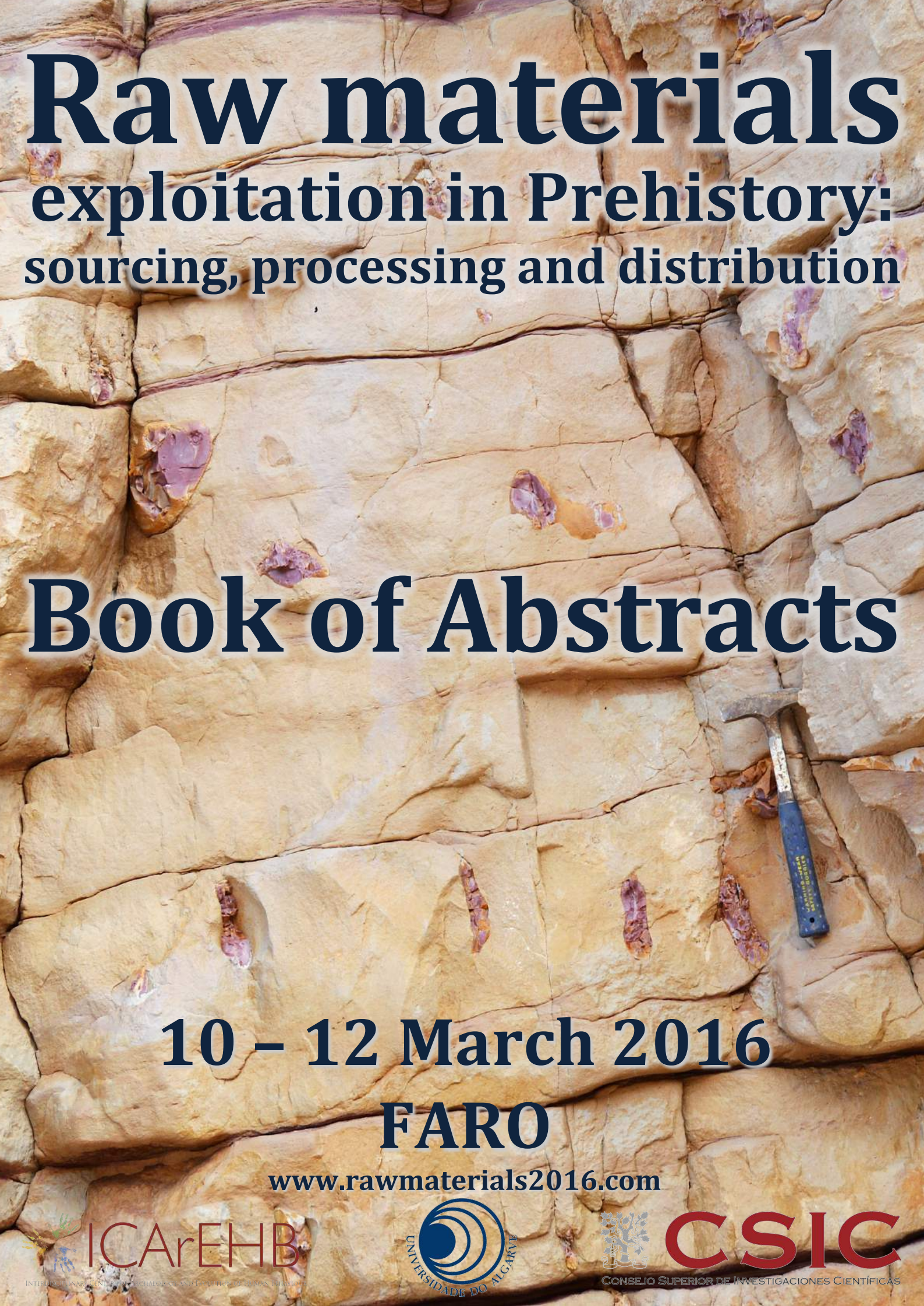
Raw materials exploitation in Prehistory: sourcing, processing and distribution

Book of Abstracts



10 – 12 March 2016

FARO

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ICArEHB

UNIVERSIDADE DO ALGARVE

CSIC

Consejo Superior de Investigaciones Científicas

University of Algarve

10, 11, 12 March 2016

Faro, Portugal

Cover image: Chert and chalcedony outcrop from Algarve, Portugal (photo: Telmo Pereira)

Book of abstracts of the Raw materials exploitation in Prehistory: sourcing, processing and distribution meeting

Designed by Telmo Pereira

Compiled by Telmo Pereira and Eduardo Paixão

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Welcome

Dear colleagues,

Greetings and welcome to the ***Raw materials exploitation in Prehistory: sourcing, processing and distribution***website.

The study of raw materials has been of major importance to infer important traits from past human populations. Among those traits one can name ecology, cognition, behaviour, technology, territory and social complexity. This has been possible to achieve across chronologies and regions. By merging archaeology with anthropology, geology and geography we have been able to acquire outstanding insights about those populations. In the last decades, these have been progressively refined due to the increased use of high-resolution methods and quantitative data, mostly brought by other fields such as physics or chemistry.

Considering such advances and the success of recent meetings, the **University of Algarve** with the **Consejo Superior de Investigaciones Científicas (IMF, Barcelona)** are pleased to announce the organization of an international conference focusing on ongoing projects studying the inorganic raw materials used during Prehistory entitled: ***Raw Materials Exploitation In Prehistory: Sourcing, Processing and Distribution***.

Topics are open to a diversity of issues, but we would like to give preference to high-resolution methods such as PIXE, XRF, EDS, mass spectrometry or other, because they give measurable data, progressively reducing the sometimes highly-criticized subjectivity of the available data; something which has been giving increased importance to archaeology and anthropology in the 21st Century. Applications of such methods to different inorganic materials (lithics, ceramics, metals, glass, beads, colorants, etc.) are welcome. Moreover, works emphasizing integration of results obtained on different subjects will be prioritized.

The number of studies is large and numerous projects using these methods are ongoing throughout the World and covering all Prehistoric periods. Therefore, a new meeting will be the perfect setup to present fresh and more mature information along with critical opinions on the advantages and limits of these methods.

Did you have frustrating results? Great! Come to Faro and show them; they will be crucial to discuss field and laboratory protocols along with applicability, ranges and limits of these methods.

The meeting will take place between the **10th and 12th March 2016** at the **University of Algarve**, Portugal.

Looking forward to meet you in Faro!

The coordinators,

Telmo Pereira (UAlg, Portugal) – telmojrpereira@gmail.com
Xavier Terradas (CSIC-IMF – Barcelona, Spain) – terradas@imf.csic.es
Nuno Bicho (UAlg, Portugal) – nbicho@ualg.pt

Organization & Scientific Committee

Organization

Telmo Pereira: Interdisciplinary Center for Archaeology and Evolution of Human Behavior, Universidade do Algarve (telmojrpereira@gmail.com)

Xavier Terradas: Consejo Superior de Investigaciones Científicas. IMF – Departamento de Arqueología y Antropología, Barcelona (terradas@imf.csic.es)

Nuno Bicho: Interdisciplinary Center for Archaeology and Evolution of Human Behavior, Universidade do Algarve (nbicho@ualg.pt)

Congress Secretariat

Eduardo Paixão: Interdisciplinary Center for Archaeology and Evolution of Human Behavior, Universidade do Algarve (eduardo.paixao88@gmail.com)

Scientific Committee

General information

How to arrive

Faro has an international airport located just 3km from the Campus Gambelas. There, you can find taxis that will bring you to the Campus Gambelas or to Faro downtown in just a few minutes.

In Faro downtown, you can find the train station and a bus stration, close to each other. They are aproximately 7km from the Campus and they both have taxis and bus stops that will bring you to the Campus. In both Sevilla and Lisbon you can find fast buses and trains to Faro.

If you chose coming by car, it is also easy to arrive to Faro and the Campus because there highways all through the way. If you are coming from Spain, just follow the indications Portugal, Algarve, Faro and if you are coming from North, follow the indications Algarve Faro.

Where to stay

Faro has a wide range of possibilities where you can rest during your stay in Faro. Hotels and hostals are constantly being upgraded and new ones opening. They targuet from exquisite costumers to easygoing bagpackers. So the best option is to check for rooms in the Internet since the prices can vary considerably. Take a look at:

www.booking.com/

http://www.budgetplaces.com/

http://www.hostelworld.com/

http://www.rumbo.pt/

www.trivago.pt/

Where to eat

The Campus Gambelas has several places, including a canteen, where you can lunch. In addition, there are also multiple places right next to to university entrance.

How to move

Campus Gambelas is approximately 7 km from Faro's city center. You can rent a car or use the urban bus lines that cross the Campus every 20 minutes (see next pages). The university will not be able to provide any shutle service.

Venues

The congress will be host in the Faculty of Economy from the University of Algarve, located in Campus Gambelas. The bus stop is right in front of the building where the congress will take place.

When you arrive just follow the indications for the congress room. A team of volunteers will be in the reception to give your documentation.

Schedule

Posters – Friday, 18h45

Timetable

10,Thursday		11,Friday		12,Saturday	
9h15-9h30	**Registration**	**9h00-9h20**	Context	**9h00-9h20**	Long Distance
9h15-9h30	**OPENING**	**9h20-9h40**	Context	**9h20-9h40**	Long Distance
9h30-9h50	Geochemical	**9h40-10h00**	Context	**9h40-10h00**	Long Distance
9h50-10h10	Geochemical	**10h00-10h15**	Discussion	**10h00-10h20**	Long Distance
10h10-10h30	Geochemical	**10h15-10h25**	Break	**10h20-10h40**	Long Distance
10h30-10h50	Geochemical	**10h25-10h45**	Prestige	**10h40-10h50**	Break
10h50-11h10	Geochemical	**10h45-11h05**	Prestige	**10h50-11h10**	Long Distance
11h10-11h20	Break	**11h05-11h25**	Prestige	**11h10-11h30**	Long Distance
11h20-11h40	Geochemical	**11h25-11h45**	Prestige	**11h30-11h50**	Long Distance
11h40-12h00	Geochemical	**11h45-12h05**	Prestige	**11h50-12h10**	Long Distance
12h00-12h20	Geochemical	**12h05-12h25**	Prestige	**12h10-12h30**	Long Distance
12h20-12h40	Geochemical	**12h25-12h45**	Prestige	**12h30-12h40**	Discussion
12h40-13h00	Geochemical	**12h45-13h00**	Discussion	**12h40-13h00**	**INVITED SPEAKER**
13h00-13h20	Lunch	**13h00-13h20**	Lunch	**13h00-13h20**	Lunch
13h20-13h40	Lunch	**13h20-13h40**	Lunch	**13h20-13h40**	Lunch
13h40-14h00	Lunch	**13h40-14h00**	Lunch	**13h40-14h00**	Lunch
14h00-14h20	Lunch	**14h00-14h20**	Lunch	**14h00-14h20**	Lunch
14h20-14h40	Geochemical	**14h20-14h40**	Pots	**14h20-14h40**	Heat Treatment
14h40-15h00	Geochemical	**14h40-15h00**	Pots	**14h40-15h00**	Heat Treatment
15h00-15h20	Geochemical	**15h00-15h20**	Pots	**15h00-15h20**	Heat Treatment
15h20-15h40	Geochemical	**15h20-15h40**	Pots	**15h20-15h40**	Heat Treatment
15h40-15h55	Discussion	**15h40-16h00**	Pots	**15h40-16h00**	Heat Treatment
15h55-16h05	Break	**16h00-16h20**	Pots	**16h00-16h20**	Quality
16h05-16h25	Colouring	**16h20-16-30**	Break	**16h20-16h40**	Quality
16h25-16h45	Colouring	**16h30-16h50**	Pots	**16h40-16h55**	Discussion
16h45-17h05	Colouring	**16h50-17h10**	Pots	**16h55-17h05**	Break
17h05-17h25	Colouring	**17h10-17h30**	Pots	**17h05-17h25**	Quarring
17h25-17h45	Colouring	**17h30-17h50**	Pots	**17h25-17h45**	Quarring
17h45-18h05	Colouring	**17h50-18h10**	Pots	**17h45-18h05**	Quarring
18h05-18h25	Colouring	**18h10-18h30**	Pots	**18h05-18h25**	Quarring
18h25-18h45	Colouring	**18h30-18h45**	Discussion	**18h25-18h45**	Quarring
18h45-19h00	Discussion	**18h45-20h00**	**POSTERS**	**18h45-19h00**	Discussion
				19h00-19h20	**CLOSING**

List of authors in alphabethic order

Abstracts -

Thursday, 10 March 2015 – 9h30

Geochemical-Mineralogical Provenance Determination Of Stone Tools And Their Archaeological Implications: Scientific Methods, Data Background And Data Evaluation

Stefanie **WEFERS -** i3mainz – Institute for Spatial Information and Surveying Technology, Mainz University of Applied Sciences, GERMANY (*stefanie.wefers@hs-mainz.de)*

Tatjana Mirjam **GLUHAK -** Institute for Geosciences, Johannes Gutenberg University Mainz, GERMANY *(gluhak@uni-mainz.de)*

The geochemical-mineralogical characterisation of raw materials used for stone tools together with the determination of their provenance plays a decisive role to promote our understanding of production, trade and distribution systems in the past. The analyses of stone tools often bear the potential to lead us to their raw material sources, and the intensive study of the variability of extraction sites through intensive sampling and their petrological analyses provide the necessary data background to reliably determine an artefact's provenance. In general specific rock types are chosen to produce certain tools, reflecting a preference which lies in the quality of the materials and various other technological-related characteristics, as e.g. durability, texture, hardness, weight, resistance to abrasion of the tools, or the possibility of a controlled raw material extraction in the quarry. Sometimes however, the selection of a certain raw material lies beyond the functional requirement, which indicates traditions for their manufacture. Furthermore, the specific raw material selection for specific tool types often means favouring non-local raw material, which consequently implies complex procurement and distribution systems. The untangling of these syst ems can only be achieved by reliable petrological provenance analyses of the raw materials used.

The session aims to be the frame for papers addressing their chosen geochemical-mineralogical methods for lithic raw material characterisation, the creation of data backgrounds for provenance analyses, data treatment and evaluation (e.g. statistic approaches, GIS evaluations etc.) linked to archaeological research questions.

- 9h30: Near Infrared imaging spectroscopy for lithic materials characterisation. From quantitative data to spatial analysis on a Mesolithic dwelling site in Northern Sweden.

Claudia Sciuto[1], Paul Geladi[2], Lorenza La Rosa[3], Johan Linderholm[1]

[1]- MAL_Environmental Archaeology Laboratory, Umeå University, Sweden
[2]- Swedish University of Agricultural sciences
[3]- University of Pisa, Italy

claudia.sciuto@umu.se

Key words: Stone tools, Mesolithic, Near Infrared Imaging spectroscopy, chemometrics

MOBIMA is a research project carried out at Umeå University which aims to develop non-destructive and image-based field techniques for chemical analysis. Within MOBIMA we test the application of Near Infrared imaging spectroscopy for lithic materials characterization.

Our paper will focus on the application of this technique on a dwelling site dated to mid-late Mesolithic at Lillsjön, Ångermanland, Sweden. The settlement was investigated in 2010-2012, the excavation revealed a semi-subterranean house surrounded by at least three lithic production activity areas. All the lithic material collected was scanned using a sisuCHEMA pushbroom shortwave infrared hyperspectral imaging system (spectral Imaging Ltd, Oulu, Finland) for acquiring images from 1000 to 2498 nm at intervals of 6-7 nm. The images obtained with the instrument were transformed into pseudo-absorbance using Evince image analysis software. The data were than processed by the standard normal variate and centred prior to principal component analysis. This method allowed us to identify spectral data from quartz, quartzite and flints making a quick quantitative evaluation of the different raw material types.

Hyperspectral NIR imaging enables scanning of huge quantities of finds in a short time frame. If then associated with the spatial coordinates of objects, NIR-based classification may contribute to a deeper understanding of the use of space in relation to different raw materials. Modelling together the data from the excavation and the hyperspectral images of finds we may create an integrated three dimensional platform on a software like ArcScene (Esri). The spectral information combined with intra-site spatial analysis, can show patterns in the distribution of different types of lithics within the site itself.

- 09h50: Non-invasive nuclear techniques applied to stone idols characterization: mobility and interaction in the recent prehistory of south Portugal

M. Isabel Dias[1], António Valera[2], M. I. Prudêncio[1], Boglárka Maróti[3], Ildikó Harsányi[3], Zsolt Kasztovszky[3]

[1]-Centro de Ciências e Tecnologias Nucleares. Campus Tecnológico e Nuclear, Instituto Superior Técnico, Estrada Nacional 10, ao Km 139,7 - 2695-066 Bobadela LRS - Portugal.
[2]-Era Arqueologia, Núcleo de Investigação Arqueológica – NIA. Cç. de Santa Catarina, 9C, 1495-705 Cruz Quebrada – Dafundo – Portugal. Interdisciplinary Center for Archaeology and Evolution of Human Behavior (ICArHEB, Universidade do Algarve, Campo de Gambelas, Faro, Portugal.
[3]-Centre for Energy Research, Hungarian Academy of Sciences, Budapest, Hungary.

isadias@ctn.tecnico.ulisboa.pt

Keywords: PGAA, PIXE, NR, stone idols provenance, Chalcolithic.

The Perdigões site is one of the largest known Portuguese Chalcolithic ditched enclosures, occupied during the late 4th - 3rd millenium B.C (Valera, et al. 2014), Reguengos de Monsaraz, South of Portugal. The burial remains are diversified comprising pottery, lithic artefacts, stone and bone idols, pecten shells, etc. (Valera, 2012a, b). Stone idols have different typologies and apparently are mostly made of marble or limestone, suggesting different origins for these artifacts, since both rocks do not occur locally, but regionally. Stone idols in Chalcolithic were also found in some archaeological sites from Estremadura and Southern Portugal.

This study aims to contribute to provenance issues, by means of compositional studies of both artefacts and potential raw materials (regional and trans-regional). In the case of carbonate rich idols, we are aware that marbles and carbonated rocks deriving from the metamorphic evolution of previous carbonates are difficult to identify, especially when only noninvasive analysis was possible. Elemental composition was obtained by Prompt Gamma Activation Analysis (PGAA) and External Beam PIXE (particle induced X-ray emission); homogeneity of the stone idol and the presence/absence of internal fractures were obtained by neutron radiography – all at the Budapest Neutron Centre (Zsoltan et al., 2015).

Obtained results are very promising and useful in general assessments of provenance. The stone artefacts at Perdigões show signs of both nearby and long distance procurement, as well as of unknown attribution, like it was already found for the ceramic materials (Dias et al, 2005). Furthermore, different raw material provenances seem to be associated with different contexts and rituals, deepening the contrasts that we can see between these funerary features in Perdigões.

It should be noted that the number of trace elements that can be measured by PGAA is restricted, thus restricting also the conclusions, although they have been relevant, especially when dealing with such heterogeneous geological sources.

Aknowledgements: C2TN/IST authors gratefully acknowledge the FCT support through the UID/Multi/04349/2013 project. Special thanks also to the CHARISMA funded project at Budapest Neutron Center (BRR-345).

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- 10h10: Geochemical Characterization of Paleolithic Obsidian Artifacts from Poland

Richard E. Hughes[1], Zofia Sulgostowska[2], Dagmara H. Werra, Dagmara H. Werra[2]

[1]-Geochemical Research Laboratory, 20 Portola Green Circle, Portola Valley, CA 94028
[2]-Institute of Archaeology and Ethnology Polish Academy of Sciences, Warsaw, 105, Solidarności Avenue, 00-140 Warszawa, Poland

rehughes@silcon.com

Keywords: geochemical characterization – obsidian artifacts – Late Paleolithic – Poland

Upland areas of Poland contain easily accessible outcrops and exposures of large nodules of macroscopically and chemically diverse, high quality, flint that was collected from the surface and mined extensively during all periods of prehistory. The mobile lifestyle of the Late Paleolithic and Mesolithic societies, living in what is today Poland, facilitated the broad distribution of these flints to territories several hundred kilometers from the outcrops.

Despite the predominance of local flint, exotic (i.e., non-local) raw materials – among them radiolarite and obsidian- are occasionally found in Poland. These are most common during later prehistoric times, but obsidian has been recovered in small numbers beginning from the Late Paleolithic period.

The nearest and most important artifact-quality obsidian sources (known as Carpathian 1 and 2) are located beyond southern border of Poland in southeastern Slovakia and northeastern Hungary. The prehistoric use of these sources has been well documented in adjacent areas, but practically nothing is known about their prehistoric significance during different periods of Polish prehistory.

To remedy this situation, we present here the results of non-destructive x-ray fluorescence ("source") characterization of 85 Paleolithic artifacts from 17 archaeological sites in Poland. The results from these sites, located between 180 to 450 km from the obsidian sources, provide a geochemically documented baseline for Paleolithic obsidian use in Poland, which can be compared and contrasted with the distribution, context, and frequency of obsidian use during later archaeological periods.

- 10h30: Hominin stone resources use along the West Coast of South Africa in the Mid-Pleistocene: Evidence from Elandsfontein

David R. Braun[1], William Archer[2], Naomi E. Levin[3], Matthew Shaw[4], Jessica Plasket[4]

[1]-George Washington University,
[2]-William Archer, Max Planck Institute for Evolutionary Anthropology Robyn Pickering, University of Cape Town
[3]-Johns Hopkins University
[4]- University of Cape Town

david_braun@gwu.edu

Keywords: Provenance, silcrete, granite, Acheulean, South Africa

Although formal investigation of the site of Elandsfontein began over 5 decades ago, the artefacts from this 1million-600,000 year old locality have received little attention. Elandsfontein is situated in a large dunefield on the western coastal plain of South Africa and includes a rich fossil assemblage, including hominins. Recent excavations have documented the in situ association between stone artifacts and fossils. Here we provide the first comprehensive review of the stone raw materials that were used by hominins at this locality. A large-scale survey combined with geochemical provenance studies allows us to develop a model of raw material availability along the western coastal plain of South Africa. We employ XRF to identify the major source of plutonic and volcanic rocks along the western coastal plain. Minor and trace element chemistry suggests that hominins transported certain rock types from isolated volcanic outcrops in the adjacent Saldanha Bay region. We employ ICP-MS on silcretes to identify rare earth element profiles of major groups of silcrete along the western coastal plain. Data suggest that silcretes can be distinguished by the underlying geology upon which ancient soils formed. We conduct intensive within outcrop studies to explore the variation in these signatures. Our data suggest that virtually none of the rocks utilized by hominins at Elandsfontein were available locally and that the sources range between 9 and 15 kms. away from archaeological sites. We combine this data with a variety of other contextual data about the archaeological collections to identify patterns of landscape use among hominin communities that lived in this area over 600,000 years ago.

Acknowledgements: This research was supported by an award from the National Science Foundation BCS-1219455.

- 10h50: Siliceous raw material sources at la Sierrita de Ticul, Yucatan, Mexico: a first approach of lithic procurement during late Pleistocene and early Holocene in the Maya lowlands

Ma. Alejandra Espinosa[1], Gabriela Armentano[2]

[1]- Facultad de Ciencias Antropológicas, Universidad Autónoma de Yucatán, km. 1 carretera Mérida-Tizimín, Cholul, C.P. 97305, Mérida, Yucatán, México.
[2]-UMR 7041 ArScAn-AnTET, Université Paris Ouest, Nanterre-La Défense,
France.

maeva1999@yahoo.fr

Keywords: Geoarchaeology, Lithic Technology, Quarry Identification, Maya Lowlands, Yucatán

In the state of Yucatan, Mexico, geological studies that identify and determine siliceous rocks and other local raw materials employed for knapping stone tools at archaeological sites are virtually non-existent. The geological origin of the archaeological pieces has been hypothesized or inferred from nonsystematic studies that lack macro- and microscopic descriptions of the materials or geomorphologic and petrographic considerations. Recently, we carried out initial prospections in the Sierrita de Ticul area and corroborated the presence of rock formations containing a high proportion of silica. During field investigations we collected geological samples and subjected them to petrographic (thin sections) and chemical analysis as well as X-ray diffraction in order to determine precise composition and genesis of the rocks. This paper presents our preliminary results, which can be summarized as follows:- Development of a regional lithic resource base (sensu Ericson 1984) for the state of Yucatan. Data of such resources were incorporated cartographically through a Geographical Information System allowing location and accurate identification of the different regional sources. Accordingly, it has been possible to:

- Estimate de physical characteristics of the rocks suitable for knapping activities and to establish an experimentation protocol.

- Information on the origin of some rocks represented in the archaeological collection of the Loltun Cave. Since preservation of the available archaeological stone tools is essential, these were exclusively analyzed through non-invasive analytical techniques (macroscopy and visual recognition).

This work provides new elements, nowadays fundamentals for any study on archaeological lithic materials, such as the application of geological techniques (macroscopy, petrographic, and geochemical analysis), detailed descriptions of sources, estimates of mineral resources, and comparison of archaeological materials with the collected geological samples.

- 11h20: The Irish Lithic Landscapes Project: a raw material provenancing project integrating geochemical (ED-XRF) and petrographic analyses of material from prehistoric Ireland

Killian Driscoll[1], Adrian Burke[2], Xavier Mangado[3], Graeme Warren[1], Gabriel Cooney[1]

[1]- University College Dublin. School of Archaeology, Newman Building, UCD, Belfield, Dublin 4, Ireland
[2]-Université de Montréal. Département d'anthropologie, Université de Montréal, 3150 Jean-Brillant, Montréal, QC H3T 1N8, Canada
[3]-Universitat de Barcelona. Dept Prehistòria, Història Antiga i Arqueologia, Universitat de Barcelona, Montalegre, 6, 08001 Barcelona, Spain

killiandriscoll@gmail.com

Keywords: Provenancing, geochemistry, petrography, chert, Ireland

The Irish Lithic Landscapes project is investigating the places where prehistoric communities obtained the raw materials for their flaked stone tools during the Irish Mesolithic, Neolithic, and Early Bronze Age, which dates to c. 8,000–2,000 B.C. While Ireland has a very rich archaeological heritage, there is a significant gap in the island's raw material sourcing research. This project is beginning to fill this gap, and therefore deepen our understanding of the prehistoric communities there. The analysis is using non-destructive energy dispersive X-ray fluorescence (ED-XRF) as a first-order technique to determine chert whole-rock geochemistry, and petrographic analysis.

The first phase of the project (2013-2015) included geological prospection centred on the northwest of Ireland in an area dominated by Carboniferous chert, and includes case study assemblages from domestic sites and ritual sites such as megalithic tomb complexes. During the 2014 field season we collected over 400 geological samples from over 400 survey points, which included examining c. 250 outcrop groups. The project's second phase (2015-2017) is focusing on the Cretaceous chert from Ireland, which is found in situ principally in the northeast of the island; this phase also includes a series of beach pebble surveys around the island to examine surficial deposits. A significant part of this project is the creation of a lithoteque reference collection of Irish cherts; this will be physically housed at the UCD School of Archaeology, Ireland and accompanied by a web-based, spatial database, open for use by other researchers.

- 11h40: The Multi Layered Chert Sourcing Approach (MLA) using LA-ICP-MS and CODA

Michael Brandl[1], Christoph Hauzenberger[2], Maria M. Martinez[3], Peter Filzmoser[4]

[1]-Austrian Academy of Sciences, Inst. OREA, Fleischmarkt 22, 1010 Vienna, Austria
[2]-University of Graz, Dept. of Earth Sciences, Universitätsplatz 2, 8010 Graz, Austria
[3]-University of Texas at Austin, Department for Anthropology
[4]-Vienna University of Technology, Department of Statistics and Probability Theory

michael.brandl@assoc.oeaw.ac.at

Keywords: Chert sourcing – MLA – microscopy – geochemistry – Compositional Data Analysis

Provenance studies of chert and flint raw materials (silicites) are an important component of archaeological research. The identification of the sources of rocks used for the production of chipped stone tools is the gateway to any further investigations concerning prehistoric resource management strategies. Chert source provenance studies thus play a significant role in the interpretation of lithic assemblages concerning the procurement, processing and distribution of lithic raw materials, e.g., revealing routes of migration, intercultural exchange and circulation networks.

A transdisciplinary concept (the Multi Layered Chert Sourcing Approach, short MLA) presents a clear possibility for successfully sourcing chert and flint. The proposed method consists of a tripartite analytical system: Visual (macroscopic), microscopic and petrological/geochemical. For geochemical analysis, Laser Ablation-Inductively Coupled-Mass Spectrometry (LA-ICP-MS) is applied. LA-ICP-MS allows for the detection of main-, trace- and ultra-trace element concentrations (-0,1 ppm) in rock materials and has been well established in lithic raw material research. The multivariate geochemical datasets are subsequently evaluated by applying Compositional Data Analysis (CODA). Since CODA is concerned with the ratios between values, raw composition data (i.e. the absolute measured values) need to be transformed into the Euclidean geometry system where statistical methods can operate. After transformation, discriminant analysis (DA) is applied for classification. Fisher's linear discriminant analysis is best suitable to achieve optimal group separation of training data derived from known geological sources. This analytical step generates pre-defined groups from the training data. The resulting discriminant rules are used for classifying and assigning the test data (i.e. the investigated archaeological specimens) to these pre-defined groups.

We demonstrate the potential of the MLA in two case studies: Sourcing of radiolarites from the Lower Austrian Krems–Wachtberg site (Upper Palaeolithic) and the characterisation of Holy Cross Mountain “chocolate silicites” (Poland). Our results illustrate that it is not sufficient to rely on a single analysis method for chert sourcing. A combination of the proposed techniques produces the most robust data base for a secure characterisation and source separation, including the possibility to lay weight on the performed method(s) that produced the best results, which is not in all cases geochemistry and statistical analysis.

- 12h00: Sourcing of flint artefacts from western Belgium and the German Rhineland: using visual and geochemical methods following a multi-layered approach

Luc Moreau[1], Michael Brandl[2], Peter Filzmoser[3], Christoph Hauzenberger[4], Éric Goemaere[5], Ivan Jadin[6], Hélène Collet[7], Anne Hauzeur[8], Ralf W. Schmitz[9]

[1]- Luc Moreau, McDonald Institute for Archaeological Research, University of Cambridge, Downing Street, Cambridge CB2 3DZ, United Kingdom..
[2]-OREA – Institute for Oriental and European Archaeology, Quaternary Archaeology, Austrian Academy of Sciences, Vienna, Austria.
[3]- Department of Statistics and Probability Theory, Vienna University of Technology, Austria.
[4]-Department of Earth Sciences, Karl-Franzens-University of Graz, Austria.
[5]-Geological Survey of Belgium, Royal Belgian Institute of Natural Sciences, Brussels, Belgium.
[6]-Quaternary Environments & Humans, Royal Belgian Institute of Natural Sciences, Brussels, Belgium.
[7]-Service public de Wallonie, service de l'Archéologie en Hainaut, Belgium.
[8]-Paléotime, France, and cooperation partner of the Royal Belgian Institute of Natural Sciences, Belgium.
[9]-LVR-LandesMuseum Bonn, Rheinisches Landesmuseum für Archäologie, Kunst- und Kulturgeschichte, Bonn, Germany.

moreau@rgzm.de

Keywords: Flint; Sourcing; LA-ICP-MS; Gravettian; Mobility

Identifying the geological and geographical origin of lithic raw materials is critical to effectively address prehistoric forager raw material economies and mobility strategies. Currently, Palaeolithic archaeology in Belgium lacks a systematic sourcing strategy to effectively substantiate detailed interpretations of prehistoric hunter-gatherer behavioural change across time and space. This paper evaluates the potential to "fingerprint" flint from the Mons Basin, western Belgium, applying the Multi Layered Chert Sourcing Approach (MLA). The latter combines visual and geochemical analyses including the use of Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) in concert with multivariate statistical analyses. Through the analysis of geological samples and Gravettian period lithic artefacts we reappraise two hypotheses raised by previous scholars based on visual raw material identification: 1) the Gravettian occupants of Maisières-Canal supplied themselves with "black flint" from one single source; 2) the sites Rhens and Koblenz-Metternich yielded artefacts indicative of long-distance transfer of western Belgian flint into the German Rhineland, ca. 260 km from the primary source area. Our results demonstrate the validity of LA-ICP-MS data with flint and compositional data analysis for fingerprinting discrete geological formations from the Mons Basin.

- 12h20: How useful are Petrological and Geochemical Methods in Identifying Upper Jurassic "Chocolate" Flint in Central Poland?

Dagmara H. Werra [1], Richard E. Hughes[2], Rafał Siuda[3]

[1]- Institute of Archaeology and Ethnology Polish Academy of Sciences, Warsaw, 105, Solidarności Avenue, 00-140 Warszawa, Poland
[2]-Geochemical Research Laboratory, 20 Portola Green Circle, Portola Valley, CA 94028
[3]- Institute of Geochemistry, Mineralogy and Petrology, Faculty of Geology, Warsaw University, Warsaw, 93 Żwirki i Wigury Avenue, 02-089 Warszawa, Poland

werra@iaepan.edu.pl

Keywords: petrology, geochemistry, siliceous raw materials, "chocolate" flint, Poland

One of the more important research avenues in Stone Age archaeology involves investigating the social mechanisms responsible for the widespread distribution of siliceous rocks. But before this can be done, replicable methods need to be in place to allow for precise identification of such rocks. Visual (macroscopic) methods of differentiation have met with limited success, and often tend to be subjective. By contrast, instrumental methods provide the opportunity for independent classification based on geochemical and petrological criteria, and have the potential to discriminate among otherwise visually similar silicic rocks. In 2012, supported by funds from the National Science Centre in Poland (PRELUDIUM 2; UMO-2011/03/N/HS3/03973), we undertook a project to apply various instrumental methods to distinguish different varieties of siliceous rocks, with emphasis on developing a more precise description of diagnostic features of "chocolate" flint. Our study focused on the Vistula River basin because several varieties of flint ("chocolate" flint, grey white-spotted, striped, Jurassic-Cracow and, on the eastern fringes of the region, Volhynian flint) used in prehistoric times occur in this area. In the past three years we have analyzed more than three hundred samples using several different methods: Scanning Electron Microscope (SEM), analyses of molecular composition of organic compounds, Cathodoluminescence, energy dispersive X-ray fluorescence (EDXRF), Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), Electron Probe Micro Analysis (EPMA) and micropaleontological analysis.

"Chocolate" flint was used by communities from the Middle Paleolithic up to the Early Iron Age. At present we know of 26 exploitation points of this flint, forming the most numerous complex of prehistoric mining fields in Poland. This talk presents a summary/overview of our results so far, with attention to the advantages and disadvantages of different instrumental methods to distinguish among various flints in Poland.

- 12h40: Research procedures for sourcing raw materials of the Stone Age flint tools found in Latvia

Liga Zarina, Valdis Seglins

University of Latvia, Faculty of Geography and Earth Sciences, Jelgavas 1, Riga, LV-1004.

Liga.Zarina@lu.lv

Keywords: flint and chert, non-destructive methods, ultraviolet light, XRF method

Previous studies indicate that most of the typical finds of Palaeolithic and Mesolithic tools in territory of Latvia are made of non-local raw material, but so far the clear indications of source material are not known.

In the study were used geological samples of flint and chert from Latvia, and samples from sites in Lithuania, Belarus, Poland, Denmark, United Kingdom, Sweden and Russia, where this valuable raw material was obtained or used during the Stone Age. In addition, flint artifacts, collected during Institute of Latvian History excavations in the Slocene settlement and Lapini settlement were studied. The largest share of attention was paid to development of methodology of evaluation of macroscopic and microscopic properties of flint, and analysis of flint chemical composition to distinguish samples with different genesis and samples from different or the same sampling site. The research specifics were defined by the archaeological importance of artifacts, and non-destructive research methods were chosen as the basic methods.

Macroscopic study of flint was performed by expanding observations from spectrum of visible light to diapason of ultraviolet light, since it allows identification of many additional structure elements and heterogeneities of the material. Separate properties of flint were determined in ultraviolet light also microscopically. Initially, this approach allows distinguishing characteristics of individual samples and it is possible to characterize these samples more fully. Further it is possible to identify a set of several characteristic features inherent to the individual samples, including common features of a particular sampling site. It allows selecting typical parts of a sample for further composition analysis in order to gain justified and comparable data. The chemical composition analysis was carried out using X-ray fluorescence spectrometry (XRF) method.

The research confirms the variety of flint properties even within small surface area, and that typical and comparatively heterogeneous sections can be established in ultraviolet light. The results obtained allow concluding that in order to gain comparable data on the physical properties and chemical composition of flint, it is necessary for the researches to be carried out systematically and targeted, by following a pre-defined organization and procedure of the research.

- 14h20: Compositional variability of flint and implications in the identification of raw materials sources of pre-historical artefacts, Eastern Spain

C. Roldán[1], A. Eixea[2], V. Villaverde[2], S. Murcia[1], I. Prudêncio[3], M.I. Dias[3], R. Marques[3]

[1]- Instituto de Ciencia de Materiales (ICMUV). Universitat de València. Spain

[2] Departamento de Prehistoria y Arqueología. Universitat de València. Spain

[3]- Centro de Ciências e Tecnologias Nucleares (C2TN). Instituto Superior Técnico, Universidade de Lisboa. Portugal

Keywords: EDXRF, XRD, INAA, flint provenance, Palaeolithic.

Flint is an abundant material in Paleolithic archaeological sites especially due to their hardness and the ease of producing conchoidal fractures with sharp edges, being a very suitable raw material for making tools (scrapers, points, etc). In this paper flint samples from the archaeological site "Quebrada shelter" (Chelva, Valencia - eastern Spain) and from geologic formations in the same area were analyzed. Macroscopic characterization has identified archaeological flint similar to Chelva outcrops (local flint Domeño type) and flint with different characteristics (allochthonous flint). In order to find patterns of similarity that may relate sources of raw materials and mobility of human groups, samples of "Quebrada shelter" were compared with those of the deposits of "Cova Negra" (Xativa, Valencia) and "Cova de les Cendres" (Moraira, Alicante) and with the flint outcrops Serreta type of the geographic area of Alcoi (Alicante).

Macroscopic characterization techniques were first applied enabling to identify colour, texture, inclusions, grain size and other properties. Afterwards samples were analyzed by non-destructively methods by using energy dispersive X-rays fluorescence (EDXRF) for the identification of major and minor elements. Due to the limitations of EDXRF for detecting trace elements, samples were than analysed by a micro-invasive method - neutron activation analysis (INAA), allowing the determination of trace elements with a range of concentrations between 0.01 and 100 ppm. Finally, a set of geological and archaeological samples were analyzed by X-rays diffraction (XRD) to identify the crystalline phases and to determine its crystallinity index (CI).

Multivariate statistical analysis of data obtained by INAA and EDXRF and CI determination on quartz by XRD have proven to be suitable methods to discriminate samples of local and allochthonous flint consistent with the macroscopic classification.

- 14h40: A Multi-Method Approach for Characterizing Chert Geochemical Variability at Azinheira-Rio Maior, Portugal: The RMAR Online Database

Paul Thacker

Wake Forest University, Department of Anthropology, Box 7807, Wake Forest University, Winston Salem, NC 27109 USA

thackep@wfu.edu

Keywords: chert geology, raw material sourcing, lithic economy

The chert deposits located near Azinheira and Rio Maior, Portugal, are among the most well-known flaked stone raw material sources in western Iberia. Plentiful and large-sized chert cobbles occur in secondary depositional context in cemented Miocene sand beds or reworked within Plio/Pleistocene gravels. Azinheira Ridge chert was knapped and transported over long distances beginning in the Upper Paleolithic; Azinheira also was the center of Portuguese gunflint and strike-a-light manufacturing until the 19th century. The geographic extent of the chert deposits was mapped over five seasons of fieldwork with systematic samples of cobbles analyzed to detail variability in color, texture, luster, and weathering rind/cortex. Over 2,330 cobbles were studied in the field with a subsample of cobbles sectioned for extensive laboratory investigation of all major variants. The remarkable textural and geochemical variability present at Azinheira stems from both a diverse chert formation and diagenetic history and significant disparity in local weathering conditions. High intra-source geochemical variability overlaps with that reported from chert deposits in other regions of Portugal. The RMAR open-access database, debuted at the Raw Materials-Faro2016 conference, makes available macroscopic imagery, textural, magnetic (κ and χfd), and geochemical (pXRF and XRD) data on the full range of Azinheira-Rio Maior cherts. Distribution of cobble sizes with both displacement volume and surface area data also are provided, information useful for modeling archaeological lithic economy and transport costs. This integrated approach to sampling and characterizing the Azinheira-Rio Maior chert deposits is an essential step for robust and anthropologically-parsimonious sourcing interpretations.

- 15h00: Preliminary geochemical results (ICP-MS) of flint debitage from a newly discovered mega extraction and reduction area in the Eastern Galilee, Israel

Meir Finkel[1], Ran Barkai[1], Erez Ben-Yosef[1], Ofir Tirosh[2] and Avi Gopher[1]

[1] Department of Archaeology and Near Eastern Cultures, Tel Aviv University
[2] The Institute of Earth Sciences, The Hebrew University of Jerusalem

Finkel2010@gmail.com

Key Words: Flint, ICP-MS, Eocene, Galilee, Quarries

Recently found open air flint extraction and tool manufacturing sites in Eastern Galilee, Israel, are the focus of this presentation. Lithic assemblages from these sites indicate late Lower Paleolithic/Middle Paleolithic and Neolithic/Chalcolithic activities. These discoveries substantially revise our knowledge on the scope of lithic extraction and reduction in northern Israel at these periods. The new sites are located along a 30 km outcrop of flint-bearing Eocene limestone indicating intensive extraction of large amounts of flint, possibly beyond immediate local consumption. Thus, a key question is the extent of the flint distribution area. Identifying indicative geochemical markers of the flint found at the research area may enable cross-referencing with flint artifacts excavated at Prehistoric sites in the region like the nearby Wadi Amud caves, and beyond. While it is common to try and match flint finds from prehistoric sites to possible raw material sources around them, here we focus on the raw material sources and present preliminary results of a detailed geochemical study using ICP-MS. Samples of flint debitage from the northern and middle parts of the outcrop (Nahal Dishon, n=30 and Achbara, n=20, respectively) were analyzed at the Geochemical Laboratory of the Institute of Earth Sciences, The Hebrew University of Jerusalem. The results, which include 40 different elements, enable the geochemical characterization of the Eastern Galilee flint source. Differences between the two sample groups in 12 rare earth elements and Ca suggest the possibility of distinguishing between specific quarrying areas within the mega-extraction zone. Thus, the new finds encourage a detailed characterization of the whole extraction strip and later on, an attempt to match the results with known prehistoric sites in the region, and beyond.

- 15h20: The Zambujal's arrowheads: a petroarchaeologic approach to flint's provenance determination

Patrícia Jordão[1], Nuno Pimentel[2]

[1]-Museu arqueológico de S. Miguel de Odrinhas (Sintra)
[2]- Universidade de Lisboa

Keywords: Source-areas; Flint; Petroarchaeology; Chalcolithic of Estremadura; Zambujal

This contribution is part of a larger work in which the study of the siliceous resources' procurement and management from the chalcolithic enclosure of Zambujal is being approached. A petroarchaeological methodology with comparative analysis between archaeological and geological materials is being pursued, aiming the identification of the flint´s source areas for the archaeological artifacts. The techno-typological analysis of the arrowheads has been concluded and this will allow to determinate the raw material's strategies of procurement, used to make more than one thousands of these artefacts.

A mesoscopic petrographic analysis, both from geological and archaeological samples has been developed and through the identification of the siliceous microfacies and weathering veneers, we tried to recognize the history of the flint and characterize the potential source-areas, from their primary to secondary sources and then to their use in artifacts.

As preliminary conclusions, it may be stated that most of the artifacts are interpreted as resulting from siliceous materials collected along the quaternary terraces of the Sizandro River, West of Torres Vedras, where decimetric-sized flint cobbles are visible at the topographic surface c. 2,5 km NW of Zambujal site. These cobbles seem to have resulted from the erosion and transport of flint nodules mainly from the Paleogenic formations and also from the Cenomanian reefal limestones outcropping c. 7 km E of Zambujal site, close to Runa. From the above, it is suggested that the main source for the silicieous materials used to produce arrowheadws has been the closest, easiest and most abundant source, a quaternary secondary deposit with an increased proportion of flint nodules, instead of those potentially available at the Paleogenic and Cretaceous primary sources, which would have needed intense quarrying work and skills.

The geochemical characterisation of the Hibarette-Montgaillard flysch cherts and Montsaunès cherts by ED-XRF and LA-ICP-MS. Archaeological implications for the Magdalenian of SW Europe

Sánchez de la Torre, M.[1,2], Le Bourdonnec, F.-X.[1], Dubernet, S.[1], Gratuze, B.[3], Mangado, X.[2], Fullola, J.M.[2]

[1] IRAMAT-CRP2A (UMR 5060). CNRS / Université Bordeaux Montaigne. Maison de l'archéologie. Esplanade des Antilles. 33607 Pessac Cedex (France). martasanchezdelatorre@gmail.com; Francois-Xavier.Le-Bourdonnec@ubordeaux-montaigne.fr; Stephan.Dubernet@u-bordeaux-montaigne.fr

[2] SERP. Universitat de Barcelona. C/ Montalegre 6-8. 08001 Barcelona (Spain). mangado@ub.edu; fullola@ub.edu

[3] IRAMAT-CEB (UMR 5060). CNRS / Université d'Orléans. 3 D rue de la Férollerie. 45071 Orléans cedex 2 (France). bernard.gratuze@cnrs-orleans.fr

Keywords: Chert, Pyrenees, human procurement, raw material characterisation, Upper Palaeolithic.

Discovered in the 1980s by Barragué and colleagues, the Hibarette-Montgaillard flysch cherts were an important workshop place used during the Palaeolithic in the French Pyrenees (Barragué et al. 2001). Near the town of Hibarette (Hautes-Pyrénées, France) were found secondary outcrops as well as lithic remains of ancient knapping. Cherts were located in the flysch limestones outcropping in primary position at the East of Montgaillard (Hautes- Pyrénées, France). These flyschs constitute an important turbiditic system from the Turonian to the Santonian.

The Montsaunès-Ausseing cherts, however, are inserted in the Nankin limestones dating from the Middle Maastrichtian and outcropping in the Ausseing Mountain and the ancient quarry of Montsaunès (Haute-Garonne, France).

Both chert types possess similar characteristics at the binocular and the petrographic microscope. Nevertheless, some differences have been observed in several samples. Thus, at the macroscopic level benthic foraminifera such as Orbitoides and Siderolites have been identified in Montsaunès cherts. At the petrographic scale, length-fast chalcedony has only been observed in some samples of Montgaillard cherts. But though some differences have been detected at the macroscopic and the microscopic scale, the differentiation between both silicifications remains difficult when these fossils or quartz phase are not present.

For this reason, we have decided to characterize geochemically the Montgaillard cherts as well as the Montsaunès cherts with the aim to obtain the elemental composition of both silicifications and to detect differences.

For the chemical characterization of both geological formations two main techniques of analysis have been considered. First, we have developed a geochemical analysis by Energy Dispersive X-Ray Fluorescence (ED-XRF). After that, we have applied the analysis by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). More than twenty samples for each type of chert have been considered.

After the geochemical characterization of both geological chert types we have tried to define the provenance of several archaeological samples from two Magdalenian sites from SW Europe: Parco Cave (Alòs de Balaguer, La Noguera, Spain) and Montlleó open air site (Prats i Sansor, Cerdanya, Spain). Results allow us to infer the provenance strategies carried out during the Magdalenian in SW Europe and the importance those cherts had in the procurement for these hunter-gatherers groups.

A new Western Mediterranean obsidian group? In pursuit of the SX obsidian source from Monte Arci, Sardinia

Laura Fanti[1], François-Xavier Le Bourdonnec[2], Carlo Lugliè[1]

[1]-LASP, Dipartimento di Storia, Beni Culturali e Territorio, Università di Cagliari, Piazza Arsenale 1, 09124 Cagliari, Italy.

[2]-IRAMAT-CRP2A UMR 5060, CNRS-Université Bordeaux Montaigne, Esplanade des Antilles, 33607 Pessac, France.

fantilau@gmail.com

Keywords: Obsidian provenance; Monte Arci; Sardinia

After more than 50 years of provenance studies, the Monte Arci volcanic complex in Sardinia, the westernmost among the four western Mediterranean obsidian sources, is well-known for its intra-source geo-chemical variability. Patterns of obsidian distribution revealed that since the Early Neolithic four different Monte Arci geo-chemical groups (namely SA, SB1, SB2 and SC) had been variously exploited and spread in Sardinia, Corsica and overseas.

Elemental characterization of thousands of obsidian artefacts from several Western Mediterranean Neolithic sites showed that, compared to an earlier heterogeneous distribution of almost all the Monte Arci geo-chemical families, out of Sardinia SB2 obsidians were preferred and, over time, replaced by SA and SC obsidians in Late Neolithic. Some years ago our survey and geological sampling carried out around the SA obsidian outcrops led us to find obsidians both in sub-primary and secondary deposits bearing visual and compositional features that do not match the already established field of variability for this geo-chemical group. The interest of these observations, that led to suppose a new archaeologically relevant group (SX), was recently increased by the identification of a few Neolithic artifacts made out of this obsidian quality.

Actually, we consider being of great interest for studies on prehistoric obsidian supply to be able to identify gathering and selection strategies by mean of the precise localization of the original deposits. Therefore, we would like to present here the characteristics of this unpublished Monte Arci obsidian group, describe its original availability and share with other analysts its main compositional features. Since we recognized that local advanced Middle Neolithic groups occasionally exploited this minor(?) source, we found surprising this “expedient” selection behavior especially if compared to the “regular” supply from the SA and SC groups. As a matter of fact, from then on these latter obsidians were systematically exploited through a well-structured organization of the production that led to the appearance of wide workshops around the respective outcrops and to the related exponential increase of Monte Arci obsidians artifacts in the North-western Mediterranean lands.

Going further in flint studies with the “chaîne évolutive” concept

Paul Fernandes [1,2], Alain Turq [2,3], Stéphan Dubernet [4], André Morala [2,3], Médard Thiry [5], Vincent Delvigne [2,] François-Xavier Le Bourdonnec [4,] Céline Leandri [6], Patrick Schmidt [7,] Pascal Tallet [1], Alexis Taylor [1], Jean-Paul Raynal [2,8].

[1-]Paléotime 6173 rue Jean Séraphin Achard Picard 38250 Villard-de-Lans
[2-] Université de Bordeaux 1, UMR 5199 PACEA, bâtiment B8, allée Geoffroy Saint-Hilaire, CS 50023, 33615 Pessac cedex,
[3-]Musée National de Préhistoire Les Eyzies-de-Tayac, 1 rue du Musée 24620 Les Eyzies de Tayac,
[4-] Université Bordeaux Montaigne IRAMAT-CRPAA, UMR 5060, Maison de l’Archéologie, Esplanade des Antilles 33607 Pessac,
[5-] Mines-Paris-Tech, Géosciences, 35 rue St Honoré, 77305 Fontainebleau, France
[6-] Service régional de l'archéologie, DRAC de Corse, Villa San Lazaro, 1 chemin de la Pietrina CS 1000320704 Ajaccio Cedex 9,
[7-] Eberhard Karls University of Tübingen, Department of Prehistory and Quaternary Ecology, Schloss Hohentübingen, 72070 Tübingen, Germany
[8-] Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, D-04103 Leipzig,

Paul.fernandes@paleotime.fr

Studies on the origin of lithic raw materials became increasingly important since the 1980’s. Sourcing studies play a key role in appreciating territory exploitation and group mobility, which are major issues of prehistoric societies understanding.

However, most approaches exploited only part of the information potentially carried by the lithic material. The improvement of our understanding of flint nature and formation processes allowed our interdisciplinary research-group to refine the methods used for its characterization. A major aspect of this renewal is the “chaîne évolutive”concept. Our work opens up new research directions such as surface analysis of flint artefacts, which reinforces the taphonomic study of archaeological sites and questions their integrity.

We present several types of surface analyses conducted on two archaeological assemblages from south-western France: 1) a Mousterian and Chatelperronian assemblage from H. Delporte’s excavations at La Ferrassie (Dordogne) and 2) a Mousterian assemblage from the open air site of Dirac (Charente). In the first case, the analyses allowed to distinguish in a single archaeological unit two sets of flints that had not been previously separated. In the second case, our approach established the geological history of flints prior to their collection by humans and characterized the successive events which affected the knapped objects after they were discarded.

Characterization of Dolerite Prehistoric tools in Mediterranean Iberia: A new methodological approach

Gianni Gallello[1], Teresa Orozcob, Agustin Pastora, Miguel de la Guardia[2], Joan Bernabeub

[1]-Department of Analytical Chemistry, University of Valencia
C/ Dr. Moliner 50, 46100 Burjassot, Spain

[2]-Department of Prehistory and Archaeology, University of Valencia
Avd. Blasco Ibáñez 28, 46010 Valencia, Spain

Gianni.Gallello@uv.es

Keywords: Dolerite, Rare Earth Elements (REE), Multivariate Statistics, Polished Axes, Prehistory, Valencia Region.

In this preliminary study we have tried to identify outcrops raw materials collected for manufacturing lithic objects during the Prehistoric period employing inductively ICP-MS to analyze rare earth elements (REE) and trace elements. No destructive geochemical analysis consisted on the use of XRF was also employed for determination of major elements. The ultimate goal was to develop a method to complete the reconstruction of transportation networks of prehistoric tools already developed in a comprehensive study of thin section analysis with polarizing microscope. Principal Component Analysis (PCA) was employed to interpret the dolerite geological provenance. These preliminary results show that statistical analysis permits to distinguish stone sample origins according to their REE profile at regional level and that Ti/Fe may be used to determine differences
between dolerite outcrops. Therefore this method may be able to discern the regional origin of lithic objects belonging to the same classes of rocks, bringing a new proposal in the reconstruction of dolerite raw material and lithic tools circulation in Recent Prehistory.

Characterization by PIXE elemental analysis of fibrolite: application to the study of Neolithic polished axes provenance

Mikaël Guiavarc'h[1], Guirec Querré[1], Quentin Lemasson[2]

[1]- Laboratoire Archéosciences UMR 6566 CReAAH. Université de Rennes 1, Campus de Beaulieu, 35042 Rennes, France.

[2]- Centre de recherche et de restauration des musées de France, C2RMF, Palais du Louvre - Porte des Lions, 14 Quai François Mitterrand, 75001 Paris, France.

guirec.querre@univ-rennes1.fr

Keywords: fibrolite, provenance, PIXE, Axes, Neolithic

Fibrolite is a rock used for making extremely polished prestige blades found in Neolithic burial mounds around Carnac region in combination with other precious and rare material from distant sources such as alpine jadeite axes or variscite beads of the Iberian Peninsula. Fibrolite is a relative rare variety of massive fibrous sillimanite, an alumina-silicate mineral. The mineral appears like a bunch of fibers twisted together that form very tenacious nodules included in high metamorphic rocks, generally migmatites. Neolithic people should sawed the blocks to shape these tools.

The aim of this study is to determine the origin of the raw material for fibrolite polished blades found in Neolithic sites from the West of France. External-beam PIXE a rapid, direct and non-destructive method was used to know the geochemical composition of the fibrolite. Results provide scientific basis to determine the provenance of fibrolite raw materials. We have determined major, minor and trace elements of fibrolite from 3 different known deposits in Brittany: Plouguin, Le Conquet in Finistère, which are known Neolithic workshops and Arzon in Morbihan and 8 polished axe blades ; 4 from Brittany localities and 4 from Banville in Normandie, relatively far from known deposits. Comparison of chemical compositions of archaeological artifacts and fibrolite deposit allow us to propose a provenance for each axes. These are the first results of the research program "Fibrolite" which aims to determine the blade production center, the broadcast network and the evolution during the Neolithic in Western Europe.

“Where does your saddle quern come from?” Grinding in the actual province of Limburg (BE) during the Iron Age

Hartoch E.[1], Gluhak T.[2], Dreesen R.[3], Goemaere E.[4]

[1]-Archaeologist, Collection management coordinator / Research at the Gallo-Roman Museum of Tongeren - Belgium
[2]-Scientific collaborator at the Gallo-Roman Museum of Tongeren - Belgium & the Geological Survey of Belgium, ,
[3]-Dipl.-Geol., Dipl.-Ing. (FH), Johannes Gutenberg University Mainz - Institute for Geosciences, Team Geomaterials and Gemstone Research, Mainz - Germany,
[4]-Geologist, Geological Survey of Belgium, Directorate Earth and History of life, Royal Belgian Institute of Natural Sciences,

else.hartoch@limburg.be

Keywords: Geo-archaeology, provenance study, querns, Iron Age, Eifel, Belgium

This poster presents the results of a recently published research project (*) on the topic of querns and millstones. Three saddle querns have been dated to the Iron Age and one rotary quern was typologically in use from the late Iron Age on. Those Protohistoric querns are part of the subject of a research project dealing with a total of eighty-one querns and millstones dating from the Iron Age until Modern Times. These have been excavated within the Province of Limburg – Belgium, and are mainly stored in the Gallo-Roman Museum of Tongeren. The major objective of this study was to identify the geographical provenances and geological origins of the lithic raw materials. This has been achieved by means of comparative petrographical, geochemical and statistical analyses, based on reference collections of rock samples taken in the field. This resulted in a better understanding of their transportation and circulation mode within the diffusion area. This study highlights also the fruitful international collaboration between archaeologists and geologists. Indeed, for the first time, it was possible to link the querns made of volcanic rocks to particular extraction sites, even to individual quarries or lava flow areas in the in the Western Eifel area as well as in the Eastern Eifel area.

In this way the petrographical-geochemical analysis of the lithic raw materials and the study of their provenance, provide new support for stressing the importance of the province of Limburg, as an importer and consumer of querns during the Iron Age.

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What for these blades? Flint blades production and circulation in Late Neolithic Sardinia

Barbara Melosu[1], Carlo Lugliè[1]

[1]-LASP, Dipartimento di Storia, Beni Culturali e Territorio, Università di Cagliari, Piazza Arsenale 1, 09124 Cagliari, Italy.

barmelosu@yahoo.it

Keywords: flint blades; pressure technique; Anglona; Sardinia

At the end of Neolithic (between the 5th and 4th millennium BC), concurrently with the origin of the Ozieri Culture, obsidian was the most exploited lithic resource in Sardinia. During this time, the early stages of the obsidian reduction system seem to have been located in close proximity to the primary outcrops in the Monte Arci Massif, where this raw material is abundant. In these areas, raw matter reduction was essentially addressed to the creation of preforms of polyhedral cores for a blade production trajectory; the end-products were after distributed through organized exchange networks.

In the same period flint sources were exploited mainly at a local level, besides some sources, identified in the North Sardinia Oligo-Miocene basin of Perfugas (Anglona region), that are exploited on a supra-local scale. This area provides particularly abundant and high-quality flint outcrops.

This material circulated in the form of artefacts produced according to high technical investment and skill: long blades obtained especially by (simple or by lever) pressure technique. These pieces, possibly coming from a single workshop, are found both in funerary and domestic contexts, frequently far away from this source area.

Despite the wide availability of other good-quality raw materials, especially obsidian, these blades are made out only of this quality of flint: multiple factors may explain this evidence, yet cultural and social explanations seem to be among the most relevant.

The results obtained from the analysis of this flint blades circulation allow us to advance some hypotheses about the origin of this phenomenon, discussing its characteristics and possible aims.

Tracking the Hunters: Geochemical Provenancing of Middle-Palaeolithic Stone Tools as a means to reconstruct Neanderthal Behaviour in the English Channel Region

Josephine Mills

Institute of Archaeology, University College London.

Josephine.mills.10@ucl.ac.uk

Keywords: Neanderthal, Flint, Provenance, Lithics, Geochemical

This project aims to explore Middle Palaeolithic Neanderthal landscape use and raw material acquisition in the La Manche region of the English Channel through geochemical analysis of flint tools and geological flint sources. Archaeological work will focus on artefacts from three stone tool assemblages in the region; La Cotte de St. Brelade (Jersey), Le Rozel (Normandy), and Mont Dol (Brittany), which are well dated to the Weichselian glacial (110,000 kya), thus temporally comparable. It will observe these assemblages within their regional setting using macroscopic analysis and geochemical profiling tools, such as portable x-ray fluorescence (pXRF), in order to establish an understanding of where raw materials were sourced. This will unlock key information about Neanderthal raw material acquisition patterns potentially revealing aspects of their social dynamics and interaction with the complex Channel landscape located at the far western reaches of their known world. Provenancing is particularly pertinent in this context because many of the flint outcrops that would have been used in the Middle-Palaeolithic have now been submerged by modern sea level. Therefore this project's artefact-centric approach will establish potential links between the raw materials being used at sites across the Gulf of St. Malo thus adding information about flint outcrops that would be otherwise unreachable. Through this work future opportunities for targeted coring will be developed in order to acquire geological samples from the Cretaceous bedrock between and to the north of the Channel Islands. Overall this project pilots a unique provenance-led exploration into what flint geochemistry can reveal about the Neanderthals who inhabited the Armorican Massif during the Middle Palaeolithic – shedding light on their adaptive strategies, raw material acquisition, and social behaviour.

Siliceous raw materials exploitation at Hort de la Boquera site (Margalef de Montsant, Tarragona, España): first approaches on ICP-MS-LA analysis

M. Rey-Solé[1], A. Scherstén[2], D. Olausson[3], X. Mangado[1] Naeraa, T.[4]

[1]-Seminari d'Estudis i Recerques Prehistòriques, Dept. Prehistòria, Història Antiga i Arqueologia, Universitat de Barcelona, C/Montalegre, 6, 08001, Barcelona, Spain.
[2]- Department of Geology, University of Lund, Sölvegatan 12, 223 62, Lund, Sweden.
[3]- Department of Archaeology and Ancient History, University of Lund, Helgonavägen 3, 221 00, Lund, Sweden.
[4]- Department of Geology, University of Lund, Sölvegatan 12, 223 62, Lund, Sweden.

mreysole@ub.edu

Keywords: ICP-MS-LA, Siliceous Raw Materials, Hort De La Boquera, Sourcing, Archeopetrology

Researches on sourcing of siliceous raw materials in Prehistory has taken a step forward with the addition of geochemical techniques and elemental analysis to the archeopetrological method. Counter to the macroscopic techniques, which continue retaining an elevated subjective percentage in their results, geochemical techniques and especially ICP-MS-LA analysis generates objetive, quantifiable and playabe data, helping us to complete another previous mineralogical analysis.

More than 85% of the siliceous raw material from Hort de la Boquera archeological site (Margalef de Montsant, Tarragona, Spain) is manufactured from an evaporitic origin type of flint and petrografically is characterized by a chalcedonic matrix with gypsum lenticules as inclusions.

Multiple flint outcrops from an evaporitic origin (Eocene - Oligocene) and with very closed characteristics as the lithic raw material from Hort de la Boquera are located nearly the site (Scala Dei Group - Montsant Fm- and Cornudella Group - Ulldemolins Complex, Morera del Montsant Fm), making they very suitable to supply the inhabitants of Hort de la Boquera site.

We have two different but complementary goals in this research: on the one hand, to characterize, describe and create a data base for all different types of flint recovered, emphasizing their geochemical marks. On the other hand, we have the aim to compare those results with those obtained from the raw material recovered at the site, that would provide a range of complementary data to discover the potential catchment areas and would help us to understand certain behaviours of the prehistoric communities from Hort de la Boquera site.

Compositional analysis on lithic beads. The case of the low paraná wetland, Argentina

Romina Silvestre[1], Natacha Buc[2], Alejandro A. Acosta[2] Daniel Loponte[2]

[1]-Instituto Nacional de Antropología y Pensamiento Latinoamericano - Universidad de Buenos Aires;
[2]-Instituto Nacional de Antropología y Pensamiento Latinoamericano – CONICET 3 de Febrero 1378 - Ciudad Autónoma de Buenos Aires (1426), Argentina.

romisilvestre@gmail.com

Keywords: beads, lithic, EDX, Paraná basin, Late Holocene.

Lithic beads were recovered from different archaeological sites of Low Paraná wetland made by Late Holocene hunter-gatherer groups. Since most of them are made on green rocks, traditionally were referred as mineral variants of copper such as chrysocolla, turquoise and malachite. The Low Paraná wetland has no lithic primary quarries, and the nearest one are those from República Oriental del Uruguay. Therefore, the aim of this paper is to make the compositional analysis of raw material beads and test if they come from this near sources. For this purpose, energy-dispersive X-ray microanalysis (EDX) was used in beads from six archaeological sites and the near lithic quarries. In the actuallistic samples, results show the presence of copper in the variant of chrysocolla. In the other hand, archaeological beads were made from different lithic quarries, most of them, without copper. Therefore, new actual quarries should be analyzed to discover the real sources of archaeological assemblage.

The quintessence of chert; the rare earth elements and their use in the provenancing of archaeological lithic material

Rosemary Stewart

University of Reading, England. Bridge Park New Abbey Dumfries DG6 4ES U.K.

pebble@freeuk.com

Keywords: Chert, geochemistry, rare earth elements.

Cretaceous flint was the most commonly used lithic raw material in British prehistory with widespread primary and drift geological deposits readily available. The extensive coastline meant that beach flint was also accessible for use in most regions of the country. However, the complex geological history of the British land-mass has resulted in the deposition of a number of different chert-bearing strata. People in prehistory knew of and exploited these materials alongside flint in chert-rich areas to make tools for use in their everyday lives. The main chert varieties available formed in various geological conditions and are of widely differing age. These characteristics have the potential to contribute to provenance analysis of archaeological lithic material. Geochemical studies have been carried out on chert in the field of geology and in a recently completed PhD project I have attempted to use these techniques in archaeological research. The main methods employed were X-ray fluorescence (XRF) and Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). Cherts are particularly silica-rich, a feature that masks their unique geochemical signature making chert analysis more difficult than that of more chemically complex rock types. Therefore, this geochemical research has focussed on the rare earth elements (REE). This suite of closely related elements has specific properties and occurrences that allow insights into the depositional environments of cherts. Differences in the values and patterns of the rare earth elements can assist with linking geological sources to archaeological lithic assemblages.

Flints of the Gravettian Workshop of Mugarduia Sur (Sierra de Urbasa, Wester Pyrenees, Spain)

Antonio Tarriño-Vinagre[1], Mikel Aguirre-Ruiz-De-Gopegui[2], Fernando Jiménez-Barredo[1], Íñigo Orúe-Beltrán-De-Heredia[2], Ana Cava-Almuzara[3], Ignacio Barandiarán-Maestu[4]

[1]-Centro Nacional de Investigación sobre la Evolución Humana (CENIEH). Paseo Sierra Atapuerca, 3. E-09002 Burgos, Spain.
[2]-UNED, CA Bergara. San Martín Plaza 4, Bergara. E-20570-Bergara (Gipuzkoa), Spain.
Irantzu ELORRIETA-BAIGORRI
Departamento de Geografía, Prehistoria y Arqueología. Universidad del País Vasco / Euskal Herriko Unibertsitatea (UPV/EHU). C/ Tomás y Valiente, s/n. E-01006 Vitoria-Gasteiz, Spain.
[3]-C/ Florida 78, 8º D. E-01004 Vitoria-Gasteiz, Spain.
[4]-Miembro Honorífico del Instituto de Ciencias de la Antigüedad. Euskal Herriko Unibertsitatea (UPV/EHU). C/ Tomás y Valiente, s/n. E-01006 Vitoria-Gasteiz, Spain.

antonio.tarrinno@cenieh.es

Keywords: Raw Materials, Urbasa flint, Gravettian, Workshop, Western Pyrenees

Nodular silicifications which were exploited during Prehistoric times can be found in Sierra de Urbasa plateau (Navarra). These flints, hosted in marls, marl-limestone and bioclastic calcarenites of the Thanetian (Paleocene, Cenozoic), contain benthonic foraminifera (Nummulites heberti and Discocyclina seunesi), pertaining to marine environments of shallow external platform.

The outcrops are arranged along a 100-300 m thick and around 10 km long. The flints, which arise in discontinuous layers parallel to the stratification, present nodular morphologies in dark colours (usually 5-20 cm). They are fine grain flints composed of micro and cryptocrystalline quartz with carbonate relicts and a distinctive microdolomitization.

Although the existence of flint outcrops has not been cited in the geological literature until present, the relation between archaeological sites and the outcrops has been described for us in recent investigations about Mugarduia. The prehistoric flint workshop is installed above the stratum itself or in its vicinity.

We analyzed the lithic material that came from an intact archaeological deposit stratified discovered in the workshop, carried out in the fieldworks of the 80's by I. Barandiarán and A. Cava. There were collected 995 retouched artefacts, around 400 cores and around 53,000 residues from the workshop.

The analysis of the retouched artefacts of the mentioned collection allows the identification of seven flint types: Urbasa (local, mostly massive and showing a variable external aspect), *Flysch, Treviño, Gaintxurizketa, Salies de Béarn, Urgonian, Loza* (allochthonous all them).

Allochthonous flint represents 7.8% of the retouched industry. This is a huge quantity taking into account the flint samples were collected from workshop context in the surroundings of Urbasa's natural outcrops.

We aim to study the nature and variability of the identified flints through geochemical and mineralogical methods and the management of the resources considering aspects of typology, typometry and technology.

Lithic raw material procurement at El Horno Cave (Cantabria, Northern Spain)

Antonio Tarriño[1], Adriana Chauvín[2], Irantzu Elorrieta-Baigorri[3], Miguel Ángel Fano[4]

[1]-Centro Nacional de la Investigación sobre la Evolución Humana (CENIEH). Paseo Sierra Atapuerca, 3. E-09002 Burgos, Spain.
[2]-Museo de Prehistoria y Arqueología de Cantabria (MUPAC). C/ Ruiz de Alda, 19. E-39009 Santander (Cantabria), Spain.
[3]-Departamento de Geografía, Prehistoria y Arqueología. Universidad del País Vasco / Euskal Herriko Unibertsitatea (UPV/EHU). C/ Tomás y Valiente, s/n. E-01006 Vitoria-Gasteiz, Spain.
[4]-Universidad de La Rioja. Departamento de Ciencias Humanas. Edificio Vives C/ Luis de Ulloa, 2. E-26004 Logroño (La Rioja), Spain.

antonio.tarrinno@cenieh.es

Keywords: Late Magdalenian, Cantabrian Spain, Flint, Outcrops, *Chaînes Operatoires*

El Horno Cave is located in the middle Asón valley, Northern Spain. From 1999 to 2007, six fieldwork seasons excavated a surface area of 3.5m2. The intact part of the deposit at El Horno (Levels 1, 2 and 3) has yielded a series of remains which can be assigned to upper Magdalenian occupations, an attribution supported by the radiocarbon dates. Lithics are coherent with the attribution of Levels 1 and 2 to this phase. In the case of Level 2, the cultural attribution is also supported by a particularly diagnostic osseous assemblage, including harpoons and portable art. The few lithics in Level 3 are equally compatible with the attribution to the recent Magdalenian.

A sample of 503 pieces from levels 1, 2 and 3 (meaning 29% of the collected lithic remains) has been considered to study the lithic raw materials. The studied sample includes all the retouched pieces and the larger knapping debris. A collection with the most representative examples of each flint type has been made, to reflect the variability in the raw materials used at the site. The method used was the textural analysis of the flint by observing them with a stereo microscope Olympus SZ61, normally at magnifications of x10 or x20, although some observations required as much as x100 magnification.

Flint is the main raw material representing 98% of the studied sample. Other lithic resources have been identified: quartzite, rock crystal and radiolarite. Among determined flint pieces is remarkable the presence of Flysch flint type (>80%), Monte Picota/Loza flint (around 10%) and flints from Treviño and *Urbasa* outcrops which represent less than 5% of the assemblage. The management of the different raw materials in the context of the chaînes operatoires is analyzed, as well as the variability of the flints procurement along the archaeological sequence.

Geochemical sourcing of chert in Portuguese Estremadura

Jonathan Haws, Grant Cooksey

University of Louisville

jahaws@gmail.com

Keywords: Chert, Paleolithic, LA-ICP MS, Geochemistry

Macroscopic attempts to establish provenance of lithic artifacts have proven unreliable in many areas due to the wide variations found within single nodules and geographic sources. Despite this, relatively few geochemical studies have been undertaken to establish provenance based on geochemical fingerprinting. In the present study, we analyzed 4 primary chert sources in Portuguese Estremadura using LA-ICP MS. Here we present the data on rare earth elements and stable isotope ratios measured from the different chert samples. We then use these results to interpret Upper Paleolithic raw material procurement in the region.

Thursday, 10 March 2015 - 16h05

The Routes Of Archaeological Colouring Materials: From The Sources To The Uses

Jean-Victor PRADEAU - CEPAM/UMR 7264 CNRS, Université Nice-Sophia Antipolis, FRANCE (*Jean-victor.pradeau@cepam.cnrs.fr)*

Laure DAYET - Institut Français d'Afrique du Sud, Johannesburg, SOUTH AFRICA (*Laure.dayet@gmail.com)*

Hélène SALOMON - F.R.S.-FNRS, Service de Préhistoire University of Liège, Liège, FRANCE (*helene.salomon@ulg.ac.be)*

Raw material provenance and selection are key features for the understanding of the social structure of prehistoric societies. The reconstruction of raw material supply strategies brings information on the socio-economical framework, mobility patterns, as well as technical, symbolical and cultural orientations at the origin of the processing sequences. Despite their informative potential to address these issues, colouring materials (iron and manganese oxides, cinnabar, copper salts, etc.) have received scant attention in comparison with geomaterials used in tool, bead or pottery manufacture such as obsidian, flint, ceramic materials or igneous rocks. Because they are commonly regarded as medium for ornamentation, non verbal communication and symbolic representations, colouring raw materials may not consistently obey to the same economic systems than stone tool or ceramic raw materials. Provenance researches of colouring materials and paintings are then crucial to enlarge our understanding of the social organization of prehistoric hunter-gatherer and agro-pastoral societies.

Since the 2000's, trace element (PIXE, XRF, INAA, ICP-MS) petrographic and mineralogical (X-ray-diffraction, Raman spectrometry) studies have widely contributed to collect data on colouring geomaterials' sources. A number of geological reference collections have been studied and there is no doubt that significant differences between sources from the same region can be identified when proper methods are used. The field is now open to archaeological applications and comprehensive studies of procurement strategies within a region or a cultural tradition. Consistent procurement patterns have already been identified at some Middle, Upper Paleolithic and Neolithic sites, from exclusive local supply to significant long distance supply, including more complex situations where both local and non local materials were collected. Whether these economical choices are determined by the geological background, the status of the colouring materials, the function of the sites, the social organization of the groups, or by pure social conventions as observed in culturally determined traditions remains to be clarified.

Two main topics will liven up this session: (i) fruitful contributions on different methodological improvements proposed to outpace the context dependent situation in provenance researches applied to colouring materials and (ii) diachronic revue of their procurement strategies through the lens of cultural contexts and site function status.

16h05: The Routes Of Archaeological Colouring Materials: From The Sources To The Uses

Hélène Salomon[1], Jean-Victor Pradeau[2], Laure Dayet Bouillot[3]

[1]- F.R.S.-FNRS, Service de Préhistoire University of Liège, Liège, FRANCE (
[2]- CEPAM/UMR 7264 CNRS, Université Nice-Sophia Antipolis, FRANCE (Jean-victor.pradeau@cepam.cnrs.fr)
[3]- Laure DAYET - Institut Français d'Afrique du Sud, Johannesburg, SOUTH AFRICA (Laure.dayet@gmail.com)

helene.salomon@ulg.ac.be

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- 16h25: Prehistoric Pigments in the Hungarian National Museum

Katalin T. Biró[1]; Tamás Váczi[2]

[1]- Hungarian National Museum, Múzeum körút 14-16, 1088 Budapest, Hungary
[2] -Department of Mineralogy, Eötvös Lóránd University, Pázmány P. sétány 1/c, 1117 Budapest, Hungary

tbk@ace.hu

Keywords: pigments, prehistory, Hungary

Prehistoric raw materials typically served for basic needs of subsistence: production of tools for food, clothing, housing, etc. There is, however, a 'human surplus' beyond simple needs for aesthetic, cultic or prestige items that may leave detectable traces in the fossil record as well.

Part of the colorants are lost forever due to decomposition, deficient excavation techniques or over-zealous cleaning. The context in which we are ready to find pigments are exploitation ('paint mine'), graves (both on the deceased and as grave goods, more typically on the objects found in the grave), in normal domestic context (pits, houses) or specific containers (crucibles).

The analytical approach to prehistoric pigments is relatively new; mainly non-invasive techniques can be used like mXRD, IR, EDS and Raman spectroscopy. The results, however, are still a far cry from provenancing; at the best, they can serve as identifying or fingerprinting the pigments. We are generally at a loss for preparation techniques, potential binders and all too often, the conservation methods used encumber or even prevent the analysis of painted ware.

This paper will present variety of pigments identified on Hungarian prehistoric sites, with the focus on lumps of mineral pigment matter and their archaeological context and identification.

- 16h45: Provenance and Processing of Upper Palaeolithic Ochre Based on Compositional and Textural Studies

Giovanni Cavallo[1,2], Federica Fontana[3], Marco Peresani[3], Maria Pia Riccardi[1], Roberto Zorzin[4]

[1]-Dept. of Earth and Environmental Sciences, University of Pavia, Italy
[2]-Institute of Materials and Constructions, Univ. of Applied Sciences and Arts - Supsi, Switzerland
[3]-Dipartimento di Studi Umanistici, University of Ferrara,(Italy) 4 Civic Museum of Natural History, Verona, Italy

giovanni.cavallo01@universitadipavia.it

Provenance studies of archaeological ochre are routinely carried out through elemental analysis [1-5] whilst the use of ancillary analytical techniques is rather limited [6-7]. Polarizing Light Microscopy (PLM) on thin sections supported by X-Ray Powder Diffraction (XRPD) was used to analyse and group ochre fragments (weight average about 0.5 g) recovered in the Aurignacian layers of Fumane cave [8] and in the Late Epigravettian stratigraphic sequence of Tagliente rock-shelter [9] in the Lessini Mountains (Verona, NE Italy). Deposits of goethite (mostly) and hematite-based natural geomaterials occurring in a radius of about 20 Km from the archaeological sites were considered as potential sourcing areas and studied by adopting the same methodological approach [10-11]. Natural Fe-based geomaterials occur in palaeokarst caves in Eocene and Mesozoic carbonate formations and are also associated with Eocene volcanic terrains (basalts and volcanoclastites). The results were enthusiastic as the characteristic mineral assemblages [12], the presence versus absence of bioclasts and their association, the texture (layered, micro-laminations, massive, homogeneous vs heterogeneous) allowed the possible sources of archaeological ochre to be identified and other potential sources excluded. In addition, archaeological ochre fragments whose composition and texture was not compatible with the geological potential sources were not included in the statistical elaboration of the elemental analysis carried out through Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The great availability of goethite-based natural geomaterials, the large number of red archaeological ochre fragments, the similar texture of yellow and red ochre, the presence of disordered hematite, were clear clues of the thermal treatment which was highlighted thanks to the presence of maghemite (γ-Fe2O3) in a few samples [12]. In conclusion the methodology demonstrated to be valid for establishing possible sourcing areas and understanding processing methods; in addition, the potential sourcing areas were narrowed down and selective statistical elaboration of the geochemical data was possible.

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- 17h05: Did Neanderthals Exploit the Material Properties of Coloured Minerals?

Peter Heyes, Marie Soressi et al.

Leiden University, Faculty of Archaeology. Einsteinweg 2, 2333 CC Leiden, The Netherlands

pjheyes@gmail.com

Whether the Neanderthal archaeological record testifies to the kind of symbolic behaviors that are considered typical for 'modern' humans is a highly debated topic within paleoanthropology, with the use of colored materials such as ochres and manganese oxides one of the possible indicators of such behaviors. Several Mousterian and Châtelperronian sites in France have yielded significant numbers of small black 'blocs'. The usual interpretation is that these manganese oxides were collected for their colouring properties and used in body decoration, potentially for symbolic expression. Neanderthals habitually used fire and if they needed black material for decoration, soot and charcoal were readily available, whereas obtaining manganese oxides would have incurred considerably higher costs. Colour is just one of the physical properties of manganese oxides and in this paper we explore the chemical properties of manganese dioxide (β-MnO2), the predominant black mineral material found at the Mousterian site of Pech-de-l'Azé I and at some Châtelperronian sites. Manganese dioxide has a wide variety of uses today derived from the chemical properties of manganese as a catalyst and in oxidation-reduction reactions. Thermal imaging, thermo-gravimetric analysis, scanning electron microscope, x-ray diffraction and statistically designed experiments based on an impact test methodology have been used to characterise manganese dioxide's interaction with other materials. Manganese dioxide had significant potential subsistence benefits for Neanderthal foragers and the archaeological evidence at Pech-de-l'Azé I is consistent with a specific and important functional role. Interestingly it is a process unknown from the ethnographic record of recent hunter-gatherers.

- 17h25: The Ethno-Archaeometry of Modern Ochre Use in Kenya

Andrew M. Zipkin[1], Stanley H. Ambrose[1], Craig C. Lundstro[1], Mercy Gakii[2], Matthew W. Magnani[3]

[1]-University of Illinois at Urbana-Champaign, 109 Davenport Hall, 607 S. Mathews Ave., Urbana IL, 61801, U.S.A.)

[2]-National Museums of Kenya, P.O. Box 40658-00100, Nairobi, Kenya)

[3]-Harvard University, 16 Prescott Street, Cambridge MA, 02138, U.S.A.

amzipkin@illinois.edu

Keywords: Ochre Provenance, Ethnography, Rock Art, Mass Spectrometry, Stable Isotopes

Ochre pigments occur in African archaeological sites from the Middle Pleistocene through historic times. Ochre is used worldwide for diverse symbolic and functional purposes, and is frequently considered to be evidence for symbolic behavior by cognitively modern Paleolithic humans. However, determining whether ochre use is specifically symbolic rather than functional is problematic. Ethnographic studies of ochre source exploitation, transport and processing, and symbolic, aesthetic, and functional uses can help test these alternative hypotheses by determining whether culturally mediated source exploitation preferences differ significantly from a least-cost energetics (closest source) null-model of source use.

In our 2012 pilot study of ochre source geochemical fingerprinting in the southern Kenya Rift Valley, Maasai and Samburu informants led us to seven of the 12 sources that we collected. Geochemical analysis of these sources demonstrated that it is possible to chemically distinguish among them on the basis of minor and trace element composition. We realized that undertaking systematic ethnographic investigations of modern ochre use would enable us to identify most sources used by Maasai and Samburu pastoralists. In 2015, informants led us to 41 previously unrecorded ochre sources used for symbolic rock art, self-adornment, and domestic purposes. Some informants were able to identify images that they had painted, and the sources of their pigments. Redundancy of information among informants suggests that we have collected most of the currently exploited ochre sources in the Kenya Rift Valley. Modern source preferences described by informants seem incompatible with least-cost models; this will be verified through provenience analysis of rock art pigment samples.

Ochre pigment samples were also collected from recent rock art sites, and Middle and Later Stone Age and Neolithic archaeological sites. Elemental and isotopic (iron, lead, and strontium) fingerprinting of rock art samples of known authorship by laser ablation and conventional mass spectrometry will allow us to corroborate ethnographic accounts of source exploitation practices, and independently determine source preference patterns. Ethnographic patterns of modern source use for symbolic purposes can provide a point of reference for provenience studies of archaeological ochre, and for tests of least-cost versus cultural preference models in prehistory.

17h45: Geochemical and mineralogical characterization of Magdalenian Age red pigments from Tito Bustillo cave (Ribadesella, Asturias)

Diego Cameno[1], Eneko Iriarte[1], Susana E. Jorge-Villar[2], Esteban Álvarez-Fernández[3]

[1]-Laboratorio de Evolución Humana, Departamento de Ciencias Históricas y Geografía, Universidad de Burgos, Edificio I+D+i, Plaza de Misael Bañuelos s/n, 09001, Burgos.
[2]-Área de Geodinámica Interna, Facultad de Educación, Universidad de Burgos.
[3]-Departamento de Prehistoria. Universidad de Salamanca.

diegocameno@yahoo.es

Keywords: colouring materials, geochemistry, mineralogy, Tito Bustillo cave, Magdalenian.

Archaeological excavations in Tito Bustillo cave recovered numerous remains of red colouring materials, both as raw material clasts or processed clayey mixtures embedded in Magdalenian age layers. It is noteworthy the presence of various red coloured and decorated Patella vulgata shells used as colouring material recipients.

In this work we present the mineralogical and geochemical characterization of the different colouring materials. X-ray diffraction (XRD), Scanning electron microscopy and Energy-dispersive X-ray spectroscopy (SEM-EDS), Raman Spectroscopy and X-ray fluorescence (XRF) analysis were performed in studied samples.

The obtained results show up the diversity of colouring raw materials, different supply strategies and probably uses of those colouring materials. These data are very useful for raw material procurement strategies and mobility pattern reconstruction, as well as technical, symbolical and cultural orientations at the origin of the processing sequences.

18h05: Prehistoric Corsica: the significance and provenance of its pigmenting materials

Maryline Lambert

PhD Student, Dept of Archaeology, Durham University, United Kingdom

The number of discoveries of iron oxide rich pigmenting materials in prehistoric Corsica has increased significantly in the recent archaeological records. Often overlooked as a meaningful artefact in the Corsican literature, it is now recognised as a potential witness of the technico-cultural choices made by prehistoric communities as well as a mean to evaluate the extent of the exchange networks in the Tyrrhenian basin.

A first examination of several pieces of iron oxide found at the well preserved late Bronze Age/early Iron Age dwelling site of Cuciurpula, in South Corsica, has indeed reveled characteristic use-wear traces which motivate the conduction of further analyses and a questionning regarding their role for the prehistoric corsican people. Taking into account the scarcity of sources for this material on the island, analytical techniques permit elemental and structural characterisations which open new horizons about the procurement patterns and the potential circulation in the Central Mediterranean.

In this paper, we present preliminary results covering several sites from prehistoric South Corsica. The variability, both intra and inter sites, of the chemical composition of the iron oxide pieces is assessed. Through a comparison with the existing characterisations in this area, especially Elba and Sardinia, we explore the possible procurement sources. We also discuss the evidence with regard to a probable heating which may have been used to obtain pigment powder of a desired colour. We therefore aim to provide a more complete portrait of the place occupied by mineral resources in the cultural sphere of these communities.

This work is done in collaboration with the archaeometry laboratory at Bordeaux-Montaigne, France.

18h25: An Early Aurignacian industry of ochres? The actualistic study of ferruginous colorants' variable polishing efficacy

Joelle Nivens

New York University

joelle.nivens@gmail.com

The Aurignacian technocomplex (40-28 kya) with its systematic traditions of personal ornamentation and the earliest figurative art represents a crucial if enigmatic sociotechnical transformation during the Early Upper Paleolithic. Whereas Proto-Aurignacians, like previous Transitional Industries, conscripted natural objects into their symbolic systems with minimal manipulation (i.e. perforation), Early Aurignacian ornaments are characterized by three degrees of raw material transformation. These later bead assemblages expand beyond pierced tooth and shell to include shaped, perforated, and polished rocks and minerals. Red colorant traces found in tool striae and perforations of the soft stone and ivory objects have been commonly interpreted as prehistoric jeweler's rouge, hematite-rich powders used as a fine metallic abrasive (Walter, 1995; White, 1995; Buisson et al., 2015). Though recent actualistic studies have tested a number of the iron oxides' utilitarian properties (Wadley, 2005; Rifkin, 2011, 2015; Rifkin et al., 2015), these materials' role in ornament production remained underexplored. This paper reports the results of an experiment testing the polishing efficacy of different iron oxide-rich rocks on steatite and lignite bead supports. Goethite powders were found to be less effective polishing agents than hematite powders. In addition, the most effective polishing agents for soft and hard bead supports differ. These findings suggest the variety of colorants found in Aurignacian sites may reflect a mineral raw material economy related to the variety of activities taking place at the site, particularly in bead production locales.

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Las Portillas Formation: a new variety of chert used by prehistoric groups in the cantabrian mountains?

Diego Herrero Alonso[1], Antonio Tarriño Vinagre[2], Natividad Fuertes Prieto[3], Ana Neira[3]

[1]-University of Salamanca
[2]- CENIEH
[3]-University of Leon

dherreroalonso@usal.es

Keywords: Raw materials management, Cantabrian Mountains, Mesolithic, Paleozoic Chert

Studies developed in order to characterize lithic raw materials in the prehistoric sites WestCentral section of the Cantabrian Mountains (NW Spain),near Picos de Europa, highlight the importance of locating geological formations containing nodules of chert. Las Portillas is a limestone Formation where nodules of chert appear. It is poorly known because of its geographical distribution, quite restricted in the southern slope of Picos de Europa Unit, near to Espinama and Jou de los Boches (Naranjo del Bulnes, Cabrales, Asturias).

The macroscopic features of this chert, presenting a very shiny black colour with abundant fractures filling (by quartz, possibly) are macroscopically consistent with certain samples of the so-called 'black chert' in Mesolithic sites of the region, such as those found in El Espertín and La Uña caves (León, Spain).Therefore, we think suitable to make a more accurate approach of this silicifications.

The age of Las Portillas Formation is from Famenian (Late Devonian) to Tournaisian (Early Carboniferous). According to the bibliography, it is a bioclastic limestone with abundant fragments of crinoids, coarsed grain and lighter colours, sometimes pinkish. Inside this limestone appears the nodules of cherts (between 5-20cm).

The aim of this work is to define this type of raw material. For this purpose, we will provide a characterization from various points of view, such as textural and mineralogic, through X-Ray Diffraction (XRD). Thermogravimetric and geochemistry analyses, such as X-Ray Fluorescence, will be carried out. They will be applied to samples from geologic outcrops and, subsequently, contrasted with similar analyses of archaeological samples from La Uña and El Espertin sites. This will allow us to check the exploitation of this kind of raw material during Prehistory in the southern Cantabrian Mountains, although the results can be extrapolated to the northern area.

Sources, Production and Distribution of Pre-Hispanic Lithic Materials in Aguascalientes, Mexico

Lailson Becket[1], Caretta Nicolás[1], Cabadas Héctor[2], Sedov Sergey[3], Pelz Ana[4], Schulze Niklas[1]

[1-] Facultad de Ciencias Sociales y Humanidades, Universidad Autónoma de San Luis Potosí. Av. Industrias 101-A, Talleres, SLP, C.P. 78494, México.
[2-]Facultad de Geografía, Universidad Autónoma del Estado de México. Paseo Universidad, Toluca de Lerdo, C.P. 50110, México.
[3-]Instituto de Geología, Universidad Nacional Autónoma de México. Ciudad universitaria, Coyoacán, México, D.F. C.P. 04510, México.
[4-]Instituto Nacional de Antropología e Historia. Juan de Montoro 226, Centro, Aguascalientes, C.P. 20000, México.

becketlailson@uaslp.mx

Keywords: Production, lithic, Mesoamerica

This is a summary of the geoarcheological analysis of lithic materials from El Ocote and Cerro Santiago, pre-Hispanic sites located in Aguascalientes, Mexico, in the northern border of Mesoamerica. The materials include polished lithic artifacts such as grinding stones (metates), hand stones, axes, and polishers, among others. They also include worked lithic tools such as projectile points, scrapers, and gravers. In parallel, we analyzed the processes of production, considering the flint-knapping waste related to that industry (hammerstones, masses of tool stone, cores and various types of flakes). The information obtained reflects the diversified production of tools used in building activities and in the production of food, handicrafts and ornaments. Our main purpose of this discussion is to present this information as a contribution to regional lithic studies and thereby strengthen the research and comparison of lithic materials found in archeological sites in Aguascalientes and the surrounding areas.

Geoarchaeology, geochemistry and petrography of jasper sources in the Alentejo region of Portugal

Adrian L. Burke, Gilles Gauthier & Ariane Burke

Département d'anthropologie. Université de Montréal

adrian.burke@umontreal.ca

Keywords: geoarchaeology, jasper, XRF geochemistry, Alentejo, Middle Palaeolithic

During the summers of 2006 and 2007, the first author carried out geoarchaeological fieldwork in the Alentejo region of Portugal. This research was done in support of the larger Sado River Drainage Survey (SRDS) project directed by Dr. Ariane Burke which focussed on the Middle Palaeolithic landscape of that part of Portugal. The primary objective of the geoarchaeological fieldwork was to identify potential sources of knappable siliceous materials for the manufacture of stone tools by Neanderthal groups. Most of Alentejo, and in particular the Sado River drainage, is poor in flint. As a result, our research focused mostly on the jasper and quartz that was available in the region to prehistoric tool makers. The SRDS survey demonstrated that jasper was clearly used by Middle Paleolithic groups. We concentrated our geological fieldwork on bedrock sources of jasper, as the quartz sources were poorly mapped and quartz cobbles are ubiquitous in the Sado River area. Veins of jasper are not uncommon in the rocks of the Iberian Pyrite Belt and are mostly related to volcanogenic massive sulfide ore deposits (VMS). Well known historic deposits exist near Aljustrel, in Baixo Alentejo for example. This jasper is fine-grained, conchoidal and can be massive. Its knapping quality can be quite good based on our knapping experiments. We sampled 15 bedrock outcrops of jasper, locating all samples using GPS. The whole-rock geochemical analysis was done using a PANalytical Epsilon 5 X-ray spectrometer (ED-XRF) on both flakes taken from geological samples as well as cut and polished samples. We also made thin sections of jasper samples from 6 sources of jasper. In this poster we present the geoarchaeological, geochemical and petrographic data that characterizes these jaspers. The jaspers are relatively pure being very high in silica (>90%), and it is not easy to distinguish them based on geochemical and petrographic data. This suggests that it will not be a simple task to connect archaeological flakes and tools to a specific jasper outcrop in the Alentejo region. However, this work is only a first step in the characterization of these numerous jasper sources and more geoarchaeological work is needed in the region.

Variability in the exploitation of lithic raw materials from Middle Neolithic to Late Chalcolithic, at Realmese site (Calascibetta - Enna, central Sicily)

Tania Quero[1], Rosa Maria Albanese[2], Enrico Procelli†[3]

[1-] Specialisation School in Archaeology - University of Trieste. Via A. De Vivo 28 – 80010 Italy
[2-]University of Catania - Dep. SAFIST Via Biblioteca 4, 95124 Catania Italy
[3-] University of Catania - Dep. SAFIST Via Biblioteca 4, 95124 Catania Italy

tania.quero@libero.it

Keywords: Central Sicily, Neo-Chalcolithic, local vs exotic materials

We present the results of a preliminary study on lithic materials from the prehistoric settlement of Realmese - Calascibetta (Enna, central Sicily), investigated by L. Bernabò Brea in 1950-52. The excavation was carried out in four trenches, with cuts made at about every 20 cm. Fine and coarse ware dates between the Middle Neolithic and the Late Chalcolithic.
The important amount of lithic artefacts reveals differed productions of lamellar, laminar and flakes blanks and a wide range of local and exotic raw materials (quartz/quartzitic rocks, fine-grained flint and obsidian), during the different periods.

Friday, 11 March 2015 - 09h00

Open Session: Putting Data Into Context

Pierre PETREQUIN - Laboratoire de chrono-écologie, CNRS, FRANCE (*archeo.petrequin@free.fr)*
Alison SHERIDAN - National Museums Scotland, SCOTLAND (*a.sheridan@nms.ac.uk)*

In this congress, sessions, presentations and posters will be mostly oriented toward the archaeometrical approaches. Archaeometrical approaches are essential for the acquisition of detailed information that allows us to describe accurately each raw material and to link them between the archaeological site, its natural source and the ways how they were processed.

However, the data gathered by these high-resolution methods is often insufficient to understand prehistoric human behavior if it is not merged with accurate informations gathered from the archaeological context and compared with hypothesis and models from actualistic studies, such as ethnography and ethno-archaeology.

Therefore, we propose an open session where we would like to bring together these two different but complementary avenues of approaching raw material sourcing, processing and distribution. Our goal is to reach closer the point of view of ancient populations, their ecological behavior, social network and ideal functioning of their societies.

We will accept case studies of complex situations where different archaeometrical approaches were mixed together with archaeological or (and) actualistic studies in order to reach more anthropological interpretations about some general questions of shared interest, such as: what criteria were people using to select their raw materials? Why and how was an artifact moving (or not) in a transfer system? For what purpose were the raw materials used in the context of the social and ideal points of view? What could have been the social conditions to such long distance circulations? Have we to deal only with technical artifacts or also with "object-signifiers", socially over-valued materials, and so on…?

- 09h00: Discriminating between potential/actual and major/minor lithic sources using geostatistical models of artifact distributions: the cherts from east-central Argentina as a case study

Luciana Catella[1], Gustavo Barrientos[2] and Fernando Oliva[3]

[1]- División Arqueología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. CEAR, Facultad de Humanidades y Artes, Universidad Nacional de Rosario.
[2]- División Antropología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. CONICET. CEAR, Facultad de Humanidades y Artes, Universidad Nacional de Rosario.
[3]-CEAR, Facultad de Humanidades y Artes, Universidad Nacional de Rosario.

catellaluciana@hotmail.com

Keywords: Lithic landscapes; GIS; interpolation; chert; lithic sources

The lithic landscapes of East-Central Argentina (35.5°—41.5° S; 56.5°—67.5° W) are currently being modeled using geostatistical interpolation (i.e. kriging) of relative frequency data from regionally distributed artifact assemblages. This GIS-based approach allows, among other things, for the discrimination between potential vs. actual and major vs. minor sources of raw materials. The rationale behind this assertion is the general expectation that, around an actual source of a given raw material, a definite peak of frequency of the same rock will be detected in the resulting spatial model. All other things being equal, the stronger the peak, the higher the likely importance of the source in that specific regional context. Moreover, to the extent that peaks of frequency are expected to happen at or near the sources, its occurrence in zones seemingly devoid of sources may alert about the presence of an undetected supply area. This helps to plan problem-oriented surveys and to implement more analytical sourcing activities. In this presentation we will exemplify the approach with a case study concerning the distribution of a silicified limestone locally called “siliceous chert”. The main, well described sources of this rock are located at the Meseta del Fresco, a plateau placed in the western portion of the study area. Some other outcrops of this toolstone are also present (El Carancho and Valle Daza), but they have been generally overlooked by archaeologist as actual sources of lithic materials for toolmaking, despite the paucity of both extensive and intensive sourcing studies. Kriging models for this raw material are clearly inconsistent with a single-source hypothesis. They show at least two robust peaks of frequency—one around Meseta del Fresco and one around El Carancho and Valle Daza—as well as some less conspicuous peaks (e.g. Laguna Chasicó), which suggests that several sources were exploited at the regional level, some of them very intensively. Our results underscore the need of deployment of a multiple approach to sourcing, particularly by incorporating techniques that integrate scatter information and take advantage of widely and readily available data like relative frequencies or percentages.

- 09h20: Alpine jades: from scientific analyses to Neolithic knowhow

Pierre Pétrequin[1], Alison Sheridan[2]

[1]-MSHE C.N. Ledoux, CNRS et Université de Franche-Comté, 32, rue Mégevand, F 25030 Besançon Cedex, France.
[2]- Department of Scottish History and Archaeology, National Museums Scotland, Chambers Street, Edinburgh EH1 1JF, Great Britain

archeo.petrequin@free.fr

Keywords: Alpine jades, Neolithic, sourcing, exchanges, stone axeheads

From 5300 BC, axeheads of 'Alpine jades' (jadeitites, omphacitites, fine-grained eclogites and certain amphibolites) circulated across the whole of Europe, up to 1800 km from the raw material sources in the Mont Viso and Mont Beigua massifs.

The presentation covers four themes:

1) Analyses of the axeheads, using increasingly sophisticated methods – but which, without a reference collection, do not allow one to source the raw material.

2) The creation of a raw material reference collection which allows one, through spectroradiometric analysis, to make comparisons with Neolithic jadeitite axeheads to suggest an origin. However, this method is not ideal for sourcing omphacitite and eclogite axeheads.

3) Research into the macroscopic characteristics of the jades, to characterise the various outcrops and to compare these with the axeheads.

4) The identification of criteria which, during the Neolithic, would have permitted people to identify the jades at the outcrops and to select axeheads made of jadeitite during long-distance transfers.

This last point – the identification of jades by Neolithic people, the reproducibility of the criteria used to recognise the materials and the transmission of this knowledge across distances of over 1000 km as the crow flies – will be compared with the practices of modern science.

- 09h40: Site catchment analysis and human behaviour during the Upper Palaeolithic in the Cantabrian Region: Coímbre cave (Asturias, Spain) as case study

María de Andrés-Herrero[1-2], David Álvarez-Alonso[3], Daniel Becker[4], Gerd-Christian Weniger[1-2], José Yravedra[5].

[1-] Neanderthal Museum. Talstraße 300, 40822 Mettmann, Germany.
[2-] Institute of Prehistoric Archaeology. University of Cologne. Albertus-Magnus-Platz, 50923 Köln, Germany
[3-] Department of Prehistory & Archaeology. UNED/C.A. Asturias. Avda. Jardín Botánico 1345
[4-] Institute of Geography, University of Cologne, Albertus-Magnus-Platz, 50923 Köln, Germany. d
[5-] Department of Prehistory. Complutense University of Madrid.

mdeandres@neanderthal.de

Keywords: Geographic Information Systems (GIS), catchment area, Least Cost Paths (LCPs), mobility, territoriality.

This paper analyses the territoriality and mobility of hunter-gatherer groups that inhabited in Coímbre in its different occupation periods (Magdalenian and Gravettian). With the objective of developing this study a Geographic Information System was used, allowing us to get new information of Coímbre cave in relation to the lithic raw materials unearthed in the excavation developed between 2008 and 2012: we have calculated the cost of the movement in the territory, and using Least Cost Paths in order to calculate the distances in kilometers and hours to different outcrops of lithic raw materials and to the areas in which the archaeological record reveals the existence of movements as, for example, the coastal area. Moreover, the creation of a Least Cost Path network allowed us to make an approach to the mobility patterns between Sella and Deva rivers. All the above-mentioned analysis provide very useful information to analyze the human behavior in Coímbre between Magdalenian and Gravettian.

Understanding human behaviour during the Upper Palaeolithic in the Cantabrian Region (Spain) by means of lithic raw materials and Site Catchment Analysis

María de Andrés-Herrero[1-2], Daniel Becker[3], Gerd-Christian Weniger[1-2]

[1-]Neanderthal Museum. Talstraße 300, 40822 Mettmann, Germany.
[2-]Institute of Prehistoric Archaeology. University of Cologne. Albertus-Magnus-Platz, 50923 Köln, Germany
[3-]Institute of Geography, University of Cologne, Albertus-Magnus-Platz, 50923 Köln, Germany.

mdeandres@neanderthal.de

Keywords: Geographic Information System (GIS), Least Cost Paths (LCPs), Accessibility; Mobility; Outcrop.

The aim of this research is to enlighten the human behaviour of hunter-gatherer groups during the Upper Palaeolithic in the Cantabrian Region by means of the data provided by lithic raw materials. We analyze if it is possible to establish links between the accessibility of the outcrops and the density and types of raw materials in archaeological sites to understand the criteria used by hunter-gatherer groups to select the raw materials. To perform this study we use Site Catchment Analysis (SCA) (Vita-Finzi & Higgs, 1970) and Least Cost Paths (LCPs). The geographical and geological conditions of the area support the use of SCA since the relief has not been affected by substantial changes since the end of the Pleistocene, taking into account that most of the known Upper Palaeolithic sites are located in caves, and most of them, in narrow karstic valleys (Risetto, 2012). The LCPs are based on walking time and cost distance modelling (Tobler 1993; White & Barber, 2012; Whitley & Hicks, 2003) and we test if there is a relationship between the LCPs generated from random starting and end points, as well as the distribution of known outcrops. Generating a network of LCPs allows us to identify the most suitable routes to transport the lithic raw materials (Llobera et al, 2011; Verhagen, 2010). We will also test the hypothesis of the "valley-territory" (Binford, 1977, 1980), which was applied to the Cantabrian area especially during the 1980s and 1990s in several cases as in the sites of El Rascaño (González-Echegaray & Barandiarán, 1981) and El Juyo (Barandiarán et al., 1987) in Cantabria or La Riera (Straus & Clark, 1986) in Asturias.

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Understanding reciprocal relationships between rocks and sources: a spatial approach to the study of competition between raw materials in specific regional contexts

Gustavo Barrientos [1] and Luciana Catella[2]

[1]-División Antropología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. CONICET. CEAR, Facultad de Humanidades y Artes, Universidad Nacional de Rosario.
[2]-División Arqueología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. CEAR, Facultad de Humanidades y Artes, Universidad Nacional de Rosario.

gustavbarrie@yahoo.com.ar

Keywords: Lithic landscapes; GIS; kriging; quartzites; lithic sources

Hunter-gatherer populations usually exploit, simultaneously, different lithic raw materials and sources. On the long run, the cumulative effects of spatiotemporal behaviors (i.e., individual and collective actions that manifest at different successive points in space and time) involving the procurement, manufacture, transport, use, and discard of lithic materials from different sources tend to produce, at any given point in space, a differential representation of each toolstone. The analysis of the spatial distribution of frequency data, particularly of relative frequencies, regarding the raw materials represented in regionally distributed artifact assemblages allows for the study of long-term trends in the reciprocal relationships between rocks and/or sources. A particular kind of reciprocal relationship is competition. When we speak of "competition" between rocks, we are using a figurative expression to depict a situation in which two or more toolstones or sources have a differential probability of being used by humans. Such a probability depends on the intrinsic properties of the rocks and of their sources but, above all, on the cultural preferences and strategic/tactical/operational decision rules applied by people in different situations. Our approach to this problem is based on the concept of "lithic landscape", which refers to the co-occurrence, in a given geographic space, of different structural units composed by two principal elements: a raw material source, either primary or secondary, and an associated scatter or strewn area. The latter comprise the spatial distribution of both unmodified and human-modified pieces of rocks procured from that source. An important property of a scatter area is the overall decrement in spatial density, size, weight, or frequency of lithic artifacts from the raw material source to the outer limits of the strewn area. The resulting fall-off curves—modeled with GIS—can be smooth or steep depending on factors like mobility patterns, the quality of the raw material, and the spatial proximity and/or competition between two or more raw material sources. In this presentation we will illustrate the proposed approach to the study of competition between rocks and/or sources by discussing selected examples from East-Central Argentina (35.5°—41.5° S; 56.5°—67.5° W).

Impressions from the past: basketry in Bronze Age Sardinia (Italy)

Noemi Fadda

Dipartimento di Storia, Scienze dell'Uomo e Della Formazione – Università degli Studi di Sassari.

noemifadda@hotmail.it

Keywords: crafts activities, Bronze Age, raw material selection, basketry, ethno-archaeology.

The close relationship between man and nature has led him to be able to manipulate and modify the raw material for the manufacture of objects. Investigate the plants used for crafts activities is important to understand the environment of the past and the social dynamics involved in the creation and use of plants objects.

The bind technique necessarily involves knowledge of the physical properties of the plants used (flexibility, strength, elasticity) and of their life cycle .

It is very difficult to find baskets remains in archaeological excavation because the material is perishable, but we can identify some direct evidence in Bronze Age pottery from Sardinia (Italy). Often we found impression of basketry on pots bases, because the basket was used to rest wet pots during the manifacture process. The analysis of impressions has identified the plant used to produce baskets: the asphodel. We know that the baskets were manufactured by an armature formed by a bundle of fibers wound in a spiral and stitched with a ribbon of grass. This method allows to produce containers of various sizes.

The asphodel baskets are still produced in some areas of Sardinia.

The aim of this study is to reconstruct the stages of work, from extraction of the plant to the creation of the basket, with an ethnographic and experimental approach. The study will be also supported by archaeological data, with the observation under a stereomicroscope of samples of pots bases with impressions from the Bronze Age site of Nuraghe Ola, located in central Sardinia.

Chaînes Opératoires and lithic raw materials procurement of the Mousterian occupation in Abrigo del Molino (Segovia, Spain)

David Álvarez-Alonso[1], María de Andrés Herrero[2], Andrés Díez-Herrero[3], Oscar Fuente Fernández[1], Julio A. Rojo Hernández[1]

[1]-Department of Prehistory & Archaeology. UNED/C.A. Asturias. Avda. Jardín Botánico 1345 (Calle interior), 33203 (Spain);
[2]-Institute of Prehistoric Archaeology. University of Cologne (Germany) / Neanderthal Museum
[3]-Geological Survey of Spain (IGME), Madrid (Spain)

dalvarez@gijon.uned.es

Keywords: Lithic Technology, Flint, Middle Palaeolithic

In this paper we present the state of the Arts of the research on the lithic raw material procurement and its use in specific Chaînes Opératoires in this site.

Abrigo del Molino is located in the upper part of Eresma river valley (Segovia, Spain), in the northern slope of Central System mountain range. The site is being excavated since 2013 and it contains a wide stratrigraphy in which three Mousterian occupation levels have been found, with a chronology between 40 and 60 Ka.

The lithological variety of the upper basin of Eresma favors the presence of a remarkable variety of rocks and minerals in its bed, which have been used for different purposes in the Chaînes Opératoires developed by different Neanderthal groups in the rockshelter. Morphology, hardness, size or the facility to be knapped of everyone of these materials have made the different raw materials appropriate for different objectives.

The presence of endogenous and exogenous materials, together with the selection of them, according to their characteristics, shows a high degree of selection and planning of the activities carried out in Abrigo del Molino.

Friday, 10h25

Advances In Tracing The Origin And Circulation Of Mineral-Based Prestige Items In The Prehistory Of The Middle East And Its Adjacent Regions

Hala ALARASHI - Archéorient-CNRS Lyon, FRANCE

Marie-Laure CHAMBRADE - Archéorient-CNRS Lyon, FRANCE

Lamya KHALIDI - CEPAM-CNRS Nice, FRANCE

tracingitems@yahoo.com

Prehistoric groups have benefited from a large diversity of mineral outcrops like those of quartz, obsidian, carnelian, agate, jade, schist, turquoise, chlorite, serpentine, feldspar, amazonite, copper, marble, limestone, clay, etc. for the production of adornments, figurines, statues, vessels, axes, and other artefacts of prestige and high symbolic value.

Symbolic values of objects are best understood in the context of a reading of the *chaine operatoire* as well as the socio-cultural and environmental contexts within which the human groups that made or owned them operated. The first step in decorticating the meaning of such items is locating their geological origin in space, and in relation to where they were deposited.

A number of non-destructive physical, chemical and optical methods that allow fingerprinting materials are available to us today. However, save for advances in obsidian provenance, the identification of source outcrops for most of these raw materials remains limited as a result of a dearth of geological surveys and sourcing analysis.

Identification of the origins of such raw materials could provide information on circulation networks and on socio-cultural interactions between human groups, complementing existing obsidian data. In this session we invite contributions on new analytical methods used to source mineral raw materials used to make objects of prestige with the aim of answering the following questions: Which materials or objects circulated in prehistory, in what form (raw material, preforms, finished products) and over what distances? Were these materials circulating in the same networks as obsidian or in different ones? What was the role of human communities settled near sources regarding the exploitation, transformation and distribution of raw materials or finished objects?

In this session we aim to discuss the origin of the varied mineral materials found in the form of items of prestige in the Near East, northeast Africa, Anatolia and the Caucasus, Iran and the Gulf, and their circulation networks. We focus on new methods used for their identification, sourcing and technological study. Papers presenting new field or remote sensing methods, new methods in GIS and modelling, geological surveys and databases ("lithotheques") are especially welcome.

- 10h25: Provenance Analysis of 'Calcite-Alabaster' Vessels from Qatna, Syria, by NAA

Tina Koester[1], Ernst Pernicka[2]

[1]- Institute for Ancient Near Eastern Studies, University of Tuebingen, 72070 Tuebingen, Germany
[2]- Curt Engelhorn Zentrum Archaeometrie gGmbH, 68159 Mannheim, Germany

tina.koester@uni-tuebingen.de

Keywords: provenance analysis; calcite-alabaster; travertine

Vessels made from 'calcite-alabaster' (also known as 'Egyptian Alabaster' or 'travertine') were a tangible part of exchange systems linking kingdoms of the Eastern Mediterranean to Mesopotamia in the 2nd millennium BC. It is widely assumed that those vessels which were found in the Levant, mostly in elite Bronze Age context, were manufactured in Egyptian workshops. This assumption is mainly based on the production of typologically very similar vessel shapes in Egypt since the 4th millennium BC and on the ancient exploitation of 'calcite-alabaster' quarries in Egypt. However, a limited number of vessels discovered at Levantine sites have a Levantine shape or display slight, but marked distinctions from the bulk of vessels known from Egypt itself. Since deposits of travertine are also known outside of Egypt, the archaeometric analysis of 'calcite alabaster' vessels may clarify whether only Egyptian raw material was used.

An initial result of this study was the development of a procedure to differentiate between 'calcite-alabaster' deposits. This involved the application of neutron activation analysis (NAA) to determine the concentration of 25 trace elements, which were selected on geochemical reasoning. Furthermore discriminating elements and element ratios were identified by principal component analysis and discriminant analysis, resulting in a multi-step interpretation procedure to differentiate between various deposits.

This routine was subsequently implemented to study the provenance of 68 'calcite-alabaster' vessels, discovered in two Bronze Age grave contexts at Qatna, Syria.

For the majority of the vessels studied an Egyptian provenance of the raw material could not be excluded, but several vessels are distinguished by marked difference in trace element concentrations from the Egyptian sources. Interestingly, not all of these anomalous vessels can be typologically classified as 'non-Egyptian', neither are they chemically homogenous. Furthermore, not all typologically 'Levantine' vessels are chemically different from the Egyptian raw material. This indicates that the typology of a 'calcite-alabaster' vessel cannot be used as the only criterion for the origin of the raw material. In the presented case, the chemically anomalous vessels indicate that Egypt was not the only source for 'calcite alabaster', but rather that deposits in other regions also need to be considered.

- 10h45: Composition and origin of felsite and amazonite prestige items in the central Sahara during the African Humid Period

Paul Sereno

Department of Organismal Biology and Anatomy, University of Chicago

dinosaur@uchicago.edu

Keywords: felsite, amazonite, African Humid Period, Gobero, Niger

The Gobero site complex in the central Sahara (Niger) records a sustained semi-sedentary occupation of to the Early and Middle Holocene (10,000-5,000 BP) that preserves a rich assemblage of mineralogically distinct prestige items. Prominent among them are "ceremonial disks" composed of opaque green microcrystalline feldspar (felsite), a lithic material long misidentified as either "jasper" or "vitric tuff", and amazonite ornaments sometimes posited as evidence of trans-Saharan trade from faraway sources. Gobero, however, is situated only approximately 100 km distant from the flanks of the Aïr uplift, a local province of hot spot Tertiary volcanism. Recently a suite of felsite quarries and geologic conditions favorable to the formation of amazonite were discovered on the eastern flank of the uplift. Neutron activation and trace element analyses and petrographic imaging of artifact and quarry samples begin to fingerprint the variation and origin of felsite and amazonite materials, which are among the most distinctive lithic materials at archaeological sites in the central Sahara.

- 11h05: Preliminary results of geochemical analyses on beads from the site of Kadruka 1 (KDK1), Nile Valley, Northern Sudan

Hala Alarashi[1], Lamya Khalidi[2], Sandrine Bonnardin[2]

[1]- Archéorient – UMR 5133 CNRS, Maison de l'Orient et de la Méditerranée 7 Rue Raulin, 69365 Lyon Cedex 7, France.
[2]- CEPAM – UMR 7264 CNRS, Université Nice Sophia Antipolis, Pôle Universitaire Saint Jean d'Angély 3. 24, avenue des Diables Bleus, F - 06357 Nice Cedex 4, France.

hala.alarashi@free.fr

Keywords: Stone beads, XRD, SEM-EDS, Kadruka, Neolithic

Kadruka 1 is a Nubian late-Neolithic (end of the 5th millennium BC) funerary mound located between the third and fourth cataract of the Nile River. 104 excavated burials pertaining to both adults and children contain a rich assemblage of personal adornments that includes more than 11,500 beads, pendants, labrets, and bracelets made from stone, clay, glass (?), resin (?), bone, shell and ivory. The large variety of mineral raw materials includes stones that were easily recognizable (e.g. white/milky opaque quartz, carnelian, agate) and materials that were uncertain (e.g. amazonite, chlorite, glazed talc, glass or resins). 22 samples from the uncertain category were analyzed using X-ray diffraction (XRD) and scanning electron microscopy coupled with energy dispersive X-ray spectroscopy sound (SEM-EDS). Some of the results were conclusive and have confirmed the use of amazonite, talc and clinochlore while the results of other analyses require more investigation, as in the case of synthetic enstatite (heated and "glazed" talc?). The latter is identified for a series of micro-beads for which the process of fabrication is quite complex and which are known from a widespread area that stretched from the Indus Valley to the Near East during the fifth millennium BC. In addition to discussing the micro-bead process of fabrication and its age, we discuss in this paper the reliability of the results and the adaptability of the archaeometric techniques used for this category of objects.

- 11h25: Neolithic Blue Beads in Northwest Turkey: the Social Significance of Skeuomorphism

Ayse Bursali[1], Hadi Özbal[2], Emma Baysal[3], Rana Özbal[1], Barıs Yagci[1]

[1]-Koç University
[2]-Bogaziçi University
[3]-Trakya University

abursali13@ku.edu.tr

Keywords: beads, personal ornamentation, Neolithic, turquoise, Northwest Anatolia

Turquoise-blue colored beads found at the seventh millennium Neolithic site of Barcın Höyük in NW Anatolia, make up the largest group of the bead assemblage at the site. Manufactured from initially a white material and treated to resemble turquoise in color and form, these beads are surprisingly reminiscent of this precious stone. As turquoise is rarely found in Anatolian sites in the Neolithic given that its closest sources are in the Sinai, the desire to copy it would not be surprising. Initial evidence suggests that ideas of imitation and skeuomorphism may be at play in the society. Based on FTIR, SEM and EDX analyses the raw material of the beads appears to be fluorapatite. Further analyses with RAMAN are ongoing to ascertain how the blue color was achieved. The wider social implications of the desire for blue beads, including the networks that carried both real and imitation materials and the restricted access of some settlements to beads are considered in relation to the results of analyses.

Finds of these fluorapatite beads in other locations, sometimes alongside real turquoise, help trace this network of skeuomorphs in the wider landscape of Anatolia and the Near East, at locations differing in proximity to turquoise sources. This paper looks both at how the materials have been identified, and the way in which the social desire for ownership of the color blue in the seemingly egalitarian and homogenous Neolithic period may have functioned.

- 11h45: The multiple origins of some obsidian beads found in a tomb at Kish, Iraq

Stuart Campbell, Elizabeth Healey

University of Manchester, UK

stuart.campbell@manchester.ac.uk

Keywords: Obsidian; Obsidian sourcing; pXRF; networks; prestige items

In this paper we consider the somewhat unexpected results of the provenance analysis, using pXRF, of 105 beads found in a tomb excavated in 1929 in Kish, in southern Iraq. They are dated to the Early Dynastic period (c.2700 BC) and are now in the Ashmolean Museum, Oxford. This specific study is part of a wider project analysing obsidian in later prehistoric and historic Mesopotamia.

Although technological analysis suggests that the beads were made locally and have limited stylistic variation, our analysis showed that the beads were in fact made of obsidian that originated from four different and diverse sources. That adds a new dimension to our knowledge of which sources were exploited as well as the form in which the obsidian from them might have circulated. This also enables us to investigate the meaning behind the choice of exotic materials to make prestige objects, and in this case their use in the construction of identities in burial contexts.

As well as discussing the origins of the obsidian we will briefly review the evidence for the use of other exotic raw materials such as carnelian and lapis lazuli. We hope to be able to tease out the social, technological and economic meanings constructed through different exchange networks and mechanisms.

- 12h05: Mapping Economic Networks of Production and Trade: Copper in Oman and Obsidian in Ethiopia

Ioana A. Dumitru, Michael J. Harrower

Johns Hopkins University

idumitr1@manchester.ac.uk

Keywords: Social Network Analysis · satellite imagery

Our research pioneers the joint applications of hyperspectral imagery analysis, Social Network Analysis, and Geographic Information Systems (GIS) to address geographies of raw material exploitation and socio-economic interaction that are of wide importance to anthropological archaeology. Through a comparison of two very different commercial contexts, of copper production in Oman and obsidian exploitation in Ethiopia, we seek to understand how the mutually reinforcing feedback loops of raw material availability, technological skill, consumer demand, and economic output manifest geographically. A long-distance trade network developed in the Persian Gulf beginning in the third millennium BCE, connecting producers of copper in Oman with consumers in southern Mesopotamia. The first evidence for the circulation of obsidian in the southern Red Sea dates to the sixth millennium BCE.

Our evaluation of copper and obsidian production and consumptionn uses hyperspectral satellite imagery and archaeological survey data to map interactions between different economic nodes within the respective social networks, of copper production in Oman and obsidian exploitation in Ethiopia. We are mapping these economic interactions at three spatial scales: the micro-scale of individual nodes (archaeological sites), the meso-scale of our specific research areas (in the Ad-Dhabirah governorate of Oman and in the Tigrai region of Ethiopia), and the macro-scale of the wider socio-economic networks of northern Oman and northern Ethiopia. Analyzing socioeconomic interactions at varying scales will lead to developing complementary interpretations of the relationships between archaeological settlements.

Methodologically, our investigations map natural copper and obsidian availability using commercial remote sensing software, ERDAS Imagine and ENVI, to analyze Hyperion hyperspectral satellite imagery. Using the spectral signatures of eight different copper-bearing minerals, we detected copper sources, including the well-known Iron Age copper mining sites, al-Raki and ʿArja. Similarly, two obsidian signatures were used to run detection on Hyperion images of Ethiopia, covering areas of volcanic activity with known obsidian outcroppings. Analysis run on an image of an area containing the volcano Erta Ale detected obsidian in an arc around its caldera. Detection run on Hyperion images of the area surrounding the exploitation site of Humbo Baantu produced a map of obsidian sources, identifying areas with known obsidian outcropping.

- 12h25: Prestige materials and materiality in the Neolithic Eastern Fertile Crescent

Dr Amy Richardson

University of Oxford. Institute of Archaeology, 36 Beaumont Street, Oxford, OX1 2PG

amy.richardson@orinst.ox.ac.uk

Keywords: Neolithic; Iraq; Iran; pXRF; materials

Throughout the Neolithic, people, things, skills and technologies moved between settlements, weaving together cultural meshworks that connected widely spread communities. Across the Eastern Fertile Crescent, these networks covered hundreds of kilometres, bringing exotic materials from far and wide, to the remotest sites high in the Zagros Mountains of Iraq and Iran. Intermittent investigations into the sites of the region have revealed early settlements connected through shared technologies, ideologies, food practices and materialities. The earliest settlements were well located for access to water, to hunting grounds, to good sources of limestone, chert, and clay. The rich outcrops of the mountains provided marble and alabaster; seams yielding serpentine, quartz and high quality cherts in the tectonic suture zone; bitumen seeps are known throughout the region. Yet, regardless of this abundance of materials, prestige objects from far afield were deposited at many of its settlements. The extent to which communities engaged in networks of exchange varied from settlement to settlement, but intensifying patterns of the movement of materials highlights the crucial role that exotic materials played in connecting communities.

The transmission of obsidian from the Eastern Anatolian sources has been documented, demonstrating clear, statistically quantifiable route ways of dispersal. However, the regular deposition of sea shell at inland sites, such as cowries and dentalium, and the rarer appearance of minerals such as carnelian and sard, turquoise and variscite, are much more difficult to quantify. Non-destructive methods such as portable X-ray fluorescence have great potential to trace the patterns of dispersal, although the acquisition of much larger datasets is vital. Through mapping the occurrence of materials, identifying not just techno-typological but also geochemical similarities, it becomes possible to establish models beyond the obsidian networks (ones which incorporated plants, animals, and people, as well as things), in order to shed light on the more complex interactions operating across the landscape and the role these played in the transformation of Neolithic societies. This paper highlights key themes in ongoing research that aims to examine these networks across the Eastern Fertile Crescent sites in Iraq and Iran, from the end of the Epipalaeolithic to the early Chalcolithic.

Stone personal adornments from Tell Mureybet (Euphrates valley, Syria): mineral composition and pathways of circulation

Hala Alarashi, Marie-Laure Chambrade

Archéorient – UMR 5133, Maison de lÓrient et de la Méditerranée, Lyon, France

hala.alarashi@free.fr

Keywords: Stone ornaments, X-ray diffraction, GIS, pathways, Neolithic

The Neolithic site of Mureybet has delivered a wide variety of mainly stone ornaments. The mineral composition of more than half of these artefacts was analyzed using the X-ray diffraction method. The identification of the stone materials demonstrated that the allochthonous rocks (phosphates, ophiolites and other metamorphic rocks) were predominant compared to local ones (carbonates, gypsum, clay). The presence of allochtonous rocks, combined with those of Mediterranean shells, attest the presence of long-distance circulation networks during the Khiamian and the PPNA periods. Where did these materials come from and how did they arrive on the site? What role did contemporary sites play in the control, distribution and circulation of these materials? These issues have raised methodological questions, one of which is the purpose of this paper: how to treat the question of circulation of people and goods during periods lacking texts or markers of such movement in the landscape?

We have started to answer those questions thanks to a pluridisciplinary approach combining the circulation of other raw materials used for prestige items like obsidian, cultural contexts, and least cost path analysis. The first results of our work have allowed us to present hypotheses on the modes of circulation of raw materials (e.g. favoured pathways, possible distribution places). However, we face two obstacles: the impossibility of identifying the exact exploited sources and the limitations of GIS applications. How can we enhance the technical approach? What kind of new parameters can we take into account and how? In this paper,we propose improvements of certain methods and discuss the limits and compatibility of the methods and tools we have used (X-ray diffraction analysis and GIS application).

The fabrication of obsidian prestige items in Late Chalcolithic northern Mesopotamia

Lamya Khalidi

CEPAM-CNRS Nice, France

lamya.khalidi@cepam.cnrs.fr

Keywords: obsidian circulation; obsidian prestige items; Late Chalcolithic; Tell Brak; Syria

Anatolian and Caucasian obsidian circulated at long distances across the Near East during the late prehistoric periods, reaching northern Arabia in the PPNB, and the Arabian Gulf in the Ubaid period. Like most unavailable materials, it was valuable to populations. Nonetheless it was primarily used for the fabrication of utilitarian tools. However, less discussed is the fabrication of obsidian vessels and personal adornment, often found alongside the fabrication of obsidian tools. Using a technological reading, and preliminary experimentation, I discuss a series of obsidian beads and a vessel recovered from Late Chalcolithic contexts at the sites of Tell Brak and Tell Majnuna in northeast Syria and compare this production to that of the obsidian tool assemblage recovered. The technological study, confirmed by LA-ICP-MS analyses of debitage and tools, shows that the same two types of obsidian were used to produce tools and objects which were part of a single *chaîne opératoire*.

The bead-maker's toolkit – The circulation of drilling technologies and gemstones in the "Middle Asian Interaction Sphere"

Federica Lume Pereira M.A.

Graduate Programme for Transcultural Studies – Cluster of Excellence "Asia and Europe in a Global Context" – Heidelberg University Voßstraße 2 – Building 4400 – Office 017 – 69115 Heidelberg – GERMANY

federica.lume-pereira@asia-europe.uni-heidelberg.de

Keywords: Drill bits – carnelian – Gonur Depe – 3rd Millennium BC

The following paper addresses the question of technological transmission in the context of newly established exchange mechanisms of the Early Bronze Age in the Near East and South Asia. During the second half of the 3rd millennium BC long range exchange networks merged connecting urban landscapes in the Near East with other centers in Central and South Asia. This phenomenon is mainly attested by the circulation of "prestige items" and the wide incorporation of exotic materials into ritual and everyday practices.

Of the circulated materials, gemstones are amongst the more prominent. The provenance and specific mineral composition of these stones have both long been subject of research and still remain contended. Quite recently the study of the elaborate technology behind the manufacture of beads has moved into focus. Inspired by experiments first conducted by L. Gorelick and further refined by J.M. Kenoyer and M. Vidale, multiple studies using silicone moulds and SEM photography have opened up new possibilities of analyzing aspects of bead production and thus shed light onto the diverse technological traditions often connected through exchange.

Drawing from my ongoing Ph.D. project I will present such a case study focusing on a number of beads from Gonur Depe (Turkmenistan) – the best known urban center of the so-called Oxus civilization (BMAC). Through its unique position at the crossroads of several interconnected landscapes in Afghanistan, Pakistan and Eastern Iran, Gonur Depe with its distinct BMAC features makes for a particularly interesting example of the dynamics involved in the circulation of mineral-based prestige items.

Pertinent Literature (selection):
Gorelick, Leonrad (Ed.), *Ancient seals and the Bible*. Vol. 2,1. Occasional papers on the Near East (Malibu, Calif 1983). Kenoyer, Jonathan M. / Vidale, Massimo, A new look at stone drills of the Indus Valley Tradition: Vandiver, Pamela B. (Ed.), *Materials Issues in Art and Archaeology* 3. Symposium held April 27-May 1, 1992 (San Francisco 1992) 495-518.

2500 Cal BC: Indus potters in the Persian Gulf

Sophie Méry[1], Michele Degli Esposito[2], Dennys Frenez[3], Jonathan M. Kenoyer[4]

[1]- CNRS, UMR 6566, Rennes, France
[2]-IMTO – Italian Mission to Oman. University of Pisa. Pisa, Italy
[3]-Dept. of History and Cultures.University of Bologna. Bologna, Italy
[4]-Dept. of Anthropology. University of Wisconsin. Madison, U.S.A.

mission@sophie-mery.fr

Keywords: Archaeometry, Potery technology, Bronze Age, Indus Civilization, Magan Civilization.

In the second half of the 3rd Millennium Cal BCE, the variety of the prestige objects from the Indus Civilization (Pakistan and NO. of India) reflects functional specializations and social hierarchy. It is the case of the black stoneware bangles, found exclusively in the biggest cities of the Indus. Figurative representations show that they were worn by the individuals at the summit of the social hierarchy and their production was under a strict administrative control. Some categories of objects reflect other forms of specialization and varied prestigious forms. It is the case of the Indus stone ornaments - the most famous example of which is the one of the heated cornelian beads. Small Indus painted ceramic jars represents a different case. They were found in the collective local graves of the Umm an-Nar period in the Magan Civilization (United Arab Emirates and Sultanate of Oman). We shall present here a state of a recent archaeometry program and the technological data who allow a rebuilding of the economy of these objects. We think most probable an installation of small Indus groups (including potters) in the E.A.U. and Oman. They integrated Umm an-Nar communities, as shown as the local production of some Indus domestic types for food preparation and cooking, and also consider the presence of painted ceramic the Indus in the collective graves as not fortuitous.

Field evidences in volcanology and geomorphology as a tool for obsidian sourcing

D. Mouralis[1], A-K. Robin[2], E. Akköprü[3], K. Erturaç[4], C. Kuzucuoğlu[5]

[1-] Université de Rouen & CNRS (Laboratoire IDEES, UMR 6266). Rue Lavoisier, 76831 Mont Saint-Aignan (France)
[2-] Université Paris 1 Panthéon-Sorbonne, & CNRS (LGP, UMR 8591). 1 Place Aristide Briand, 92195 Meudon cedex (France).
[3-] Van University, Edebiyat Fakültesi, Cografia Bölümü, 65080 Campus Van- Turkey.
[4-] Sakarya University, Fen-Edebiyat Fakultesi, Gografia Bölümü, Esentepe Campus 54187 Serdivan, Sakarya.
[5-] Université Paris 1 Panthéon-Sorbonne, & CNRS (LGP, UMR 8591). 1 Place Aristide Briand, 92195 Meudon cedex (France).

damase.mouralis@univ-rouen.fr

During Prehistoric times, the obsidians of Eastern Anatolia have been intensively exploited and exported all around the Middle East. In the framework of the GeObs scientific project, we propose to intensively and systematically study the geological outcrops of Eastern Anatolia in order to process a complete database of the obsidian sources in this area.

In this talk, we want to demonstrate how field evidences (including geomorphology and volcanology) interest the characterization and the sourcing of obsidian. Indeed, the main characteristics of obsidian, the abundance of raw material and their availability are controlled by volcanic and geomorphologic processes.

1) The main chemical and physical *characteristics* of the obsidian outcrops are controlled by the volcanology, including magmatic processes (differentiation), mode of emplacement (flow, dyke, etc.) and type of outcrops (large and massive “banks” or small nodules of obsidian) associated with rheology of the lavas.

2) The *abundance* of obsidian within a volcanic massif is also controlled by the volcanic history (age of the eruptions, modes of emplacement and types of outcrops) as well as the erosional processes.

3) The *availability* of the raw material is constrained by the evolution and history of the landscapes. Later volcanic activity and geomorphologic processes may be responsible of destruction or fossilization (both by volcanic activity and/or erosional processes). Moreover, these evolutions also control the abundance and availability of the secondary sources of obsidian within colluvial and alluvial (terraces) deposits.

The different examples taken all around Eastern Anatolia will illustrate the importance of field evidences for the understanding of the obsidian sourcing.

GéObs program: Integrated study of the Eastern Anatolian obsidians (Identification, characterization and diffusion)

D., Mouralis[1], C. Kuzucuoğlu[2], L. Astruc[3], E. Akköprü[4] and all the team of the GéObs Project

[1-] Université de Rouen & CNRS (Laboratoire IDEES, UMR 6266). Rue Lavoisier, 76831 Mont-Saint-Aignan (France).
[2-]Université Paris 1 Panthéon-Sorbonne, & CNRS (LGP, UMR 8591). 1 Place Aristide Briand, 92195 Meudon cedex (France).
[3-] CNRS (ArScAn, UMR 7041). M.A.E., 21, allée de l'Université, 92023 Nanterre Cedex (France).
[4-]Akköprü E. – Van University, Edebiyat Fakültesi, Cografi bölümü, 65080 Campus Van- Turkey.

damase.mouralis@univ-rouen.fr

Keywords: Eastern Anatolia; Obsidian; Geological sources; Characterization; Diffusion

The GeObs project proposes an integrated and multi-disciplinary approach to study the exploitation of the Eastern Anatolian obsidian by ancient groups for the manufacture of tools and prestige objects, and its spatial diffusion through exchange networks among communities across the ancient Near-East (including Anatolia and Caucasus).

Until now, the obsidian geological sources in Eastern Anatolia are still imprecisely identified and characterized. It is thus difficult to properly understand the diffusion of the obsidian items from their origins to their discards; i.e. from the geological sources to the Near-Eastern archaeological sites.

The aim of the GéObs project is to establish a detailed database and geographical information system of the obsidian sources in eastern Anatolia together with the new analysis of some archaeological collections. We thus propose an integrated and pluri-disciplinary approach for obsidian sourcing based on:

- Intensive field investigation in order to precise the morphological and geologic settings of the studied obsidian sources, together with a systematic sampling, both in primary and secondary context;

- Multi-methods characterization using chemical (using LA-ICP-MS, XRF methods) as well as physical properties (especially petrography and mineralogy).

The characterization of the geological sources will be interpreted in link with the results of the field investigation. The characterization of archaeological collections will be processed together with typological and technological interpretations.

- Using the methods of spatial analysis, we will try to understand the diffusion of the obsidian during prehistoric times, from its geological origin to its deposition in archaeological sites.

All the data produced during this program will be implemented within a database and an associated GIS.

Friday, 14h20

Raw Materials For Making Pots

Miriam CUBAS - BioArch. University of York, UK (*mcubas.morera@gmail.com)*

Technology and provenance studies of pottery allow researchers to better understand aspects such as the production organisation, distribution and use patterns of these products. How ceramics were produced, exchanged and used are key elements to elaborate interpretations about important archaeological topics, related to strategies of environmental exploitation, mechanisms of knowledge transfer, technological innovation, labour distribution and exchange networks, all of them basic for our understanding of the development of social processes, like craft specialization and the arisen of hierarchical and complex social systems.

The application of methodologies related to the analysis of raw materials procurement and clay composition offers great opportunities in the development of those technology and provenance studies. A great variety of techniques can be applied in these analyses, focused on the compositional, mineralogical and textural characteristics of these products to explain the different socioeconomic conditions of the pottery production and its role in the prehistoric societies.

The session welcomes papers focusing on raw materials for making pots in relation to work with analysis and contextualization of prehistoric pottery ensembles in different chronologies and geographical areas of the world. The session hope to assemble archaeologists, anthropologists, archaeometrists and ethnographers who are working on raw material procurement and provenance studies of prehistoric pottery.

- 14h20: "Distinguish the similar": sourcing raw materials of different ceramics chemically and petrographically identical, the contribution of microanalysis by LA-ICP-MS

B. Gehres[1], G. Querré[2]

[1]-Laboratoire d'archéologie et d'histoire Merlat (LAHM), UMR 6566 CReAAH, University of Rennes 2.
Laboratoire d'Archéologie et d'Histoire Merlat (LAHM), UMR 6566, CReAAH, Université Rennes 2, bâtiment A, salle A 118, Place du Recteur Henri Le Moal, CS 24307, 35043 Rennes Cedex, FRANCE
[2]-Ministère de la Culture et de la Communication, Laboratoire Archéosciences, UMR 6566 CReAAH.
UMR 6566 CReAAH, 263, Avenue du général Leclerc, Campus de Beaulieu, bâtiment 24-25, Université de Rennes 1, CS74205, 35042 Rennes Cedex, FRANCE

benjamin.gehres@gmail.com

Keywords: LA-ICP-MS, microanalysis, minerals, sourcing, archaeological ceramics

Analysis of archaeological ceramics can be realized in a variety of ways: there are the petrographic analysis with polarizing microscope on thin section or by X-ray diffraction (XRD), and the global chemical analysis of paste generally by spectrometric methods (XRF, INAA, ICP-OES...). These analysis are mostly performed to determine manufacturing techniques or origin of potteries.

However, in some cases, the cross-referencing data of this analysis don't allow us to determine the geographical origin of the raw material used to shape the potteries. This is particularly the case for pots mounted with clays from the weathering of granitic and granito-gneissic rocks (eg. granites, gneiss, gabbros...). Indeed, the natural inclusions and the global chemical compositions of this type of ceramics are often similar.

As a consequence, we have developed a method based on the analysis of typical mineral inclusions (eg. biotite, opaque minerals, amphibole) present in ceramic pastes by mass spectrometry coupled plasma source and a laser ablation system (LA-ICP-MS). Therefore, it is possible to make a connection between ceramics and rock minerals and, as a result, discriminate the different raw materials sources.

In this communication, we will present the latest advances we have made in the field of ceramic sourcing, thanks to the analysis by LA-ICP-MS, through several case studies distributed over a large period (from the Neolithic to the Antiquity), located on different islands of Brittany in the western France.

Thanks to this method, we are able to distinguish the productions of gabbro-granitic potteries during Vth to Ith century B.C. from two different workshops in Brittany (France), through the analysis of amphibole grains. Moreover, the investigations on biotite crystals allowed us to identify sources of clays issue from weathering of different granitic rocks. Finally, we will talk about the analysis of opaque minerals to distinguish the source of ceramics made with ultra-basic rocks alteration.

- 14h40: Potting in the arctic: Ceramic technological strategies among hunter-fisher-gatherers at Nunalleq, Alaska

A. Jorge[1], N. S. Müller[2], R. Knecht[3]

[1]-Department of Archaeology, University of Aberdeen, St Mary's Building, Elphinstone Rd, Aberdeen AB24 3UF, Scotland, UK
[2]-Fitch Laboratory, British School at Athens, 52 Souedias Street, 10676 Athens, Greece,
[3]-Department of Archaeology, University of Aberdeen, St Mary's Building, Elphinstone Rd, Aberdeen AB24 3UF, Scotland

a.jorge@abdn.ac.uk

Keywords: technology, arctic, hunter-gatherers, petrography, organic temper

Pottery production and use among hunter-gatherers has received increasing attention over the last few years. Given the much greater residential mobility and potentially specific food processing requirements of these communities, this new line of research raises interesting questions regarding both ceramic provenance and technology. However, the focus on the origins and spread of early pottery has side-lined its role among more recent hunter-gatherers. In far northern regions like Alaska, where pottery was made and used for around 2500 years, it remains understudied beyond traditional classification and cultural sequencing. During the later prehistoric 'Thule' period (from c. 800BP), the two main categories of ceramics are vessels and lamps. Limited vessel morphological and decoration variation and overall paste 'coarseness' have contributed to an image of pottery as homogenous, crude, poorly fired or unfired, and unchangeable. Yet, these assumptions about manufacture and function remained untested.

This paper will present the first systematic technological study of late prehistoric hunter-gatherer pottery from Alaska, which considers raw material sourcing, paste preparation, and firing regimes using an integrated approach, by combining a suite of analytical techniques, including thin-section petrography, FT-IR and SEM with a detailed macroscopic study. It focuses on the prehistoric village of Nunalleq, the largest excavated site in the region. The ceramic assemblage of the site shows a wider morphological and decorative range than expected, raising questions about uniformity of design and use. Analytical results indicate very specific manufacturing strategies, including clearly distinctive choices for vessels and lamps both in terms of paste recipes and firing regimes.

We will discuss these strategies in view of the social and practical functions of pottery as well as the relationship between material production and landscape among arctic hunter-gatherers. The information gained will ultimately help to address issues of tradition, cultural change and social interaction among these late prehistoric communities.

- 15h00: Petro-mineralogical and Geochemical characterization of Neolithic pottery from settlements of Eastern Europe (Dvina-Lovat' basin)

Marianna Kulkova, Alexander Kulkov, Natalja Vlasenko

Herzen State University, St.Petersburg, Russia, 191186 St.Petersburg, nab. Moyki, 48/12

kulkova@mail.ru

Keywords: Neolithic pottery, Eastern Europe, petrography, X-ray microtomography, Scanning Electron Microscope (SEM).

The mass character of pottery distribution is an indicator of cultural-historical processes and therefore pottery is the most important information source about Neolithization process on territory of Eastern Europe. The mineralogical and geochemical methods (petrography, X-ray microtomography, Scanning Electron Microscope (SEM)) were used for determination of the composition, the manufacturing technology and sources of raw material of Neolithic pottery (4 ka. BC) from archaeological sites in Dvina-Lovat' region. When a pottery technology is reconstructed it is advisable to know so much technological characteristics as is possible. The complex of these features is an important criterion for study of ancient ceramics, because sometime just small fragments of pottery are saved. They can't be classified only according to morphological and typological principles. One of the most significant features in technological reconstructions of pottery is the investigation of ceramic pastes, that is mineral composition and amount of clay, temper, porosity, ect. The visualization of pore shapes and reconstruction of organic inclusion distribution inside of sherd can be used for understanding of technics of pottery molding. The application of combination of petrography, X-ray microtomography and SEM methods allow to reconstruct the ceramic past composition more detail, to establish natural and artificial additives in ceramics and to differ the ceramic types as well as to establish row material sources. X-ray microtomography can be applied also to define the replica of organic inclusions, which were burnt out during the firing process and their types inside of sherd. In the some cases a type of plant can be identified on the base of 3D pore visualization. The most of ceramic wares under investigation were made with using of local clay and sand materials from lake and moraine deposits of Quaternary period. There are variations in the temper composition and firing temperatures which are connected both with cultural tradition, and with quality of local sources of raw materials.

- 15h20: Different temper, different function: clay pastes for lasinja culture pottery from two sites in northwestern Croatia

Lea Čataj[1], Hrvoje Posilović[2]

[1]-Croatian Conservation Institute. Division for Archaeological Heritage. Department for Archaeology. Croatia
[2]-Croatian Geological Survey Department of Geology Sachsova 2. Croatia

lcataj@h-r-z.hr

Keywords: Lasinja culture, Copper Age, northwestern Croatia, clay paste, clay temper

Lasinja culture spread from westernmost part of Vojvodina, throughout continental Croatia and northern Bosnia, Slovenia, Austria and western Hungary in the middle Copper age (4300 – 3900 BC). Although it occupied rather large area, pottery was shaped and decorated in a similar way.

This paper aims to show the clay composition of various pottery types and explain how different clay pastes depend on vessel function. In addition, pottery from two regions in continental Croatia will be compared in order to see the difference in the mineralogical composition of clay. One of the sites (Črečan) is situated in the Međimurje region (northernmost part of Croatia) and the other one (Barilović) in the Kordun region (central Croatia).

There are two main functional vessel types. Vessels made to be exposed to higher temperature during the cooking and vessels with storage or decorative function.

Vessels intentionally made to be used as a cooking ware have coarse texture with significant addition of coarse sand and fine gravel. Fine textured pottery is mainly made from very pure or purified clay material, or with small addition of fine sand and silt. On both sites the base technology of ceramic production is essentially the same. There is no difference in the base clay material composition between the sites or functional vessel groups. The difference between two sites can be found in the coarser (grit) material added to the base clay material in the cooking ware vessel group. The grit mineral composition consistently reflects local geological composition.

Pottery from Barilović contains significant amount of carbonates in the form of crushed limestone or sparite calcite crystals. This area is situated on the carbonate base, such material was locally available and hence the logical choice. Pottery from Črečan contains large amount of sand and fine gravel reflecting petrologic and mineral composition of the area. The grit fraction is composed from grains of quartz (more than 90 percent) and grains of metamorphic or magmatic rocks (gneiss, granitoids). This sand and gravel material is alluvial and could be taken from the river or creek bank or from the old Pleistocene and Holocene deposits.

- 15h40: Ceramic raw materials in Linear Band Pottery Culture (LBK) in the Carpathian region, Poland

Sławomir Kadrow, Anna Rauba-Bukowska

[1]-Institute of Archaeology and Ethnology Polish Academy of Sciences, Centre for Mountains and Uplands Archaeology

slawekkadrow@gmail.com

Keywords: Pottery**,** technology, raw materials, Linear Band Pottery

A technological analysis was carried out on pottery and raw material samples - almost 400 thin sections. Different features were examined including sourcing and selection of materials, preparation and composition of the pottery paste, manufacturing methods, and firing. The results revealed that there were subtle changes in technology between successive phases of LBK and of post-LBK Malice culture evolution. In the early and classic phase, the potters willingly used heavy clay as starting material. A substantial change was observed for the last Želiezovce phase and then continued in younger times. Heavy and greasy clay was replaced by fine grained silty clay of alluvial origin – chosen especially for fine vessels. This modification was probably the result of frequent contact with the Eastern Linear Pottery Culture. The analysis of pottery from the Eastern Linear Circle shows that such clay was widely used in pottery production. In the light of this data, we can infer that intercultural contacts also resulted in the transfer of new technological ideas and brought a new approach to pottery production. An additional explanation of use of different raw materials was their accessibility in the local outcrops.

- 16h00: Technological diversity of the Early Neolithic pottery of Muge (Portugal): the case study of Cabeço da Amoreira (excavations from 2008 to 2014)

Ruth Taylor[1], Daniel García Rivero[1], João Cascalheira[2], Nuno Bicho[2]

[1]- Department of Prehistory and Archaeology, University of Seville
[2]-ICAEHB, University of Algarve

Key words: Neolithic pottery, Technology, Petrography, Chemistry, Taxonomy.

The shellmidden of Cabeço da Amoreira (Salvaterra de Magos, Ribatejo) is one of the most important internationally renowned Portuguese archaeological sites. It has been excavated since the middle of the 19th century and it has become one of the key settlements for the understanding of the Mesolithic-Neolithic transition.

The recent archaeological excavations carried out by the University of Algarve at this site from 2008 to 2014 have provided a great amount of new data, not only in relation to the Mesolithic shellmidden but also to the first Neolithic populations of Central Portugal.

A very detailed and systematic documentation and analysis of the recovered pottery has provided a large dataset with many different classes of information for more than one thousand individual pottery records belonging to the upper stratigraphic levels of the shellmidden as well as from the surrounding area.

Based on the visual analysis of the different morphometric and technological traits, the pottery dataset has been approached with different taxonomical techniques and methods in order to shed light on the diversity of the technologies involved in pottery production. This analysis has suggested the existence of several different technological groups. Samples belonging to each group have been analyzed with thin-section petrography and scanning electron microscopy (SEM-EDS) techniques that allow us to know about their textural, mineralogical and compositional characteristics. In this way we assess the diversity of the pottery assemblage and we finally explain the main physical differences between the technological groups as well as the possible practical and cultural factors behind them.

- 16h30: Pottery for the dead: exploring the raw materials exploitation in the pottery of Can Gambús-1 (Sabadell, Cataluña)

Miriam Cubas[1], Miguel Ángel Sánchez Carro[2] , Jordi Roig[3], Joan Manuel Coll Riera[4], Juan Gibaja [5]

[1]- BioArCh-University of York.
[2]- Dpto. de Ciencia e Ing. Del Terreno y de los Materiales-Instituto Internacional de Investigaciones Prehistóricas-Universidad de Cantabria.
[3]- Universidad del País Vasco (UPV-EHU)
[4]- Arrago S. L.
[5]- CSIC-IMF. Departamento de Arqueologia y Antropologia.

miriam.cubas@york.ac.uk

Keywords: petrography, thin section, pottery, technological choices, Middle Neolithic

The development of studies focused on pottery in Cataluña has increased since the beginning of this century. Most of these studies consider pottery as the result of a technological process and they are focused on raw material procurement, modifications of clay and technological aspects of its manufacture. The application of this kind of studies allows us to distinguish the different technological choices used in the manufacturing process and to propose new interpretations about the productive organization.

In this study we present the methodology and first results of the analysis of the pottery ensemble from Can Gambús-1 (Sabadell, Cataluña). It is a complex archaeological site with evidence of different chronologies, among them we have to highlight the necropolis attributed to the Middle Neolithic due to its relevance and to the quality of the archaeological materials recovered. Radiocarbon dates available allows us to propose a chronology focused on the end of the 5th and beginning of the 4th millennium cal BC. This necropolis is composed by different funerary structures for which the construction and the composition of the grave goods may indicate some social differentiation between the individuals buried. The grave goods include different kind of vessels of different morphologies and decoration.

This contribution is focused on the mineralogical analysis through thin section of samples selected by their morphological and decorative characteristics. The petrographic study in thin section has allowed a systematic description of textural and mineralogical aspects of the samples. Based on the petrographic description, we propose different manufacturing groups with similar textural and mineralogical characteristics. The analysis allowed us to propose different areas of raw material procurement based on the geological coherence with geological environment and to stablish different methods of manufacture, suggesting different technological choices in the preparation of clays.

- 16h50: Distinguishing the Non-Local Rather than Matching the Exotics: Ceramic Sourcing Methods and Research Design at Castro de São Martinho, Portugal

Paul Thacker

Wake Forest University, Department of Anthropology, Box 7807, Wake Forest University, Winston Salem, NC 27109 USA

thackep@wfu.edu

Keywords: clay geology, raw material sourcing, ceramic analysis, archaeological research design

Many geochemical sourcing studies attempt archaeological interpretations with only compositional data from artifacts, an approach that often leads to erroneous results because of geological decontextualization. Other studies significantly undersample intra-source variability of clay deposits in geological formations, focusing instead on inter-source comparison. This project illustrates the utility of research design founded on a comprehensive investigation of clays in the local region of the archaeological site of Castro de São Martinho near Alcobertas, Portugal. The study region is ideal for developing clay sourcing methods because of the unusual proximity of very different geological formations in which workable clays are present. Clay samples were taken from 34 different deposits, with the origin of the clays ranging from the limestone bedrock of the Serra dos Candeeiros, to the magnetite-rich prismatic basalts of the Alcobertas ridge, to the cemented alluvial beds of the upper tributaries of the Rio Maior drainage. Raw clay samples were analyzed through integrating a minimally-destructive X-ray diffraction technique with pXF elemental data, complementary studies of iron mineralogy using magnetic susceptibility instrumentation, and microscopic characterization of paste inclusions. All of the major geological formations in the proximity of São Martinho have been sampled and our integrated methodology has successfully characterized the low range of intra-formational variability. Clay test tiles and archaeological sherd subsamples were fired to 950°C in a precision laboratory furnace. About two-thirds of the archaeological sherds sampled from São Martinho were likely made of clays procured from beds formed in reworked Jurassic fluvial sediments. Multiple lines of evidence indicate that the magnetite-rich clays derived from the Alcobertas ridge, the marl clays from Pe de Serra, and the limestone-derived clays were not used to produce any of the archaeological samples. A small but significant fraction of our archaeological ceramic sample has chemical composition significantly different from all of the major geological formations in the proximity of São Martinho. The comprehensive, local-scale investigation of clay source deposits provides foundational support for the anthropological conclusion that these ceramic vessels were produced outside of the immediate vicinity.

- 17h10: Archaeomagnetic analysis on archaeological pottery as a method to infer heating temperatures. A case study from El Portalon Cave (Sierra de Atapuerca, Burgos, Spain)

M. Francés-Negro[1], Á. Carrancho[2], E. Iriarte[3], A. Pérez-Romero[3], J.M. Carretero[3]

[1]- Edificio I+D+i. Laboratorio de Evolución Humana. Plaza Misael Bañuelos s/n. 09001 Burgos Universidad de Burgos.
[2]-Edificio I+D+i. Área de Prehistoria.Plaza Misael Bañuelos s/n. 09001 Burgos Universidad de Burgos.
[3]-Edificio I+D+i. Laboratorio de Evolución Humana.Plaza Misael Bañuelos s/n. 09001 Burgos Universidad de Burgos

martafn86@gmail.com

Keywords: Archaeomagnetism, thermoremanence, iron oxides, prehistoric pottery.

The use of palaeomagnetic techniques to the study the ancient record of Earth´s magnetic field in archaeological samples is known as archaeomagnetism. Archaeomagnetic dating is probably the most known application of magnetic methods to archaeology but there are others still underutilized and of great interest to prehistoric archaeology. Here we report a novel application of archaeomagnetism to determine the last heating temperature undergone by archaeological ceramics. The method is tested in a set of Neolithic and Chalcolithic potsherds from El Portalón Cave (Sierra de Atapuerca, Burgos, Spain).

Most archaeological potteries contain small amounts of iron oxides such as magnetite or haematite. When heated to high temperatures (> 500 – 600 ºC) and subsequently cooled these minerals acquire a remanent (permanent) magnetization parallel to the ambient magnetic field through a mechanism known as thermal remanent magnetization or TRM. If heating temperatures do not exceed the Curie temperature (TC) of the ferromagnetic mineral present (e.g., TC of magnetite: 580 ºC), the material may acquire a partial TRM (pTRM), partially overprinting any previous magnetization. Progressive thermal demagnetization of the natural remanent magnetization (NRM) was used to identify the maximum unblocking temperature of pTRMs. This is the temperature at which the pTRM vector switches its direction, defining the last heating temperature. Two types of behaviour were observed: (i) specimens showing a single stable palaeomagnetic component, related to their elaboration and firing > 600 - 700 ºC and (ii) others showing two paleomagnetic components: a high-temperature (HT) component related with the potsherds' manufacture and an intermediate temperature component or pTRM with maximum unblocking temperatures mostly comprised between 400 – 450 ºC, representing the last heating temperatures experienced by these ceramics most probably due to cooking activities.

In order to demonstrate the suitability of archaeomagnetism to infer heating temperatures, preliminary archaeomagnetic results obtained from a set of experimentally manufactured pottery are reported. Both archaeological and experimental results are compared and discussed, highlighting the potential and limits of the method. Although still preliminary, this information may help to infer the use and the technological process for pottery manufacture in the past.

- 17h30: The pots from the Nuragic site of Sant'Imbenia (Sardinia, Italy): analyses of the raw materials and the technological evolution

Beatrice De Rosa

ARS.Lab, Università degli Studi di Sassari, Viale Umberto 51, 07100, Sassari

bderosa@uniss.it

Keywords: nuragic, pots, raw materials, Sardinia, technological evolution.

Five clayey raw materials collected in the Porto Ferro, Lago Baratz, Cala Viola, Porticciolo, Palmadula and Calabona areas of Alghero in northwest Sardinia (Italy) were used to prepare handmade bricks samples that were fired under oxidizing conditions at temperatures ranging between 750 and 1000 ˚C to evaluate their possible use in the archaeological pottery production. The samples have been compared with same archaeological ceramics from the Nuragic site of Sant'Imbenia, in the Porto Conte area, Alghero, that have already been studied with archaeometrical analysis. The site was inhabited between approximately the 14th and the 7th century BC. During the last centuries of its life, Sant'Imbenia lived a population of locals and foreigners, Levantines and, probably, Greeks. It is obvious that as well as goods and raw materials they exchanged ideas, knowledge and technologies. Some of the pottery artefacts produced during this period do not seem to belong to the Nuragic tradition because of their shape and type, which suggest that local craftsmen were influenced by the contacts with foreign cultures. The mineralogy of the raw materials and the clay-size fraction was studied by XRD diffraction; bulk chemical analyses were performed by means of the X-ray Fluorescence technique; the texture of the samples was observed in thin section with a polarizing optical microscope. Then, the samples were studied taking into account their colour using a portable spectrophotometer. Our results reveal that all this raw materials are compatible with the archaeological production, but we observed that the different types of clays were used for products with different functionality. This aspect required specific characteristic of the raw materials to make, for example, ceramics for cooking food or pottery to conserve them. This shows a clear strategic choice in production technology. It is possible to observe a technological evolution that began in the Bronze Age and finishes during the Iron Age. Through this work, in fact, we studied technological aspects in the production process that demonstrate a high degree of specialization, knowledge of raw materials, expertise in the cooking of the potteries than in earlier times were not found.

- 17h50: Raw materials and their use in the making of pottery from basagain (Basque Country, Spain), archaeological and experimental research

Judit López De Heredia[1], Javier Peña Poza[2], Juan Félix Conde Moreno[2], Fernando Agua Martínez[2], Manuel García Heras[2]

[1]-Aranzadi Society of Sciences
[2]-Institute of History, CCHS-CSIC

jlzdeheredia@gmail.com

Basagain is an Iron Age fortified site in the Basque Country (Spain). As common in Iron Age, evidence has been found of the coexistence and complementarity of two types of pottery production, which can be differentiated by its own modes of production and use even though both were made with the same raw materials. This contribution presents the results derived from an archaeometric study carried out to determine the clay sediments and the non-plastic materials possibly used in the making of the pottery recipients coming from Basagain. Product acquisition and selection of raw materials and their preparation are some of the most important variables that influence the making of a ceramic. With the aim to understand the production processes, a representative set of raw materials obtained in the surroundings of this site was prepared and fired in the laboratory, following the same sequence of production than that determined for the archaeological ceramic materials, which had been previously assessed. Samples were prepared with different association of sediments and non-plastics materials (calcite). Same research techniques used with archaeological items were applied: petrographic analysis by thin section and X ray diffraction (XRD). This study has been useful to determine the type of clays and non-plastic materials used by the Iron Age communities who inhabited these settlements to make its pottery, as well as the technology employed to produce it. Key words: Pottery; Iron Age; Archaeometry; Raw materials; Clay.

- 18h10: Chemical analysis of pigments, paste and residues in Tupi archaeological ceramics from Southeastern Brazil

Marianne Sallum[1], Carlos Roberto Appoloni[2], Marisa Coutinho Afonso[3]

[1]-PhD student, Museu de Arqueologia e Etnologia, Universidade de São Paulo. Avenida Professor Almeida Prado, 1466, 05508-070, São Paulo-SP, Brasil.
[2]-Departamento de Física – CCE, Universidade Estadual de Londrina – UEL, Caixa Postal 10.011, 86057-970, Londrina – PR, Brasil
[3]-Museu de Arqueologia e Etnologia, Universidade de São Paulo. Avenida Professor Almeida Prado, 1466, 05508-070, São Paulo – SP, Brasil.

marianne.sallum@gmail.com

Keywords: chemical analysis of ceramics, archaeometry, pottery, Brazil

X-ray fluorescence has been used to analyze chemical elements from archaeological ceramic pastes and pigments. In other contexts, chemical residue analysis has been used to examine the function of pottery vessels. However, it is unusual to employ these two analytical approaches together. This paper presents both residue and energy dispersive X-ray fluorescence (EDRXF) analyses results, identifying chemical elements present in Tupi pottery fragments collected at Gramado archaeological site (Brotas, State of São Paulo, Southeastern Brazil) and aiming to understand aspects related to the composition of the ceramic paste, chemical residues and possible functions for the vessels. Results showed the presence of key element Fe, indicating the use of raw material with iron oxides, both in pigments and paste. The key element for black pigments was Mn, revealing its presence in the raw material's composition. Chemical analyses indicated the presence of phosphate in pottery with painted and plastic surface treatments with another common characteristic, a high level of protein residues in small vessels, suggestive of some functions. One of the vessels was different from all others, showing carbonate. We also noted that some fragments presented different pastes, a sign that, though living in the same environment, the group made different choices regarding the raw material (clay). Pigments used in painting were from mineral origin and fire resistant, confirming the idea that the painting fabrication preceded burning. As to vessel functions, we observed different uses between potteries with plastic and painted surface treatments, inferred from different chemical residues found in each type.

Local resources and pottery production: Bronze Age cooking pots in Central Sardinia (Italy)

Noemi Fadda

Dipartimento di Storia, Scienze dell'Uomo e Della Formazione – Università degli Studi di Sassari.

noemifadda@hotmail.it

Keywords: pottery technology, Bronze Age, raw material selection, cooking pots, archaeometric analysis.

Identify and characterize the raw materials used in ceramic production is fundamental to understand the ceramic process and the people who fabricated and used the vessel. It is directly linked to different aspects of the natural and the social reality.

We must consider the ecological possibility that the area offers and also the influence of social, economic and ideological dynamics.

The tipical repertoire of Nuragic community sees, from the Middle Bronze Age, the presence of ceramic containers, defined trays or pans, that for their morphological features and technology seem to be suitable for preparing and cooking food.

The materials analyzed in this study come from the site of Nuraghe Ola, a small nuragic village, located in central Sardinia, where the cooking pots represents more than 70 % of the ceramic repertoire. The context is inserted in a region characterized by a geology mostly granite and trachyte, rich in water , where it was possible to have clay deposits located a few kilometers from the village.

The aim of this study is to clarify the relatioship between the natural resourses and Bronze Age pottery production in orden to obtain information on the selection and treatment of raw material and, as well, of they manifacturing technology.

Ceramic fabric variability was analysed, first at macroscopic level, considering the amount and the presence of inclusion; the color variation on the surface, which is depends from the composition and granulometry of the clay and from the atmosphere and the firing temperature, and the surface treatment.

After we have started with the archaeometric analysis of the collected samples with the use of XRF, XRD and thin section petrology.

The results showed the use of local raw materials for the production of the vessels and the peculiarity of the fabrics, as the heat resistance, demonstrates a selective choice of the raw materials made by the potters.

New tools and old questions in archaeometric analysis of ceramics

M. Francés-Negro[1], E. Iriarte[2], Á. Carrancho[3], A. Pérez-Romero[2], J.M Carretero[2]

[1]-Edificio I+D+i. Laboratorio de Evolución Humana. Plaza Misael Bañuelos s/n. 09001 Burgos Universidad de Burgos.
[2]-Edificio I+D+i. Laboratorio de Evolución Humana.Plaza Misael Bañuelos s/n. 09001 Burgos Universidad de Burgos.
[3]-Edificio I+D+i. Área de Prehistoria.Plaza Misael Bañuelos s/n. 09001 Burgos Universidad de Burgos.

martafn86@gmail.com

Keywords: Archaeometry, ceramic, mineralogy (XRD), geochemistry (FRX), computerized axial tomography (CAT).

Since the 80's, the incorporation of compositional analysis helped to make a better description of ceramic pots providing a systematic and scientific base to the typological description. The compositional studies from tools like X-Ray diffraction (XRD) or X-Ray fluorescence (XRF), along with petrographic analysis provide meaningful information to know the raw material and de pottery elaboration process. This type of analysis completes the typological studies, gives information about the technological process and helps to define possible areas of supply of the raw materials used.

In this communication the study of the Neolithic and Chalcolithic potsherds recovered from El Portalón de Cueva Mayor (Atapuerca, Burgos) is shown. In addition to the techniques described above, the use of Computerized Axial Tomography (CAT) is presented as a non-destructive technique, and it completes the information provided by the other analysis. The variations observed in the components and the manufacturing of ceramic pottery can reflect moments of stability or technological innovations within social groups, changes in the use of the ceramics or changes in land occupation by groups with different technological traditions.

The job of the archaeologist and the art of cultural mediation

Valentina Amonti

Indipendent research .Address: Via Giulio Romano, 946043 Castiglione delle stiviere (MN)

Keywords: pottery, Bronze Age, clay, experimental methodology

The preliminary results of a research project on ceramic production of the Pile-dwellings of Lake Ledro during the Bronze Age are summarized hereinafter.

Since the pottery found in the site is characterized by a dark grey color, we tried to reproduce this result through experimental methodology.

I started with gathering of local clay (from Cretegn, a location near Molina of Ledro) and I de-stoning and soaking it. When the clay was ready to be molded, I made pottery in a range of size and I compared it with the archaeological record.

After the drying I put the pots into a kiln in earth pit and after the cooling I extracted pottery: the surface and the kneading shown dark gray color.

The results of the firing seems to confirm:

- The dark grey color has been obtained with firing in a complete reducing atmosphere;

- In the earth kiln the temperature doesn't exceed 850°, this is the correct sequence to avoid the transformation of calcium bicarbonate inclusion in quicklime that could damage the artifacts;

- The clay found in Cretegn was better for potting than other local clays that I found;

The successful experiment allowed to add the pottery among the specimen showcased in reconstructed hut, as a part of the exhibition itinerary developed into the Pile-dwelling Museum of Lake Ledro.

The hut was made to "enhance the invisible" so visitors could see and directly experience the results of the studies on the archaeological excavation in the archaeological site.

The next step will be to compared the chemical analyzes on mixtures of the archaeological record with experimentation to try to get useful results for the purpose of experimentation.

Technological and functional identification of cooking slabs: evidences from the Bronze Age pile dwellings settlement of Grotta di Pertosa (Salerno, Southern Italy)

Delia Carloni[1], Felice. Larocca[2], Sara Tiziana Levi[3], Valentina Cannavò[4]

[1]-Centro Regionale di Speleologia "Enzo dei Medici", Via Lucania, 3 - 87070 Roseto Capo Spulico (CS)
[2]-Università degli Studi di Bari, Gruppo di ricerca speleo-archeologico, Piazza Umberto I, 1 - 70121 Bari. Centro Regionale di Speleologia "Enzo dei Medici", Via Lucania, 3 - 87070 Roseto Capo Spulico (CS)
[3]- Università degli Studi di Modena e Reggio Emilia, Dipartimento di Scienze Chimiche e Geologiche, Via G. Campi, 103 – 41125 Modena (MO)
[4]-Università degli Studi di Modena e Reggio Emilia, Dipartimento di Scienze Chimiche e Geologiche, Via G. Campi, 103 – 41125 Modena (MO)

delia.carloni@hotmail.it.

Keywords: Italy, Grotta di pertosa, Protohistory, Pottery, Technology

Cooking devices as hearts and slabs are relatively common in archaeological records, mainly in settlements, since they are related with daily domestic activities. Conversely, it's often hard to identify the presence of cooking structures when they are fragmented and in secondary context. Recent researches in the Bronze Age pile dwellings settlement of Grotta di Pertosa (Salerno, Southern Italy) returned 138 ceramic flat pieces of unknown function, found in a circumscribed zone of the entrance chamber. We successfully tested an integrated approach combining morphology, macroscopic observation and analytical investigation (minero-petrographic and chemical – XRF). We present both technological functional evidences that allowed us to identify those ceramic flat pieces as cooking slabs.

Technology of pottery production of the burials Argaric Group (2250-1550 Cal BC) by Scanning Electron Microscopy and X-Ray Difraction. The case of El Cerro de la Encina (Monachil, Granada, Spain)

Josefa Capel[1], Elena Molina-Muñoz[2], Gonzalo Aranda[3], Rocio Márquez[4]

[1]-Department of Prehistory and Archaeology. University of Granada (Spain). Departamento de Prehistoria y Arqueología. Facultad de Filosofía y Letras. Campus de Cartuja. C.P. 18071. Granada, Spain.
[2]-Department of Prehistory. Autonomous University of Barcelona (Spain). Mòdul de Recerca A. Edificio MRA -106. Autonomous University of Barcelona. C.P.08193. Bellaterra (Barcelona, Spain).
[3]-Department of Prehistory and Archaeology. University of Granada (Spain). Departamento de Prehistoria y Arqueología. Facultad de Filosofía y Letras. Campus de Cartuja. C.P. 18071. Granada (Spain).
[4]-Centro de Instrumentación Científica (SEM-FF). University of Granada. Facultad de Farmacia. Campus de Cartuja. C.P. 18071, Granada (Spain).

jcapel@ugr.es

Keywords: Bronze Age, Argaric Culture, funerary ceramics, craft technology.

Recent excavations at El Cerro de la Encina in southwest have revealed a large number of habitation areas and burials located withtin the settlement area under the floors of dwellings. This archaeological site were one of the main economic and political centres of Argaric Bronze Age Society (c. 2200-1550 BC), a classical “culture” of the Early Bronze Age in Western Europe.

Early excavations had revealed a continued occupation of the site between 2000/1950 and 1450 cal BC, characterizing the Argaric occupation. The current research has completed the study of the western sector of the site.

The focus of this paper will involve the analysis of material culture, technologies and raw materials related to Argaric ceramic production used as grave goods. The study have carried out by SEM-EDX and XRD. The main goal is characterize production distinct patterns. We are selected 19 ceramic pieces belongs to 4 Argaric burials. We are selected samples acording to sex, age and chronology.

Neolithic pottery from Ljubićeva cave (Istria, Croatia)

Tihomir Percan

Croatian Conservation Institute, Juršići 7, 52 342 Svetvincenat, Istria, Croatia

tpercan@h-r-z.hr

Keywords: Ljubićeva cave, pottery, decoration, production, analyses

Due to its exceptional geographical position on the crossroads of ancient paths, the Istrian peninsula was an important link between east, west, north and south ever since the prehistoric times. The Ljubićeva cave is situated in southern Istria (Croatia), only 15 kilometers east of Pula, the pennisula's largest city. The cave itself is positioned on the bottom of a large sinkhole, making itself almost unnoticable in the peaceful landscape. Sinkholes are very common in a karst region such as Istria. In the area around the Ljubićeva cave there are many other recorded caves and pits. From 2008 to 2011 archaeological excavations were carried out in cooperation between Musee d'Anthropologie prehistorique de Monaco (Principality of Monaco) and The Croatian Conservation Institute (Croatia). Recorded findings, specially ones from the Neolithic period, implied that the cave was itnensively in use during this period. A large number of pottery fragments were nicely decorated with different motives and ornaments characteristic for the cultural phenomenons from Early (Impresso culture), Middle (Danilo culture) and Late (Hvar culture) Neolithic therefore making it the period of the most intense usage of the cave. With this poster we will put the focus on the Middle Neolithic (Danilo culture) pottery and its ornaments (S shaped decoration, different spiral motifs, incrustation) including mineralogical and textural characteristics and analyses. We will try to compare the found material with similar ceramics from Northern Adriatic and the Mediterranean. Our aim is to explain how ceramics were produced and what kind of technologies were used for decorating pottery during this period. Furthermore, laboratory analyzed pottery and ornaments are showing the significance of this multidisciplinary kind of approach to archaeology and pottery. With this kind of experiments, interesting results were collected. It wouldn't be possible without good cooperation of archaeologists and the laboratory where the analisys was held (Metris, Pula, Croatia). We also emphasize the significance of the modern technology and methods to improve and advance knowledge connected to technology and production of pottery during the archaeological periods.

Raw materials procurement for pottery manufature in Southwest Iberian Peninsula during Prehistory

Nuno Inácio

University of Huelva (Spain)

nuno.inacio@dhis1.uhu.es

Keywords: Clay, Raw Materials, Pottery Manufacture, Prehistory, Southwest Iberian Peninsula.

The study of the strategies of raw materials procurement for the manufacture of ceramic vessels provides information on the economic and social context of the production process. The selecting of raw materials for the manufacture of ceramic vessels involves technological choices and behaviour that cannot be determined only by cost / benefit principles.

The selection of raw materials is an activity embedded in broad social strategies and in a larger cultural context. In fact, ethnographic studies have revealed the existence of several mechanisms that influence the procurement and selection of pottery resources.

From the data provided by own archaeometric research in several archaeological sites of the Third Millennium B.C.E. and the bibliometric study, the strategies of raw materials procurement for pottery manufacture in the South of the Iberian Peninsula from the Neolithic to the Bronze Age are evaluated.

Saturday, 9h00

Long Distance Provenance And Distribution Of Raw Materials Used In Stone Tools Production: Case Studies

Juan F. GIBAJA - CSIC-IMF. Archaeology of Social Dynamics. Egipciaques, 15. 08001 Barcelona, SPAIN; ICArEHB –University of Algarve, PORTUGAL (*jfgibaja@gmail.com)*
Xavier TERRADAS - CSIC-IMF. Archaeology of Social Dynamics. Egipciaques, 15. 08001 Barcelona, SPAIN *(terradas@imf.csic.es)*

Studies about the provenance of lithic raw materials along Prehistoric times have been receiving increased interest and attention from the archaeological community for a long time. Among others, the type of stones used, their sources, the methods and techniques implemented in their exploitation, the condition in which they were transported and arrived to the consumption places, the existing links among lithic tools producers and consumers, have been some of the most relevant issues approached in these investigations.

In this session, we will focus the long distance origin, exploitation and distribution of raw materials used in the production of stone tools in any chronology or region prior the metallurgy. We will especially accept papers and posters where specific case studies attested the existence of a long distance between the original natural sources and the place of discard. All types of raw materials will be considered as long as they were used to produce stone-tools, knapped or polished. We would like to discuss issues such as the routs of raw materials circulation, the morphology of the transported products, the possible existence of exchange networks, thus the presentations should stress how the analysis of the raw materials was the mean to allow to propose interpretations about the economy and social organization of the pre-metallurgic Prehistoric societies.

- 9h00: Long distance flint procurement and transportation in the Sea of Azov coast and Kuban basin regions in the Middle Paleolithic

Dr. Ekaterina V. Doronicheva[1], Dr. Marianna A. Kulkova[2]

[1]-Peter the Great Museum of Anthropology and Ethnography,
Russian Academy of Sciences, St. Petersburg, Russia

[2]-Herzen State Pedagogical University, St. Petersburg, Russia

edoronicheva@hotmail.ru

Keywords: flint outcrops, long distance provenance, petrography analysis, Eastern Micoquian, Northern Caucasus.

Increasing data indicate that long distance raw material procurement and transportation represent the important feature of the Neanderthal subsistence (Slimak, Giraud 2007; Le Bourdonnec et al. 2012; Spinapolice 2012; Doronicheva, Shackley 2014). We report preliminary results about long distance raw material procurement based on data from Mezmaiskaya cave in the Kuban River basin (Northern Caucasus; Golovanova et al. 1999; 2010) and the open-air site of Rojok-1 (Praslov 1968) located in the steppe area of the eastern coast of the Sea of Azov. These sites are assigned to the Eastern Micoquian tradition that was present during Middle Paleolithic in both regions and was closely related to industries of Central and Eastern Europe.

Raw material sources (54 in total) were studied during field surveys conducted in 2007-2015 in the Northern Caucasus and the Azov sea coast region (data on some of them was published: Doronicheva, Kulkova 2011; Doronicheva, Kulkova, and Shackley 2013). We obtained series of petrography and geochemical data for each source, as well as for archaeological samples from Mezmaiskaya and Matuzka caves, Baranakha-4, Besleneevskaya 1 and Hadjoh-2 open-air sites in the Northern Caucasus and Rojok-1 site.

Our preliminary results show that in each archaeological sample the number of artifacts made of high-quality flints procured from sources located more than 300 km from the site is insignificant (< 1%). These types of flints are represented usually among tools, chips, and small fragments; however, no cores from long distance raw materials were identified in the studied collections. Based on the results, we conclude that the data on flint transport from distant sources may be served as an additional confirmation of cultural contacts among different Neanderthal groups and potential intra-regional migrations of Neanderthal groups within a huge area from the Sea of Azov coast, in the north, to the Large Caucasus Ridge, in the south, and from the Black Sea coast, in the west, to the Central Caucasus, in the east.

- 9h20: Long distance obsidian distribution and the organization of Palaeolithic societies

Dr Theodora Moutsiou

Archaeological Research Unit, Department of History and Archaeology, University of Cyprus.

dora81m@yahoo.com

Keywords: obsidian, Palaeolithic, stone tools, long distance movement, social networks

A recent study on the Palaeolithic use of obsidian has demonstrated that obsidian was a widely circulated material for stone tool manufacture much earlier than previously thought (Moutsiou 2011). The investigation, which encompassed Africa, Europe and the Near East, demonstrated that obsidian was chosen in all three regions throughout the Palaeolithic for the making of a wide variety of tool types. Most importantly, the work showed that obsidian was utilised not only when locally available but also at great distances from source. This paper discusses these occasions of long distance obsidian circulation in three distinct parts of the Old World at the earliest part of Prehistory as a means of elucidating past human social behaviour and modes of communication.

Reference
Moutsiou, Th. (2011). The obsidian evidence for the scale of social life during the Palaeolithic. PhD thesis. Royal Holloway, University of London, UK.

- 9h40: The stone raw materials in pirulejo (priego de córdoba, córdoba, spain). The example of level 5

Isabel Cánovas Calle, Andoni Tarriño, María D. Simón Vallejo, Victoria Aranda Sánchez, Lydia Calle Román y Miguel Cortés

Universidad de Sevilla/Grupo Tellus HUM-HUM-949
Proyecto HAR2013-44269-P. Ministerio de Economía y Competitividad

Keywords: Late Glacial, microblades, stone resources.

In this work we present a revision about the stone raw materials used by the hunter-gatherer societies in the cave of Pirulejo, focused above all for the manufacturing of lithic industries and in particular the ones documented in the P5 level that corresponds to a Late Glacial chronology.

This work will be composed by the following methodological steps:

1. Prospecting and sampling siliceous formation.

2. Macroscopic and petrographic analysis of the geological sample and archaeological material.

3. Comparation of the petrographic analysis between the archaeological and geological set, being able to assign the archaeological samples to the siliceous outcrops, and describe the mobility and siliceous sources catchment areas.

Results.

The absence of information about the siliceous outcrops in the peninsular Southwest lead us to present a petrographic characterization, as well as the location and extention of the main siliceous outcrops in this area.

Once the closest outcrops to the site were characterized, and characterized petrographically, we can assign the 70% of the archaeological material to local siliceous formations.

However, the macroscopic characteristics show that this exploitation of formations exceed the local areal (20 km), due to the local formations contain a diaclased flint that also make impossible a conchoidal fracture, therefore this flint is not suitable for knapping activities.

Thus, we propose other areas sources that exceed the 20 kilometers from the site and which are still in a preliminary phase to determine these areas sources.

Another line of study that we present is the way of exploitation of these flint, according to the Chaîne Opératoire of the lithic knapping represented on the site.

The absence of cortical flakes and the presence of flakes Jano, leads us to propose a first hypothesis, in which these hunter-gatherers groups carried out the grinding tasks and a first preparation of cores outside the site, developing in this area of the site works related to the production, use, restoration and amortization.

The general characteristics of the industry would be defined by small size blades production and large number of microblade industry.

Likewise, we find in this level other lithologies used as support for developing proper graphics in palaeolithic mobiliary art, as well as passive elements (hammerstones, anvils, etc.) that are also into the process of characterization study.

- 10h00: Lithic raw material reservoirs or “cache” record in the área ecotonal húmeda seca pampeana, Argentina, as an strategy for supply and territorial marking

Fernando Oliva

CEAR, Facultad de Humanidades y Artes, Universidad Nacional de Rosario.

fwpoliva@gmail.com

Keywords: Lithic landscapes; GIS; caches; lithic sources

Theoretical and methodological approaches related to the regional record of "caches or reservoirs lithic" are presented. This is a particular type of archaeological evidence of hunter-gatherer societies of the Late Holocene recorded in the Area Eecotonal Humid Pampa Seca (AEHSP) of Argentina.

The Pampas of Argentina is a vast plain where the lithic resources are limited to punctual surface outcrops and isolated hills systems. This region is subdivided into: Humid Pampa subregion, east of the 600 mm isohieta, and Dry west. The convergence of these two regions is characterized by an "ecotonal area", a place where phytogeographic provinces with shrub and grassland characteristics. This allows the concentration of resources which are distributed in the form of concave arc, located in nearby Meridian 62° to the east, and from the parallel 32° to 38°.

The record of "caches" in different sectors AEHSP would indicate a specific characteristic strategy of this area of research, which would be conditioned first by the special environmental and social complexity in capturing good quality stone materials by hunter-gatherer societies. This situation reflects a decision in the landscape lithification, signaling, maintenance and standardization in artifact composition, and allows us to propose the existence of space management social networks, share of common codes in the use of lithic resources to broader regional level. This record assigned to hunter-gatherer societies seeks to discuss the material manifestations of certain strategies of use of space and time, as they would be implying a planning of group activities taking place in the near future. The appearance of these "caches" in different distant latitudes, allows the proposal of a specific approach in terms of sourcing, conservation and "lithification strategies" in a broad regional landscape. The "caches" presented correspond to sets of standardized lithic artifacts produced in a variety of good lithic material (eg rhyolite, quartzite, chalcedony). The "lithification" of the landscape through the development of "caches" represents strategies that correspond to consensual decisions that express aspects of economic, social, ideological, and technological type. This situation results in decision-making, planning the use, conservation and storage of stone critical resources.

- 10h20: Elemental Characterization of Obsidian artifacts from Epipaleolithic and Neolithic sites in the Iron Gates, Southeast Europe

Adina Boroneant[1], Clive Bonsall[2]

[1]-Romanian Academy Institute of Archaeology, Bucharest
[2]-Archaeology, University of Edinburgh

boro30@gmail.com

Keywords: obsidian provenancing, Iron Gates, Epipaleolithic, Neolithic

Artifacts made from obsidian were recovered from Epipaleolithic and Early Neolithic sites in the Iron Gates section of the Lower Danube Valley, during excavations in the 1960s. Archaeologists of the time disagreed over the likely provenance of the obsidian, variously attributing it to Carpathian, Aegean, or even 'local' sources. We present the results of non-destructive pXRF analyses of museum-curated obsidian from three sites on the Romanian bank of the Danube. The obsidian is shown to originate from at least two distinct sources. Comparison is made with geological obsidian samples from sources in the Aegean, Anatolia, Carpathians and Central Mediterranean.

- 10h50: Exploitation of Raw Materials in Belovode (Serbia): Sourcing, Processing and Distribution

Vera Bogosavljević Petrović

National museum in Belgrade

vbogosavljevicpetrovic@gmail.com

Keywords: sourcing, distribution, stone raw materials, local acquisition, provenance, archaeopetrological studies.

Belovode is one of the most important settlements of the Vinča culture, which has been excavated in the last two decades in Serbia. Its development lasted over 650 years (5400-4600 cal BC). The main reason why Belovode was positioned there could be explained from an archaeometallurgical point of view, since there is a huge amount of metal ore deposits whose extraction was highly developed and continuously performed. Also, other aspects of community processes at Belovode indicate a high level in all spheres of life.

The origin and use of siliceous minerals and sediments was considered incidental to the general remarks on the suitability of the environment for local exploitation until extensive research of resources, production and distribution of chipped artefacts has recently been undertaken. General characteristics of Belovode production are the reduction process of tools, the existence of a group of typologically and technologically defined blades of white cherts, as well as multifunctional tools and a high percentage of recycled artefacts.

On the other hand, correlation of the structure of raw materials from the village and systematic "covering" of the territory by sampling geological deposits within a radius of 50 km have questioned a number of previous statements, such as: local acquisition, the importance of making stone artefacts for the community in favour of primary activities of metal crafts specialization, the extent of land use and the effect of people on their environment. The basic analyses applied are: macroscopic petrological examination and systematization of data obtained by microscopic analyses. The main result of the study of stone resources boils down to the fact that only 10 % of local lithic raw materials were in use at the site. Also, it is important to mention that there was an extensively developed concept of exchange and acquisition from communities of the wider environment, which included various types of siliceous rocks, as well as other goods.

- 11h10: Exchange networks between the Rhone and Ebro valleys: A view from the northeast of the Iberian Peninsula

Xavier Terradas, Juan F. Gibaja

CSIC-IMF, Barcelona.

terradas@imf.csic.es

Since the middle of the fifth millenary cal BC and for a thousand years, the so-called «Sepulcros de fosa» culture is attested in the northeastern part of the Iberian Peninsula, approximately in parallel with the French Chassey culture. Only a few habitats were discovered and excavated so far, preventing a better knowledge of the subsistence patterns, of the organisation of inhabited spaces and of the economic strategies implemented by these populations.

However, the funerary expressions of theses societies are abundant: to date more than 600 graves were identified. These funerary manifestations are characterised by larges necropolis gathering many burials, mostly individuals. These burials provided numerous grave goods including elements manufactured elsewhere from exotic raw materials, whose presence in the graves indicate a type of exploitation overstepping the frame of regional resources.

Since the fourth millenary cal. BC, a significant increase of the number of grave goods and of the distance from the origin of the products is noticeable, amongst them flint from Provence, polished stone axes from several sources and Sardinian obsidian blades. The diffusion of these elements all along the Mediterranean axe connecting the Rhone and Ebro valleys, across distances over several hundred kilometres and under shapes resulting from specific manufactures according to constrictive technical norms, allows us to highlight the circulation of these productions, but also of the ideas and populations across an extended territory. Therefore, these burial contexts constitute a privileged frame to the study not only of funerary practices, but also of the relationships within these groups and with the neighbouring communities.

- 11h30: Long distance provenances of the callaïs adornments along Atlantic Europe from the fifth to the third millennium

Guirec Querré[1], Thomas Calligaro[2], Serge Cassen[3], Salvador Dominguez-Bella[4]

[1-] Laboratoire Archéosciences UMR 6566 CReAAH. Université de Rennes 1, Campus de Beaulieu, 35042 Rennes, France.

[2-] Centre de recherche et de restauration des musées de France, C2RMF, Palais du Louvre - Porte des Lions, 14 Quai François Mitterrand, 75001 Paris, France.

[3-] Laboratoire de recherches archéologiques (LARA) - UMR CNRS 6566 CReAAH. Université de Nantes, BP 81227 , 44312 NANTES cedex 3.

[4-] Earth Sciences Department. Faculty of Sciences. Cádiz University. Campus del Río San Pedro. 11510. Puerto Real, Cádiz. Spain.

guirec.querre@univ-rennes1.fr

Keywords: variscite, provenance, chemometrics, Neolithic, Europe

The large grave mounds from Brittany are among the most impressive funeral architecture of the Neolithic period in France. The exceptional quality of the adornments such as polished stones, axes and beads necklaces deposited in burial chambers, reflects the high status of the buried persons. Among these funerary deposits, callaïs jewelry with the highest density is in the region of Carnac: more than 800 artifacts, beads and pendants, were found in 33 Neolithic sites located on a narrow coastal strip of few kilometers wide and thirty long.

A research program based on chemical analysis by PIXE of archaeological artifacts was conducted over 10 years to determine their provenance. To address this question, the study has required to set-up a referential dataset of phosphates with sampling of all deposits in Western Europe and their analysis by PIXE. On the basis of this geochemical database and trace element fingerprint of each potential sources, we have established a chemometric model allowed to assign a geographical origin for each set of callaïs objects from a Neolithic site.

We conclude that most of pendants and beads are in variscite but very few are in turquoise. Of the oldest objects from the middle of fifth millennium until about 4000 years BC, variscite comes from the Encinasola deposit (Huelva). A change seems to occur early in the fourth millennium: most of the objects are from the Palazuelo de las Cuevas deposit (Zamora). Then, variscite imported from the Iberian Peninsula stop in the middle of the third millennium. No Neolithic object from Brittany appears to be from Gavà (Barcelona) where, however, the mines variscite worked during this period. Long-distance exchanges of variscite is therefore made only along the Atlantic seaboard during the Neolithic.

- 11h50: Jades and related HP greenstone polished stone implements from Hungary

Zsolt Bendő[1], György Szakmány[1], Zsolt Kasztovszky[2], Katalin T. Biró[3], István Oláh[3], Anett Osztás[4], Ildikó Harsányi[2]

[1-] Eötvös L. University, Department of Petrology and Geochemistry, Pázmány P. sétány 1/c, 1117 Budapest, Hungary,
[2-] Hungarian Academy of Sciences, Centre for Energy Research, Konkoly Thege M. út 29-33, 1121 Budapest, Hungary
[3-] Hungarian National Museum, Múzeum körút 14-16, 1088 Budapest, Hungary
[4-] Hungarian Academy of Sciences, Research Centre for the Humanities, Institute of Archaeology, Úri u. 49, 1014 Budapest, Hungary

bendozs@caesar.elte.hu

Keywords: polished stone tool, jade, eclogite, provenance, non-destructive analyses

Good quality high pressure (HP) metaophiolite rock types suitable for making stone implements, like jade and eclogite, are absent from the geological formations of Carpathian Basin and its surroundings. Therefore this raw material type was unknown among Hungarian findings for a long time, and henceforward this is one of the rarest type of raw material of polished stone implements in Hungary. Their investigation is very important because of their scarcity and distant origin. The nearest geological locality where these raw materials can be found is over 1000 kms away. The specific form and integrity of these stone implements indicate that they were transported as complete artefacts.

After the first mention of these stone tools detailed petrological investigations of large stone implement collections (Miháldy and Ebenhöch collections) revealed their presence in relatively large number. According to our current knowledge 25 HP metaophiolite stone implements are known from Hungary. Unfortunately most of them are stray finds, but 11 pieces have known archaeological context from four localities (Alsónyék (5), Zengővárkony (3), Szombathely, Olad plateau (2), Hódmezővásárhely-Gorzsa (1)). Most samples were found in Transdanubia, only one piece turned up in Eastern Hungary. All of them are connected to Late Neolithic cultures, prevailingly Lengyel Culture.

Only non-destructive analytical methods were used in this study. SEM-EDX investigation was used to mineral chemical analyses and textural investigation. Prompt Gamma Activation Analysis was used to determine the average bulk concentrations of major and some trace elements of few cm^3 volume. Based on these data stone implements were divided into raw material type groups. Our results are corresponding to results on HP metaophiolites of North-western Italy, obtained both on geological and archaeological samples. Based upon these facts, the HP metaophiolite stone implements in Hungary probably originated from the same raw material sources as Italian (and other Western European) HP metaophiolite stone tools. According to technical literature, these primary sources can be the Monviso, the Voltri Massif and secondary in the resedimented Oligocene conglomerates in Quaternary of River Po, Staffora and Curone equally.

This research is supported by the Hungarian Scientific Research Fund (OTKA) K 100385 and JADE2 program.

- 12h10: Contact metamorphic rocks as long distance import raw materials of Prehistoric polished stone tools in Hungary

György Szakmány [1], Zsolt Bendő [1], Zsolt Kasztovszky [2], Ildikó Harsányi [2], Katalin T. Biró [3], F. Horváth[4]

[1]- Department of Petrology and Geochemistry, Eötvös L. University, Pázmány P. sétány 1/c, 1117 Budapest, Hungary.
[2]- Hungarian Academy of Sciences, Centre for Energy Research, Konkoly Thege Miklós út 29-33, 1121 Budapest, Hungary.
[3]- Hungarian National Museum, Múzeum körút 14-16, 1088 Budapest, Hungary.
[4]- Móra Ferenc Museum, H-6720 Szeged, Roosevelt tér 1-3.

gyorgy.szakmany@geology.elte.hu

Keywords: polished stone tool, contact metabasite, hornfels, provenance, non-destructive analyses

Fine grained contact metamorphic rock types were widely used as raw material for polished stone artefacts in Prehistory. They were also used in large amount in the Carpathian Basin. Basically, two rock types can be assigned to this group: contact metabasites and hornfels. Both of them are very fine grained, massive, hard but tenacious raw materials, very useful for polished stone tools which should be resistant to mechanical stress. The main aim of our study is the characterization of these artefacts based on their petrographic and geochemical properties. Other important goal is to determine their provenance and distribution.

Several of these finds are complete and exhibition quality artefacts, therefore they can only be analysed by non-destructive methods. After macroscopic description and magnetic susceptibility measurements, we used two non-destructive analytical methods, the "original surface investigation", which is a type of SEM-EDX investigation, used in order to determine chemical composition of rock forming minerals and characterize the texture of the rock types. Prompt Gamma Activation Analyses, have been used for determination of major elements in the bulk. More than one hundred polished stone artefacts moreover several geological samples from potential raw material sources have been investigated.

The provenance of the contact metabasites are dominantly the Krkonoše-Jizerské Mountains, in the Northern Bohemian Massif (Czech Republic), which is one of the most important and best known locality of this raw material, however subordinately other localities (Želešice and Little Carpathians, Czech Republic) were also used. The provenance of hornfels artefacts was identified in the Southwestern Rusca Mts., and the Southern Apuseni Mts. (Romania).

Both contact metabasite and hornfels stone tools distribute on the whole territory of the Carpathian basin but their pattern of distribution is different. Contact metabasite artefacts occur mainly in Transdanubian area, while hornfels artefacts dominate in the Eastern part of Carpathian basin with increasing amount to SE direction. The two different source areas were connected by commercial connections mainly during the Late Neolithic and the Copper Age.

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The flint acquisition through final Upper Paleolithic and Mesolithic: A territory contraction

Guilhem Constans

Université Toulouse II Jean Jaurès UMR 5608 – TRACES

guilhem.constans@hotmail.fr

Keywords: Mesolithic, Upper Paleolithic, Territory, Contraction, Mobility

The study of lithic toolkits provides a real means of investigating the life ways of different prehistoric populations. Through an analysis of the geographic origin of the different raw materials used for stone tool production, the spatial aspect of prehistoric life ways can be interrogated, allowing us to reflect upon the territory and mobility strategies of these societies. During the Upper Paleolithic, the spatial scope of raw material acquisition and exchange spaces is quite vast, and thus emphasizes quite complex mobility strategies. On the other hand, at the Pleistocene-Holocene transition, raw material acquisition strategies change, logically reflecting significant changes in the life ways and mobility strategies of these hunter-gatherer populations. During the last 20 years, several researchers have revealed a reduction in the size of acquisition territories after this key transition in human prehistory. Raw materials studied from Mesolithic sites in France highlight the use of exclusively local materials, which differs significantly from preceding periods. It is thus necessary to investigate the nature of such a reduction in acquisition and exchange territories throughout the entire Pleistocene-Holocene transition, from the Magdalenian to the early Mesolithic, including the Epipalaeolithic, which will allow for an understand of the principle mechanisms of such a reorganization. The study of lithic assemblages from several sites in the Quercy region of southern France (Murat, Peyrazet, Mirande 2, Cuzoul de Gramat and Fontfaurès) for these periods (Badegoulian, Magdalenian, Azilian, Laborian and Mesolithic) highlights several key aspects regarding the size and exploitation of territories in the long time by different Late Glacial and Mesolithic cultural groups. The spatial scale of raw material acquisition does shrink over time, but this long term and gradual trend cannot be conceived of as linear and steady. Thus, for the Mesolithic in southern France, there is a notable absence of exotic raw material across multiple sites in Quercy (Cuzoul de Gramat, Fontfaurès), indicating a major difference with Late Glacial sites (Murat, Peyrazet, Mirande 2). It is therefore possible to investigate the concept of long distance acquisition based on varying cultural and geographical contexts.

High quality flint sourcing and distribution in the Holocene: Case studies from Bulgaria

Maria Gurova

National institute of Archaeology with Museum, Bulgarian Academy of Sciences
2 Saborna Str. 1000 Sofia

gurovam@yahoo.fr

Keywords: Balkan Flint, Ludogorie Flint, Neolithic, Chalcolithic, toolkits

This paper contributes new data on the sourcing and long-distance distribution of two types of high quality flint from northern Bulgaria with intensive and widespread use in the Prehistory.

The first type is the so-called Balkan flint (yellow, waxy, white-spotted flint) originating from the Moesian Platform. Its outcrops are localized in chalky Upper Cretaceous deposits of Mezdra formation limestones in the Pleven-Nikopol region. Many secondary placer deposits of this raw material are identified along the Danube bank (Bulgarian-Romanian section). Balkan Flint is used for manufacturing the most diagnostic Early Neolithic toolkits consisting of blades with (bi)lateral semi-steep to steep retouch and sometimes pointed or rounded (end-scraper-like) ends. The blades are produced using indirect percussion (punch) technique. Sickle inserts made on blades and with evidence of multiple posterior re-sharpening are also included in the toolkit. The tools of the above-mentioned types, as well as the blanks (rarely nodules) of Balkan flint also represent one of the defining characteristics of the supra-regional techno-complex of the Karanovo I–Starčevo–Criș-Körös culture.

The second type is the so-called Ludogorie (Dobrudzha) flint, hosted in Lower Cretaceous micrite limestones with many different types of secondary (placer) deposits. This flint possesses optimal parameters for knapping and was extensively used during the Chalcolithic when blade production reached its peak in the form of super-blades found in cemeteries and hoards. A variety of knapping techniques were used for removal of blades with different proportions and purposes. Apart from domestic use of blades there is a distinct domain of production of superblades with strictly non-utilitarian symbolic use. The distribution of Ludogorie flint during the Chalcolithic is well documented beyond present-day Bulgaria – in northern Greece, Moldavia and Ukraine.

It is still debatable how early in prehistory the exploitation of both Balkan flint and Ludogorie flint took place. The large scale distribution and use of these raw materials suggests a highly developed procurement strategy, workshops for knapping and tool manufacturing as well as extensive networks of raw material exchange.

A new model of mobility for the Late Aurignacian in South-Western France

Solène Caux, Alexandre Michel, Jean-Guillaume Bordes

Université Bordeaux. UMR 5199 - PACEA Préhistoire, Paléoenvironnement, Patrimoine. B8 allée Geoffroy St-Hilaire. CS 50023 - 33615 PESSAC CEDEX

solene.caux@gmail.com

Keywords: Grain de mil flint; territory; raw material; Aurignacian; petroarchaeology; techno-economy

Characterising lithic raw materials is an important means of studying palaeolithic territories, allowing modes of mobility and the organization of human groups to be deduced. The Aquitaine Basin is one of the best-documented archaeological regions of Europe. However, certain materials have long been recognised within archaeological collections without their geographic origin or even their uniqueness being clearly demonstrated. The recent characterization of the 'Grain de mil' flint, a material from the extreme north-west part of this Basin, allowed a revision of territories and modes of mobility during the Late Aurignacian. Based on the study of three north-aquitaine archaeological sites (Caminade, Abri Pataud and Roc-de-combe), we proposed that regular provisioning territories are centre to the north of the Aquitaine Basin, but sometimes open to a wilder territory threw the west and also the north (Paris Basin). 'Grain de mil' then appears to be at the heart of large-scale networks of circulations.

Raw material extraction and circulation around the Western Carpathians in the Early Neolithic

Małgorzata Kaczanowska, Janusz K.Kozlowski

Institute of Archaeology, Jagiellonian University, Kraków, Poland

janusz.kozlowski@uj.edu.pl

Keywords: Early Neolithic, raw materials, Western Linear Pottery Culture (LBK), Eastern Linear Pottery Culture (ALP).

In last years a real progress has been realized in the identification of raw materials in the Carpathian basin and north of the Western Carpathian range. Raw material circulation in the Early Neolithic was analyzed in the frame of two taxonomic units (Western Linear Pottery Culture – LBK and Eastern Linear Pottery Culture – ALP) and several chronological horizons. Systems of supplying in raw materials were presented on the level of extraction points including associated workshops and settlements or households. In the western Carpathian zone in some regions extralocal materials were preferred and in some areas mostly local sources were exploited.

The use of stone raw materials in the Mesolithic of the Sudeten Mountains, SW Poland

Tomasz Płonka, Jarosław Bronowicki

The Sudetes mountain range runs SEE to NWW in south-western Poland, north-eastern Czech Republic) and south-eastern Germany. These are mountains of medium elevation, gentle relief, their highest peak, the Śnieżka, rising to 1602 m a.s.l. The Sudetes are accompanied by a foreland and a foothills region, with a characteristic hilly landscape, and elevations rising to a few hundred metres. During the Pleistocene the northern region of the Sudetes and their foreland zone were covered twice by the ice sheet of the Elster and of the Saale glaciations. Postglacial sediments found in the region are rich in lithic resources of northern origin, e.g., erratic flints, eroded by the ice-sheet from their primary deposits, presumably in the Baltic Sea basin.

The flint found in the glacial deposits was modified heavily during the transport of the sediments. The flint nodules became damaged: fragmented and fissured; as a result, the flint discovered in the glacial sediments in the Sudetes region occurs in the form of fragments that range from a few to a dozen-odd centimetres. Many of them are also fissured internally. Despite these unfavourable parameters erratic flints were used widely by the Mesolithic population settling the Sudetes. In many Mesolithic camps it was the only stone raw material.

Single artefacts struck from other varieties of flint, e.g., chocolate flint from eastern Poland, had a negligible economic significance – more likely to play a role in the social relationships between the groups. A lithic resources used much more frequently than the exotic flints were the local raw materials available in the Sudetes which often have outcrops found in the vicinity of archaeological sites in which these flint finds were recorded, i.e. chert, hornstone, chalcedony, rock crystal and others. From this perspective we can identify two zones of Mesolithic settlement: zone A (area with glacial deposits containing erratic flint) and zone B (outside the zone affected by glaciations). In zone A the main resource in use was erratic flint, with the local Sudetes raw material varying in significance. In zone B we can identify two groups of sites: I. with a domination of erratic flint and of other imported stone raw materials; II. with an obvious domination of the local Sudeten lithics.

Differences in the sourcing of the stone raw materials in the two zones are both a reflection of the mobility of the groups and their members and evidence of the existence of complex exchange networks within the hunter-gatherer societies.

Saturday, 12h40
ENVITED SPEAKER

Problems and Potential Solutions for Inter-Laboratory Elemental Composition Data Comparison and Combination for Geological and Archaeological Obsidian

Robert H. TYKOT - Department of Anthropology, University of South Florida, Tampa, USA (*rtykot@usf.edu*)

Successful chemical analysis on obsidian to distinguish different geological sources was first accomplished more than 50 years ago, and since then much has been accomplished in the Mediterranean, Near East, and other parts of the world, regarding trade and the socioeconomic characteristics of prehistoric cultures. Many analytical methods have been used, including instrumental neutron activation analysis (INAA), X-ray fluorescence (XRF), laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), scanning electron microscopy (SEM), and electron probe microanalysis (EPMA). In recent years, non-destructive, portable XRF instruments have allowed analyses of large assemblages within museums and storage areas, providing statistically significant data sets for interpretation. Many studies clearly show differences between contemporary sites, variation between contexts at a single site, and changes over time. Yet some of the same fundamental issues still remain for such studies, especially comparison of the analytical results on artifacts with those for geological samples analyzed with different instruments and/or in different labs, which is necessary for assigning the artifacts to specific sources and subsources. The sharing of obsidian standards and of open-access calibration software will be presented, along with examples from my own studies in the Mediterranean using all of these analytical instruments.

Saturday, 14h20

Heat Treatment Of Raw Materials: Objectives, Changes And Procedures

Xavier TERRADAS - CSIC-IMF. Archaeology of Social Dynamics. Egipciaques, 15. 08001 Barcelona, SPAIN (*terradas@imf.csic.es)*

Handling raw materials by means of experimentation has become a continuous experience from the beginning of mankind. So, human societies have been trying to modify the original conditions of several matters in order to take advantage of the new got physical and mechanical properties. The aim was to produce materials more suitable for the human purposes than those originally offered by nature. Regarding the archaeological record examples can be found everywhere. Perhaps the most evident and widespread is the heat treatment of rocks and minerals. The pursued objectives by heating materials, blanks or products can be diverse: either to change its properties for knapping or retouching processes, to favour obtaining of standardised products, to improve its effectiveness in some productive processes, to modify its colouring or other.

Proposals focussing intentional changes promoted by humans with the intention to improve the original conditions of any type of raw material are welcomed. The topic of the Session can be faced by means of communications taking into account the nature of changes, processes implemented, objectives pursued, archaeometrical approaches to attest them, etc. Contributions can face these topics starting from specific archaeological cases, interrogating about its causality, from the point of view of experimental research, reproducing the procedures followed or testing their effectiveness, or by proposals mixing both approaches.

- 14h20: The habitual heat-treatment of silcrete by the Howiesons Poort groups from southern Africa

A. Delagnes[1,2], K. Douze[1,2], S. Wurz[2,3], P. Schmidt[4], K. van Niekerk[2,3], C. Henshilwood[2,3]

[1-] CNRS - université de Bordeaux, PACEA, allée Geoffroy St Hilaire, CS50023, 33615 Pessac CEDEX, France
[2-] Evolutionary Studies Institute, University of the Witwatersrand, 1 Jan Smuts Avenue, Braamfontein 2000, Johannesburg, South Africa.
[3-] Institute for Archaeology, History, Culture and Religious Studies, University of Bergen, Øysteinsgate 3, N-5007 Bergen, Norway.
[4-] Eberhard Karls University of Tübingen, Department of Prehistory and Quaternary Ecology, Schloss Hohentübingen, 72070 Tübingen, Germany.

a.delagnes@pacea.u-bordeaux1.fr

Keywords: Middle Stone Age, South Africa, silcrete, heat-treatment, lithic technoloy.

Heating stone in order to enhance its flaking qualities lists among the multiple innovative adaptations introduced by the early modern human groups from southern Africa, in particular the Still Bay and Howiesons Poort groups. Very little is known about the role and impact of this technology on the early modern human behaviours and cultural expressions. We address this issue through the technological analysis of a lithic assemblage from a recently discovered and excavated MSA site: Klipdrift Shelter (Southern Cape region, South Africa), that evidences the extensive use of fire for the heat treatment of silcrete blocks. The heat treatment of silcrete at KDS was performed in an early stage of the *chaîne opératoire* and it has thus impacted all stages of core reduction and all subsequent operations of tool manufacturing. For the artisans, the benefits of a heat treatment were multiple. Beyond transforming and improving the quality of silcrete, heat treatment limits the risk of core fragmentation at an advanced stage of production. The Howiesons Poort groups have therefore considerably developed and optimized a technology that emerged before, maybe as early as 164 Ka but still restricted to specific tools and to specific manufacturing stages.

- 14h40: An overview over the temporal and spatial variations and change of heat treatment in the Middle Stone Age on South Africa's west coast

Patrick Schmidt

Eberhard Karls University of Tübingen, Department of Prehistory and Quaternary Ecology, Schloss Hohentübingen, 72070 Tübingen, Germany.

patrick.schmidt@uni-tuebingen.de

Keywords: Silcrete heat treatment; Modern behaviour; Transformative technology; Middle Stone Age

The earliest known evidence of heat treatment of stone dates back to the Middle Stone Age (MSA) of Southern Africa. Silcrete, a continental silica rock of rather good knapping quality, was heated for tool production from 164ka on. The published sources on MSA heat treatment indicate that, in at least some of the sites, the phenomenon became broad scale from ~80 ka on (in the Howiesons Poort, HP), when almost all silcrete was heated before knapping. The exact spatial and temporal variations throughout the MSA remain poorly understood. The heating techniques used and the investment necessary for them also remain subject to debate. I present here the results of a three years lasting research project on these questions. It was possible to assess the spatial variations of heat treatment-related behaviours in the HP throughout the west coast of South Africa and to compare it to the post-HP. The frequencies of heat treated silcrete artefacts strongly vary in different sites and at different times. The heating technique used appears to have been more stable throughout the studied time periods and area, consisting in direct heat treatment in the embers of fires. These findings open up new research perspectives on the cost and benefit of heat treatment or the motivations to conduct it.

- 15h00: Preliminary results of chemical and physical evidence of heating treatment of the Middle Stone Age ochre from Rose Cottage and Sibudu, South Africa

Marine Wojcieszak, Tammy Hodgskiss, Lyn Wadley

Evolutionary Studies Institute, University of the Witwatersrand, 1 Jan Smuts Avenue, Braamfontein, Johannesburg, 2000, South Africa

marine.wojcieszak@gmail.com

Keywords: Ochre, Heat treatment, Middle Stone Age, Multi-analytical Approach

Rose Cottage and Sibudu Caves yielded a large quantity of ochre pieces with a range of use-traces. Some attributes of the ochre have already been studied purely from a visual point of view. Visual comparisons have been made between sites to understand the use of ochre during the Middle Stone Age in South Africa, but physico-chemical evidences needed to complete the work. This project aims to use a multi-analytical approach (including Raman spectroscopy, FTIR, XRD and XRF) to characterise ochre pieces from both archaeological sites. Physico-chemical investigations on the archaeological ochre will help us to gain a deeper understanding of changing patterns in ochre collection, preparation, and use through time. Part of the preparation phase may have involved heat treatment to alter the colour and mechanical properties of the ochre. Two experimental methods of heating were used. Heating in an open fire, with each piece being heated to particular temperatures, at the soil surface (therefore directly below the fire) and also buried in the sand 5 cm underneath the fire. Temperatures are difficult to control exactly, especially for prolonged periods. Heating 'control' samples in a muffle furnace create a useful control. Observations made during heating experiments inform our understanding of the physical and physico-chemical changes when ochre is heated. Investigating this is important because heat treatment has significant cognitive implications for the people who were practicing it.

- 15h20: Tracing the early production and use of lime-plaster in Kharaysin PPNB site (Jordan)

Eneko Iriarte [1], Susana Jorge-Villar [2], Jonathan Santana [3], Luis Teira [4], Juan Ramón Muñiz-Álvarez [5], Juan José Ibañez[6]

[1]-Laboratorio de Evolución Humana, Departamento de Ciencias Históricas y Geografía, Universidad de Burgos, Edificio I+D+i, Plaza de Misael Bañuelos s/n, 09001, Burgos, Spain.
[2]-Área de Geodinámica Interna, Facultad de Educación, Universidad de Burgos, Spain.
[3]-Instituto de Ciencia y Arqueología, Universidad Estatal de la Península de Santa Elena, Ecuador.
[4]- Instituto Internacional de Investigaciones Prehistóricas de Cantabria. luis.teira@unican.es
[5]-Pontificia Facultad de San Esteban de Salamanca.
[6]-Departamento de Arqueología y Antropología, Institución Milà i Fontanals-CSIC, Spain.

eiriarte@ubu.es

Keywords: lime production and use, petrology, geochemistry, Kharaysin PPNB site, Jordan

Although the extensive use of lime plaster for architectural and other purposes is a characteristic hallmark of the Pre-Pottery Neolithic B (PPNB) in the southern Levant, no obvious kilns have been identified in archaeological contexts yet. In this work we present details of archaeological pit-kiln structures used to lime-plaster production found in the Kharaysin PPNB site (Jordan). Geochemical, mineralogical and petrological characterization of the associated raw materials and products, lime-plaster floor and mortars, from the same site allowed the tracing of the early production and use of lime.

- 15h40: Flint heat treatment practice at the Pre-Pottery Neolithic A site of Hasankeyf Höyük, southeast Turkey

Osamu Maeda

University of Tsukuba, Japan 1-1-1Tennoudai, Tsukuba, Ibaraki 305-8572, Japan

osmaeda@yahoo.co.jp

Keywords: Ancient Technology, Technological failure, Experimental study, Neolithic, Anatolia

The recent excavations at Hasankeyf Höyük, a sedentary hunter-gatherer settlement of the Pre-Pottery Neolithic A period on the upper Tigris in southeastern Turkey, have yielded hundreds of flint artefacts showing signs of heat treatment. At this site, heat treatment technique was introduced in the last phase of the occupational sequence in the late 10th millennium cal. BC and applied to various types of locally acquired raw material, from which many blades and flakes were produced. This technique enabled the production of larger tools, but the local traditions of the lithic industry were not markedly changed by its introduction. It is significant and interesting to note that there are many flint blades and flakes which were seemingly overheated, sometimes cracked, and therefore not usable as tool blanks. It appears likely that people at this site often failed to achieve the best possible results from heat treatment. However, my experimental study using an electrical furnace and bonfire has demonstrated that the application of heat treatment to the local flint used at Hasankeyf Höyük does not necessarily require high skill levels, once the factors of heating time and temperature are learned. This suggests that improving the success rate of heat treatment was not a primary concern for the people at this site, who rather preferred flexible and optimistic use of this ancient technology.

Saturday, 16h00

Approaches To Measure Lithic Raw Material Quality

Telmo **PEREIRA -** ICArEHB –University of Algarve, PORTUGAL (*telmojrpereira@gmail.com)*
João **MARREIROS -** ICArEHB – University of Algarve, PORTUGAL (*jmmarreiros@ualg.pt)*
Eduardo **PAIXÃO -**ICArEHB – University of Algarve, PORTUGAL (*eduardo.paixao88@gmail.com)*

For millions of years, one major reason for raw material selection was, most probably, its quality and suitability for the different intended tasks. Actualistic studies developed in many different parts of the world show that hunter-gatherer communities from present days usually have relatively restricted sets of empirical criteria that allows them to classify a raw material as good or bad. However, this immaterial information is not clearly available in the archaeological record and might have been different not only from region to region but also through time. Thus, in archaeological and anthropological sciences the inference of lithic raw materials quality has been often subjective and based on criteria more related with knapping abilities than use suitability, which is the opposite of the usual criteria of those present-day communities.

In this session we intend to gather a set of presentations approaching the quality of lithic raw materials through multiple angles and based on high-accurate analysis and measurable data, namely those approaching density, hardness, toughness, resiliency, abrasion, uniformity, elasticity and stiffness using mechanical testing such as Schmidt Hammer, Young's Modulus, Taber Abrasion, Los Angeles Abrasion Test or others. With this, we expect to bring a considerable input for the construction of a framework for the classification of lithic raw material quality based on absolute criteria and, consequently, reduce in a very considerably amount the subjectivity that presently rules the definition of such relevant feature of lithic raw materials.

In the end, this framework might also be useful to reach the same objective in other raw materials such as different bones within a same species, or bone between species.

- 16h00: Mechanical properties of stones influences selection decision in chimpanzees and hominins

Susana Carvalho[1,2], David R. Braun[3,4], R.S. Kaplan[3], Dora Biro[5], Tetsuro Matsuzawa[6]

[1-] Institute of Cognitive and Evolutionary Anthropology, University of Oxford, U.K.
[2-] ICArEHB - Interdisciplinary Center for Archaeology and the Evolution of Human Behaviour, Algarve, Portugal
[3-] Department of Anthropology, George Washington University, USA
[4-] Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany
[5-] Department of Zoology, University of Oxford, Oxford, U.K.
[6-] Primate Research institute, Kyoto University, Japan

susana.carvalho@anthro.ox.ac.uk

Keywords: Mechanical properties, elasticity, hardness, Oldowan, selection

One of the few consistent features of early hominin stone tool behavior is the selection of certain rock types for artifact manufacture. Until recently there have been few systematic investigations of the exact mechanical properties that hominins selected for. Furthermore there is little understanding of how and why these selection patterns manifested in hominins. Unlike hominin behavior, chimpanzee behavior can be observed. Here we present data on the selection of certain rock types by chimpanzees at the site of Bossou in Guinea, Conakry. Variables such as rock shape and size affect tool selection decisions of wild chimpanzees during percussive tool use. However, very little is known about how chimpanzees discriminate between different rock types. At the outdoor laboratory, in Bossou, Guinea, we investigated tool selection among a group of wild chimpanzees. We provided them with rock types preferred by hominins to make chipped stone artefacts at the site of Kanjera South, Kenya, which are not available in the modern Bossou habitat. We investigated chimpanzee selectivity by calculating indices of selection based on the use of different rock types. Tests on rock elasticity and micro-hardness allow us to link selection to material properties. Results show that decisions on tool selection by chimpanzees correlate with mechanical properties of rocks. Not only do mechanical properties influence selection decision by chimpanzees but also these selection decisions differ depending on tool use (hammer vs. anvil). This pattern is more evident amongst older individuals with greater efficiency and skill in nut cracking.

- 16h20: Linking Geringonça and Schmidt hammer results to infer lithic raw material quality

João Marreiros[1-3], Eduardo Paixão[1-2], Anne Farias[2], Catarina Andrade[2], David Nora[2], Rui Martins[2], Telmo Pereira[1]

[1-] ICArEHB - Campus Gambelas, Universidade do Algarve, 8005-139 Faro PORTUGAL
[2-] NAP - Campus Gambelas, Universidade do Algarve, 8005-139 Faro PORTUGAL
[3-] Consejo Superior de Investigaciones Científicas e IMF, Egipciaques, 15, 08001 Barcelona, Spain

jmmarreiros@ualg.pt

Keywords: Raw materials; mechanical tests; mechanical properties.

For millions of years, quality must have been one of the most relevant features at the moment of selection of lithic raw materials. That assumption is supported by ethnographic studies with modern hunter-gatherer communities. However, this aspect has been highly neglected and lithic raw materials quality is often considered in what concerns knapping aptitude and using subjective criteria. Recently, we started a new and ongoing experimental program that uses a mechanical prototype to test stone-tool performance with high control of the variables in action that aims to reduce the subjectivity during the acquisition the data related with raw material performance and aptitude, e.g., quality.

In this presentation we compare edge performance of some of the most used lithic raw materials across the world: quartzite, quartz, chert and basalt. Then we cross that information with the results obtained with Schmidt hammer tests. Our results show that coarse raw materials tend to perform worst when used to cut although it does not necessary mean that they are the softest. On the contrary, some coarser specimens show higher rebound values, clearly indicating that they are, in fact, the hardest. Thus, edge performance and edge effectiveness seems to be also dependent, at some degree, on other traits of each raw material such as the edge thickness and edge durability that are directly related with the physical structure.

How the rebound value is quality factor of the chert?

Anne Farias[1], Catarina Andrade[1], Telmo Pereira[2]

[1]-NAP – Núcleo dos Alunos de Arqueologia e Paleoecologia, Universidade do Algarve, Campus Gambelas 8005-139 - Faro – Portugal
.[2]-ICArEHB - Interdisciplinary Center for Archaeology and Evolution of Human Behavior, Universidade do Algarve, Campus Gambelas 8005-139 - Faro – Portugal.

annef.email@gmail.com

Keywords: quality; Schmidt Hammer; chert; Portugal.

During the last decades has been produced a vast methodological re-examination of raw materials sources. This news allows define and describe with some precision the mobility networks in Prehistory. Viewing raw material sourcing activities like early point of chaînes opératoires provides information into human behavior. However, their quality is an issue which is still under explored and, when it is, it is usually by subjective means.

The aim of our ongoing investigation is to systematically test geological chert samples in order to determine the variation in their mechanical properties and, ultimately, quantify these properties. The data will allow us to understand, for instance, possible discrete variations between geological formations within the same region. To reach our objectives we used the rebound value taken with a Schmidt Hammer and convert to a quality scale.

The experiment comprehends 50 specimens from, mainly, West-Central Portuguese territory. The acquisition of these geological samples was made within the ambit of the project LusoLit (lithotheque the University of the Algarve). All samples have similar densities and were performed in using the vise as press and base attached to a wooden board. Each sample was tested 30 times on the most regular surface. Due to a broad range that may occur for small differences in the Schmidt Hammer position, the 10 values that were further off range were excluded to generate the hardness average and converted in grade quality.

This study will help us to better understand the preferences observed in lithic collections, they are conditional on the quality of the source. Recreating the possible mobility routes of raw material procurement. In order to better understand the behavioral patterns of the prehistoric man that depended on the efficiency of his strategies to survive.

Testing raw-material suitability for Ground stones: Experimental program in Quartzite and Greywacke

Eduardo Paixão[1], João Marreiros[1], Juan Gibaja[2], Telmo Pereira[1], João Cascalheira[1] and Nuno Bicho[1]

1- ICArEHB - Interdisciplinary Center for Archaeology and Evolution Human Behavior, University of Algarve
2- CSIC (Consejo Superior de Investigaciones Científica)

eduardo.paixao88@gmail.com

Keywords: Raw-materials; Experimental; Ground stones; Paleolithic.

Ground stone technology is present in various Upper Paleolithic chronologies of Portuguese sites covering most of the country. Although the premature state of research does not allow a detailed characterization, this type of artifacts is present both in the south, mostly made in greywacke and in central Portugal mainly made in quartzite.

In order to identify, characterize and compare use wear traces, this project seeks to develop an experimental program, based in the application of pressure and impact with several types of organic and lithic elements, in greywacke and quartzite blocks with metric and morphological features similar to the archeological materials. The marks will be macro and microscopic analyzed in order to identify, describe, quantify and recognize their distribution patterns, in order to relate them with the different human activities. The main goal is to infer human behavior by understanding the differences among raw-materials from a use-wear perspective.

This study will be essential to recognize how different raw-materials preserve use wear marks and which preserves better and worst some specific marks that are caused by different activities. In the end, we intend to contribute to the understanding of which raw materials represented a better canvas for some specific past human tasks and why.

Saturday, 17h05

Quarrying And Mining During Prehistoric Times

Jacek LECH - Institute of Archaeology and Ethnology, Warsaw Polish Academy of Sciences, Poland (*flint.lech2@gmail.com)*

From the collection of coarse volcanic blocks in Lomekwi to the outstanding flint mines such as Krzemionki Opatowskie, Grime's Graves or Spiennes, raw material acquisition was always the first step of an artifact chaîne opératoire. However, the methods, techniques and tools employed in their extraction changed, not only through time but also from region to region. At the same time, the continuous or intermittent use of a specific source had different reasons related to different factors such as the existence of human occupation itself in the region, and to the knowledge and visibility of, and access to, the source. The combination of these archaeological factors can be combined with paleoenvironmental and paleoscape data and converted into inferences on territoriality, behavior ecology, settlement patterns, technology, cognition and social complexity of past human populations.

In this open session we would like to invite researchers to present their results on recent or current research projects focusing on prehistoric quarries and mines, regardless of the raw material studied. Among other questions we would like to focus issues such as: from which sources, and for what purpose, were people exploiting specific raw materials? What were the time spans of their exploitation? What was the range of distribution of those raw materials? What is the relationship between the exploitation of certain sources and global and local environmental shifts, the cognitive abilities, or the social complexity of the human populations?

- 17h05: A Middle Paleolithic workshop at Giv'at Rabi East, Lower Galilee, Israel: preliminary results of salvage excavations

Alla Yaroshevich, Maayan Shemer, Joel Roskin and Naomi Porat

allayaroshe@gmail.com

Numerous flint quarries and workshop sites recently discovered in the Galilee, Israel, comprise an excellent opportunity to investigate issues related to Paleolithic flint economy, the scale of resource exploitation, social organization and site formation processes. The sites comprise complexes of hundreds of large piles containing quarry wastes and knapped flints still visible on the sloping hilly landscape, as well as accumulations rich in flint artefacts covered by dark clay sediments in colluvial deposits or in valleys. The immense scale of the phenomenon and the sheer amounts of flint items allowed only limited test excavations of selected complexes and distinct sites. The prominent use of Levallois technique and the presence of bifacial tools affiliate the sites to the Middle and the late Lower Paleolithic. So far, however, no absolute dates have been obtained to clarify their chronological and cultural association.

Recent development of the industrial area of the city of Nazareth necessitated salvage excavations at the Middle Paleolithic workshop of Giv'at Rabi East. The excavations took place in the winter of 2013-2014 and exposed an extensive area of dense flint accumulations as well as several round cupmarks cut in the soft limestone bedrock at the base of the archaeological deposits. These comprise a unique feature which might reflect attempts to extract flint nodules from the bedrock and indicating actual in situ accumulation of the flint artefacts. The assemblage contains knapping waste including hundreds of items made through the Levallois technique alongside scores of bifacial tools such as handaxes. The sequence of preliminary OSL ages obtained so far from one of the sections indicates that the accumulations of the flint artefacts are associated with the second and the third phase of the Levantine Mousterian thus corroborating the likelihood of a connection between this workshop and the Qafzeh Cave located ca 5 km to its south. However, the beginning of the site use associated with the cupmarks could have started at the early phase of the period. The detailed investigation of the techno-typological and physical characteristics of the assemblages derived from different spatial and chronological units alongside geomorphological analysis, and the absolute ages allow better understanding of the underlying behavior related to procurement and primary reduction of raw materials, site formation processes and its connection with Middle Paleolithic occupations known elsewhere in the area.

- 17h25: Raw material diversity, distribution and acquisition in the River Lis Basin, Central Portugal

Telmo Pereira[1], Eduardo Paixão[1-2], Anne Farias[2], Catarina Andrade[2], Vânia Carvalho[3], Susana Carvalho[1, 4]

[1-] ICArEHB - Campus Gambelas, Universidade do Algarve, 8005-139 Faro PORTUGAL
[2-] NAP - Campus Gambelas, Universidade do Algarve, 8005-139 Faro PORTUGAL
[3-] Divisão de Ação Cultural, Museus e Turismo Museu de Leiria - Convento de Santo Agostinho, Leiria, Portugal
[4-] School of Anthropology, Institute of Cognitive and Evolutionary Anthropology, University of Oxford, Fellow, UK

The project EcoPLis - Human Occupations in the Pleistocene Ecotones of the River Lis started in central Portugal in 2015. This project aims to understand the ecology of the behavior of humans during the Pleistocene in a region where sub-rectilinear rivers link the coast to the inland mountains, through open riverine and canyon environments. This project is deeply related with Leiria's mapping project – CARQLEI – managed by the City Council of Leiria, that has been mapping archaeological sites and off-sites since 2004, including some found by Cultural Resource Management projects.

One of the most important aims of the EcoPLis is the systematic mapping and measuring of raw material sources. The Lis basin has a large diversity of rocks suitable for knapping and multiple sources of these materials can be found both in primary and secondary sources. However, some rocks were preferred and selectively used in the production of stone-tools, namely chert, quartzite and quartz. The last two are aloctonous, show great diversity and are highly abundant in river and marine gravels. On the other hand, chert is autochthonous, thus it can be obtained from secondary, sub-primary, and extracted from primary outcrops that are considerably limited in space, such as those of Ribeira das Chitas valley.

This systematic mapping allows us to reliably link, each lithic artifact recovered during surveys with the known sources in the basin. More over, because the EcoPLis also aims to create a Portuguese Lithoteque for knappable raw materials (LusoLit) we are also able, in some cases, to link some artifacts with sources located outside of the basin.

- 17h45: "Quarrying as social and political strategy during the Mesolithic-Neolithic transition, in southern Norway"

Astrid J. Nyland

Department of Archaeology, Conservation and History, University of Oslo

a.j.nyland@iakh.uio.no

Keywords: Neolithic quarrying, Social practices, Regionality

To quarry, to exploit certain extraction sites, and the acquisition of specific raw materials, was strategically undertaken to mark cultural affinity and social relations during the Stone Age in southern Norway. In my PhD-work, I have analysed 21 extraction sites of different types of rock and demonstrated chronological and spatial variations in lithic procurement which cannot be explained by natural preconditions, availability, or the quality of the quarried rock alone. Indeed, when quarrying and extraction sites have been interpreted in a wider material and social context, it has become apparent that sometimes it was not the type of rock procured, but the character of procurement that mattered, including the importance of place of origin, and the group the rock could be associated with. Based on a *chaîné opératoire* analysis of the task of direct procurement of rock, I argue that the practices of quarrying and lithic procurement can reflect social-political strategies. Key features are knowledge of the scale of extraction, the degree of distribution and the time-depth of activity.

As a case study, I will discuss the lithic procurement during the Early Neolithic in Southern Norway. In this phase, there was an increase in interactions between groups of local hunter-gatherers and immigrating farmers from southern Scandinavia. Based on the archaeological record, the character of this interaction and incipient process of neolithisation is different in the western and eastern part of southern Norway. This is also reflected in lithic procurement. That is, along the western coast, there is an increase in the regional expressions of cultural affinity. The transition to the Early Neolithic is demarcated by a sudden and massif exploitation of a particular source of rhyolite for making flake and blade tools. The rhyolite was quarried from the top of a mountain on the west coast and distributed to a wide geographical area, even into areas where similarly high quality rock was available. Moreover, Hespriholmen, a large adze quarry for greenstone which had been in use from the Middle Mesolithic was continually employed. Whereas in eastern Norway, there was a shift in raw material preferences too, but there local rock for adzes was collected from moraines, not quarried. Furthermore, even if there is no flint in Norwegian bedrock, flint appears to be the preferred rock type, imported as complete ground adzes and nodules from southern Scandinavia.

- 18h05: An Analysis of the use of Quarries and Workshops by Late Prehistoric People in Western Pennsylvania

Chiarulli Beverly

Indiana University of Pennsylvania (retired)

bev@chiarulli.net

Keyword: Quarries; Workshops; Stone tools; Late Prehistoric; Pennsylvania

During the Late Prehistoric period in the central Allegheny Valley of Western Pennsylvania, at least four major lithic raw material types were used for the manufacture of a limited variety of tool types. The major tool forms were small triangular projectile points and flake tools. The major raw material types used in this region include Onondaga, Loyalhanna, and Shriver cherts and Vanport Siliceous Shale. Workshops and quarries have been identified have been identified for these materials and are found on the north, south, east and west sides of this region. An analysis of the lithic assemblages from several villages investigated by our field schools and other projects has found that these raw materials were used throughout the area. Additional investigation of the raw materials used in the villages suggests that although the frequency of raw materials used in any particular village generally reflects the distance to sources, there are some materials that are present in greater than expected quantities. For example, the source of the most used raw material at one site (the Johnston sit)e is not Loyalhanna which is the closest source less than 10 miles from the site, but is Onondaga chert brought from quarry and workshops at least 25 miles from the site. Analysis of the assemblages suggests that the use of raw materials may reflect both proximity to sources and some perceived qualitative differences in the materials.

While there is no expectation that native groups in western Pennsylvania were transporting the quarry products in great quantities, it is possible that some raw materials could have been moved either overland or through canoe transport on the regional rivers. Chert from a more distant type like the Onondaga could very easily been brought to some of the sites by canoe while the Loyalhanna chert would have been transported overland or by hand to hand trade from village to village. In the past, I have argued that Onondaga chert was common at the site, because it was preferred. However, it may instead be common because its transport by water was easier than the transportation methods for other chert types. This analysis looks at the role these different factor might have played in the choice of raw materials used by these pre-European knappers.

18h25: Exploitation of raw materials in prehistoric Europe. General remarks

Jacek Lech

Institute of Archaeology and Ethnology, Warsaw Polish Academy of Sciences, Poland

lech@iaepan.edu.pl

Among the numerous fields of research into the distant past is the archaeology of prehistoric flint mining, which focuses on the systematic exploitation, working and distribution of flint and others siliceous rocks such as chert, hornstone, radiolarite, and obsidian.

Siliceous rocks played an important role in the culture of the Stone Age and the Early Bronze Age communities in many regions of Europe, and the mining of siliceous rocks in the Old World began as early as the Middle Palaeolithic and only ended at the close of the Bronze Age, about 1000 BC. Research into flint mines offers an important glimpse into the practical knowledge and skills of human communities in those ancient times, showing the organization and scale of the activities undertaken. Flint mining took various forms, ranging from the systematic gathering of nodules from seashore beaches and river gravels to the exploitation of weathering clays, to sinking of shafts through Cretaceous and Calcareous rocks to reach underground seams of flint or chert nodules.

For a long time now, there has been a considerable discrepancy between what is known about shafts and galleries, mining techniques and tools, and what is known about flint working, and chaîne opératoire at prehistoric flint mines, what is known of chipping floors and the flint waste from mining fields. Chipping floors should be among the most important mine features studied, yet are one of the least well known. At the best preserved mining sites they are found under a shallow covering of soil. Investigation of such workshops yields a host of information about the flint blanks and preforms produced, the organization, techniques and scale of the operations, and the behaviour of prehistoric communities in connection with the supplying of raw materials.

In prehistoric Europe the significance of different raw materials varied. Only a small number of siliceous rocks were of interregional importance. The fact that only a few kinds of siliceous rock were of particular importance makes it possible to study mutual contacts between prehistoric villages and different communities.

Enigma of the Borownia prehistoric flint mine site (Central Poland)

Jacek Lech[1], Dagmara H. Werra[2]

[1]-Cardinal Stefan Wyszyński University in Warsaw, Institute of Archaeology, Warsaw, Wójcickiego Street, bud. 23, 01-938 Warszawa, Poland
[2]- Institute of Archaeology and Ethnology Polish Academy of Sciences, Warsaw, 105, Solidarności Avenue, 00-140 Warszawa, Poland

werra@iaepan.edu.pl

Keyword: flint mining, striped flint, Poland, Borownia, Neolithic

One of the best known types of siliceous rock exploited in central Europe in prehistoric times was striped flint from the Krzemionki Opatowskie mine lying on the north east fringe of the Holy Cross Mountains. In the Eneolithic Age striped flint was a valued raw material for producing highly rated axe blades, distributed up to six hundred kilometres from deposits and found, among other places, in megalithic graves.

The Krzemionki Opatowskie mine was the largest mine of striped flint, but not the only one. In the vicinity, several much smaller mines with deposits of the same raw material have been discovered. The most interesting is Borownia in Ostrowiec Świetokrzyski district, discovered in 1921. This mining field, considerably smaller than Krzemionki, lies at the eastern edge of the Kamienna River valley and covers an area of about 240-270 ares. The prehistoric relief of the land has been well preserved. The shafts stretch from the edge of the valley in a south easterly direction for about 700 m, forming a narrow belt 30-50 m wide. The site has still to be excavated underground, but material collected from the surface indicated that the mine was exploited by communities of the Early Bronze Age (J. Budziszewski 1980). Recently collected material suggests that flint mining at Borownia may have begun earlier, in the Middle Neolithic or at the beginning of the Late Neolithic Age, so at the same time as in Krzemionki.

The area where the remains of the prehistoric mining landscape have been preserved is protected, but many flint artefacts can also be found on the neighbouring farmlands. To the north of the mining field, in the western part, there are remains of what was probably a settlement/camp connected with the mine.

In recent years in Poland striped flint has become a much desired gemstone used by jewelers. As a result, the Borownia mine and the nearby prehistoric mine at Korycizna are being devastated by looters digging for material. Numerous chipping floors and shaft depressions have been irretrievably destroyed.

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The prehistoric exploitation of ferruginous mineralizations at grotta della monaca (Calabria, Italy): preliminary geoarchaeological data

Luca Antonio Dimuccio [1,3], Felice Larocca [2,3], Nelson Rodrigues [4], João Pratas [4,5]

[1-] CEGOT - Centre of Studies on Geography and Spatial Planning, University of Coimbra, Portugal
[2] -UNIBA - Gruppo di ricerca speleo-archeologica, Università degli Studi di Bari Aldo Moro, Italy
[3] -CRSEM - Centro Regionale di Speleologia "Enzo dei Medici", Roseto Capo Spulico, Italy
[4] -DCT - Department of Earth Sciences, Faculty of Sciences and Technology, University of Coimbra, Portugal
[5-] MARE - Marine and Environmental Sciences Centre, University of Coimbra, Portugal

luca@ci.uc.pt

Keywords: Grotta della Monaca, Prehistoric iron mine-cave, Massive ferruginous mineralizations, Geochemical characterization, handheld-XRF.

The presence and use of iron minerals in certain archaeological contexts, including karstic caves, with wide range of exploitation chronologies, is well known in literature. Geochemical characterization of these minerals has become increasingly common practice for geoarchaeological interpretations, particularly to support the identification of ancient mining strategies and the construction of the resource use-trade-exchange models.

Located in the municipality district of Sant'Agata di Esaro (Calabria, Italy), Grotta della Monaca represents one of the most striking and known examples of ancient iron mine-cave from southern Apennines. Frequented for mining purposes, although sporadically, since Upper Palaeolithic, the cave becomes the seat of an intense exploitation of ferruginous mineralizations at the end of Neolithic, between late V and early IV millennium BC.

In addition to the common minerals of underground karst environment, significant outcrops of geochemically heterogeneous massive dyke/stratiform ferruginous mineralizations were observed inside Grotta della Monaca, along inclined bedding planes, where the most abundant phases are goethite [α-FeO(OH)], its polymorph lepidocrocite [γ-FeO(OH)] and limonite [FeO(OH)·nH2O]. It seems plausible to assume that these massive ferruginous mineralizations are the result of the oxidation (in oxygen-rich environment) of scattered primary iron sulfide (e.g. pyrite) contained in the carbonate substrate in which the cave develops. Near some fireplaces of historical age, goethite-hematite [α-Fe2O3] thermal transformation also occurred.

Selected samples of ferruginous mineralizations were collected in the main archaeological sectors of Grotta della Monaca and they were studied by handheld X-Ray Fluorescence (XRF), to have a quick selection of all the materials based on major elements trends, and by Atomic Absorption Spectrophotometric analyses for trace-elements. In addition, structural and mineralogical inspections were made using binocular/petrographic microscopes and X-Ray Diffraction (XRD). Multivariate and discriminant statistical treatment of elemental concentration data were used to differentiate geochemical groups within sample sets.

As expected, the identified geochemical groups permit to construct an identity-card of the ferruginous mineralizations of Grotta della Monaca, which can be compared with similar raw materials discovered in other neighbor archaeological contexts, with obvious implications in understanding the local exploitation strategies through time, as well as the exchange and kinship networks of these materials.

The importance of the Gabbro formation for the Late Neolithic communities in the Middle Morava Valley

Vesna Vuckovic

Hometown Museum ‘‘Paracin’’, Paracin, Serbia,
PhD candidate, Universitat Autònoma de Barcelona, Barcelona, Spain

Keywords: archeopetrological investigation, gabbro, the Late Neolithic, The Middle Morava Valley, Central Balkans.

During the older Palaeozoic, the gabbro formation occurred, which now represents the hinterland of plain area, on Middle Morava Valley. During the Late Neolithic around this elevation, two settlements were founded, where, the right bank of the Velika Morava River, in the southern part of the by the archaeological excavations, macro-lithic tools made of this plutonic rock were found.

Based on this work, we have tried to explain the impact of geomorphological processes on morphological and petrological characteristics of the gabbro rock on this location, which, during the Late Neolithic, determined its use value as a raw material and the raw material transformed in an object. Geomorphological and petrological characteristics influence the simplicity and efficiency in gabbro processing, and its mechanical properties classify it into different technological processes, by which it gains a social significance on the level of the Late Neolithic communities in this part of the Middle Morava Valley.

As for data on mechanical properties, which had been previously tested by an experiment, we supplemented them with the topographical, geological and geomorphological data collected during the surveys conducted in 2015.

Neolithic flint quarries of Montvell (Catalan Pre-Pyrenees, Spain)

Xavier Terradas [1], David Ortega [2], Dioscórides Marín [3], Alba Masclans [4], Carles Roqué [5]

[1]- CSIC – IMF, Department of Archaeology and Anthropology. Egipcíaques, 15. 08001 Barcelona (Spain)
[2]- CSIC – IMF, Department of Archaeology and Anthropology. Egipcíaques, 15. 08001 Barcelona (Spain)
[3]- Universitat de Lleida, Department of History. Pl. Victor Siurana, 1. 25003 Lleida (Spain)
[4]- University of Girona. Department of History and History of Art. Pl. Ferrater Mora, 1. 17071 Girona (Spain)
[5]- University of Girona. Department of Environmental Sciences. Campus de Montilivi s/n, 17071 Girona (Spain)

terradas@imf.csic.es

Prehistoric societies have mined and quarried flint for many thousands of years across Europe. Nevertheless, this kind of activity has remained unrecognized in the Iberian Peninsula until the discovery these last fifteen years of the Casa Montero (Vicálvaro, Madrid) and Sierra de Araico (Treviño, Alava) Neolithic mining complexes. The flint quarries of Montvell (Castelló de Farfanya, Lleida), recently excavated, configure the first example of a flint extraction specialized site in the North East of the Iberian Peninsula. Therefore, it grants a unique opportunity to make an accurate approximation to this phenomenon.

Nodular brown flint has been attested inside the lacustrine Oligocene limestones in the area of Montvell. This particular raw material can be considered as one of the best fitted for knapping activities in the North East of the Iberian Peninsula. Evidences of extraction activities were located stepped along the hill slopes and were carried out removing the layers containing the bigger flint nodules. The flint exploitation was easy thanks to the fact that the pursued layers outcrop vertically and are quite accessible. This situation allowed the opening of successive extraction fronts without being necessary to withdraw huge quantities of residues.

In 2004 the late Neolithic-Chalcolithic site of les Auvelles was excavated. Given that it is located near the Montvell quarries, it was then suggested that it could be related to the local flint management. It was also proposed that the processing techniques may have included heat treatment of flint nodules, although for the time being it has not been proved. The on-going investigation will lead us to establish not only the chronological duration and the scope of the extraction activities, but also the possible contemporaneity between the two sites.

Domoszló: Grinding stone and millstone production center in Hungary

Bálint Péterdi [1]; Katalin T. Biró[2]; Zoltán Tóth[3]

[1-] Geological and Geophysical Institute of Hungary, Stefánia út 14, 1143 Budapest
[2-] Hungarian National Museum, Múzeum körút 14-16, 1088 Budapest, Hungary
[3-] University of Miskolc, Sámuel Mikoviny Doctoral School of Earth Sciences

peterdi.balint@gmail.com

Keywords: grinding stone, millstone, andesite, quarry, workshop

Typological and petroarchaeological characterisation of chipped stone artefacts and polished stone tools have considerable tradition and consequently, important results in prehistoric archaeology. Other artefacts made of lithic materials, however, are often neglected and only recently studied systematically. The most characteristic type group among these 'other stone utensils' are tools for grinding and milling different substances, mainly cereal grains but also various pigments. The production and transport of these objects is rarely documented and inadequately studied.

This communication is presenting a multi-period exploitation site for both millstones and grinding stones. Located in the Mátra Mountains, in the village of Domoszló, andesite bombs were locally processed for this purpose. Traces of millstone and grinding stone production were systematically studied by non-invasive documentation techniques. Current work on petrographical characterisation and distribution studies on archaeological sites will be presented. The most important and still open questions concern dating and transport of the products of the Domoszló workshop.

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Hominin occupation at the Dmanisi site, Georgia, southern Caucausus: Raw materials and technical behaviours

Ana Mgeladze

Free University of Tbilisi, Kakha Bendukidze University Campus 240, David Agmashenebeli alley, 0159, Tbilisi, Georgia

anukamge@yahoo.fr

Keywords: Georgia, Dmanisi, Early Pleistocene, Raw materials, Technical behaviours

Dmanisi is the oldest site outside of Africa that records unquestioned hominin occupations as well as the dispersal of hominins in Europe and Asia. The site has yielded large numbers of artefacts from several periods of hominin occupation. The lithic assemblage gives insights into the hominin behavior at 1.7-1.8 Ma in Eurasia. Dmanisi hominins exploited locale rocks derived from either nearby riverbeds our outcrops, and petrographic study provides data on patterns of stone procurement. Recent geological surveys and technological studies of the artefacts illustrate the roles of hominins in composing the assemblage. Dmanisi hominins selected two types of blanks, including cobbles and angular blocks, of basalt, andesite, and tuffs. Many complete cobbles, pebbles, and rolled blocks in basalt were unmodified. Cores, flakes and debris show that all stages of flaking activity took place at the site. Knapping was influenced by the blank shape and natural angles. The Dmanisi lithic assemblage is comparable to Oldowan sites in Africa in terms of reductions sequence, organization of the removals, platform types, and the lack of retouched flakes.

próximo

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