Adam Mickiewicz University
Poznań

Treasures of Time

Research of the Faculty of Archaeology of Adam Mickiewicz University in Poznań

Location of the main research areas.
Numbering, compare the table of Contents.

Adam Mickiewicz University Poznań

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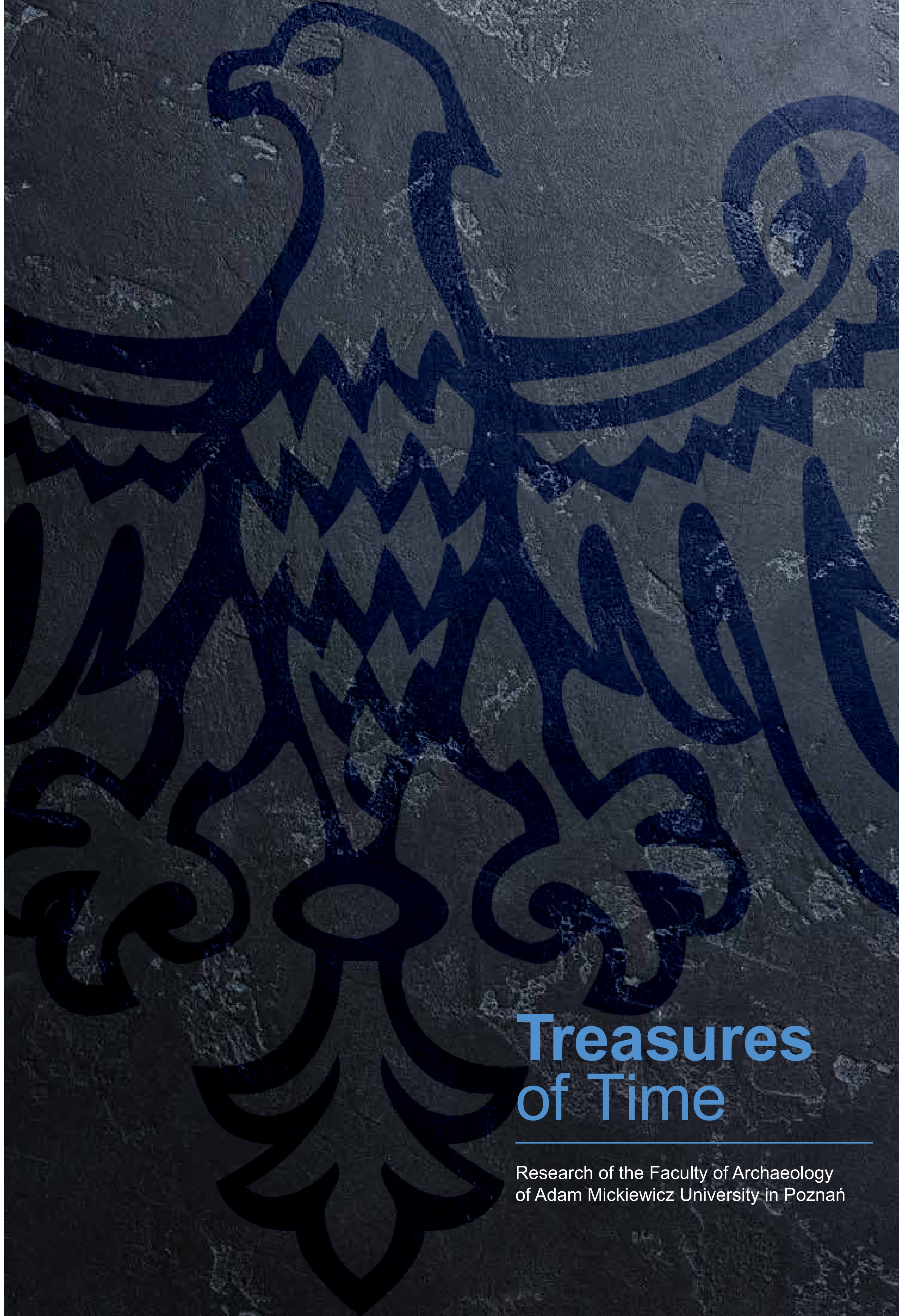

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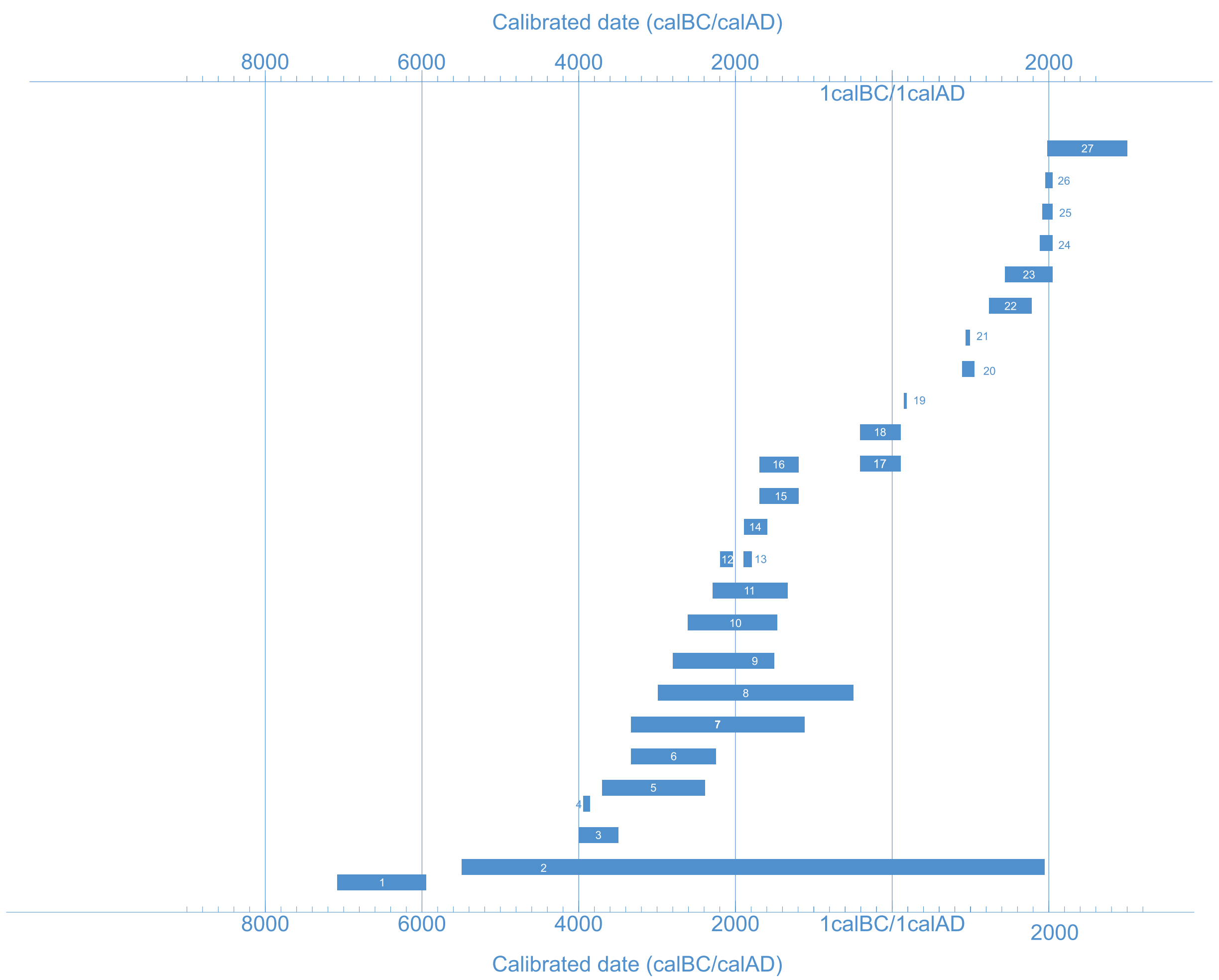
Contents

Treasures of Time: Research of the Faculty of Archaeology of Adam Mickiewicz University in Poznań

Introduction

In 2019, archaeology at the Adam Mickiewicz University in Poznan celebrated its honourable 100th anniversary! The establishment of archaeology at this university was associated with the strong influence of the authority of Prof. Józef Kostrzewski and a succession of eminent scholars, many of whom we today call Masters.

The year 2019 was a real breakthrough. We started the second century of existence within the Alma Mater Posnaniensis with a new structural independence and quality that the academic archaeology of Poznań had not yet known for its one hundred years of existence. This change, the formation of the first Polish Faculty of Archaeology, has opened new chances and possibilities of which we are now taking advantage.



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Prof. Józef Kostrzewski
(1885-1969)

Currently, the Faculty of Archaeology of Adam Mickiewicz University is formed by a number of teams, each with their own leaders. In the majority of cases, these teams are united by interdisciplinarity, which integrates within selected projects the experience of many so-called 'auxiliary' sciences of archaeology. This trend is paralleled by the development of specialised laboratories armed with the latest equipment in the Faculty of Archaeology.

This publication presents the current scientific interests creatively developed by such teams at the Faculty of Archaeology of Adam Mickiewicz University. The research of these teams covers vast areas in time and space, summing up at least the last 9,000 years of prehistory. The following articles, arranged in chronological order, allow us to explore the prehistory of various areas.

The adventure begins around 7100 BC, in the Neolithic settlement of Çatalhöyük located in Turkey. Then, we move on to the loess uplands near Krakow, where the first farmers from the south of Europe had just arrived (5500 BC). A little later (4000-3500 BC), and a little farther north, in the area of Greater Poland, some of the first megalithic constructions in this part of the world were built. Around the same time, about 800 km to the southeast, a settlement of the Trypillia culture remains in the phase of development (3950 BC). The end of the Stone Age in Poland was described in the history of Late Neolithic communities on a hill in the center of Kujawy region (3700-2400 BC). Farther east, in the forest-steppe area of Ukraine, significant cultural and social changes resulted in the formation of the Yamnaya culture (3350-2250 BC), beginning the Bronze Age.

Intense elements of this era can be traced in the area of southern Europe in the Greek Anthemous Valley (3350-1150 BC), in Attica (3000-500 BC) on the plains of the Hungarian Lowlands (2600-1450 BC) and to the Upper Dniester Valley, where numerous burial mounds were formed (2800-1500 BC). A similar chronological range is presented in the articles devoted to a unique site in Bruszczewo, Greater Poland (2300-1350 BC), which not only accumulates valuable metal artefacts, but is also the subject of interest of an interdisciplinary team focused on reconstructing its environmental context.

The next text take us far to the east, to the area of Iraqi Kurdistan, where we can appreciate the importance of Mesopotamian influences in shaping the picture of the Early Bronze Age (2200-2150 BC).

Subsequent texts describe the discoveries of Poznań scientists in Syria (1906-1787 BC) and in Greater Poland (1900-1600 BC). These two distant points describe various aspects of life in contemporary communities in the Middle and Early Bronze Age.

The characteristic archaeological materials of the later centuries of the Bronze Age (1800-1200 BC) reveal an intensification of military conflicts and migration processes (1700-1200 BC). The turn of the eras is illustrated in this volume by texts on the interpretation of representations on ancient Greek and Roman sculpture (400 BC-100 AD), as well as the cultural situation in the Polish lands (400 BC-100 AD).

We are introduced to the new era by an article on the funerary customs of communities from the Polish lowlands describing discoveries at the site of Mirosław (160-175 AD). Moments of the formation of elements of Polish statehood are referred to in texts describing towns at Grzybowo (919-1050 AD) and Poznań in the early Middle Ages (950-1000 AD).

Later parts of the Middle Ages are described by sacral monuments located also in the area of the contemporary city of Poznań: the Collegiate Church of St Mary Magdalene (1263-1802 AD) and the still extant Church of the Blessed Virgin Mary on Ostrów Tumski, founded around 1431 AD in the immediate vicinity of the previously described early medieval site of the 'origin' of the city of Poznań.

The final texts of the volume do not refer directly to a particular period of prehistory, but present the history of Polish archaeological research on the Iberian Peninsula, the contemporary perception of prehistoric art by the inhabitants of present-day Canada and Siberia, and the development of methodological thought among Poznań archaeologists.

The volume closes with a text describing one of the many perspectives currently faced by the staff of the Faculty of Archaeology of Adam Mickiewicz University in Poznań: the new ArchaeoMicroLab.

We look to the future with great hope that the Staff of the Faculty will provide ideas for many more volumes of Treasures of Time. We trust that this set of articles will present archaeology at the Adam Mickiewicz University in Poznań in its new structure as a Faculty and show its potential. We would thus like to encourage you to get acquainted with our Poznań perspective on archaeological studies, and to reflect on ways of exploring the past.

Andrzej Michałowski

Danuta Żurkiewicz

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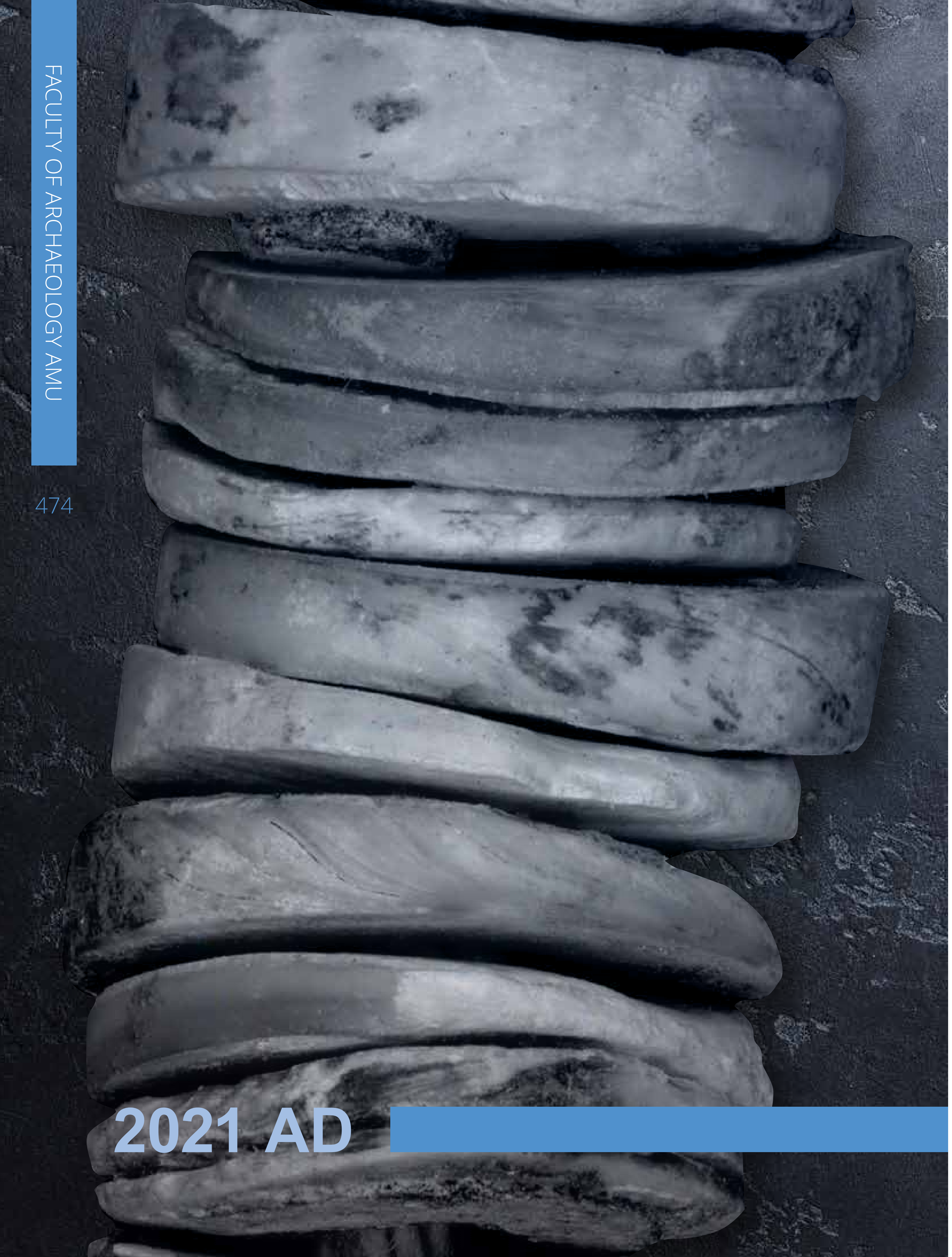

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Archaeology under a microscope: research at the ArchaeoMicroLab of the Faculty of Archaeology Adam Mickiewicz University in Poznań

Aldona Kurzawska, Iwona Sobkowiak-Tabaka

Abstract

This article presents the newly established ArchaeoMicroLab – the Laboratory of Microscopic Analysis in Archaeology – in the Faculty of Archaeology at Adam Mickiewicz University, its equipment, and the scope of research carried out in this facility. Microscopic analyses are essential research tools used in archaeology for examining artefacts and traces of their use, organic remains, pigments, and many other objects. The use of high magnification enables researchers to capture interesting details that are not visible at the macroscopic level. The article discusses different categories of artefacts, samples and the possibilities of their examination in the laboratory.

Keywords: Microscopic analyses, Microwear analysis / Traceology, Organic residues, Ornaments, Pottery, Stone Tools

Introduction

Archaeological research is, above all, exciting but also involves tedious field work. It is obvious to researchers that what they can see at an archaeological site is only a fragment of the discovered and documented past. What is invisible to the naked eye is often discovered in laboratory conditions through samples collected in the field or artefacts and materials submitted for further detailed analyses. Microscopy is currently a very important research tool used in archaeology and environmental archaeology to examine both archaeological artefacts and plant or animal remains. The aim of various microscopic techniques is to obtain enlarged images of small objects or relevant details. They make it possible to observe and obtain information about the shape, size, structures, microstructures, and texture of the objects or samples under analysis. The ArchaeoMicroLab in the Faculty of Archaeology at Adam Mickiewicz University is outfitted with all of the equipment necessary to perform these important analyses and facilitate the preliminary selection of materials or their preparation as samples for further analyses, including chemical analyses such as FTIR (Fourier-transform infrared spectroscopy), XRF (X-Ray Fluorescence), or GC/MS (gas chromatography – mass spectrometry), isotopic analysis, and many others.

Microscopes used in archaeology

Depending on the type of radiation and the imaging method used, two basic types of microscopes can be distinguished. These are optical and electron microscopes (Bartoszek & Rosowski, 2017). The ArchaeoMicroLab of the Faculty of Archaeology primarily uses various types of optical/digital microscopes (Figure 1A). In addition, the study of artefacts uses an Image Dimension Measurement System, the use and potential of which in archaeology are presented in this paper.

Optical and digital microscopes are primarily used to identify the material under examination, including its characteristics and morphology, and to compare examined objects and previously prepared samples and microscope slides. These techniques are used to observe micro-traces on the surface of the studied objects, to perform use-wear analyses, and to detect residues present on the objects or traces resulting from taphonomic processes. Modern microscopes allow for efficient documentation of objects observed at a micro-scale in the form of digital images and for making precise measurements.

The Keyence VHX-6000 and VHX-7000 digital microscopes in the presented laboratory allow high-resolution images of analysed objects to be obtained. The Keyence VHX-6000 microscope has a magnification of 1000x, while its successor, the Keyence VHX-7000, provides magnifications of 2500x. An additional component – the 4K CMOS sensor – not only ensures high image quality, but also permits High Dynamic Range (HDR) image recording. Specimens can be viewed in both reflected and transmitted light. The VHX-7000 microscope can be tilted

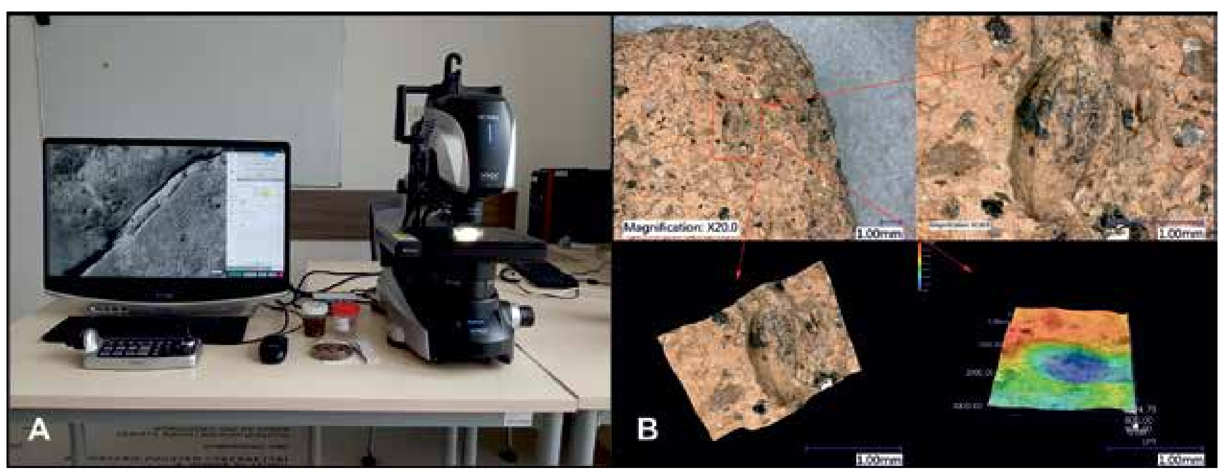

Figure 1. A. The Keyence VH-7000 digital microscope in the ArchaeoMicroLab; B. Negative impression of grain on pottery (versions 2D and 3D).

in the horizontal axis and positioned at the proper angle to examine the sample, while the VHX-6000 model allows the camera to be removed from the tripod and placed over the object. This is very useful for examining larger objects that do not fit on the microscopic table.

The Nikon SMZ 445 stereo microscope is a basic optical microscope that allows samples to be observed in reflected light. The ranges of possible magnifications are 10x, 15x, and 20x with 0.8x-3.5 zoom magnification. It is equipped with a LED ring light. Thanks to its small size, the microscope is very handy, but its low magnification capacity permits only the initial observation and verification of examined samples and objects such as small remains of plants and animals (i.e., negative impressions of grain, impressions of fabric on pottery, traces of residues of organic substances on artefacts) or the selection of samples for further analysis.

The Nikon Eclipse LV150 metallographic microscope allows the examination of opaque samples in reflected light using bright field imaging mode. It is equipped with four Plan Fluor objective lenses at magnifications of 5x, 10x, 20x, and 50x. These provide a flat image and sharpness across the field of view – both in the centre and at the edges. Metallographic microscopes are used primarily in materials science to study the structure of metals and their alloys, microcracks, and so forth. In the ArchaeoMicroLab, they are used for studying traces formed on flint tools, bone tools and ornaments as a result of their use (i.e., usewear analysis).

The Keyence IM-7000 Image Dimension Measurement System permits non-contact measurement of objects and is designed for very high accuracy. It is mostly used in measurement laboratories and the engineering industry. In the ArchaeoMicroLab, it is used to measure many objects at the same time with even dimensions, such as coins and beads made of various materials.

The scanning electron microscope uses an electron beam to create an image and allows the structure of the object under study to be examined at the atomic level. The surface, a small area of the test object or sample, is scanned line by line with the electron beam. As a result of the interaction of the beam with the sample surface, the electron signals collected by the detectors are transformed into images displayed on a monitor screen (Bartoszek & Rosowski, 2017). Importantly, SEM ensures higher magnifications and a more detailed topographic analysis. It is more and more often used in artefact studies and analysis of various archaeological samples. Therefore in January 2022 a Scanning Electron Microscopy Tesca Vega 4 GMU will be added to the laboratory.

Selected archaeological artefacts seen through the lens of a microscope

Pottery

Pottery is the most common find at the majority of archaeological sites. Its history dates back to the Palaeolithic [2.6 million years ago (mya) to 10,000 BC] and the oldest products date back to 13,000 BC (Imamura, 1996). It is a basic tool for determining the taxonomic and chronological affiliation of the discovered assemblages. The basic research carried out in relation to pottery is the recognition of its manufacturing technology, its micro- and macro-morphology, as well as ornamentation. When it is not possible to make absolute determinations of the age of a settlement, pottery permits details of its chronology to be established and identifies potential contacts with other communities or the presence of possible imports (Kozłowski et al., 2014). For this purpose, fracture and thin section analyses are used, which serve to identify admixtures tempering the clay, study the composition of the clay, and determine its provenance (Figure 2A). Ornaments made on the outer and inner surfaces of pottery (Figure 2C) can additionally be filled with an incrustation – usually a white substance. Microscopic observation of the substance at high magnification is the first method used to identify the type of material from which it was made, such as bone, antler or shell (Kos et al., 2015; Figure 2B).

Moreover, pottery can be a valuable source of information concerning grains used by people living in a given settlement. For this purpose, negative impressions of grains (Figures 1B and 2D), leaves, or stems are taken and, if their characteristics are preserved, an archaeobotanist determines the family or the species to which a given plant belongs. The walls of a pottery vessel may also contain preserved impressions of cloth used for rubbing and in this way smoothing out its surface or on which the vessel was placed on the potter's wheel (impressions on the bottom of the vessel). Other things to find on the surface of vessels are organic residues in the form of tar (as a result of making ornaments, repairing vessels by gluing

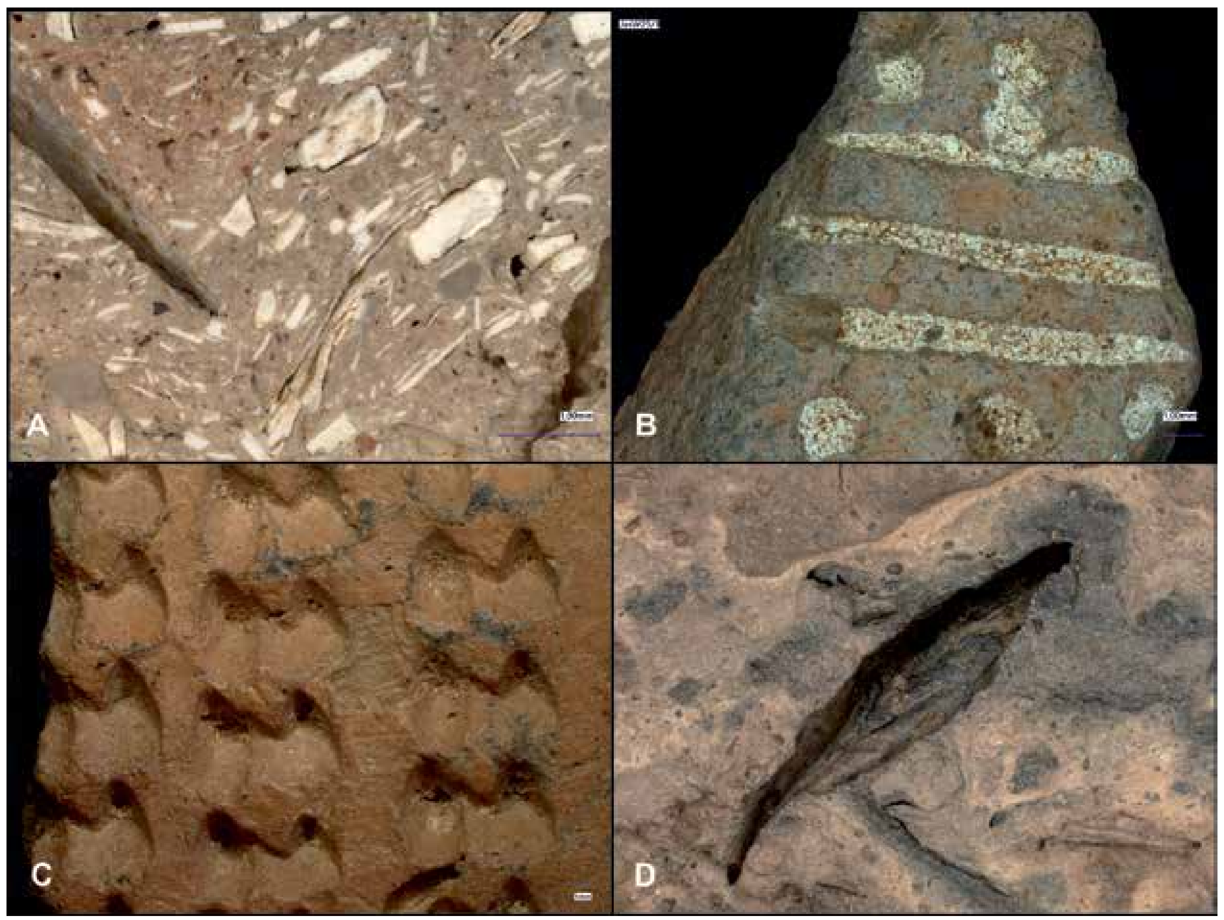

Figure 2. Pottery: A. Pottery section (Kopydłowo, Site 6); B. Pottery with incrustation (Kiełczewo, Site 45); C. Ornament on pottery (Kiełczewo, Site 45); D. Impressions of grains on pottery (Żuławka Mała, Site 1).

the cracked walls or ears, or sealing the walls) as well as organic residues (crusts). These types of residues are usually dark in colour, but their precise identification is only possible using physicochemical methods and/or scanning electron microscopy (e.g., tar, food remains – for the presence of characteristic phytoliths) (Kubiak-Martens et al., 2015).

Flint and stone artefacts

Flint and stone tools occur equally as frequently at sites as pottery. For hundreds of thousands of years, along with organic materials such as bone, antler, and wood, they were the only materials the *Homo* species used to make tools. The oldest are dated at around 2.6 mya and are associated with the development of *Homo habilis* in Africa (Rozmus, 2020).

In the case of flint and stone artefacts, it is vital to identify the type of raw material from which they were made. This is of great importance for the study of interactions among prehistoric communities and the identification of possible imports via determination of the provenance of the raw materials. For this purpose, microscopic images of thin sections can be used. Another equally important task is to determine the function of a tool based on observations

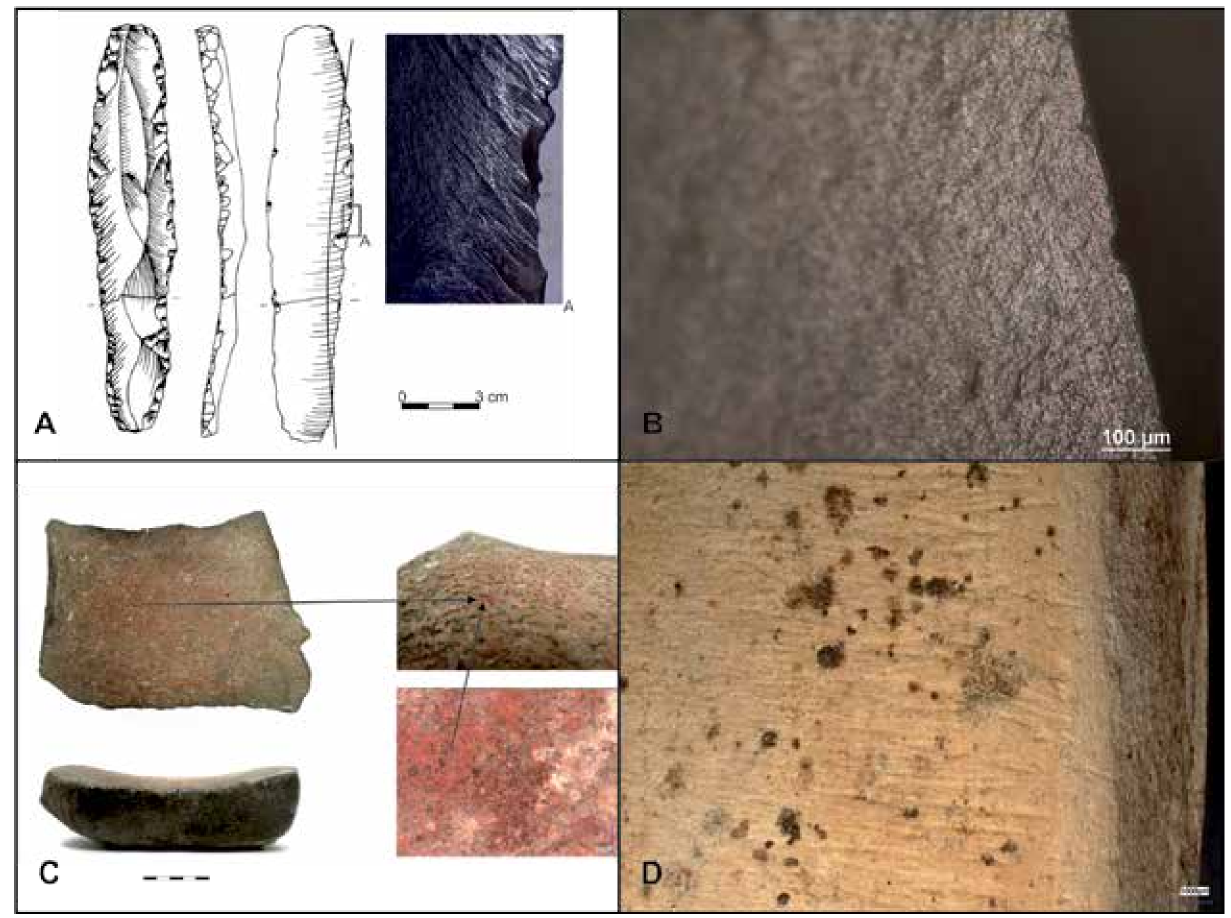

Figure 3. Stone tools: A. Blade with sickle gloss (Jasienica Sufczyńska, Site 5); B. Blade with traces of use (Lubrza, Site 10; metallographic microscope); C. Palette for grinding dyes (Przemęczany, Site 13) – Photo by P. Rutkowska, I. Sobkowiak-Tabaka; D. Whetstone with traces of use (Jasienica Sufczyńska, Site 5).

of characteristic use wear traces (Figure 3A). Such traces are analysed mainly using metallographic microscopes (the domain of microwear analysis; Figure 3B). Observations of such traces on flint tools make it possible to determine what the analysed tool was used for, such as processing hard materials (i.e., bones, teeth, and antlers), harvesting plants, cutting meat, and so forth (Małecka-Kukawka, 2012). Similar studies can be carried out with regard to other stone tools (Figure 3C).

Ornaments

Ornaments usually represent small personal items, such as decorations of clothes and the body made of a variety of materials such as shells, bones, stones, minerals, and metals (Bar-Yosef Mayer & Choyke, 2017). In addition to their purely decorative function, ornaments have always played a significant role in human non-verbal communication (Sommer, 2003). For example, they could symbolize the manifestation of membership in a particular social group, emphasize the gender distinction, age or social status of an individual, and carry certain meaning or indicate the way of life of people in the past. In archaeological research, they are distinguished

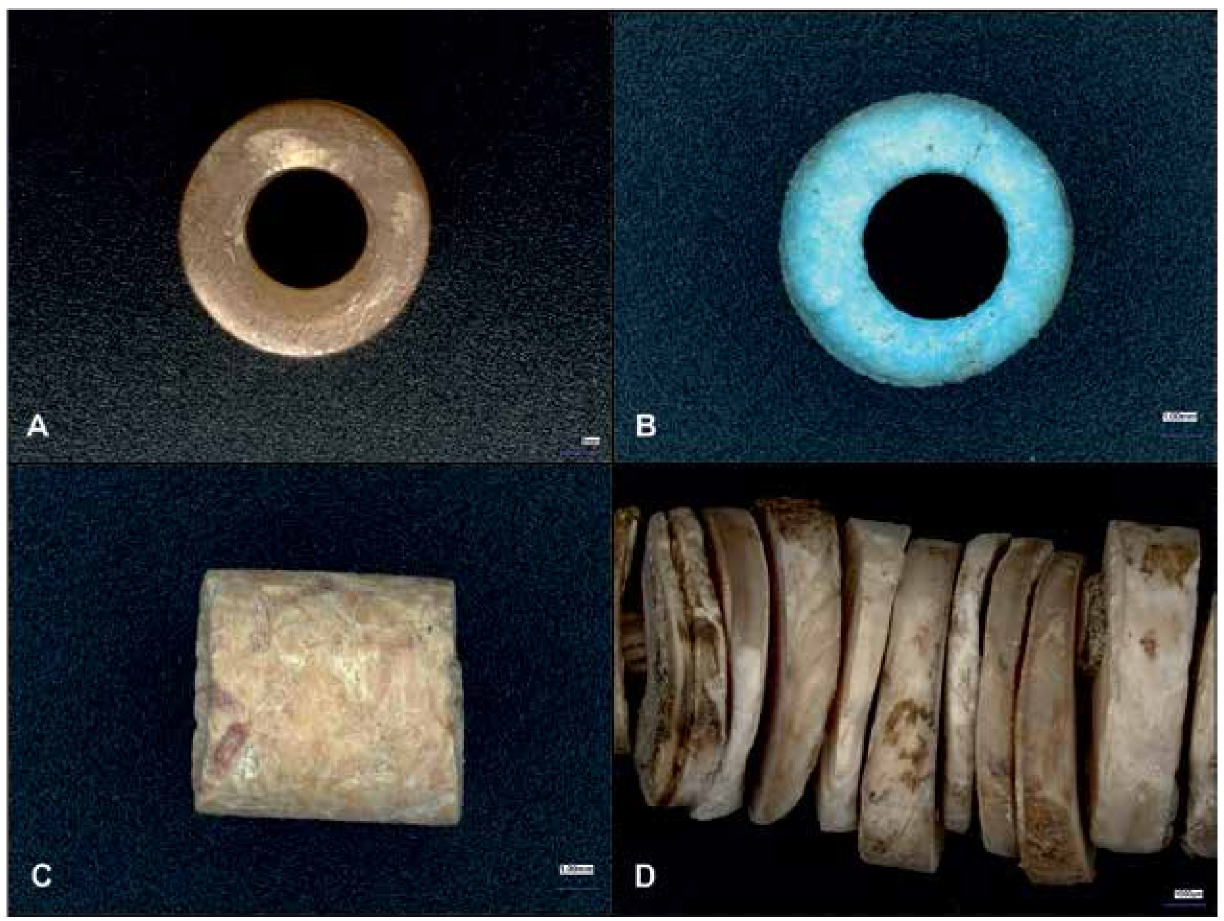

Figure 4. Beads: A. Belemnite bead (Szarbia, Site 9); B. “Faience” bead (Szarbia, Site 9); C. Bone bead with clear remains of red powder (Żerniki Górne); D. Fragment of bracelet made of *Unio sp.* shell (Szarbia, Site 9).

as an extremely diverse group of artefacts that constitute an engaging research material. Knowledge about ornaments facilitates understandings of technological progress, changes in the function of these artefacts, and the way they were used. This also informs about their circulation and trade contacts and evidences the relations that existed between human groups (Baysal, 2019).

Detailed analyses of unearthed ornaments consist first of identifying the raw material from which they were made, which is directly connected with the identification of the sources of their acquisition (Figure 4A, B, and D). Microscopic identification is carried out not only on the raw material itself but also on any microscopic traces indicating the production methods used, the tools employed, and how they were used (i.e., how the ornaments were worn). Recently, thanks to appropriate treatment of these materials at archaeological sites (i.e., no washing or cleaning and securing the ornaments together with the sediment for further exploration in the laboratory) and microscopic analyses (i.e., optical, digital, or with the help of SEM) it is possible to more effectively identify the remains of organic materials preserved on ornaments from, for example, burial sites. These are mostly residues of plant and animal fibres in the interiors of beads (old strings or threads) and on the external surfaces of ornaments that used to be

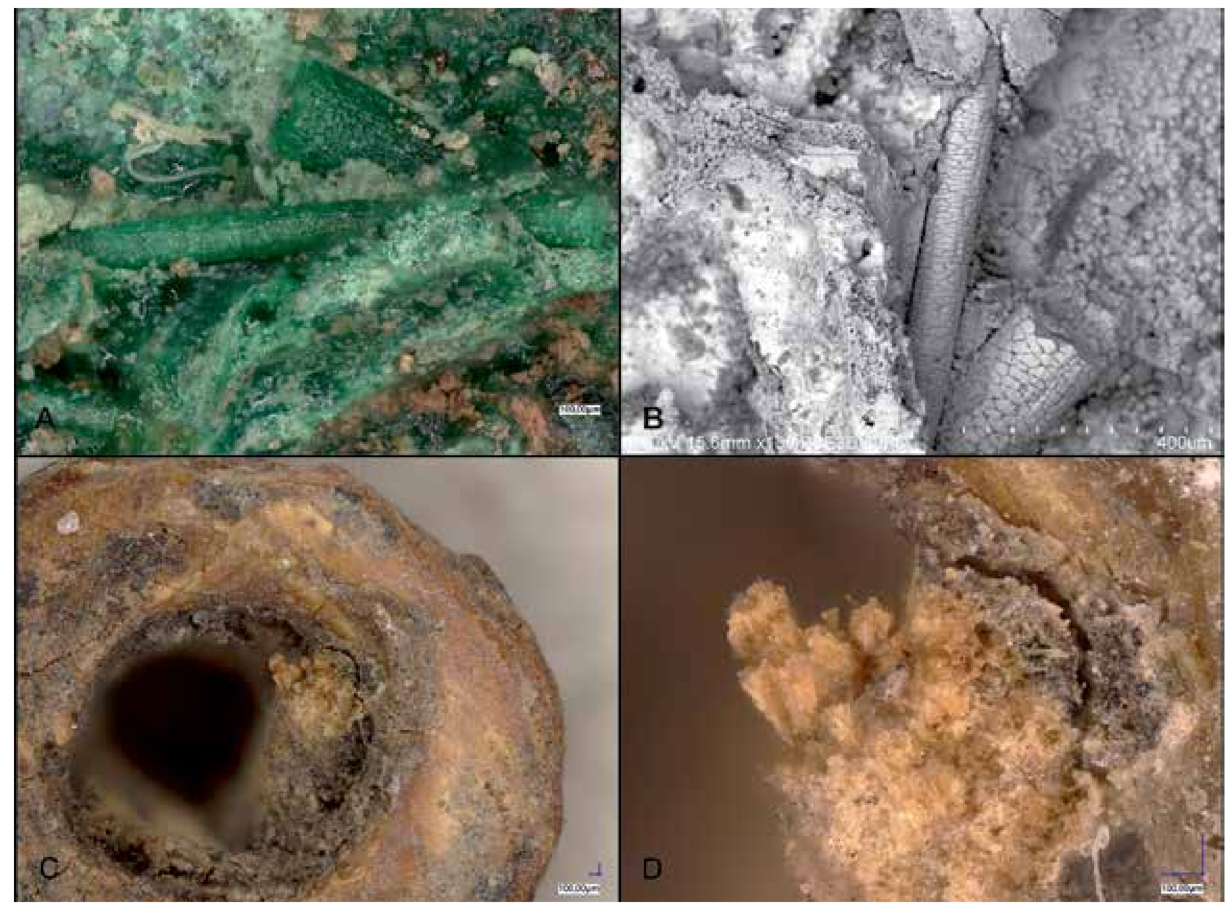

Figure 5. Plant and animal fibres discovered on artefacts: A. Wool fibre on a copper ornament fragment (Stryjów, Site 30); B. SEM image of a wool fibre on a copper artefact (Photo: M. Mrozek-Wysocka); C. and D. Remains of a plant-based cord in the interior of a shell bead (Krzyżanowice Dolne, Site 81).

elements of textiles (Figure 5). This also applies to trace microscopic amounts of pigments/ dyes preserved on artefacts and not visible to the naked eye (Figures 3C and 4C). The analysis of such materials would be impossible without access to a microscope, which permits both the observation of the object on desired levels of magnification and illumination, and ongoing digital documentation of the observed images.

Working on large collections of multi-element ornaments (necklaces, bracelets, waistbands, and diadems) often consisting of hundreds of similar or even identical beads is greatly facilitated by using the Image Dimension Measurement System to obtain the necessary measurements, schematic drawings, and contemporaneous comparisons of the examined elements. An additional advantage of this method is that measurement does not involve contact, which in the case of fragile and small elements eases the work without taking the risk of damaging the artefacts (Figure 6).

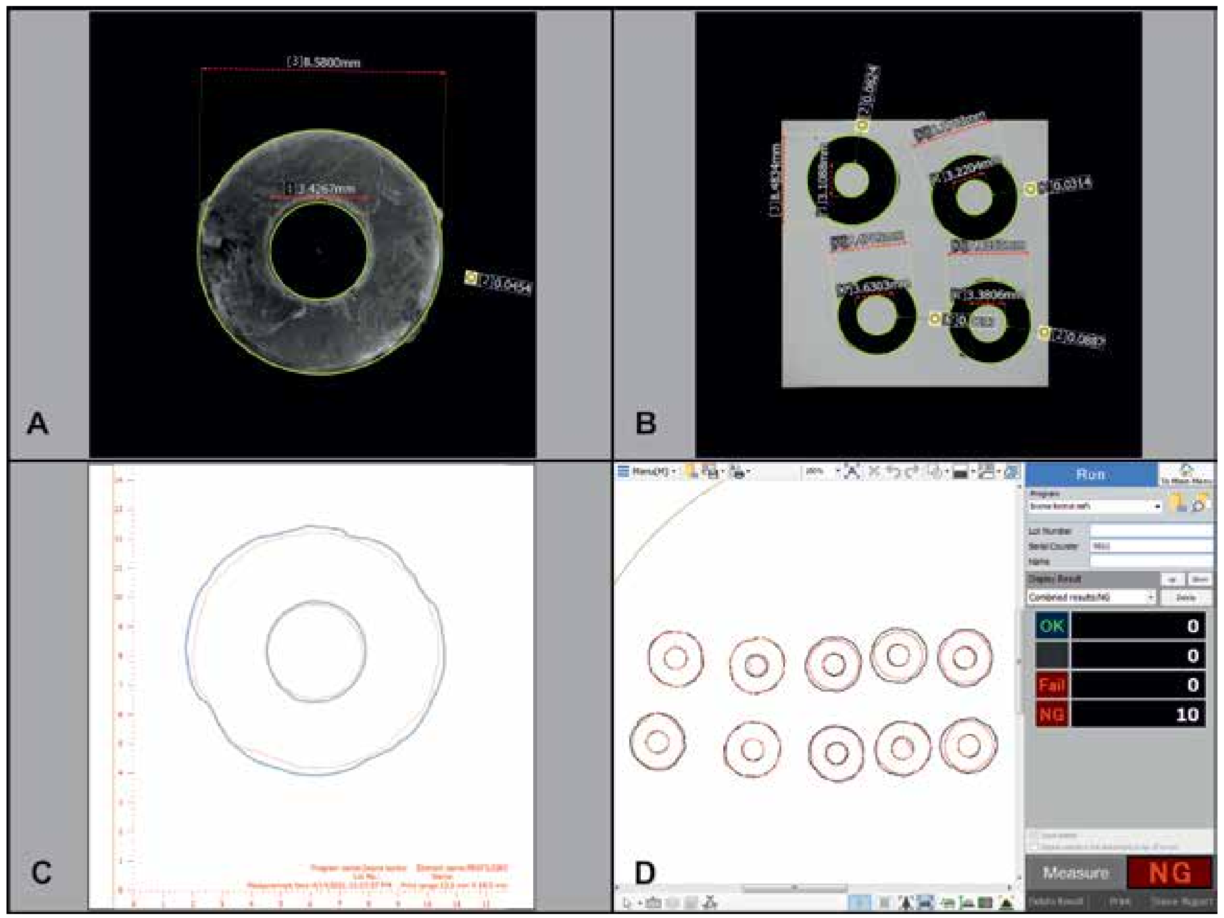

Figure 6. Exemplary measurements of shell beads taken from an ornament performed using the Image Dimension Measurement System A. Measurement the diameter of the bead and of its perforation; B. Simultaneous measurement of four disc beads; C. Measurement of the bead outlines; D. Combined results of the beads' measurements.

Palaeobiological samples and microscope slides

The digital microscope in the ArchaeoMicroLab is also applicable for analyses of palaeobiological samples (Figure 7). With its magnification and the possibility of observation in reflected and transmitted light, it is easier to select, observe, identify, and document remains obtained from palaeobiological samples. These represent macroscopic plant and animal remains observed in reflected light (e.g., bones, mollusc shells, or fish scales; Figure 7D). In transmitted light and using high magnifications of up to 2500x, it is possible to examine slides of, for example, pollen or phytoliths obtained by chemical treatment of soil samples and stone or flint tools (Figure 7A and B). Phytoliths are silica formations, occurring in some plant cells. Moreover, they are found inside dental calculus, organic residues on pottery or flints, inside pottery and daub, and also on surfaces of flints and stones (Cabanes, 2020). Phytolith analyses make it possible to study ancient diet, plant domestication, and crop processing, and applies to non-dietary uses of plants such as for fuel, determination of the spatial arrangements of plant use at archaeological sites, and the identification of ancient field systems (Ryan, 2014).

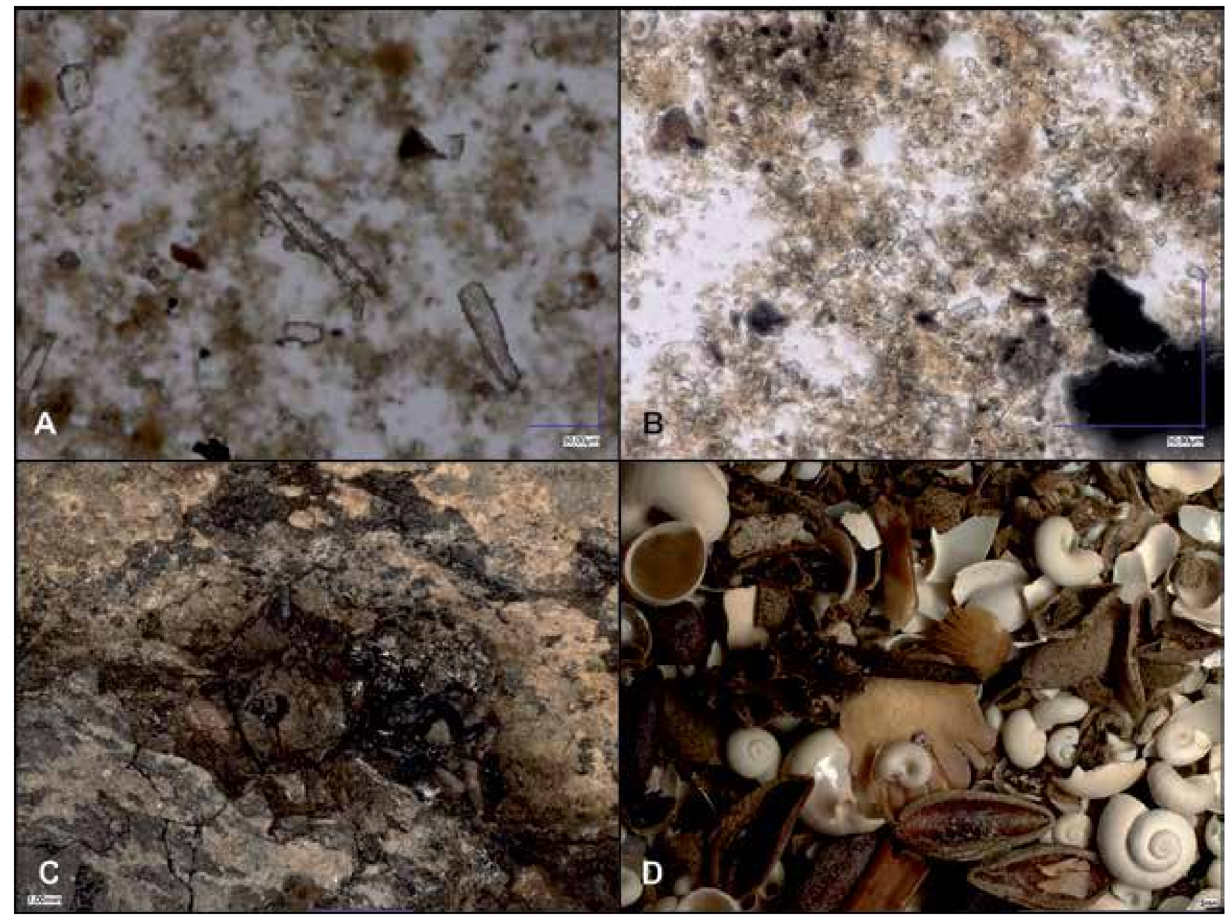

Figure 7. Exemplary photos of samples and slides observed in reflected and transmitted light:
A. Slide – phytoliths; B. Slide – phytoliths; C. Organic residue (crust) on pottery (Nowa Wieś, Site 11);
D. Palaeobiological remains from the peat bog in Nienawiszcz AZP Nos 47-28, Sample No 2.

Conclusions

The presented examples of imaging and digitally measuring archaeological artefacts are just an outline of the possibilities that exist in the use of microscopy in archaeological research and the direction of research development in the newly established ArchaeoMicroLab. The presented microscopic analyses of archaeological artefacts certainly do not exhaust the topic, but they are intended to show the great research potential of microscopic analyses and their application in examples of current research conducted in this laboratory. The authors of this text hope that micro-archaeological analyses in the laboratory of the Faculty of Archaeology of the Adam Mickiewicz University will develop in various directions through work on the projects carried out by the researchers from both the Faculty of Archaeology and other research units. On an ongoing basis, over the course of subsequent research and projects, a comparative collection of various materials (including contemporary ones) and their microscopic documentation in the form of digital photos are being created. The present authors intend to make them available in the future in the form of a digital database of the ArchaeoMicroLab. The current direction of research that is planned concerns primarily the analysis of archaeological artefacts made of various materials and the identification of micro-traces and organic residues (both plant and animal).

The equipment of the ArchaeoMicroLab is also intended to be used for training the undergraduate and graduate students of the Faculty in the microscopic techniques employed for archaeology and to encourage them to actively participate in the projects and analyses conducted in the Laboratory.

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