



7th Developing International Geoarchaeology (DIG) Conference

4th – 7th September 2017
Newcastle University, UK
School of History, Classics and Archaeology





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CONFERENCE PROGRAMME

3rd September	
16.00 – 18.00	DRINKS RECEPTION – MINING INSTITUTE
4th September	
7.45 – 8.30	REGISTRATION
8.30 - 14.30	<i>Geoarchaeology and Landscape</i>
14.30– 18.20	<i>Site formation – Early Prehistory to the Bronze Age</i>
19.30	DINNER - BLACKFRIARS
5th September	
8.00 – 14.40	<i>Site formation – The Iron Age to Medieval</i>
14.40 – 18.20	<i>Geoarchaeology and Material Culture</i>
6th September	
8.00 – 10.45	<i>Heritage and the Historic Environment</i>
10.45 – 11.00	PRIZE GIVING
11.00 – 17.30	WORKSHOPS
7th September	
9.00 – 15.00	FIELDTRIP



DIG2017 - SOCIAL EVENTS

3RD September – Drinks Reception

Our drinks reception will be held at the **The Mining Institute: North of England Institute of Mining and Mechanical Engineers**. The Mining Institute is located in Neville Hall, a Victorian building built in a high Gothic style. The reception is located in the Library, which features stonework, wood and paintings with a glass roof and the original custom designed furniture from 1872.

The Mining Institute contains centuries of history relating to the Great North Coalfield, with the Library containing the largest coal mining collection in the world. It is an important resource for the history and archaeology of the Industrial Revolution. We welcome DIG2017 attendees to this stunning location for an informal social evening prior to the beginning of the conference on the 4th September.

The Mining Institute is located adjacent to Newcastle Central Train Station, about a 15 minute walk from the university. The drinks reception runs from 17:00 – 19:00. Wine and mineral water are provided free of charge, other drinks are available for purchase at the cash bar.

For further information on the venue: <https://mininginstitute.org.uk/>

The North of England Institute of Mining and Mechanical Engineers
Neville Hall
Westgate Road
Newcastle upon Tyne
NE1 1SE



4th September – Conference Dinner

The conference dinner will be held at **Blackfriars Restaurant**. Blackfriars is an award winning restaurant located in Blackfriars, dating to 1239. The building was established by the Dominican Friars, with the land being donated by three anonymous sisters and the first Mayor of Newcastle Sir Peter Scot. Further land and money donations helped establish the site, including grants from King Henry III. The Priory had an extensive library with many of the books being written and illuminated by the Friars. The friars wore white tunics and black cloaks, which is where the name came from. This is also said to be the reason for the colours of the Newcastle United football team today!

When King Henry VIII came to the throne in 1509 the Dominicans eventually had to leave as part of the Reformation that started in 1536. The church was stripped and fell into disrepair, and the original church building was largely demolished. The Priory building was preserved after being granted in 1552 to the trade Guilds, the “most ancient trade and mysteries of the town”, who used it as their headquarters. The Guilds adapted the architecture in the late 16th and early 17th centuries. Throughout the 19th and into the 20th century the buildings fell into increasing disrepair, and was acquired by the Newcastle Corporation in the 1950s, and was eventually restored between 1973 -1981.

Blackfriars is located close to Newcastle Central Train Station, about a 10 minute walk from the university. The dinner starts at 19:30, and includes a free glass of wine on arrival.

Due to the size of the group, the restaurant requires that menu choices are made in advance. The menu options will be emailed to delegates who have registered for the dinner and we ask that you return your choices as soon as possible.

For further information: <http://www.blackfriarsrestaurant.co.uk/>

Blackfriars Restaurant and Banquet Hall
Friars Street
Newcastle Upon Tyne
NE1 4XN



7th September – Fieldtrip

The DIG2017 fieldtrip is to **Roman Vindolanda**. Vindolanda has an ongoing archaeological excavation as well as a museum, which includes the famous Vindolanda Writing Tablets. The tablets are thin slices of wood with ink writing, and were excavated from waterlogged deposits. They are the oldest surviving handwritten documents in Britain. The archaeological site has a wealth of physical remains including bath houses, barrack buildings and temples.

The coach will depart from the university promptly at 8:30. The journey time to the site is approximately 40 minutes. Delegates attending the fieldtrip are advised to arrive 15 minutes early; we will be unable to wait for delegates who do not arrive on time. We aim to arrive at the site around 9:15, where there will be time for independent exploration of the site before an introductory talk from the museum staff at 11:00. Directions to the location of the talk will be provided by the staff.

For more information: <http://www.vindolanda.com/experience/day-planner/visiting-roman-vindolanda>

Following the Vindolanda talk, delegates have the option of **either** staying at Vindolanda for further independent exploration of the site, **or** taking the coach to visit the iconic Sycamore Gap and additional sections of Hadrian's Wall. This is about a 5 minute coach ride from Vindolanda and we will park at Steel Rigg car park. Sycamore Gap is a 20 minute walk from the car park. Please note that the terrain may be challenging and you are advised to join this part of the trip only if you are comfortable walking on uneven, steep terrain.

The coach will return from Sycamore Gap to Vindolanda at approximately 13.30 to pick up delegates who remain at the site. Please keep to the timetable as we are unable to wait for people who are late. In the event people wish to spend longer at the site and make their own way back, please inform Lisa Shillito +447872349504

FIELDTRIP ITINERARY

8.15 Meet outside the main entrance to the Armstrong Building

8.30 Coach departs

9.15 Coach arrives at Vindolanda; independent exploration of site

11:00 Museum talk

11.30 **EITHER** stay at Vindolanda for further exploration and lunch **OR** coach to visit Sycamore Gap

11:40 Coach arrives at Steel Rigg car park; approximately 20 minute walk to Sycamore Gap

12:00 Walking group arrives at Sycamore Gap. Approximately 1 hour to explore area and have lunch

13:00 20 minute walk back to Steel Rigg car park, rejoin coach

13:30 Coach returns to Vindolanda

14:00 All delegates to join coach for return to Newcastle University

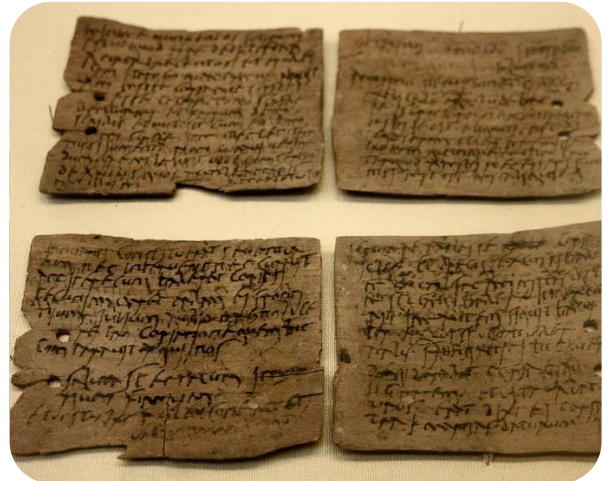
14:15 Last boarding time for return coach journey

15:00 Approximate return time to Newcastle

Fieldtrip – what to bring

Delegates who are not visiting Sycamore Gap have the option of purchasing refreshments in the Vindolanda cafe which offers a selection of hot and cold food and drinks, or can bring a packed lunch. Picnic tables are available in the museum gardens and the replica croft.

Delegates walking to Sycamore Gap **MUST** bring a packed lunch, and are advised to bring footwear appropriate for walking on uneven terrain. Waterproof clothing is advised as the weather can be unpredictable.



DIG2017 Keynote Speakers

Following the theme of the conference, Geoarchaeology from Landscape to Material Culture, and our aim to bring together geoarchaeologists from both geoscience and archaeological backgrounds, our guest speakers for DIG2017 have expertise that encompasses geoarchaeology in all its forms, bringing both archaeological and geoscience perspectives.

Dr Lisa Maher is Assistant Professor of Archaeology in the Department of Anthropology, University of California Berkeley. She directs the Geoarchaeology and Southwest Asia Prehistory Laboratory, which houses archaeological material from the Eastern Mediterranean as well as contemporary experimental lithic collections, and an archive/reference collection of sediment micromorphology slides from a variety of sites worldwide. Her research focuses on hunter-gatherer societies in the eastern Mediterranean, with the aim of reconstructing human-environment interactions during the Late Pleistocene. Her paper, "Geoarchaeology Today: Perspectives, Debates, Future Directions", discusses a range of issues in contemporary geoarchaeological research, and particularly the issue of how we integrate with other types of archaeological evidence.

Professor Jamie Woodward is Professor of Physical Geography at the University of Manchester. He was part of a team that set up the Quaternary Environments and Geoarchaeology Research Group at Manchester in 2004, and much of his research is in collaboration with archaeologists. He is currently working on two projects in the Nile Valley of Northern Sudan, with archaeologists from the British Museum, investigating the relationship between human activity and environmental change over the last 10,000 years. He is also interested in the theoretical and practical interface between geography, geoscience and archaeology, and is co-editor of *Geoarchaeology* journal. He is also the author of *The Ice Age: a Very Short Introduction*. His paper "From Green Sahara to Desert River: 6000 Years of Environmental Change in the Sudanese Nile Valley" discusses current interdisciplinary geoarchaeological research in the Nile Basin.

DIG2017 committee

DIG2017 has been organised by a team of staff and students from Newcastle University headed by Dr Lisa-Marie Shillito, with Professor Lucy Wilson representing the Developing International Geoarchaeology committee. Dr John Blong is a Research Associate in Geoarchaeology, based in History, Classics and Archaeology, working on the NERC funded Paisley Caves project. Dr Helen Mackay is a Research Associate in Geography, Politics and Sociology working on the AHRC funded Celtic Crannogs project. Ms Alicia Sawyer is a PhD student in Geoarchaeology in History, Classics and Archaeology, working on micromorphology and geochemistry of Viking age Icelandic middens.

DIG2017 Prizes

Thanks to sponsorship from the McCord Centre for Landscape at Newcastle University, we are delighted to be able to offer prizes for the best student/ECR paper and poster presented at DIG2017. These will be judged by the keynote speakers and DIG committee. The best paper will be awarded a Munsell soil colour chart, and the best poster will be awarded a WHS trowel and copy of Charles French "Handbook of geoarchaeological approaches for investigating landscapes and settlement sites".

Conference Accommodation

Delegates who have booked travel through Newcastle University will be staying at Castle Leazes. Reception at Castle Leazes is open between 1.30 – 6pm and delegates are requested to arrive during

reception opening hours where possible. Out of hours arrivals will need to contact security who will be on site. The address for accommodation is:

Castle Leazes
Spital Tongues
Newcastle upon Tyne
NE2 4NY

Telephone: +44 (0) 191 208 8300

Email: castle.leazes@ncl.ac.uk

Out of hours:

Estates Security Service

Telephone: +44 (0) 191 208 6817



DIG2017 SCHEDULE

Newcastle University UK, Percy Building, Lecture Theatre G5

Monday 4th September

GEOARCHAEOLOGY AND LANDSCAPE

Chair: Helen Mackay

7.45 – 8.30 *Registration and coffee (Foyer)*

8.30 – 9.00	Jamie Woodward	KEYNOTE From Green Sahara to Desert River: 6000 Years of Environmental Change in the Sudanese Nile Valley
9.00 – 9.25	Robyn Inglis	Geoarchaeological Approaches to the Palaeolithic Surface Record: Unravelling Early and Middle Stone Age Activity at Wadi Dabsa, SW Saudi Arabia
9.25 – 9.50	John Blong	Regional Stratigraphy, Tephrochronology, and Human Occupation of the Upper Susitna Basin, Central Alaska
9.50 – 10.15	Alvise Barbieri	How the Late Pleniglacial landscape changes diversified the Gravettian record of Ach and Lone valleys
10.15 – 10.40	Jeroen Verhegge	Allerød landscapes in the lowlands of NW Belgium: palaeoenvironmental reconstruction and geoarchaeological mapping approaches

10.40 – 11.10 *Coffee 30 mins (Foyer)*

11.10 – 11.35	Katja Kothieringer and Astrid Röpke	Tracking prehistoric pastoralism in subalpine and alpine soils - preliminary results of the Montafon and the Silvretta Alps (Austria/Switzerland)
11.35 – 12.00	Wendy Matthews	Developing high-resolution theoretically-informed Geoarchaeology: Interdisciplinary approaches to changing human-fire relations in early agricultural environments and communities
12.00 – 12.25	Zachary Dunseth	Subsistence Practices in the Arid Negev Highlands during the Intermediate Bronze Age (c. 2500-1950 BCE): A Geoarchaeological Perspective
12.25 – 12.50	Nina Helt Nielsen	Manuring practices in the Danish Late Bronze and Early Iron Age: Geoarchaeological investigations of three Celtic field systems from Eastern Jutland, Denmark

12.50 – 13.50 *Lunch and posters 50 min*

13.50 – 14.10	Rachel Kulick	Approaching Landscape Transformations through Urban Micromorphology at Bronze Age Palaikastro, Crete
14.10 – 14.30	Carol Lang	Breathing new life into archaeological soils

SITE FORMATION – EARLY PREHISTORY TO THE BRONZE AGE

Chair: Lisa-Marie Shillito

14.30 – 14.50	Mareike Stahlschmidt	A Microcontextual Investigation of Combustion Features to Reconstruct Site Maintenance and Occupational Phases at the Upper Paleolithic Site of Satsurblia Cave, Georgia
14.50 – 15.10	Magnus Mathisen Haaland	Evaluating the nature and behavioral implications of laterally extensive occupation deposits in the Middle Stone Age levels of Blombos Cave, South Africa
15.10 – 15.30	Christopher Miller	Geoarchaeological investigations of Aghitu-3, and Upper Paleolithic cave site in the Armenian Highlands

15.45 – 16.15 *Coffee 30 min*

16.15 – 16.40	Diego Angelucci	Ciota Ciara cave and the Monte Fenera Palaeolithic (Italy): new data, new views
16.40 – 17.05	Tom Gardner	Towards high-resolution sediment chronologies: regular natural sediment incursions in burnt mound deposits as a proxy for time
17.05 – 17.30	Conor McAdams	Artefact preservation in saturated, tropical cave sediments: constraining site formation processes in the humid tropics through experimental reconstruction of sedimentary palaeoenvironments
17.30 – 17.55	Susanna Cereda	A Palace under the microscope - insights into a IV th mill. BCE representative building through a deposit-oriented approach
17.55 – 18.20	Carolina Mallol	Micro-contextual Investigations of Organic Matter in the Archaeological Sedimentary Record

19.30 *Dinner Blackfriars*

Tuesday 5th September

SITE FORMATION – THE IRON AGE TO MEDIEVAL

Chair: Alicia Sawyer

8.00 – 8.30	Lisa Maher	Geoarchaeology Today: Perspectives, Debates, Future Directions
8.30 – 8.55	Matthew Dalton	Activity areas and geoarchaeological triage in the ancient Egyptian houses of Amara West, Sudan
8.55 – 9.20	David Brönnimann	Garbage in – wisdom out! Geoarchaeological investigation of sedimentation processes and waste disposal practices at the Latène settlement Basel-Gasfabrik
9.20 – 9.45	Luc Vrydaghs	Phytolith analysis on thin sections of urban dark earth in Brussels. A state of the art
9.45– 10.10	Barbora Wouters	An integrated micromorphological and phytolith study of urban dark earths from Atuatuca Tungrorum (Tongeren, Belgium)
10.10 – 10.35	Amanda Dolan	Burn hillfort, burn – Dun Deardail inferno
10.35 – 11.10	Coffee 30 mins	

11.10 – 11.35	Lenka Lisá	The prospects for geoarchaeological interpretations of Medieval dwelling floors; case studies from Czech Republic
11.35 – 12.00	Yannick Devos	Town development in Mons (Belgium): the contribution of the geoarchaeological study of Dark Earth
12.00 – 12.25	Marie Grousset	Medieval sunken buildings in the North of France: from samples to micro-features
12.25 – 12.50	Manuel Fernandez-Gotz	Geophysical surveys and digital elevation modelling at the Roman military complex of Ardoch, Scotland

12.50 – 13.50 *Lunch and posters 60 min*

13.50 – 14.15	Karen Milek	An Integrated Ethno-Geoarchaeological Study of Small-Scale Nomadic Herding Sites in Woodland Environments
14.15 – 14.40	Hans Huismann	Erosion of Archaeological Sites: Quantifying the threat using OSL and fall out isotopes

GEOARCHAEOLOGY AND MATERIAL CULTURE

Chair: Lucy Wilson

14.40 – 15.05	Géraldine Fiers	Characterization and patina formation of flint used on prehistoric sites in NW Belgium
15.05 – 15.30	Donald Butler	Mineral Phases in Burned Salmonid Bone and their Relevance to Studies of Northern Hunter–Gatherers
15.30 – 16.15	<i>Coffee and posters 45 min</i>	
16.15 – 16.40	Giovanni Pesce	A multidisciplinary approach and a double level of validation for the radiocarbon dating of lime mortars
16.40 – 17.05	Ana Abrunhosa	Characterization of silica Mousterian tools from Navalmaíllo Neanderthal Rockshelter (Madrid Spain) using Petrography, SEM-EDX and portable XRF
17.05 – 17.30	Marta Lorenzon	Where are the mudbricks? A geoarchaeological analysis of Minoan earthen architecture
17.30 – 17.55	Lucy Wilson	Patterns of flint raw material procurement and use in the late Neolithic through Early Bronze Age at Ein Zippori, Israel
17.55 – 18.20	Aviad Agam	Blind test evaluation of consistency in macroscopic lithic raw material sorting
19.00	<i>Pub</i>	

Wednesday 6th September

GEOARCHAEOLOGY: HERITAGE, ENVIRONMENT AND SUSTAINABILITY

Chair: John Blong

8.00 – 8.25	Krista Gilliland	Rescuing the Ranch: Geoarchaeology and Historic Resources Impact Mitigation at the FM Ranch Campsite (EfPk-1) in Southern Alberta, Canada
8.25 – 8.50	Rowena Banerjea	All along the watchtowers! Balancing heritage protection and development of castle sites with scientific research potential of buried archaeology
8.50 – 9.15	Alex Brown	Late-glacial/early Holocene palaeoenvironments and evidence for the 8.2ka event in the southern North Sea Basin: new data from the Dudgeon Offshore Wind Farm
9.15 – 9.40	Virgil Yendell	The Battersea Channel Project: Geoarchaeological deposit modelling as a unifying and dynamic resource for historic environment mitigation and dissemination
9.40 – 10.05	Christin Heamagi	From shipwrecks to <i>Sphagnum</i> - Geoarchaeology in the marine zone
10.05 – 10.30	Lara Homsey Messer	Geoarchaeology and landscape history at the Squirrel Hill Archaeological Site, USA
10.30 – 10.45	Chris Carey	Deposit Modelling for Archaeological Projects: Development of Technical Guidance for Historic England
10.45 – 11.00	SUMMARY AND PRIZE GIVING	

ABSTRACTS – SPEAKERS (in alphabetical order by first author surname)

Characterization of Silica Mousterian Tools from Navalmaíllo Neanderthal Rockshelter (Madrid-Spain) Using Petrography, SEM-EDX and Portable XRF

Ana Abrunhosa^{1,3}, M. A. Bustillo², Telmo Pereira¹, Belén Márquez³, Alfredo Pérez-González⁴, Juan Luis Arsuaga^{5,6} and Enrique Baquedano^{3,7}

¹ ICArEHB - Interdisciplinary Center for Archaeology and Evolution of Human Behaviour. Faculdade das Ciências Humanas e Sociais. Universidade do Algarve, Portugal

² MNCN- Museo Nacional de Ciencias Naturales. Department of Geology, Madrid, Spain

³ MAR- Museo Arqueológico Regional, Madrid- Spain

⁴ CENIEH - Centro Nacional de Investigación sobre la Evolución Humana. Burgos (Spain)

⁵ Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Spain

⁶ Centro Universidad Complutense de Madrid-Instituto de Salud Carlos III de Investigación sobre la Evolución y Comportamiento Humanos, Spain

⁷ I.D.E.A. – Instituto de Evolución en África, Madrid, Spain

This work reports the geoarchaeological combined analysis of siliceous raw materials used in Mousterian lithic tools from the Navalmaíllo Rockshelter by standard optical microscopy, SEM-EDX and portable XRF. Navalmaíllo Rockshelter is an Upper Pleistocene site in a karst complex of Upper Cretaceous dolomites intensely used by Neanderthals. It is located in the Lozoya river valley at about 1100 m.a.s.l. within the National Park of the Guadarrama Mountain Range in the Central System. This region is marked by a wide variety of lithic resources that are present in the archaeological context. The shelter measures c. 300 m² and shows a stratigraphic sequence with successive hominin occupations. Level F represents the most intense one containing hearths, lithic tools and faunal remains in situ. Seven archaeological samples consisting mainly of quartz were analyzed by the first two methods and per their textures three rock types have been defined. Type 1 and 2 are silica rocks that can be traced to an origin in veins or dykes, and type 3 is recognized as a chert formed by silicification of Cretaceous dolomites. All of them are compatible to an origin in the Lozoya valley. A set of Mousterian lithic tools from different levels of the Navalmaíllo Rockshelter that correspond macroscopically with the seven samples were examined with a portable X-ray Fluorescence Spectrometer to evaluate if it was possible to differentiate the same three types. This multi-criteria process of combined analyses allowed to improve the characterization and lithological discrimination of the silica raw materials used in Pinilla del Valle and the recognition of probable geological sources to target on planned future surveys. With it we hope to better understand the extension of Neanderthal strategic and abstract thinking through the discovery of mental patterns, cognitive abilities, mobility, exploration and exploitation of the territory and the different ways of perceiving and occupying the landscape in the centre of the Iberian Peninsula.

Blind Test Evaluation of Consistency in Macroscopic Lithic Raw Material Sorting

Aviad Agam¹ and Lucy Wilson²

¹ Department of Archaeology and Near Eastern Cultures, Tel Aviv University, Israel

² Department of Science, Applied Science and Engineering, University of New Brunswick, Canada

At the base of every lithic raw material archaeological study lies the macroscopic examination, wherein archaeological artefacts are sorted into petrographic (rock) types. For instance, flint artefacts can be sorted into types based on visual characteristics such as traits of the cortex, colour, and visible fossils. This process often serves as a platform for petrographic and/or geochemical analyses, aimed at accurately identifying the sources of these flints. However, as the human eye is a subjective tool, some inconsistencies in classification may rise. Since macroscopic classification is an essential stage in lithic raw material studies, a process for evaluating and increasing the reliability of macroscopic raw material analyses is needed. In this study, we undertook a blind test of raw material classification of archaeological material taken from the Acheulo-Yabrudian assemblages from Qesem Cave (Israel). Twelve students, with various degrees of experience and familiarity with the Qesem Cave material, but without prior experience in raw material classification, sorted 100 randomly-selected flint pieces into flint types, based on a previously established data base, which includes flint-type samples and their descriptions, after a brief tutorial process and a group-practice-classification of a sample of an

additional 50 pieces. Also, L.W., who has regularly performed lithic raw material research for more than 30 years, and A.A., who has been studying raw materials since 2013 under the instruction of L.W., performed the same blind test. We then compared the 14 sets of results, using L.W.'s results as an anchor. Our results show that experience and practice significantly affect the degree of consistency, as the participants who were more experienced with the Qesem material (albeit from undertaking typo-technological studies) achieved higher correlations with L.W.'s results. Also, while some flint types are harder to identify, leading to heterogenous results, other flint types are easier to detect, resulting in a high correlation between participants. More generally, blind tests are demonstrated to be a valuable instrument in the process of raw material studies, pin-pointing repetitive inconsistencies, and thus improving the reliability of classification.

Ciota Ciara Cave and the Monte Fenera Palaeolithic (Italy): New Data, New Views

Diego E. Angelucci¹, Marta Arzarello², Maurizio Zambaldi¹

¹ Dipartimento di Lettere e Filosofia, Università di Trento, Italy

² Dipartimento di Studi Umanistici, Università di Ferrara, Italy

Situated at the southern border of western Alps, Monte Fenera is a low, mostly carbonate-built hill, hosting several palaeontological and archaeological sites – among which karstic caves bearing evidence of Palaeolithic occupations. The Monte Fenera sites have a long history within Alpine archaeology: they have been extensively explored since the 19th century, but information on their stratigraphy, chronology, formation and function remains incomplete or even lacking. Being among the few Palaeolithic cave-sites prior to LGM in the area, their systematic study is crucial for understanding human peopling and environmental evolution of the region in the Pleistocene. We here focus on the Ciota Ciara site, a complex, active cave modelled in Triassic dolostone. Systematic fieldwork at this cave resumed in 2009, along with new analyses and dating that has allowed us to revise the site's archaeology and formation. Our contribution deals with the geoarchaeological analysis of the Palaeolithic succession that was unearthed at cave entrance. After accurate field description and sampling, we have performed routine sedimentological analyses, basic geochemical characterisation and micromorphological observation. Preliminary results suggest that the succession at the Ciota Ciara entrance is older than formerly assumed and may date to Middle Pleistocene – early Upper Pleistocene. Sediment accumulation in this sector of the cave results from consecutive events of concentrated flow and runoff from the inner karstic system, alternating with episodes of éboulis accumulation from wall/roof disintegration and short phases of surface stabilization. Post-depositional processes include frost action, hydromorphism and diagenesis, and weathering dynamics have selectively affected archaeological components, which thus show distinct degrees of preservation. We discuss the first results of the geoarchaeological revision of the Ciota Ciara site and set them in the context of Pleistocene cave archaeology and of the debate on the evolution of Neandertals in Mediterranean Europe.

All Along the Watchtowers! Balancing Heritage Protection and Development of Castle Sites with Scientific Research Potential of Buried Archaeology

Rowena Banerjea¹, Hans Huisman², Cristiano Nicosia³, Quentin Borderie⁴, Jesper Colenberg⁵, Irène Béguier⁶, Melinda Bizri⁷, Guillermo García-Contreras Ruiz⁸, Bénédicte Guillot⁹, Aleks Pluskowski¹, Xavier van Dijk¹⁰, Jan van Doesburg²

¹ University of Reading, UK

² Cultural heritage agency of the Netherlands

³ CReA- Université Libre de Bruxelles, Belgium

⁴ Département d'Eure-et-Loir, CNRS - UMR 7041 ArScAn "Archéologies Environnementales", France

⁵ Independent, The Netherlands

⁶ Service départemental d'archéologie du Calvados, France

⁷ Université de Bourgogne / UMR 6298 ARTEHIS - "Archéologie, Terre, Histoire et Sociétés", France

⁸ Universidad de Granada, Spain

⁹ Institut National de Recherches Archéologiques Préventives (INRAP), France

¹⁰ RAAP, The Netherlands

Successive waves of conquest and colonisation throughout the Middle Ages have shaped society and the cultural geography of modern Europe. Castles and their remains are iconic remnants from that period, and as such form an important part of our cultural heritage. Across Europe, only recently is the scientific potential of the buried archaeological deposits within castles being realised, which can be overlooked in favour of the protection and consolidation of standing remains, and developments such as reconstruction and rebuilding projects. This paper reviews the state of archaeological remains within medieval castle sites across Europe (Estonia, France, Latvia, Poland, Italy, Spain and The Netherlands), their scientific value and potential threats to the buried archaeology based on geoarchaeological research. No standing remains survive at Karksi and Elbląg (Estonia and Poland) but both sites contained exceptionally well preserved waterlogged occupation deposits dating to the initial colonisation during Crusades. In Caen, Gien (both in France), Elbląg, and Kessel (The Netherlands), excavations were done ahead of development. They are examples of sites where different heritage perspectives had to be balanced due to development and rebuilding. In the Baltic, Dutch, French and Italian examples, micromorphology was instrumental in discovering that buried deposits contained the remains of (probably wooden) buildings from a first construction phase, or in characterising the changing use, and, following decay, the re-use occupation of structures. Molina de Aragón (Spain) is located in a UNESCO geopark. Geoarchaeological samples were collected recently from profiles created during previous excavations, which were conducted to support the architectural restoration but without a scientific focus on the medieval stratigraphy. These examples highlight the importance of a geoarchaeological perspective for both identifying and conserving cultural deposits within castles. They not only demonstrate the archaeological value of buried archaeological deposits, but also stress the threats to them due to development, rebuilding, and conservation.

How the Late Pleniglacial Landscape Changes Diversified the Gravettian Record of Ach and Lone Valleys

Alvise Barbieri¹, Andreas Taller², Felix Bachofer³, Geraldine Quénéhervé⁴, Nicholas J. Conard,^{1,2,3} Chris E. Miller⁵

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³ Department of Geosciences, University of Tübingen, Germany

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The Ach and Lone valleys of the Swabian Jura (In Bade-Württemberg, Southwest Germany) represent a key region in the study of human migrations in central Europe. In contrast with the Aurignacian and the Magdalenian, the Gravettian record preserved in the cave sites of these two valleys is poorer and appears variable. Previous lithic analyses conducted on the Gravettian stone tools of the Ach Valley have discovered multiple refitted artefacts found across several different cave sites, which might indicate that this part of the Jura was repeatedly occupied by the same group of humans. In contrast, in the Lone Valley material and ¹⁴C dating indicative of the Gravettian occupation are sparser and are largely redeposited within younger sediments. Over the past years we have investigated the natural processes that shape the landscape and the cave deposits of these two valleys. By combining a variety of methods (including geophysical prospection, coring, micromorphology, FTIR, and radiocarbon dating) we demonstrate that alternating phases of soil formation, hillside denudation, river valley incision and floodplain aggradation have been the major processes active in the Lone and Ach valleys throughout the Pleistocene and Holocene. Here we evaluate how local variables (such as valley gradient, drainage basin extent, size and relative elevation of caves) influenced these processes and their impact on cave sedimentation. Our results suggest that a phase of river valley incision and subsequent, intensive mass wasting of the hillsides promoted the erosion of Gravettian-aged deposits from the caves of these valleys. The eroded sediments accumulated at the foot of the hill, where they promoted a phase of floodplain aggradation. In the Lone Valley this final phase of aggradation occurred at a lower rate in comparison with the Ach Valley. As a result the effect of the drop in base level lasted longer in the Lone Valley, thereby promoting further erosion of the cave deposits. We conclude that the record of Gravettian-aged occupation is variable across the two valleys as a result of natural landscape-scale geomorphological processes.

Regional Stratigraphy, Tephrochronology, and Human Occupation of the Upper Susitna Basin, Central Alaska

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The mountainous upland landscapes of central Alaska play an important role in understanding key issues in Beringian archaeology, including human adaptation to new landscapes and changes in landscape use in response to environmental change. This paper presents the geomorphological and paleovegetation record of the upper Susitna River basin in the central Alaska Range, and discusses late Pleistocene and Holocene landscape and vegetation change and how this affected human use of this upland landscape. Geomorphological data suggest that the last significant glacial ice sheet covering the upper Susitna basin receded by 14,000-13,000 cal yr BP. Following deglaciation, there is evidence for high-energy aeolian activity spanning the late Pleistocene and early Holocene. There are at least three Holocene tephra falls recognized in the upper Susitna basin, and there are preliminary indications that tephra fall may have affected vegetation patterns in the study area. Initial human occupation occurred by 11,000-10,500 cal yr BP, at least 2000 years after the end of full glacial conditions, and 1000 years after first evidence of landscape recovery. Early Holocene use of the study area appears to have been ephemeral, but human activity intensified in the middle and late Holocene as modern vegetation patterns were established. There is evidence for a hiatus in human occupation of the upper Susitna region during the middle Holocene, possibly related to deposition of the most substantial tephra fall in the study area.

Garbage In – Wisdom Out! Geoarchaeological Investigation of Sedimentation Processes and Waste Disposal Practices at the Latène Settlement Basel-Gasfabrik

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Basel-Gasfabrik is an unfortified Late Iron Age settlement with domestic and economic structures and two associated cemeteries. It is among the large, unfortified, proto-urban settlements playing a major role in the La Tène period and which are usually connected with trade and craft production. Since 1911, numerous excavations revealed more than 600,000 artefacts and 900,000 animal bones, mostly from infilled storage or cellar pits. The majority of these findings are associated with dark sediments which contain much organic and inorganic garbage and form a major component of the materials used to fill in the settlement's pits. Thus the question is raised as to how and where those dark sediments were formed before they were used as pit backfill. This question will be addressed by means of micromorphological and geochemical analysis of well-preserved settlement features. House floors, trampled outdoor areas, ditches and pits were analysed in order to characterize different activities and their corresponding sediments. Additionally, investigations of posthole backfills reveal information about the abandonment of buildings. Our results show that there are significant differences in sediment compositions, associated anthropogenic components and taphonomic proxies between features. The geoarchaeological data are supplemented by bioarchaeological and archaeological findings to arrive at comprehensive assessment of syn- and post depositional processes at Basel-Gasfabrik. This permits the reconstruction of waste disposal practices, activity areas and resource management, which is essential for interpreting complex assemblages like the inventory of an infilled pit. Furthermore, an insight into the daily life of Late Iron Age inhabitants in the settlement of Basel Gasfabrik was gained.

Late-Glacial/Early Holocene Palaeoenvironments and Evidence for the 8.2 ka Event in the Southern North Sea Basin: New Data from the Dudgeon Offshore Wind Farm

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It is well known that the North Sea conceals an extensive Late Pleistocene and early Holocene palaeolandscape. Archaeological finds from the seabed show this former landscape was occupied by humans during periods when sea-levels were significantly lower than today and the British Isles formed the north-western promontory of the European continental shelf. Renewed interest in submerged palaeolandscapes has occurred chiefly in response to increasing pressure from commercial aggregate dredging, oil and gas exploration and offshore windfarm developments. This paper presents the results of an integrated palaeoenvironmental study (pollen, foraminifera, ostracods, plant macrofossils, molluscs) of organic sediments taken as part of geoarchaeological investigations on the site of the Dudgeon Offshore Wind Farm. The sediments cover a period of as much as 4,400 years (12,700-8300 cal yr BP), including a substantial peat covering the late Devensian/early Holocene transition (12,700-9260 cal yr BP). During the late Glacial the local environment is characterised by sub-alpine plant communities with open birch woodland, followed by development of birch and hazel woodland during the early Mesolithic. A phase of marine inundation occurred around 9500-9000 cal yr BP, with a final marine inundation of the area around 8400 cal yr BP, possibly linked to a meltwater pulse following the collapse of the Laurentide icesheet, precipitating major palaeogeographic and climatic changes within and beyond the North Sea. The results begin to address the deficiency in detailed palaeoenvironmental studies from the area, providing new data on patterns of physical, vegetation and environmental change in the context of rising post-glacial sea-levels

Mineral Phases in Burned Salmonid Bone and their Relevance to Studies of Combustion Features at Northern Hunter-Gatherer Sites

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Primarily owing to poor preservation, ichthyoarchaeological evidence is uncommon at hunter-gatherer sites from various regions and timeframes. In particular, the absence of salmonid bones is conspicuous at many ancient sites across the Arctic region. Given ethnoarchaeological observations on discard of meal remains into domestic hearths at fisher camps, this research focuses on the development of heat-related geoarchaeological indicators useful for identifying salmonid fishing economies. Specifically, heat altered bone mineral is explored as a prospective marker for fish remains discarded in domestic hearth contexts. A series of laboratory incineration experiments was used to characterize the mineralogy of burned salmonid vertebrae, in comparison to bones of northern game mammals and birds. Fourier transform infrared spectroscopy and X-ray diffraction distinguished the formation of high quantities of the phosphate mineral beta magnesium tricalcium phosphate at temperatures as low as 600°C exclusively in salmon bones. In other fish, mammal, and bird bones studied this mineral formed only above 800°C. This indicates that the presence of beta magnesium tricalcium phosphate is expected in combustion features at hunter-gatherer salmonid fishing sites. An archaeological case study of a Mid-Holocene hunter-gatherer site located on a salmon migration route in northern Finland is underway. This approach has promise as a new means of further evaluating the temporal, geographic, and cultural scope of salmonid harvesting among northern hunter-gatherers.

A Palace Under the Microscope - Insights into a IVth Mill. BC Representative Building Through a Deposit-Oriented Approach

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Located at the crossroad of the main civilizations of the Near East, the site of Arslantepe (Malatya, Turkey) reveals an extremely long occupation sequence, marked by several socio-political and cultural transformations. The most striking of these shifts occurred during the Late Chalcolithic period, in the so-called VIA phase of the site (3350-3000 BC), with the development of a political and economic centralized system, which is exemplified by the construction of a monumental mud-brick complex labelled "Palace" for its articulation in interconnected, multi-functional areas. In this perfectly sealed context (destroyed by a fire), archaeologists recognized two temples, a storeroom complex, administrative areas with thousands of *cretulae* (clay sealings), a monumental gate, corridors and courtyards. More than just spaces, these buildings were socially-constructed places, and they offer an excellent chance to explore those dynamics involved in the continuous renegotiation of the social, economic and political meanings that structured the IVth millennium communities. Using a deposit-oriented approach, I integrate the traditional analysis of *in-situ* finds and architectural features with the

microscopic material traces buried in the physical space, and thus aim at enriching the archaeological narrative by investigating the materiality of spaces and of performed actions. In this paper, I present the preliminary results of the micromorphological and chemical analyses carried out in one of the most recently excavated and best preserved rooms, characterised by a large central platform with a built-in fireplace. This study offers a high-resolution investigation of the consumption modes of this monumental space, by focussing on the nature of deposits and their spatial variations, and hint at the occurrence of specific practices.

Activity Areas and Geoarchaeological Triage in the Ancient Egyptian Houses of Amara West, Sudan

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Recent largescale micromorphological and geochemical analyses of sedimentary house floors and occupation deposits from the New Kingdom Egyptian settlement of Amara West provide strong evidence for a range of domestic activities including craft and food production, animal penning and the practice of household magic. The presentation will draw upon this case study to illustrate the potentials and challenges of undertaking robust geoarchaeological activity area identification in large and microstratigraphically well-preserved settlements under wide-scale excavation. In the context of inevitably limited time and resources, the presentation will consider forms of geoarchaeological 'triage' and reflect on the successes (and limitations) of a few of the hard choices made in formulating this project's sampling strategy: is it better to explore houses or neighbourhoods in detail? Should spatial or temporal depth be targeted? What activities are we likely to miss, and how will we know if we've missed them? The presentation will ultimately consider how micro-scale geoarchaeological methodologies can and cannot be used to contribute to 'big questions' of social organization and household specialization.

Town Development in Mons (Belgium): The Contribution of the Geoarchaeological Study of Dark Earth

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During the excavation on the site of Mundaneum in the historical centre of Mons in 2013-2014 thick, dark coloured, humic, homogeneous units covering the whole excavated surface were discovered (=Dark Earth *sensu lato*, Nicosia & Devos 2014). Interpretation of Dark Earth based on traditional archaeological methods alone has shown to be a difficult, if not impossible, task. Over the last decades geoarchaeology, and soil micromorphology in particular, has shown to be a particularly valuable approach. It enables us to discriminate the major processes involved in its formation and to detect human activities and natural events triggering them. Furthermore a chronology of events can be established. The geoarchaeological study of the Dark Earth of the site of Mundaneum allowed us to document the urbanisation process of the site and its surroundings. During the oldest phase the area and its surroundings showed a clear rural character. In the next phase abundant domestic, artisanal and construction waste were recorded, indicating a denser occupation and the incorporation of the area within the urban tissue. The excavated area itself remained open as witnessed by the important bioturbation and was probably used as backyard.

Subsistence Practices in the Arid Negev Highlands During the Intermediate Bronze Age (c. 2500-1950 BC): A Geoarchaeological Perspective

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A massive settlement phenomenon characterizes the arid Negev Highlands (southern Israel) during the Intermediate Bronze Age (IBA) (ca. 2500-1950 BC). However, the subsistence practices of this large desert population are poorly understood. Previous work has suggested the existence of two complementary elements during the period: large central sites specialized in copper processing and production, and smaller ephemeral sites supported by nomadic-pastoralism. Both settlement types have been assumed to have practiced livestock rearing and dry seasonal farming. However, to date, these assumptions have been based on ceramic typologies, presence of flint blades, grinding stones, and scant zooarchaeological assemblages. Direct evidence for either herding or cultivation is very limited. Recent geoarchaeological work at other sites in the Negev Highlands has shown the potential for recovering direct evidence for subsistence practices through the identification of sediments containing degraded animal dung, followed by the analysis of phytoliths from this material. The latter reflect animal foddering practices, and thus whether cereal cultivation was carried out. Following this approach, two central and one ephemeral IBA sites were excavated. A study of a second ephemeral site is underway. The excavations focused on sediment sampling from varied contexts (habitation floors, courtyards, pits etc.). Analyses included mineralogical characterization via FTIR spectroscopy, extraction and quantification of phytoliths as well as morphotype analysis, extraction and quantification of ash pseudomorphs and dung spherulites, and XRF analyses to detect evidence for copper production/processing. The results show the presence of ancient livestock dung at the ephemeral site, with phytolith assemblages indicative of free-ranging animal husbandry. In contrast, the two central sites show no evidence for any type of food production or copper processing activities. These results force a new discussion about subsistence and society at central sites and the role of larger international economies in the arid Negev Highlands during the Intermediate Bronze Age.

Burn hillfort, burn – Dun Deardail inferno

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The vitrification of Iron Age hill forts occurs when the timber framed stone built rampart is destroyed by fire. The fire can generate temperatures (>1000°C) that can melt the rubble core of the defensive walls, however vitrification does not occur at every burnt site. The process of hill fort vitrification is still not fully understood and no one has successfully recreated this process, in the field, in modern times. There are still many questions regarding the geological processes of vitrification and the temperature that these rocks melted at. This presentation seeks to discuss the comparison of Scottish vitrified hillfort sites, primarily Dun Deardail and Craig Phadrig, and attempt to answer some of these questions. Geological investigation has recognised that Iron Age hill forts are constructed using localised materials and there has not been pre-selection of rock with increased fusibility. Laboratory and field analysis have been used to ascertain their geological composition, to identify the changes vitrification has had on mineralogical configuration and whether the temperature of melt can be determined by using a combination of different chemical analytical techniques. Preliminary laboratory analysis has concluded that the temperature of the melt at both Dun Deardail and Craig Phadrig were in the region of 1000-1200°C and using data from several analytical methods and experimental furnace melting, evidence will be presented concerning the temperature of the vitrification and the constraints that geology has on the vitrification process.

Geophysical Surveys and Digital Elevation Modelling at the Roman Military Complex of Ardoch, Scotland

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The Roman military complex of Ardoch (Braco, Perth & Kinross) is one of the most important archaeological sites for the study of Rome's military expansion in northern Britain. It comprises the remains of a main fort with a rectangular area of around two hectares, and at least five, partly overlapping marching camps dating between the 1st and 3rd centuries AD. They constitute one of the best-preserved series of military earthworks in the whole of the Roman Empire. During the course of a fieldwork campaign carried out in March 2016, a geomagnetic plan of the entire main fort was completed, providing new insights into the internal organisation and the defences. Some selected areas were also analysed by means

of geoelectric. This research was complemented with a drone flight of the main fort and some adjacent areas, producing a high-resolution digital elevation model of the archaeological site. The large-scale combination of drone flight and geophysical surveys represents an innovative research project in the archaeology of the Roman Gask Ridge Frontier.

Characterization and Patina Formation of Flint used on Prehistoric Sites in NW Belgium

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This study aims at analyzing the mineralogical and chemical characteristics of raw flint material, used for the production of prehistoric stone tools in NW Belgium. Material used in this study includes flint from outcrops in the Mons Basin and flint found on the beaches of the Western Scheldt. Due to the formation process, raw flint material is defined by a wide variety of internal structures, chemical variations and impurities. Moreover, weathering processes can alter the flint material and cause additional changes making the study of this material complex. Weathering of flint is mostly expressed as patination which is linked to the geological and depositional context. Therefore it is important to understand how the flint characteristics influence their weathering behaviour. The first goal of this study is to investigate the characteristics of unaltered flint using a combination of traditional techniques such as microscopic analysis, XRF and SEM-EDX. Secondly, structural and chemical differences between unaltered flint, cortex (rim on flint nodules found in chalk beds) and patina will be investigated using the above mentioned methods together with non-destructive high-resolution X-ray computed tomography (micro-CT). The possibilities of micro-CT, providing 3D information of internal structures of flint, will be explored since this technique is not frequently used in studies analyzing flint material. In particular, both natural and laboratory-induced patinas will be analyzed using micro-CT. White patinas are reproduced by experiments with alkaline solutions in relatively short time. This way, the patination process and the relation between patina formation and flint characteristics can be studied. The results of these investigations will later be considered in the analysis of archaeological artefacts from Mesolithic-Neolithic sites in the Scheldt valley, NW Belgium.

Towards High-Resolution Sediment Chronologies: Regular Natural Sediment Incursions in Burnt Mound Deposits as a Proxy for Time

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Burnt mound sites represent the most common application of fuel-use strategies across the Bronze Age landscapes of Great Britain and Ireland. Multiproxy scientific examinations of burnt mound deposits are becoming more common, especially through rigorous planning consent and good commercial archaeological practice. However, radiocarbon based chronologies often struggle to offer high-resolution results. This leads to the environmental evidence retrieved from burnt mound sites often being homogenised by spit-based bulk sampling, and offering a reduced resolution on changing human practices. This study will assess a suite of Neolithic to late Bronze Age burnt mound sites across the Orkney archipelago and north Northumberland, all of which have been subjected to high-resolution micromorphological and XRF analysis. Amongst many other findings, these analyses have indicated that 1. Annually/sequentially deposited natural sediments can appear in otherwise homogenous anthropic deposits when assessed under the microscope 2. If properly modelled by examining local hydrological and sedimentological processes, these can be used to subdivide deposits, and provide high-resolution distinctions between deposits at a microscale 3. This can then be used to establish tighter chronologies and site-use biographies, and in turn to differentiate between archaeobotanical, geochemical, and geoarchaeological assemblages of extracted and disarticulated material. Some sub-coastal burnt mounds were regularly inundated by Aeolian sands in periods of increased storminess, providing microscopic (and sometimes macroscopic) seriation of sediments and components. The same can be seen with alluvial flood deposits encroaching on burnt mounds in lacustrine basins. Through micromorphology and concurrent XRF analysis, it may be possible to model these natural sediment incursions and use them to increase the resolution of existing strands of data on ecology, environment, and direct indicators of human activity. Ultimately, it is argued that multidisciplinary geoarchaeological and environmental analyses of landscapes which see regular natural sediment deposition can lead to new avenues of research and interpretation.

Rescuing the Ranch: Geoarchaeology and Historic Resources Impact Mitigation at the FM Ranch Campsite (EfPk-1) in Southern Alberta, Canada

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Heavy rainfall in June 2013 triggered catastrophic flooding in southern Alberta that accelerated natural erosional and depositional processes, altering the Bow River valley and damaging many archaeological sites in the area. In response, the Alberta government funded a multi-year Flood Impact Assessment Program, intended to assess and mitigate (where possible) the damage to sites along the Bow and its tributaries. Under this program, Western Heritage was contracted to undertake mitigative excavations and geoarchaeological studies at the FM Ranch Campsite (EfPk-1), part of an ancestral Indigenous campsite/bison jump complex that is one of the Province's most highly valued historic resources. The primary objectives of this work were to establish stratigraphic and chronological frameworks for the site, and to document and preserve the numerous cultural features observed to be eroding along riverbank exposures. Our approach included standard field-based methods, but emphasized detailed stratigraphic descriptions, magnetometry, luminescence profiling, and handheld magnetic susceptibility. Laboratory-based methods included AMS radiocarbon dating and soil micromorphological and bulk sedimentological analysis of six exposed combustion features. Macrofossil analysis of the combustion features was also undertaken in collaboration with the Royal Alberta Museum. Our results indicate that at least seven occupations took place on different parts of the landform during the past 1300 years. The analysed combustion features demonstrate variations in their use history, with some representing intact single or multiple uses, while others have been culturally redeposited. Occupations in the southern portion of the site occurred beginning about 900 years ago and were likely related to use of the adjacent bison jump. However, occupations in the northern portion likely occurred before the southern portion was stable enough for occupation, before the bison jump was in use. This work has wider resonance with issues such as increasing the interpretive value of data recovered during archaeological mitigations, and the importance of adopting an holistic approach to investigating archaeological sites on the northern North American Great Plains.

Medieval Sunken Buildings in the North of France: From Samples to Micro-Features

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Thirty years of development of preventive archaeology in France have permitted to renew the research on Early Medieval period. Archaeologist of the French national institute INRAP have unearthed a lot of original data and totally changed our incomplete vision. Most of the sites seem to be built the same way and one type of structure is often documented as a small building: the sunken hut. It happens to occur more often in rural settlements from the 5th to the 12th Centuries. By the light of further studies in geoarchaeology, it has been possible to demonstrate that the fillings of excavated huts, which appear to be homogeneous, are much more complex in thin sections of soils. Micromorphological studies are considered by sampling in vertical and horizontal sequences. Thus science of micro-layers has renewed our often simplistic vision of the activities settled in these sunken buildings. The archaeological sites of Champagne are therefore very representative of the informative potential of the fillings of these archaeological structures. These sites are settled most likely in wet areas where ancient rivers used to be active almost one part of the year. The substratum, locally called 'graveluche', is made of calcareous gravels from the decomposition of chalky material all over the region of Champagne. The infillings are composed of pedofeatures due to the proximity of water. It is possible to examine more closely the construction methods suitable for this particular environment. Indeed, it is often filled with thin collapsed pieces of building material and specific fitting can be noticed. Although biological activity is frequently responsible for the dislocation of sediments in the sequences, it is possible to make a good characterization of some anthropic features. The arrangement of these elements, added to a pedologic analysis of soils, gives information on the past activities practiced in these archaeological structures. Nowadays the archaeologists of the INRAP tend to lead intra-site geoarchaeological

approaches. Micromorphology of fillings is a precious method for a better understanding of medieval huts. These case studies aim to reassert the importance of interdisciplinary research from landscape to micro-features on the archaeological field. This will improve our understanding of such structures called 'simple' in order to reconsider the necessities related to the establishment of past societies.

Evaluating the Nature and Behavioral Implications of Laterally Extensive Occupation Deposits in the Middle Stone Age Levels of Blombos Cave, South Africa

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The spatial patterning of archaeological remains has been studied at several southern African Middle Stone Age (MSA) sites, yet intra-site activity patterns for this time period are not well understood, and the spatial configuration of prehistoric MSA hunter-gatherer camp sites remains largely elusive. There are several reasons for this. First, relatively few MSA sites have been excavated, and fewer still have been excavated over a large enough surface area that allow for behaviourally meaningful intra-site spatial analyses. Second, some MSA contexts simply do not contain laterally extensive, continuous and undisturbed occupation deposits and their general lack of spatial and stratigraphic integrity make them unsuitable for conventional archaeological site structure analysis. Third, many MSA sites are located in caves and rock-shelters where the recurrent use of the same confined space, by multiple depositional agents over time, have led to the formation of complex deposits that contain a combination of *in-situ*, partially *in-situ*, and completely reworked deposits. These complex, often laminated deposits can contain a high-resolution record of individual occupational events. However, the thin, finely laminated nature of the sediments makes it difficult to recover information on lateral spatial patterning using standard excavation techniques. In this study, we aim to identify and characterize intra-site spatial activity patterns through site-wide micromorphological microfacies analysis at the MSA site of Blombos Cave (BBC), South Africa. At this cave site, more than 18 m² of the interior has been excavated, and the sedimentary sequence – which is more than 3 m deep – contains numerous lenses and micro-contexts, many of which are laterally extensive and can be associated with different phases of prehistoric human occupation. We focus on micromorphological samples collected from four different MSA occupation phases at the site: M1 (Still Bay, c. 72 ka), M2 Upper (Still Bay, c. 77 ka), M3 Upper (85 ka) and M3 Lower (101 ka). By combining micromorphology, microspectroscopy and organic petrology with high-resolution site documentation our objective is to study the lateral and vertical variability of anthropogenic microfacies, in particular in terms of their genetic interpretation (behavioral implications), temporal and spatial resolution (chronological implications) and intra-site spatial distribution (implications for prehistoric site use and organization of cave space).

From Shipwrecks to *Sphagnum* - Georchaology in the Marine Zone

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This paper will explore the challenges and advantages of undertaking development led georchaology in the marine zone by using results derived from wind farm developments around the UK coasts

Over the last few years a notable change has occurred in the attitude towards marine georchaology in the development led offshore archaeological field in the UK. Thanks to support from Historic England and an increased understanding of taking a staged approach, developers have, if sometimes reluctantly, started to understand why georchaological analysis and assessment must take place and how the information contributes to the wider research framework. The research potential for microfossils, such as the ubiquitous *Sphagnum* and other environmental indicators from the North Sea is very high. Studies such as the North Sea Palaeolandscape Project (University of Birmingham, 2011) and Vince Gaffney's Mapping Lost Worlds are providing good background knowledge across large areas. In contrast to the broad approach of

the research projects, development led archaeology is mostly tied to the cores and material collected by developers for their own purposes which are often from a relative defined area and tend to avoid the soft fine sediments with the highest preservation potential. Therefore, we as geoarchaeologists must find the best way forward in utilising the information we can gather from the geotechnical core material while encouraging more comprehensive geoarchaeological assessments and analysis to take place. This presentation will summarise the current status of offshore marine geoarchaeology in the UK by focusing on a number of case studies where wind farm developers have not only protected the more visible shipwrecks within their development area but also supported the study of less obvious indicators of submerged landscapes and environmental indicators preserved below their wind turbines.

Manuring Practices in the Danish Late Bronze and Early Iron Age: Geoarchaeological Investigations of Three Celtic Field Systems from Eastern Jutland, Denmark

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Indications of manure are often found at the so-called 'Celtic fields' that were used throughout large parts of north-western Europe in the Late Bronze and Early Iron Age. Manuring may well have been an important aspect of arable cultivation in this period, and in addition to having influenced the organization of daily life, it may have been related to a change towards more permanent rights to the individually enclosed fields. Although recent investigations have significantly improved our knowledge of the type of manure used at specific sites, less attention has been given to the fact that manuring strategies may have varied between regions according to aspects such as soil conditions, available resources and cultural traditions. In 2016, new targeted fieldwork was therefore carried out at three Celtic fields situated in Eastern Jutland: Hjortsballe, Silkeborg Vesterskov and Boes Skov. The investigations had two overall objectives: 1) to determine the manuring practices and possible variations between and within the investigated sites, and 2) to date the accumulation of earthen banks and lynchets separating the individual fields. At each site, a trench was dug through a field boundary and the adjacent fields, and samples were taken for OSL and ¹⁴C dating, pollen, thin section analysis, and geochemistry (including multi-element analyses by ICP-MS and analysis of iodine). Furthermore, in order to determine the intra-site variation of the manuring practices, additional randomized samples of the topsoil in selected fields were collected and subjected to geochemical analyses. In this paper, the results and archaeological interpretations as well as the methodological approach will be presented and discussed with reference to previous geoarchaeological investigations of Celtic fields.

Geoarchaeology and Landscape History at the Squirrel Hill Archaeological Site, USA

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The Squirrel Hill archaeological site (36Wm0035) is a Johnston-phase Monongahela village located in Westmoreland County, Pennsylvania (USA), on a terrace of the Conemaugh River near the modern town of New Florence. Although the site is listed in the National Register of Historic Places, previous investigation is extremely limited; many questions remain to be answered, including verifying occupation and cultural affiliations; identifying the location and extent of site boundaries; characterizing the internal arrangement of houses, plaza, and stockades; and reconstructing the site's paleo-landscape. In partnership with the Midwest office of the Archaeological Conservancy, we began to investigate these questions as part of the Indiana University of Pennsylvania's 2016 Archaeological Field School using a combination of geophysical survey, test excavation, and geomorphic testing. Preliminary results of a ground penetrating radar survey in the northwest portion of the site revealed what may be a large rectangular structure at 23-46 cmbs, with a size and shape that does not conform to the typical circular Johnston-phase "petal structure" house. Auger cores taken from the northern end of the site revealed what appear to be a series of buried landscapes at depths of ~108, ~130, and ~163 cmbs, suggesting that earlier occupations at the site may exist. Interestingly, these buried horizons do not appear in cores taken from the southern end of the site. Cores along the eastern edge of the site revealed alternating flood and gleyed deposits, suggesting and that the paleo-environment was more dynamic than researchers have previously thought. This paper will

report on these field results, as well as recent radiocarbon, particle size and soil micromorphology analyses designed to refine the nature of occupation and past landscape history for the site.

Erosion of Archaeological Sites: Quantifying the Threat Using OSL and Fall-Out Isotopes

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Archaeological sites with surface topography or on slopes can be susceptible to different types of erosion, resulting in progressing damage to the site. Tillage increases this threat because of the stronger susceptibility to water erosion of barren, loose topsoil after ploughing but also due to direct soil displacement by agricultural implements. Although there is ample visible evidence erosion has damaged many sites, there is little or no data to assess rates of soil redistribution (e.g. in mm/yr). This makes it hard to determine scale and urgency of the threat of erosion. Numerous techniques are available to measure soil erosion rates, each with its own pros and cons. Few of them, however, have been tested or used on the short timescales (years or decades) needed to assess erosion rates on archaeological sites. We selected three archaeological sites (Neolithic, Roman, Medieval) where erosion rates were expected to be high (ploughed loess slopes and artificial mound). We combined OSL-SAR dating and the distribution of fall-out isotopes to assess erosion rates. A schematic depth-age representation of OSL-SAR single aliquot ages was developed that was found well suitable to determine past erosion and colluviation, but also to identify stable land surfaces on timescales of centuries and longer. Radioactive fall-out isotopes of cesium (Cs) and plutonium (Pu) were suitable for shorter time-scales: Pu isotope ratios and a positive Pu-Cs correlation showed that these isotopes were derived from the atmospheric nuclear tests of the late 1950s and early 1960s. The distribution of these isotopes in soil profiles could be used to estimate that erosion rates in the last c. 50 years; ranged from 2 - 6 mm/year on these sites.

Geoarchaeological Approaches to the Palaeolithic Surface Record: Unravelling Early and Middle Stone Age Activity at Wadi Dabsa, SW Saudi Arabia

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The Palaeolithic record of the Saharo-Arabian belt occupies a key position in debates surrounding the dispersal of hominin populations from Africa, and the majority of artefacts are distributed across the surface of present-day landscapes. Whilst archaeological work has focussed mainly on the location of stratified, dateable artefacts, the surface record poses its own set of unique challenges and opportunities for Palaeolithic archaeologists that are, in the main, bound up in the geoarchaeological context of these artefacts. The SURFACE project examines the Palaeolithic record of SW Saudi Arabia through a geoarchaeological lens. Utilising remote sensing, geomorphological and archaeological survey, it employs an interdisciplinary approach to the region's important but under-researched Palaeolithic record, the landscape it is situated within, and its implications for our interpretations of hominin activity in these landscapes. The locality of Wadi Dabsa, SW Saudi Arabia, has yielded >2000 Early and Middle Stone Age lithic artefacts recovered from the surface of tufa deposits in a basin headwaters. The richest recorded Palaeolithic site in SW Saudi Arabia, it has a major potential to inform on early hominin activity in its environmental setting. Multi-scalar geoarchaeological investigations were undertaken at the site in

early 2017: remote sensing and geomorphological survey to develop a landscape stratigraphy and map surface sediment cover across the tufa exposure; systematic collection and recording of artefacts within a 100 m x 60 m area, and recording of their geomorphological context; targeted excavations to refine the relationship between the artefacts and tufa; collection of samples of basalt and tufa to constrain landscape evolution and provide palaeoenvironmental information. This paper will present the initial findings of the investigations and their interpretations, and will discuss the potential for the site to inform on early hominin activity in SW Saudi Arabia and its implications for global dispersals.

Tracking Prehistoric Pastoralism in Subalpine and Alpine Soils –Preliminary Results of the Montafon and the Silvretta Alps (Austria/ Switzerland)

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Subalpine and alpine soils in high mountainous regions of the Alps have been influenced by pastoral activity for thousands of years. Building on previous palaeoecological, geoarchaeological and archaeological investigations in the Montafon (Austria) and the adjacent Silvretta Alps (Austria, Switzerland), we assume increasing pastoral activity during the Bronze Age. Total phosphate content was measured in subalpine (~1300 -2300 m a.s.l) soils in order to receive more knowledge about past grazing intensity at different altitudes. We mostly selected soils which have been radiocarbon dated by charcoal, if possible charcoal layers. So far, our results suggest that the uppermost topsoil clearly reflects recent pasture activity. Abandoned or less-used pasture areas have lower phosphate values. In the subalpine region of Val Urschai (Silvretta), a mesolithic soil profile at the steepleft flank of the valley, which nowadays is barely used for grazing, shows rather low phosphate concentrations; however, the values indicate pastgrazing of wild animals or livestock. According to our radiocarbon dates, we also have evidence of increased phosphate concentrations in Bronze Age colluvial layers at Bartholomäberg, and maximum phosphate values have been measured in a Bronze Age enclosure in Las Gondas (Silvretta). Additionally, high phosphate concentrations in different colluvial layers at Schafberg, Gargellen (Montafon) can be interpreted as long-term grazing pressure. Beside tracking former pastoral activity, phosphate concentrations seem to be a suitable parameter to identify palaeosurfaces (fossil A-horizons) and thus help to reconstruct past and present soil formation processes. Measurements of phosphate in alpine soils above 2300 m a.s.l are still pending, first results of which will be presented at the conference.

Approaching Landscape Transformations Through Urban Micromorphology at Bronze Age Palaikastro, Crete

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At Bronze Age Palaikastro, Crete, archaeological sequences are defined by destructive events, which provide snapshots of cultural material in a particular time and space. Evidence for occupational phases is mainly based on materials found above floors/surfaces, while evidence for transitional phases is largely based on the accumulation of sediments and debris between floors/surfaces. Micromorphological evidence can correspond to both occupational and transitional phases and assist in determining the extent to which landscape transformations affected the urban site during particular phases. Two general microfabric groups are observable in the Palaikastro sediment thin sections: (1) more rounded, sorted sediment grains deposited gradually by coastal/river flooding or aeolian processes, and (2) coarser, unsorted sediment grains deposited rapidly by slope processes. Moreover, these two microfabric groups may be correlated with occupational and transitional phases, respectively. Group 1 tends to be found immediately beneath larger debris sequences and may be related to periods of gradual accumulation (and more stable slope conditions) that coincided with active use of the new site area and/or initial abandonment. Group 2 tends to be found after episodes of gradual accumulation and is representative of periods of rapid sediment accumulation, which indicate slope instability, and which coincided with gaps in active occupation and/or prolonged abandonment. While the causal factors of the gaps in occupation phases and intervening transitional phases cannot at this time be attributed to particular socio-natural pressures, based on this

micromorphological study, one may conclude that periods of slow sediment accumulation may have preceded gaps in occupation phases. At the newly excavated area of Bronze Age Palaikastro, it appears that significant, slope-derived depositional episodes occurred immediately after MM I-II, MM III - LM IA (possibly with a first debris flow phase occurring post-MM III B), during/at the end of LM IB, and at the end of LM III occupations.

Breathing New Life into Archaeological Soils

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Soils are essential for achieving food security as FAO indicates they sustain 95% of the world's food production, additionally they have the potential to help mitigate negative impacts from climate change through the capture/retention of carbon as root stock. The management of soils/sediments and water across a landscape can be the most crucial factor for increasing its agricultural potential particularly in semi-arid areas, where water stress can occur. Worldwide irrigated agriculture accounts for 20% of the cultivated land and 40% of the global food production, with Sub-Saharan Africa having the greatest potential, according to the FAO, to increase food production, ultimately providing increased food security for areas in East Africa that are suffering from the effects of acute population growth. The identification of past soil and water management systems and the reclamation of soils that were once believed to have been abandoned due to mismanagement and ecological failure can help to reduce soil degradation; estimated to be 33% of agricultural land, globally. Over the past three years the AAREA project (Archaeology of Agricultural Resilience in Eastern Africa) has focused its attention on the abandoned agricultural landscape of Engaruka, NE Tanzania. This paper focuses on modern agricultural utilisations of the archaeological sediments and their reclamation from what was believed to be a degraded state. Furthermore, challenging assumptions that the highly visible irrigated landscape, which was employed to mitigate water run-off and prevent soil erosion, was not abandoned solely from climatic change and ecological failure. By applying geoarchaeological techniques, new evidence has been obtained that indicates geochemical composition and structure of the soil/sediment across the abandoned site are still viable agriculturally. Evidence will be presented that point to reclamation of the agricultural soils over a short period of time using local land-management skills, thus returning the abandoned land into sustainable agricultural production.

The Prospects for Geoarchaeological Interpretations of Medieval Dwelling Floors; Case Studies from Czech Republic

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The beginnings of Medieval towns in Central Europe (13th Century) are known just from archaeological excavations, therefore the demarcation of the medieval burger's plots is the main interest of urban archaeology. One of the discussed issues in medieval archaeology is recognition of differences between dwelling houses and farming-out buildings. Their type of construction, type of used construction material as well as floor plans are quite similar. One of the possibilities how to study differences between those two types of dwellings is to study their infillings. The basic methodological tools we suggest are micromorphology, geochemistry and phytolith analyses. There were macro and microscopically described laminated deposits within Medieval Age objects of different age and usage in the Centre of Brno. The sites are located at the edge of the old Brno Centre near town walls (Bašty) as well as in the very centre (Panenská street). The interpretation of the oldest object is farming house with preserved stabling (but not visible as a stabling in macro). According to the micromorphological study there was identified the composition of floor layers and using phytolith analyses was interpreted the composition of stabling. Grass and straw was used for bedding. Using micromorphology we can be sure that phytoliths found there are from stabling not from excrements. The interpretation of younger object is dwelling house with preserved deposits originated during daily use of house. Trampling was documented there. The material similar to the stabling was recognized also in deep hole nearby (working pit?, storage pit?, waste pit?). Upper part of the laminated infilling recorded in this pit was burned. The interpretation of this finding might be connected with the maintenance of the

storage pit. The lamination documented in the infill of the storage rooms was interpreted as a relict of the floors covered by remediation loess layers.

Where are the Mudbricks? A Geoarchaeological Analysis of Minoan Earthen Architecture

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The aim of this paper is to investigate earthen architecture as part of material culture focusing on the geoarchaeological analysis of selected samples from three Bronze Age sites in Crete. This research focuses on understanding the reasons of specific variation in construction techniques and manufacturing practices, raw source material selection and usage through the combined datasets obtained from XRF, XRD, FTIR and thin-section petrography. Specifically multivariate statistical analyses are performed to determine patterns of raw source collection over time and across the island, while technological choices are investigated through the use of petrography and archaeobotanical identification. The datasets indicate the presence of a precise labour organization behind earthen construction strategies in Bronze Age Crete. The main aim of this paper is to advance the theory of sediments as an important part of material culture and sheds light on earthen production process of an area which has not been fully investigated before. Finally the research highlights patterns in raw source materials procurement, construction and manufacturing practices, which have been largely impacted by the socio-political development of Bronze Age Crete.

Geoarchaeology Today: Perspectives, Debates, Future Directions

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Geoarchaeology has a relatively long history of development, but has recently taken off with advances in scientific analytical techniques, such as remote sensing, micromorphology, multi-element analysis, and FTIR, to name just a few. The high-resolution data provided by these methods deal directly with landscape reconstruction, cultural attitudes and perceptions of landscape, landscape modification, issues of subsistence, settlement, technology, daily activities, and sustainability, as well as material culture itself. Methods of geoarchaeological analyses can be as varied as the types of questions asked, and contemporary geoarchaeologists borrow techniques from earth sciences, geography, computer science, biology, ecology, and a number of other disciplines. Macro-scale analyses are employed in most archaeological projects and often govern the design of surveys, on- and off-site prospection, and excavation strategies. Although arguably lesser studied, microscale analyses suggest a revived role for middle range theory, now coming to the forefront in the name of geo-ethnoarchaeology (Friesem 2016; Shahack-Gross 2017). Here I address some issues I see in contemporary geoarchaeological research, with particular attention to discussing current trends in the field, issues of sampling, scale and context, the role(s) of theory in geoarchaeology, and how to teach geoarchaeology. The most significant debate is how to integrate the study of archaeological contexts or deposits with other lines of archaeological evidence; namely, situating geoarchaeology within the same theoretical footing as we seem to so easily do with other types of data. I highlight here that geoarchaeology is not a-theoretical. Context is everything and if we view archaeological deposits themselves as traces or artifacts of human behavior, then we can see this 'material context' as similar to how we view material culture: as the tangible and socially-meaningful embodiment of human experience, or 'being-in-the-world'. Within the framework of practice theory and contemporary approaches to human-landscape dynamics, geoarchaeological techniques for analyzing the daily activities of past people have great interpretive power for reconstructing the use of space within sites (and features) as well as deciphering the social relationships between people, places and things in a broader socially-constituted landscape. These interpretations depend on both understanding landscapes as cultural constructs, as well as deciphering the physical traces of its constituents. With this approach to geoarchaeology, its interpretative power is enormous.

Micro-Contextual Investigations of Organic Matter in the Archaeological Sedimentary Record

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Here, I provide an overview of the work carried out at the Archaeological Micromorphology and Biomarker Research Lab, Tenerife, Spain. Archaeologists are implementing an increasingly wide range of high resolution geoarchaeological techniques in search of new sources of behavioural information and most of these sources are inorganic (i.e., mineral). Although in recent years there has been considerable advance in applied organic geochemistry research, there is still a considerable gap between the organic and inorganic domains of geoscience. In an attempt to bridge this gap and enrich the archaeological and paleoenvironmental records from different time periods, our research team is currently carrying out interdisciplinary investigations of archaeological sediment from different sites through a microcontextual approach that integrates soil micromorphology, spectroscopy and biomarker research. Context lies at the core of our approach, as any potential clues about food items, clothing, bedding, fuel and the natural vegetation associated with past human groups that might be concealed in the sedimentary record can only be understood within its microstratigraphic spatial and temporary framework. One of our current projects focuses on archaeological charred matter, which has a high preservation potential and is common in archaeological sedimentary deposits and combustion features. We are exploring the thermal degradation pathways of different plants and animals to identify critical stages of biomarker loss and the formation of combustion-related biomarkers or pyro-biomarkers, as well as characterizing their micromorphological counterparts. In parallel, we are exploring Palaeolithic contexts to characterize microscopic charred particles and assess the preservation potential of biomarkers in very old charred matter from different sedimentary environments.

Developing High-Resolution Theoretically-Informed Geoarchaeology: Interdisciplinary Approaches to Changing Human-Fire Relations in Early Agricultural Environments and Communities

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The aim in this paper is to evaluate ways in which high-resolution theoretically-informed approaches can be applied in analysis of multi-scalar geoarchaeological data sets to explore the interconnectedness between environment and human ecology, technology and social roles and relations. As a case-study, this paper examines theories and approaches in investigation of the inter-relationships between fire ecology, fuel-selection, and the socio-economic context and specific uses of fire. Theories and approaches are drawn from ecology, anthropology, material studies and archaeology. The analytical techniques reviewed and applied include micro-charcoal analyses, micromorphology, biomolecular analyses by GC-MS and FTIR. The geoarchaeological data sets examined are drawn from landscapes and built environments that inform on one of the most significant step-changes in human lifeways and interrelations with environment and other species – the transition from mobile hunting-gathering to more sedentary agriculture in a key heartland of change, the Zagros region of Iraq and Iran, c. 12,000-8,000 BP. In the review and case-studies multiple links are investigated between human fire-use and environment, ecology, energy use, technology, the built environment, health, social roles and relations, cultural practices and catastrophic events. From the selected examples presented, it is evident that a wide range of ecological and social theories and analytical techniques are applicable in geoarchaeology and can be combined to develop interdisciplinary enquiries that encourage analysis of the multifaceted, multi-scalar and inter-related aspects and human-environment inter-relationships and in this case, the impacts of fire and thus bring us closer to robust consideration of alternate hypotheses and interpretations. The interdisciplinary analytical techniques reviewed enable identification of diverse fire-affected plant, dung, micro-artefactual and architectural materials, and high-resolution analysis of their precise associations and taphonomy, crucial to interpretation of the context, history and impact of fire and the specific linkages, couplings and interrelations between humans, environment and other species.

Artefact Preservation in Saturated, Tropical Cave Sediments: Constraining Site Formation Processes in the Humid Tropics Through Experimental Reconstruction of Sedimentary Palaeoenvironments

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Archaeological site formation processes active in the Pleistocene caves of the humid tropics are currently poorly resolved. This uncertainty impacts archaeological understandings of settlement patterns, subsistence strategies and hominin interactions in Southeast Asia, a region increasingly at the forefront of Palaeolithic research. Sedimentary environments inside caves have been a focus of geoarchaeological research in temperate latitudes, but our current understanding of post-depositional alteration of archaeological material within these environments is based largely on field observations. Post-depositional changes are often claimed to be accelerated by tropical climates, but these claims are difficult to relate conclusively to observed sedimentary features. To generate much-needed reference data and bolster our understanding of diagenetic processes in tropical regions, we are conducting experiments that involve the construction of stratigraphic sequences as analogues for sedimentary palaeoenvironments in tropical caves. A basal layer of sand provides a surface upon which archaeological material is distributed, representing a typical occupation deposit associated with modern humans. Each stratigraphic sequence has two, virtually identical sets of archaeological “artefacts.” Guano is deposited on top of this ‘cultural layer,’ and the sediments are saturated with water, simulating the anoxic, waterlogged conditions inferred from micromorphological analysis of excavated sites. Electrochemical data will be collected to characterise changing sedimentary environments, while a combination of analytical techniques, including X-ray analyses, vibrational spectroscopy and electron microscopy, will be used to observe the progression of mineralogical changes, organic taphonomic processes and element transport. Thin sections will be made to link the chemical and physical alterations affecting the excavated assemblage to visible micromorphological features. Excavations will be carried out at regular intervals, and include control samples, to allow for comparisons of diagenetic processes through time and under different environmental conditions. In this paper we will discuss our initial experimental results, together with a discussion of their broader implications.

An Integrated Ethno-Geoarchaeological Study of Small-Scale Nomadic Herding Sites in Woodland Environments

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Locating and interpreting camp sites of nomadic herders and hunter-herders is exceptionally challenging, especially in wooded environments. Yet, it is precisely these types of sites that need to be located if archaeologists are to understand the complex, changing relationships between humans and other animals during the Mesolithic and Neolithic periods, when Eurasia was dominated by woodland environments. In order to improve knowledge of probable site locations, site formation processes, and environmental impacts associated with small-scale animal husbandry and nomadic lifeways in forest environments, an ethnoarchaeological study integrating geoarchaeology and palynology was conducted at a site used by modern reindeer herder-hunters in the boreal forests (taiga) of Tofalaria, in the Sayan Mountains, south-central Siberia. Ethnographic research provided information on animal husbandry and hunting practices and on the topographic locations and internal spatial organisation of seasonal camp sites. Pollen and geoarchaeological analyses conducted on soil samples from a contemporary spring and autumn camp, including multi-element, magnetic susceptibility, soil micromorphology, and lipid biomarker analyses, were compared to the observed spatial organisation of human and animal activity areas to assess their effectiveness at detecting signatures for the presence of camp fires and small herds of reindeer and horses. The study highlights the fact that narrowing down the possible locations of nomadic hunter-herder camps in a wooded environment (or a formerly wooded environment) requires an intimate understanding of the needs of the animals and local environmental conditions. Once possible site locations have been identified in a particular study area, pollen and coprophilous fungal spore analysis, coupled with magnetic susceptibility and multi-element surveys, could help to identify the locations of camp sites. Finally, archaeological soil micromorphology and faecal lipid biomarker analyses of key areas identified in the magnetic susceptibility and multi-element surveys can confirm the identification of fire features and animal congregating areas. This ethno-geoarchaeological study demonstrates that an interdisciplinary approach that integrates multiple geoarchaeological and palynological techniques has the potential to locate and interpret the ephemeral camp sites of nomadic herders and hunter-herders.

Geoarchaeological Investigations of Aghitu-3, an Upper Paleolithic Cave Site in the Armenian Highlands

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Aghitu-3 is a cave site within the Vorotan drainage of southern Armenia. Recent excavations conducted by the Tübingen-Armenian Paleolithic Project (TAPP)—a collaboration between the Institute of Archaeology and Ethnography of the National Academy of Sciences of the Republic of Armenia and the Heidelberg Academy of Sciences and Humanities—have uncovered a rich record of Upper Paleolithic occupation dating between 40,000 and 24,000 cal yr BP. From a geoarchaeological perspective, Aghitu-3 is exceptional because it is a rare example of an archaeological site found within a basaltic blister cave. As such, it allows us to examine formation processes and post-depositional modification outside of the more usual karstic settings. Additionally, the TAPP team has conducted a wide range of supporting studies, including microfauna, pollen, charcoal and tephra analyses, which provide an excellent picture of environmental change in Armenia during the Pleistocene. Here we present the results of a geoarchaeological study of the deposits at Aghitu-3, focusing on the results of micromorphological, FTIR and μ -FTIR analyses. In particular, we address several key aspects of the Aghitu-3 sequence: a) the natural processes of infilling of the basaltic cavity during the occupation of the site, including the deposition and redeposition of tephra; b) the evidence for the construction of hearths; and c) post-depositional modification of the deposits, in particular the formation of ice-segregation lenses. For the final aspect, we compare the results of our analysis with those of other paleoenvironmental proxies, to test the reliability of the presence of freeze-thaw structures in cave deposits in reconstructing past environmental change.

The Battersea Channel Project: Geoarchaeological Deposit Modelling as a Unifying and Dynamic Resource for Historic Environment Mitigation and Dissemination

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The Battersea Channel, buried in part beneath the modern Nine Elms area of London, is hypothesised to be a relict Late Glacial landscape feature that formed a low-lying part of the prehistoric floodplain of the Thames. The Nine Elms redevelopment involves a £15 billion regeneration of 560 acres of central London along the South Bank from Lambeth Bridge to Chelsea Bridge, including the iconic Battersea Power Station. The large area and large number of sites under investigation has led to a rapidly increasing knowledge base (particularly in terms of deposit modelling and landscape reconstruction), albeit split between several archaeological organisations which might traditionally be seen as competitors, rather than collaborators. The number of sites being worked on simultaneously presents the risk that without rapid integration, areas of interest will be lost or not appropriately dealt with in the short time frames involved. This risk was recognised by Historic England, who consequently formed the Battersea Channel Project to attempt to bring together the key players working in the area. These organisations (predominantly MoLA, Wessex Archaeology and QUEST) are now sharing data and results freely and in real time, creating an unparalleled opportunity to develop our understanding of the landscape evolution and archaeology of a key tranche of land associated with the Thames and its palaeodrainage. As part of this talk we aim to: Present an overview of the Battersea Channel Project, the archaeological and environmental context of the Nine Elms development, and the importance of deposit modelling in guiding archaeological and geoarchaeological investigations; Present the results of deposit modelling and initial geoarchaeological works and consider how these data have advanced our understanding of the archaeology and landscape development of the Thames in the Nine Elms area; Consider how the methods and resources used to consolidate data from separate commercial unites (mainly MOLA, Wessex and Quest) can be used in the future to enable more dynamic integration of ongoing archaeological work.

A Multidisciplinary Approach and a Double Level of Validation for the Radiocarbon Dating of Lime Mortars

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This contribution discusses the importance of a multidisciplinary approach to the application of the radiocarbon dating method to mortar samples, and the need of a double level of validation of the related results for a successful application of the method in archaeological and/or historic research. Application of the radiocarbon dating method to mortar samples was first suggested in the 1960s. Since then, a number of procedures have been developed to successfully apply the method. Unfortunately, despite the simplicity of principles underlying this application, all studies have highlighted drawbacks and limitations, mainly related to the sample contamination from undesirable carbonaceous substances that can alter the results of the dating work. However, recent experiences have demonstrated that it is not just the removal of these contaminants that can guarantee the success of the dating work. Beside this problem, in fact, a number of other factors can affect the usability of the results in archaeological and historic research. These are, for example, the careful evaluation of the stratification in the structure where the samples are taken, the representativeness of the sample in relation to a specific construction phase, and the understanding of the behaviour of the material (i.e. lime) before, during and after its use. To make sure that all factors influencing the successful application of the method are considered, all results should be critically analysed before their use in the archaeological and/or historic research. To be effective, such evaluation should be carried out at two levels: 1) at sample level, in which the quality of the sample is evaluated (e.g. by comparing the results of different CO₂ fractions), and (2) at archaeological level in which the representativeness of the sample (even though uncontaminated) should be investigated. The correct application of the laboratory procedures to an uncontaminated sample, in fact, cannot rule out possible errors during the sampling work and, similarly, an AMS results apparently fitting the archaeological record cannot be acquired without an independent evaluation of the quality of the sample. Overall, this means that to successfully apply the radiocarbon dating methods to mortar samples, a multidisciplinary approach should be used. In such approach both, field and laboratory procedures should be carefully planned and carried out, and the results should be critically evaluated at archaeological and laboratory level before their use in historic and archaeological investigations. This contribution aims to highlight details and importance of such approach by presenting a number of cases in which the radiocarbon dating method was applied to mortar samples.

A Microcontextual Investigation of Combustion Features to Reconstruct Site Maintenance and Occupational Phases at the Upper Paleolithic Site of Satsurblia Cave, Georgia

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Archaeological sediments and features, such as combustion features, are mainly produced by human activity and hold information on these activities, for example site maintenance activities. Site maintenance practices are behaviours directed at keeping a site in a state that facilitates future use. Reconstructing site maintenance practices can inform us about site use, organisation of space, duration and intensity of occupation. Intensity of occupation is used to explore changes in mobility and is commonly measured by frequency of artefacts or dates, neglecting issues of site formation and neglecting combustion feature as a further artefacts class. This study investigates site maintenance activities (reuse of hearths, rake out, dumping of ash, trampling) and their diachronic and synchronic variability at Satsurblia Cave using the microcontextual approach. Satsurblia Cave has a rich Upper Paleolithic sequence that holds a multitude of combustion features and includes human occupation prior and after the Last Glacial Maximum (LGM), a time period of harsh climatic conditions. Recent archaeological research into the LGM explores the retreat into refugia, changes in mobility and occupation intensity. This paper presents micromorphological analysis and Fourier transform infrared spectroscopy on the combustion features at Satsurblia to reconstruct changes in site maintenance activities and fire use in response to the LGM.

Allerød Landscapes in the Lowlands of NW Belgium: Palaeoenvironmental Reconstruction and Geoarchaeological Mapping Approaches

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Palaeosols from the Bølling and Allerød are known in the sandy lowlands of NW Belgium since the 60s. They were mainly discovered in Lateglacial (Weichsel) deflation depressions, shallow lakes and paleochannels of the Scheldt river and tributaries. More recently, the Allerød landscape evolution has received particular attention in geoarchaeological studies of Federmesser culture hunter-gatherer landscapes. Two outcropping, shallow contexts - a Lateglacial dune pond and a freshwater palaeolake - were analyzed using a multiproxy palaeoecological analysis. These studies revealed a vegetational evolution from a tundra landscape during the Bølling (when the lake/pond was formed) and Older Dryas, over an open birch woodland during the Early and Middle Allerød and finally into a boreal pine forest during the Late Allerød. Three short climatic oscillations (GI-1d; GI-1c2 and GI-1b) were characterized by a colder, dryer setting and a temporary return to a shrub-tundra. Particularly the Early Allerød (GI-1c2) oscillation seems to have triggered more aeolian activity than the Older Dryas, leading to the further development of attractive settlement locations on sand ridges. Starting from these insights, Lateglacial palaeosols were mapped over extensive surfaces to find potentially sealed, well-preserved settlement locations of Federmesser culture hunter-gatherers. These sites could give insights into human responses to these rapid environmental changes. Thin peaty palaeosols could be correlated to a small peak in the Friction number of published Cone Penetration Tests. Several such peaks, separated by sandy sediments, were also observed at a new site between 6-8 m below the present surface of the embanked estuarine floodplain of the Scheldt river and lead to further CPT advances. Radiocarbon dates on terrestrial organic remains recovered from these palaeosols revealed the GI-1a, GI-1c1, and GI-1c3 of the Allerød. Thus, this deeply buried sequence provides palaeoenvironmental evidence lacking in the shallow archives, which end before the onset of the GI-1a.

Phytolith Analysis on thin Sections of Urban Dark Earth in Brussels. A State of the Art

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Phytoliths are plant microfossils that, due to their formation process, differ markedly from any other plant remains. Their incorporation within archaeological deposits relies on specific taphonomical processes. The common practice for studying phytoliths in soils is to take bulk soil samples with a trowel and to put them in a plastic bag. In the laboratory, the samples are subsequently put in various solutions and vigorously stirred. This results in phytoliths deriving from different taxa and/or plant parts, each with potentially different taphonomical histories, being mixed together. As soil thin sections allow researchers to document specific taphonomical processes, integrating phytolith analysis and soil micromorphology has the potential to be a valuable alternative to these disruptive extraction methods. Accordingly, if researchers hope to use phytoliths to reconstruct accurate local and regional vegetation histories for a site, such an integration to establish the depositional histories of the phytoliths is a useful and perhaps critical step. By focussing on medieval and post-medieval urban contexts from Brussels, this presentation will discuss the contribution of such an integrated approach by addressing two issues: the distribution patterns of phytoliths observed within soil matrices; does such analysis provide statistically valid data for archaeoenvironmental reconstruction?

Patterns of Flint Raw Material Procurement and Use in the Late Neolithic Through Early Bronze Age at Ein Zippori, Israel

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For the Neolithic period in the Levant, many studies have looked at the typology and technology of flint tools, as well as use-wear traces. However, little has been written about the raw materials themselves, nor about their geologic sources. During the Neolithic, and into the Bronze Age, dramatic changes in subsistence, site form and size and social structure occurred. These resulted, among other outcomes, in an increase in territoriality. Since territoriality directly relates to the exploitation of flint sources, lithic raw material studies can uncover patterns of land use, territorial ownership and social structure. We address this issue through the petrographic analysis of the lithic assemblages of the Neolithic to Early Bronze Age site of Ein Zippori, Israel. Using visual identifications and some thin-section analysis, we compare samples from the assemblages to geologic samples collected in the region of the site, in order to identify the types of flint used, their geologic sources, and the overall proportions of use of the types. Ein Zippori is located at an abundant source of flint, which was abundantly used, but the assemblages also contain flint from more distant sources, and there are differences in use of raw materials by tool type and through time, which indicate some selectivity in flint choices, even for flint from local sources. In addition, the non-local flints must have been obtained through a separate mechanism or mechanisms, such as trade, direct procurement, or through embedded procurement during other activities. Altogether, these results suggest that factors more complex than simple availability influenced the formation of the lithic assemblages at Ein Zippori.

Keynote speaker Jamie Woodward – TBC

An Integrated Micromorphological and Phytolith Study of Urban Dark Earths from *Atuatuca Tongrorum* (Tongeren, Belgium)

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Tongeren (*Atuatuca Tongrorum*) is the only Roman administrative capital within the borders of present-day Belgium. It developed in the first century AD and became an important *civitas*. Here, as in many European towns, the transition between the archaeological strata of Roman date and those of the High Medieval Period remains poorly documented. Many excavations in the centre of town have uncovered dark earths dating to Roman as well as early medieval times. These are typically thick, dark coloured, homogeneous deposits covering large surfaces. A large-scale excavation at Vermeulenstraat (phase 4, 2014) is the first occasion where dark earths from this town were sampled for micromorphological study and phytolith analysis in thin section. Three separate dark earths spanning the Early to Late Roman Period were analysed. The results indicate a range of different activities, such as cultivation, house preparation layers, waste dumping, uncovered surfaces and gardening, and their different formation histories illustrate the evolution of the area. While micromorphology has become an established method in the study of urban dark earths, its integration with phytolith studies is rare in this field. Especially in contexts where other botanical remains (pollen, plant macro-remains) are poorly preserved, as is the case in Tongeren, the study of phytoliths in thin section is a valuable tool to identify plant remains in archaeological deposits. Its integration within a micromorphological study improves our understanding of their taphonomy and function.

ABSTRACTS – POSTERS (in alphabetical order by first author surname)

Developing New Approaches to Dating Ancient Irrigation Features

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The surface mounds often found associated with irrigation systems such as qanats (ventilation shafts) and canals (banks) potentially contain a sequence of upcast that was deposited during the construction and subsequent maintenance of the irrigation system. The sedimentary nature and mode of deposition of the upcast is potentially suitable for the application of optically stimulated luminescence (OSL) dating techniques to obtain age estimates for the burial of the sediments. OSL has been successfully applied to qanat shaft mounds (Bailliff et al., 2015) and similar approaches have been applied to the dating of canal fill (e.g., Berger et al., 2004; Huckleberry and Rittenauer, 2014). Recent research has focused on the combined application of luminescence, sedimentological and micromorphological analysis of upcast mounds associated with qanat and canal features and we examine the extent to which a complete record of deposition since initial construction survives in upcast mound deposits examined in our recent studies of qanats in Spain, Morocco and Azerbaijan and a canal system in Azerbaijan.

Untangling Animal Management and Bioturbation at Beckery Chapel, Glastonbury, UK

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Beckery is the site of a medieval monastery and chapel and is situated on a small island of hard geology in the Avalon Marshes near Glastonbury, and was previously excavated in the 1880s by John Moorland and the 1960s by Philip Rhatz. Activity at the site began in the Iron Age continuing into the later medieval period when two stone chapels are built over the monastic cemetery. In May 2016 excavations led by the South West Heritage Trust excavated bodies from the chapel area (trench 1), a section across a ditch that appears to enclose the top of the hill (trench 3), and a new stone building identified by the geophysical survey (trench 2). Micromorphology samples were collected to understand the formation of sediments within a profile within this building dating to the medieval period: the upper layer was a layer of loose roofing stone that went across the whole building, possibly representing collapse of the roof after the dissolution of the monasteries. The deposits outside the building were different from those within, so it is possible that a lot of the deposit could have built up before the building was erected and no credible floor surface was observed during excavation. This sequence has been extensively reworked by earthworms and mites. With this caveat, micromorphology has tentatively established a sequence of events with two possible phases of animal penning characterised by concentrations of sub-angular aggregates dark brown organic sediment, possibly representing reworked interfaces between non-constructed floor surfaces and overlying dung. The sequence contain a wide range of microfossils in thin-section, including coprophilous fungal spores, parasite eggs, and phytoliths, which are being investigated further with extractions. This building was used to house animals rather than as a domestic living space, which may explain the absence of an actual floor surface.

Paleoecology, paleogeography and geoarchaeology of Cape Smith, Nunavik, Canada

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Cape Smith is an island near Akulivik, located on the northeastern coast of Hudson Bay (Canada). The Inuktitut name for the island is Qikirtajuaq. The Kangiakallak site (JeGn-2) is a large multicomponent site including Dorset and Thule/Inuit occupation located in a valley in the northeastern part of the island. The Dorset built shallow semi-subterranean houses on top of the highest portion of the valley. Not far later, the earliest Thule/Inuit inhabitants of Nunavik constructed much deeper semi-subterranean sod houses (qarmait) on the edge of the beach ridges. The proximity of a partial polynya situated between the island and the mainland most likely explain the presence of numerous winter houses in the area. The Kangiakallak site is also important as it was among the first Nunavik sites excavated in the 1940's and 1950's (Manning 1951; Avataq, 2015). The combination of paleoecological, paleogeographical and micromorphological data with archaeological and historical data made it possible to document the evolution of Holocene paleoenvironments and

the habitability of the northeastern of Cape Smith, as well as the interactions between humans (Dorset, Thule/Inuit) and the environment in the context of climate change. In this poster, we will provide a synthesis of the data from this interdisciplinary research.

Micromorphology of Domestic Space in an Early Medieval Village: Anthropogenic Dark Earth from “S. Stefano di Poviglio” (Northern Italy)

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This paper presents the results of the geoarchaeological study of the stratigraphic sequence exposed during excavations in the historical center of the village of Poviglio (Emilia Romagna, N Italy), located in the vicinity of the Po River. The area, also referred to as “Santo Stefano di Poviglio”, revealed an exceptionally well-preserved Anthropogenic Dark Earth sequence, including occupation deposits and wooden structure remains. Both thermoluminescence dating and analysis of archaeological data (pottery and timber structure remains) confirm that the medieval village of Popilii was active between the 9th and the late 11th century A.D. The sealing of the sequence due to the construction of a stone stronghold in the 13th century together with the waterlogged nature of the site prevented homogenization by bioturbation in the well-stratified deposits and reworking by later human activities. Geoarchaeological observations in the field and the micromorphological study of soil thin sections allowed the reconstruction of the natural and anthropic processes involved in the formation of the site stratigraphic sequence. Making use of soil micromorphology we defined different Soil Microfabric Types (SMT) and Micro Facies Types (MFT) of a polyphased sequence of occupation surfaces: particularly interesting is SMT 3C, that consists in a floor made by lime-based plaster. The model observed at Santo Stefano di Poviglio could partly explain the strong vertical accretion of urban deposits during the Middle Age and provide a possible way of formation for Anthropogenic Dark Earth sequences in medieval rural settlement in Northern Italy.

Preliminary Results of an Inter-disciplinary Palaeoenvironmental Investigation at a Middle Palaeolithic Rock Shelter (Abric del Pastor) in Alicante, Spain

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Our current understanding of Neanderthal palaeoenvironments is largely based on palynological/anthracological data and more broadly marine isotope data. These datasets yield valuable environmental and climatic information at a regional, global or millennial scale but overlook the probable existence of localised microhabitats or econiches. This represents a considerable draw-back to the study of Neanderthal environmental interactions and behavioural ecology. The PALE-OCHAR ERC project is developing a novel inter-disciplinary approach which seeks to investigate microscopic and molecular organic remains at Neanderthal sites in order to approach their environmental context at a high temporal and spatial resolution, down to the microstratigraphic scale. Specifically, this research targets charred organic residues preserved in thermally altered sediments associated with combustion structures. Recent studies have highlighted these features as potentially rich repositories of well-preserved organic matter. Here we present preliminary results of a palaeoenvironmental investigation at Abric del Pastor, a small rock shelter situated in the Mariola Mountains of Alicante, Spain, which has yielded evidence for multiple Neanderthal occupation episodes. Activity at the site is chronologically situated on the cusp of a poorly understood transition from relatively mild climatic conditions in MIS 5 to less favourable conditions in MIS 4, which is marked by a rapid decrease in temperatures and the onset of the last glacial cycle. This study incorporates a suite of complementary methods which include soil micromorphology, lipid biomarker characterization and compound specific isotope analysis. Early results are encouraging and highlight the utility of this approach for high resolution investigations of past ecosystems.

High-resolution Thin-section Scanning

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Digital images of thin-sections are traditionally either limited to their resolution or the area which they cover. Our novel method of using commercial film-scanners, not only provides high-resolution images that cover an entire thin-section, but also offers new possibilities for micromorphological workflows, analyses and publications. In established workflows, commercial flat-bed scanners were used to cover an entire thin-section on macro-scale, whereas micrographs showed details on a higher resolution. More recent methods such as macro-photography and micrographs-mosaics from microscopes with motorized stages, already addressed the demand for large-scale images with a high detail-level. Although these methods provide satisfying results, our comparative analysis of all methods indicated that film-scanners combine most of the benefits with very few disadvantages. Due to their original purpose for digitizing films from small dia-positives up to medium-format- negatives, film-scanners provide excellent conditions for the digitalization of thin sections. Similar to flatbed scanners, they cover an entire thin-section seamless, either in plain- or cross-polarized light, within a single scan process. Additionally, the inbuilt lense-system provides high resolution images with almost no optical distortion as known from microscopes or camera lenses. Our experience demonstrates that the simple and quick availability of a digital thin-section at high-resolution significantly enhances the micromorphological workflow. The level of magnification (30-40x) is sufficient to considerably reduce microscope-time. As a spatial reference system, the images keep a record of features and provide an additional analytical context. Furthermore, the concept of the image as digital archive allows to preserve and to share the thin-sections for collaboration and educational purposes.

Tracing the Properties and Use of Flint Tools

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Flint and other siliceous lithics were the most important raw materials for stone tools for the vast majority of human history. Due to their good preservation, artefacts made of these materials are often the only surviving source of information we have about human history throughout the greater time of Stone Age. Therefore, lithic analysis is a popular research topic in geoarchaeological studies. More precisely, characterisation of these raw materials is a highlighted topic and has a rather long research history. Microwear analysis is a method that investigates the use of tools, more precisely the microscopic surface alterations that reflect the contact material that has been worked with the tool and the techniques of use. Therefore, this approach is crucial in our understanding of past daily life and technologies. The characteristics of the raw material highly affects the development of microwear traces. Moreover, post-depositional processes, such as patination and burning, have an influence on the preservation of these traces. Our research project aims to explore these connections. Different techniques are used to investigate flint characteristics, weathering processes and the relation between both, as well as the development of microwear traces and their preservation. Replicas of prehistoric stone artefacts will be analysed on microwear traces, both before and after experimental weathering (patination, burning, etc.). The possible use of different archaeometrical techniques will be tested in both phases. The outcome will be the development of a protocol for the registration of microwear traces and weathering processes using new, and non-destructive methods, such as high resolution X-ray computed tomography, SEM-EDX, XRF and others. The protocol will be further tested on prehistoric artefacts from sites that belong to the transitional period of Final Mesolithic-Early Neolithic of the Scheldt valley in NW Belgium.

A Coupled Micromorphological and Molecular Study of Combustion Structure Assemblages at the Middle Paleolithic Site of El Salt, Spain.

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Our current knowledge on Neanderthal behavior is mainly based on the inorganic record of archaeological sites and the organic archaeological record is commonly overlooked. However, the main components of human contexts are organic in nature and there are a growing number of studies showing great potential for the preservation of microscopic and molecular organic remains in archaeological sediment. In this study, we present results from a coupled micromorphological and biomolecular study of a series of combustion structure assemblages from the Middle Paleolithic Site of El Salt, Spain. We conducted a microcontextual analysis whereby we identified and correlated different combustion-related microfacies and performed lipid analysis of samples from these microfacies. Our multi-proxy microstratigraphic approach has provided information relevant to Neanderthal behavior related to fire at a high temporal resolution. We distinguished among different human occupation episodes, identified discrete combustion structures and characterized sources of fuel, as well as other organic matter present in the underlying substrates. Coupled with field observations and other sources of archaeological data, these results will advance our understanding of Neanderthal behavior at El Salt through time. This study is part of the PALEOCHAR ERC research project, based at the Universidad de La Laguna, Tenerife, Spain, an interdisciplinary project to characterize contextualized charred organic remains preserved in Neanderthal sites as a way to approach their behavior and demise.

Micromorphological Evidence of Water Management and Well Abandonment Phases in the “Terramara Santa Rosa di Poviglio” (N Italy)

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Soil micromorphology in thin section was applied to the study of processes in the water management of the “Terramara Santa Rosa” located in Fodico di Poviglio (N Italy). In this site have come to light numerous structures and wells intended to draw and distribute water. Their number, size and complexity show precise planning, a considerable investment of time and work to achieve them and a particular attention to the exploitation of water resources. The micromorphological analysis of the fills of the well structures allowed to distinguish the main stages in their history and the differences between various zones. In the fence area of the site two different facies are described: a “laminated facies”, with the alternation of clays and silts with lenses and sand laminae, testifies the use phase of the wells due to the pumping of the aquifer and the presence of turbidity. The “decantation facies” above is massive, clayey and rich in organic matter, with presence of vesicles and bioturbation. This is related to the abandonment phase of the site, characterised in this area by the presence of stagnant water with moderate biological activity. In the moat area, more external to the inhabited village, the same laminated facies is found, but above it is a massive “clayey facies”, rich in hydromorphic features, lithorelicts and charcoal. This suggests a different development of the abandonment phase with rapid natural degradation of the well sides, or in some cases with the intentional filling of different well structures. These findings, in combination with the study of the archaeological remains, suggest phases of water shortage and show how the change in water availability and management was key in the collapse of the Terramare culture in N Italy.

Micromorphological Study About Floors to the Early Iron Age: The Case of Calvari del Molar Settlement (Tarragona, Spain)

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We present a micromorphological study of an archaeological profile of the Early Iron Age in the NE region of Iberia. This profile corresponds to the sector VIII of the archaeological site of Calvari del Molar (Tarragona, Spain) and contains several stratigraphic units identified in the field as basically different floors and a bench.

Through the micromorphological study we have distinguished the two main moments of use of this area. This has been possible thanks to the clear identification of the two floors, with their levels of preparation and even the time of abandonment and filling. These pavements are composed mainly of a yellowish-gray sand groundmass of quartz and calcite with a massive microstructure. These contrasted with the filling moments of the area and with the earthen structures (fragments of constructive elements or the bench). Both components of different sediments which are more clayey and more reddish. With the micromorphological study we have identified components of all stages of the area, from their own flooring, the filling between the two pavements, the level of preparation of the pavement and to characterize the bench. We have also done a study comparing different geologic formations around the site to determine in particular the origin and possible treatment of these sediment layers, included in or used in the preparation of these earthen structures. In short, we present the results of the application of the micromorphology in the study of a protohistoric archaeological site. Overall, we obtain the general interpretation of the archaeological site from its construction and determining what materials and sediments were used, including their use and their destruction, and final filling. We believe these studies, though not very traditional in these time periods in this geographical area, are necessary and with great potential.

Using Microscopic Characteristics to Predict the Knappability of Flint

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Flint knapping is surprisingly complicated, although it has been done by humans for millions of years. It is known that the way in which flint is knapped is largely dependent on the way it is struck, and that the quality differs between samples; however, there is a lack of research into the influence of microscopic characteristics on the knappability of flint. The purpose of this study, therefore, is to determine what microscopic properties have an impact on the knappability of flint. A literature search was conducted to establish whether any characteristics have already been identified. Thin sections of 10 flint samples were studied, and their properties, such as grain size and shape, percentage of non-silica minerals, presence of fractures, and presence, size and mineralogy of microfossils, were evaluated. Based on these properties, a prediction was made as to the ease of knapping of each sample. The samples were then knapped and rated as easy, moderate, or difficult; additionally, the bulb of percussion was measured to estimate the relative force needed to knap the sample. It is hypothesized that any irregularities disrupting the cryptocrystalline structure of the flint will negatively impact its knappability. Thus, if the flint contains grain irregularities, non-silicate minerals, microfossils, or fissures then it should demonstrate poor knapping quality. The results will determine whether it is possible to use microscopic properties to predict the quality of any given flint sample. It is not likely that early humans chose flint for stone tools based on its microscopic qualities, but improving our ability to identify which samples are more easily knapped may provide some insight into their decisions about which flint sources to use.

A Geoarchaeological Investigation of the Site Formation of Cuncaicha Rockshelter, Peru

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Cuncaicha Rockshelter, situated in the Pucuncho Basin in the southern Peruvian Andes northwest of Arequipa, is one of the most outstanding Paleoindian sites in South America. Cuncaicha Rockshelter has been excavated between 2010 and 2015, revealing an extraordinary multi-component archaeological record. With earliest ages of 12,400–11,800 cal yr B.P., it provides some of the first insights into early settlement of South America and the initial colonization of high-altitude settings. Therefore, a multidisciplinary geoarchaeological examination of Cuncaicha to investigate the site's integrity and study its formation history is of utmost importance. The goal was to develop a stratigraphic chronology, tied to geological formation processes, and to assess the role of bioturbation at the site. Micromorphological analysis, complemented by pedological and FTIR analyses, could confirm the previously suggested stratigraphic sequence. Besides geogenic and biogenic inputs, anthropogenic material, especially combustion related residues, e.g. ashes, contributes

greatly to the sediment in the deposits at Cuncacha Rockshelter. Furthermore, the formation of a soil horizon in the stratigraphic sequence could be confirmed and linked to post-depositional processes, e.g. decalcification, in the deposits. Moreover, the formation and diagenetic alteration of a tufa layer at the transition from Terminal Pleistocene to Early Holocene sediment could be identified. The soil formation, as well as the formation of the tufa layer, links to paleoclimatic changes, which have been reported in the Andean paleoclimatic record from the Terminal Pleistocene to the Early Holocene. Furthermore, they coincide with phases of stasis in the deposition at Cuncacha Rockshelter.

Geoarchaeological Research at Bizmoune Cave, Morocco

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Bizmoune Cave is a Middle and Later Stone Age archaeological site located in a coastal zone near the modern town of Essaouria. Intensive excavations and geoarchaeological research at the site began in 2014. Geoarchaeological work has focused on reconstructing the broad formation processes of the cave, history of infilling and erosion, mode of sediment deposition, and taphonomy of anthropogenic deposits and features. The main methods of analysis include (1) 3D modeling of the site with photogrammetry, (2) documentation of sediment composition, structure and fabric using micromorphology, (3) mineralogical identification using Fourier transform infrared spectroscopy (FTIR) and x-ray diffraction (XRD), and (4) mapping of element distribution within the sediments using microscopic x-ray fluorescence (μ -XRF). The cave is formed in a calcareous bedrock consisting of layers of dolomite and limestone. The cavity appears to have formed due to a combination of mechanical weathering and karstic dissolution along a fault scarp. Large tufaceous bioconstructions and flowstones indicate that dripping and flowing water – possibly associated with a former spring system – contributed to sedimentation and cementation of the archaeological deposits. Micromorphology reveals that the sediment is rich in anthropogenic materials such as microscopic fragments of charcoal and bone; however, bioturbation has disturbed the original depositional fabrics and recrystallization has impacted the preservation of ashes.

Palaeoenvironmental reconstruction through mechanical coring along the SW margin of Pompeii (Italy)

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In the frame of the project MACH, carried out by University of Padova, ten mechanical cores were drilled along the SW margin of the city of Pompeii. This area is contiguous to the façade of the s.c. "Terme del Sarno", a thermal complex currently dated to the beginning of 1st century AD, which constitute the SW city limit. Here, it was possible to investigate the deposits (and thus the environment) occurring around the city until they were buried by the pyroclastic materials of the famous eruption of 79 A.D. These represent a unique chrono-stratigraphic marker and also allowed for an excellent preservation of the sediments they sealed. Mechanical cores allowed us to establish the presence of a palustrine-marshy area in this part of the landscape, characterised by an accumulation of organic muds. These materials will be made object of absolute dating, pollen and micromorphological analyses, in order to provide a high-resolution reconstruction of the environment south of the Terme del Sarno complex before and during the Roman period.

Biomolecular and Micromorphological Analysis of Suspected Fecal Deposits at Neolithic Asıklı Höyük, Turkey

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Suspected fecal matter from the Neolithic site of Asıklı Höyük in Turkey was analyzed using biomolecular and micromorphological approaches to study behavioral and environmental processes in an early settlement context. Archaeological excavations provide evidence for five main occupation phases during the 8th and 9th millennium B.C. The settlement of Asıklı Höyük is mainly characterized by its mud brick buildings with a distinctive settlement pattern and burials. Data obtained during excavation represent transitional characteristics of a forager/producer community which makes it a significant site in the context of early sedentism outside the Fertile Crescent. Suspected fecal materials from midden and open space deposits (e.g. dung layers, coprolites) were analyzed using gas-chromatography/mass-spectroscopy to determine their chemical composition and distinguish between fecal and non-fecal sources. Steroid biomarkers such as coprostanol and bile acids were used to differentiate between human and faunal excrements and to assess the degree of chemical alteration. Additionally, micromorphological observations in thin sections allow a further differentiation between environmental and behavioral processes and identification of associated materials (e.g. phytoliths, bones) within the site. The project contributes to a better understanding of how and where people in the past disposed their waste within a site. Furthermore, this study expands the existing knowledge of the neolithisation process in Anatolia and may result in implications for the transitional period from humans subsisting as hunter-gatherer to sedentism and early agriculture.

Investigating the nature and timing of the earliest human occupation of North America using a novel integration of biogeochemistry and micromorphology

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Coprolites contain a suite of biomolecules and microfossils, making them incredibly useful palaeoenvironmental and palaeodietary archives. The short-term nature of their production within the human body offers a very high temporal resolution, contrasting with traditional dietary proxies in archaeology such as skeletal C/N isotopes, which give an average lifetime signal. Some of the earliest evidence of human occupation in North America is a coprolite from Paisley Caves (Oregon, USA) which contained ancient human DNA in a matrix dated between 14,170 to 14,340 cal BP. However, there have been debates over the stratigraphic integrity and preservation of the aDNA. This debate is difficult to resolve as there is currently little understanding of the nature of biomolecule taphonomy and movement within the cave environment. Before broader questions of palaeodiet and resource use of these early settlers can be investigated, the identification of coprolite proxies as human or otherwise must be confirmed, and their stratigraphic integrity assessed. This research aims to address these issues by using a novel integration of biogeochemistry, compound specific radiocarbon dating, and sediment microstratigraphy to investigate the survival and taphonomy of different biomolecules within the cave environment and to understand how these early settlers interacted with their seasonal environment.

Dynamics of Upland Field Systems in the Central Caucasus: A Multidisciplinary Approach

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The Caucasus has long been recognised for its distinct geographical position, connecting the Near East with the Russian Steppe to the North and providing key route-ways for the movement of people, animals and commodities through the landscape. Such analyses has generally focused on route systems, especially in upland areas, but an interesting aspect of these landscapes is the unique preservation of complex field systems and terraces in well protected isolated hilltop areas. Our knowledge of the settlement chronology, landscape management and environmental history in remote and highly dynamic mountainous landscapes, such as the Central Caucasus, remains limited. This research aims to provide a new multidisciplinary approach to the study of field-systems in this region, combining settlement data, luminescence dating, bulk sedimentary characterisation and micromorphology to understand the timing, impacts and scale of Late

Antique and Medieval landscape management and agricultural practices. This in turn can be integrated into our growing body of knowledge on the social and political history of the region during these periods.

Micromorphological Approaches to the Formation and Biographies of Early Medieval Towns in Northwest Europe

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Even after decades of intensive research, the complex stratigraphy of many early medieval and Viking towns in continental Europe remains poorly understood. Debate continues about crucial aspects such as their origins, the changes they underwent through time and, in some cases, their supposed 'decline'. By applying micromorphology, a new set of geoarchaeological data is created to complement existing archaeological and written sources of information. Micromorphology is an effective method for the research of complex sites and the technique is highly applicable to two types of challenging stratigraphy commonly present at urban sites: microstratified units, and thick homogeneous units termed "dark earths". Five case studies (Kaupang (Norway), Hedeby (Germany), Tongeren, Antwerpen and Lier (Belgium)) demonstrate how micromorphology, in combination with associated geoarchaeological methods such as textural analysis, μ XRF elemental analysis and phytolith analysis of thin sections, can tackle questions that range from the basic understanding of stratigraphy, site formation processes and environmental context, to the identification of different activities. The results are grouped into seven themes, together constituting a biographical interpretive framework: (1) pre-town environments and predecessors, (2) town foundations - earliest evidence for settlement or built environment, (3) urban living: evolution of activities through time, (4) the functions of buildings, (5) spatial organisation, (6) moving on - the youngest early medieval urban phases, and (7) post-depositional transformations. This framework makes it possible to gain a deeper, more detailed understanding of the sites' evolution through time as well their spatial organisation, and to mutually compare them without losing sight of their individual idiosyncrasies. At the same time, this approach bypasses a generalising discourse of early medieval towns. By juxtaposing the results of these five case studies with existing debates on early medieval towns, a number of set historical narratives can be challenged.

Phosphorus Concentrations as a Proxy for Identifying Ancient Activities in Urban Dark Earth: The Example of Brussels (Belgium)

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Urban stratigraphy is characterised by complicated sequences resulting from many superimposed phases of human occupation and activity. Parts of these deposits are difficult to interpret solely based on field data. One typical example is "Dark Earth": thick, dark coloured, humic, homogeneous archaeological deposits covering large areas. The present contribution discusses the potential of applying near total and inorganic phosphorus analyses as a quick and relatively cheap method to obtain a preliminary characterisation of such urban deposits. For the town of Brussels (Belgium), a large database of 12 types of well-identified urban deposits was created. Despite a series of post-depositional processes, such as bioturbation and redox changes, that affected most of these urban deposits, significant differences in near total (P_{nt}), inorganic (P_i), organic (P_o) phosphate levels, and/or P_{nt}/P_i, P_{ni}/P_o ratios were observed in most types of deposits, thus enabling the rapid characterisation of urban dark earth deposits in Brussels.

Cultural Layers of the Central Part in Krakow (Poland) as Example of Heterogenous Profile Conditioned by Medieval Activity in the Light of Micromorphological Studies

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The study, related to pedology, micromorphology, geology, geoarchaeology as well as history of soil formation, was aimed to reconstruct pedological process based on an excellent preserved soil profile exposed during archaeological excavations carried out in the Main Market Square (MMS) of Krakow (Poland) in 2007. This study assessed the impact of human activity on the properties of urban soils and the formation of cultural layers (CLs) over several hundred years by examining the micromorphological, physical and chemical features of those soils. The study on CLs allows to better understanding the human impact on soil environment. Studies based on the soil material originated from CLs allow also to reconstruct soil's formation history caused by anthropogenesis, get to know the interaction degree between the man and soil environment and assess the degree of soil contamination, as well as the changes induced by human activity. In this study the 'A horizon Development Index (ADI)' have been introduced. ADI was used to assess the degree of advancement of pedogenesis in the different layers. The primary methods of quantitative and qualitative evaluation of the artefacts are micromorphological studies. Macroscopic observation allows determination of the composition of CL unveiled in archeological excavation and more detailed aspects of the inherent structure and soil properties. Cultural layers were distinguished from natural horizons by microstructure type, porosity and $c/f_{5\mu m}$ related distribution. Moreover, artefacts described in the soil thin sections came from CLs generally. Micromorphological properties helped to divide profile partition. In the presented soil thin section lithological discontinuity (LD) was found - which manifests itself in the form of cultural layers (CLs) overlaid on the natural, buried soil.

UNESCO Global Geoparks, Developing International Geoarchaeology

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North West Highlands Geopark
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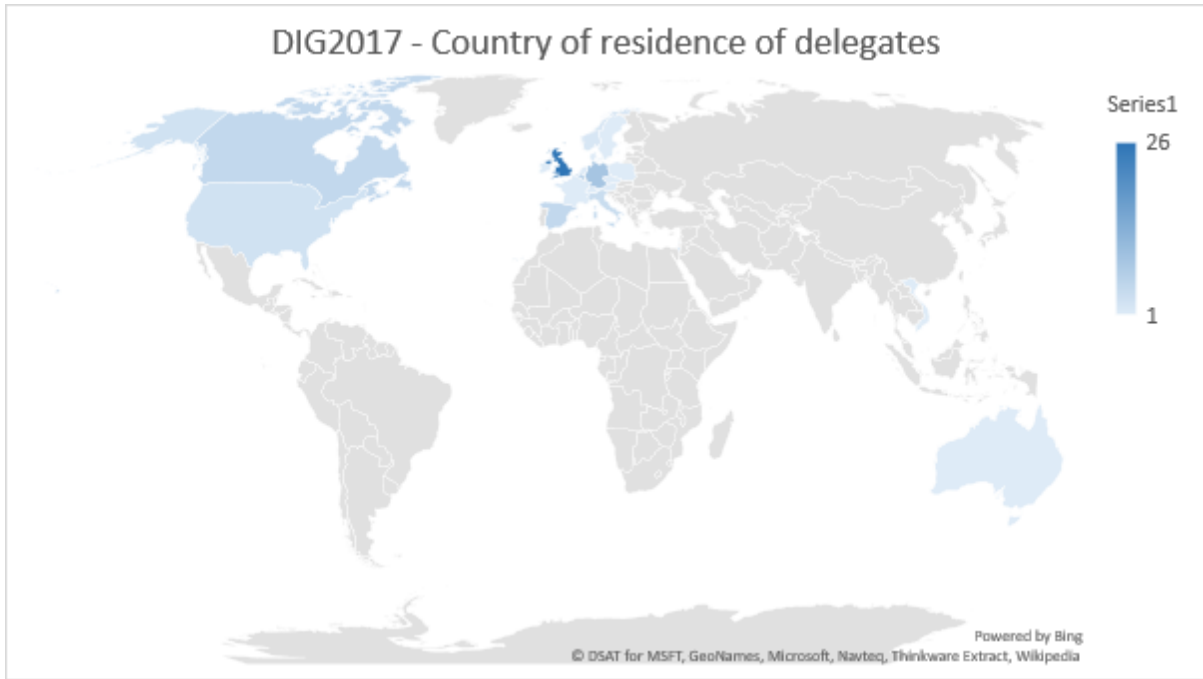
UNESCO Global Geoparks are territories with landscapes of international geological significance, managed with a holistic concept of protection, education and sustainable development. In 2015 the 195 member states of UNESCO ratified the creation of a new label; the UNESCO Global Geopark, which bestows these regions with the same level of recognition by the United Nations as World Heritage Sites. Global Geoparks exist to tell the stories of their landscapes and the natural and anthropological evolution which forges them. This helps to enhance awareness of the issues facing society today. For example; sustainable resource use, climate change or natural disaster risk reduction. Geoarchaeological theory meshes well with the aims of UNESCO Global Geoparks as both seek to develop new understandings of landscape evolution and how it is influenced by and influences people. Through raising awareness of the importance of their regions geological heritage in history and society today, Global Geoparks help communities to acquire a deeper understanding of their heritage. Through forming partnerships with Global Geoparks, geoarchaeological research can provide the contribution to knowledge which can be practically transferred into communities for public benefit. This poster demonstrates two ways Geoarchaeology is already working in practice with the North West Highlands UNESCO Global Geopark. It is anticipated it will inspire researchers to form partnerships with the 127 Global Geoparks across the world. Partnerships can enhance the public benefit of geoarchaeological research and also provide additional strength to leveraging research funding.

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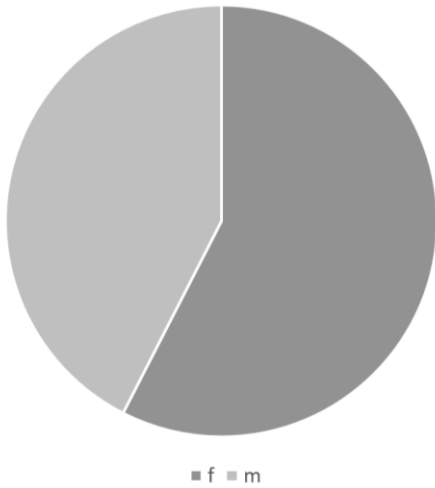
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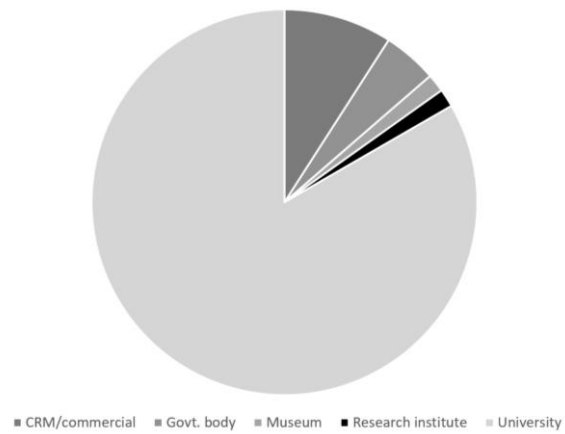
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Career Stage



Sector



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