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05TH INTERNATIONAL SCIENTIFIC CONFERENCE

METHODOLOGY & ARCHAEOMETRY

Zagreb, 30th November – 1st December 2017

IMPRESSUM

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Jacqueline Balen

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Ina Miloglav

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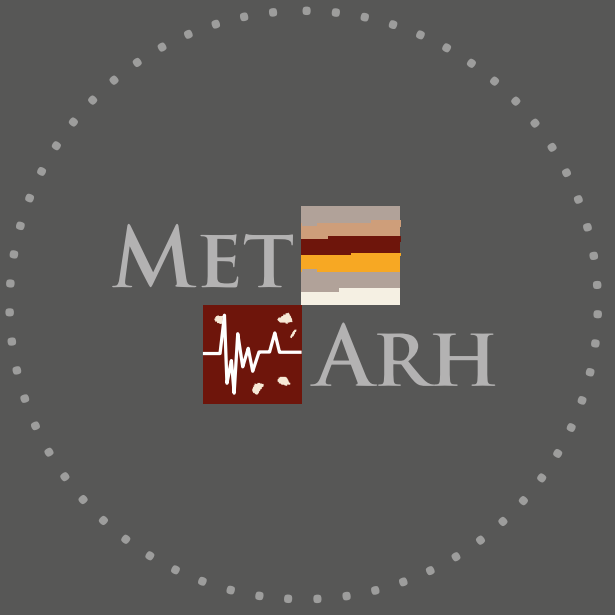
CONTENT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CONFERENCE METHODOLOGY & ARCHAEOMETRY

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.

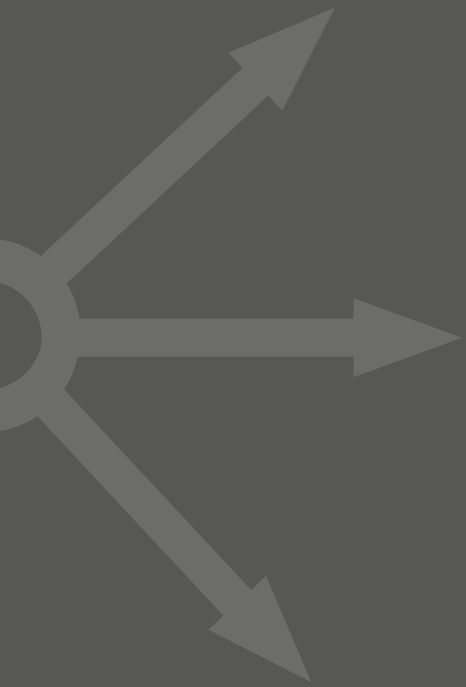
The interdisciplinary character of the conference brings together archaeologists and researchers from other scientific disciplines with whom archaeologists collaborate closely; and who – through their work, projects and ideas – promote new insights about Interpretation of the human life in the past.

Section Methodology

Obtaining and collecting data is the 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 the past processes and to give more objective and comprehensive picture of the past. Contemporary interpretation tools alleviate and speed the data collection and also provide us with countless possibilities of interpretation, protection and presentation of archaeological sites and the landscapes encompassing them.

Section Archaeometry

Having in mind limited information we obtain from archaeological excavations and from the classification of archaeological material, cooperation with other scientific disciplines becomes unnecessary, to obtain as much information as possible on the conditions and the way in which the 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 arhaeometrical 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 a continuous cooperation of a specific expert and an archaeologist from sample collection to the final interpretation.



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PROGRAMME

PROGRAMME

Thursday, 30st November

9:00 – 9:20
Opening

KEY-NOTE LECTURES

Chair: Ina Miloglav

9:20 – 9:50
Predrag Novaković
Methodological challenges in 'hostile' environments of preventive archaeology

9:55 – 10:25
Darja Grosman
Structural and architectural survey – Why talk about it?

10:30 – 11:00
Coffe break (Library Foyer)

Chair: Predrag Novaković

11:00 – 11:20
Vujadin Ivanišević & Aleksandar Stamenković
The GIS Platform of Caričin Grad (Justiniana Prima)

11:25 – 11:45
Silva Sabkova
Identifying a relict cultural landscape. The Lower Danube Limes in Bulgaria

11:50 – 12:10
Lujana Paraman & Dinko Tresić Pavičić
St. Elijah's hill above Trogir - monitoring and documenting of complex site endangered by contemporary stone exploitation

12:15 – 12:35
Luka Gruškovnjak
Surface visibility of archaeological record

12:40 – 13:00
Coffe break (Library Foyer)

Chair: Darja Grosman

13:00 – 13:20
Esmeralda Agolli
The archaeological research in Albanian prehistory: a striking challenge between space explorations and narratives of the past

13:25 – 13:45
Tomislav Hršak & Marko Dizdar
Can we really see what lies beneath the ground without a shovel? Expectation vs reality – experience from the excavation of the Late Bronze and Early Iron Age and Roman cemetery in Batina

13:50 – 14:10
Maja Grgurić
Drone – a new member of the archaeological team (using a drone in photogrammetry)

14:15 – 14:35
Maja Kaleb & Roko Surić
Implementation of methodology and archaeometry in the case of Veruda shipwreck near Pula, Croatia

14:40 – 15:00
Hrvoje Vulić
Statistical indicators for obligatory use of metal detectors on metal age archaeological excavations

15:05 – 16:00
Lunch break

16:00 – 17:00 Poster presentation in the Library Foyer

Dragana Antonović & Momir Vukadinović
Pinga 2 at Mali Šturac: archaeological and geophysical investigation of ancient mining

Vidan Dimić
The (Re)construction and Usage of Mining Hammerstones from Copper Mining site of Prljuša - Mali Šturac: Experimental archaeology

Jesús Gámiz Caro, Laura Vico Triguero & Alberto Dorado Alejos
The technology changes in the pottery productions of the Neolithic from south Iberian Peninsula: The transition from Middle Neolithic to Late Neolithic in Los Castillejos (Montefrio, Granada)

Silvia Amicone, Maja Gori, Emil Podrug, Giulia Recchia, Helena Tomas & Ivan Šuta
Characterising Cetina pottery technology. Petrographic analyses from the Poliakuše and Vučevica tumuli in Central Dalmatia.

Ariadne Kostomitsopoulou Marketou
A colours workshop in the ancient aegean world: an archaeometric approach to the material remains of a late Hellenistic-early Roman pigment production site (Kos, Greece)

Lorenza La Rosa
Interdisciplinarity and Environmental Studies: assessing the impact of pottery production on the environment

Miroslav Vuković
Image based modeling of archaeological artefacts

Katarina Gerometta & Robert Matijašić
Roman centuriation in the Vrsar municipality (Istria, Croatia): preliminary LiDAR data

Antonia Vodanović & Ivan Huljev
''To cast away the evil'' - Ethnoarchaeological Research on Apotropaic Marks in Shepherd's Village Podglogovik at Biokovo Mountain

Afternoon programme:

18:00 – Visit to the Archaeological Museum in Zagreb
• conservation and preparation workshop, Museum depository and permanent exhibitions
• temporary exhibition *Recycle, ideas from the past*

20:00 – Mingling in Kôta caffe bar, Medulićeva 20

Friday, 1st December

Chair: Jacqueline Balen

10:00 – 10:20
Branko Mušič, Tajana Sekelj-Ivančan, Sibila Borojević Šoštarić, Igor Medarić, Barbara Horn, Stanko Ružičić & Tomislav Brenko
TransFER – Iron production along the Drava River in the Roman period and the Middle ages: Creation and transfer of knowledge, technologies and goods. The case studies of Virje and Velike Hlebine

10:25 – 10:45
Nikola Vukosavljević & Zlatko Perhoč
Circulation of lithic raw material at the end of Pleistocene: the view from Kopačina Cave (island of Brač, Dalmatia, Croatia)

10:50 – 11:10
Selena Vitezović
The typology is dead, long live the typology: problems of typological classifications in prehistoric bone industries

11:15 – 11:35
Ana Đuričić
Neolithic ash pits from the site of Pavlovac – Čukar – function and interpretation

11:40 – 12:00
Milica Tapavički-Ilić & Jelena Anđelković Grašar
Experimental archaeology – *pro et contra*

12:05 – 12:35
Coffe break (Library Foyer)

Chair: Nikola Vukosavljević

12:35 – 12:55
Martina Dubolnić Glavan
Velebit Highlands vs. Ravni Kotari Lowlands- different approaches in field survey

13:00 – 13:20
Kelly Kouzeli
The contribution of scientific analysis to the study and preservation of monuments. The case of the ancient theater of Delphi (Greece)

13:25 – 13:45
Andreja Sironić, Damir Borković, Jadranka Barešić, Ines Krajcar Bronić,
Alexander Cherkinsky &Ljiljana Kitanovska
Radiocarbon dating of mortar: Case study of the Aqueduct in Skopje

13:50 – 14:10
Dubravko Gajski & Katarzyna Dzięgielewska-Gajski
Spectral reflectance of archaeological artefacts

14:15 – 14:35
Josipa Marić, Željana Bašić, Ivan Jerković, Ivana Kružić, Frane Mihanović
& Šimun Anđelinović
Forensic Facial Reconstruction of the mummified remains of St. Nicolosa Bursa

14:40
Closing

ABSTRACTS

Predrag Novaković
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Methodological challenges in 'hostile' environments of preventive archaeology

Archaeology underwent a transformation from almost purely academic discipline to a research/expert service with a statutory role in spatial planning and development (more than 90% of all research). With the increase in a number of projects of several orders of magnitude, archaeology was transformed into a data-driven discipline. The change also increased 'openness' of archaeology to a series of influential external factors determining tasks, funding, the extent of projects etc., which frequently act in the opposite way, in diminishing the role and powers of protection. This situation, coupled with moving a series of research services on the market, boosted the development of archaeological research but also created a series of new challenges. Different professional environments and conditions tend to create a divide between the academic (AA) and 'applied' research (PA) which may put the disciplinary unity in risk. The differences between AA and PA are definitely visible, and some of them may have epistemological consequences, but what unites both poles is methodology. However, it is what methods are used and to what 'depth', which is the topic of the discussion. The fact is that specific social, legal and economic conditions of PA research have substantial effects on the ways how research in day-to-day practice is performed.

In this sense, AA and PA differ in reasons for research, while AA is autonomous in selecting research topics, PA is much more limited. PA acts in a much less controlled environment and conditions. AA attempt to solve specific research problems, PA's primary goal is securing the heritage (objects and information). In PA the development of new methods is predominantly oriented towards increasing the efficiency of the working process, while new methods in AA are developed alongside and dialectically with new research problems. And, last but not least, the decisions in PA bear much greater responsibilities in every-day social contexts, whereas the responsibilities of AA lie primarily within the disciplinary and academic contexts. All these issues must be considered when reflecting the methodology in archaeological practice today.

Darja Grosman
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Structural and architectural survey: why talk about it?

Searching for archaeological remains on the surface is one of the oldest field methods of data gathering in our discipline. It is traditionally referred to as archaeological topography and is predominantly site oriented using structural and architectural parts to define the functions related to site classification.

In the last five decades the focus in archaeological work has shifted towards a capture off landscape as a single complex entity. An array of different prospecting techniques, both remote sensed and terrestrial supported by new detection and recording technologies, have multiplied the stratified and non-stratified archaeological record beyond the proverbial "delimited site". Two of this methods: a) a structural survey and b) an architectural analysis of standing buildings are still not used as extensively as i.e. systematic field walking resulting in surface finds scatters. Apart from being precisely located, the larger or more complex structures within a surveyed area are simply described.

The paper is an attempt to look at this particular segment of the archaeological record. We will try present the elements of detailed study of standing structures in different stages of preservation (from standing monuments, to ruins or subtle relief forms) that can be observed on the surface and in shallow waters. The chosen case studies reflect the perspectives and limitations of reading single structures and/or their spatial context during the non-invasive work on the surface and in post-field work analysis. The adopted principles of single unit correlation is the basis to decipher and explain the sequence of building, remodelling, destructing or deserting activities. Another important weakness in archaeological studies of architecture can be emphasised in this connection: our reluctance to engage in more detail in features called ruins. They hide an immense quantity of diagnostic material essential to understand the typology and technology of single constructions. A technique similar to stratigraphic principles is the basis to also study the spatial relations within built in areas and give better insight in the use of space.

The results of this type of work can be used as separate studies but compared and integrated with other prospecting data they can give a more enhanced view on the building history in specific conditions related to characteristics of particular area, or period.

Vujadin Ivanišević[1] & Aleksandar Stamenković[2]
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The GIS Platform of Caričin Grad (Justiniana Prima)

Thanks to recent technological developments, the methodology of archaeological excavations has undergone significant advances, enabling an uniform system of documentation based on geographic information system (GIS). During the last three years a database for the archaeological site of Caričin Grad (Justiniana Prima) was developed, based on free GIS-software solution packages, providing the possibility to create a virtual space and to reduce it in a two-dimensional or three-dimensional data models.

The GIS platform of Caričin Grad includes a broad range of geodata, such as SRTM, LiDAR scans, geophysics and photogrammetric records, as well as those related to the characteristics of the physical environment as maps (topographical, geological, pedological and geomorphological), aerial photographs and orthophotos. The database comprises numerous plans from old excavations in addition to new ones. Parallel with the development of the GIS for Caričin Grad a platform for the whole region of the Leskovac basin was created that includes data concerning the prehistoric, roman and medieval remains.

The applied methodological approach based on a GIS proved to be a valuable step and crucial point in archaeological research, enabling an improved understanding of the site and the environment. The GIS facilitates the analyses, interpretation, visualization and the publishing of geospatial information. The database also gives us instructive starting points and possible approaches for future researches, considering surveying, prospection and excavations themselves.

Silva Sabkova
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Identifying a relict cultural landscape. The Lower Danube Limes in Bulgaria

The paper refers to the problems of identifying the elements and relationships that form a relict cultural landscape which evolves around a system of interrelated archaeological sites. Such an example is the Lower Danube Limes in Bulgaria. It is an important part of the Frontiers of the Roman Empire both in the historical sense and as a potential extension of the multinational serial World Heritage Site of the same name.

The Danube Limes is a system that consists of three main material elements: defensive structures, infrastructure and landscape. What binds together these elements and turn them into an integral cultural landscape are the relationship between them: functional, situational, visual, infrastructural and chronological. Principal challenge when studying such kind of cultural landscapes is their identification within the contemporary landscape as many of the related material elements are invisible or destroyed, the original character of the surroundings is altered and, as a result, many of the original relationships are hard to detect.

To face this challenge, a methodology for analysis of the territory was developed, designed to guide the process of identification of the cultural landscape Lower Danube Limes in Bulgaria in view of its protection as cultural heritage site. Each fortified location is evaluated according to a set of criteria regarding the present state of the site itself and its surrounding landscape in comparison with their hypothetical past state, in view of their authenticity and integrity. The methodology facilitates the detection of: preserved valuable elements belonging to both archaeological sites and landscape; relationships that the site has with other locations, or with the landscape; risk factors affecting the property.

The result of the analysis may serve as a basis for the designation of protected areas and buffer zones and design of other measures for the protection of the cultural landscape.

Lujana Paraman[1] & Dinko Tresić Pavičić[2]
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St. Elijah's hill above Trogir - monitoring and documenting of complex site endangered by contemporary stone exploitation

Apart from a few excavation reports published after some of the urban excavations of Trogir, archaeological data about the Trogir area and its hinterland are still very scarce.

St. Elijah's hill in Seget Gornji above Trogir (ancient Tragourion/Tragurium) is one of the most important sites for understanding the Late Prehistory and Protohistory of Trogir area as well as the history of quarrying in Dalmatia. The complex site with the continuity of anthropogenic activities, possibly from the Upper Paleolithic/Mesolithic to Modern Period is characterised by two distinctive features: located on the top of the hill are the remains of the Iron Age hillfort and the medieval Church of St. Elijah, while the south and east slopes of the hill are occupied by the remains of quarries dated from the Roman to Contemporary Period. The stone mining continues to this day, with three active quarries on the east and northeast slope of the hill. The shift from architectural-building to technical-building stone exploitation over the last 20 years resulted in the vast devastation of the landscape, as well as the destruction of the archaeological features.

The project of monitoring and documenting the site started in 2013. with field survey and recording of anthropogenic features and surface finds, and continued in 2015. with geodetic survey and high resolution 3D photogrammetry of the entire hill. The objective of the survey was to document the present state of the site and to create a base documentation for tracing the changes in anthropogenic activities and monitoring of the site, by comparison with available spatial data (aerial photographs, cadastral maps), as well as the base for spatial and archaeological structures analysis in order to plan further research and excavations of the site.

Luka Gruškovnjak
Department of Archaeology, Faculty of Arts, University in Ljubljana, Slovenia

Surface visibility of archaeological record

The capabilities and limitations of archaeological surface survey are often not well understood, especially its capabilities as a discovery method. This problem comes to the forefront especially when surface survey is used as a tool for evaluating the presence of archaeological resources before large-scale development projects. The standard procedures of surface survey do not enable critical evaluation of precision, reliability and accuracy of survey results or simply addressing a key question of »How much did we miss? «. In survey design and evaluation of survey results it is crucial to take into account the visibility of archaeological record on the surface, which must be considered on multiple levels: (1) visibility determined by geomorphological and other post-depositional processes, (2) visibility determined by the nature of archaeological record, (3) visibility

determined by techniques and strategies of the survey method, (4) visibility determined by surface and other environmental conditions during survey, and (5) visibility determined by fieldworkers themselves. Without considering all of these the survey results cannot be critically evaluated. But such an evaluation is not possible using only standard survey procedures which is why geomorphological mapping, seeding experiments and property-based investigation methods should be incorporated into survey design. It must be realised that surface survey is not a discovery method which would show the presence or absence of archaeological record in the landscape, but primarily its exposure to a variety of cultural and natural processes which disturb it, for only in a disturbed and exposed state is the archaeological record visible on the surface. It is also necessary to distinguish between the totality of archaeological record, i.e. empirical reality of archaeological remains, and archaeological record realised through archaeological observations, i.e. the results of archaeological field work, which are influenced by many different factors, archaeological record itself being only one of them.

Esmeralda Agolli
Department of Archaeology and Culture Heritage, Faculty of History and Philology, University of Tirana

The archaeological research in Albanian prehistory: a striking challenge between space explorations and narratives of the past

Research in Albanian prehistory experiences interesting dynamics intermingled through intensive systematic archaeological excavations and narratives over the past. The significant attention towards the systematic excavations comprises the most notable development in the field. On the other hand, publications, comprehensive analysis and interpretations do not justify the eagerness of this immensity of explorations.

This paper analysis the relationship between the explored space on late prehistoric sites in Albania and the nature of discussions and interpretations addressed through these explorations. Particular attention is given to analysis of sample strategy and non-destructive methods applied during the process of the data collection and to what extent this methodology of research conditions the current research and the applications of recent scientific methodologies. What does this experience teaches us about future research and to what extent non-destructive methods and sampling strategy are to be taken more carefully into consideration?

Tomislav Hršak[1] & Marko Dizdar[2]
[1]Museum of Slavonija, Osijek, Croatia; [2]Institute of Archaeology, Zagreb, Croatia

Can we really see what lies beneath the ground without a shovel? Expectation vs reality – experience from the excavation of the Late Bronze and Early Iron Age and Roman cemetery in Batina

As part of the Archaeological Heritage of Baranja project, a trial excavation started in Batina in 2010. A prehistoric and Roman period site in Batina was situated at the elevated position on the extreme north-eastern part of Bansko brdo, rising above the Danube, with outstanding visual communication westward toward Transdanubia up to Pécs, eastward up to the Bačka and southward to the Eastern Slavonia. In a period from 2010 to 2017, 121 graves from Late Bronze and Early Iron Age were found, as well as from the Roman period. Two burial mounds have been excavated with wooden burial chambers which contain finds from the late 8th–early 7th century BC. In 2016, the Berlin-based company Eastern Atlas realised a magnetic prospection in the archaeological site of Batina. The objective of the investigation was to identify prehistoric and Roman settlement remains as well as further burials of the already known prehistoric and Roman cemetery at the Batina- Sredno site.

In this paper we will compare the results of the magnetic prospection with the results of archaeological excavation conducted in the autumn of 2017 and try to answer the question of whether it is possible to interpret the results of magnetic prospection without archaeological excavation.

Maja Grgurić
Department of Archaeology, University of Zadar, Croatia

Drone – a new member of the archaeological team (using a drone in photogrammetry)

Unmanned aerial vehicles, commonly known as drones, are becoming more and more popular as a useful instrument for gathering data on archaeological sites. Through the use of photogrammetry, using a drone on a daily basis during the excavation process has turned out as a good practice for speeding up the process of data collecting. Instead of the time consuming total station surveying or taking a great number of photographs from the ground, we now have the opportunity for rapid gathering of spatial data using low-altitude shots while the total station is only used for georeferencing the 3D model.

Maja Kaleb & Roko Surić
International Centre for Underwater Archaeology in Zadar, Croatia

Implementation of methodology and archaeometry in the case of Veruda shipwreck near Pula, Croatia

In 2013 archaeologist from the International Centre for Underwater Archaeology in Zadar (ICUA) found a 16th century shipwreck in the waters of Veruda island near Pula. At a depth of only 6 meters, a cluster of ballast stones appeared with small metal finds and parts of the wooden ship construction beneath them. In 2016 first archaeological excavation was conducted by ICUA in cooperation with Deutsches Archäologisches Institut (DAI-RGK), University in Dresden (HTW) and company UWA-Logistik.

During that occasion, new system of digital documentation of finds and wooden construction was developed and used. While complete wooden construction was uncovered, a very precise 3D model and drawing was produced using the aluminum structure, so-called "bridge". In 2017 a second and the final excavation was conducted. All collected finds have been preliminary processed, but for some special finds, an XRF analysis and the X-RAY was made. Additional treatment was applied on concretions- iron nails which make 40.9 % of all finds. Interesting results in interpretation of Veruda shipwreck have been achieved using diverse methodology and archaeometry.

Hrvoje Vulić
Vinkovci Municipal Museum, Croatia

Statistical indicators for obligatory use of metal detectors on metal age archaeological excavations

Since 2011, Archaeological department of Vinkovci Municipal Museum has been using metal detector as a standard piece of equipment on both rescue and systematical excavations. Usage of the metal detector resulted in a significant increase of metal finds compared to ''classical methodology'', particularly coins. With the methodology we have established and that will be explained it is possible to connect objects found on soil heaps to the corresponding stratigraphic unit.

The presentation will analyse and compare data about metal finds found with metal detector and with ''classical'' archaeological methods, as well as advantages and disadvantages of using metal detectors in archaeological excavations. Analysis of the finds lists from various excavations led by different institutions has also revealed large differences in the way the forms are filled and what is considered ''special find'' (PN).

Branko Mušič[1], Tajana Sekelj-Ivančan[2], Sibila Borojević Šoštarić[3], Igor Medarić[1], Barbara Horn[1], Stanko Ružičić[3] & Tomislav Brenko[3]

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TransFER – Iron production along the Drava River in the Roman period and the Middle Ages: Creation and transfer of knowledge, technologies and goods. The case studies of Virje and Velike Hlebine.

Archaeological sites Virje and Velike Hlebine are situated in the Croatian lowland, on the bank of the upper course of Drava River. On slightly sloped areas, parts of a primary iron processing smelting workshops were discovered and explored. Since these types of sites are quite rare in northern parts of Croatia, and in order to get a better understanding of the development and organization of the settlement, noninvasive methods were applied.

With the help of magnetic method, measurements of apparent magnetic susceptibility and shallow drilling, waste disposals of a workshop, few pit furnaces from the Late Roman period (4th and 5th century), as well as settlement remains from Late Iron Age (3./2, and 1st century BC) were discovered. Additionally, magnetic results and results on 2D electrical resistivity tomography were carefully analyzed at several locations for comparison with results on soil samples analyses for determining origin of iron ore deposits and with the excavated archaeological structures in order to get more reliable interpretations and to check possibilities and limitations of magnetic and resistivity methods on these sites in the specific environmental settings.

Nikola Vukosavljević[1] & Zlatko Perhoč[2]

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Circulation of lithic raw material at the end of Pleistocene: the view from Kopačina Cave (island of Brač, Dalmatia, Croatia)

Lithic raw material provenance studies present valuable source of information about prehistoric hunter-gatherers' territorial patterns, mobility, exchange and social networks. Here we present results about origin and circulation of lithic raw material used during Late Epigravettian in Kopačina Cave. Its lithic raw material economy is characterized by the exploitation of different cherts and radiolarites. Based on micro- and macroscopic analyses we propose probable sources for lithic production in Kopačina Cave. Cherts are both locally and regionally available, while radiolarites originate from more distant areas. Use of local sources is predominant in all phases. Use of regional sources shows a gradual trend of increase in frequency from the earliest to the latest phase, while use of extra-regional sources has an obvious drop in frequency from the eldest to the youngest phase.

Temporal trends in lithic raw material use suggest certain continuity during the whole Epigravettian sequence. However, one can also observe changes in terms of larger exploitation areas and/or more intensive long-distance contacts in earlier Epigravettian phases in Kopačina than in the later ones. Origin and use of radiolarites in Kopačina's Late Upper Paleolithic layers suggest movements of hunter-gatherers deeper in east Adriatic continental hinterland where up to now only a few traces of human settlements from Late Glacial have been found. Possible contacts with the west Adriatic coast are indicated by lithic raw material of several artifacts from the site.

Selena Vitezović
Institute of Archaeology, Belgrade, Serbia

The typology is dead, long live the typology: problems of typological classifications in prehistoric bone industries

Typological classification is a very important tool for every archaeological research. It was used for analyses of chronology, contacts, innovations, and much more. Numerous studies were written on the typology only, and the entire approach was heavily criticized, especially in the second half of the 20th century with novel theoretical approaches. Particularly long debate on the usefulness of typology took place in the studies of chipped stone industries, although for other types of artefacts the approaches changed considerably. Increasing number of technological studies also initiated attempts of creating purely functional classifications. However, is typology completely out-of-date or do we still need it as an analytical tool?

In this paper we will analyse classifications currently used in analyses of prehistoric bone industries, their possibilities and restrictions. The osseous industries are particularly difficult for classifications since they are usually less standardized than, for example, lithic or metal artefacts, therefore, certain flexibility is needed if we want to compare different assemblages in different regions, cultures and periods. The easiest, but not very useful approach is the classification based on the raw materials. Also other typologies were offered, with more or less strictly defined types. French archaeological school offered a typological classification that combines different criteria, form, function and raw material. Such typology also possesses certain flexibility and its application on diverse prehistoric osseous industries from South-East Europe will be discussed.

Ana Đuričić
Laboratory for Bioarchaeology, Department of Archaeology, Faculty of Philosophy, University of Belgrade, Serbia

Neolithic ash pits from the site of Pavlovac – Čukar – function and interpretation

During the rescue archaeological excavations at the site of Pavlovac – Čukar, a total of 5 large pits filled up with ash and charcoal were found. The pits contained different amounts of loose red, orange, grey and white ash, compact white ash and charcoal. In some parts of the pits, thin layers of different colours and textures could be defined, but in other parts different types of ash were overlapping. It should be mentioned, that in those pits, but also throughout the excavated part of the site, both Starčevo and Vinča culture material was found, together with hybrid forms which had the characteristics of both cultures. Precisely, the mixing of the material and styles, and scarce and extremely poorly preserved architectural features from the Vinča period, make it difficult to define clear chronological relations at the site of Pavlovac – Čukar.

In order to fully understand the situation found at the site, an effort should be made to define the chronological framework and the function of the pits. The first step in understanding the function of these pits is defining which type of activity produces this amount and this type of ash. In order to achieve that, ethnological data and micromorphological studies, will be used. The aim of this presentation is to offer a methodological approach suitable for this type of feature and show the preliminary interpretation of the conducted activities, function of the pits, and the settlement layout during the Early and Late Neolithic at the site of Pavlovac – Čukar.

Milica Tapavički-Ilić & Jelena Anđelković Grašar
Institute of Archaeology, Belgrade, Serbia

Experimental archaeology - *pro et contra*

In recent times, there has been a huge development of what is called „experimental archaeology“, especially in the always growing number of archaeological open-air museums. They seem to offer good conditions regarding enough space and material, but also skilled craftsmen, to perform various experiments. Wooden houses and other facilities are being built, stone, metal, wood or leather are processed, textiles are woven, various objects made etc.

Still, the idea of an archaeological experiment is strange to many scholars. One of the most common opinions is that performing such experiments has no real impact on classical archaeological knowledge and that it does not contribute to science.

In this paper, an attempt shall be made to name „pros“ and „contras“ for performing archaeological experiments by taking into account as many aspects as possible. In addition, an experiment conducted in early 2013 in Viminacium shall be presented, in order to illustrate criteria, preparation, performance and outcome evaluation of experiments in archaeology.

Martina Dubolnić Glavan
Croatian Academy of Sciences and Arts, The Institute for Historical Sciences in Zadar, Croatia

Velebit Highlands vs. Ravni Kotari Lowlands - different approaches in field survey

The paper discusses results of two field surveys conducted in the coastal area of the North-Dalmatian mainland during a period of about 10 years. This study analyses particularly contrastive geomorphological areas in Zadar region: Velebit Mountain (Starigrad-Paklenica and Jasenice Municipalities) and Ravni Kotari (Town Nin and Vir, Privlaka and Vrsi Municipalities). Karst slopes of the South Velebit with rich pastures, small portions of arable land and rare water sources shaped the settlement of the area and directed economic activities towards livestock farming. The surveyed part of Ravni Kotari on the other hand covers coastal plains with flysch zones suitable for agriculture.

Conducted analysis of the numerous documented sites, suggest diverse spatial and chronological patterns of landscape use through various periods in the past. This paper considers different approaches in organization, dynamics and methodology of the field survey but also in the interpretation of the collected data.

Kelly Kouzeli
Stone Conservation Center, Greek Ministry of Culture and Sports, Athens, Greece

The contribution of scientific analysis to the study and preservation of monuments. The case of the ancient theater of Delphi (Greece)

The present work aims to highlight with evidence the importance of the scientific analysis of the building materials and deterioration products of a stone monument to its study and preservation. More specifically, in such cases, the results of an archaeometric study contribute to:

- the archeological research (identification and provenance of the building materials – exploration of possible ancient quarries);

- restoration (proposals for new stone similar in nature, texture and properties to the original);

- conservation (the knowledge of the nature and properties of the building material is one of the prerequisites for the selection of suitable conservation materials such as mortars and grouts, and the investigation of deterioration products contributes to the decision on their removal, elimination or maintenance).

The ancient theater of Delphi (Phokis, Greece) was built in the 4th c. B.C.E., further up the hill at a higher point from the Temple of Apollo. The building material of the theater consists of very fine (micritic), dense, calcareous mass in which numerous microfossils filled with sparitic calcite are discerned. Many veins of coarser calcite (maximum grain size 200 μm) intersect the micritic matrix. The presence of thin discontinuities filled with aluminosilicates is remarkable, while few macropores (vug, channel, fracture types) are also observed. It is a whitish compact limestone, although macroscopically it appears gray (to dark gray when wet) due to biological activity.

The samples of the ancient quarry of Profitis Elias in the surrounding area present strong similarities to the stone of the monument, implying local provenance of the building material of the theater.

Taking into account the nature and properties of the stone and the results of all the necessary laboratory tests, mortars and grouts have been proposed. The thick (up to 3 cm), hard, porous crust which covered part of upper rows of seats consists mainly of calcite, while quartz is present in minor quantities and illite in traces. It is a type of encrustation due to the selective path of water in that area of the monument. Its controlled removal has been considered necessary since it significantly affected the dimensions (due to its thickness) and appearance of the architectural elements in that area of the monument.

Andreja Sironić[1], Damir Borković[1], Jadranka Barešić[1], Ines Krajcar Bronić[1], Alexander Cherkinsky[2] & Ljiljana Kitanovska[3]

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Radiocarbon dating of mortar: Case study of the Aqueduct in Skopje

Radiocarbon (^{14}C) can be successfully applied to organic materials such as wood, charcoal, paper, parchment, bones etc. Mortar is a difficult material for ^{14}C dating because of potential contamination with dead carbon from unreacted limestone left during preparation of quick lime and mortar. Attempts for radiocarbon dating of mortar have been performed since the early days of the method development without significant success. The accelerator mass spectrometry (AMS) measurement technique has recently enabled development of various sample preparation techniques taking into account various phases of mortar.

The Aqueduct in Skopje (FYR Macedonia) is one of the landmarks of Skopje, a monumental building more than 380 m long. It was a part of a water-supply system with a total length of about 10 km. The age of the Aqueduct is not known –several hypotheses place it to periods between 6th and 16th century. Six mortar samples from different positions of the eastern façade were collected in July 2017.

In order to prevent the dead carbon contamination during ^{14}C analyses of carbonates in mortars, only the carbonate fraction associated with the carbonation of slaked lime, i.e., calcite that is formed only during mortar hardening had to be extracted. First, the mortar samples were broken by alternately changing temperatures from -198 °C to 80 °C. Three strategies for separation of slaked lime were used: 1) mechanical separation of calcite inclusions formed during mortar hardening (not possible for all mortar samples), 2) selection on the basis of particle size and suspension in water induced by ultrasonic shock, and 3) collection of at least two fractions of CO_2 produced by reaction of calcite with acid. The results of the analyses will be presented and possibility of using the method for future mortar dating will be discussed.

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Spectral reflectance of archaeological artefacts

Spectral reflectance of the surface of an archaeological artefact is its essential feature. Human vision uses the spectral characteristics of visible light reflected from the surface to detect and analyse all objects in our surroundings and is the natural way to explore them. However, the reflected light does not depend just on spectral characteristics of the surface, but it is heavily dependent on the spectral characteristics of the incident light, too. The incident light varies a lot, depending on the light source and the media the light passes through at the moment of taking the photography of the artefact, and does not have any historical value.

Therefore, the impact of lighting has to be extracted from the reflected electromagnetic radiation, and just the spectral reflectance of the surface shall be left for further processing and analyses. Especially in case of digitalisation and modelling of the artefacts for presenting them in the virtual surroundings (virtual museum), the spectral reflectance of its surfaces becomes crucial. Namely, these models are usually illuminated by virtual lights, animated and rendered, and the impact of real illumination, recorded at the time of taking the photographs, can just bother impression of the virtual reality. This paper describes the technology of obtaining the spectral reflectance of the archaeological artefacts by recording and processing the spectral information of the incident and reflected visible light and discusses the need for recording of it in the archaeological documentation.

Josipa Marić[1], Željana Bašić[1], Ivan Jerković[1], Ivana Kružić[1], Frane Mihanović[2] & Šimun Anđelinović[3]
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Forensic Facial Reconstruction of the mummified remains of St. Nicolosa Bursa

This study shows the forensic facial reconstruction of the mummy of St. Nicolosa Bursa whose body is kept in the parish church in Vodnjan. This Saint was imaged by Multi-Slice Computed Tomography (MSCT), on Somatom 16 device (Siemens, Erlangen, Germany), with 16 rows of detectors and the spatial resolution of 30 lp/mm. Parameters for scanning used in the study were 120 kVp, 162 mA, protocol – Body Angio Routine, Convolutional Kernel B30f. For the acquisition, the slice thickness was 16×0.75 mm, and 3 mm for image reconstruction. The 3D model of the skull was created by 3D Surface Rendering technique using software DICOM viewer, Osirix v.3.9.4 (Pixmeo, Geneva, Switzerland). The model was exported, post-processed in software Blender v2.79, and printed on the 3D printer FORCEBOOK UltraPrint 3D with a slice thickness of 0.15 mm.

The facial reconstruction was performed using the Manchester method, developed at the University of Manchester in the UK. The face of St. Nicolosa was reconstructed firstly by positioning the tissue depth markers on the 3D printed model. In the next step, the individual muscles were attached to the skull, and skin layer was applied. In the final stage, the face of the Saint was completely defined using artistic approach. The researcher that conducted facial reconstruction did not know the identity of the person being reconstructed. Thus the success of facial reconstruction could be compared both with the pictorial sources and face of the mummified body.

In this study, we showed that facial reconstruction could be accurate when performed by a trained person with knowledge of anatomy, forensics, anthropology, and arts. This method can be used in presentations of cultural heritage, reconstruction of historical figures as well as in scientific research.

P O S T E R S

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Pinga 2 at Mali Šturac: archaeological and geophysical investigation of ancient mining

Pinga 2 is located on the north-eastern border of the zone of copper mineralization and prehistoric mining works as well at the Prljuša site at Mali Šturc, the lowest peak of Rudnik mountain in central Serbia. In its immediate neighborhood, there is a mine shaft which has been excavated since 2014 and dated, according to pottery finds in the Early Eneolithic Bubanj-Hum I culture. The exploration of Pinga 2 was undertaken to determine whether it is the trace of prehistoric or later mining from the Roman or Medieval Age.

Pinga 2 is a funnel-shaped surface depression, 18 meters long and 14 meters wide. The research was started with a small trench (3x2m) in the central part of the pinga. Only one layer of humus mixed with large stones was detected in the trench. The excavation was suspended at a depth of 1.8 m and followed by geophysical measuring. Geoelectric scanning in the central part of Pinga 2 revealed a thick layer, almost 10m deep, composed of large stone material. This layer leans on a border rock almost vertically descending to the bottom. Another archaeological excavation was undertaken on the eastern border of the Pinga 2. The excavation revealed the steep rock representing the edge of the pinga. Along the top of this rock a narrow eleven meters long track carved in the rock was discovered, connecting two entrances into mining shafts. The waste stone material from these shafts was thrown into the central part of the pinga infilling it and probably covering earlier mining works.

During excavations archaeological material was not found , but the appearance of mining works and the absence of malachite in surrounding rock indicate that the works certainly do not originate from the time of the Early Eneolithic as the neighbouring mine at Mala Šturca.

Vidan Dimić
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The (Re)construction and Usage of Mining Hammerstones from Copper Mining site of Prljuša - Mali Šturac: Experimental archaeology

The Rudnik mountain in central Serbia is famous for its ore richness, in particular of malachite (carbonate copper ore), whose deposits were recognized and exploited from prehistory up to modern times. Archaeological remains show clear traces of mining activities during the Roman and especially medieval period, when there was an important mining centre on the mountain. Recent excavations at the site of Prljuša – Mali Šturac uncovered rich material remains showing exploitation of malachite during the Eneolithic period. Over 15 objects were discovered (mining shafts) which constitute the structure of this site. Beside other archaeological finds, the quantity of mining hammerstones is very impressive. It is estimated that over 2000 tools are scattered on the site, clearly demonstrating the intensity of mining activities on this location during the Eneolithic times and conspicuous mining potential the mountain possesses.

During the archaeological research, 688 hammerstones were discovered and analysed (478 of them are from recent excavation campaigns). Based on their analysis, hypotheses were made regarding their manufacture and use. In summer 2017, experimental (re)construction was undertaken on three basic types of these tools, as a complementary segment to functional and typological analyses. The goal of the experimental research was to gather as much data as possible which would serve as a comparative filter for testing previously raised hypotheses and research questions related to the manufacture and usage modes of this category of mining tools. Obtained results enabled a more complete understanding of the prehistoric mining technology on this site, as well as reconstruction of the chaine opératoire from the raw material procurement and production, to the use, damage and discard of hammerstones.

Jesús Gámiz Caro, Laura Vico Triguero & Alberto Dorado Alejos
Campus de la Cartuja, University of Granada, España

Peninsula: The transition from Middle Neolithic to Late Neolithic in Los Castillejos (Montefrio, Granada)

In this research paper we will present the results of the archeometrical analysis of pottery dated to Middle and Late Neolithic period from the archaeological site of Los Castillejos (Montefrio, Granada).

Through stereomicroscopy and XRD we have been able to sort the pottery in to separate chrono-cultural periods, which are divided by a hiatus of around 600 years. On the one hand, this hiatus shows the end of Middle Neolithic and on another hand the beginning of the Late Neolithic, the deep technological and typological changes in pottery production are also evident. We interpret these cultural changes as a consequence of demographic transfer from others areas of Andalucia. This evidence is show with the appearance of the "cazuelas carenadas", with the increase of the pottery volume and the changes in ceramics decoration. In addition of these changes, there is an increase in agricultural activities and changes in the preference of the domestic animals. This event will be the basis of the development of a Copper Age society from the southeast of the Iberian Peninsula, which will eventually result in a stratified society managed by the elites.

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Characterising Cetina pottery technology. Petrographic analyses from the Poliakuše and Vučevica tumuli in Central Dalmatia

The proposed poster presents the preliminary results of archaeometric analyses carried out in the framework of the Cultural Encounters across the Adriatic and Ionian seas. 2500-2000 BC and the CeVaS-Cetina Valley Survey projects. These represent the first petrographic analyses undertaken on Early Bronze Age Cetina–type pottery from Dalmatia.

Analysed shards come from two clusters of tumuli: Poliakuše, Šibenik, and Vučevica, Split (Šuta 2013). 8 samples from Poliakuše (6 from Tumulus 1, 2 from Tumulus 2) and 8 samples from Vučevica (1 from Tumulus 1 and 7 from Tumulus 4) have been analysed at the Competence Center Archaeometry- Baden-Württemberg (CCA-BW), University of Tübingen. These preliminary results show that the two analysed sample sets have common technological traits but also differences, possibly linked to the variability in the available raw materials sources and specific technological choices.

Ariadne Kostomitsopoulou Marketou
Department of Archaeology, Conservation and History, University of Oslo, Norway

A colours workshop in the ancient aegean world: an archaeometric approach to the material remains of a late Hellenistic-early Roman pigment production site (Kos, Greece)

The systematic excavations of the Greek Archaeological Service at the south sector of the ancient Agora of Kos (Greece) brought to light the material remains of late Hellenistic–early Roman pigment production site. The revealed archaeological context includes a plethora of pigments, raw materials and tools, as well as the ruins of fire structures. The finds indicate the production of Egyptian blue as one of the workshop's core activities, while earth pigment lumps—in different stages of production—were also found, illustrating a treatment process carried out on the site. The understanding of the workshop's complexity requires a thorough and interdisciplinary perspective, including the examination of archaeological data, scrutinizing ancient treatises related to pigments, and understanding the broader archaeological and historical context of the flourishing late Hellenistic and early Roman Kos.

The archaeometric examination of the material culture of the site aims to shed light on the ancient manufacturing technology of pigment production—with a special focus on the artificially produced Egyptian blue—the provenance of the raw materials and the applications of the final products. Non-destructive analytical techniques (including XRF, FTIR, Raman, and XRD) will be performed on both the raw materials and the pigments revealed on the site. Additionally, in situ analysis on pigments preserved on coeval Koan wall paintings will give a rather comprehensive picture of the workshop's applications and activities in time and space. The proposed poster presentation aims to schematically lay out the methodology carried out for this project, the occurring challenges and dilemmas—depending on the research questions—and to illustrate some preliminary results on the characterization of pigments.

Lorenza La Rosa
Department of Archaeology, Conservation and History, University of Oslo, Norway

Interdisciplinarity and Environmental Studies: assessing the impact of pottery production on the environment

During Roman late republic and early empire period, specialised pottery production districts were established in different parts of the Roman world. In this context, the concept of serial production rises, oriented to high standardization and optimization of the whole process in order to deliver more items. One of the most representative productions in this time is terra sigillata.

Poster shows how the combined use of ancient sources, typological studies, quantifications, archaeometric (e.g. provenance and technology studies, by means of thin-section petrography and Scanning Electron Microscopy coupled with Energy Dispersive X-ray Spectroscopy) and environmental analyses (e.g. the study of faunal and botanical remains) can provide a holistic perspective on the production, shifting the focus from the object itself to the context in which it was produced. The presented case study is the manufacture located in Pisa (Tuscany, Italy), a site strongly oriented to mass production. Particular attention will be given to the assessment of the environmental impact of this site, highlighting the technological aspects and the consumption of this district in terms of:

- Geologic resources (extraction of clay and minerals);
- Fuel, in this case wood, and its impact on the environment through deforestation (and eventually reforestation);
- Water management.

Miroslav Vuković
Department of Archaeology, Faculty of Humanities and Social Sciences

Image based modeling of archaeological artefacts

The digitalization of archaeological artefacts is an important part of cultural heritage preservation, once digitalized the resulting 3D models can serve a documentational purpose as well as a presentational one. Presentation of archaeological artefacts in their digital form has especially increased in the recent years with the rise of social networks and mobile internet. Many renowned cultural institutions use 3D models of archaeological artefacts for the promotion of exhibitions and to entice the potential audiences to visit the actual museums.

The goal of this presentation is to showcase the workflow used in image based modeling when dealing with close-up objects. The objects in question consist mostly of iron-age pottery in various sizes with detailed decorations, kept in the Archaeological museum in Zagreb. The digitalization process itself is a part of the INTERREG project “Monumentalized Early Iron Age Landscapes in the Danube river basin”. 3D models of these artefacts are reproduced in the .obj format which allows us to store and archive the models in their digital version, and to export them to various visualization software. For our purposes we used the open-source „Blender“ game engine for the visualization of 3D models in the form of short movie clips and still images.

Katarina Gerometta & Robert Matijašić
Centre for Interdisciplinary Research in Landscape Archaeology, Faculty of Humanities, Juraj Dobrila, University of Pula, Croatia

Roman centuriation in the Vrsar municipality (Istria, Croatia): preliminary LiDAR data

In early spring 2017 we have obtained airborne LiDAR data of the territory of Vrsar from commissioned flights, which revealed the existence of numerous archaeological features previously hidden from aerial reconnaissance and ground survey by thick Mediterranean forests, woodland and scrub. Preliminary analysis combining LiDAR data with historical aerial photographs and targeted survey data shows the extent of previously unknown traces of the Roman centuriation grid. The presence of the Roman centuriation was known in the area, but the thickly wooded areas limited the results of both conventional aerial photography and fieldwalking. With LiDAR these features are clearly recognizable; they are particularly evident in the eastern part of the Municipality of Vrsar where the centuriation lines ran across karstic valleys Together with mounds (stone heaps) that may also belong to the Roman period they are the result of cleaning the arable land of stones, which abound in the Istrian karst landscape.

Antonia Vodanović[1] & Ivan Huljev[2]
[1]Independent researcher, Podgora, Croatia; [2]Independent researcher, Primošten, Croatia

''To cast away the evil'' - Ethnoarchaeological Research on Apotropaic Marks in Shepherd's Village Podglogovik at Biokovo Mountain, Croatia

The Podglogovik abandoned shepherds settlement on the Biokovo mountain consist of ruined drywall houses inhabited on the seasonal basis, during summer pastures. The dwellings were built mostly during 19th and at the beginning of 20th century and they commonly housed both humans and animals. The village was being abandoned gradually, throughout the 20th century, when the inhabitants ceased to practice transhumant livestock raising.

The main goal of our research is to shed light on the connection between vernacular beliefs and spatial practices. Various research methods from different disciplines were deployed, including ethnology, archaeology and history. Such interdisciplinary research utilises different but nevertheless related labels such as archaeology of folk religion, archaeology of folklore, archaeology of ritual and magic.

The first order of business in our project was to conduct a field survey in the village area. The aim was to locate the positions of carved graffiti. Each item was then mapped in order to analyse their spatial distribution. Finally, the graffiti were documented and photographed and their measurements taken. Oral histories were documented using several informants. The information provided was utilized in the interpretation of gathered data. Comparative examples of cross carving, along with other practices known from published historical and ethnographic record, were used to supplement our research.


ARHEOLOŠKI MUZEJ U ZAGREBU
TRG NIKOLE ŠUBIĆA ZRINSKOG 19
I. KAT 14. 11. – 10. 12. 2017.

About the Exhibition: ***RECYCLE, IDEAS FROM THE PAST***

Archaeological Museum in Zagreb
Trg Nikole Šubića Zrinskog 19
Duration: November 14th – December 10th, 2017

The Recycle, ideas from the past exhibition is the result of the cooperation between the Institute of Archaeology, the Department of Archaeology of the Faculty of Humanities and Social Sciences of the University of Zagreb, and the Archaeological Museum in Zagreb.

The exhibition strives to display the modes in which our ancestors recycled materials and reused objects, and how that concept affected past cultures. Seeing as recycling is a highly complex, but also a universal phenomenon, whether seen from today's point of view or within the scope of past cultures and communities, the exhibition strives to bridge these temporal gaps through thematic and artistic units. The rich archaeological heritage provided a selection of finds made of different materials (stone, bone, pottery, glass and metal), that are portrayed through several thematic units: the transformation of space, the materials and symbolic recycling. The displayed examples of recycling, the reuse and the repairing of objects, are the indicators of cultures that did not discard objects, but leaned towards a culture of reuse, providing the visitors with a valuable lesson from the past.

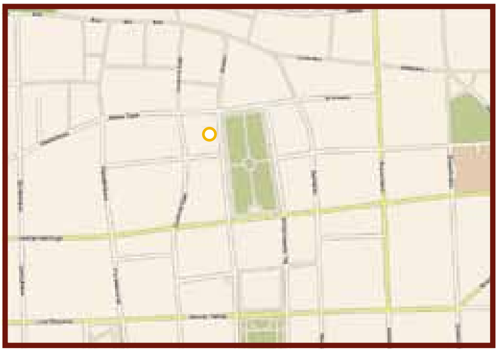
By finding the (dis)harmony between past and present ideologies and experiences of the material, the landscape and the social and economic situations, the exhibition authors also turn to contemporary ideologies and the modified construction of human consciousness about the material, as well as the landscape. The exhibition highlights the practical nature of recycling recorded in archaeological artifacts, but does not neglect the numerous examples of the symbolic reuse, i.e. "recycling", of objects and landscapes in the past.

NAVIGATION

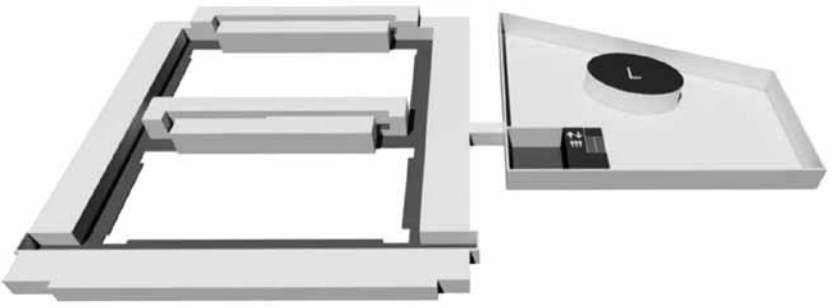
ODSJEK ZA ARHEOLOGIJU FF SVEUČILIŠTA U ZAGREBU
DEPARTMENT OF ARCHAEOLOGY FACULTY OF HUMANITIES AND SOCIAL SCIENCES, UNIVERSITY OF ZAGREB
Ivana Lučića 3
www.ffzg.unizg.hr/arheo/

ARHEOLOŠKI MUZEJ U ZAGREBU
ARCHAEOLOGICAL MUSEUM IN ZAGREB
Trg Nikole Šubića Zrinskog 19
www.amz.hr

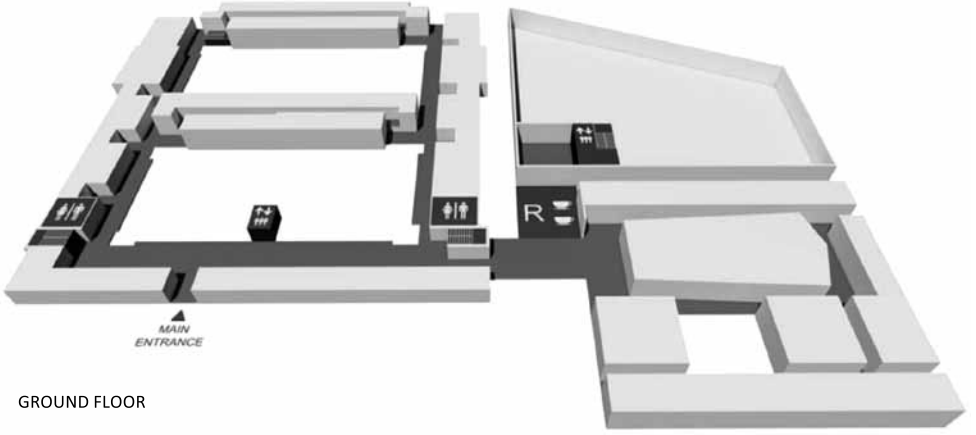
KÔTA CAFÉ BAR
Medulićeva 20
www.kotabar.hr



GROUND PLAN



2ND FLOOR



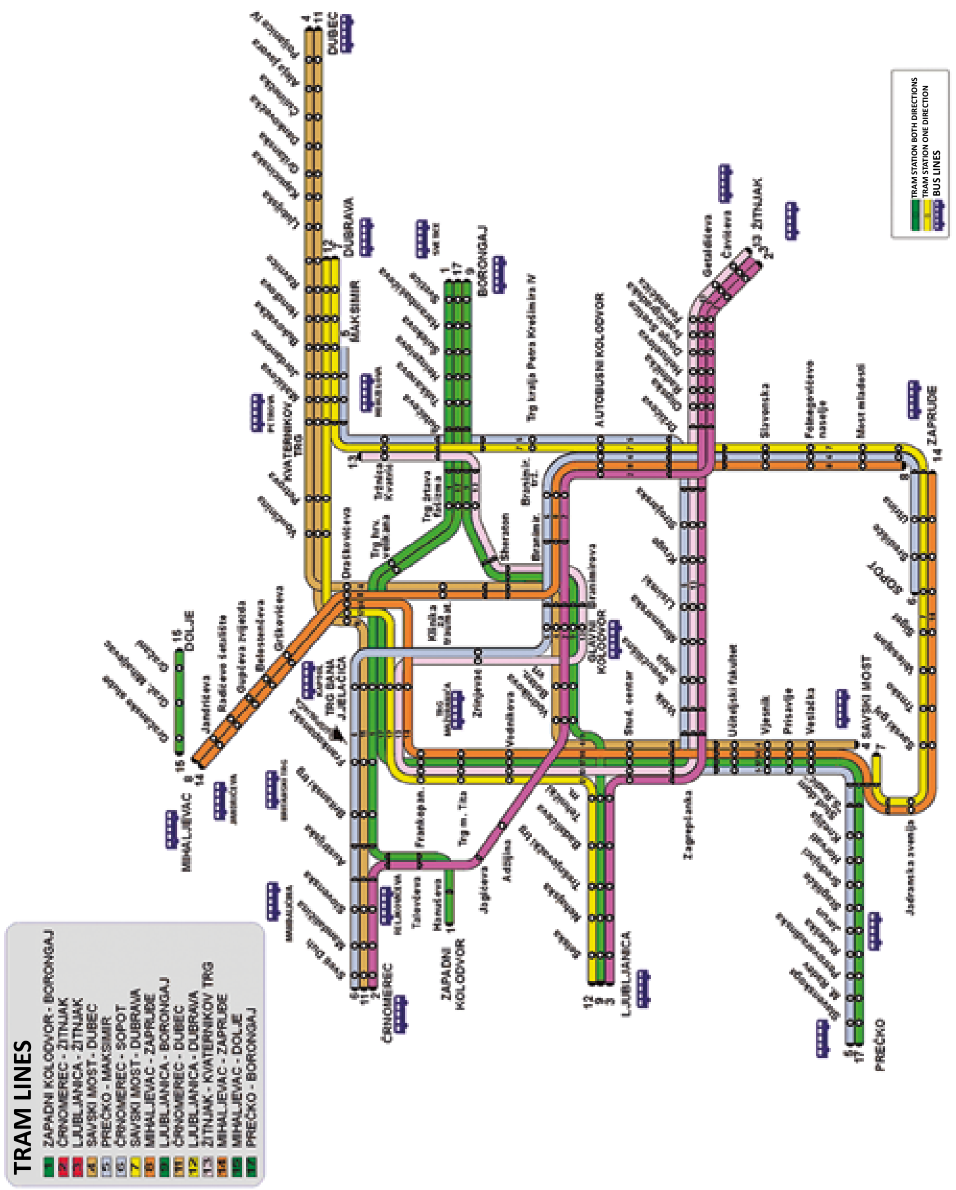
GROUND FLOOR

L LIBRARY CONFERENCE HALL - LECTURES
COFFEE
R REGISTRATION
TOILET
STAIRS
ELEVATOR

The lectures will be held at the Conference hall on the 2nd floor of the Faculty Library - on the right of the main entrance of the Faculty building.

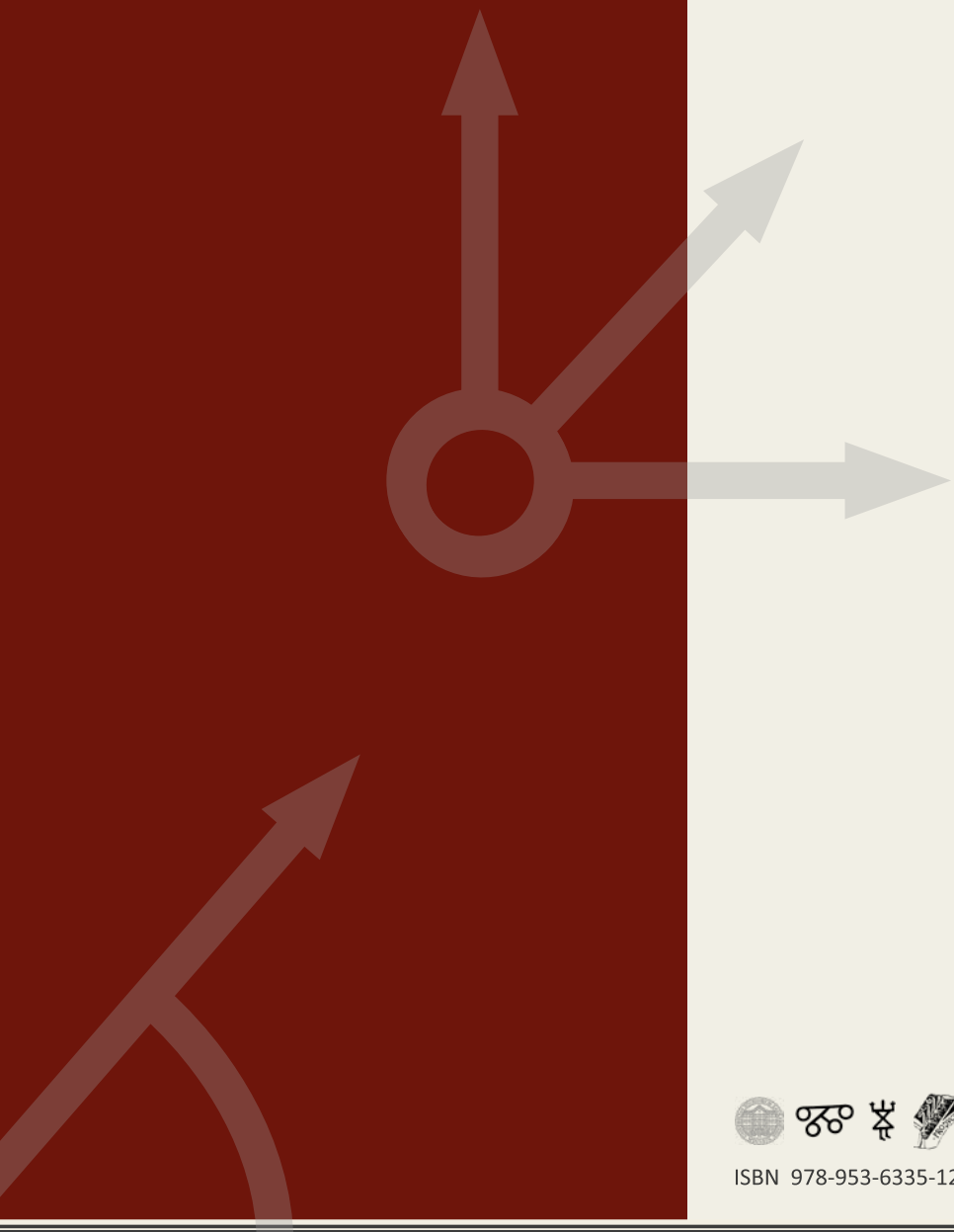
ZAGREB MUNICIPAL TRANSIT SYSTEM (ZET)

http://www.zet.hr/



TRAM SCHEDULE

LINE NUMBER	TERMINAL	DEPARTURE TIME								
		MONDAY - FRIDAY			SATURDAY			SUNDAY		
		FIRST	LAST	EVERY	FIRST	LAST	EVERY	FIRST	LAST	EVERY
1	Zapadni kolodvor	4:42	23:29	12 - 19						
	Borongaj	4:51	23:20	min						
2	Črnomerec	4:42	23:20	8 - 13	4:44	23:15	10 - 16	5:33	23:29	15 - 20
	Savišče	4:44	23:30	min	4:49	23:32	min	5:40	23:37	min
3	Ljubljanica	4:03	23:30	12 - 16						
	Savišče	4:50	00:16	min						
4	Savski most	4:49	23:26	9 - 14	4:52	23:43	9 - 15	5:41	23:29	12 - 19
	Dubec	4:38	23:26	min	4:30	23:20	min	5:42	23:11	min
5	Prečko	4:48	23:28	10 - 15	4:55	23:21	11 - 15	5:46	23:18	12 - 16
	Maksimir	4:51	23:31	min	4:56	23:22	min	5:39	23:11	min
6	Črnomerec	4:44	23:30	6 - 13	4:44	23:23	8 - 13	5:40	23:24	9 - 17
	Sopot	4:49	23:29	min	4:48	23:28	min	5:47	23:14	min
7	Savski most	4:49	00:19	7 - 12	4:48	00:12	9 - 15	5:47	00:11	11 - 16
	Dubrava	3:56	23:26	min	3:57	23:20	min	4:56	23:21	min
8	Mihaljevac	4:42	23:20	15 - 17						
	Zaprude	4:42	23:20	min						
9	Ljubljanica	4:07	23:25	8 - 14	4:09	23:26	9 - 17	5:06	23:30	10 - 17
	Borongaj	4:41	23:57	min	4:43	00:00	min	5:40	00:05	min
11	Črnomerec	4:38	23:38	6 - 12	4:45	23:21	8 - 17	5:39	23:23	11 - 17
	Dubec	4:43	23:18	min	4:45	23:25	min	5:40	23:22	min
12	Ljubljanica	3:56	23:28	7 - 11	4:02	23:20	8 - 15	5:02	23:16	9 - 17
	Dubrava	4:39	00:12	min	4:46	00:04	min	5:46	00:00	min
13	Žitnjak	4:52	23:53	12 - 19	4:41	23:24	11 - 22	5:45	23:21	12 - 18
	Kvaternikov trg	4:32	23:35	min	4:52	23:23	min	5:45	23:22	min
14	Mihaljevac	4:40	23:30	8 - 14	4:40	23:20	7 - 12	5:40	23:32	8 - 12
	Zaprude	4:37	23:33	min	4:45	23:19	min	5:45	23:07	min
15	Mihaljevac	4:30	23:23	11 - 12	4:30	23:23	11 - 12	5:38	23:23	11 - 12
	Dolje	4:41	23:34	min	4:41	23:34	min	5:50	23:34	min
17	Prečko	4:46	23:15	7 - 12	4:45	23:17	9 - 15	5:42	23:18	9 - 15
	Borongaj	4:43	23:23	min	4:53	23:25	min	5:50	23:26	min



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