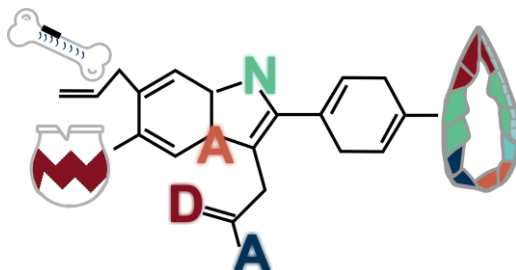


# New Approaches in Digital Archaeology

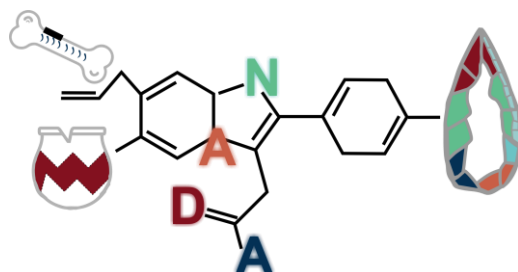
Book of abstracts

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## KEYNOTE SESSION



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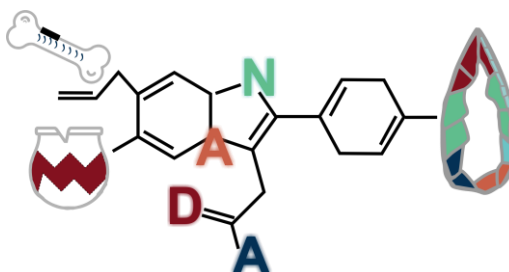
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## Session 1

# 3D- AND CT-SCANNING AND STATISTICAL METHODS IN BIOLOGICAL ANTHROPOLOGY AND PALEONTOLOGY

*Chair – Hugues Plisson*

The recent development of 3D imagery allows access to critical microscopic information at the surface and within internal structures of mineral and biological samples. The internal structure of the bones and teeth holds a significant amount of valuable paleobiological information for assessing taxonomy, phylogenetic relationships, functional, dietary and ecological adaptive strategies, and reconstructing overall evolutionary history. Non-invasive and non-destructive technologies based on X-ray microfocus (X- $\mu$ CT) microtomography are increasingly used to investigate the endostructural properties of fossil mineralized tissues. Confocal microscopy is a relatively new technique for the study of dental and archaeological artefacts microwear allowing quantification of the surface modifications previously unreachable with classic microscopic technics. Applied to the analysis of teeth surface, 3D rugosimetric analysis combined to morphometric data provides new insights on morphological adaptations (interplays between morphology, diet, and environmental constraints). Applied to the study of archaeological materials, roughness measurements using confocal microscopy allows for a quantified and reproducible distinction between various states of alteration among archaeological material and explore the complex taphonomical and functional histories of the artefacts. This session will focus on studies implementing these methods to examine biological and archeological remains.



## CUSTOM TOOLS FOR FINE GRAVING VISUALIZATION

Laurent LESCOP<sup>1</sup>, Lydia ZOTKINA<sup>2</sup>, Catherine CRETIN<sup>3</sup>

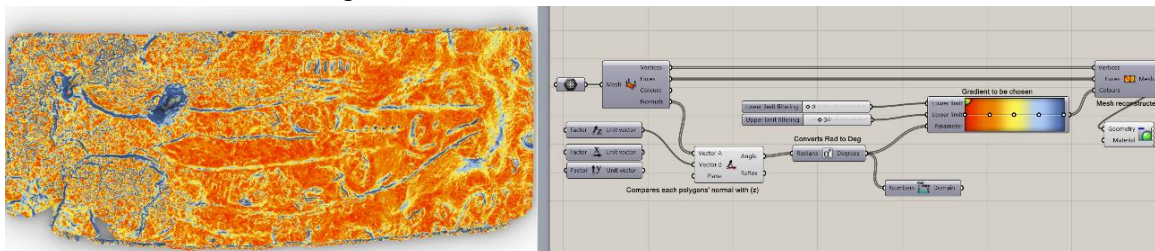
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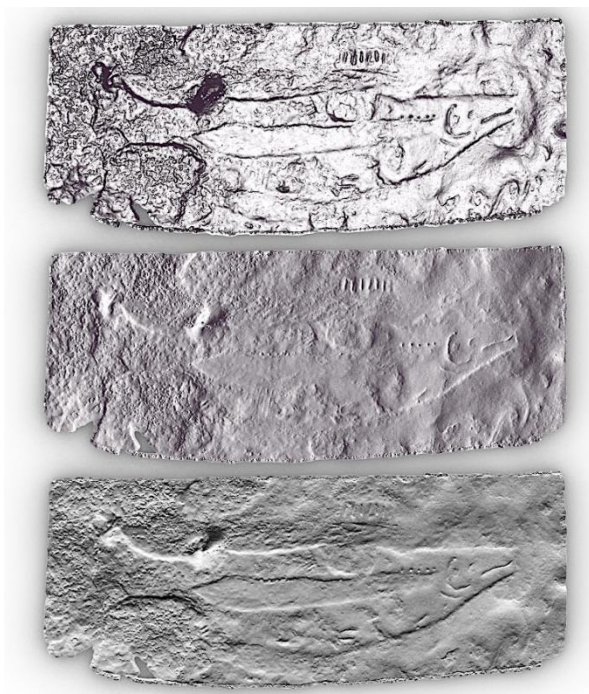
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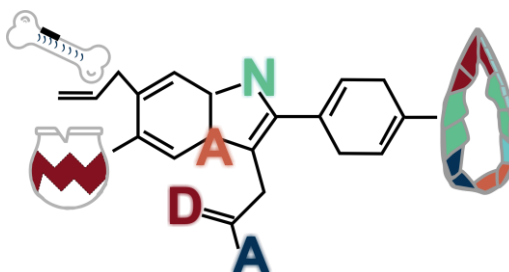
A preliminary study conducted in September 2016 in the Abri du Poisson, in the frame of Artemir French-Russian cooperation, established a high potential for techno-traceological information on the Fish Figure.



The detection of fine details is a significant challenge in the study of archaeological carvings. It is necessary to be able to distinguish between what is anthropic and what is natural, to establish a chronology, to comprehend the techniques of realization, and, eventually, to restore the original figures.



There are numerous techniques for this, ranging from stamping to directed light for analog techniques and color variation to deviation calculation for digital techniques. We describe a set of custom tools for calculating and visualizing fine details on a photogrammetric model in this presentation. The parametric software Grasshopper is used to create these tools. It enables very precise and interactive geometry analysis. The use of these custom tools forged with Grasshopper, revealed previously unseen details on the Abri du Poisson's parietal figure.





## FROM EUROPE TO SIBERIA: UNEXPECTED JOURNEY IN THE MIDDLE PALEOLITHIC (DENTAL EVIDENCE)

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<sup>2</sup> The Center of X-ray diffraction studies at the Research park of St.Petersburg State University, Russia

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Middle Palaeolithic Micoquian industries are widespread over vast territories of Northern Eurasia including Europe, the Caucasus, and Altai region of Siberia, where the easternmost Micoquian sites are found (Okladnikov Cave, Chagyrskaya Cave).

Here we undertake a taxonomic assessment and analysis of the biological affinities of a permanent upper second molars from the Rozhok I and Chagyrskaya Cave Micoquian sites, located in the Azov Sea and Altai region respectively.

We analyzed enamel-dentine junction topography and 2D- and 3D- enamel-thickness proportions. The EDJ morphology and volumetric characteristics of enamel and dentine permit classification of Rozhok 1 and Chagyrskaya samples as Neanderthals.

The results of comparative analysis of the external crown diameters reveal that Rozhok 1 and Chagyrskaya individuals is closely related with an Eastern European (Stajnia Cave) Micoquians, which is supported by the results of recent genetic studies.

## NEANDERTHAL BONE TOOLS; LOOKING FOR INTERNAL MARKERS FROM USE

Malvina BAUMANN<sup>1</sup>, William RENDU<sup>3</sup>, Ksenia KOLOBOVA<sup>4</sup>, Svetlana SHNAIDER<sup>4</sup>, Nicolas VANDERESSE<sup>2</sup>, Hélène COQUEUGNIOT<sup>2,5</sup>, Serge MAURY<sup>6</sup>, Hugues PLISSON<sup>2</sup>

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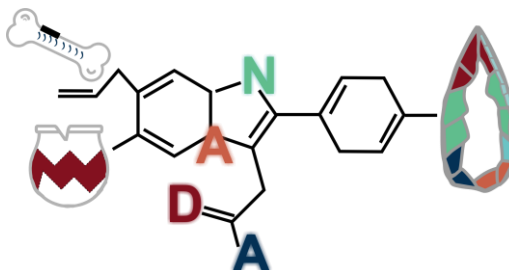
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<sup>4</sup> Institute of archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, Paleolithic Department, Russian Federation

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Among the common archaeological legends is that of the Neanderthals being unable to use bone materials. There are various reasons for this belief, but the main one is the difficulty



in identifying a bone industry that does not resemble those of the Upper Palaeolithic in both shaping techniques, functional categories and raw material. Classical typological criteria are not sufficient to establish the existence of a variety of bone tools in the Middle Palaeolithic, while the exploitation of the corresponding technological and traceological evidence requires a particular expertise. The presentation will show how microtomography can provide complementary clues for characterising "discrete" bone artifacts.

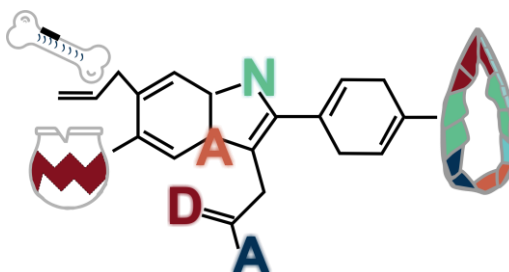
#### FROM MICROSTRIAE ON DENTAL ENAMEL TO CUT MARKS ON BONES: QUANTITATIVE STUDIES OF 3D SURFACES ACQUIRED VIA CONFOCAL MICROSCOPY

Antoine SOURON

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The use of confocal microscopy in paleosciences allows building high-resolution 3D models of various surfaces (dental enamel, bones, stones). Those models can then be subjected to quantitative analyses with low inter- and intra-observer errors to quantify the differences in surface topography. I present two examples: 1) dental microwear texture analyses to reconstruct paleodiets; 2) multivariate analyses of cross-section profiles (linear measurements and geometric morphometrics) to identify origin of bone surface modifications (cut marks, bite marks, trampling marks).



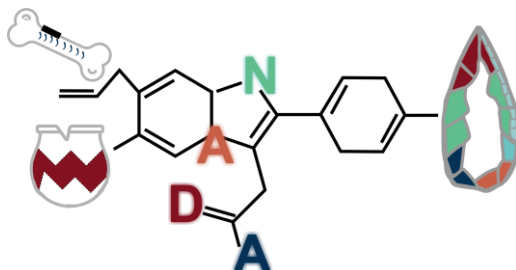


## Session 2

### COMPLEX DIGITAL AND COMPUTATIONAL METHODS IN LITHIC ANALYSIS AND ART (INCLUDING 3D GEOMETRIC MORPHOMETRY IN LITHIC AND BONE ARTIFACT STUDIES)

*Chair - Leore Grosman*

Recently, three-dimensional modeling of lithic and bone artifacts has become a widely accepted approach because, in addition to high-quality images, it makes obtaining new data possible. Such new data are not available by means of other methods, and improved research allows it to be verified, giving us all the opportunity to introduce new techniques and improve the scientific quality of our research. This session will discuss novel approaches to the study of stone and bone artifacts and portable art objects. Special attention will be paid to 3D geometric-morphometric analysis, including its advantages and disadvantages.



## FROM TRADITIONAL TO COMPUTATIONAL ARCHAEOLOGY

Leore GROSMA

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As the largest archaeological organization that runs around 300 excavations per year, the Israel Antiquities Authority has passed the turning point from old traditional documentation methods into the digital era. The huge amount of data accumulated annually at the IAA calls for a systematic and complete solution that goes beyond the feasibility test of scanning archaeological artifacts in 3D. The presentation will report on the innovative activity at our lab – 'The National Laboratory for Digital Documentation of Archaeological Artifacts'. The purpose of the lab is to harness mathematical and computational methods to support archaeological research, documentation and visualization. The laboratory is equipped with modern, high precision scanners which provide digital models of archaeological finds. We apply and continue to develop several tools and algorithms which are used routinely as the ultimate procedure for the analysis, publication and digital storage of the finds. A review of the latest studies will be presented together with the global activity of the lab.

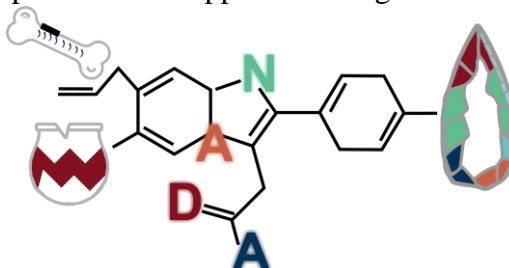
## TRACKING PREHISTORIC LEARNING COMMUNITIES – A 3D-BASED COMPUTATIONAL APPROACH TO LITHIC MANUFACTURING TRADITIONS IN THE FINAL UPPER PALAEOLITHIC AND EPIPALAEOLITHIC OF THE SOUTHERN LEVANT

Francesco VALLETTA

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We introduce a series of novel measuring tools for extracting local quantitative features from 3D models of flint cores. These features reflect technological traits of the lithic reduction sequence that, based on their different visibility and malleability, are more likely to be transmitted horizontally among interacting groups, or vertically between subsequent generations of the same community. Patterns in technological traits can, thus, be used to suggest the relations among lithic assemblages on different hierarchical levels.

The present study analyzes six core assemblages attributed to different cultural entities, representing chronologically separated Upper Palaeolithic and Epipalaeolithic occupations of the Ein Gev area and the Sharon Plain, in Israel. The results of our analysis allow to sort them in three separate learning communities. These communities can, in turn, be organized in two groups, reflecting the identity of the prehistoric knappers on a higher hierarchical



level. The ability to track prehistoric communities based on quantitative features allows to increase the objectivity and the resolution in the reconstruction of past cultural dynamics.

## THE NEW APPROACH TO STUDY BONE RETOUCHERS: SELECTIVITY AND MANIPULATION

Kseniya KOLOBOVA<sup>1</sup>, Vladimir M. KHAREVICH<sup>1</sup>, Willam RENDU<sup>2</sup>, Malvina BAUMANN<sup>3,4</sup>, Pavel CHISTYAKOV<sup>1</sup>, Anastasiya KOLYASNIKOVA<sup>1</sup>, John OLSEN<sup>5</sup>, Alena KHAREVICH<sup>1</sup>

<sup>1</sup> Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, Russia

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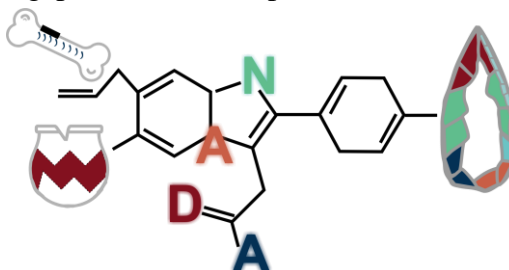
<sup>3</sup> PACEA, University of Bordeaux

<sup>4</sup> Traceolab, University of Liege

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When studying bone tools and, in particular, bone retouchers, researchers pay close attention to the morphological characteristics of the tool's active zone, and the lithic raw material processed. In our research, we found that the orientation of the bone retoucher in the hand and the grip employed to retain and manipulate it are crucial factors that affect the morphological characteristics of the retoucher's active zone. By examining two alternative grips for manipulating bone retouchers (1. Using all the fingers of one hand in a power grip; 2. Using only the first three digits of one hand – thumb, index, and middle fingers – in a pinch grip), we found that when the retoucher is held in the first manner, the active area is larger, as is the amount of bone removed by the retoucher. We calculated the volume of bone removed during the retouching process based upon our measurements of the 3D models' active area. To do this, we first determined the volume of the experimental retoucher. We then filled in a three-dimensional model of the retoucher, reconstructing the tool to its unused state, and measured the volume. The difference between the volume of the reconstructed and the used retoucher defines the volume of bone lost from the retoucher during use. When the retoucher was pinched with only three fingers in a precision grip, retouch damage was more densely concentrated and less bone was removed. The orientation of the retoucher in the hand and the grip employed have a greater influence on the active area than the extent of retoucher use, which we assessed by measuring the number of stone tool edges processed. By gripping the retoucher with all the fingers of one hand, the knapper automatically applies greater force, which results in the removal of more bone. When holding the retoucher with only three fingers in a precision grip, the knapper maintains greater control over the retouching process, so the percussive marks on the



retoucher are densely concentrated. Comparison of experimental bone retouchers with those recovered from Middle Paleolithic archaeological contexts in Chagyrskaya Cave (Altai Mountains, southern Siberia, Russia) revealed that Altai Neanderthals practiced two methods of grasping bone retouchers; with a three-finger pinch grip being dominant. We applied geometric-morphometric shape analysis to Middle Paleolithic bone retouchers from Chagyrskaya Cave. Geometric-morphometric analysis indicates that the anatomical origin of bone blanks does not significantly influence the retouchers' shape, which may point to strict blank selection and, at the same time, intentional modification. Our results raise questions regarding the integration of retouchers into a complex, multidimensional "*chaîne-opératoire*" as well as the nature of Neanderthal cognitive abilities.

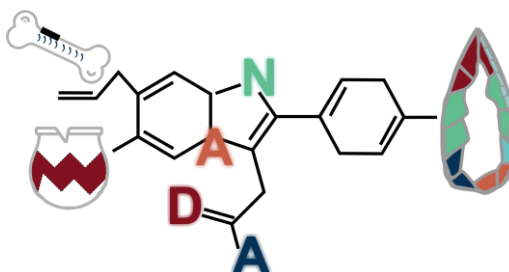
## ANDROID POWERED EXTENSION FOR LEICA TS FOR ARCHEOLOGY

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The Total Station (TS) is a irreplaceable tool during archeological excavations. While stand-alone TS is sufficient for many cases, measurements automation using third-party devices or application significantly simplifies the usage of TS. In our case the common such combination is Leica TS and EDM-mobile software that runs on Windows Mobile device. Unfortunately EDM-mobile software can not answer all our requirements anymore and modern replacement is required. To resolve this issue we developed new complex that consist of two separated parts: the transmitter part that connected to TS itself and that send/receive commands/answer to the application for Android powered smartphone/table through WiFi connection. Because of the chosen approach there are almost no requirements for Android device and almost any improvement could be done just by updating the application without changing the transmitter part. Our complex has been tested and polished on two sites: Chagyrskaya Cave, Russia, and Aktas, Kazakhstan. We believe this new complex could be a better and easier to use replacement for previously developed software complexes.



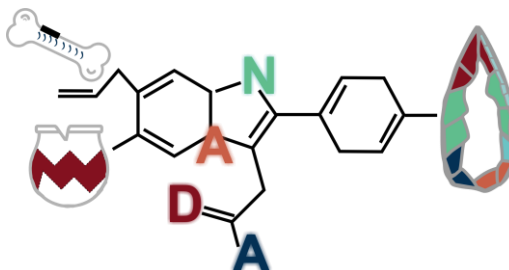
## Session 3

### INNOVATIVE VS. TRADITIONAL APPROACHES: WHY DO WE NEED BOTH TYPES OF METHODS?

*Chair – Malgorzata Kot*

The tremendous potential of new methods gives archaeologists new keys to unlock our understanding of past human beings. Current methods in the archaeological sciences often harness the power of 3D modelling, machine learning, and many types of analyses since they are able to detect new patterns, invisible to the human eye and standard or traditional approaches. The inclusion of evermore sophisticated techniques has provided archaeologists with a useful toolkit able to tackle different kinds of problems and research questions. But, is it possible to employ new methods separate from the classical tools of traditional archaeology? What can traditional archaeology still provide the researcher?

In this session, we will discuss new approaches in conjunction with traditional methods. We look forward to receiving presentations about projects and approaches combining traditional analyses and digital methods. We wish to discuss practical experiences and find the golden mean in using both research approaches, their combination and the importance of understanding when it is permissible to use them.



## THE USE OF PREDICTIVE MODELING IN THE SEARCH FOR PALEOLITHIC SITES IN THE WESTERN TIEN SHAN PIEDMONT

Małgorzata KOT<sup>1</sup>, Michał LELOCH<sup>1</sup>, Galina PAVLENOK<sup>2</sup>, Karol SZYMCZAK<sup>1</sup>, Mukhiddin KHUDJANAZAROV<sup>3</sup>, Konstantin PAVLENOK<sup>2</sup>

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The Western Tian Shan piedmont, due to its high mountainous nature, is an exceptionally difficult area in which to conduct systematic surface research. In response to the specificities of the landscape, we decided to attempt to use predictive modelling to select sites with the greatest potential for the occurrence and preservation of Pleistocene layers and Palaeolithic sites. The aim of the project was to determine to what extent the high-mountain areas of the Tian Shan piedmont were penetrated and inhabited by the Palaeolithic population. On the basis of the devised model, areas were selected for further prospecting in the field, which allowed the search area to be narrowed by a factor of five. In the course of the surface research carried out on the selected areas, it was possible to locate nine new Palaeolithic sites and 18 settlement spots within one season, significantly increasing the number of known open-air sites in the region.

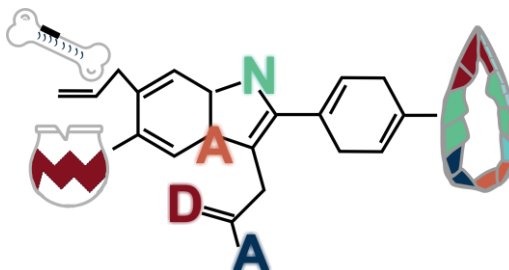
## TRADITIONAL APPROACHES AND 3D VISUAL TECHNOLOGY COMBINED FOR THE ANALYSIS OF THE INNER STRUCTURE OF AN ARTIFACTS' CONCENTRATION

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Tridimensional technology is being increasingly used in archaeological research; it fits well with traditional approaches and increases the analytical perspectives. Thanks to the combination of different software, we were able to develop a new method to virtually reconstruct artifacts' concentrations. This protocol was applied to a total of 123 lithic implements unearthed in the Gravettian, open air site of Piovesello, situated in the Italian northern Apennines. Standard documentation collected in 2013, consisting of pictures and quotes, was processed to place 3D models of each product in space. This allowed to recover





information lost during the excavation activity and to reconstruct the depositional process. Combining data about spatial relationship with the artifacts' features, six main phases were recognized, supporting the hypothesis of primary deposition. The application to experimental accumulations and the method's automation will provide useful tools to investigate even further the archeological contexts.

### USING SURFACE ANALYSIS TO UNDERSTAND OCHRE USE DURING THE MIDDLE STONE AGE

Daniela Eugenia ROSSO<sup>1</sup>, Francesco D'ERRICO<sup>2,3</sup> Alain QUEFFELEC<sup>2</sup>

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<sup>2</sup> PACEA UMR 5199, University Bordeaux, CNRS, France.

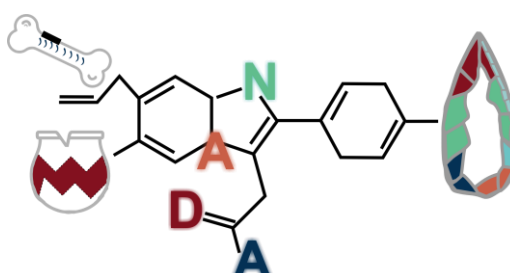
<sup>3</sup> SFF Centre for Early Sapiens Behaviour (SapienCE), University of Bergen, Norway.

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Ochre is a recurrent feature in numerous Middle Stone Age sites and is often interpreted as evidence for complex behavior. Over the past few years, different methods were developed to study ochre, including technological, petrographic, elemental and mineralogical analyses. Three-dimensional modelling techniques and surface texture analysis are still rare in ochre studies. Surface texture quantification allows to reduce intra-observer error and can provide important data on how ochre was processed. We present the technological and surface texture analysis of one of the largest known MSA ochre assemblages, comprising 40 kg of ochre, found at Porc-Epic Cave, Ethiopia, in levels dated to ca. 40 cal kyr BP. Our results identify patterns of continuity in ochre use interpreted as the expression of a cohesive cultural adaptation consistently transmitted through time. Evidence for the grinding of ochre with different tools to produce small quantities of ochre is consistent with a use in symbolic activities for at least part of the ochre assemblage.

### BISON SEX MATTERS: THE POTENTIAL OF USING THE METHOD OF DETERMINING THE SEX OF BISON BY PEPTIDOMIC ANALYSIS OF TOOTH ENAMEL TO SPECIFY THE SUBSISTENCE STRATEGES OF ANCIENT HUMANS

Nataliya BEREZINA<sup>1,3</sup>, Rustam ZIGANSHIN<sup>2</sup>, Kseniya KOLOBOVA<sup>3</sup>, Anna KOLIASNIKOVA<sup>3,1</sup>, Stanislav MEDVEDEV<sup>1</sup>, William RENDU<sup>4</sup>, Alexandra BUZHILOVA<sup>1</sup>



<sup>1</sup> Anuchin Research Institute and Museum of Anthropology, Lomonosov Moscow State University, Moscow, Russia

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<sup>3</sup> Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, Russia

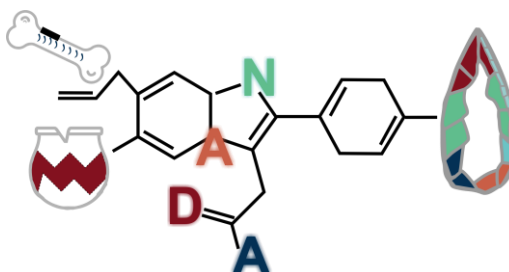
<sup>4</sup> ZooScan, CNRS, Institute of Archaeology and Ethnography SB RAS

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Determining the taxonomic affiliation and sex of animals based on fossil bone remains is one of the most important questions in studying the lifestyle of ancient people. The use of traditional morphological methods based on the analysis of skeletal markers of sex differences is often difficult due to the high degree of fragmentation of bone remains and the lack of morphological markers. Determining the species belonging by fragmentary bone remains in addition to traditional morphological methods, are currently effectively solved by the methods of genetic analysis and Zooarchaeology by Mass Spectrometry analysis (ZooMS). Another method for determining sex is the proteomic analysis of sex-specific amelogenin peptides in tooth enamel. Protein is considerably more robust than DNA molecules, particularly when it is physically associated with mineral surfaces such as tooth enamel. Therefore, it is the most appropriate approach for biochemical sex determination. This method was developed and successfully applied in the study of sex in archaeological skeletons of people of different antiquity and taphonomic preservation, both adults and children.

The investigation was conducted on the series of teeth of modern bison with known sexes and age, and several groups of ancient bison dated to Paleolithic period. Etching of tooth enamel and extraction of peptides were performed according to the modified technique developed in previous studies of human teeth. Liquid chromatography and mass spectrometry was performed with an Ultimate 3000 Nano LC System which was coupled to the Orbitrap Q Exactive Plus mass spectrometer via a nanoelectrospray source. MS/MS data were analyzed with the Peaks studio 10 (Bioinformatics Solutions Inc.). Peptide sequences generated by the PEAKS Studio were analyzed using the UniProtKB/Swiss-Prot (25.10.2019) database for *Bos taurus* (Bovine) as a reference. The list of identified proteins contains proteins for which at least two unique peptide sequences were determined.

On a control group of bison with known sex and age, the analysis conducted by blind test showed its effectiveness. The effectiveness on Bovinae is identical to the effectiveness of the same method for human samples. The presence of AMEX and AMELY genes in other animal species suggests the possibility of conducting a peptidomic analysis for sex determine. The method has also demonstrated its effectiveness on archaeological materials



dated to Late Pleistocene. Sex determination is possible and for the permanent and deciduous teeth.

Taking into account the fact that bison were often the main life-supporting strategies of the oldest Pleistocene populations, it is difficult to overestimate the prospects of this method for zooarchaeological and archaeological research.

## PRELIMINARY RESULTS OF APPLICATION OF SR ISOTOPIC COMPOSITION AND GEOCHEMISTRY ON THE INVESTIGATION OF PALEOLITHIC SITES

Arina KHATSENOVICH<sup>1</sup>, Irina VISHNEVSKAYA<sup>2</sup>, Evgeny MIKHEEV<sup>3</sup>, Tatiana OKUNEVA<sup>3</sup>, Dashzeveg BAZARGUR<sup>4</sup>

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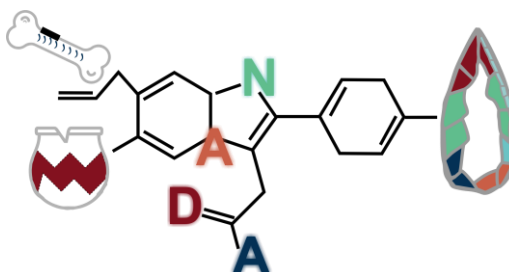
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The integrated study of various isotopic systems (C, O, N, Sr) reveals the paleodiets of both animals and humans and can facilitate the reconstruction of their migrations (Scharlotta, 2014). This approach assumes, first, the study of archaeological material, and the sampling of relevant remains, minimally impacted by post-depositional changes. Based upon research conducted both in the field and in the laboratory, we sampled visually intact animal teeth. We also sampled sediments underlying the analyzed bones. These sedimentological samples create an isotopic and geochemical baseline for comparison with results obtained from locally sourced bones. We studied ten sedimentological samples from Moiltyn-am, an equid tooth from Layer 8 at Orkhon-7, and a tooth identified as *Bos* (*Poephagus*) *baikalensis* from Layer 7 at Orkhon-1. Here we present the first results of <sup>87</sup>Sr/<sup>86</sup>Sr ratios study for sediment and bone samples from Orkhon valley, Mongolia.

## LITHIC USE WEAR ANALYSIS: TOWARD RECONCILIATION BETWEEN CLASSIC AND NEW APPROACHES

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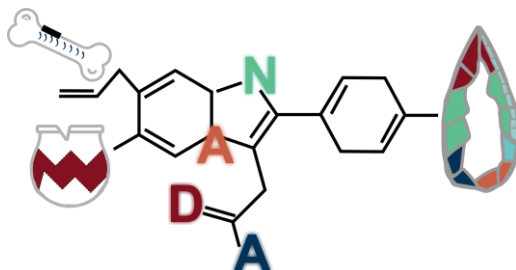
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Lithic use wear analysis has recently experienced a revival, partly associated with the introduction of new methods for data acquisition, such as 3D surface metrology. The infusion of new techniques and instruments has also fueled an interest in the fundamentals of how wear traces form, as well as in improving and democratizing the process of interpretation through the sharing of quantified experimental data and the standardization of protocols, both experimental and analytical. In this presentation, I will discuss the tensions between these new trends and the traditional traceological approach, attempting to reconcile the two.



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