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10TH
INTERNATIONAL
SCIENTIFIC
CONFERENCE
METHODOLOGY & ARCHAEOLOGY
Zagreb, 1st – 2nd December 2022

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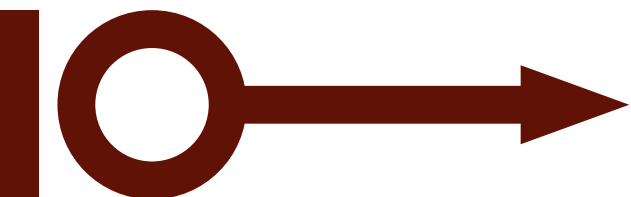
METHODOLOGY & ARCHAEOOMETRY

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Book of abstracts

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The scientific conference *Methodology and Archaeometry* is being organised by the Department of Archaeology, Faculty of Humanities and Social Sciences since 2013. The goal of the conference is to entice interdisciplinarity, critical thinking, new insights and approaches as well as new theoretical frameworks in contemporary archaeological science.

Coverage of a wide spectrum of themes and scientific disciplines has resulted in papers and discussions that promote scientific issues in the fields of methodology, documentation and interpretation of archaeological data.

The interdisciplinary character of the conference brings together archaeologists and researchers from other scientific disciplines with whom archaeologists collaborate closely; and who – through their work, projects and ideas – promote new insights about Interpretation of the human life in the past.

Section Methodology

Obtaining and collecting data is an essential part of the archaeological research process. How we collect and interpret data defines the validity of our interpretation. We use different techniques, approaches and tools which help us to reconstruct past processes and to give a more objective and comprehensive picture of the past. Contemporary interpretation tools alleviate and speed the data collection and also provide us with countless possibilities for the interpretation, protection and presentation of archaeological sites and the landscapes encompassing them.

Section Archaeometry

Having in mind the limited information we obtain from archaeological excavations and from the classification of archaeological material, cooperation with other scientific disciplines becomes necessary, to obtain as much information as possible on the conditions and the way in which humans lived in the past. Contemporary archaeology is a very heterogeneous discipline encompassing interest groups focussed on various periods, regions, theoretical frameworks and methodological techniques. Aside from the description of mechanical and physical features of a specific artefact or material, various archaeometrical analyses help us to direct our scientific focus to questions regarding the ways and features included in the social and cultural life of people who made, used, exchanged and discarded those objects. Cooperation with the natural sciences provides answers to many questions, but it also demands an additional level of caution when selecting adequate scientific analysis for a specific archaeological problem. It also demands continuous cooperation of a specific expert and an archaeologist from sample collection to the final interpretation.



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PROGRAMME



PROGRAMME

Thursday, 1st of December**10:00 – 10:15*****Conference opening*****Keynote lecture:*****Chair: Ina Miloglav*****10:15 – 10:55****Patrick Sean Quinn****Scientific analysis of archaeological ceramics: Findings and thoughts from a quarter century of research****11:00 – 11:30****Coffe break****Session 01*****Chair: Jacqueline Balen*****11:30 – 11:45****Ana Fundurulić, Ana Manhita, Sérgio Martins, Leonor Rocha, Dora Teixeira, Alessandra Celant & Cristina Barrocas Dias****Organic residue analysis of funerary vessels from the Great Dolmen of Zambujeiro, Portugal****11:50 – 12:05****Andreja Kudelić, Natali Neral & Lujana Paraman****Bronze Age Pottery from central Dalmatia – archaeometric approach****12:10 – 12:25****Maja Miše & Jelena Jovanović****Potters and painters: Application of geochemical analysis to Greek and Hellenistic painted vases****12:30 – 12:45****Benjamín Cutillas-Victoria & Anno Hein****Non-invasive protocol for the study of the post-firing painted ware from the Iberian Peninsula****12:50 – 13:10****Coffe break**



Session 2

Chair: Predrag Novaković

13:10 – 13:25

Dimitrij Mlekuž Vrhovnik

Modelling long-term demographic patterns of the area of Slovenia

13:30 – 13:45

Zoran Čučković

Digital landscapes: new algorithms for archaeological site detection and mapping on the basis of Lidar data

13:50 – 14:05

Domagoj Tončinić, Miroslav Vuković, Joško Zaninović & Domagoj Bužanić

The transformation of the cultural landscape between the Krka and Cetina rivers: Preliminary analysis of potential archaeological structures recognized on LiDAR images

14:10 – 14:25

Jerko Luka Gašpar

Viewshed analysis of Late Antique fortresses of eastern Adriatic coast and the methodological questions it raises

14:30 – 14:45

Andrej Janeš, Palma Karković Takalić & Valerija Gligora

The construction history of the Ledenice castle: application of the archaeology of standing structures

14:50 – 15:05

Michael Doneus, Bernhard Höfle, Dominic Kempf, Gwydion Daskalakis & Maria Shinoto

AFwizard – Human-in-the-loop development of spatially adaptive ground point filtering pipelines

15:10 – 16:00

Lunch break

Session 3

Chair: Miroslav Vuković

16:00 – 16:15

Luka Gruškovnjak, Agni Prijatelj, Petra Vojaković & Matija Črešnar

A smithy revealed by the micro-refuse analysis in the Late Halstatt Building 24 at the hillfort of Pungrt above Ig, Slovenia

16:20 – 16:35

Agni Prijatelj, Luka Gruškovnjak, Petra Vojaković & Matija Črešnar

From a house to a stable: a micromorphological study of the Late Hallstatt Building 21 at the proto-urban hillfort of Pungrt above Ig, Slovenia

16:40 – 16:55

Luka Gruškovnjak

The influence of topography and soil geomorphology on the archaeological record within the landscape

17:00 – 17:15

Katarina Jerbić

Assessing the archaeological and paleo-environmental potential of a submerged prehistoric site: A case study from Zambratija Bay

17:20 – 17:35

Tena Karavidović & Tomislav Brenko

Reconstruction of bog iron ore deposits in the lowland landscape: a case study predictive model for the analysis of exploitation in archaeological periods

17:40 – 18:00

Coffe break

Session 4

Poster presentation

18:00 – 18:30

Mila Andonova-Katsarski

Bio-archaeology of the pit-fills of Sexaginta Prista (2BC – 1AD)

Dario Hruševsar, Koraljka Bakrač, Božena Mitić, Ivona Baniček & Rajna Šošić-Klindžić

The Neolithic site Gorjani-Topole – preliminary results of palynological analysis from the Slavonia region (eastern Croatia)

Valentina Lončarić

Image-based low-powered technological analysis of archaeological ceramics and its potential on-site and educational applications

Dunja Martić Štefan

Sickle gloss on knapped flint artefacts recovered at the Galovo Site in Slavonski Brod and the Dužine site in Zadubravlje



Emilija Nikolić, Ivana Delić-Nikolić, Ljiljana Miličić, Nevenka Mijatović, Mladen Jovičić & Snežana Vučetić

Searching for elements – creating a composition: from archaeometry to conservation of Roman constructions on the Danube in Serbia

Tosho Spiridonov & Svilen Stoyanov

DAGIS 4.0 – Balkan Information System

Katarina Šprem, Lana Blažinić, Elena Orbanić & Adriana Sponza

Lithic analysis of finds from the field surveys of Lovas Municipality, Eastern Croatia

Selena Vitezović, Danica Mihailović, Vidan Dimić & Dragana Antonović

Tracing prehistoric mines and quarries: preliminary results of the field survey of Rudnik area (Central Serbia), campaign 2021

Katarzyna Zdeb & Maciej Sierakowski

Food biomarkers in glazed pottery

Veronika Gencheva

Geospatial archaeological database of Eastern Rhodopes, Bulgaria

Milica Tapavički-Ilić & Timka Alihodžić

All soul is immortal (Plato)

Pio Domines Peter

More than shells and shrapnels: Approaching the materiality of Second World War in karst landscape - Case study of battlefield site on Kozjak hill (Senj, Croatia)

Sara Iglič, Igor Kulenović & Šime Vrkić

Community, archaeology and modern conflicts – example of Obrovac, Croatia

Friday, 2nd of December

Session 5

Chair: Selena Vitezović

10:00 – 10:15

Petros Chatzimpaloglou

Provenance investigation of stone tools and its archaeological application

10:20 – 10:35

Vidan Dimić

The use of polished stone axes and adzes in the Neolithic of Serbia - experimental research

10:40 – 10:55

Kata Szilágyi, György Szakmány, Sági Tamás, Józsa Sándor, Szilágyi Veronika, Oláh István, Anett Oszás & Katalin T. Biró

Preliminary results of provenance studies on the polished stone material at the Neolithic site of Alsónyék, Hungary

11:00 – 11:15

Tamás Sági, György Szakmány, Sándor Józsa, Veronika Szilágyi, Kristóf Fehér, István Oláh & Anett Oszás

Polished stone tools from the Bátaszék-Alsónyék Neolithic settlement (Hungary)

11:20 – 11:50

Coffe break

Session 6

Chair: Maja Miše

11:50 – 12:05

Meghna Desai & Thilo Rehren

Carbon content determination of hypereutectoid wootz steel using image analysis

12:10 – 12:25

István Fórizs & Kata Dévai

New data on the cage cup fragments from Gorsium/Herculia, Pannonia (Hungary)

12:30 – 12:45

Mila Andonova-Katsarski

The archaeological softwoods of ancient Serdica (Sofia, Bulgaria)

12:50 – 13:05

Katarina Botić, Tena Karavidović, Tajana Sekelj Ivančan & Metka Culiberg

Between technological choices and resource availability: an insight into wood exploitation strategies for iron production and common use

13:10 – 13:25

Ana Đuričić

Late Neolithic Vinča culture hearths – location identification and function

13:30 – 14:00

Coffe break

Session 7

Chair: Nikola Vukosavljević

14:00 – 14:15

Tina Bareša, Ivan Jerković, Anita Adamić Hadžić, Mario Šlaus, Mislav Čavka, Željana Bašić & Ivana Kružić

Visibility of epigenetic cranial traits on multi-slice computed tomography (MSCT) scans and dry bones

14:20 – 14:35

Lia Vidas, Sara Silvestrini, Matteo Romandini, Federico Lugli, Cristina Real Margalef, Siniša Radović, Ivor Janković & Stefano Benazzi

Filling in the blanks: the application of palaeoproteomics in faunal analysis

14:40 – 14:55

Kyriaki Tsirtsis & Evi Margaritis

Plants and people in Classical/early Hellenistic Sikyon: what we got through the analysis of archaeobotanical material

15:00 – 15:15

Andreja Sironić, Alexander Cherkinsky, Damir Borković, Jadranka Barešić & Ines Krajcar Bronić

International radiocarbon mortar dating intercomparison – MODIS2

15:20 – 15:35

Marija Krečković Gavrilović, Mihailo Radinović, Marko Porčić, Jugoslav Pendić, Lidija Milašinović & Sofija Stefanović

Absolute and relative chronology of the Early Bronze Age necropolis in Mokrin, Serbia

15:40 – 15:55

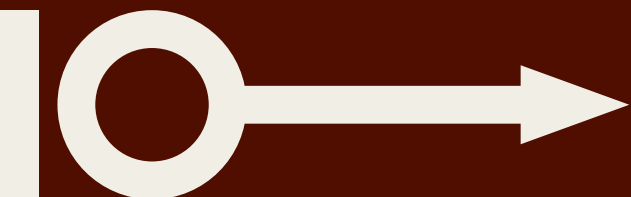
Predrag Novaković

How much and what STEM are we teaching in archaeology?

16:00

Closing

ABSTRACTS



ABSTRACTS

Patrick Sean Quinn

UCL Institute of Archaeology, London, UK

Scientific analysis of archaeological ceramics: Findings and thoughts from a quarter century of research

Using examples of the speaker's personal research and supervision, spanning over 25 years, this talk will demonstrate the wide spectrum of themes and human processes that can be tackled via the scientific analysis of ancient ceramics. These include maritime and terrestrial trade and exchange, migration and settlement shift, cultural interaction, manufacturing technology, craft tradition, quality control and the supply chain logistics of pottery production. Case studies covering a diverse range of chronological periods and geographic areas will be presented including the prehistoric Aegean, Hellenistic Adriatic, Roman northern Europe, Medieval Iberia, pre-contact USA and Qin Period China. The talk will also discuss the advantages and challenges of the main methods of scientific analysis, as well as highlighting novel approaches that can provide extra insights into the hidden cultural meaning of archaeological pottery and other types of ceramics. This presentation coincides with the publication of a new textbook on the analysis of ceramics via thin section petrography, geochemistry, scanning electron microscopy and x-ray diffraction.

Ana Fundurulić^{1,2}, Ana Manhita^{2,3}, Sérgio Martins², Leonor Rocha^{4,5}, Dora Teixeira^{2,6}, Alessandra Celant¹, Donatella Magri¹ & Cristina Barrocas Dias^{2,6}

¹ Department of Environmental Biology, Sapienza University of Rome, Italy

² HERCULES Laboratory, University of Évora, Portugal

³ Instituto de Investigação e Formação Avançada (IIFA), University of Évora, Portugal

⁴ Department of History, University of Évora, Portugal

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⁶ Department of Chemistry and Biochemistry, School of Sciences and Technology, University of Évora, Portugal

Organic residue analysis of funerary vessels from the Great Dolmen of Zambujeiro, Portugal

Zambujeiro Dolmen (Anta Grande do Zambujeiro) is the biggest chambered megalithic tomb in the Alentejo region of Portugal, constructed between the 4th and mid-3rd millennium BC. Dolmens, funerary structures consisting of a polygonal chamber, were constructed by large vertical stone slabs covered by a capstone and complemented with a corridor formed by vertical stones, smaller than those from the chamber, arranged in parallel rows and covered. They were used for multiple burials and could safeguard the remains of numerous individuals, uniting the community through generations, even after death. At Zambujeiro various burial goods, including amber beads, chert arrowheads, and remains of pottery vessels, were retrieved. The organic residue analysis was done using gas chromatography coupled with mass spectrometry (GC-MS), after extracting the absorbed residue from the pottery wall. Residues of fats and oils of plant origin were identified in all the vessels, while clear evidence for the use of beeswax was detected in several pots, conical open bowls, and a cup. The examination of the organic content of the vessels gave an insight into the relationship of the agrarian communities with their natural environment and helped to understand the use of natural products.



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Andreja Kudelić¹, Natali Neral¹ & Lujana Paraman²

¹ Institute of Archaeology, Zagreb, Croatia

² Museum of the city of Trogir, Croatia

Bronze Age Pottery from central Dalmatia – archaeometric approach

The Bronze Age pottery in Dalmatia is still a relatively unexplored area. Although ceramic finds are present on many archaeological sites, pottery still represents a data set with a mostly incomplete stratigraphic context, usually processed selectively and in an unsystematized manner using the traditional approach. This resulted in a lack of research questions and challenges. However, questions focused on the technology of production, use, and distribution of ceramics have the potential to provide a new research direction that will ultimately enable a better understanding of the everyday life of Bronze Age communities of Dalmatia.

Therefore, this research is focused on the study of pottery raw materials from which ceramic vessels were made. This paper presents the results of archaeometric analysis of pottery from six Bronze Age sites in the area of Trogir, i.e. central Dalmatia. A mineralogical-petrographic analysis of 38 thin sections of ceramics was carried out using the method of optical microscopy, while the mineral composition of a smaller number of samples was determined using the X-ray powder diffraction method. The research provided data on the characteristics of the clay raw material, data on the type and proportion of non-plastic temperers intentionally added to the clay, as well as information on the production techniques and firing temperatures. Research has shown that Bronze Age potters used two types of non-plastic temper material, crushed calcite, and grog. The analysis of the results indicates technological differences, especially in the choice of tempering material, between ceramics of the early and probably middle Bronze Age compared to ceramics dated to the late Bronze and early Iron Age in the area of central Dalmatia.

Maja Miše¹ & Jelena Jovanović²

¹ UCL, Institute of Archaeology, London, UK

² Archaeological Museum Split, Croatia

Potters and painters: Application of geochemical analysis to Greek and Hellenistic painted vases

Greek and Hellenistic painted vases have attracted scholars of classical archaeology for centuries, either for the artistic value of their painted decorations or as evidence of ancient everyday life depicted. With the development and application of scientific methods for the analysis of ancient pottery, scholars began to investigate the technological aspects of Greek and Hellenistic painted vases; how the thin layers of coloured slips and decorations were applied and at what temperature the vases were fired in kilns. These are just some of the questions that can be investigated using different analytical methods. However, to answer these questions, the vases or

fragments must be destroyed, as most methods used to analyse pottery are destructive. For this reason, museum curators and archaeologists are reluctant to provide material for analysis.

The aim of our study was twofold, to develop a new semi- and non-destructive method for compositional analysis of Greek and Hellenistic painted vases and to understand the technology of their production. The authors will present the results of compositional analysis of the Hellenistic painted ware, Gnathia ware and slips of Black Slipped, Grey and Hellenistic Relief Ware, Hellenistic Red Slipped, Brown and White Slipped Ware from the Greek town of Issa (island of Vis) by Laser Ablation Inductively Coupled Plasma Mass Spectrometry and compare these results with commonly used Scanning Electron Microscopy. The results revealed differences in composition between the slips on the surface and the body of the vases, indicating different clay preparation process, one for the slips and another for the body.

Benjamín Cutillas-Victoria & Anno Hein

Institute of Nanoscience and Nanotechnology, NCSR Demokritos / Grupo de Investigación en Arqueología, Universidad de Murcia, Athens, Greece

Non-invasive protocol for the study of the post-firing painted ware from the Iberian Peninsula

Post-fired painted pottery is a type of handmade tableware that spread across the Iberian Peninsula during the first half of the first millennium BC. Its appearance can be explained by the arrival of Eastern Mediterranean influences at the end of the Late Bronze Age, although the autochthonous communities subsequently reproduced this style of pottery creating different regional styles. Its characteristics have led to its identification as luxury ware because of the quality of the burnished ceramics and the compositions painted on it with complex motifs and colours such as red, yellow, blue, white or black. However, the exceptional nature of these ceramics, their scarce number and their low weight preclude their examination by destructive techniques due to heritage conservation issues. For this reason, our work presents a non-invasive analysis protocol by which to investigate the chemical composition of these ceramics through portable X-ray fluorescence (pXRF), and the characterisation of the pigments with micro X-ray fluorescence (μ XRF). In order to explore questions of provenance and formation of paste compositional reference units, a number of local materials previously characterised by XRF, XRD and thin section petrography have also been incorporated into the pilot study. The results have made possible to define a production centre of this pottery on the Iberian Peninsula for the first time. Additionally, they have revealed the presence of exogenous individuals from the exchange networks.

Dimitrij Mlekuž Vrhovnik

Department of Archaeology, Faculty of Arts, University of Ljubljana; Institute for the protection of the cultural heritage of Slovenia, Ljubljana, Slovenia

Modelling long-term demographic patterns of the area of Slovenia

Paper tackles the long-term demographic and settlement dynamics model of the area of Slovenia in the last 10,000 years based on radiocarbon dates and the density of archaeological sites. With the development of AMS dating and by increasing the number of dates, we can use radiocarbon dating not only for determining the age of individual samples but as data that enables



the detection of previously unobserved trends and patterns. The approach is based on combining probability distributions of radiocarbon dates from archaeological sites. The main assumption is that the high density in space and time indicates more intensive settlement dynamics; as the number of people and the number of sites increases, it also means increased depositional activity, which is reflected in the density of radiocarbon dates.

The second approach uses an aorist analysis of the spatio-temporal dynamics of the corpus of archaeological sites in Slovenia. The aorist analysis is based on the sum of the probabilities that the archaeological site was inhabited in a certain period; with a sufficiently large number of sites, we can recognize spatio-temporal concentrations, patterns and trends. In the model, we compare both approaches, discuss the discrepancies and analyze the spatial aspect of the dynamics. The model is compared with historical reconstructions for the last 2000 years.

Zoran Čučković

Université Clermont Auvergne, Clermont-Ferrand, France

Digital landscapes: new algorithms for archaeological site detection and mapping on the basis of Lidar data

In the last two decades, archaeologists have been at the forefront of LIDAR (laser scanner) deployment and analysis. Suffice to mention spectacular discoveries made in tropical rainforests (Mesoamerica, SE Asia) or in woodland areas of temperate Europe. The technology uncovered large swaths of hitherto invisible settlement traces, field systems and structures. While these advances sparked interest in the technical aspects of the digital topographic survey in the archaeological community, the overall methodological commitment remains rather low. In general, archaeologists remain “end users” working on heavily pre-processed and filtered datasets, if not simple image snapshots. These may hide rather than reveal topographic features of interest. For these reasons a user-friendly library of algorithms for topographic analysis in the widely used QGIS software was developed by the author (Terrain Shading module*). The included modules were developed specifically for the detection and visualisation of topographic features, on the basis of existing solutions or as entirely new implementations. For instance, the eccentric topographic index is responding in parallel to terrain orientation and local elevation, thus combining two particularly useful pieces of information for the detection of potential archaeological features.

Another module is rendering natural shadows while providing information on shadow depth (behind the illuminated object). This permits to evaluate relative heights of objects and to adjust shadow translucency on the basis of its depth. The potential of this toolset will be demonstrated on several examples of Lidar-derived datasets, acquired in Central France. Various types of archaeological sites can be found in the hilly region of the Massif Central, such as prehistoric hillforts and oppida, medieval motte and bailey strongholds, or historical field systems. Different approaches in topographic visualisation and detection will be discussed in relation to the geometry of such archaeological features (voluminous fortifications, tiny pastoral dwellings, remnants of field systems, etc.).

Domagoj Tončinić¹, Miroslav Vuković¹, Joško Zaninović² & Domagoj Bužanić¹

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² The Public Institute of Krka National Park, Department for Archeology, Cultural and Historical Heritage, Šibenik, Croatia

The transformation of the cultural landscape between the Krka and Cetina rivers: Preliminary analysis of potential archaeological structures recognized on LiDAR images

The cultural landscape between rivers Krka and Cetina has been the subject of numerous historical and archaeological research efforts. In recent times, a large number of potential and previously unknown archaeological sites were discovered by archaeological prospection methods, among which LiDAR data interpretation proved to be the most effective one. In the framework of this research, most of the attention was focused on features that could represent the ruins of Roman military infrastructure along the Delmataean Limes. The aim of this paper is to present the preliminary results of the research conducted on selected potential archaeological sites which were not a part of the previous archaeological interpretations of LiDAR data. The paper will further stress the importance of interpreting all features of the landscape regardless of their construction date, as only an objective approach to the data present in the field can yield valid interpretations of the changes that took place in the landscape. Some of the sites are spatially distributed in the surroundings of Roman military camps and along Roman roads, but some can also be found in positions that cannot be connected with the activities of the Roman army and Roman roads or even with the activities from the Roman period. The need to defend and monitor the area under different historical circumstances was present from Protohistory to Modern times, and numerous new sites that came to light with the interpretation of LiDAR data reflect that fact. Based on the current state of research, some of these potential sites could represent important locations where the transformation of the cultural landscape between the rivers Krka and Cetina under different historical circumstances from Protohistory to Late Antiquity could be observed.

Jerko Luka Gašpar

Department of Archaeology, Faculty of Humanities and Social Sciences, University of Zagreb, Croatia

Viewshed analysis of Late Antique fortresses of eastern Adriatic coast and the methodological questions it raises

In the aftermath of the Gothic War (535-554) the eastern Adriatic coast under Byzantine rule underwent a major phase of fortification of its coastline and its archipelagoes. The construction of the new fortification system, sometimes referred to (in older literature) as *limes maritimus* has significantly changed the littoral landscape of Dalmatia from a cultivated, peaceful and economy-oriented one to a one more fortified and military-oriented in a process known as *Kastrizacija* ("Castrization" from lat. *Castrum*). It has long been observed that the specific placement of these fortresses served the purpose of providing the garrison with a direct overview of the maritime trade routes of the eastern Adriatic. However, new digital technologies give us the ability not only to verify those claims through viewshed analyses conducted in GIS but also to identify which maritime routes were prioritized for protection, and how well could those fortresses have served their purpose given their placement in space. Naturally, using GIS software to conduct visibility analysis raises many methodological questions which need to be addressed. Questions such as the impact of vegetation on visibility, the presumed height of the viewing point, atmospheric impacts on visibility and some others will be raised and an attempt will be made to provide an answer to them during the presentation.



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³ Valdir, Zagreb, Croatia

The construction history of the Ledenice castle: application of the archaeology of standing structures

The remains of the Ledenice castle are situated on the top and south slope of a hill named Gradina, in the hinterland of Novi Vinodolski, on the southeast rim of the Vinodol valley. The castle is located on the top of the hill, surrounded by the settlement on the west, south and east sides. The whole settlement is encircled with a defensive wall and the parish church is positioned by the settlement's entrance. The castle is known from written sources at least from the mid-13th century. The castle and the settlement continued to flourish from the 13th till the 16th century, stagnating during the 17th century, to be abandoned through the 18th and 19th centuries. From 2019 the Department of Art History of the Faculty of Arts in Rijeka, with the collaboration of the Croatian Conservation Institute, began the documentation of the standing structures and field and structural survey of the site. The aim of the project is to document the remaining structures, analyze them and reconstruct the construction history of the site. During the 2021 campaign, the remains of the central castle have been documented. The castle remains have been documented using UAV, image-based modelling and drawing made in AutoCAD. Using the method of the archaeology of standing buildings, the remains of the castle have been analyzed. Six different construction phases have been detected among the standing structures. The earliest one is represented by the remains of a possible church dated to the 12th/13th centuries. That structure was supplemented by the construction of the castle that was enlarged during the next three construction phases, dated from the 13th to the end of the 15th century. The change of the owner, from the noble Frankopan family to the Habsburg Military Frontier, caused new construction changes during the 16th century. The last phase is represented by the physical remains of trenches and pill boxes of the Italian army during World War II. The aim of this paper is to present the results of the structural and field survey of the Ledenice castle and to show the possibilities of the analysis of standing structures in archaeology as one of the noninvasive field methods.

Michael Doneus¹, Bernhard Höfle^{2,3}, Dominic Kempf³, Gwydion Daskalakis³ & Maria Shinoto⁴

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⁴ Institute for Prehistory, Protohistory and Near Eastern Archaeology, Heidelberg University, Germany

AFwizard – Human-in-the-loop development of spatially adaptive ground point filtering pipelines

LiDAR data have become indispensable for research in archaeology and a variety of other applications. To derive products (e.g., individual trees, buildings, terrain models), a reduction of the acquired and georeferenced point cloud to the points representing the desired objects of interest is usually needed. This process is known as classification or semantic labelling, where each indi-

vidual 3D-point is assigned to an object class. In archaeological prospection, digital terrain models exposing the microtopography of the bare Earth's surface are desired to be able to identify and map archaeological and palaeoenvironmental traces. The definition of what still belongs to the terrain often varies between target applications. It requires to integrate expert and domain knowledge into the classification process which consists of the central ground point filtering step and subsequent terrain model interpolation. Setting up such filtering workflows and automatic processing pipelines is time-consuming and prone to information loss, especially in geographically heterogeneous landscapes. There one filter setting can lead to qualitatively very different results, depending on varying terrain parameters such as steepness or vegetation density. In this lecture, we show that these heterogeneous environments need a special workflow for optimal ground point filtering results, which integrates human knowledge. We present a novel Python-based open-source software solution, which helps to optimize this process and creates a single terrain model by an adaptive filter based on spatial segments. The software is also useful to study the effects of different algorithm and parameter combinations on terrain modelling with a focus on practical and time-saving implementation. As the developed pipelines and all meta-information are made available with the resulting data set, ground point filtering becomes white boxed, and consequently scientifically comprehensible and repeatable. Together with the software's ability to simplify filtering workflows significantly, it will be of interest for many applications also beyond the examples shown from archaeology.

Luka Gruškovnjak^{1,2}, Agni Prijatelj^{1,2}, Petra Vojaković¹ & Matija Črešnar^{1,3}

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³ Institute for the Protection of Cultural Heritage of Slovenia, Ljubljana, Slovenia

A smithy revealed by the micro-refuse analysis in the Late Halstatt Building 24 at the hillfort of Pungrt above Ig, Slovenia

Since the development-led excavation in 2020 and 2021, the proto-urban hillfort of Pungrt above Ig, located in the vicinity of the Slovenian capital of Ljubljana, has rapidly gained a reputation as one of the most important Early Iron Age sites in Slovenia. The ongoing laboratory analyses of Pungrt settlement deposits and micro-artefact assemblages – undertaken within a research project funded by the Slovenian Research Agency (ARRS, grant number J6-3126) – are part of the first high-resolution study of the structured use of space at any hillfort site in Slovenia. As such, they propel the development of Slovenian archaeological science in general and Iron Age settlement studies in particular. One of the methods used in this study is the micro-refuse analysis concerned with reconstructing daily activities within the Iron Age buildings. By examining minute pieces of refuse measuring 2–6 mm, which would, due to their size, have evaded regular cleaning and maintenance practices and become unintentionally trampled into the floor surface, we were able to reconstruct distinct activity areas within the Late Hallstatt Building 24. Most notably, the seemingly inconspicuous southern room that provided no hints of its use during the excavation was identified as a smithy. Different types of hammerscale suggest that the room was used by a blacksmith forging iron. The hammerscale distribution within the room with an exit onto a wide street next to the stone rampart indicated where the smithing hearth and anvil would have stood. In addition, micro-artefacts indicate ore-roasting activity at the hearth and the presence of large furniture in the corner of this workshop. Meanwhile, the northern room behind the smithy was used for domestic activities, including food preparation.



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From a house to a stable: a micromorphological study of the Late Hallstatt Building 21 at the proto-urban hillfort of Pungrt above Ig, Slovenia

During the development-led rescue excavation in 2020 and 2021, a systematic geoarchaeological sampling programme was undertaken at the proto-urban hillfort of Pungrt above Ig, Central Slovenia. Some 300 intact micromorphology blocks and 1,800 bulk samples from various floor sequences, open area surfaces and accumulated residues were collected across the best-preserved areas of the settlement. Here, we present a dynamic socio-economic history of the Late Hallstatt Building 21. The wooden structure had stone foundations, internal partition walls, and several hearths and ceramic bowls, built into floor surfaces. The floor sequence in the building consisted of a series of interchanging earthen floors and dark, homogenous layers. Our microstratigraphic analyses have revealed the nature of these floor materials and accumulated occupation residues, their precise depositional pathways and micro-contextual associations, and their sociocultural and ecological significance. Throughout the building's life-cycle, three types of earthen floors were used, including constructed, clay-rich floors, calcareous mortars, and beaten floors. In addition to longer-term cycles associated with these deposit types, the microstratigraphic sequence in Building 21 contained records of various seasonal and daily activities. These included cyclical replastering of floor surfaces with finishing coatings and "red wash"; re-deposited rake-outs in the vicinity of the hearths; and micro-laminations of occupational debris. In its final phase, the nature of the building changed and the structure, originally employed for dwelling, became a stable. The results of the integrated micro-contextual analyses of the stratigraphic sequence from Building 21 provide information on distinct architectural choices and household organisation, as well as insights into technological knowledge, social practices, human-animal relations, and multiple temporalities associated with the building's life cycle. As such, they allow us to address previously under-explored topics within the hillfort research, most notably the issues of the structured use of space, ecological relations, distinct discard and sanitation practices, and overall community sustainability.

Luka Gruškovnjak

Department of Archaeology, Centre for Interdisciplinary Research in Archaeology (CIRA), Faculty of Arts, University of Ljubljana

The influence of topography and soil geomorphology on the archaeological record within the landscape

The movement of material across the landscape is one of the key formation processes affecting the archaeological record on a regional scale. It is primarily caused by a number of distinct erosion, transport and deposition processes, which operate in different sections of the landscape and cause differences in the preservation, transformation and visibility of the archaeological record. By using the five slope elements model, soil maps and soil thickness model, it is possible to predict areas where each of the three processes predominates. Case studies presented

in this paper demonstrate that such an approach successfully identifies those parts of the landscape where buried archaeological sites that field survey methods cannot discover can be expected. It also foresees landscape areas where survey methods detect archaeological materials transported from elsewhere, including areas of backslopes, footslopes and toeslopes, as well as areas with Fluvisols and Gleysols. Nevertheless, given the differences between the present and past topography and a number of variations at the microtopographic level, detailed insight into geomorphic and pedogenic processes can only be garnered with a subsurface inspection. The latter allows for the reconstruction of sedimentation and soil formation through time, as well as the recognition of various anthropogenic interferences which cannot be predicted with topographic analyses alone. Such information is crucial for planning either archaeological survey or excavation projects since it enables identification of the depths to which testing for the presence of the archaeological record is required. Also, when using archaeological methods that inspect the subsurface record, the soil thickness model proves indispensable for understanding soil geomorphology processes. Not accounting for these, on the other hand, may lead to significant errors in archaeological interpretations.

Katarina Jerbić

Flinders University, Adelaide, Australia

Assessing the archaeological and paleo-environmental potential of a submerged prehistoric site: A case study from Zambratija Bay, Croatia

This paper presents the underwater archaeological methods used in the interdisciplinary fieldwork in Zambratija Bay, organised and performed by the author as part of her PhD research in 2017. Zambratija is a submerged archaeological site situated three metres below mean sea level, with stratified evidence and architectural wooden remains indicating human activities in a landscape that was evidently once coastal or terrestrial. The proximity of the site to the current shoreline allowed for a reconstruction of former sea-levels and a means to assess the local environmental history, and the preserved organic remains indicated a possibility for performing tree-ring analyses. The three selected fieldwork methods were therefore chosen to assess the range of research perspectives that this site offers: 1) sub-bottom profiling survey, 2) seabed coring and 3) wooden sample collection. Representing a combination of archaeological and environmental science disciplines used within submerged and wetland archaeology, these methods have proven to be crucial for addressing Zambratija Bay's unique archaeological and paleo-environmental potential and have placed the site on the global archaeological map.

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Reconstruction of bog iron ore deposits in the lowland landscape: a case study predictive model for the analysis of exploitation in archaeological periods

The fundamental raw material used for iron production in the lowland areas from Iron Age up to the Middle Ages was bog iron ore. Such is the case of the lowland alluvial plain of the Drava River Valley (today Podravina region (NW Croatia)) during Late Antiquity and the Early



Middle Ages. Analysis of ore properties and deposits can contribute to the understanding of natural mechanisms that conditioned the exploitation and use of ores in the past. However, locating the deposits used by past societies is challenging, due to the possibility of full exploitation in the past, degradation and inhibited regeneration or development caused primarily by long-term human activities and the subsequent impact on the environment. Geoarchaeological research showed that in the modern landscape of the Podravina region, the Kalinovac - Hrastova greda 1 - 3 position, had the highest potential for ore development and the only, partially destroyed ore deposit known today. Based on multi-method predictive analysis, a model of the formation mechanism, physiognomy and potential area of deposit development in the lowland region of the Drava River alluvial plain is proposed. Methods of deposit recognition within the natural environment (pedological, relief, hydrological and vegetational indicative features) as well as the spatial dependency of potential deposit formation (exploitation) areas and positioning of archaeological sites with iron production remains are discussed. Data from surface field survey, geoarchaeological probing, predictive spatial analysis and satellite imagery analysis as well as granulometric, mineralogical (XRD) and chemical analysis (ICP - AES) of samples of ore development stages are used in the study.

Petros Chatzimpaloglou

Department of Archaeology, University of Cambridge, UK

Provenance investigation of stone tools and its archaeological application

Stone tools are a vital component of the material culture of prehistoric communities and useful markers of technological, cultural and social change. Indeed, the origin of the raw materials and the technologies employed on tools have been investigated in order to understand the identities of prehistoric people and their social organization. Furthermore, they have contributed to the identification of trade/exchange networks and possible interactions between these societies. Therefore, addressing the provenance of stone tools is a new potential avenue of research that might be able to address some of the uncertainties surrounding the socio-cultural transformation of the Balkan and beyond. This presentation will focus on a successful provenance investigation conducted on Neolithic stone tools and artefacts from Malta and rock resources from Malta and Sicily. It will explain the main components of this methodological approach and provide background information about the Neolithic period in Malta. These will be followed by suitable examples demonstrating the application of such interdisciplinary research. Additionally, it will display some initial findings of a research project working on Palaeolithic lithic assemblages found at sites near Banja Luka (North Bosnia). These will be used to highlight the great prospects of such investigations for a better understanding of Balkan prehistory.

Vidan Dimić

Institute of Archaeology, Belgrade, Serbia

The use of polished stone axes and adzes in the Neolithic of Serbia – experimental research

The polished stone tools with cutting edge, in addition to other polished stone objects with practical and symbolic use, represent a peak of stone processing in prehistory. The main types of these tools are polished stone axes, adzes, and chisels, which in the Neolithic, we can assume, to the greatest extent have practical use in woodworking. It is also reasonable to assume that

some of these tools were used in a number of other activities in the Neolithic, such as butchering, hide processing, digging, making bone/antler tools, or as a battle or symbolic tools, as evidenced by numerous ethnoarchaeological examples. The use of polished tools with cutting edge, and their efficiency at work, is one of the least researched aspects of the polished stone industry, therefore the reconstruction of their use was a significant and very inspiring segment within a much wider archaeological experiment conducted between 2016 and 2019. One of the goals of this phase of the experiment was to offer answers to various research questions from a functional-technological point of view, among which the following stands out: what is the reason for the noticeable predominance of adzes in relation to axes at Neolithic sites in Serbia? Based on previous analyses of the materials, we know that adzes are much more represented than axes, so we were interested in whether such quantitative disproportionality is a consequence of the greater functionality, efficiency, or applicability of adzes. We wanted to determine how much time and physical effort are required to carry out each segment of the operational chain in the life cycle of these tools, as well as to examine the dynamics of their damage and repairs. One of the main focuses was on determining the effectiveness of axes and adzes when performing various woodworking tasks. The presentation shows the preliminary results of the experiment which will be expanded in the future to other abovementioned activities and materials.

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Preliminary results of provenance studies on the polished stone material at the Neolithic site of Alsónyék, Hungary

The polished stone assemblage from the settlement features and burials of Neolithic (ca. 5800-4500 cal BC) Alsónyék-Bátaszék site were studied by macro- and microscopic petrographic and instrumental analyses. It is our aim to integrate the entire lithic assemblage into a comprehensive database and apply archaeological and geological approach with equal importance. The majority of the raw materials of the polished stone tools originates from Mecsek Mountains in the vicinity of the site (Lower Cretaceous alkaline igneous rocks, variegated marl, bituminous limestone, spiculite). In addition to the local lithic types, many stone tools made from long-distance raw materials: mainly serpentinite, contact metabasite (so-called Železný Brod type), hornfels, 'white stone', and the less frequent Na-pyroxenite, eclogite and nephrite, which indicate the Czech Massive, Transylvania, Banat and the Alps as raw material source areas. The primary tool types are variable axes, adzes, chisels, and maces. We observed correlations between the main lithic types and the axe's shape in several cases. The imported stone tools made from extremely high-quality raw materials (e.g. contact metabasite, hornfels or 'white stones') are significantly smaller sized than stone tools made from local raw material. The working traces of axes recovered from the graves show great variability. Many of them are finely crafted and perfectly polished, with no signs of wear visible to the bare-eye, while others show wear, resharpening, chipping and cracks from use. A further aim of our work is to refine the raw material groups and supply zones by means of mostly non-destructive petrographic and geochemical analyses. From an archaeological point of view, in addition to the



reconstruction of the technological sequence of the axe-making process, we will gain new insights into the environmental use, knowledge on the surroundings and lithology, stone tool-making and burial customs of the Neolithic communities of Alsónyék.

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Polished stone tools from the Bátaszék-Alsónyék Neolithic settlement (Hungary)

A Neolithic (~5800-4500 cal BC) settlement has been identified in the vicinity of Bátaszék and Alsónyék (Hungary). 668 polished stone tools (perforated axe, axe, shoe last axe, flat axe (chisel), mace) have been unearthed from the settlement and its burials. Our aim is to identify the raw materials of the artefacts and their location of origin to reveal the short and long-distance stone tool trade relations of the Neolithic settlement. The assemblage was classified into specific petrologic groups based on a macroscopic description (petrographic description, magnetic susceptibility analyses). 96 samples were chosen for a detailed petrographic examination (Polarizing Microscopy and Scanning Electron Microscopy). Measurements were carried out on thin sections and, if it wasn't feasible, on polished stone tools by a non-destructive SEM-EDS analysis at the Department of Petrology and Geochemistry, Eötvös Loránd University and at the Centre for Energy Research, Eötvös Loránd Research Network.

Based on the preliminary investigations, a lesser but significant amount of the artefacts have a long-distance provenance area (serpentinite, contact metabasite of Železný Brod-type, hornfels, „whites-tone”, Na-pyroxenite, eclogite, nephrite from the Bohemian Massif, Transylvania, Banat and the Alps). Most stone tools have a local origin (Mecsek Mts. and surroundings, Hungary). Local raw materials are dominantly igneous rocks (Palaeozoic microgranite; Lower Cretaceous ankaramite, alkaline basalt, phonolite, alkaline dolerite, microdolerite, alkaline trachyte; Cenozoic andesite). Sedimentary raw materials (marl, clay marl, bituminous limestone, spongy limestone, sandstone, crystalline limestone, travertine, aleurolite, dolomitic aleurolite, greywacke) are dominantly Mesozoic, however, there are few Permian and Quaternary samples. In contrast to those of long-distance origin, within local raw materials metamorphic rocks are particularly rare: quartzite, metasandstone and metaaleurolite (possibly from Miocene conglomerates of the Mecsek Mts.).

Meghna Desai & Thilo Rehren

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Carbon content determination of hypereutectoid wootz steel using image analysis

Carbon content determination of wootz ingots remains crucial to studying crucible steel production. Published estimates of carbon content based on metallography have provided a wide range of values (Smith 1960:22; Scott 2013: 118-20; Wayman & Juleff 1999). CSCE

(Crucible Steel Carbon Estimator) is an image analysis tool developed for determining the carbon content of un-etched hypereutectoid wootz steel ingot samples based on high-contrast SEM-BSE imaging. Using ingots from Telangana, India, early trials of CSCE show a consistent carbon content between 1.7-2.0 wt%, which falls within the expected range. The precision and accuracy of the tool were tested and showed a low statistical variance. This study explores the possibility of using CSCE more widely as an objective method to determine the carbon content of un-etched high-carbon crucible steel ingots.

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New data on the cage cup fragments from Gorsium/Herculia, Pannonia (Hungary)

Cage cups, also known as vasa diatreta, were doubtless one of the most sophisticated glass products, both artistically and technologically, of the Roman period. While there is an ongoing lively debate over how these objects had been manufactured, data on their chemical composition is limited. Fewer than 100 examples of this type of luxury vessel, which could date to the late Roman period and often associated with Christianity, are known from the Roman Empire. Fragments from four sites in Pannonia are known so far (Szekszárd, Gorsium, Brigetio and Fejér county). In the following, we would like to discuss the chemical composition of three colourless fragments from the city of Gorsium, which was an important administrative centre in the late Roman times. The fragments were found during the 1939 excavation in one of the palace's apsidal rooms. Major, minor and trace elements have been determined by scanning electron microscope attached with energy dispersive X-ray spectrometer, and X-ray fluorescence techniques. Two fragments have identical chemical compositions, but the third one is different, so the three cage cup fragments from Gorsium most probably represent two cage cups. Their chemical composition fits well with that of the general Late Roman cage cups. They are made of sodium-rich and calcium-poor base glass, which is very favourable for Sb-decolourised transparent glass. The Late Roman cage cups show a very close chemical composition, except for Yambol Cup, which can be a weak indication that not all cage cups were made in the same workshop.

Mila Andonova-Katsarski

Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria

The archaeological softwoods of ancient Serdica (Sofia, Bulgaria)

This study aims at the identification and interpretation of softwoods (coniferous wood) of the ancient town of Serdica (contemporary Sofia, Bulgaria). Their different roles (between 2 AD and 6 AD) as material for architectural purposes of structures directly related to the fortification walls of Serdica or for creating housing entities adjacent to the walls are explored in this paper. The provenance of the raw material along with the physical and mechanical properties of coniferous wood are also discussed. A possible journey of the softwood material is suggested and outlined. In addition, a brand-new web resource, dedicated to archaeological wood and at first – to coniferous wood, is presented.



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Between technological choices and resource availability: an insight into wood exploitation strategies for iron production and common use

Wood consumption by past societies had a significant role, whether for common use in an unaltered state such as construction, fire setting, object production or as charcoal for metallurgical activities. Antracological analysis of charcoal samples from settlements and iron production sites located within a unique lowland landscape of Drava River Valley (Podravina region, NW Croatia) dated to late Antiquity and Early Middle Ages, shows patterns of wood species used. These can be associated with archaeological context and presumed functional use of wood and technological reasoning behind specific wood species used in iron production processes (smelting and smithing). Potential areas of exploitation are presumed through analysis of natural prerequisites for vegetational growth and the potential of wood species occurrence in the wider area of the Drava River Valley floodplain and its natural bounding Bilogora hills. The results show that the organisation of iron production activities (location selection for workshops) and technological choices made, wood exploitation and charcoal production are intertwined and conditioned by resource availability.

Ana Đuričić

Laboratory for Bioarchaeology, Department of Archeology, Faculty of Philosophy, University of Belgrade, Serbia

Late Neolithic Vinča culture hearths – location identification and function

Thermal structures represent a standard repertoire in almost every Vinča culture house. Usually, those fire installations are ovens, but archaeologists sometimes mention the presence of hearths, both inside, and outside the houses. Ovens are enclosed thermal structures and the Vinča culture ones have a dome and a base made from mud plaster, floors from pure clay and, in the majority of cases, a potshard foundation. Unfortunately, due to their form and material properties, ovens are usually preserved only on the floor level with dome parts either extremely fragmented and mixed with the house debris or completely missing. On the other hand, hearths are open thermal structures, but there was not a formal typology or consensus on how the Vinča culture hearths looked like. The majority of thermal structures interpreted as hearths were located inside the houses and looked exactly like poorly preserved oven floors. Without presented criteria for their interpretation as hearths, it can be assumed that it was the level of their preservation in the archaeological record. Hearths found in the past several years offer new opportunities for further insight into Vinča culture hearths - typology, distribution and function. They were all located outside the houses and were dug into the soil, like a small pit. The aim of this presentation is to show the newly established typology of the Late Neolithic hearths at the territory of the Central Balkans, as well as the criteria for their identification.

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Visibility of epigenetic cranial traits on multi-slice computed tomography (MSCT) scans and dry bones

Epigenetic traits are defined as the expression of genes affecting development. In the fifties of the 20th century, genetic studies conducted on mice showed the epigenetic traits to be the most convenient for determining family relationships and population affiliation as they show high heritability even though they are partly influenced by the environment. Various studies on human crania showed that the frequencies of epigenetic traits could be used for studying biological distances between populations. To examine if multi-slice computed tomography (MSCT) images could be used as a reference for the study of the modern population, we conducted a pilot study in which we compared the visibility of the same 80 epigenetic traits on 40 dry archaeological skulls from two medieval sites, 32 from Velim Velištak (21 males, 11 females) and 8 from Radašinci (4 males, 4 females) and their MSCT scans. From a total of 80 traits analyzed, we identified 54 (67.5%) of them in the sample. When Cohen's kappa was calculated, 24 traits showed almost perfect or perfect agreement ($K = 0.81-0.919$), 19 traits showed substantial agreement ($K = 0.611 - 0.794$), one showed moderate agreement ($K = 0.588$), 5 showed fair agreement ($K = 0.281 - 0.557$), and 5 showed slight agreement ($K = 0.003 - 0.17$).

The study showed that most identified traits could be analyzed on dry bones and CT images interchangeably. However, some traits showed lower agreement levels, and their application should only be restricted to dry bones. Future studies are required to prove consistency between the two scoring modalities because the prevalence of some traits can be extremely low, thus disabling the comparison.

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Filling in the blanks: the application of palaeoproteomics in faunal analysis

Faunal assemblages from archaeological contexts are often abundant in the form of highly fragmented osseous remains which can be a limiting factor for the purposes of standard archaeozoological analysis. Therefore, the number of identified specimens (NISP), the minimum number of individuals (MNI), the minimum number of anatomical elements (MNE), age profiles etc. can be misrepresented. Because of this, efforts to further improve our knowledge of human-animal relationships in the past have been intensified in the last few decades. Apart from the already well-established ancient DNA analyses, in the past ten years, the use of palaeoproteomics in archaeology has been increasing. Proteomic studies range from exploring whole proteomes of tissue or substrate



(e.g., bone, enamel, shell) to detecting peptides to identify the taxon of the bone specimen. The latter can be achieved with Zooarchaeology by Mass Spectrometry (ZooMS), a technique of peptide mass fingerprinting (PMF). ZooMS aims at discriminating tissue rich in collagen type I from a taxonomic point of view because the amino acid sequence of COL1 varies across different taxonomic groups. This method analyses collagen, a protein less prone to decay thanks to its high abundance in osseous tissues and its arrangement into a highly stable triple helix. ZooMS is a fast and cost-effective method that has been explored and improved rapidly in the past decade and is especially suitable for improving and complementing faunal analysis. Its effectiveness varies based on the taphonomic processes and the age of the sample itself but, generally, it has a significantly higher success rate than the DNA analysis. Here, we present the possibilities and limitations of proteomic studies in archaeology and preliminary results of the analysis conducted on Palaeolithic sites in Istria, Croatia as a part of the PREHISTRIA project (IP-2019-04-7821) and iNEAL Cost Action (CA-19141).

Kyriaki Tsirtsis & Evi Margaritis

The Cyprus Institute (STARC), Nicosia, Cyprus

Plants and people in Classical/early Hellenistic Sikyon: what we got through the analysis of archaeobotanical material

Daily activities related to food production or procurement and storage, as well as cooking stages, reflect important scheduling decisions and ancient economic models which can be deciphered through the study of archaeobotanical remains. This presentation attempts to showcase the need of applying archaeobotanical research in archaeological sites, as both macrobotanical (carbonized grains) and microbotanical (such as starch granules) remains have the potential to decode the agricultural and cooking activities that took place in a site, and eventually unfold snapshots of daily agrarian life. While macrobotanical remains can shed light on a wide range of human-plant interactions, from resource management and environmental impact to cultural modification of plant products and the plants themselves (such as specific olive tree varieties), starch granules are a source of information concerning plant use and human dietary behaviour. For the needs of this paper and in order to address the different proxies, in particular macrobotanical analysis, starch granule analysis, geometric morphometric analysis and SEM analysis that can be integrated, the Classical-Early Hellenistic site of Sikyon (Peloponnese) will be used as a case study, in which all these disciplines have been so far applied allowing to trace not only the exploited plant resources but also the relationships between people and plants during the Classical-Early Hellenistic periods in NE Peloponnese (Greece).

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International radiocarbon mortar dating intercomparison – MODIS2

In 2020 three mortar samples from different sites and chronologies were distributed among 11 radiocarbon laboratories as a part of the Second International Mortar Dating Intercomparison Study (MODIS2). The samples were in form of bulk mortar and particle size fraction smaller than

150 μm . The Zagreb Radiocarbon Laboratory approach to radiocarbon analysis of the MODIS2 samples was to separate 32 – 63 μm particle size fraction and to collect three CO_2 – gas fractions by sequential dissolution with acid. The first fraction was reported as the age of the mortar, while others were used for the characterization of mortar. Data extrapolation of the result was also used (but not reported to MODIS2) and gave results closer to the expected historical age for some samples. Here we also present different approaches to radiocarbon mortar dating.

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Absolute and relative chronology of the Early Bronze Age necropolis in Mokrin, Serbia

Mokrin necropolis, situated in northeastern Serbia, is one of the most important Early Bronze Age and Maros culture cemetery sites. Osteological remains and grave goods have been featured in a number of studies aiming to answer important questions about social structure, division of labor, health, diet and ancestry of the Early Bronze Age communities. However, the chronology of the necropolis is still poorly understood. With only six published radiocarbon dates so far, dating the necropolis between circa 2100 and circa 1800 BC, the reconstruction of the chronological sequence of graves and the manner in which the necropolis had formed was difficult. In this study, we revisit the issue of the absolute and the relative chronology of the Mokrin necropolis. We present 10 new radiocarbon dates and we use all available radiocarbon evidence to test two hypotheses regarding the relative chronology of the Mokrin burials: 1) a seriation sequence of burials based on the forms of ceramic vessels found in 165 graves 2) a relative chronological sequence proposed in the literature which assumes a specific spatio-temporal pattern for the expansion of the necropolis in the southeast-northwest direction. The new radiocarbon dates confirmed the previously established chronological span for the necropolis. The seriation sequence based on the pottery forms is moderately and significantly correlated with the radiocarbon dates, suggesting that the seriation sequence recovers the true relative chronology in general, but not in details. On the other hand, the hypothesis which assumes that the necropolis expanded from the southeastern to the northwestern corner was not supported by the radiocarbon data, as the correlations between calibrated dates and the sequence based on this hypothesis was low and not statistically significant.



Predrag Novaković

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How much and what STEM are we teaching in archaeology?

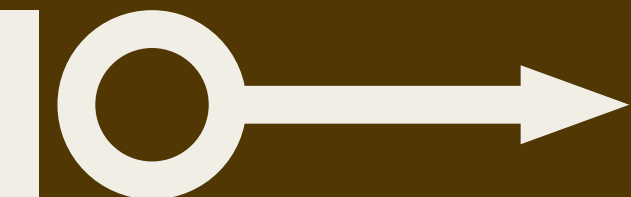
This paper presents the result of a survey of STEM subjects and contents in archaeological undergraduate and graduate (BA/BSC and MA/MSC) curricula in different European countries. Altogether, 163 study programs from 76 universities in 27 countries were examined for their STEM contents. In general, 3 universities were selected per individual country. However, this figure was lower in some cases, for example, in smaller countries.

All data were collected from online resources. It is difficult to get the exact number of European universities that offer archaeological study programs. Based on data from the QS University Ranking and Times Higher Education rankings, we have estimated that somewhere between 250 and 300 universities in Europe have archaeological study programs; the surveyed universities present some 25-30% of all relevant universities. However, we are fully aware that our surveyed sample could not be considered highly representative. Still, on the other hand, the results we intended to achieve were about very general patterns and trends in the educational landscape.

We were already surprised by the educational landscape's complexity and heterogeneity during the collection of data, even regarding the very limited area such as archaeology. The organization of studies and structure of their curricula reflect the influence of multiple factors, from cultural (national) traditions, disciplinary traditions, the organizational structure of the universities or faculties, and infrastructural capacities of the institutions, to many other factors, including even personal preferences and influence of the leading scholars in academia.

The results are presented in several topics structured simultaneously and cross-sectional along several different perspectives of observation: a) geographic perspective (European, regional national), b) disciplinary perspective (actual STEM contents), and c) organizational perspective (structure STEM is structured in the curricula). The results are presented in more detail in the paper. Nevertheless, the general conclusion is that based on our empirical data, the teaching of archaeology in the last decades is going through a profound transformation under the influence of STEM sciences. This transformation's positive and negative effects are still to be fully reflected and discussed.

POSTER ABSTRACTS



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Bio-archaeology of the pit-fills of Sexaginta Prista (2BC – 1AD)

This poster discusses the bio-archaeological findings of the flotation samples retrieved from the pit field of Sexaginta Prista (North Bulgaria). They include abundant archaeobotanical remains, but also malacological and ichthyological findings. The current study proposes several probabilities of the pits' possible use(s), according to the pit fills and the retrieved material. These options include the use of the pits as kitchen-related structures, features related to fishing, sacred space or disposal areas.

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The Neolithic site Gorjani-Topole – preliminary results of palynological analysis from the Slavonia region (eastern Croatia)

Pollen and non-pollen palynomorphs has become standard biological proxies used in archaeology for understanding human-nature interactions, i.e. anthropogenic pressure or ecological "footprint". In addition, charcoal particles often indicate human-induced fire activity in some area. The multiproxy study of eight subsamples, isolated from four cores: GT-1, GT-3, GT-4, GT-6, were conducted with the aim of paleoenvironmental reconstruction. In total, 44 different polymorphs were recorded: 12 pollen taxa, 23 fungal spores/remains, four algal cyst, one amoebae and four palynomorphs of unknown origin. Among non-pollen palynomorphs with the greatest frequency and number occurred *Pseudoschizaea*. As the pollen spectrum is reduced, the analyzed samples do not allow the reconstruction of the plant cover in the subject area. The low pollen richness accompanied by the presence of only a few sporopollenin-rich pollen types indicates unfavourable preservation conditions in analysed core samples. The dominance of erosion/desiccation indicators supports the scenario of significant oscillations of the water column, with periodic drying of the substrate. Nevertheless, it is still possible to indicate paleoecological trends and partially interpret them, considering the indicator value of the few preserved palynomorphs. Of great importance are the finding of cultivated grass pollen (*Cerealia*) and other anthropogenic indicators like weed pollen (*Convolvulus arvensis*) in the GT-4 core. Moreover, *Riccia* moss spores or fungal *Epicoccum* spores could also indicate the anthropogenic impact on the study area.



Valentina Lončarić

Center for Scientific Research and Popularization of Archaeology – ZipArh, Zagreb, Croatia

Image-based low-powered technological analysis of archaeological ceramics and its potential on-site and educational applications

Ceramic artefacts are arguably the most abundant category of finds encountered on archaeological sites dating from the Neolithic to recent centuries. In fact, morphology-based typological schemes of archaeological pottery are still widely used in relative chronologies or as indicators of cultural contacts. As such, typological analysis is an almost intuitive tool archaeologists use to handle and interpret large fragmentary datasets, but it fails to provide unequivocal information on technological aspects of ancient pottery making. Technological investigation of archaeological ceramics plays a crucial role in understanding the way past people interacted among themselves and with their environment, providing insight into past pyrotechnology, resource management, skill transfer, and social structure influencing production organisation. State-of-the-art analytical techniques provide science-backed answers to the aforementioned questions, but their high-cost renders them unavailable to small-size research projects. Recent research on a prehistoric hillfort settlement Cvituša (Lovinac, Croatia) provided an opportunity to test and further develop a low-powered, low-cost methodology for initial technological assessment of archaeological ceramics. In particular, the use of open-source image processing software to minimise observer error when describing macroscopic features of ceramic cross-sections. The updated methodology and results of a small set of samples are presented as a workflow which is applicable both on-site, or as a practical education tool. While only limited information on ceramic technology is available with this approach, its main advantage is that it can help archaeologists make better informed decisions when choosing samples for archaeometric analyses designed to answer the questions of ceramic technology.

Dunja Martić Štefan

Archaeological Museum of Istria, Pula, Croatia

Sickle gloss on knapped flint artefacts recovered at the Galovo site in Slavonski Brod and the Dužine site in Zadubravljje, Croatia

This paper discusses finds of knapped flint from the Galovo site in Slavonski Brod and the Dužine site in Zadubravljje on which functional analysis identified sickle gloss. The two sites are 15 km apart, both located in the proximity of Slavonski Brod in the Brodska Posavina region [the Sava River basin in the Slavonski Brod area]. The Galovo site in Slavonski Brod has been dated to the Linear A phase of the Starčevo culture of the Early Neolithic Brodska Posavina region, while finds recovered from the ploughed layer and immediately beneath it are attributed to a Late Bronze Age grave of the Barice-Gređani group. The date of the Dužine site in Zadubravljje corresponds to the Starčevo Linear A phase. Sickle gloss is a characteristic wear trace present on tools used to cut silica-rich plants of the Gramineae (domesticated cereals and other grasses), Typhaceae (e.g., bulrush) and Compositae (e.g., marsh-elder) families. To the naked eye it is recognisable as a high "wet" sheen that extends from the working edge and runs across much of a tool's surface. Sickle gloss is formed over an extended period of time, developing from small gloss-covered areas to coating the entire working edge, at times even the whole tool. Viewed microscopically, sickle gloss—in its most developed form—exhibits comet-shaped pits, pronounced rounding of the edge, and a

dense, uniform, bright and "wet" surface sheen. The analysis performed for the production of this paper was done at a relatively low microscopic magnification of 200x. Various phases of the formation of sickle gloss were identified on 19 blades, blade fragments or blade tools from the Galovo site in Slavonski Brod, and on a truncated bladelet and a flake from the Dužine site in Zadubravlje. The distribution of gloss on individual specimens at these sites exhibits the characteristic appearance of harvesting tools.

**Emilija Nikolić¹, Ivana Delić-Nikolić², Ljiljana Miličić², Nevenka Mijatović², Mladen Jovičić¹
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³ Faculty of Technology, University of Novi Sad, Serbia

Searching for elements – creating a composition: from archaeometry to conservation of Roman constructions on the Danube in Serbia

Roman mortars have long been one of the most intriguing topics in the field of construction history, which together with archaeology has embraced many sciences and professional practices in order to unravel the technologies and knowledge of ancient builders. Among them, geology occupies a special place in the investigation of the origin of raw materials. At the same time, with the help of chemistry, it looks for their mutual relationships, which eventually led to composites with the use of which the most monumental Roman buildings were erected.

Through the project Mortar Design for Conservation – Danube Roman Frontier 2000 Years After, the characterisation of more than 120 samples of Roman mortars originating from buildings erected along the former Danube Limes in Serbia, in the period from the 1st to the 6th century, was carried out. Research executed in laboratories in order to get mineralogical-petrographic and chemical characterization, and determination of physical and mechanical characteristics of samples brought completely new data about the use of building materials for the purpose of preparing mortar in this period on the outskirts of a Roman province. The results enabled materials scientists to prepare over 60 models of compatible conservation mortars using detected raw materials, which were then experimentally applied in the field. The promising results of the behaviour of applied conservation mortars show the importance of previous multidisciplinary scientific research for the needs of architectural conservation of monuments. At the same time the entire project process - from characterization to conservation, can present a valuable contribution to the nomination dossier for the Frontiers of the Roman Empire – Danube Limes in Serbia which the Republic of Serbia is currently preparing with the aim of recognising these precious ancient archaeological sites along the great river as properties of the UNESCO World Heritage List.

Acknowledgements: This research was supported by the Science Fund of the Republic of Serbia, PROMIS, #6067004, MoDeCo2000.



Tosho Spiridonov & Svilen Stoyanov

Society for Study of Community and Settlement (DIOS), Sofia, Bulgaria

DAGIS 4.0 – Balkan Information system

During the period 1998-2009 we created the DAGIS 4.0 Information System, which affects all areas related to the cultural and historical heritage of the Balkans (www.dagis-bg.eu). A separate program is prepared for each Balkans country (so far, separate programs have been prepared for North Macedonia and Moldova, reported in various scientific forums), adapted so that each specialist from a given country can work as he is used to working. The system went through a test period of two years in one museum, after which it was implemented in museums in three settlements. Currently, it covers 9 working programs-modules (out of 18) - MuseuM - for the digitization of museum's funds; Glotta - to digitize linguistic data for the Thracian language; Biblos - a program for introducing scientific literature; Folk - for field work (Folk-TereDoc) and for archiving data (Folk-Archive) on intangible cultural heritage; MapTour - for cultural tourism. Separately, there is a program for entering modern settlements (Settlement), for mapping (Tabular) and for entering images (PhotoStorage). Separately, there is a program for creating archaeological field diaries (PIN). One of them is the Arche module, with two main functionalities - Situs and Inventaria. Situs allows the introduction of published archaeological sites with all the necessary attributes - modern settlement, site name, place name, geographical coordinates of the site, era, period, dating, etc. Inventaria digitizes the data for published finds. The system automatically displays the site on a map based on OpenLayer platform with cartographic signs specially created for the archaeological map, allows automatic drawing of the route to the site, contains links to found and published finds from this site, and published literature containing data about the site and its finds. The system contains data for the publication (in the Biblos module) - summary, keywords, and full text as a PDF file, which can be downloaded separately or from the description of the object. DAGIS is a web application that supports standard methods for exchanging information with external systems.

Katarina Šprem¹, Lana Blažinić², Elena Orbančić² & Adriana Sponza²

¹ Independent Researcher

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Lithic analysis of finds from the field surveys of Lovas Municipality, Eastern Croatia

The Lovas Municipality in Western Syrmia, Croatia, is an archaeologically rich region that has been known in archaeological circles since the 19th century. It has become even more famous since the discovery of a very valuable Middle Bronze Age hoard of gold and bronze finds found near the village of Lovas in 1939. However, until very recently there was no large-scale archaeological research, other than a few field surveys in the 1970s. In 2011 the Archaeological Museum in Zagreb started a research project that was continued in 2017 and 2018 in cooperation with Lovas Municipality and the Institute of Classical Archaeology of Charles University in Prague, Czech Republic, which included systematic field surveys, geophysical research, and test trench excavations. In this poster we will present the results of the analysis of lithic finds from the aforementioned field surveys. We conducted technological and typological analysis of lithic finds, as well as raw material analysis which can tell us a lot about the circulation of material in this part of Eastern Croatia. We will compare our results with the pottery finds analyzed earlier and discuss what this data can tell us regarding the prehistoric life in this region.

Selena Vitezović, Danica Mihailović, Vidan Dimić & Dragana Antonović

Institute of Archaeology, Belgrade, Serbia

Tracing prehistoric mines and quarries: preliminary results of the field survey of Rudnik area (central Serbia), campaign 2021

Prehistoric communities exploited diverse sources of raw materials, from relatively small ones up to large mines and quarries. However, tracing down in the archaeological record the exact source of raw material exploitation is in certain occasions rather difficult – these sources may have been completely destroyed and exhausted with later activities, they may have been comprising small, difficult to detect area, preserved archaeological traces may be too scarce to be detected, etc. Certain areas where the present-day geological data show that sources of raw materials are relatively abundant and particularly interesting for archaeological research. One of these areas is Rudnik mountain, the second major volcanic area in central Serbia, known for its richness and variety of raw materials used in the past. Abundant historical and archaeological record of Rudnik showed intensive exploitation of diverse ores in medieval and pre-modern times., as well as prehistoric exploitation of malachite, dated to the Bronze Age period. The site of Prljuša – Mali Šturac was discovered in the 1980s; research with the limited scope was then conducted and systematic research was initiated in 2011 and is still in progress. However, the settlements of the populations that exploited this mine are unknown. Furthermore, the area of Rudnik mountain and adjacent areas are also known for sources of diverse lithic raw materials. This is why the Archaeological Institute in Belgrade initiated systematic field reconnaissance with the main scope to search for sources of raw materials exploited in prehistory and associated settlements. In this poster will be presented the preliminary results of the 2021 field survey campaign. During the 2021 campaign, the areas of the municipalities of Kragujevac and Knić were extensively surveyed. Three modern quarries and their adjacent areas were researched, Ramača, Rogojevac and Vučkovica, and limited traces of prehistoric activities were discovered in the relative vicinity.

Zdeb Katarzyna¹ & Maciej Sierakowski²

¹ Institute of Archaeology, University Cardinal Stefan Wyszyński in Warsaw, Poland

² Institute of Biological Sciences, University Cardinal Stefan Wyszyński in Warsaw, Poland

Food biomarkers in glazed pottery

The authors of the poster will present the results of chemical tests carried out on ceramic vessels from late medieval and early modern sites. The aim of the research was to check the function of the vessels covered with glaze. Did the dishes serve as a kitchen and table, or only decorative? Samples taken from the vessels were tested by gas chromatography combined with mass spectrometry. As a result of the research, data on food biomarkers were obtained. The fatty acids were extracted from the dishes and then analyzed and interpreted to identify the types of food that had been in contact with the dishes. The authors will present the possibilities and limitations of the GC-MS method in the identification of food on the basis of fatty acids extracted from the pores of ceramic vessels.



Veronika Gencheva

National Archaeological Institute with Museum, Bulgarian Academy of Sciences, Sofia, Bulgaria

Geospatial archaeological database of Eastern Rhodopes, Bulgaria

The main goal of this paper is to show how to create and maintain a geospatial database for archaeological projects. The example is from my PhD thesis for the Eastern Rhodopes region in Bulgaria. One of the basic components of modern archaeological research is the storage and retrieval of archaeological data within computer databases. Creating a database that allows access to GIS programs increases their utility to archaeological projects. PostgreSQL is a free, open-source, object-relational database system in which data is stored in a complex, but efficient, set of tables. The relational structure allows efficient data retrieval, spatial visualization and querying. In other words, it allows complex questions to be asked of the data and allows for easier integration with other data sources at multiple levels. The data stored in such databases usually have an inherent hierarchy, with the archaeological site at the top level and the results from analyses performed on these at the lower level. Vector files and raster files can also be stored in such a database.

Milica Tapavički-Ilić¹ & Timka Alihodžić²

¹ Institute of Archaeology, Belgrade, Serbia

² Archaeological Museum Zadar, Croatia

All soul is immortal (Plato)

In almost every Roman grave, there were items that belonged to a standard repertoire of grave-goods, such as coins, oil-lamps and different kinds of pottery vessels. This repertoire was universal, i.e. spread throughout the Roman Empire in both geographical and chronological sense. All of these items were given in order to secure safe trespassing of the deceased, actually their souls, into the Underworld. However, the question was rarely asked how long it took the deceaseds' souls to go through this dangerous journey in order to reach Afterlife.

The main focus of this paper will be an attempt to illustrate the connection of oil-lamps and other vessels deposited in graves of Roman times (basically from the late 1st century until the beginning of the 4th century). By doing this, the authors will try to determine how long a deposited oil-lamp would theoretically burn and how often it had to be refilled from another deposited vessel in order to make it possible for its deceased user to successfully finish the last journey. Another focus of the paper will be an attempt to explain the meaning of specific grave-goods through the prism of philosophical theories of the ancient period regarding passing of the soul and the light from this world to the other.

Pio Domines Peter

Department of Archaeology, University of Zadar, Croatia

More than shells and shrapnels: Approaching the materiality of Second World War in karst landscape - Case study of battlefield site on Kozjak hill (Senj, Croatia)

The archaeological record of the Second World War in Croatia is poorly evaluated in terms of its extent and condition because conflict archaeology is still struggling to find its place among modern researchers and relevant institutions. Due to the negligence of legal authorities and the absence of a systematic approach, the patrimony of the Second World War is often exposed to devastation because its historic significance is mostly neglected or unrecognized. In mountain and rural areas, where human destructive factors are less expressed, sites of conflicts provide a unique opportunity for studying different aspects of the complex interaction of warfare activities on changing landscapes where ephemeral wartime activities occurred. The area of Croatian Littoral is mostly a typical karst landscape with a great number of human drywall interventions still well preserved, particularly on intact and undisturbed locations, as well as many military artefacts from modern conflicts which are even today visible on karst surface of battlefields. Second World War left a permanent mark on the landscape which is presented in various types of military structures which have not yet attracted the attention of archaeologists. Due to its prominent military significance, Senj was an important stronghold guarded by a series of fortifications that had been built around the town. An area of Kozjak hill with strongly evident military remains was chosen for the case study. The methodology was based on a field survey and all the archaeological features and in situ locations with small finds were documented and referenced by GPS devices. Collected data from different sources were integrated into a GIS to form a database that will serve as a basis for future enhancement plans. As a result of fieldwork, it was possible to encompass basic conclusions on the diachronic formation of the conflict landscape of Kozjak hill as well as to properly examine the material traces in order to understand the dynamics of wartime activities.

Sara Iglić, Igor Kulenović & Šime Vrkić

Department of Tourism and Communication Studies, University of Zadar, Croatia

Community, archaeology and modern conflicts – example of Obrovac, Croatia

In the town of Obrovac and in its close vicinity, a field survey of an Italian military complex from the Second World War has been conducted. Throughout the past year, the main goal was to document all the military infrastructure on several fortified positions along the river Zrmanja. The complex was built by Italian forces, later expanded after the German occupation, and consists of four strategic positions. As there is no great public interest in these remains, they have remained undocumented and overlooked by the community. There is a certain reluctance to discuss the shared heritage and a need to erase parts of the history that have marked the community today. As the surveyed military infrastructure presents material evidence of oppression and fascism, the community chose to represent the history and values that are to be remembered and implied the ones that are meant to be forgotten. How to approach the research of wars and their material remains without the support and help of the community? What role does the public have in archaeological research of recent wars, such as the Second World War or the Croatian War of Independence? What are the dynamics between the public and the contested heritage and how can we as archaeologists bridge the gap? How can archaeologists contribute to the post-war reconciliation and to heritage sites? The relationship between modern conflicts, archaeology, and the community will be examined in this local example.



STORIES OF THE PAST —
JOURNEY INTO LOST LANDSCAPES

During the conference the exhibition of the Archaeological Museum in Zagreb *Stories of the Past – Journey Into Lost Landscapes* will be presented in the Library Hall of the Faculty of Humanities and Social Sciences.

The exhibition will be opened from
1st–9th of December 2022.

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STORIES OF THE PAST — JOURNEY INTO LOST LANDSCAPES

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Danube Transnational Programme
Danube's Archaeological
eLandscapes



izložba
exhibition

01-09-12-2022



The exhibition ***Stories of the past – journey into lost landscapes*** allows visitors to experience the heritage as it once was through the use of the latest visualizations of virtual and augmented reality technology, created as part of the Interreg project *Virtual Archaeological Landscapes of the Danube Region*.

Digital visualizations are presented through different media and they offer visitors to explore the landscape of three Iron Age sites through VR glasses (Kaptol in the Požega basin in Croatia, Großklein in Austria and Ulaka in Slovenia). Digital visualizations of the Paleolithic site of the Vindija cave near Varaždin, the Bronze Age site of Viškovci-Gradina near Đakovo, the Iron Age site of Großklein in Austria and the Roman city of Flavia Solva in Austria are presented via touchscreen technology.

The exhibition will be opened in the following period

1st – 2nd of December 2022 during the MetArh conference

5th – 9th of December 2022 from 10 am to 4 pm

Exhibition is organized by the Archaeological Museum in Zagreb.

Authors of the exhibition

Porin Šćukanec Reznicek

Marta Rakvin

Coordination

Jacqueline Balen

Project *Virtual Archaeological Landscapes of the Danube Region* (acronym: *Danube's archaeological eLandscapes*, DTP: 3-641-2.2) is implemented within Interreg Transnational Cooperation Programme VB Danube 2014-2020 and it is co-funded by the European Regional Development Fund (ERDF).

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Thin Section Petrography, Geochemistry and Scanning Electron Microscopy of Archaeological Ceramics

PATRICK SEAN QUINN (AUTHOR)

Using over 400 colour figures of a diverse range of artefact types and archaeological periods from 50 countries worldwide, this book outlines the mineralogical, chemical and microstructural composition of ancient ceramics and provides comprehensive guidelines for their scientific study within archaeology.

Thin section petrography, geochemistry, scanning electron microscopy and X-ray diffraction are key scientific methods used to investigate the raw materials, origins and production technology of archaeological pottery, ceramic building materials, ancient refractories and plaster. Using over 400 colour figures of a diverse range of artefact types and archaeological periods from 50 countries worldwide, this book outlines the mineralogical, chemical and microstructural composition of ancient ceramics and provides comprehensive guidelines for their scientific study within archaeology. The core of the book is dedicated to the versatile approach of ceramic petrography. This is complemented by a detailed account of the principles of bulk instrumental geochemistry, as well as the SEM microanalysis and XRD characterisation of ceramics. The book is intended as a reference manual for research as well as a course text for specialist training on scientific ceramic analysis.

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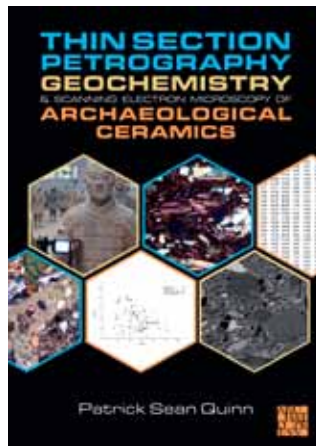
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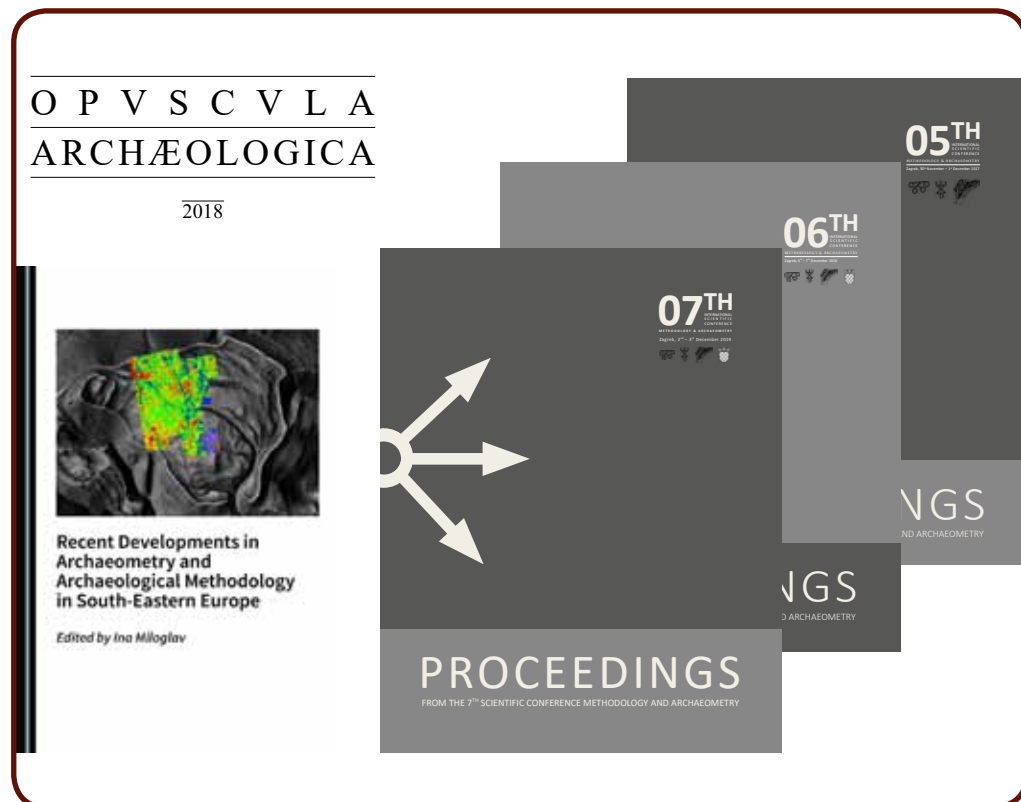
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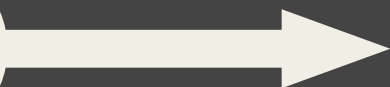
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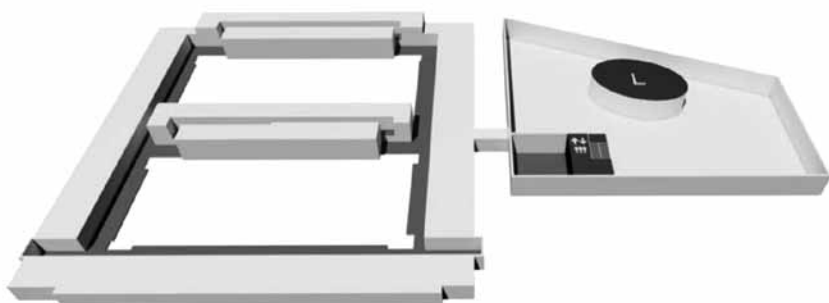


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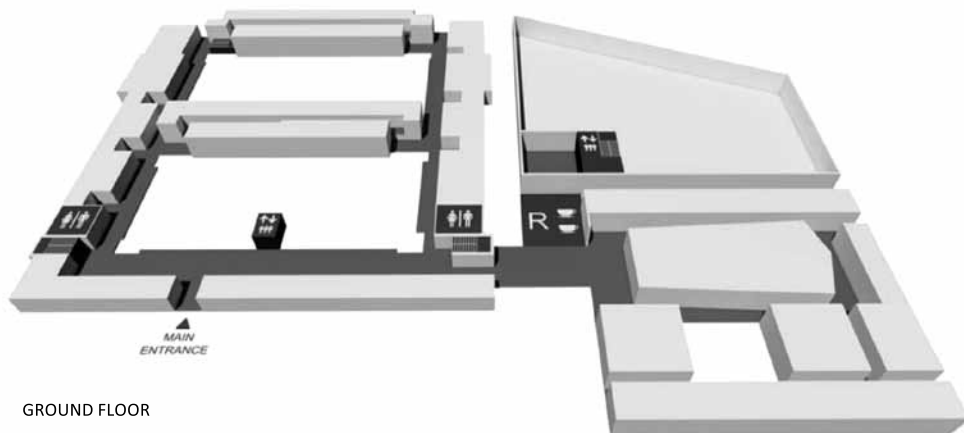


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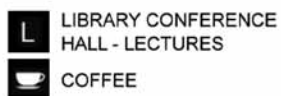
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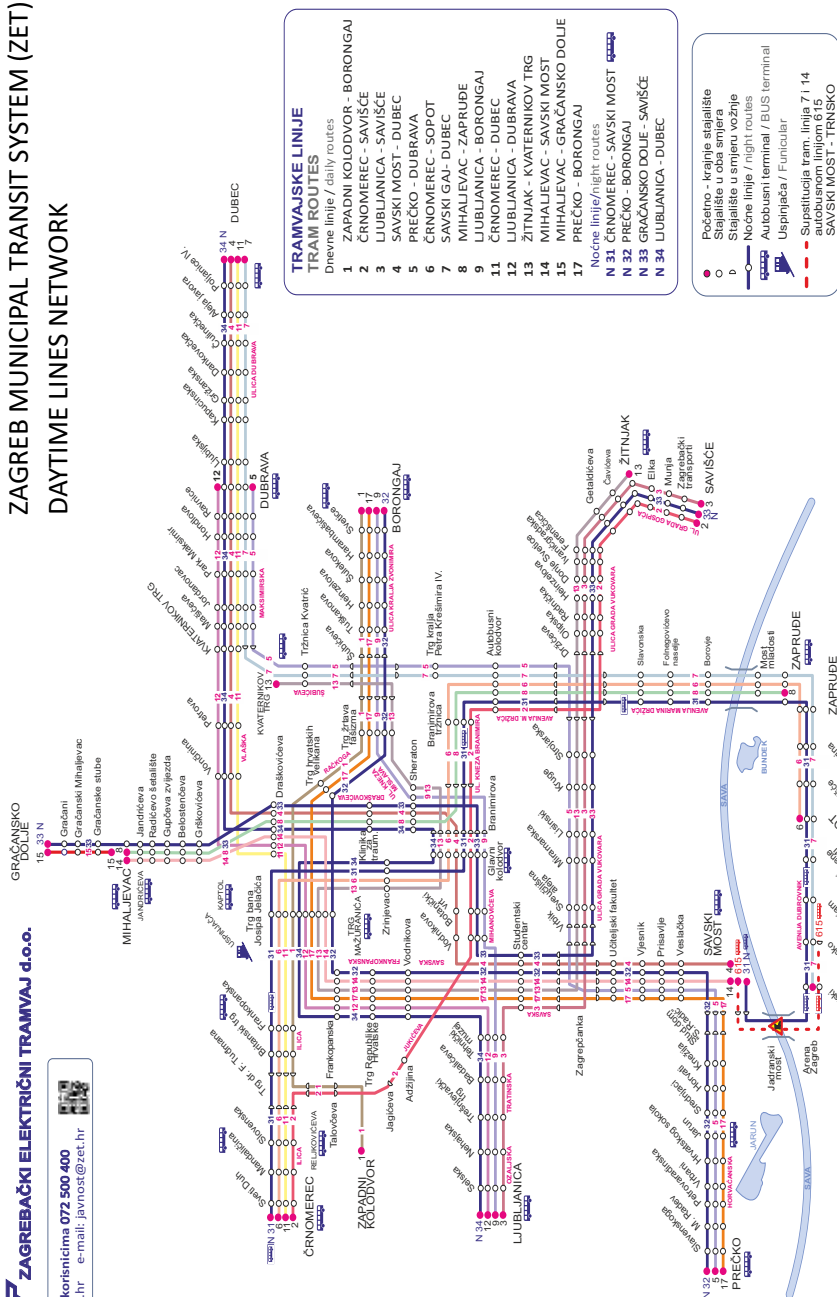
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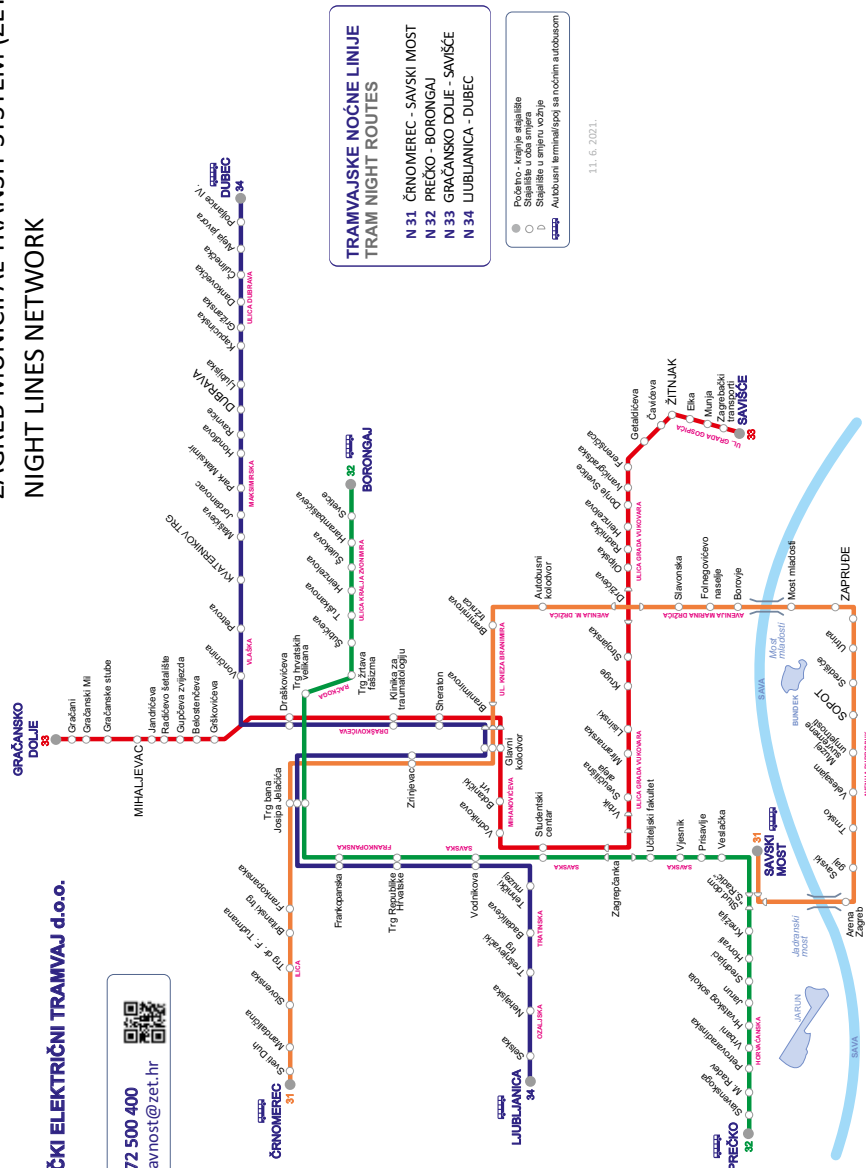


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