and composition, and b) the tempering material available in the plain. Furthermore, the results of this study are compared to Minoan pottery from sites in the area, as well as to modern pottery, locally manufactured by the traditional potters of Kentri, which was one of the most important pottery centers in the 20th century on the island.

Despite the fact that archaeological work in the area is in a preliminary stage, the results of this study provide new evidence and allow us to reconsider well established and widely accepted ideas concerning the production and distribution of Minoan pottery is this area, and consequently to infer on exchange networks and the socio-cultural relationships.

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A preliminary study of early Roman glass from Ioannina, Greece

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Abstract

Since the late 20th century and more intensively during the last two decades, the systematic investigation of glass objects using analytical techniques has gained the attention of the scientific community. Glass excavated in Greece has been the subject of study by various research groups (Kaparou et al., in press and references therein), nevertheless, no attention has been given to Roman glass from NW Greece and more specifically from the prefecture of Ioannina.

This study presents the preliminary results of the archaeometric analysis using SEM/EDS of an early Roman glass assemblage from the excavation of a Roman cemetery located at Serviana, in the region of Ioannina (NW Greece) (Pliakou in press) (Fig. 1). The main aim of this work is to identify the technology/raw materials used for the manufacture of the glass objects; also to provide information about the glass production centers of the Early Imperial period.

The assemblage under study is in a fragmentary state and consists of 42 fragments of transparent glass having mostly green and aqua blue hues, while there are four samples demonstrating stronger colours (1 yellow, 1 blue and 2 light blue) (Fig. 2). The fragments belong to different objects such as, among others, unguentarias, beakers and bowls.

Fig. 1 Map indicating the location of the site discussed in this study.

Fig. 2 Characteristic glass fragments of unguentaria from Serviana.

According to the results obtained, all samples fall to the general category of soda-lime-silica glass (Sayre & Smith, 1961). Sand is the main silica source and was fused using the mineral natron as it is indicated by the low amounts of both MgO and K_2O (Shortland 2004).

The majority of samples form a tight cluster (*Fig.*) while there are a few samples with excess of MgO (levels above 0.8 wt.%). This is possibly an indication of different manufacturing recipes. A similar distinction is noticed in the CaO vs Al_2O_3 graph (**Error! Reference source not found.**) where there are few samples showing very low lime content (levels below 4 wt.%). Taking into consideration that both elements, i.e. lime (CaO) and alumina (Al_2O_3), are present in sands we may assume that these two groups were possibly made using two different sands (Jackson et al. 2005).

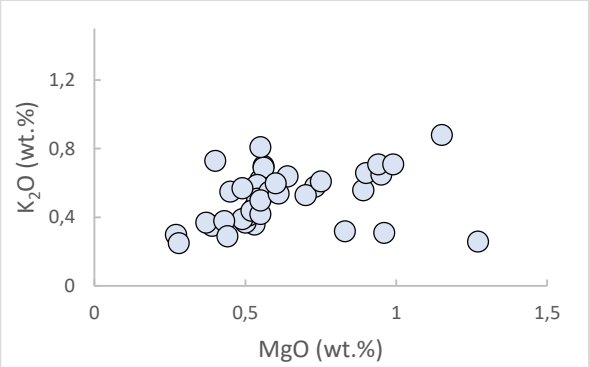

Fig. 3 MgO vs K_2O concentrations in glasses from Serviana, Ioannina.

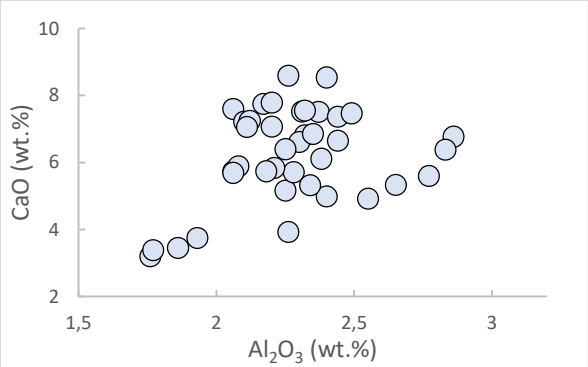

Fig. 4 Al_2O_3 vs CaO concentrations in glasses from Serviana, Ioannina.

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Digital preservation and accurate 3D reproduction of rare archaeological San skull specimen.

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Abstract

Fossil hominins were first discovered in the Dinaledi Chamber of the Rising Star Cave system in South Africa during an expedition led by Lee Berger beginning October 2013. In November 2013 and March 2014, over 1550 specimens from at least 15 ***Homo naledi*** individuals were recovered from this site. This excavation remains the largest collection of a single hominin species that has been found in Africa. Rick Hunter and Steven Tucker found an additional 133 ***Homo naledi*** specimens in the nearby Lesedi Chamber in 2013, representing at least another 3 individuals – two adults and a juvenile. In 2017, the Homo naledi fossils were dated to between 335,000 and 236,000 years ago

The 3D measurement of the cranium was performed on a Shining 3D Einscan 2X 3D Scanner. The scanner was set up to acquire in, Feature-only Rapid Mode with a resolution of 0.2mm. For post processing, quality option was selected.

In order to 3D print the duplicate, an Einstart C printer was used. The model was scaled down to 65% of the original dimensions. The layer height of 0.1mm was selected in order to preserve most of the details.

The material used was PLA and out-supports were added because of the lack of flat surfaces. The software's "quality mode" was used and the rest of Shining 3D's 3DStar slicer's settings were set.

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Tracing environmental patterns and human activities via the chemical synthesis of soil stratigraphy: The MY.SPE.AR archaeological project

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Mycenaean Foundation; Mycenean Lower Town Excavation

Abstract

The five-year Mycenaean Spercheios-Valley Archaeological Project (MY.SPE.AR.), realized in the Lamia Municipality in central Greece, started in 2018 including extensive and intensive archaeological survey, aerial reconnaissance, geophysical survey, and targeted excavation. During the excavation period of 2019, two test trenches were created on the Lamia Acropolis where the Lamia castle is located. Trench A located west of the castle's main building revealed a significant array of pottery fragments, roof tiles, bones, etc. dated in different periods. For the purposes of this research paper, soil analysis of the excavation area was realized. In particular, 51 soil samples were extracted from the 13 layers from trench A's stratigraphy for further examination through soil particle size analysis and p-XRF analysis (Liritzis and Zacharias, 2010).

The research goal is to present geological data in context to the archaeological interpretation of land use of the Lamia Acropolis (Papakonstantinou, 2009). This is carried out by applying scientific techniques to the analysis of the soil samples. Each sample was first examined using particle size analysis in order to study their composition by separating different ranges of sizes and determining their relative proportion by weight. In addition, p-XRF analysis was applied to examine their chemical composition. The results are then presented in an attempt to classify the archaeologically related soil samples by means of use, type of formation, or chronological period (Karkanas & Goldberg, 2018) (Panagiotidis et al, 2020).

The My.SPE.AR. project is implemented under the dual directorship of the Ephorate of Antiquities of Fthiotida and Evritania with Dickinson College, assisted by the scientific coalition of the Geophysics Laboratory of the Aristotelian University of Thessaloniki, the Architectural Design and Research Laboratory of the Democritus University of Thrace, the Laboratory of Archaeometry of the University of the Peloponnese and the support of the Municipality of Lamia and the Mycenaean Foundation.

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Agreement between ESR and TL ages for a recent Romanian Plane deposit

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Abstract

One of the most used and well know technique for dating is Thermoluminiscence (TL) . In the same time, all text books presents the Electron Spin Resonance (ESR) spectroscopy as the one which use the same method, based on the accumulation of radiation defects, to determine the age of archaeological sample [1]. However, from our best knowledge, there is no studies in which this assumption is verified from the same sample. Therefore, the goal of this research is to determine the age of the loess from Eastern Romanian Plane by the two independent age methods i.e., TL and ESR. For this we have used the same quartz fraction. In both cases the additive method was used to determine the local paleodose (PD) while the local annual dose rate was recalculated starting from the content of radioactive elements in soil determined by high resolution gamma-ray spectrometry. Final results gave coincident results within experimental uncertainties of 19.85 ± 2.60 and 20.38 ± 2.93 ka for TL and respectively for ESR age [2]. Due to the good coincident between the ages obtained with the two techniques we need to reconsider the use of ESR as one of the main method for archaeological dating.

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ESR study of ceramic fragments collected from several archaeological sites in Romania

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Abstract

Electron spin resonance (ESR) spectroscopy study the microwave radiation absorption of the unpaired electrons in an external magnetic field. The number of chemical elements which present ions with unpaired electrons is quite large and many of them are found also in the he archaeological samples. The ESR spectroscopy can be used to identify the ions of differents chemical elements and în the same time the ESR spectra is sensitive to the symmetry of the environment in which they are found.

The current study was carried out on a consistent batch of ceramic fragments collected from several archaeological sites in Romania, that belong to a chronological period that covers the entire Neolithic period in this area, starting with the Early Neolithic (ca. 6600/6500-5500 BC) and finishing with the Late Chalcolithic (ca. 4500-3900/3800 BC).

The analyzed batch consists în more then of 100 sherds of which some are decorated with paintings of different colours (white, black and red), and others with excisions and incisions of various shapes and sizes that are inlaid with white paste.

Due to the wide chronological interval and the large amount of material analyzed, this study has the potential to answer important questions regarding pottery technology by identifying similarities and differences in the composition of the paste and its preparation, thus highlighting the preferences of potters within the same communities or other ones located in different areas and other time spans, when it comes to decorating their products.

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Exploring the potential of calcium sulfates as luminescence dating dosimeters

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Abstract

Calcium sulfate (in the forms of dihydrate, hemihydrate and anhydrous $CaSO_4$) is a common material since antiquity, as it has been used as a building material and as a main constituent of artifacts, such as in the plaster layers of paintings, stuccoes and sculptures. Towards the age assessment of objects and minerals, luminescence techniques are widely used because of their absolute results. Preliminary thermoluminescence (TL) measurements on both commercial and mineral calcium sulfates indicate the presence of stable TL peaks along the dihydrate and hemihydrate samples, despite their water content (Polymeris *et al.*, 2013; Malletzidou *et al.*, 2019).

In the framework of this study, the three aforementioned groups of calcium sulfates are being investigated regarding their luminescence properties, including their TL, optically stimulated luminescence (OSL) and infrared stimulated luminescence (IRSL) properties. Their TL, OSL and IRSL features are further supported by dose response measurements, in order to investigate their linearity features and to estimate their lowest age limits, in conjunction to dose rate measurements using gamma spectrometry. The calcium sulfates under study are additionally characterized by means of Fourier Transform Infrared spectroscopy (FTIR), X-Rays Diffractometry (XRD) and Scanning Electron Microscopy (SEM), to explain sensitization patterns and to further resolve content matters.

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