

## **Интердисциплинарните проекти на департаменти „Археология“ и „Природни науки“ на Нов български университет**

**Ирена Димитрова<sup>1</sup>, Боян Думанов<sup>1</sup>, Живко Узунув<sup>1</sup>,  
Биляна Костова<sup>2</sup>**

<sup>1</sup>*Нов български университет, департамент „Археология“,  
бул. „Монтевидео“ № 21, 1618 София, България*

<sup>2</sup>*Нов български университет, департамент „Природни науки“,  
бул. „Монтевидео“ № 21, 1618 София, България  
idimitrova@nbu.bg*

## **The interdisciplinary granted projects of the departments of Archaeology and Natural sciences at New Bulgarian University**

**Irena Dimitrova<sup>1</sup>, Boyan Dumanov<sup>1</sup>, Zhivko Uzunov<sup>1</sup>, Bilyana Kostova<sup>2</sup>**

<sup>1</sup>*New Bulgarian University, Department of Archaeology,  
21 Montevideo St., 1618 Sofia, Bulgaria*

<sup>2</sup>*New Bulgarian University, Department of Natural Science,  
21 Montevideo St., 1618 Sofia, Bulgaria  
idimitrova@nbu.bg*

**Резюме:** Целта на работата е да представи разработените и финанси-  
рани от ФНИ, МОН интердисциплинарни проекти на департаменти  
„Археология“ и „Природни науки“, Нов български университет в пе-  
риода 2014 – 2019 г.

**Ключови думи:** археология, археометалургия, археометрия, археологическа  
химия, геархеология

**Abstract:** The aim of the work is to present the interdisciplinary projects  
developed and funded by the Bulgarian Science Research Found. These  
projects are created in Departments of Archaeology, and Natural Sciences,  
New Bulgarian University in the period 2014–2019.

**Keywords:** archaeology, archeometallurgy, archaeometry, archeological chemis-  
try, geoarchaeology

Archaeological science is a discipline which is growing rapidly in its scope and maturity. In its endeavor to understand human behavior primarily through the material remains of past societies, archaeology has interacted more and more with the sciences of physics, chemistry and geology. Undoubtedly, archaeology is one of the few disciplines which interconnect the humanities and the natural sciences. The natural sciences provide to archaeology with numerous techniques and approaches to facilitate data analysis and interpretation, enhancing the opportunity to extract more information from the material record of past human activity. As a result, various sub-disciplines of archeology develop: geoarchaeology, archeometallurgy, archaeometry, archeological chemistry [Pollard, Heron, Eds., 2008; Glascock et al, Eds., 2006; Goffer, Ed., 2007; Zlateva, Kulev, 2016; Chernih, 1978; Friede, 1992; Roberts et al. 2013].

Using the all possibility of classical archaeology and its sub-disciplines, the Departments of Archaeology and Natural sciences at New Bulgarian University have created four interdisciplinary projects granted by National Science Fund – Ministry of Education and Science, Republic of Bulgaria:

- “SARCHUS-AIR Center: Search and experimental reconstruction of ancient routes, communications and habitats using spatial analysis, archaeometry and airborne imagery” with project coordinator prof Ivan Gatsov, PhD, Department of Archeology – completed project;

- “Archaeology of Raw Materials trough Chemistry and Geology” with project coordinator assist. prof. Boyan Dumanov, PhD, Department of Archaeology – running project, in the final report stage;

- “Landscape Archaeology: Models for Reconstruction of Ancient Environment” with project coordinator assist. prof. Zivko Uzunov, PhD, Department of Archaeology – running project (started January 2020);

- “Materiality and ancient environmental knowledge reconstruction trough Archaeological chemistry analytical techniques (RE:MATRIARCHES)” with project coordinator assoc. prof. Bilyana Kostova, PhD, Department of Natural Science – running project (started January 2020).

**The project “SARCHUS-AIR Center: Search and experimental reconstruction of ancient routes, communications and habitats using spatial analysis, archaeometry and airborne imagery”**

The project covers the territories of the municipalities Stara Zagora, Chirpan and Bratya Daskalovi.

The aim was to combine data from three physically and geographically diverse areas (plain, semi-mountainous and mountainous) to build a fairly clear picture of the transformation of the settlement patterns during a series of historical periods, the reconstruction of individual human habitats in the context of the palaeo-environment also the fate of the ancient routes connecting Thrace with the

Sub-Balkan fields and the lands beyond Hemus. In the aspect of the study of communications in the selected work area, two routes are combined – a fragment of Via Diagonalis passing through the plain and another alternative road which probably reaches Via Diagonalis in the Maritza River, descending from the North where it overcomes Sarnena Medina forest at the passage St. Nicholas. It is not documented by the written records and is a great opportunity to apply new approaches.

The aim will be to realize through a series of conventional and innovative methods of archaeological research, such as field crawling, cabinet processing of collected materials, exploration of archaeobotanical samples from known and newly discovered archaeological sites, research of archaeological collections, geomagnetic scanning of representative and poorly researched or entirely newly discovered complexes, aerial orthophotography and infrared scanning. Such an approach would provide relevant masses of information from various accessible sites and areas, and would contribute to the completion of a common archaeological map of a uniquely culturally-historically but deeply heterogeneous region of study.

The main focus of the project is on the use of a flying platform, which, through a standard camera, draws orthophotographs, but also uses infrared scanning to detect difficult-to-terrain interventions. Connected and georeferenced photos are processed with special software to confirm typical or specific surface anomalies within previously identified but not excavated archaeological sites. The nature of the signals thus obtained help to identify sites in other areas and to plan the implementation of further studies such as geomagnetic analysis and paleobotanics. The capture of the sites around the sites also determines the clearer listing of the complexes in the context of the landscape, whose study is of fundamental importance for clarifying the interaction between the human populations and the living environment.

The foundation of the study is to combine different personalities with a multi-layered complex and could be an alternative to standard archaeological research. The approach can also be used in areas where real archaeological monuments are threatened by demolition in order to better locate and provide primary but maximally informative characterization of structures at risk.

All the results from this projects are published in the book “SARHUS-AIR Localization and experimental reconstruction of ancient routes and habitats” [Dumanov, Ed., 2017].

### **The project “Archaeology of Raw Materials through Chemistry and Geology”**

The general subject of the project is determined by the idea about the reconstruction of ancient and premodern economic systems, based on facts and assumptions relating to the extraction, processing and transport of raw materials and finished products (artifacts). Emphasis is placed on two basic metals – iron and copper and the accompanying extraction of stone materials.

The area of investigation embraces the mountain of Etropole (part of West Stara planina), the valley of Mirkovo and the north slopes of Ihtimanska Sredna gora mountain. The choice of the region is justified by its low level of research in the field of the cultural heritage, but also because of the wealth of materials concerning the project.

The tasks to achieve the objectives of the study are related interdisciplinary, using the approach of Archaeology, Chemistry and Geology.

The archaeological approach includes methods of conventional archaeology as bibliographic research on geography, ethnography, toponymy and previous archaeological research (the most recent in 2012 with the participation of NBU); field studies (intensive, extensive and selective surface collection, and unmanned flying vehicles).

Chemical approach combines field studies (sample collection) and a series of innovative techniques such as X-ray fluorescence spectrometry and mass spectrometry with inductively coupled plasma and laser excitation and New wave Nd YAG laser ablation coupled to Elan Perkin Elmer DRC.

The geological approach provides sampling and tracing of sources and mineral resources, as well the creation of a parallel to the archaeological map of Bulgaria geo-based map and placing the results from the investigation within the environment of the Geographical Information Systems (GIS).

Some of obtained results up to now are creation of search and diagnostic criteria to looking for sites where such mining has been performed. Based on these criteria, field tours were also drawn up. As a result, many ancient mining places have been registered and documented. They confirm the realization not only of ancient metallurgical but also of ancient mining activity in the studied area [Kostova et al., 2019].

### **The project “Landscape Archaeology: Models for Reconstruction of Ancient Environment”**

The main objective of the project is reconstruction of the landscape from antiquity on the territory of southern slopes of Eminska Stara Planina between the Dylinski Pass and Cape Emine. It is emphasized on tracking the anthropogenic impact on the environment and restoring ecological settlement patterns of habitation. Approaches that will be used to achieve the objectives set are determined by the specific methods of implementation. Regarding the interdisciplinarity of the project they can be divided into four groups: GIS, archaeological, geological and chemical approaches.

The GIS approach includes the development of a terrain digital elevation model using historical topographic maps of the research area from the end of the 19<sup>th</sup> century as well as aerial photography from the 40's of the 20<sup>th</sup> century. The next step is to build a model for determining the areas with a sediment overlay

caused by weathering of rocks on the slopes of Eminska Stara Planina – a process that makes chronologically earlier archaeological sites hard to detect because of their constant covering. For the purposes of the study, a GIS model will be applied for determination of water catchments and localization of the remains of watercourses from antiquity and subsequent periods. The archaeological approach includes methods of conventional archaeology – bibliographic studies on geography, ethnography, and previous archaeological research, as well as selective field surveys and excavations.

The main objective of the geological approach is searching and sampling of clays and ore from deposits. Establishing the location of quarries and mines is essential for the restoration of economic models in antiquity that directly affect, dynamics and transformations of settlement patterns in the research area.

The chemical approach provides – analysis of registered raw materials sources of clays and ores and comparison with samples obtained during archaeological excavations in order to establish the presence of local pottery and metal production.

The expected result is building a credible model of the landscape that leads to understanding of the environment in the research area in antiquity and middle ages, which respectively is a key to understanding settlement patterns and models. A basic idea of the developed methods is that they can be applied in other archaeological researches concerning landscape reconstruction and settlement systems of similar territories from antiquity, both in the sphere of paleoecology and in the preparation of an environmental impact assessment.

### **The project Materiality and ancient environmental knowledge reconstruction trough Archaeological chemistry analytical techniques”**

The aim of the project is obtaining a new data for material culture (synthetic composite materials as ceramics, cements, slags) and for people knowledge of ancient environment (local raw materials for building and household items as well as development of their production technologies). The investigations will be made for the Sarnena Sregna Gora Mountain, at the region situated between Stryama and Tundzha rivers via methods of archaeological chemistry combined into a complex of modern analytical methodologies for structural and compositional investigations of archeological artefacts and raw materials.

The interdisciplinary of this project proposal requires the three different approaches to achieving the aim. The first two of them – archaeological and the geological, will provide a reasonable material for laboratory investigations. The third approach, of the archaeological chemistry one, will provide a broad analytical study of the collected samples with a new approach of data interpretation for the area of interest.

The selected complex of analytical methods include the traditional and well known analysis: X-ray fluorescence (XRF) for chemical composition eval-

uation, powder X-ray diffraction (XRD) measurements for crystal phase diagnostic, Fourier transform infra-red (FTIR) spectroscopy for determination of amorphous organic components, Mossbauer spectroscopy for  $\text{Fe}^{2+}$ -  $\text{Fe}^{3+}$  resolve and simultaneous thermal analysis for obtaining of quantitative, thermal and energy properties of the studied artifacts and raw materials [Sánchez et al, 2019; Krapukaitytė et al, 2008; Naseeruthee et al, 2013].

The expected results from the project are a new fundamental knowledge for ancient composites production technologies and people knowledge for the environment in different archaeological eras at one and the same geographical area. The obtained results can be used to: compare the composites with the same age from different geographical areas; realization of archaeological conservation activities; discover and study techniques for the production of composite materials. The described options presents the potential for future development and opportunity to the continuing project activities.

The fundamentality of expected results of the multidisciplinary project will help to support the understanding and interpretation of cultural and environmental issues that are among the objectives of the UNESCO World Heritage Convention.

### **Acknowledgements**

The authors gratefully acknowledge the Bulgarian Science Research Found under grants DN10/11 (2016) – coordinator of the research team B. Bumanov, KP-06-PN-40/6 – coordinator of the research team – Z. Uzunov and KP-06-N39/9 – coordinator of the research team B. Kostova.

**Author contributions:** B. D., Z. U. and B. K. are developed the projects. Dissemination of the projects results leader, I. D., wrote the manuscript, which was read, revised and approved by all co-authors.

**Conflict of interest:** The authors declared no conflict of interest.

### **REFERENCES**

- Chernih E. Mining and metallurgy in ancient Bulgaria. Горное дело и металлургия в древнейшей Болгарии. Publishing house of BAS. Sofia. 1978 (in Russian)
- Dumanov, B., Ed. SARHUS-AIR Localization and experimental reconstruction of ancient routes and habitats. 2017. Askoni-izdat OOD, Sofia, 182, ISBN: 978-954-383-118 (in Bulgarian)
- Friede, H., A. Hejja, A. Koursaris. Arhaeo-metallurgical studies of iron smelting slags from prehistoric sites in Southern Africa. Journal of the South African institute of mining and metallurgy. 1982. February. 38-48.
- Glascok M. D., R.J. Speakman, R. S. Popelka-Filcoff, (Eds). Archaeological Chemistry. Analytical Techniques and Archaeological Interpretation. ACS

- symposium series 968. American Chemical Society, Distributed by Oxford University Press. 2006.
- Goffer Z., 2<sup>nd</sup> Ed. Archaeological chemistry. Chemical analysis: A series of monographs on analytical chemistry and its applications. *Wiley & Sons, Inc., Hoboken, New Jersey*. 2007, 623.
- Krapukaitytė A., S. Tautkus, A. Kareiva, E. Zalieckienė. Thermal analysis – a powerful tool for the characterization of pottery. *Chemija*. 2008. 19 (2). 4–8.
- Kostova, B., B. Dumanov, Z. Uzunov, I. Dimitrova. Ancient mining of magnetite on the territory of Etropole and Botevgrad municipalities – pilot study. *Annual of Department of Natural Sciences* 2019. 10-17. (in Bulgarian)
- Naseerutheen A., R. Ravisankar, G. Raja Annamalai, A. Chandrasekaran. Application of TG-DTA to study of Ancient Potteries from Kaveripakkam, Vellore district, Tamilnadu, India. *Canadian Journal of Basic and applied sciences*. 2013. 01. 44-48.
- Pollard M., C. Heron. 2<sup>nd</sup> Ed. Archaeological Chemistry. The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 0WF, UK. 2008. 438.
- Roberts, B.W., Thornton Ch. P. (Eds.). Archaeometallurgy in Global Perspective. Methods and Syntheses. *Springer* New York Heidelberg Dordrecht London. 2013. 868.
- Sánchez A. M., M.J. Nuevova, M.A. Ojedab, S. Guerra Millánc, S. Celestinod, E. Rodríguez Gonzálezd. Analytical techniques applied to the study of mortars and coatings from the Tartessic archaeological site “El Turuñuelo” (Spain). *Radiation Physics and Chemistry*. 2019.
- Zlateva, B., I. Kulev. Archaeometry in Bulgaria at last ten years. *Bulgarian e-journal of Archaeology*. 2016. 6. 109 – 134. (in Bulgarian)