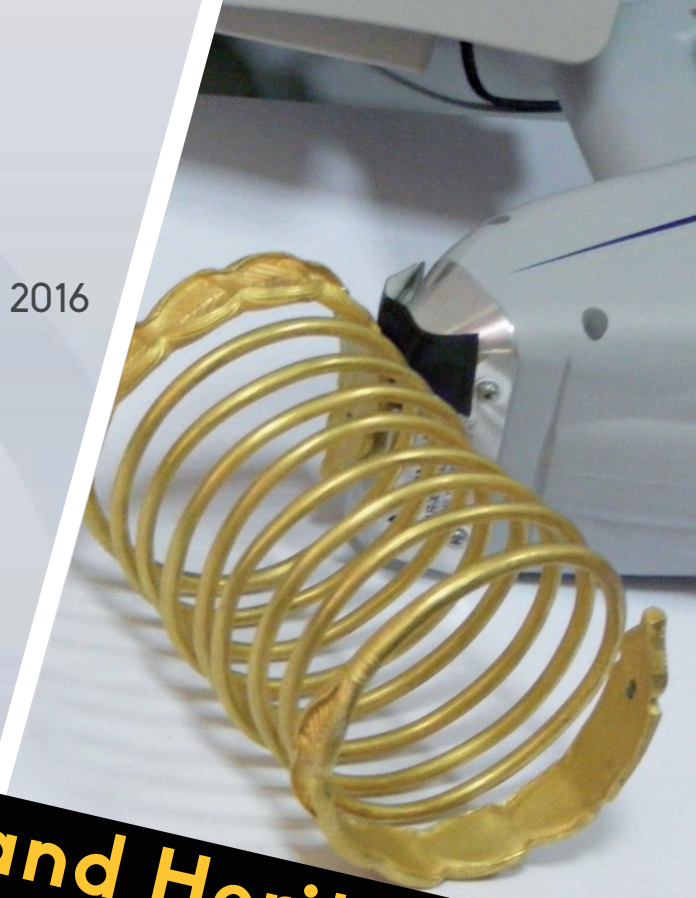
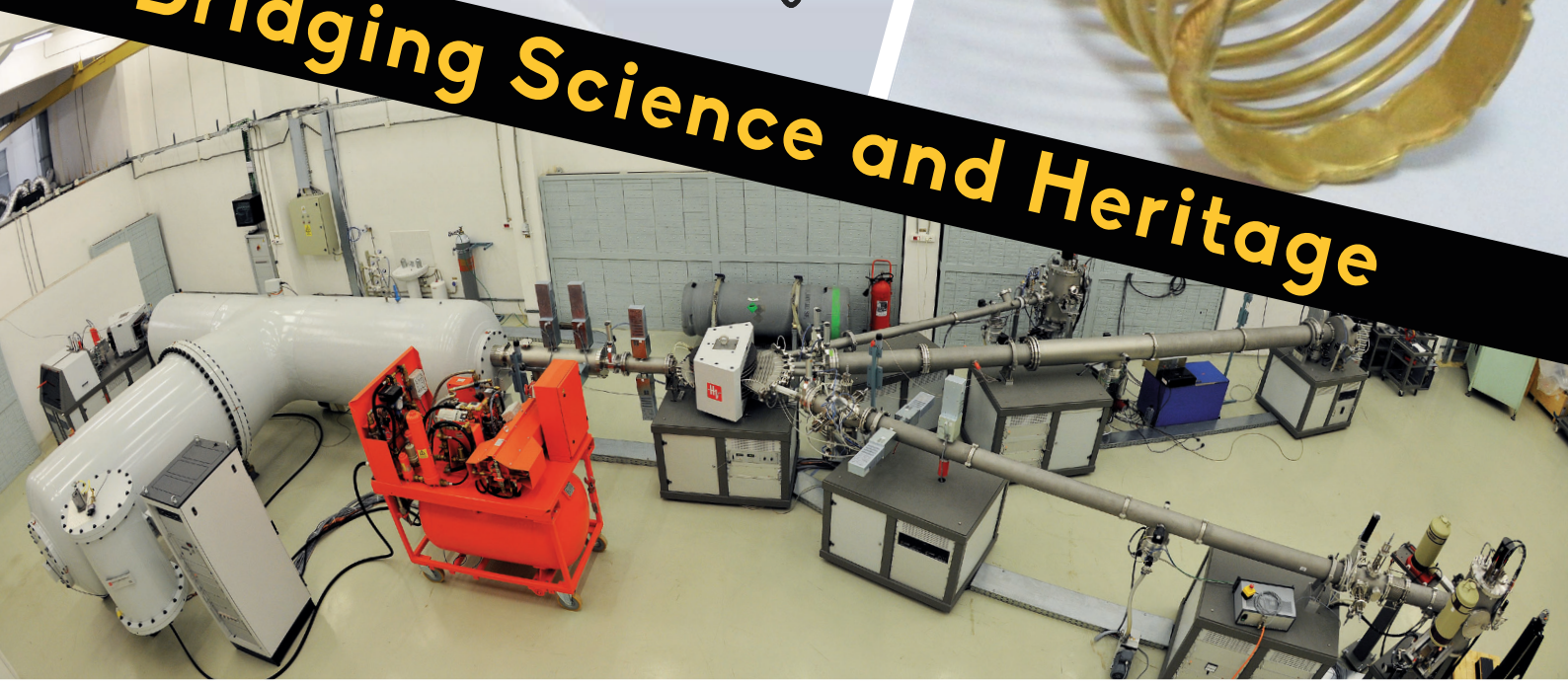
5th BSA

Fifth Balkan Symposium of Archaeometry 2016

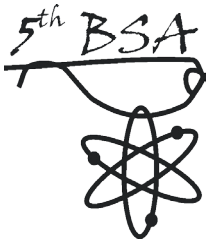


Bridging Science and Heritage



Book of Abstracts

Sinaia, Romania
September 25-29, 2016



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FOREWORD

The **Fifth Balkan Symposium of Archaeometry 2016 (BSA5)** will take place between September 25-29, 2016, in the Carpathian resort of Sinaia, Romania. The tradition of BSA began in 2008 in Ohrid (Macedonia) and continued in 2010 in Istanbul, in 2012 in Bucharest and in 2014 Nesebar (Bulgaria).

The title chosen for this year's event is: **"Bridging Science and Heritage"** and the organizers of the symposium are "Horia Hulubei" National Institute for Physics and Nuclear Engineering (IFIN-HH) Bucharest-Magurele, the University of Bucharest (UB) and the "Vasile Parvan" Institute of Archaeology Bucharest (IAB) of the Romanian Academy.

The Symposium will focus on the application of modern physical and chemical methods in archaeometry, including nuclear methods and techniques used in dating, in the analysis, investigation and characterization of ancient artefacts, as well as their conservation and consolidation. Subjects from the related fields of archaeology and art history will be included.

The program includes invited lectures (40 min.), oral (20 min.) and poster presentations on the following topics:

- Analytical methods for cultural heritage diagnostics
- Lithic materials
- Archaeometallurgy
- Radiocarbon Dating
- GIS applications
- Preservation of cultural heritage - conservation and restoration
- Optoelectronic applications
- Experimental archaeology
- Multidisciplinary research in archaeology

BSA5 will have 5 ordinary sessions of half a day each and a session in round table format on the last day, Thursday. The round table is entitled ***Multidisciplinarity in archaeology: Situating archaeometry in education and research*.** Officials of the host country involved in research policy and in the management of research and higher education, politicians and media representatives will be invited to join the BSA5 participants.

Tuesday afternoon is reserved for conference's excursion and dinner.

Welcome to Romania, welcome to Sinaia and to the realm of archaeometry!

The Organizing Committee

Program

Monday, September 26, 2016

Chair: L. Trache – Session: Radiocarbon dating		
Time slot	**First author**	Title of paper
9.00- 9.20	**OPENING**	
9.20-10.00	**Bâlici**	National Institute of Patrimony: mission and means
10.00-10.40	**Kutschera**	Radiocarbon dating and archaeology in the Middle to the Late Bronze Age of the Eastern Mediterranean: a happy marriage?
10.40-11.00	*Coffee break*	
11.00-11.40	**László**	Archaeological/historical information and radiocarbon dating. Old-new problems of LBA-EIA chronology of the Carpathian-Danubian-Balkan regions
11.40-12.00	**Sava**	ROAMS – Status of the new Bucharest AMS center
12.00-12.20	**Stanciu**	Radiocarbon dating of archaeological bone samples belonging to Vinča Culture
12.20-12.40	**Simion**	Searching for a Medieval Cemetery and Church in Arges County: A radiocarbon dating story
12.40-13.00	**DISCUSSIONS**	
13.00-15.00	*Lunch*	

Chair: T. Sava – Session: Ceramics and glass		
15.00-15.40	**Sommer**	Micro- and macroarchaeology: how can the two be combined?
15.40-16.00	*Coffee break*	
16.00-16.40	**Šmit**	Glass analysis – relation to historical questions
16.40-17.00	**Măţău**	Cucuteni C pottery technology from Eastern Romania: A multi-analytical study
17.00-17.20	**Dragoman**	A technological study of red and white colours in the Boian "sanctuary" at Cascioarele -Ostrovel, Southern Romania
17.20-17.40	**Opriş**	Archaeological and archaeometrical analyses on Eneolithic pottery from Nanov-Vitireasa (Co. Teleorman)
17.40-18.00	**Palincaş**	Analyses of pigments from encrusted Middle and Late Bronze Age pottery from the Lower Danube using PIXE and FT-Raman spectroscopy
18.00-18.20	**Neacşu**	XRF comparative analysis of ceramics discovered in the multi-layered archaeological site Branisca-Pescarie Est; local production versus imports
18.20-18.40	**Bugoi**	Compositional characterization of ancient glass finds discovered at Troesmis (Turcoaia), Romania
18.40-19.00	**Vataj**	The study of ancient glass objects discovered in Albania using non-destructive analytical methods
19.00-19.20	**DISCUSSIONS**	

Tuesday, September 27, 2016

Chair: W. Kutschera – Session: Pigments		
Time slot	**First author**	Title of paper
9.00- 9.40	**Vandenabeele**	Developing Mobile Raman spectroscopy for archaeometry
9.40-10.00	**Duliu**	A comparative study of some Russian, Russian school (Lippovan) and Romanian popular icons of 19th c.
10.00-10.20	**Petroviciu**	Liquid chromatography with UV-Vis and mass spectrometric detection for the identification of natral dyes in 19th – 20th c. Oriental rugs
10.20-10.40	**Stojanović-Marić**	Spectroscopic analysis of wall paintings from Peć Archbishopric, Serbia
10.40-11.00	*Coffee break*	
11.00-11.20	**Naumovska**	Decorated Islamic manuscript from the Ottoman Turkish period: Paper characterization, dating and conservation
11.20-11.40	**Iancu**	Perspective in-depth elemental analyses of large objects by using brilliant gamma beams
11.40-12.00	**Mardare**	New methods in Raman spectroscopy for mineral and pigment analysis in arts and archaeology
12.00-12.20	**DISCUSSIONS**	
12.20-13:40	*Lunch*	
14.00-20.00	**EXCURSION**	
20.00-20.20	**Kutschera**	The ugly and the beautiful: The use of the 14C bomb peak to measure the age of human cells
20:20 – late	**CONFERENCE DINNER**	

Wednesday, September 28, 2016

Chair: N. Palincaş – Session: Analytical methods		
Time slot	**First author**	Title
9.00- 9.40	**Constantinescu**	Archaeometallurgical studies on artefacts from Romanian museums using X-Ray based methods
9.40-10.00	**Borş**	Preliminary archaeometrical investigations on the Sarasău hoard
10.00-10.20	**Duka**	Case study of ancient iron slag found in the east and northwest of Albania
10.20-10.40	**Micle**	Non-invasive archeology in Romania: archaeological topography, GIS analysis and remote sensing application
10.40-11.00	*Coffee break*	
11.00-11.20	**Stavilă**	Location analysis of the settlement from the Late Bronze Age in the high plane of Vinga
11.20-11.40	**Teodor**	Geophysics and landscape archaeology. A large scale geophysical survey on Limes Transalutanus
11.40-12.00	**Bakardzhiev**	Concession area 'Boyadzhik': Using GIS technology for the protection of cultural heritage
12.00-12.20	**Alexandrescu**	Vibrational spectroscopy analysis of flint industry from the Paleolithic site Giurgiu-Malu Roşu, Romania
12.20-12.40	**Haită**	The petrograpny of lithic inventory from Borduşani-Popină tell settlement (Ialomiţa County, Romania)
12.40-13.00	**Beldiman**	Archaeology and microscopy. Recent contributions to the analysis of artefacts made from animal skeletal raw materials
13.00-13.20	**DISCUSSIONS**	
13.20-15.00	*Lunch*	

Chair: D.G. Ghita – Session: Heritage restoration		
15.00-15.40	**Ponta**	Irradiation - from nuclear science to cultural heritage preservation
15.40-16.00	*Coffee break*	
16.00-16.40	**Cortella**	Nuclear technics for preservation treatments of archaeological organic materials and how to take into account archaeological studies while applying such treatments
16.40-17.00	**Badea**	Thermal microscopy, DSC, unilateral NMR and ATR-FTIR spectroscopy revealing the effects of gamma radiation on vegetable leather
17.00-17.20	**Lungu**	Mechanical properties of gamma irradiated leather
17.20-17.40	**Ene**	Microbiology contribution to saving heritage artefacts by gamma irradiation
17.40-18.00	**Haiducu**	Biologically hazardous agents at work and efforts to protect workers? Health from museums and heritage deposits
18.00-18.20	**Atanassova**	Laser assisted removal of graffiti paints on stone: potential for restoration of cultural heritage monuments
18.20-18.40	**Prună**	Establishing biodeterioration causes of wooden elements of churches and historic monuments of cultural heritage. Case studies
18.40-19.00	**DISCUSSIONS**	

Thursday, September 29, 2016

Chair: E. Alexandrescu – Round table: Multidisciplinarity in archaeology		
Time slot	**First author**	Title
8.30-10.00	**POSTER SESSION**	
10.00	**Alexandrescu**	Introduction
	Zaharia	Challenges and expectations for a curriculum in archaeology and heritage studies
10.40-11.00	*Coffee break*	
11.00	**Micle**	Romanian school of archaeology: a shift of paradigm
	Căpiţă	New trends, new skills: Multidisciplinarity in the field and in the interpretation and the initial training of the younger generation
	CLOSING	
13.00-14.00	*Lunch*	
14.30	**Departure to Bucharest**	

Invited talks

Investigations of Pigments and Papers of some Historical Postage Stamps by Multiple Analytical Techniques

Tanil Akyuz and Sevim Akyuz

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Stamps, which are considered a cultural heritage, serve as recording source for information that illustrates the cultural, historical, social and artistic aspects of a society in their own unique style. They constitute a sort of artwork which could be very rare and precious. Many chemical pigments and dyes are used as colorant for the colored inks of this artwork. Mineral-based or inorganic pigments and dyes, particularly those containing heavy metals, were widely used in past, but due to their toxic effect, environmental concerns have reduced the application of heavy metal containing pigments at the present time.

The first postage stamps of Ottomans, known as Duloz series, were printed in 1865-1876. These first stamps showed the Tughra (signature) of Ottoman Empire Abdulaziz, over a crescent in which Devleti Aliye Osmaniye, or "The Sublime Ottoman Empire" was written. After being a member of Universal Postal Union, founded in 1875, Ottomans issued a new set of stamps known as Crescent series which was first issued in September 1876. The Crescent series stamps bore the name of the country and the values in western characters as well as Arabic. The design consists of a crescent, with ends pointing upward. For this reason they are known as "Crescent Stamps".

In this study Duloz and Crescent series of Ottoman postage stamps, the first postage stamps of Ottomans, printed in 1876-1890 have been analyzed non-destructively using Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR), Raman and Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry methods. Lead chromate, Prussian blue, vermillion, calcium carbonate, gypsum, cellulose and degradation products of cellulose were identified. The merging of data coming from ATR-IR and Raman spectroscopy and EDXRF techniques have allowed the characterization of the pigments used on the surface of each stamp and dispersed between the paper fibers. Moreover, the adhesive on the rear side of the stamps was also investigated.

Vibrational spectroscopy analysis of flint industry from the Paleolithic site Giurgiu-Malu Rosu, Romania

E.D. Alexandrescu[1] and I. Stănculescu[1,2]

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IR and Raman spectral methods are used complementarily to identify the structure of pure compounds or components of a material by comparison with reference data. There are several macro and micro vibrational spectroscopy techniques that can be further classified after the spectrometer used for measurements, *e.g.* dispersive or with interferometer (Fourier Transform (**FT**)), or the detected radiation, *e.g.* transmitted, reflected (specular, diffuse (**DRIFT**)), attenuated totally reflected (**ATR**) and scattered (Raman). Some of these low cost techniques are fast, non-destructive, most of them do not require sample preparation and may be performed *in situ* by portable instruments.

Given the complex structure and composition of the silicolites, our investigation aimed at the identification of characteristic bands in the IR and Raman spectra of Giurgiu-Malu Rosu flint industry, in order to determine both the source of the raw material and the relation between the physicochemical properties of the flint and the technique used by the Paleolithic populations from the Romanian Plain.

Several non-destructive vibrational spectroscopic techniques were used: micro Diffuse Reflectance Fourier Transform Infrared (micro DRIFT), Attenuated Total Reflectance (ATR), micro ATR, NIR FT-Raman, micro Raman and Raman mapping.

The raw material consists almost entirely of a bluish silex (**A**), a reddish silex (**M**) (only 4.8 %) and an insignificant number of other rocks (black schist, sandstone and quartzite).

The minerals identified using the position of the vibration bands were: α-quartz, moganite, calcite, anatase, aragonite, etc. The small shifts in the α-quartz vibration bands position and the α-quartz: moganite bands intensity ratio as well as other spectral parameters were used for provenance studies. Possible sources of raw material, established previously, are the Frăteşti Formation and Danube's terrace deposits.

The heterogeneous composition of Giurgiu-Malu Rosu flint industry and different mineralogical constituents of **A** and **M** major types of silicolites were emphasized. The wide heterogeneity of raw material and high percentage of "lower quality" silex could explain the vast quantity of rests and thus the flint industry of Giurgiu-Malu Rosu belongs to an Upper Paleolithic facies characteristic for the Romanian Plain.

References:

1. E. Alexandrescu et al., Nouvelles données chronologiques, technologiques et typologiques sur le Paléolithique supérieur de la Plaine Roumaine du Danube: le gisement de Giurgiu-Malu Roşu, L'Anthropologie 2004, 108, 407-423
2. E.D. Alexandrescu, Arhaeocharts, 2012, http://aniri.ro/arheo/index.php

INP: mission and means

Stefan Bâlici

INP National Institute of Patrimony, Bucharest, Romania

Abstract not submited

Archaeo-metallurgical studies on artifacts from Romanian Museums using X-Ray based methods

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The following case-studies will be presented:

- Scythian and Greek metallurgy of bronze arrowheads (VIIth-VIth Centuries BC)
- Geto-Thracian metallurgy of silver adornments (IVth Century BC)
- Dyrrhachium silver drachms metallurgy (Ist Century BC) - original, debased, plated, tinned coins
- Roman tinning procedure – the case of Piatra Rosie iron shields

As analytical methods we used X-Ray Fluorescence (XRF) - for general aspects, micro-Proton Induced X-ray Emission (micro-PIXE) and micro-Synchrotron Radiation X-Ray Fluorescence (micro-SR-XRF) for micro-structural investigations.

Nuclear technics for preservation treatments of archeological organic materials and how to take into account archeological studies while applying such treatments

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In Grenoble, France, nuclear technics for preservation of cultural heritage artifacts have developed in the early seventies together with the systematic excavation of a medieval site that provides a very large collection of waterlogged wooden items, giving a solution to treat such unstable materials with radio-curable resins. Meanwhile, gamma rays have been used for biocide treatments on historic and archeological collections, including the famous mummy of Ramses II. Today, both gamma rays biocide and consolidation technics are still used and offering very suitable answers for the conservation of archeological items. We proposed to review these techniques, highlighting recent examples in which they fit not only in complete conservation projects, but also in archaeological studies programs.

Radiocarbon dating and archaeology in the Middle to Late Bronze Age of the Eastern Mediterranean: a happy marriage?

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The absolute time scale of the Eastern Mediterranean before 500 BC was established through the work of many scholars by piecing together temporal evidence from various sources connected to the dynastic periods of ancient Egypt. This formed – and still forms – the backbone of the absolute time scale going back to about 3000 BC.

When radiocarbon dating was developed some 60 years ago, it first appeared as a true revolution to archaeology for establishing an independent absolute time scale based on the well-established law of radioactive decay. However, the initial enthusiasm was damped by the fact that the $^{14}C/^{12}C$ ratio in atmospheric CO_2 was not constant over time, and the determination of absolute ages depends on a ^{14}C calibration. The "wiggly" character of the calibration curve often limits the precision of absolute radiocarbon dates. Great strides have been made to reduce the uncertainty when additional information about the temporal order of archaeological samples was available, applying methods of Bayesian statistics. In a seminal work by the Oxford AMS lab, a direct comparison of radiocarbon dated material from the dynastic period revealed essentially a good overall agreement with the historical chronology of ancient Egypt [1].

However, a particularly persistent disagreement of about 100 years remains in the 2nd Millennium BC between the absolute time scale derived from archaeology and radiocarbon dating, respectively. The current status of this dispute will be discussed, including the results from the Hyksos site at Tell el-Daba in the Nile delta [2], from the Minoan eruption of Santorini [3], and a more recent comparison of radiocarbon results in the Levant [4].

References:

[1] C. Bronk Ramsey et al., Radiocarbon-based chronology for dynastic Egypt, *Science* **328** (2010) 1554-1557.
[2] W. Kutschera et al., The chronology of Tell el-Daba: A crucial meeting point of ^{14}C dating, archaeology, and Egyptology in the 2nd Millennium BC, *Radiocarbon* **54** (2012) 407-422.
[3] S.W. Manning et al., Dating the Thera (Santorini) eruption: archaeological and scientific evidence supporting a high chronology, *Antiquity* 88 (2014) 1164-1179.
[4] Höflmayer et al., New evidence for Middle Bronze Age chronology and synchronisms in the Levant: radiocarbon dates from Tell el-Burak, Tell el-Daba, and Tel Ifshar compared, *Bulletin of the American Oriental Research* **375** (2016) 53-76.

The Ugly and the Beautiful: The use of the ^{14}C bomb peak to measure the age of human cells

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During the Cold War of the 1950s and 1960s, the USA and the Soviet Union performed atmospheric nuclear weapons testing of ever increasing power and intensity. When it became clear that by this action the whole world would be contaminated with life-threatening radioactive fallout, the Nuclear Test Ban Treaty of 1963 was signed by the USA, Soviet Union and Great Britain, essentially stopping atmospheric nuclear weapons testing. By this time, the intense neutron flux from the hydrogen bomb tests had produced some excess ^{14}C on top of the natural ^{14}C in atmospheric CO_2, creating a unique isotope label of carbon at a known point in time. Since atmospheric CO_2 exchanges continuously with the biosphere and the hydrosphere, the ^{14}C excess was transferred to every material which participated in this exchange. As a result, all human beings who lived between 1950 and 2000 were labeled with ^{14}C from this "bomb peak".

This unique signal of all living matter on Earth can be used for a variety of applications ranging from forensic medicine to basic research in molecular biology. Among these applications, perhaps the most interesting one is the possibility to study the birth date of cells in the human body. It allowed for the first time to retrospectively (i.e. after the death of an individual) reconstruct the time distribution of cells in the body from measurements of $^{14}C/^{12}C$ ratios in DNA extracted from human cells [1].

The current presentation will describe the use of the ^{14}C bomb peak to learn more about the human brain and other important cells in humans, and will also mention connections to forensic studies of various kinds [2,3].

References:

[1] K.L. Spalding et al., Retrospective birth dating of cells in humans, *Cell* **122** (2005) 133-143.
[2] D. Grimm, The mushrooms cloud's silver lining, *Science* **321** (2008) 1434-1437.
[3] E.M. Wild and W. Kutschera, Altersbestimmung dank Atomtests, *Spektrum der Wissenschaft* (März 2016) 62-65 (in German).

Archaeological/historical information and radiocarbon dating. Old-new problems of LBA-EIA chronology of Carpathian-Danubian-Balkan Regions

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This paper analyzes the relation between the traditional archaeological relative and absolute chronology - i.e. stratigraphy, typo-chronology, and cross-dating relying ultimately on the Egyptian historical chronology - and the dating by radiocarbon in the case of some Late Bronze and Early Iron Ages cultural assemblages from Central and Eastern Romania (Transylvania, Moldavia, Dobrudja). It shows that there is a consistent disagreement between the two dating methods which we do not know how to account for.

There are relatively few radiocarbon data as for the Late Bronze Age and the Early Iron Age chronology in the area under discussion. One may notice firstly the fact that, beyond its absolute chronological value, radiocarbon dating (including the uncalibrated, BP data) is a useful instrument to establish relative chronology (synchronisms, anteriority and posteriority relations). This instrument is at least just as useful and trustworthy as the typological-comparative method. In this paper the analyzed radiocarbon dates are in good agreement with the stratigraphical observations related to the succession of the Noua(-Coslogeni) culture and the so-called „Early Hallstatt" cultures of chanelled and incised-impressed pottery (Gáva-Holihrady, Corlăteni-Chişinău, Babadag-Cozia and related groups). At the same time, the calibrated radiocarbon age determinations show that the replacement of the Noua with the Gáva-Holihrady culture took place earlier in the Northeastern Carpathian regions (around the middle of the 14th century cal BC), and, likely, in central and southeastern Transylvania (towards the middle or end of the 13th century cal BC), when the evolution of the Noua (-Coslogeni) culture was longer in the Pruth-Dniester River Basin (until the middle of the 12th century cal BC), and in Dobrudja (until the middle of 11th century cal BC). The late phase of the Noua-Coslogeni culture in these areas may be

synchronized with the early phase of the Gáva-Holihrady culture in the Northern Carpathian region. It is most likely that only the late phase of the Noua-Coslogeni culture from its south-eastern periphery came into contact with the Northern Aegean LBA (LH III C) civilization, e.g. Kastanas, Macedonia, layer 14-13; Troy VIIb1. The „Early Hallstatt" Babadag culture and related groups (with their incised, impressed and knobbed ware) started also later as the Gáva-Holihrady culture and (in accordance both with the typological data and radiocarbon dating) may be synchronized with Troja VIIb 2-3. These regional chronological differences could have only with great difficulty been revealed without the contribution of radiocarbon dating, the only method that makes it possible for the specific cultural evolution of various geographical-historical areas to be followed. However, don't forget that „ A radiocarbon determination is not a date, but a measure of time subject to complex statistical variability in the light of a wiggly calibration curve of radiocarbon „years" against real elapsed time" (Christopher Chippindale, Antiquity, 1987, p. 5).

The specificity of the „protohistoric" LBA and EIA consists of the fact that the available calibrated radiocarbon dates may be compared with the cross-dating results based on historical chronology which were established for the Eastern Mediterranean region, especially for the Aegean (Late Helladic, Submycenaean, Protogeometric, Geometric periods). The calibrated radiocarbon dating obtained for the sites which are analyzed in our paper reveal dates that are 100-200 years „higher" than the expected age based on historical (contact) chronology. A similar phenomenon - i.e. a systematic deviation between calibrated radiocarbon dates and historical chronological data-was also noticed in the Egyptian and Aegean chronology. According to traditional chronology, which relies on the cultural contacts established between the Danube areas and the LH, PG and G civilization of the Aegean (and, ultimately, on historical Egyptian chronology), the periods called BzD and HaA were dated within the 13th to 11th centuries BC. Yet, the calibrated radiocarbon dates calculated for the sites, as representative for the mentioned periods, are „higher", included in a longer time interval, namely at least between the 14th and 12th centuries BC. Considering this deviation, which has not yet been sufficiently accounted for, and for avoidance of any doubt, it is recommendable to specify (and mark accordingly) the chronological system that is used: either calibrated radiocarbon dates (expressed in *Cal BC years*), or historical (contact) chronological dates (expressed in *BC/a.Chr. years*).

Irradiation - From nuclear science to Cultural Heritage preservation

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The discovery of radioactivity at the end of XIXth century was the milestone in the development of *nuclear science*. In the process entities carrying energy called radiations occur. Specific concepts operate in the nuclear science. Thus, the interaction between radiation and substance is called *irradiation* and radiation whose energy exceeds the binding energy of atoms in molecules (~ eV) is called *ionizing radiation*.

Ionizing radiation produces modifications in the irradiated substance of physical, chemical or biological nature. All practical applications exploit the changes resulted. *Radiation processing* is a technical domain that includes several industrial applications. Mostly known is the *sterilization of medical devices*. In this technology the desired effect is to eliminate microorganisms from contaminated medical devices without affecting the physical and chemical properties of medical devices.

Stakeholders of biodegradable cultural heritage (CH) artifacts (wood, paper, leather, textiles et al), like museums, archives, some buildings, are sometimes confronted with the same need for disinfection. In any CH treatment chosen for disinfection, preserving the integrity of treated artifacts is a must. *The similarity of the treatment needs and basic requirements prompted the consideration of CH irradiation as a disinfection method*. Medical supplies sterilization and CH treatment use the same equipment, technical procedures, management and control methods. Reliability, efficiency and safety are at the highest level, as they were perfected in a mature industrial process, worldwide applied for more than half a century.

Advantages:

SAFETY – there is no risk for the operator because the treatment is performed in a confined and protected area; there is no risk for the restorer, curator, museum visitor or environment either, because the treated artifacts do not become radioactive and there is also no residue left in the treated item.

EFFICIENCY - efficiency is only related to the absorbed dose, which is a parameter easy to set, measure and control; extended efficiency on the whole inner volume of the artifact.

TIME - treatment in days or hours: large amounts of objects can be simultaneously treated.

SIDE EFFECTS - modification of the basic properties of wood, paper, leather, parchment, hay, silk, cotton, wool and other textiles, moving film peliculles is negligible;

OTHERS - oversized objects, composite artifacts, raw materials for restoration may be treated; treatment is performed in transport boxes and at room temperature.

Favourable circumstances for application: emergency intervention on large quantities in need; intervention on objects with complex structure and on large objects/assemblies, in case the treatment cost/benefit ratio must be low.

Glass analysis - relation to historical questions

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Glass is a material of complex composition that varies with time and is characteristic for particular historic periods. An interesting period starts with late antiquity, with the introduction of HIMT glasses, and later in the beginning of the IXth century, when the flux made of natron, a dry sediment of Egyptian lakes, was replaced with the ash of halophytic plants.

Ion beam methods are a suitable tool for glass analysis, as they do not require demanding sample preparation and are little destructive. The method established in the lab now includes PIXE for the analysis of silicon and heavier elements, and PIGE for analysis of sodium, magnesium and aluminum. Gradual improvements of the method include development of a handy fitting program for the evaluation of gamma spectra, and different methods for normalization of the X-ray yields.

Recent studies include further analysis of glass from the late Roman settlements, which showed glass of Levantine origins, but only a few examples of the HIMT glass that was quite common in Western Europe. We further complemented the study of medieval glass beads, circulating in the territory of the present Slovenia from Late Antiquity until about the 11th century AD. The beads were made of glass using either natron or plant ash as flux, the latter beads not being older than about 800 AD. The occurrence of such beads in particular graves can then be used as a terminus *ante quem non*, and is applied for dating of the Köttlach culture in central Slovenia, particularly of its earlier phase that some archaeologist dated to 7th and 8th c. AD. The appearance of plant-ash beads in such graves then speaks for a later dating to the 9th c. AD.

Micro- and Macro archaeology – how can the two be combined?

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One of the aims of the excavations in Tasnad-Sere, Iud. Satu Mare, Romania, that I have been running since 2012, is to clarify the relations between occupation layer, archaeological features like pits and postholes, and the finds distribution in Neolithic settlements, or, more simply put, how do get finds into pits?

In Tasnad, we excavated a Neolithic occupation layer of about 40 cm thickness buried under ca. 1m of alluvial sediment which covers, in turn, postholes and pits of the late Starcevo-Cris culture. We recorded every single find >1cm three-dimensionally with the Totalstation, and took samples every m2 and every 5 cm. As well as the exact location of the finds, their orientation and dip is also recorded. According to the original interpretation, the occupation layer was created by riverine erosion of a Neolithic surface. However, the finds are not preferentially oriented in the direction of the water-flow, but instead form individual concentrations that correspond to discrete dumping events, probably on an area that was not in actual use as a habitation at the moment. If this theory is correct, this equates to a taphocoenosis ("Death-assemblage"), assemblage that was falling out of use and deposited at exactly the same point of time, and which originated inside one specific habitation, whose location, unfortunately, is unknown at the moment. In order to better understand the formation of both the occupation layer and of specific features, Elena Chernycheva has analysed soil

chemistry and soil biology, which in part corresponds to visible features. Ph, organic carbon, magnetic susceptibility and soil phytoliths are routinely analysed for each excavation unit. Size and preservation of sherds gives a good indication of the amount of mechanical stress an assemblage has been subjected to. However, recording the state of every single sherds is normally too time-consuming to be routinely used for large scale settlement excavations. Bruno Vindrola has, however, developed a method to automatically record and analyse pottery shapes using image-analysing software.

It is at this interface that micro- and macro- archaeological questions meet. On a macro-level, we would like to find out about Starcevo-Cris social structure, the organisation of a village, as well as the ways social cohesion was achieved. Genetic studies, isotope analyses as well as the distribution of raw materials indicate a high degree of personal mobility. But how did this work "on the floor"? How were incoming individuals integrated into an existing settlement and how was access to resources organised on a settlement level? Was there "private" or group ownership of specific resources, or were they shared by the whole community? Can we get a grip on who moved, on how often? At the moment, Silvia Amicone is analysing the pottery from the whole settlement and specific dumping events to see if specific raw materials are exploited by the whole group or not, and how this compares to specific manufacturing techniques, choices of temper and the timing of manufacture. This can be compared to the choice of lithic raw materials. Pottery analysis has also revealed phytoliths that can help to identify organic tempers used.

My aim is to use this analysis on a micro-level to understand formation processes and also to identify analytical methods that can be used more routinely on “normal” excavations to better understand the formation of features and the function of the settlement.

Developing Mobile Raman spectroscopy for archaeometry

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During the last decades Raman spectroscopy has grown to be one of the important techniques for the non-destructive investigation of art and antiquities. The method has multiple advantages, such as its non-destructive character, the ability to obtain high-quality molecular spectra and the possibility to analyse micrometer-sized particles. The application of this technique has merged from simple identification of pigments (comparison with spectra of a reference database) to more advanced studies where people try to understand degradation phenomena.

Moreover, also from the technical aspect, the methodology has improved, and new applications come into scope. Laboratory applications profit from enhanced technology, like sensitive detectors and the possibility to perform dispersive measurements using an infrared (1064 nm) laser. Also, by using microscope optics and having stable micro positioning tables, it is possible to perform mappings and in this area, quite some advances are made to speed up the measurements and obtain high-quality Raman maps.

Finally, given the non-destructive nature of Raman spectroscopy, and the ability to couple fiber optics probes, it is possible to perform in situ measurements of art objects. Despite the idea seeming simple, there are some challenges in the approach and working conditions, which sometimes hamper the measurements. Often measurements are performed under rather harsh conditions and the instrumentation has to be carried on site. Moreover, sometimes it is fruitful to combine mobile Raman spectroscopy with other approaches, such as handheld X-Ray Fluorescence analysis (hXRF), to obtain complementary information. This approach and solution will be illustrated with examples from our recent work.

Laser assisted removal of graffiti paints on stone: potential for restoration of cultural heritage monuments

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Graffiti paintings are well expressed part of the contemporary street art in the big cities but very often, being subject to vandalism, the aesthetics and integrity of the buildings facades, monuments, etc. are endangered. The paints that are commonly used are difficult to extract completely from the surface beneath. Considering this, graffiti become a great problem for restorers.

This contribution presents laser cleaning as a potential restoration technique. In the searching for optimal results two laser systems are used: Copper Bromide vapour laser (CuBrVL) generating wavelength 510.6 nm with pulse repetition frequency 20 kHz, and Q-switched Nd:YAG laser generating fundamental wavelength 1064 nm and second harmonic 532 nm with pulse repetition frequencies 1 Hz and 10 Hz. The laser technique is compared with usual chemical (solvent) and mechanical (abrasives) methods. Evaluation of the results was done by means of spectroscopic (Laser-Induced Breakdown Spectroscopy) and microscopic (optical, SEM) techniques.

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Thermal microscopy, DSC, unilateral NMR and ATR-FTIR spectroscopy revealing the effects of gamma radiation on vegetable leather

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The potential use of gamma irradiation as an inexpensive method for mass decontamination of organic historical/archaeological objects and artefacts is highly desirable especially in the field of big collections/items conservation. However, it is important to first assess if there is any evidence of change in the material structure and physical-chemical properties are not affected during their long time post-treatment use/storage.

The influence of gamma irradiations on the structure and thermal stability of vegetable leather at its different levels of hierarchy has been evaluated using a multi technique investigation. Differential scanning calorimetry (DSC), thermal microscopy (image MHT method), unilateral nuclear magnetic resonance (NMR) and attenuated total reflection-Fourier Transform Infrared spectroscopy (ATR-FTIR) were used to investigate whether there is any evidence for change to collagen within leather samples after their exposure to increasing doses of ^{60}Co gamma rays (10, 25, 50 and 100 kGy). New leather samples were prepared from calf, sheep and goat hides using mimosa-bark, chestnut-wood and quebracho-wood commercial extracts. This approach has allowed us to integrate the data from different techniques and overcome the intrinsic limitation of each single technique. The results are expected to be of use for choosing safe treatment doses for leather decontamination as well as for clinical applications and other purposes.

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Concession area "Boyadzhik": Using GIS technology for the protection of culture heritage

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In 2011, a team from Regional historical museum of Yambol started the search for archaeological sites in the concession area of "Boyadzhik", situated in the territory of the villages Boyadzhik, Galabintsi and Zlatari in Tundzha Municipality, Bulgaria. The area covers around 8.5 sq. km.

During the field survey of the area, eight open-air settlements were registered along with one medieval monastery and one burial mound. The area of all sites was covered by GPS-points and was dated based on the pieces of ceramics collected during the survey.

The aim of this presentation is to show the different methodologies used by the team from Regional historical museum in Yambol for field surveys, in the protection of cultural heritage. The methodology used depends largely on the environmental conditions of the survey area. The team is one of the pioneers in Bulgaria which started to use information technologies during the field surveys.

Archaeology & microscopy. Recent contributions to the analysis of artefacts made from animal skeletal raw materials

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The paper offers some synthesis data regarding recent microscopic analysis of archaeological artefacts made of osseous raw materials (bone, deer antler, teeth, shells etc.) dated from various epochs (Neolithic – Early Middle Ages, about 6000 BC-1300 AD) discovered within 14 sites from Romania.

The assemblage comprises more than 300 artefacts included in large morpho-typological categories as: tools, weapons, adornments, pieces from cultic inventories etc.

The application of a unitary methodology aims at highlighting the paleotechnological specificity (manufacture and use), the constant aspects, but also the innovations that appeared in time.

The analysis offers a unique *panopticum* from a close-up perspective of the always present and spectacular phenomenon of processing animal skeletal raw materials and related to various aspects of evolution of ancient human communities from the territory of Romania.

Site	Age					
	Neolithic	Copper Age	Bronze Age	Second Iron Age	Roman Period	Middle Ages
Ardeu, Hunedoara County				■		
Berești, Galați County		■				
Blandiana, Alba County				■		
Fântânele, Bistrița-Năsăud County				■		
Isaccea/Noviodunum, Tulcea County					■	■
Jucu, Cluj County						■
Luduș, Mureș County			■			
Negrilești, Galați County	■		■		■	
Păuleni, Harghita County		■	■			
Reșca/Romula, Olt County					■	
Stoicani, Galați County		■				
Suceveni, Galați County		■				
Turdaș, Hunedoara County		■				
Uroi, Hunedoara County			■			

Preliminary Archaeometrical Investigations on the Sarasău Hoard

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The aim of this paper is to explore the information provided by the X-Ray Fluorescence and microscopy investigations on a batch of gold pieces from the Sarasău hoard, currently kept in the custody of the National History Museum of Romania.

The hoard was found by chance in mid-19th century and much of it was lost as parts of it were shared among the discoverers. As a result, only a small number of objects are still preserved in the collections of the Magyar Nemszeti Múzeum in Budapest and in a private collection in Romania, currently to be acquired by the National History Museum of Romania.

The hoard can be dated around the end of the Bronze Age and represents one of the greatest discoveries of this period, both due to the history of the treasure, and to the uniqueness of the seven discoid appliques preserved in this lot. Although another batch of this hoard is nowadays exhibited in the Magyar Nemszeti Múzeum in Budapest, the batch from the National History Museum of Romania can provide new information about the ancient gold metallurgy. It's important to mention the particular characteristics of the area where the hoard was discovered, namely the Maramureș region – an area rich both in natural mineral resources as well as in archaeological finds, especially from the Bronze Age.

Therefore, in order to get a thorough understanding and a broader view on the ancient gold metallurgy, the authors will present the preliminary results of the XRF and microscopy investigations along with the conclusions which can be drawn based on such analyses. The National History Museum of Romania holds an important reference database for the given topic, following the participation in the ARCHAEOMET (http://www.arheomet.ro) and ROMARCHAEOMET (http://www.romarchaeomet.ro) research projects, when a significant number of prehistoric gold artefacts discovered on nowadays Romania's territory were analyzed. Direct outcomes for the preliminary analysis made with regard to the Sarasău Hoard derive from the comparisons made with other relevant prehistoric finds already investigated in the framework of the above-mentioned projects. These preliminary results for the Sarasău Hoard indicate the use of alluvial gold for manufacturing the analysed artefacts.

Compositional characterization of ancient glass finds discovered at *Troesmis (*Turcoaia), Romania

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This presentation will discuss the chemical composition of twenty glass fragments discovered during the 2012 archaeological survey at *Troesmis* (Turcoaia, Tulcea County, Romania) (Alexandrescu and Gugl, 2016) and dated to the Roman and the Byzantine/Early Medieval periods. The data were obtained by two external Ion Beam Analysis (IBA) methods: Particle Induced X-ray Emission (PIXE) and Particle Induced Gamma-ray Emission (PIGE) at AGLAE accelerator located in the basement of the Louvre Museum, Paris, in the frame of CHARISMA EU FP7 project (Pichon et al. 2014). The analytical results were compared to the recognized compositional glass groups from the Mediterranean region during the first millennium AD. The *Troesmis* assemblage turned out to contain samples belonging to several distinct categories of ancient glass, obtained from different raw materials and manufacturing procedures. Some of the analyzed vitreous finds from *Troesmis* were the result of glass recycling, while others were identified as deriving from Roman glass vessels imported from the Levantine or Egyptian shores of the Mediterranean. This pioneering archaeometric study (Bugoi et al. 2016) brings some hard science arguments for the long-range commercial exchanges during the Roman period.

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A technological study of red and white colours in the Boian "sanctuary" at Cascioarele-Ostrovel, Southern Romania

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Since its publication in 1970, the elaborately painted Boian "sanctuary" (*c.* 4800-4550 BC; phase Boian-Spanțov) discovered in the tell-site of Căscioarele-Ostrovel, in Southern Romania, has been mentioned in numerous texts dedicated to the European Neolithic, Chalcolithic architecture, or the religious life in the Chalcolithic time. However, the pigments themselves have received no attention, and no technological analyses have been made so far. Thus, the aim of this paper is to present the results of the first study on the white and red colors used by prehistoric people for painting various architectural elements of the "sanctuary" and some of the objects found in it.

The sample material consisted of wall fragments, clay house models with animal necks and heads, pottery sherds, a whole vessel, and a fragment from a clay column. For the sake of comparison, a painted pot fragment from another Boian construction has been included in the sample.

The chemical composition of the white and red colours has been analyzed using the Particle Induced X-ray Emission (PIXE) technique. A 3MV Tandetron™ particle accelerator installed at the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH) was used to generate and deliver the proton beam. Recently the 3 MV Tandetron™ [1] was upgraded with an "in-air" analysis setup. This facility allows the measurement of fragile and large samples without any risk of damage implied by the vacuum chamber conditions. A proton beam of 2.735 MeV was generated and directed towards the samples. The resulting characteristic X-ray spectra were recorded using a Silicon PIN (Si-PIN, Amptek, USA) [2] and analyzed with the Gupix software [3].

In addition, the pigments were analyzed using a Bruker Vertex 70 FTIR spectrometer equipped with a RAM II Raman module (with N2 cooled detector and Nd:YAG laser excitation source of 1064 nm).

The two methods have led to the identification of calcite, quartz and ochre. For the study region, the results are similar with those obtained for other Boian-Spanțov pottery samples, such as the one from Radovanu-La Muscalu site, but seem to be more uniform than the case with the pottery sample from the Boian "sanctuary" at Gălățui-Movila Berzei, dating from an earlier chronological phase (Boian-Giulești).

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Case study of ancient iron slag founded in Eastern and Northwest of Albania

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In Albania many ancient iron artifacts and slags were found, which are evidence of an early metallurgy. Slag is the best material for studying this metallurgy, and can help in the search for the origin of artifacts of iron as well as production technique. The size, shape, microstructure of slag, resistance to corrosion, and chemical composition, enable connection of slag and minerals to detect specific treatments minerals and specific technologies (increased flows, etc.). The mineralogical composition study gives us more information on the conditions of slag formation. Archaeologists have found ancient slags coming from iron production in antiquity in Eastern (Qukes, Katund Plak) and Northwestern (Merqi and in Varosh) Albania. Methods used to analyze those slags are optical microscopy (reflected and polarized light) for microstructure investigations, X-ray diffraction / X-ray fluorescence to define the qualitative and quantitative phase and elemental compositions, as well as SEM-EDS. The densities of the slag samples are measured by double weighting method. The carbon content of steel grains founded inside the slags are measured using carbon and sulfur system, also Vickers microhardness were measured. Grains had different dimensions, they started from the smaller ones up to those of 1 cm and are steels of low carbon 0.1 to 0.35% C. Iron slags were mainly composed of wustite and fayalite set inside amorphous glass matrix, as well as of quartz and few magnetite. Comparing the distribution of slag phase compositions slag Mërqi 1 and Qukës 1, may be smelting slag.
Key words: Ancient iron slag, SEM-EDS, OM, XRD, XRF, Vickers microhardness, archaeometallurgy.

A comparative study of some Russian, Russian school (lippovan) and Romanian popular icons of nineteenth century

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The results of a comparative study of seven wooden Orthodox icons are presented and discussed. All icons are from the collections of two monasteries: Antim Monastery in Bucharest and "Dintr-un Lemn" Monastery in Valcea. Two of them are from Russia (most probable Suzdal', the first half or the XIXth century), three are painted in the Russian style but produced in the Lippovan (starovery) Northern Dobrogea and Danube Delta Russian community in Romania and two are most likely from Wallachia.

Several noninvasive investigation techniques such digital radiography (DR) and UV photography (UVP), X-Ray fluorescence (XRF), Fourier-Transform Infrared (FT-IR) and Raman spectroscopy, as well as the invasive epithermal neutron activation analysis (ENAA) were used.

DR and UVP highlighted some details of the painting layer as well as of the wooden base – allowing to identify some of the pigments used, *i.e.* white lead, vermillion and red lead. XRF and FT-R spectroscopy were useful in investigating

the inorganic pigments such as lead white, zinc white, titanium white, yellow chrome, green malachite, realgar, vermilion and ultramarine. All icons showed similar FT-IR spectra, confirming the use of egg yolk as a binder, characteristic for tempera technique commonly used in the nineteenth century. At its turn, ENAA evidenced the presence of As and Hg as main components of the red color while the presence of Sr together with Ca (correlation coefficient of 0.724 at $p< 0.05$) suggests the use of gypsum for the preparatory layer.

All results allow estimating the icons ages as not earlier than 19th century. The presence of titanium white (a pigment used beginning with 1919 in Europe) suggests some icons were later restored or partially repainted.

Except for style, no major differences were found, indicating the existence of common traditions in the use of pigments in liturgical paintings.

Microbiology contribution to saving heritage artefacts by gamma irradiation

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Microbiology applied in the service of cultural heritage preservation has its specificity. More than that, preservation through irradiation treatment, for microbial decontamination, directs the investigation towards estimation of required dose and confirmation of its microbicidal effect.

Radiation sensitivity of microorganisms, expressed by their D10 value, is traditionally assessed on single isolate. Literature shows that the value tends to vary significantly with culture substrate, temperature and humidity during irradiation. Considering the goal of object saving through irradiation treatment and the high diversity and heterogeneity of contamination, an overall estimation of population sensitivity to irradiation seems the appropriate strategy.

We here show that, despite its lower accuracy, populational radioresistance is a good approach to serve the preservation goal, especially in case of mass treatment.

Biologically Hazardous Agents at Work and Efforts to Protect Workers` Health from Museums and Heritage Deposits

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The presence of microorganisms in museums and heritage deposits is a permanent risk to the museum employees, who are daily exposed to bacteria and micro-fungi spores, this risk triggering a serious condition.

The presence of microorganisms on heritage objects from museums represents a real challenge for all museum staff, as well as for those responsible for safety and health at work. This is because microorganisms have a destructive effect not only on heritage assets, but also on workers' health.

There are two main risks for workers that come into direct contact with heritage objects: the biological risk (the source being the objects themselves) and the chemical risk (given by chemical substances used in the objects` restoration process).

It is important to improve the current understanding of the health hazards caused by biological and chemical factors from the workplace. This study briefly describes these factors and provides some examples of their adverse health effects. It also reviews risk assessments, protection with workers` personal safety equipment, regulations, as well as vaccinations.

The petrography of lithic inventory from Bordușani - Popină tell settlement (Ialomița County, Romania)

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Bordușani-Popină site is located in South-Eastern Romania, in Balta Ialomiței island, the floodplain area delimited by Borcea River and Danube itself. The Chalcolithic levels investigated so far in this important tell settlement, with a stratigraphy recording 9 m of archaeological deposits, are attributed to the Gumelnița A2 phase, with successive layers of occupation characterized by unburned and fired dwelling structures, passage ways and waste areas.

Together with varied ceramic and clay objects, bone and antler tools, a very rich and varied lithic inventory was uncovered, represented by objects made from both chipped and polished stone.

The petrographic study is based on macroscopic characterization and on the optical microscopy in polarized transmitted light. The chipped lithic inventory is composed of various silicolites, of which the "Balkan flint", characterized by fine texture, massive structure with fine inclusions, rarely banded, homogeneity and yellowish ochre color, is predominant.

The polished stone inventory is represented by various tools made from different types of rocks, of magmatic, sedimentary and metamorphic origin. From these, very important frequencies have the green schists, very weakly metamorphosed, from which the majority of grinding stones and polishing tools were made. As occurrences, silicolites are frequent in central Dobrogea, in the form of chert, as nodular inclusions in calcareous deposits of Jurassic age, as those near the tell site from Hârșova, or in the proximity of the Gumelnița settlement from Ghindărești. The types of rocks used for polished stone artifacts have source areas in the entire territory of Dobrogea; the magmatic rocks and mezzo metamorphic schists in the northern zone, the green schists and limestones in the central area, and an entire series of sedimentary rocks in the southern zone.

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Keywords: Chalcolithic, tells, Gumelnița culture, lithic inventory, petrography.

Prospective in-depth elemental analyses of large objects by using brilliant gamma beams

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ELI-NP facility will deliver an ultra-bright monochromatic gamma-ray beam energy-tunable in the range of 0.2–19.5 MeV, produced by the laser-Compton backscattering technique. These high-brightness γ-rays meet all the technical requirements for investigations of large and complex archaeological artifacts and works of art. The non-destructive and non-invasive assays planned at ELI-NP target the use of nuclear resonance fluorescence (NRF) and computed tomography (CT) to provide in-depth elemental analyses of objects of various nature and composition. This is a key technology for applications such as trace element analysis of Cultural Heritage objects. The unique features of the ELI-NP gamma beam coupled with a high-efficiency gamma array detector will meet criteria for high sensitivity NRF measurements that are crucial in these fields. Moreover, the NRF method used in conjunction with radiography and tomography can produce isotope-specific trace element distributions in bulk materials. Accordingly, the radiography and tomography setups to be developed at ELI-NP are designed to allow high-resolution scans in objects up to 150 kg and one meter wide. Here we discuss industrial and Cultural Heritage applications that can benefit from the quality and characteristics of the ELI-NP gamma beam.

Mechanical properties of gamma irradiated leather

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Cultural heritage is ineffably degrading due to physical, chemical and biological factors. If physical and chemical degradation can be delayed by controlling the storage conditions, the biological attack, once installed, can be stopped only by a drastic intervention. Among others, ionizing radiation treatment has the following advantages: the certainty of biocide effect, fast treatment, mass treatment, no harmful chemicals and residues. However, because of the complexity and diversity of the constituents of cultural heritage items, there is always the question whether the radiation induces a supplementary degradation in the material or not. In literature there are very few data on the behavior of the physical and mechanical parameters of leather under the effect of ionizing radiation and even fewer on historical (aged) leather and parchment [1]. The main concern in the analysis of natural materials is their uniformity. One of the major problems when working with natural materials is the heterogeneity of the samples. This is caused by the animal constitution and the manufacturing process. In order to exclude some of the mentioned errors, all the tested samples were collected from the middle section, close to the back bone of the animal. The leather was sampled from a bovine. This research has two main objectives: first, the characterization of leather uniformity across the analyzed area and its mechanical properties, i.e. breaking force and tensile stress. Secondly, to establish its tolerance when exposed to ionizing gamma radiation as a per-requisite for cultural heritage irradiation treatment. The leather was exposed to gamma radiation and characterized in terms of breaking force, tensile stress and elongation. Different doses were applied: 3, 6, 10, 15, 20, 25, 35, 50 and 100 kGy. For every dose 10 (ten) test specimens were sampled for a better characterization. Between these radiation doses there were interleaved 4 (four) non-irradiated samples in order to observe the uniformity and strength of the leather. Non-irradiated samples were placed before 3 kGy and after 10 kGy, 25 kGy and 100 kGy.

The results indicate that the natural mechanical resistance decreases along with the growth of the distance from the backbone of the leather. The higher average value for tensile stress closest to the backbone is 12.98 N/mm2 and farthest, 10.67 N/mm2. Also, the thickness varies from averages of 0.98 mm to 1.021 mm independent from the position from the backbone. Regarding the irradiated samples, a constant decrease of tensile stress average starting from the first non-irradiated sample (12.98 N/mm2) was observed. A slight increase in tensile stress was observed from 3 kGy (11.81 N/mm2) to 6 kGy (12.23 N/mm2) up to 10 kGy (12.46 N/mm2). Nonetheless, these values are lower than the first non-irradiated sample (12.98 N/mm2). In order to take into account the natural decrease in tensile stress, we have calculated the average of the first non-irradiated sample and the second one (12.42 N/mm2, sampled after the 10 kGy set). This value is similar with the one obtained at 10 kGy, meaning that irradiation does not induce modifications in the material up to 10 kGy. Following the same principle, the tensile stress average of the second non-irradiated samples and the third ones equals 11.75 N/mm2. This value (11.75 N/mm2), correlated with the irradiated samples at 15 kGy (11.78 N/mm2), 20 kGy (11.25 N/mm2), 25 kGy (11.01 N/mm2) leads to the conclusion that even at 15 kGy, radiation does not induce modifications in the material. Starting from 20 kGy modification in the tensile strength (from 11.75 N/mm2 to 11.25 N/mm2) can be observed.

In conclusion, from the mechanical testing results, radiation effects induced on bovine leather can be observed starting with 20 kGy. These results and conclusions must be interpreted in comparison with complementary methods, i.e. thermal analysis or vibration spectroscopy taking into account the hierarchically complex leather architecture.

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New methods in Raman spectroscopy for mineral and pigment analysis in Arts and Archeology

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New methods and latest developments for Raman analysis in arts and archaeology are presented. The Renishaw Raman InVia approach to high performance Raman analysis and imaging is reviewed, including some of the accessories specifically developed for applications in arts, restoration, archaeology, minerals and combined techniques like SEM-Raman. Some application examples are also shown. Furthermore, a new Renishaw development will be presented due to its direct applications in this field, where processing samples or preparing them by altering their initial state is to be avoided as much as possible: this new development will allow easy creation of Raman maps for samples with complicated geometries, rough, tilted samples or dynamic samples that tend to go out of focus during the analysis.

Cucuteni C pottery technology from Eastern Romania: A multi-analytical study

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The Cucuteni C pottery is considered by the archaeologists a ”foreign and inferior” ceramics, representative for the contacts of the Cucuteni-Trypillia communities, which evolved during the 5th-4th millennia BC, with the ones coming from the steppe region.

In this study we focus on the technology used for the Cucuteni C pottery production from Eastern Romania. Multi-element analyses of 50 pottery fragments sampled to represent the stylistic and technological diversity of the Cucuteni C pottery was carried out for determining the chemical composition in order to trace their provenance. The chemical analysis was carried out by both X-Ray Fluorescence (XRF) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), and then the data have been analyzed by using main component analysis (PCA) and hierarchical cluster analysis (HCA) in order to obtain information about their similarity and clustering. The rare earth elements have been determined using LA-ICP-MS to establish the geochemical pattern, small changes between them indicating differences in their relative behavior due to the chemical environment alteration. The results of the chemical analysis provided evidence that the Cucuteni C pottery sherds from Eastern Romania may have different sources of provenance.

In order to investigate the technological attributes of the Cucuteni C pottery the mineralogical transformations caused by the firing process and the microscopically structure were analyzed. The mineralogical composition of the samples was determined by X-Ray Diffraction (XRD) and the mineralogical phase quantification was done by the Rietveld method. Further Scanning Electron Microscope (SEM) studies on potsherds have been carried out for inferring the microstructural transformations caused by the firing process. The results for the Cucuteni C pottery analysis were compared to previous results obtained on the Cucuteni painted pottery.

Non-invasive archaeology in Romania: archaeological topography, GIS analysis and remote sensing applications

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Romanian archaeological research has continually adapted to the new trends in the field, particularly as far as preliminary, non-invasive investigation at the beginning of archaeological digging proper, conforming to the modern working methodology used all over the world. If, at the beginning, Romanian archaeology had to face the lack of proper technology, the main issue nowadays is the lack of specialists able to use it. Though the results of such an investigation are spectacular and ease the archaeologist's work of identifying and locating the sites with accuracy, there is still some reservation regarding "modern" techniques that tend to replace the "classical" ones. This study addresses those archaeologists who wish to better understand the usefulness of these methods of investigation and compare results based on case studies that show corroborated data from topography, GIS analysis, geophysical prospects and tele detection.

Decorated Islamic manuscript from the Ottoman Turkish period: paper characterization, dating and conservation

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Some illuminated and rich decorated Islamic manuscripts which date back to the Ottoman period (1299 – 1923 AD) are deposited at the National Institution Museum of Macedonia in Skopje. In the present study, an analytical investigation and conservation treatment of one of them was carried out (Fig. 1). The main damage was that the manuscript was affected by microorganisms and certain insects, influenced by the poor storage conditions, which has led to weakening and britllement of the paper support. Previous restoration interventions had been carried out for this object at the past, but the state of the paper and manuscript became very bad in time and required the removal of the old materials used and the carrying out new restoration process. This research aims to:

Fig.1 The frontispieces of Islamic manuscript *Tefsir-i kuran envarut tensile ve esrar ut tevil*

1. Study the composition of the paper, such as: fibers and adhesive used to size the pulp forming the folios as well as the acidity of the paper in order to date the manuscript and to define proper materials for replacement.
2. Treatment and conservation of the manuscript

The analytical techniques used in this study were micro-chemical (spot) tests supported by optical microscopy (OM). The results indicated that the original paper support consists of rag fibres (linen, hemp and/or cotton) and the sizing material is animal glue (gelatine) with the addition of alum and starch indicating that the manuscript dated most probably from late 17th century, but couldn`t have been written before the 16th century.

Treatment and conservation of the manuscript included: disinfection in anoxic environment, mechanical and chemical surface cleaning, and removal of the previous restoration materials. Furthermore; consolidation, replacement of the missing parts with strengthening the surface of the paper support and bookbinding in a new leather cover.

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XRF comparative analysis of ceramics discovered in the multi-layered archaeological site Branisca-Pescarie Est; local production versus imports

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The aim of this approach is the comparative analysis of a series of samples of ceramic material covering about 4,000 years, originating from the site Brănișca–Pescărie Est (Hunedoara County, Romania). The preventive archaeological excavation of this site was occasioned by the construction of the Lugoj–Deva Motorway (sector 4) and took place in 2014. On the maps and surveys of the 18th-19th century, on the spot of the existing piscatorial ponds is visible the stream of Târnaviţa, nowadays disappeared, the site no. 3 being situated on the first terrace of this ancient flow.

The physical, geographical and climate features of the region, apparently not very favourable to the habitation of human communities for long periods, have been yet not too adverse to the presence of certain habitation structures (from Prehistory to the Middle Ages), especially due to the existence of important sources of raw materials.

There have been investigated 114 archaeological features dated to distinct historic periods, from the end of the Copper Age to the 7th -9th century AD, the site no. 3 being only a periphery of a settlement of large size.

The samples were analyzed using XRF spectrometer. For each of the samples three measurements were taken (on the outer surface, inner surface and medium layer) and their average was further used. The analysis was focused on the concentration levels of major and minor elements (Ba, Ca, Ti, Fe) - with the concentrations level higher than 0.1% w/w - and trace elements (Mn, Pb, Rb, Sr, Zn, Zr) - with the concentration level lower than 0.1% w/w, respectively 1000 ppm.

The experimental results were statistically treated using Principal Component Analysis approach, in order to investigate which elements show major contribution in differentiating the given samples based on the historical period to which they belong. Through this method, we aimed at characterizing the approximate chemical composition of the local ceramics, attempting to predict which samples have been imported.

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Archaeological and archaeometrical analyses on Eneolithic pottery from Nanov-Vistireasa (Teleorman County)

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Recent excavations (2012) from Nanov-'Vistireasa' (Teleorman County) yielded an Eneolithic settlement of the Boian-Spanţov phase (c. 4800-4450 BC) with an impressive quantity of pottery. From this, here we will focus only on the complete batches of sherds discovered in two large pits. Previously, these were macroscopically analysed for preliminary observations on manufacturing technology (types of fabric, temper, building methods, surface treatment, decoration, and firing conditions), and function.

Given that the chemical composition of clay artefacts is strongly related to the sources of clay and recipe of making, while the chemical composition of the pigments used for decoration is of great importance in the investigation of the manufacturing technology and provenance studies, the aim of the second stage of analysis was to determine the chemical

composition of the ceramic paste and pigments. To this end we used methods as the Particle Induced X-ray Emission (PIXE), FT-IR and/or FT-Raman spectroscopy and Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM/EDAX). Most of the samples were selected on the basis of their paste composition as observed macroscopically and others by the presence of decorating pigments (white and/or red) on their surfaces.

Our analysis, based both on the archaeological and archaeometrical methods, aims to bring new data and add safety to assumptions concerning provenance, manufacturing technology and organisation of production of the pottery discovered in the aforementioned two Eneolithic pits.

Analyses of pigments from encrusted Middle and Late Bronze Age pottery from the Lower Danube using PIXE and FT-Raman spectroscopy

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The aim of this paper is to gain a first set of information on the composition of pigments and fabric of the Middle and Late Bronze Age encrusted pottery from the Lower Danube area (*c*. 2000−1300 BC in Southern Romania) – a pottery for which there are no technological analyses whatsoever.

The samples stem from sites locate in the Eastern and Western part of the study-area – Muntenia and Oltenia, respectively – and three chronological stages – early and late Middle Bronze Age (i.e., Tei II, Tei III and Verbicioara III phases, c. 2000–1550 BC) and Late Bronze Age (i.e., Fundeni-Govoraand ŽutoBrdo–Gârla Mare styles, c. 1550–1200 cal BC).

PIXE measurements were carried out at the external beam setup of the 3 MV Tandetron™ accelerator of IFIN-HH, Măgurele-Bucharest [1], in order to determine the chemical composition of pigments (and fabric). A 2.7 MeV proton beam was focused to approximately 2 x 2 mm^2, the current has been kept under 5 nA, for a data acquisition time of 300 s per spectrum. A 500 μm thick Amptek Si-PIN detector, positioned at 45° with respect to the beam direction was used to measure the characteristic X-rays [2]. The quantitative data analysis was performed using GUPIX software [3, 4]. The pigment was then analyzed using a Bruker Vertex 70 FTIR spectrometer equipped with a RAM II Raman module (with N2 cooled detector and Nd:YAG laser excitation source of 1064 nm). The results of the two methods were strikingly similar and allow for deductions concerning transmission of local tradition in pottery manufacturing and possible inter-regional contacts.

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Liquid chromatography with UV-Vis and mass spectrometric detection for the identification of natural dyes in 19th-20th c. Oriental rugs

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Natural dyes were the only source for textiles dyeing until the second half of the 19th century, when synthetic dyes were discovered. Natural dye sources were initially used only locally, then became subject of trade, records of their commerce being documented, as connected to geographical discoveries or historical events. Significant information about historical textiles provenience and manufacturing period may be revealed based on dyes identification, in correlation with the natural sources origin and trade records.

Natural dyes in textiles from Romanian collections have been studied since 1997, first by liquid chromatography with UV-Vis (diode array) detection, in a collaborative effort with the Royal Institute for Cultural Heritage (KIK/IRPA) Brussels and more recently by liquid chromatography with UV-Vis and mass spectrometric detection. The latter approach is based on the progressive use of the (ion trap) mass spectrometer from the Full Scan Mode followed by data procession by Ion Extracted Chromatograms according to the molecular ions of dyes in the database, to the MS/MS Product Ion Scan analysis.

The present study discusses the results obtained by the application of the above mentioned analytical protocol in the identification of dyes in 19th-20th c. Oriental rugs from the collection of the National Museum of Art of Romania. *Rubia tinctorum* L. (madder) was the most used biological source while other sources such as *Dactylopius coccus* (Mexican Cochineal), *Reseda luteola* L. (weld), *Delphinium semibarbatum* L. (isparak), *Rhamnus* sp. (berries), *Rumex/Rheum* sp. (buckthorn), *Caesalpinia* sp. (redwood) and indigoid dyes (*Isatis tinctoria* or *Indigofera* sp.) were also detected. Synthetic dyes were also identified. Their presence suggests interventions or dates the objects after the second half of the 19th c., when detected in the original parts of the textiles.

The results obtained are in perfect correlation with those reported by other researchers, enrich the existing knowledge on the Oriental rugs in Romanian collections and confirm liquid chromatography with UV-Vis and mass spectrometric detection as an important tool in the study of natural dyes in historical textiles.

Establishing biodeterrioration causes of wooden elements from churches and historic monuments of cultural heritage. Case studies

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Cultural heritage refers to mobile and immobile goods, made of organic and inorganic materials, with distinct significance concerning the achievement techniques, typical to a characteristic historical period and with specific features of each component material by point of view of conservation status. Aggressive, physical, chemical, thermal and biological elements, as well as the anthropic factor, are responsible for the cultural heritage state.

Keeping buildings and objects of architectural, historical and religious cultural heritage is one of the scientists`, conservators` and restorers` preoccupation, from the museum system, as well as skilled state authorities. Knowing the causes of degradation involves carrying out elaborated interdisciplinary studies, which underlies the development of standards and technical expertise, in order to perform intervention decisions to extend the lifetime of these cultural goods. Wood is a traditional material widely used in making the constituent elements of historical monuments and churches with multiple and known favourable properties, but without appropriate conservation techniques, being subjected to a slow and continuous biodegradation, often irreversible.

Case studies on the wood phytosanitary state are presented for the following national cultural heritage important objectives: Sf. Ilie-Gorgani church of Bucharest, Evangelic "Din Deal" church of Sighişoara, Tower with clock of the Peles Casttle, Coral Temple of Bucharest and Cesianu house of Bucharest.

RoAMS - status of the new Bucharest AMS Center

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We present an insight of new AMS facility at the Horia Hulubei National Institute for Physics and Nuclear Engineering, starting with its official foundation in 2013. The HVEE 1MV Tandetron was installed to perform multi-isotopic AMS analysis, especially to determine infinitesimal quantities from the ^{14}C, ^{26}Al, ^{10}Be, ^{129}I, $^{239,240}Pu$ isotopic species. Simultaneously, the radiocarbon group started to set-up the sample preparation laboratory for various material types, relying mainly on a modern automated graphitization station, produced by Ionplus AG. We present the measurement results for the reference and standard materials, along with the results for the SIRI (Sixt International Radiocarbon Inter-Comparison) proficiency test samples. Some of the typical inherent problems specific to radiocarbon dating laboratories, and their solutions are also listed. Finally, comments and conclusions for the current status of the RoAMS laboratory and projections for the future work are shown.

Searching for a Medieval Cemetery and Church in Arges County: A radiocarbon dating story

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In the last years the RoAMS Radiocarbon Dating Laboratory (IFIN-HH) has been involved in an original research work in Cicăneşti (Co. Argeş). There, investigations carried out since 2012 by a team of archaeologists from the County Museum Arges in Pitesti confirmed partly an oral tradition about the presence of a small rural community beginning with the foundation of Wallachia – i.e., immediately after the beginning of the thirteenth century −, through the existence of a church with cemetery dated to the 14th – 18th c. AD.

Calibrated ages obtained on collagen extracted by osteological material processing, and AMS dating at 1 MV Cockcroft-Walton Tandetron accelerator confirmed the archaeological dating. One of the excavated graves dates to the late 13th − first half of the 14th c., thus preceding by more than two centuries the first written mention of the settlement. Although we could not determine the extent of the cemetery and the location of the last burials, we were able to date the most relevant area from the point of view of the local community − that is, the area around the church, and establish an interesting sequence of burials.

As for the building, the absence of evidence for destruction by fire seems to support the hypothesis of moving to another location. This would make it a "faring church". In the hope of discovering its remains albeit as parts of a newer church, our research was directed to another wooden church located in the surroundings of the town of Curtea de Arges, in Valea Iaşului, Borovineşti village. Old records show that at the middle of 19th c. the Cicăneşti community decided to donate their dilapidated church to the villagers of the "Boroghineşti hamlet". Radiocarbon dating of wood fragments from several construction elements shows that the altar of the present-day church in Borovineşti (which is also abandoned) was constructed in the second half of 17th c. or in the first half of the 18th c. The analysis of other architectural elements shows several transformations of the building during the 19th c. The research was expanded in order to have a more appropriate image of the intervention phases and find the old elements in the present-day church.

Radiocarbon dating of archaeological bone samples belonging to Vinča Culture

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In this work we present the radiocarbon dating results of six samples belonging to Vinča Culture, Phase A, in order to certify that the Vinča culture was grown around the village Tărtăria, Gura Luncii.

To obtain information about the quality of the material of interest, i.e. the collagen from the bones, we did a qualitative and quantitative analysis for knowing the preservation degree and the percent of carbon and the nitrogen from the raw material and after that we continued with the extraction of the collagen from the bones [1]. This phase was followed by the combustion of the collagen in an elemental analyzer and the reduction of carbon dioxide to graphite with the automated graphitization station, produced by Ionplus AG [2].

The radiocarbon dates were correlated with the archaeological context.

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Location analysis of the settlements from the Late Bronze Age in the high plains of Vinga

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The Vinga Plain is a well-defined area both morphologically and from the point of view of dwelling in the Bronze Age. The presence within this morphologic unit of the fortification of Corneşti-"Iarcuri" speaks of itself about the archaeological potential of dwelling in this area at the end of the Bronze Age: they have identified a number of settlements that are the basis of our analysis. This study aims at analysing systematically these settlements by integrating them in GIS environments and by identifying those relevant criteria that have determined the preference of a community for a certain landscape or another. The analysis criteria mentioned previously can be grouped into two main categories: *morphologic aspect of the landscape* and *types of resources*, monitoring such indices as morphometry of the landscape occupied by the settlements of the bronze age, resources such as water or soils as main factors in producing food; *relationships within the system of settlements*, relying on data regarding the distance to the neighbouring settlements or power centres represented by fortifications, visual level relationships or models of communications as transport. Multicriteria analysis of these settlements allowed the identification of a hierarchy of the factors that have determined the establishment of communities in the Vinga Plain and the shaping of a general view regarding the landscape preferred by these communities by generating a prediction map.

Spectroscopic analysis of wall paintings from Peć Archbishopric, Serbia

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Monastery Complex of Peć is located at the entrance to Rugova Canyon, in the municipality of Peć. It presents the seat and mausoleum of the Serbian archbishops and patriarchs. It is assumed that the first church of the monastery complex was built in the third decade of the 13th century. The church was dedicated to the Holy Apostles, and it was painted for the first time in 1260 (it was painted again in the 14th and in the 17th century). In the 14th century, on the north of the Church of the Holy Apostles, the Church of St. Demetrius was built, and on the south of the Church of the Holy Apostles, the Church of the Holy Virgin and the Church of St. Nicholas were built. An entire history of the styles of medieval wall paintings from 1300-1620 can be seen on the walls of the Monastery Complex of Peć. The Complex is on a permanent conservation, and in 2006 it was inscribed on the UNESCO World Heritage List.

In this study wall paintings from the Church of the Holy Virgin were investigated by a combination of micro Raman and FTIR spectroscopies and optical and scanning electron microscopy-energy dispersive X-Ray spectroscopy (SEM-EDS). The wall paintings belong to the fourth decade of the 14th century and are well preserved. The presence of the characteristic peaks from calcite in all Raman spectra obtained from the substrate, as well as from painted layers confirms the application of the fresco technique. The combination of micro Raman and SEM-EDS revealed the existence of azurite in blue colors and green earth (celadonite) in green colors. In some fragments green grains of malachite were identified beside grains of azurite, as these minerals may sometimes occur admixed or banded together. Different red tones are attained by hematite, vermilion and red lead. The analysis of yellow grains led to identification of iron (III) oxyhydroxide, α-FeOOH, also known by the name of the mineral goethite. Identification of pigment orpiment, As_2S_3 on the saints haloes was identified by SEM-EDS. The application of a carbon black layer below a blue one was a common method in Byzantine hagiography. The purpose of the black layer is to enhance the blue color tone. Lazurite was applied only in combination with hematite, magnetite, vermilion and carbon for attaining pink color. Organic binder was applied below black layer. The painting technique used in the Church of the Holy Virgin was compared with techniques applied in Serbian medieval monasteries Žiča and Mileševa.

Geophysics and Landscape Archaeology. A large scale geophysical survey on *Limes Transalutanus*

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During the last decades, archaeological surveys have become increasingly concerned with expanding the research scale from site level to surroundings and regions, consolidating, thus, the status of landscape archaeology as relevant exploration approach. Following this trend, geophysics has been adapted to cover larger spaces too, even if customary applied on site scale, by developing efficient methods, like magnetometry, and especially by measuring the magnetic susceptibility of soil with a k-meter. The last mentioned method is not commonly applied in archaeology because it does not deliver data at the resolution necessary to identify archaeological features. Still it has the greatest advantages of discriminating between site and non-site and of outlining areas of intense anthropic activity within a site, while remaining the most cost effective in the field, in terms of time, human resources and ease of implementation.

An ongoing research project focused on investigating by mainly non-invasive means the southern sector of the Roman border known as *Limes Transalutanus* has been dealing with the archaeological exploration of a 157 km long corridor. After the initial aerial examination undertaken along the frontier´s line, at middle and low altitude with UAV, combined with linear field surface survey, several hot spots in need for clarification were established and they were further assessed with efficient geophysical methods. The authors will present their results, both methodological (efficient means to explore large scaled archaeological territories) and historically significant, while discussing also about spatial resolution and relevance versus time and cost.

The study of ancient glass objects discovered in Albania using non-destructive analytical methods

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While antique glass objects detected in Albania have been studied and characterized by archaeological methods, there are very few studies regarding their characterization with analytical methods. Such objects are discovered wholesale mainly in Durres, Elbasan, but in smaller amounts in Apollonia, Pogradec, Butrint and other areas belonging to the ancient period. The discovered glass objects, covering a long period of time, from antiquity to their industrial period, and in their composition reflect changes that have occurred during this period as well as raw materials in glass production technology.

The main objective of the study has been to collect data on the composition of various glass objects belong to IV-VI century AD coming from different places. These data will allow us to identify the materials and technology probably used for their manufacture, conservation conditions, etc. In addition we will be able to highlight the similarities and differences between similar objects discovered in different times and places.

In the study are included glass samples from objects (vessels, window glass and mosaic tesserae) discovered in Elbasan, Bylis, Saranda and Lin, most of which belong to the end of the fifth century and beginning of sixth century AD. For the characterization of glass samples are used different analytical methods such as Colorimetry, Optical Microscopy, Scanning Electron Microscopy in environmental mood connected with Energy Dispersive Spectrometer, Micro X-ray Fluorescence and Micro-Raman Spectroscopy.

From the analytical data we conclude that all the antique glass objects are silica-soda-lime type. The source of soda has been Natron, originating from Egypt indicated by the low contents of MgO and K_2O (<1.5%). All the samples belong to groups Levantine I and HIMT, produced with sand from the Middle East region.

Elements with lower concentrations P, S, Cl, Ti, Mn, Fe, Co, Cu, Zn, Sn and Pb are related with their contents in the raw materials as well as with the additions used to give various features to the glass, like color and opacity. Thin Au foils placed between two transparent glasses were identified in the gold coloured tesserae.

Posters

Data related to the investigation and restoration of a Neolithic cult vessel

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The multi-layered site of Baia, the point In Muchie, was introduced in scientific circuit in 2000, offering remarkable results since the first archaeological research campaign, made in 2012, when there were unveiled two houses belonging to Precucuteni I culture, especially through the discovery of a large batch of cult vessels, of which the most interesting made the subject of the present work. The author wants to emphasize the results of physico-chemical investigations achieved on this exceptional cultural good, and some issues related to its restoration.

Archeomagnetic research of an oven from the medieval period from Thracian and Ancient town near Kabyle village, Yambol Municipality, Bulgaria

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The ancient town of Kabyle is 8 km North-West from Yambol town in Bulgaria. The first settlement arose at the end of 2nd mil. BC around the sanctuary of the goddess Kybela-Artemis. Gradually, the small settlement became one of the main trading and political centers in Ancient Thrace. The town is conquered by Roman general Marcus Luculus in 72 BC and kept its leading position in Roman Empire. Kabyle was destroyed at the end of 6th c. by Barbarian intruders. The area of the town was also partly inhabited during the medieval period (11th - 14th c.).

In 2013, during a rescue archaeological excavation, an oven was examined. It's connected with the life of people from medieval period (11th- 12th c.).

From the oven presented, 22 samples were taken for research and dating via the archeomagnetic method. Archeomagnetic dating represents the comparison of received values for different elements of ancient magnetic field for analysis structure with benchmark curves for appointed epoch.

The aim of this poster is to present results from this archeomagnetic research of the oven from medieval period on the territory of ancient Kabyle.

Prehistoric symbolic artefacts - a close-up view. Bronze Age decorated red deer antler plate discovered in Transylvania, Romania

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The poster presents the data issued from the analysis regarding a unique symbolic artefact made of red deer antler discovered in the archaeological site of Şoimeni – "*Dâmbul Cetăţii*", Păuleni-Ciuc Commune, Harghita County, Romania. The object was recovered during the 2000 excavation campaign from a Wietenberg Culture complex (Hut 7).

The study was done using a unitary methodology (Beldiman 2007) which takes into account all quantifiable data. Systematic microscopic examination of the piece has been performed; photos taken (general views, detailed views, and microscopic views) were added to the previous image database.

A special attention was drawn to technological aspects (manufacturing, traces of use) that have been studied and defined on the basis of data issued from microscopic analyses. Some specific procedures are attested, such as fracturing, splitting, abrasion, chopping, grooving.

The artefact: Fragment of a decorated plate. Dimensions: length 35 mm; initial diameter cca 50 mm. Red deer antler. Triangular fragment. Probably circular plate made from a red deer antler beam fragment (*compacta* tissue). Black uniform colour resulted by burning. The ornamentation consists in two parallel grooves, made probably with a metal blade.

The possible manufacturing chain includes several stages: extraction, shaping, drawing the ornamentation (circle). The piece seems to have been intentionally broken and coloured probably by intentional burning.

This is a type of artefact which had not been found in other systematically studied Bronze Age sites and assemblages from Transylvania or other regions of Romania. This belongs to the Middle/Late Phase of the Bronze Age in Romania, Wietenberg Culture (Middle Phase, II; cca 1800 – 1600 BC).

We have here a rare/unique red deer antler plate that have been attested for the first time in this site and are rarely present in the area of Wietenberg Culture.

The analysis offers new chrono-cultural, typological and paleotechnological markers for complex and extensive analysis of symbolic behaviour of Bronze Age communities from Transylvania region.

RoAMS radiocarbon dating of a series of Palaeolithic archaeological samples

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Poiana Ciresului is one of the most important Palaeolithic archaeological sites from Romania and from this part of Europe. One of its main characteristics is its age spanning over more than 10.000 years.

The following work is describing a series of radiocarbon dating of samples coming from the "Poiana Ciresului" Piatra Neamt archaeological site, the Palaeolithic ages found are ranging between 20 000 and 30 000 years old, being in good agreement with previous radiocarbon datings performed by Beta-Analytic Company. The agreement with the already known ages is persisting even for different materials, i.e. bone and charcoal.

Characterization of iron slags from the Brâncoveneşti, Călugăreni and Vătava sites of the *Limes Dacicus Orientalis* (Mureş County, Romania)

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The study focuses on iron slag samples from three important sites of the Eastern frontier (*limes*) of Roman Dacia: the well-known Roman auxiliary forts of Brâncoveneşti and Călugăreni (linked by the Eastern *limes* road) and the recently discovered Roman watchtower from Vătava (all in Mureş County, Romania). Relying on the natural defence offered by the nearby mountains and hills combined with a built defensive structure and a watchtower system (like that of Vătava), the two forts controlled the border sections leading towards East around the upper Mureş Valley (Brâncoveneşti) and around the upper Niraj Valley (Călugăreni), representing the ancient traffic routes towards the *barbaricum.* According to the syntheses on the military history of Roman Dacia, in the II-III centuries AD both forts were among the strategically most importants sites of the Eastern border of the Dacian provinces.

During the research excavations carried out inside and in the vicinity of the two military forts and at the Vătava watchtower site rich Roman material was recovered, consisting mostly of ceramic pottery and ceramic building materials, but marble, stone, worked bone, glass, iron, bronze artifacts as well. Rich iron slag deposits were also unearthed at the Brâncoveneşti and Călugăreni sites. At Vătava besides the slag remains several iron-working tools have been found too. Smelting-zones or furnace remains in the area were not yet discovered.

After a preliminary characterization of numerous iron slag probes unearthed at the three sites prospected, two sample sets (4 from Brâncoveneşti and 6 from Călugăreni) completed with a representative sample from Vătava were selected for further study in an attempt to assess the slag types. In this purpose the samples were analysed using XRF (INNOV-X Alpha-6500) and ICP-MS (Elan DRC II, Perkin Elmer), with the aim to determine the major and micro-elemental composition; XRD (Bruker D8 Advance, CuKα1) and FTIR spectroscopy (JASCO 6100 FTIR), with regard to their mineralogical-structural characteristics. The Fe^{2+}/Fe^{3+} rate was determined by EPR spectroscopy performed at room temperature in the X-band (9.46 GHz) on the samples, firstly untreated and then thermally treated at 300 C (Bruker ELEXSYS E500).

The composition data obtained suggest different provenance for the raw materials, while the mineralogical data indicate several slag types, the main mineral phases being, as expected, fayalite, hematite and/or magnetite.

The EPR spectra evidenced properly the presence of Fe^{3+} ions in the samples, and the method used permitted the quantitative determination of the Fe^{2+}/Fe^{3+} rate in good concordance with the XRD and chemical analysis data.

Innovative nanostructured substrates for SERS method for the identification of materials in art works

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One of the most potent methods for the identification of various materials used by artists in their work of art is surface-enhanced Raman spectroscopy (SERS), in order to obtain highly detailed spectra with unique patterns.

Raman spectroscopy has been successfully employed from decades as facile method to identify many pigments and synthetic dyes in the work of conservation scientists.

Since, unfortunately, standard Raman spectroscopy still requires significant amounts of sample materials, SERS technique become the election method in order to minimize the quantity of the chemical component to be collected from the art work.

This work presents an innovative SERS substrate based on hybrid nanoparticles to enhance the weak Raman scattering effect. The nanoparticles consist in a core of silica with a controlled-size of Au or Ag, deposited on a solid surface, for simple handeling of samples during the measurements.

Reference materials tested were natural and synthetic pigments and varnishes (malachite, indigo, Dammar).

The proposed novel substrates for SERS method allow a significant enhancement of the details in the spectra collected, using both Raman microscopes and portable instruments and show great potential for the improvement of unambiguous identification of dyes and varnishes in cultural heritage objects.

Case studies for the dating of Bronze Age cremation burials from Hungary

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Cremation of dead bodies was a very common practice in the Carpathian Basin during the early, middle and late phases of the Bronze Age (2600/2500–800 BC). However, researchers have to face several problems during the investigation of cremated remains. While it is not easy to collect the tiny cremated bone pieces within a cremation burial, these bone remains provide only limited bio anthropological information. Another problem is the dating of the cremated bone remains, because the secondary calcite seems to be a challenge for researchers due to their identical chemical formula. All these explain why, contrary to the nearly 70 year old development of the traditional ^{14}C dating, a compilation of ^{14}C dates over the last 50 years shows that less than 6% of all the bone dates were performed on purified bioapatite.

Our poster provides case studies of Early and Middle Bronze Age (2600/2500–1600/1500 BC) cremation burials from Hungary. Measuring parallel organic bones, or charcoal remains as reference a refined chemical pre-treatment was tested and applied on bioapatite samples at Hertelendi Laboratory of Environmental Studies (HEKAL), Debrecen. The dating of these assemblages, and testing of burnt bones (bioapatite) and unburnt bones (collagen) from the same burial assemblages can help build a more proper absolute chronology of the nearly two thousand-year-long Bronze Age period when communities in large parts of the Carpathian Basin followed the tradition of cremating the dead.

Investigations of XIX century manuscripts Case study – Letter of Ion Minulescu, MNLR

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Since the nineteenth century was a time of innovation and discovery, with significant results in chemistry, which formed the basis of technological developments in the next century, various technologies for obtaining paper and numerous adjustments in the ink composition have been generated. Thus, assessment of the degradation and the choice of the interventions are hindered by the large variety of materials present in the manuscripts together with the lack of standardized methodology of investigation of such artifacts.

In the present work a rational methodology is proposed for the investigation of XIXth century manuscripts, consisting in a simple set of relevant methods.

A letter of Minulescu (great Romanian poet), from the National Museum of Literature, was investigated.

The main composition of the inks used and the paper support were determined using FTIR and Raman spectroscopy, XRF and optical microscopy. Significant chemical components such as galic acid, ferrous sulphate, gum arabic etc. were used as reference compounds in the study of the state of degradation.

A mechanism for the degradation is proposed based on the chemical modification of the cellulose fibers due to the migration of the metalic ions.

The methodology proposed, based on the rational selection of suitable methods, leads to a simple, price reasonable, but reliable scheme of investigation of the manuscripts, that could provide good quality data to evaluate the degradation.

The proposed methodology will improve the protocol of administration (exposure, storage, transportation) of the manuscripts as mobile cultural heritage.

Preliminary study for the characterisation of historic mortars

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The behavior of some samples of historical mortars obtained by using different ratio between sand and lime, was investigated toward the action of carbon dyoxide, CO2, by means of visual inspection, optical microscopy (OM), X-Ray Fluorescence (XRF), Raman spectroscopy, Electron Paramagnetic Resonance (EPR) and petrographic microscopy techniques. The assessment of the relationship between the composition of the historical mortars and the effects of the carbondioxide attack was the main goal of this study.

In addition the X-Ray Diffraction (XRD), was used in order to enlarge knowledge about the impact of the composition of historic mortars under the action of outdoor/indoor degradation agents.

The Electron Paramagnetic Resonance (EPR) is not comonly used for the investigation of mortars, although it has a great potential for dating and for the identification of active and irreversible degradations of radical nature in materials through the presence of paramagnetic centres of marc elements (Mn, Fe, Cr, Cu).

AMS ^{14}C dating measurements for single amino acids isolated by HPLC method from archaeological bone samples

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In 2013 a new HVEE 1MV Tandetron AMS system was commissioned at Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH), Bucharest, Romania. To support the research activity performed at this Tandetron accelerator, a ^{14}C dating laboratory was founded.

Our activity at this moment is mainly focused on radiocarbon dating of organic samples, especially bones. The standard procedure for measuring an organic sample using AMS technique consists in extracting and graphitization of the collagen, following a very complex sequence of chemical transformations from bone to graphite, using a fully automated graphitization unit developed by IonPlus, Zürich, Switzerland.

The archaeological bone samples preservation can be significantly influenced by the burial environment. Under these conditions, the bone collagen can be chemically and / or physically degraded over 90%, and consequently the number of bone samples suitable for AMS radiocarbon dating can be considerably reduced. Beacuse of that we are trying to improve the classical pre-treatment methods by using a High Pressure Liquid Chromatography (HPLC) system for the separation and identification of individual fractions of amino acids from raw collagen.

This fractionate dating technique is a very useful verification tool for cross checking the dating results.

The effect of halloysite nanotubes on the thermal stability, morphology and wettability of aged vegetable tanned leather

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Historical objects are of high importance and developing new methods for their conservation and restoration is a permanent concern of heritage researchers.

In this study, the filling process of vegetable tanned leather with a mix of natural clay nanotubes (HNTs) [1] and bee wax was investigated. Two types of calf leather tanned with mimosa and tara extracts were purposely exposed to accelerated ageing (at 40°C in controlled RH atmosphere, using alternate one week cycles at 30% and 75% RH) and then treated with the filler mix.

The treated leather surface morphology was characterized by scanning electron microscopy (SEM) coupled with energy dispersive X-ray (EDX) [2], while the dynamic contact angle measurement allowed us to follow the changes in its wetting properties [3]. Thermal microscopy (image MHT method) [4] was used to evaluate the changes in the thermal stability of collagen fibers.

The nanotubes potential to uniformly distribute in the leather fibrous structure and to significantly enhance the surface hydrophobicity without affecting leather thermal stability, suggest that HNTs are suitable for the historical leather treatment. Moreover, their versatility of use is a gateway for new biocompatible conservation and restoration approaches.

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Scientific investigations and conservation/preservation of cultural heritage artifacts

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Nowadays, the works of art and artifacts that constitute our cultural heritage are subject to deterioration. Their surfaces interacting with the environmental pollutants are the most prone to aging and decay and soiling is a serious factor in the degradation of surfaces, chemical and mechanical degradation that can lead to the disfigurement of a piece of art. Knowledge of the chemical composition of the building materials of our monuments may help us to preserve and protect them from the pollution of our cities.

The aim of this work is to identify the materials of works of art, artifacts and buildings, as bulks, surfaces and interfaces involved in Cultural Heritage, in the main topics:

- Characterization of deterioration processes: alteration products, causes and mechanisms of material decay, accelerated ageing processes.
- Interactions between climate/environment and the supports and materials used for conservation/restoration and chemical reactions involved.

- Chromaticity in preservation and restoration of a cultural good: pigments from nature, ochres or iron oxides, and organic ones, many of them being too expensive or have completely disappeared from art.
- Photochemistry and photophysics of the ageing processes and mechanisms for different artifact objects.
- Development of new methods and materials for restoration and conservation with cultural heritage artifacts in support of their long-term preservation.
- Characterization by scientific analytical investigations based on spectroscopic and chromatographic techniques for the characterization of organic materials mostly of them being non-destructive (Research Center for Scientific Investigations and Conservation/Preservation Of Industrial, Cultural and Medical Heritage (http://erris.gov.ro/RESEARCH-CENTER-FOR-SCIENTIF)
- A new method based on nanomaterials (hydroxyapatite) for a conservative preservation of the treated surfaces.

The examples will involve different supports: book paper, wall stones, stuccoes, paintings, with preservative and conservative measures based on nanomaterials.

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Micro-chemical and Spectroscopic Study of Component Materials in 18th and 19th Century Old Printed Holy Books

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The Cyrillic books *Menology for May (1705)*, *The Bible (1822)* and *Mirror (1816)* were appointed to preservation in the Laboratory for Conservation and Restoration at the National Library in Skopje in order to stop and remove the physical, chemical and biological deteriorations. The first two books represent the Russian printing traditions, while the third book was printed in Vienna thus representing the West European printing traditions, although it originates from the territory of the former Ottoman Empire (present-day Republic of Macedonia).

In the present study the emphasis is on characterization of *paper*, original and restoration, and of *inks* used in the text and ornamentation by the application of micro-chemical tests and sophisticated instrumental spectroscopy techniques. Optical microscopy was used to examine the type of fibres forming the paper support while micro-chemical analyses were performed to identify the materials added to the paper support such as starch, alum, rosin and gelatine (or animal glue). Fourier Transform Infrared Spectroscopy (FTIR) was applied to confirm the findings for the sizing and fillers found in the paper support. Mineral and inorganic pigments were revealed by micro-Raman spectroscopy.

The study showed that the original paper in Russian books was made of rags with lignin fibres present in less than 5% (Fig.1), whereas the paper in *Mirror* was found to be made of raw and unbleached hardwood. Distinct types of sizing have been identified to form the paper material. Thus, gelatine/alum type of sizing was present in *Menology for May* and *Mirror*, while gelatine/rosin type was identified in *The Bible*. Starch was detected as an additive to the binding agents in restoration paper of *Menology for May*. The pigments identified are lamp black (Fig. 2), vermilion, Prussian blue and chalk.

Fig.1 Photomicrograph (x200) of rag fibers treated with Graff 'C' stain found in original paper of old printed books *Menology for May* and *The Bible.*

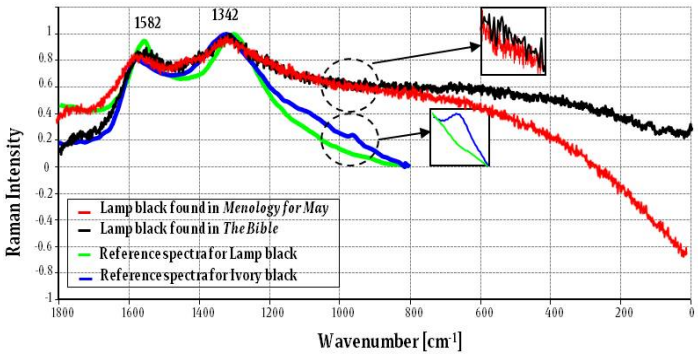

Fig.2 Raman spectra of lamp black found in black ink of old printed books *Menology for May* and *The Bible*

Non-destructive analysis used for characterization of medieval silver coins

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The paper presents the results obtained by combining non-invasive techniques (optical microscopy, fluorescence spectroscopy X - XRF and SEM) in determining the composition and structural characterization of silver coins belonging to the treasury of Iasi (14,206 pieces), dating from the XIVth -XVIIth.

In this paper, coins from nine locations are analyzed by non-destructive methods, archaeological pieces from the Moldavia's History Museum**,** "Moldova" National Museum Complex of Iasi. After analyzing inventory the nature of the numismatic materials was identified.

A study of the surface analysis of metal artifacts (optical microscopy) revealed physical damage processes (cracking, fragmentation, grinding or erosion), chemical altering generated by the soil conditions. Following investigations by XRF and SEM analyzes, important data regarding the chemical composition were obtained. These data will be compiled into a database.

Keywords: treasury, coins, analytical non-destructive techniques, OM, XRF, SEM

New dinuclear copper (II) and iron (III) complexes with non-linear optical properties as pigments in artefacts

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Copper chloride (II) as green pigment and iron chloride (III) as brown pigment are used in oil and tempera painting. In this study, we propose four complexes of these salts, with NLO properties, for using as pigments in artifacts.

Eco-friendly synthesis of novel copper (II) and iron (III) binuclear complexes with 1,2,3,4,5,6,7,8-octahydroacridine (OHA) and its N(10)-oxide (OHAO) is presented and discussed herein. New synthesized complexes were confirmed by elemental analysis, Fourier transform infrared (FTIR), and Raman spectroscopies.

Thermogravimetry (TG), derivative thermogravimetry (DTG) and differential scanning calorimetry (DSC) have been applied to investigate the thermal behaviour of complexes. Copper complexes (I and II) have similar geometries, but different pathways of thermal decomposition, while iron complexes (III and IV) possess both the structure and thermal decomposition different.

Generally, heating of the compounds first results in the release of water molecules. The thermal stability of the complexes can be ordered in the sequence: I > II ≈ III > IV. IR and Raman data suggest pentacoordinated metal for I-III complexes and hexacoordinated iron in case of IV.

The nonlinear optical (NLO) response of Fe (III) and Cu (II) complexes is investigated by the static hyper polarizability coefficients (β), calculated using DFT at M11/ktzvp level of theory.

DNA Analysis of a Copper Age Funerary Context from Eastern Romania

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The aim of this study is to analyse the ancient DNA and to identify the haplogroups, also presenting the first results obtained on bone samples selected from a funerary context assigned based on the archaeological context to the Copper Age communities from Eastern Romania. The archaeological site is located on the terraces integrated in the Jijia river basins. The funerary discovery was identified in the Vorniceni village (Vorniceni commune, Botoșani County) and was largely attributed based, mainly, on the associated finds in the archaeological discoveries, to the Cucuteni communities.

The aDNA extraction from bone remains involved two main activities: samples preparation and extraction protocol. Every bone was prepared using the required standard protocols for aDNA analysis (facemask, gloves, and disposable lab coat), sterile and disposable tools in a controlled environment.

The mitochondrial hyper variable region 2 (HV2) was amplified via PCR method using four pairs of specific primers. The PCR was performed in a 25 µL reaction volume using GoTaq® Hot Start Polymerase (Promega). The PCR products amplicons were purified using the Agencourt AMPure XP (Beckman Coulter, USA) and direct sequenced with Genome Lab DTCS Quick Start Kit (Beckman Coulter, USA) in the CEQ 8000 Genetic Analysis System (Beckman Coulter). The sequence analysis was performed using the CEQ8000 instrument software.

mtDNA is effectively a single haplotype that is transmitted from mothers to their offspring, which means that mitochondrial lineages can be identified in a much more straightforward manner than nuclear lineages, which, in sexually reproducing species, are continuously pooling genes from two individuals and undergoing recombination.

The ancient DNA analysis performed on bone samples assigned to the Cucuteni communities offered us the possibility to infer the ancient human population admixtures from Eastern Romania using amtDNA isolated from bone remains.

Acknowledgement: The financial support for this study was provided by the PCCA 1153/2011 Nr. 227/01.10.2012 *Genetic Evolution: New Evidences for the Study of Interconnected Structures. A Biomolecular Journey around the Carpathians from Ancient to Medieval Times GENESIS.*

Micro-XRF investigation of the decoration materials and techniques of three 18th-19th century mosques in Berat

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We will present here the data obtained from the examination with micro-XRF of a series of micro samples taken from the decorations of three mosques in Berat. These are part of an Islamic religious complex situated at the central area of the old town and include the "Helvetia Tekke", the King's Mosque and the Bachelor's mosque, which were built or reconstructed during the second half of the 18th century and the beginning of the 19th century. Beside the architectural values of the buildings the interiors of the monuments are decorated with paintings of the walls and the ceilings made of carved wood.

As part of a restoration project, a sampling campaign was organized last year and a number of samples of decorative materials were collected in different parts of the buildings. The samples were measured at the lab using micro-XRF spectrometer ARTAX.

The results of the measurements indicate that the preparation layer of the paintings on wooden ceiling was made of gypsum while that of the wall paintings was made of calcium carbonate. The palette includes the following inorganic pigments: lead white, gold, yellow and red ochre, vermilion, red lead, a copper based green, smalt and probably carbon black. Some modern pigments were identified in the decorations of the King's Mosque. Similarities and differences observed between the monuments and indications about the painting technique, as well as the degradation of some pigments will also be discussed.

Archaeometric approach for the restoration of "Mother of God with the Child" icon of Cahul

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The dating of artworks and identification of materials used by various analytical methods have a major significance in art authentication and conservation, leading to a better knowledge of art history and a detailed characterisation of techniques of realization. In this work, several methods, radiocarbon dating, XRD, XRF and FT-Raman spectroscopy were applied for the investigation of "Mother of God with the Child" icon of Cahul (Fig. 1) and the results obtained were correlated.

It can be considered that the icon belongs to the oldest iconographic type of the Virgin Mary - Ἡ Ὁδηγήτρια (Adviser/Guide), by its appearance but the stylistic analysis could not identify the workshop or the school. Thus the aim of this study refers to the opportunity of having relevant results, which will give a concrete support for the physical and chemical study of the icon compositional structure, helping in this way to a better diagnostic of its conservation state and to a real suggestion about the restoration treatments, necessary to stop degradation, to consolidate structural components and to recreate, as possible, the uniform appearance of the icon image.

Although initially it was assumed that the icon is a fresco on wood by XRD analysis was showed that the preparation layer consists of gypsum mixed with lead white and a small quantity of sifted sand that is the classic preparation style for icons of XVIII-XIXth centuries. For carnation lead white was used in combination with cinnabar for collaring and barium sulphate as filler. For brown eye colour ochre (iron oxides) was used. For grey background, the lead white was mixed with iron oxides, possibly with carbon black which is not evidenced by the used analytical methods.
Radiocarbon dating with Accelerator Mass Spectrometry (AMS) found that the icon most likely was made in the nineteenth century.
FT-Raman spectroscopy helped to identify the pigments: lead white, cinnabar, gypsum and barium sulphate in agreement with XRF data that indicates the presence of heavy elements: Barium, Mercury, and Lead.

Fig. 1. Mother of God with the Child (Hodighitria) of Cahul before restoration

Preliminary instrumental analysis of an archaeological sample from unip "Dealu Cetățuica", Timiș County, Romania: a case study of a ceramic vase repaired with a resin-based natural adhesive

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Unip "Dealu Cetățuica", Timiș County, Romania, is a pluri-stratified site with dwellings from the Hallstatt, Dacian period (Latene) and Slavic period (7th century). On the central plateau of the site, we identified several holes with ritual deposits dating from the classical Dacian period (1st century BC – 1st century AD). In one of these holes, we identified a broken ceramic vase that was repaired with a resin-based natural adhesive. This is unique in the Dacian world and extremely rare in Ancient times. This study attempts to identify the composition and origin of this adhesive through chemical analyses to understand the usefulness and functionality of such a manufacturer approach. Thermal stability of the sample was analysed using a Perkin Elmer DIAMOND thermo-balance, by recording thermo-analytical curves TG, DTG and HF. Samples with mass between 5.7 and 8.3 mg were heated in aluminium crucible between 25 and 500 °C in dynamic air atmosphere (100 mL·min^{-1}) with a heating rate β of 10 °C·min^{-1}. For determining the thermal effects, the DTA data (in μV) were converted in HF (Heat Flow) data (mW). In order to assure the coherence of the data, each analysis was repeated three times and the results were practically identical. FTIR spectra were recorded on two techniques: on a JASCO 670 plus device using the KBr pellet dispersion method vs. UATR-FTIR analysis on a Perkin Elmer SPECTRUM 100 device. Spectra were collected after 64 co-added scans, with a resolution of 4 cm^{-1}, on the spectral domain 4000-600 cm^{-1}. A comparative discussion of the obtained results by the employed instrumental techniques was carried out.

A digital radiography, UV Florescence, X-Ray Fluorescence, as well as Fourier Transform Infrared and Raman spectroscopy complex investigation of a wooden painted model

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For a correct identification of pigments and binders used in painted icons of 18th-19th centuries, a reference panel was created by using the same type of material and the same technique as in contemporary works of that period. The panel was made of lime wood dried for two years and painted by using the Kremer Pigments GmbH & Co. KG pigments, as this company produces pigments by using both classical recipes and original raw material. In this case, white and minium lead, cinnabar, orpiment, ocher, lazurite as well as gold leaf were chosen. The paints were prepared by traditional tempera technique with egg yolk as binder. At the same time, a turpentine diluted damar resin was used as varnish.

The panel was divided into eight fields, each covered with only one type of paint. A field was left without paint in order to evidence the preparation. To investigate the possible effect of varnish, this was applied so as to cover only half of each field.

More noninvasive and complementary techniques were used to investigate different peculiarities of traditional painting on wooden panel: digital radiography (DR) and UV photography (UVP), X-Ray Fluorescence (XRF) as well as Fourier-Transform Infrared (FT-IR) and Raman spectroscopy.

While DR evidenced not only wooden plane texture but the minute differences between pigments as related to their mineral composition, UVP was useful in discerning mainly lead and mercury pigments by a specific fluorescence color. At its turn, XRF allowed identifying all pigments by evidencing the presence of specific elements, and, at the same time, the existence of a certain degree of mixing between pigments, a common characteristic of all paintings. FTIR was very utile in evidencing the protein matter characteristic for the hen yolk used as binder, while FT-Raman spectroscope confirmed the presence of cinnabar and white lead pigments.

All results allowed clarifying more aspects related to the use of physical, noninvasive methods of investigation for the old school paintings.

Using radiometric and non-radiometric methods for a complex characterization of an historical monument ensemble; Otetelesanu Ex-Mansion from Magurele County Romania case study

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IFIN-HH provides the opportunity of combining expertise of certified laboratories and working teams with international visibility in a range of methods and techniques for investigation of cultural heritage which is unique in Romania nowadays. Opportunity to launch RoAMS laboratory for radiocarbon dating starting with 2012 at the same time with opening the project for restoration, rehabilitation and enhancement of historical Otetelesanu Ensemble ("core" that have emerged and developed the institutes of Magurele Platform of Physics), it marked the completion of a decade of investigation using radiometric and non-radiometric methods of analysis developed in our institute for more than 65 years when began the research in physics at Magurele. Radiometric methods aimed the use of liquid scintillation counting in determining the activity concentration of tritium in different environmental compartments, as well alpha-beta and high resolution gamma spectrometry in determining radionuclides which are present in soils, sediments and building materials. Interpretation of results yielded new information on the transformation time of the original park of the Ensemble into a garden-monument with a particular Orchard inventory, but also give us the opportunity to study the dynamics of land, lakes, water tables and springs and how they have influenced and still influence the evolution both of the park and the historical building. Analysis of building materials samples and those resulting from boreholes taken to the proximity of Otetelesanu Mansion offers some answers on their provenience. The non-radiometric methods were focused on radiocarbon dating by accelerator mass spectrometry of osteological material excavated under the current building during basement formation / enlargement, on FT-IR and TGA analyzes of raw bone material and extracted collagen before dating in order to determine the conservation degree and characteristics of diagenetic processes induced by post-depositional stage, and not least on the compositional analysis method PIXE of archaeological materials taken during excavations. All these investigations have served to further characterize or help establish the first settlement, the stratigraphy to the current walking level, and evolution of the first form(s) of the historical building(s).

Archaeological charred seeds; an introduction for a better understanding of off-sets

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Radiocarbon dating of charred seeds sometimes offers inconsistent results compared to archaeological context of the discovery. The literature gives few answers and solutions to these cases. Starting from a situation encountered at IFIN-HH RoAMS laboratory, we have achieved some results and preliminary conclusions by comparison with those for modern wheat grains subjected to various thermal treatments. In the first stage of the experiment we produce modern charred seeds in laboratory conditions that are close to the initial context that lead to a large off-set between expected age and measured / calibrated value (i.e. between an expected age of third Century BC to third Century AD, and fifth Millennium BC). These conditions comprise different time and temperatures of heating in the laboratory furnace (in a limited quantity of oxygen). The %N, %C, C:N ratio and the general appearance of the old seeds are similar to those of the modern seeds suffering a thermal treatment. The conditions most likely to result in preservation by charring are heating to temperatures between 220 and 240°C with a limited supply of oxygen rendering them less susceptible to microbial attack. This statement is consistent with the archaeological context. The survival of organic matter (organic carbon i.e.) in patera vessel is infirmed by the lake of microbial and fungi attack followed by the preservation of the initial C-14 level in seeds after carbonisation. The comment is also applied somewhat for the subsequent intake of C-14 from the environment during site deposition. The lower C-14/C-12 value as expected reinforces this statement. The properties of the combustion atmosphere play a significant role regarding the source of carbon by so called "old wood" effect during firing. As for charcoal and bones, radiocarbon dating may potentially result in too high radiocarbon ages. The exchange processes between the CO_2 produced during combustion control the stable carbon isotope ($\delta^{13}C$) signature and radiocarbon age. It seems to be no crucial difference between patera vessel type and the controlled laboratory experiments where the laboratory combustions occurred in closed furnaces which likely resulted in larger CO_2 concentration. The nature of fire and the weather could play an important role in the exogenous carbon intake and preservation during burial conditions. The identity of the contamination source gas and the reason and process of this contamination are important issues that need to be addressed in future research. According to latest literature data, when old wood, coal, or peat have been used as fuel or accidental source of fire, an off-set of some decades, centuries, potentially up to millennia were expected. A strong correlation between age off-set and $\delta^{13}C$ & $F^{14}C$ values became a useful tool in identifying large inputs from ^{14}C-depleted fuels. Further research studies on another similar situations may be useful.

Archeomagnetic research of an oven from the Early Bronze Age from the prehistoric settlement mound Maleva mogila near Veselinovo village, Yambol Municipality, Bulgaria

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The prehistoric settlement mound Maleva mogila is situated 2 km South-East from the village of Veselinovo in Yambol Municipality, Bulgaria. It's located on the left bank of the Tundzha River. The archaeological site is 5.30 m high with base diameter of 80.00 x 120.00 m. The settlement mound was inhabited during the Late Neolithic – Karanovo III, Karanovo III-IV and Karanovo IV cultures (5200 – 4900 BC) and Early Bronze Age (3200 – 2500 BC). It was partly inhabited and during the Medieval period (11^{th} – 12^{th} c.).

In 2014 during archaeological excavation, an oven was examined. It's connected with the daily life of prehistoric people from the Early Bronze Age. From the present oven 20 samples were taken for research and dating via the archeomagnetic method. Archeomagnetic dating represents the comparison of received values for different elements of ancient magnetic field for analysis structure with benchmark curves for appointed epoch.

The aim of this poster is to present results from this archeomagnetic research and data on the last culture split from the Early Bronze Age layer from Maleva mogila.

FTIR Spectroscopy and Thermal Analysis studies on special cases of wooden artefacts consolidated by radiopolymerization

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The analysis of materials from cultural heritage collections has a vital role in a responsible modern approach to restoration and conservation. Nowadays, the disinfection and conservation of art objects and archaeological artefacts by gamma radiation treatment appears to have more and more perspective. Gamma rays have been also employed for the polymerization of a styrene-unsaturated polyester resin in liquid state, used to consolidate decaying wooden objects by impregnation, consisting in the diffusion of the resin dissolved in a reactive monomer, into the pores of a deteriorated material. The outcome of this radiation-crosslinking is the formation of a three-dimensional macromolecular structure that fills the pores of the artefact, ensuring increased mechanical resistance to the wooden object. Radiation polymerization has a great advantage over conventional polymerization using a chemical catalysts, due to the fact that the heat rise can be very well controlled by varying the radiation dose rate.

It is well know that styrene is toxic and carcinogenic to humans, that's why, one of the aims of this work was to compare resins with or without styrene and to observe their behaviour and effectiveness in impregnations of different kinds of wood: old painted wood, modern spruce wood and oak wood. Two particular cases of impregnated wood were also studied, one of them having a $CaCO_3$ or $CaSO_4$ cover and the other one being subjected to accelerated degradation artificially induced by UV-radiation (UV-Ageing). In order to characterize them, we performed FTIR spectroscopy, colorimetry, thermogravimetric and scanning electron microscopy analysis.

Molecular structure characterization was performed by Nicolet FT-IR Micro-Spectroscopy. Vibrational spectra ensured information about changes in the molecular structure of the artefact given by the presence of the polymer inside wood's structure, but also changes in resin's structure after UV artificially induced degradation.

This approach could provide information on the effect of the resins on the wood and shows that styrene-free resins could be an alternative to the styrene-polyester resin consolidation.

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A study of glass objects excavated in Bylis: bulk characterization and relationships with production technologies

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The present study aims at the collection of analytical data on the composition of various glass objects excavated in Bylis that will be used for a better archaeological interpretation of the finds and will be helpful for their restoration and conservation. In the study glass samples from objects (vessels, window glass) discovered in Bylis are included, most of which belonging to the end of the fifth century and beginning of sixth century AD.

Different analytical methods are used for the characterization of glass samples, such as Optical Microscopy, Scanning Electron Microscopy in environmental mood connected with Energy Dispersive Spectrometer and Micro X-Ray Fluorescence.

The concentrations of major elements in all the samples show that they belong to the silica-soda-lime type of glass. The low contents of MgO and K_2O (<1.5%) indicate that the source of soda has been Natron, originating from Egypt, while concentrations of Al_2O_3, CaO, TiO_2 and Fe_2O_3 show that the studied glass samples should belong to groups Levantine I and HIMT, produced with sand from the Middle East region, that have been the prevalent glass types in the Roman Empire during the V - VI century AD.

Elements with lower concentrations P, S, Cl, Ti, Mn, Fe, Co, Cu, Zn, Sn and Pb are related to their contents in the raw materials as well as with the additions used to give various features to the glass.

The data collected for the raw materials and technology used for the production of the glass artifacts support their archaeological dating.

Round table

Multidisciplinarity in archaeology: Situating archaeometry in education and research

A special outreach session in a round table format will take place on Thursday morning, September 29th. The chosen subject for it is: ***Multidisciplinarity in archaeology: Situating archaeometry in education and research****. Officials of the host country involved in research policy and management of research and higher education, politicians and media representatives will be invited to join the 5th BSA participants.*

New trends, new skills. Multidisciplinarity in the field and in the interpretation and the initial training of the younger generation

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The aim of the present paper is to explore the ways in which multidisciplinarity, an evolving process that influences both practical, in-the-field approaches and patterns of handling the resulting data is accounted for in the training of the younger generation of archaeologists.

The working hypothesis is that as the field of archaeology is evolving towards an integrated field of research that challenges traditional definitions, the training of younger archaeologists has to become more dynamic and focused on transferrable skills and competences. By analyzing academic curricula and existing definitions of archaeology, the paper will compare the initial training with what academic common wisdom implies, and with what the public seems to demand from this field of research. The initial results indicate the fact that, while initial training seems to cope with changes in the field, it does so by accretion and narrowing the field of training, instead of identifying integrated courses and approaches to teaching. The paper will propose several possible paths to solving this issue.

Romanian school of archaeology: a shift of paradigm

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After a long period of transition from "classical" to "modern", Romanian archaeologists have managed to overcome almost all obstacles (objective and subjective) to the modernisation of the working techniques and methods specific to archaeology: legislative, financial, bureaucratic and even personal. The devices are now affordable, the legislation has been adapted, and people are now aware of the usefulness of the new technologies. The great archaeological projects in Romania use important methods and techniques adapted to our conditions. Topography and 3D archaeological cartography, geophysical prospects, satellite images, dating, physical and chemical analyses, computerised graphics, databases and specialised software are successfully used in more and more Romanian archaeological sites. A problem not yet solved is that of the changing of curricula to adapt to the new demands of the labour market. Though, based on academic autonomy, each school of archaeology (Cluj, Iași, București, Timișoara, etc.) attempted at modernising curricula, they have not yet reached a standard or at least a common denominator regarding compulsory courses, teaching techniques, archaeological practice, evaluation methods, etc. Each great university in Romania has adapted its curricula on the fly, depending on the vision and training of the programme coordinators, without any correlation whatsoever with the labour market. They still teach useless theoretical courses that do not confer the future graduate the guarantee of consistent practical training. This study is an analysis of the labour market and of the necessity of introducing in the curricula courses that guarantee a good professional training of the future archaeologists; the study provides a few examples of good practice in the field, laboratory and classroom.

Challenges and expectations for a curriculum in archaeology and heritage studies

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In the last two decades, important changes in scientific fields like archaeology, and more generally, prehistory and ancient studies, are also a factor of change for university curricula dedicated to those sciences. Through those studies a multidisciplinary education, offering functional correlations between experimental sciences and the more traditional, cultural and anthropological approaches is the foundation of a new paradigm, not only in the research field but also in higher education. In the same time the universities are more interested and more open to heritage studies, where professionals are traditionally trained in post-university programs, or even directly on-site. Some of the more important European universities are offering today programs in heritage studies not only as M.A., but also for the B.A. level. A new relation among scientific disciplines, humanistic and experimental, unavoidable in a modern research, remains nevertheless a challenge for the universities, as they need to restructure education in order to familiarize students mainly attracted to a humanistic/cultural approach, with methods and principles specific for natural sciences. Our paper will offer a comparative study among university programs in some of the most important universities in Europe, USA and other centres with solid traditions in archaeology and heritage studies in order to underline the main curricular systems in those fields and their connection with the most important evolutions in research and field applications.