Environmental and Archaeological Science Conference
AEA & UKAS 2013

Cardiff University 11th-14th April 2013

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Thursday 11th April

12.30 Registration opens. The Council Chamber, Main College Building, Park Place
Authors of posters should either mount their poster on the allocated board in the Council Chamber or conference assistants can mount the poster during the presentation session. Oral presentations are in the Wallace Lecture Theatre, Main College Building, South Wing

Session 1: Lifeways and Subsistence
Session Chair: Penny Bickle

13.45 Mulville, J. Welcome and announcements
14.00 Owen, J. Domestication and Heterochrony in Sus scrofa
14.20 Linderholm, A. What can 60000 single nucleotide Polymorphisms tell us about admixture between local and domesticated pigs in South East Asia?
14.40 Madgwick, R. Integrated approaches to the study of European Fallow deer (Dama dama dama): Trade, treatment and translocation.
15.00 Boulden, K. Quantifying faunal isotopic variation in the British Isles
15.20 BREAK
15.50 Salque, M. Earliest evidence for cheese making in the sixth millennium BC in Northern Europe
16.10 Smyth, J. Bubbling over: organic residue analysis and the Irish Neolithic
16.30 Stewart, J. What can eggshell tell us about the past?
16.50 END

The technical sessions will be followed by a wine reception in the Council Chamber. The public archaeological science ‘question time’ event will follow, in the Reardon Smith Lecture Theatre of the National Museum Wales, from 18:30.
Friday 12th April

8:30  **Registration opens.** The Council Chamber, Main College Building, Park Place
Oral presentations are in the Wallace Lecture Theatre, Main College Building, South Wing.

**Session 2: Lifeways and Subsistence (contd.)**
**Session Chair: Richard Madgwick**

9.10  **Jauss, C.** Investigating food politics at the time of urbanization in Mesopotamia. Potentials of an integrated approach.

9.30  **Colonese, A.** Assessing dietary variability in South America hunter-fisher-gather: collagen stable isotopic analysis of human remains from Brazilian Sambaquis

9.50  **Mannino, M.** Mediterranean hunter-gatherer diets in the late Pleistocene: an isotopic study of the Gravettian and Epigravettian humans buried at the Arene Cadide cave in Liguria (Italy)


10.30 **Montgomery, J.** Strategic and sporadic marine consumption at the onset of the Neolithic: increasing the temporal resolution in the isotope evidence

10.50 **BREAK**

11.20 **Dobney K.** Dental palaeomicrobiology: A new way to explore past diet and health.

11.40 **Lewis, J.** Lying through your teeth: strontium diagenesis in archaeological enamel

12.00 **O'Connell, T.** The diet-body offset in human nitrogen isotopic values: a controlled dietary study

12.20 **Stevens, R.** Are bone and intra-antler collagen $\delta^{13}C$ and $\delta^{15}N$ equivalent.

12.40 **Howcroft, R.** Season to taste - Infant feeding practices of the pitted ware culture in the Central Baltic

13.00 **LUNCH**

**Session 3: Populations and relations**
**Session Chair: Richard Madgwick**

14.00 **Lebrasseur, O.** DNA dog tales: reconsidering the dispersal of Lapita societies into Remote Oceania through the genetic signatures of dogs

14.20 **Trinks, A.** Of mice and ocean-going men

14.40 **Grimes, V.** The basque of 'Butus': life at a 16th century whaling enterprise in the New World

15.00 **Ewonus, P.** Interpreting village settlement variability in the North Pacific Salish Sea

15.20 **BREAK**

15.50 **Martinez-Jarreta, B.** Skeletal analyses allow to retrieve valuable data of early Medieval ancestors of the Spanish royal family: an interdisciplinary approach

16.10 **Gerling, C.** A mobile elite? Stable isotope analysis of Iron Age human and faunal remains from Central Asia.

16.30 **END**

We have reserved Gwdihŵ bar in the town centre to meet for drinks from 18.00 onwards. Please see the map enclosed in your registration pack for directions.
Saturday 13th April

8.30  **Registration** Opens. Authors of posters should either mount their poster on the allocated board in the Council Chamber or conference assistants can mount the poster during the presentation session. Oral presentations are in the Wallace Lecture Theatre, Main College Building, South Wing.

**Session 4: Environment Landscape and Climate**  
**Session Chair: Dušan Borić**

9.10  **Macklin, M.** River dynamics and the Neolithic of the Lower Danube catchment
9.30  **Johns, C., Charman, D. et al.** Paleoenvironments and sea-level change from inter-tidal and sub-tidal sediments of the Isles of Scilly
9.50  **Russell, J.** Geoarchaeological investigations on the Dogger Bank, North Sea
10.10 **Huckerby, E. and Druce, D.** Tales of the river bank: prehistoric environments and occupation along the River Eden, Carlisle, Cumbria
10.30 **Abrunhosa, A.** How new documentation can shed light on a 1930s digging methodology
10.50  **BREAK**
11.20 **Vaughan, A.** A carbon and oxygen isotope analysis of faunal tooth enamel from the Iberomaurusian layers at Taforalt, Morocco: did environmental change contribute towards changing human activity
11.40 **Muldner, G.** Animal husbandry in the Flemish coastal plain, 1st to 15th century AD: a stable isotope approach.
12.00 **Fuller, B.J.** Radiocarbon dating and isotopic analysis of Pleistocene fauna: a novel method for tar
12.20 **Taché, K.** Integrating multiple data sources to investigate pottery uses among hunter-fisher-gatherer communities: a case study from the Eastern Woodlands of North America.
12.40 **Flohr, P.** The reconstruction of past water availability using crop isotopic composition
13.00  **LUNCH**
Saturday 13th April

Session 4: Environment Landscape and Climate (Continued)
Session Chair: Oliver Craig

14.00  **Stallibrass, S.** What's so great about northern Britain? 30,000 Roman soldiers recommend Hadrian's Wall

14.20  **Brace, S.** Rice rats of the Caribbean: human impact on rice rat colonization in the Lesser Antilles

14.40  **Lodwick, L.** A multi-proxy reconstruction of townscape and landscape at the Late Iron Age *Calleva Atrebatum* (Silchester Hampshire, UK)

15.00  **Bates, J.** An alternative approach to studying Indus agricultural strategies: the combination of macrobotanical and phytolith analysis from rural sites in Haryana.

15.20  **BREAK**

15.50  **Dunne, J.** Pastures new? Molecular and isotopic evidence for plant processing in pots in the Holocene Libyan Sahara

16.10  **Demarchi, B.** Ancient amino acids: dating for a long time, until death do them part (and beyond).

16.30  **END**

The Conference Dinner takes place in Aberdare Hall at 19:30, venue open from 19:00. The AEA student skittles evening will take place in The Gower public house, from 19:00.

Please see the map enclosed in your registration pack for directions.
Sunday 14th April

9:00  **Registration opens.** The Council Chamber, Main College Building, Park Place Authors of posters should either mount their poster on the allocated board in the Council Chamber or conference assistants can mount the poster during the presentation session.

Oral presentations are in the Wallace Lecture Theatre, Main College Building, South Wing

**Session 5: Materials: technologies and conservation (Organics)**
**Session Chair: Paul Nicholson**

9.30  High, K.  **Fading Star.** Understanding accelerated decay of organic remains at Starr Carr
9.50  Von Holstein, I.C.C.  **Rags which were once riches.** Identifying traded wool textiles in archaeological deposits.
10.10  Brettell, R.  **The semblance of immortality.** A molecular based approach to the identification of resinous materials in late Roman mortuary contexts in Britain and evaluation of their significance
10.30  Atherton, S.  **The mummification of birds past and present**
10.50  BREAK

**Session 6: Materials: technologies and conservation (Inorganics/Metals)**

11.20  Nicholas, M.  **Casting a wider net: portable X-ray Fluorescence and Anglo-Saxon non-ferrous metalwork.**
11.40  Meek, A.  **The PIXE analysis of glass inlays from the Staffordshire hoard**
12.00  Smyrnaios, I.  **Investigating technological knowledge in the production of Attic Early Iron Age finewares: a scientific approach**
12.20  Ganio, M.  **Was Roman glass produced in Italy?**
12.40  Watkins, D.  **Quantifying post-excavation corrosion of archaeological iron to develop management strategies for long-term storage of site archives.**
13.00  END
Domestication and Heterochrony in *Sus scrofa*

Joseph Owen¹, Kieran McNulty², Allowen Evin¹³, Thomas Cucchi¹³, Keith Dobney¹, Greger Larson⁴, and Una Strand Vidarsdottir⁵.

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Domestication creates a variety of unique animal morphologies and behaviours. Traditionally these have been explained through the framework of heterochrony: changes in the rate and timing of development. The domestic phenotype is often described as paedomorphic, the descendent population resembling the juvenile ancestral state. Recent advances in techniques like Geometric Morphometrics (GM) allow this hypothesis to be tested in a multivariate framework, which have falsified hypotheses of paedomorphism in dogs and heterochrony in the crania of hominines and howler monkeys. Here we examined the theory of heterochrony being responsible for the development of the domestic phenotype in pigs (*Sus scrofa*) by applying three dimensional GM methods to three longitudinal ontogenetic series (one wild, two domestic) to compare ontogenetic trajectories. We also tested wild and domestic pigs for evidence of paedomorphism and allometries. We conclude that heterochrony is not a sufficient descriptor of phenotypic change to explain the domestic morphology of pigs, nor is there evidence of paedomorphism in five of the six domestic breeds tested. Evidence of evolutionary and ontogenetic allometries were discovered. Thus the traditional explanation of heterochrony as the causal mechanism for the domestic phenotypic is incorrect, and a new explanation must be sought.
What can 60 000 Single Nucleotide Polymorphisms tell us about admixture between local and domesticated pigs in South East Asia?

Anna Linderholm¹, Laurent Frantz², Ross Barnett¹, Linus Girdland Flink¹, Hendrik-Jan Megens², Richard Crooijmans², Martien Groenen², Keith Dobney⁴, Greger Larsson¹

¹ Durham Evolution and Ancient DNA, Department of Archaeology, Durham University, United Kingdom.
² Animal Breeding and Genomics Group, Wageningen University, The Netherlands
³ Ancient DNA laboratory, Department of Palaeontology, Natural History Museum, London,
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Previous studies have demonstrated that humans moved pigs from East Asia into the Islands of Southeast Asia (ISEA) as part of the Neolithic expansion. The Lapita culture was responsible for the last big human expansion and it started around 4000 years ago with the Neolitisation of this region. Part of this agricultural driven expansion was domesticated animals, dogs, chickens and pigs. These were moved out from East Asia and into the Islands. However on several of these islands there was already an indigenous pig population present, such as the *Sus celebensis*, *barbatus*, and *verrucosus*. Looking at the mitochondrial data alone it seems likely that the first domesticated pigs introduced into this area carried the Pacific Clade haplotype. In order to understand if the different pig populations hybridized, we tried to ascertain and quantify the degree to which the introduced pigs admixed with local populations and species of *Sus* on the islands in ISEA. We analysed around 60,000 SNPs from over 300 modern pigs from the region, using the latest sequencing technologies and methods. When analysing the data it is clear that a degree of admixture has taken place and that the introduced pigs did mix with the local pig populations.
Integrated approaches to the study of European Fallow deer (*Dama dama dama*): Trade, treatment, and translocation

Richard Madgwick¹, Naomi Sykes², Holly Miller², Karis Baker³, Angela Lamb⁴, Jane Evans⁴

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³School of Biological and Biomedical Sciences, Durham University, United Kingdom.
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Fallow deer remains are rarely recovered in substantial quantities from archaeological sites and therefore the species has been subject to relatively little research. In recent years, several publications have investigated the presence of fallow deer in specific areas but relatively little is known about the broader European biogeography of this species. During the last glacial maximum European fallow deer were restricted to a limited refugium in Anatolia, but through human-mediated expansion, breeding populations are prevalent throughout the world. The timing and nature of this movement, the motivation behind it and the management of the populations remains poorly understood and thus a valuable source of cultural information remains unexploited.

This paper presents preliminary data from a more holistic study of fallow deer and European society. Results include new stable isotope (δ¹³C, δ¹⁵N, δ¹⁸O, ⁸⁷Sr/⁸⁶Sr and δ³⁴S) and genetic data from fallow deer from across Europe, with samples ranging from Neolithic to modern in date. Although research is ongoing, the integration of multi-isotope results with genetic data provides new insights into the complexity of the movement and management of the species. New evidence for the trade of body parts, varied management strategies and previously unknown translocations is presented.
Quantifying faunal isotopic variation in the British Isles

Kathryn J. Boulden\textsuperscript{1} and Rhiannon E. Stevens\textsuperscript{2}

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Archaeological science is well versed in the technique of isotopic analysis of bone collagen to address questions of past diet in humans, by looking at the variability in carbon and nitrogen values in populations. In studies of diet, human $\delta^{13}C$ and $\delta^{15}N$ values are always compared with faunal values from the same site so accounting for ‘background’ variability. This background variability is generally under-examined, and could be a potentially useful indicator of past lifeways in its own right. Land use is traditionally gauged using a suite of environmental techniques such as soil science, palynology and molluscan analyses. Increasingly, isotopic analyses have been employed to aid the reconstruction of past landscapes and human/animal interaction within these. These have used strontium isotopes, and carbon and nitrogen isotopes within the soil itself, but never a holistic combination of soil science and isotopic analysis. This paper will present preliminary modelling of the patterns seen between soil and faunal dietary isotope data, and appraise their use as a proxy for land management and landscape change, through examples from British prehistory.
The introduction of dairying was a critical step in early agriculture with milk products being rapidly adopted as a major component of the diets of prehistoric farmers and pottery-using late hunter-gatherers [1-5]. The processing of milk, particularly the production of cheese, would have been a critical development since it not only allowed the preservation of milk products in a non-perishable and transportable form, but also made milk a more digestible commodity for early prehistoric farmers [6-10]. Significantly, potsherds pierced with small holes appear at Early Neolithic sites in temperate Europe in the 6th millennium BC and have been interpreted typologically as ‘cheese-strainers’ [10], although a direct association with milk processing has not yet been demonstrated. Here we apply an approach based on the $\delta^{13}C$ and $\delta^{13}C$ values of the major fatty acids in animal fats preserved in pottery to investigate the function of sieves/strainer vessels, providing unequivocal direct chemical evidence for their use in milk processing. The presence of abundant milk fat in these specialised vessels, comparable in form to modern cheese strainers, provides compelling evidence of the vessels having been used to separate fat-rich milk curds from the lactose-containing whey. This new evidence emphasises the importance of pottery vessels in processing dairy products, particularly in the manufacture of reduced-lactose milk products amongst lactose intolerant prehistoric farming communities [6-7].

Bubbling over: organic residue analysis and the Irish Neolithic

J. Smyth* and R. P. Evershed*

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SCHERD (a Study of Cuisine and animal Husbandry among Early farmers via Residue analysis and radiocarbon Dating) is a two-year project funded by a Marie Curie Intra-European Fellowship (May 2011-April 2012). Its primary objective has been to identify the original contents of Irish Neolithic pottery vessels through systematic lipid analysis of the ancient organic residues contained within them.

Molecular and stable isotopes analyses have been undertaken on c. 500 pottery vessels from 15 sites of varying date, function and geographic location. Nothing of this scale has been carried out on Irish ceramics and SCHERD has provided important new insights into Neolithic daily life. Discoveries include the earliest evidence for dairying on the island, as well as different patterns of commensality across sites of different function, such as causewayed enclosures and timber houses. The project has also explored the potential of $^{14}C$ dating absorbed lipids from pottery, with a range of samples (both charred residues and bulk absorbed residues) submitted to the NERC Radiocarbon Facility for dating.
What can eggshell tell us about the past?

John Stewart

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This paper will describe a new direction in biomolecular zooarchaeology; the development of ZooMS (Zooarchaeology by Mass Spectrometry) as a rapid and reliable system for taxonomic identification of archaeological eggshell. This material is a common component of many archaeological contexts and is extremely durable. However, due to the highly fragmented preservation state of most eggs and concomitant difficulties in identification of fragments, eggshell has tended to be underused in archaeological interpretation. The new technique described here is able to analyse entire eggshell assemblages, where fragments often number in the thousands; this allows the archaeological potential of eggshell to be more clearly established. Some potential applications of eggshell will be outlined in the context of results obtained from a range of sites; these include Viking Age urban sites in York (Coppergate, Hungate), roughly contemporaneous coastal sites in Orkney (Quoygrew) and the Outer Hebrides (Udal North), and the major Roman site of Pompeii.
Investigating food politics at the time of urbanization in Mesopotamia. Potentials of an integrated approach.

Carolin Jauss¹, Marisol Correa Ascencio², Richard P. Evershed²

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Food was a crucial element in the process towards urban lifeways in 4th millennium Mesopotamia, and control over food represented a powerful instrument in the hands of elites. This paper will discuss different lines of evidence and the potential of an integrated approach to better understand food politics in the context of urbanization. Early administrative texts dealing with various foodstuffs, including processed animal and plant products together with cylinder seal imagery provide insights into early food economy from an elite perspective. Direct evidence of food is available from archaeobotanical and zooarchaeological data. However, the starting point for this paper is ceramic vessels in which food was stored, processed and consumed. The approach involved analyzing technomorphological properties and use-wear traces on vessels complemented by a cooking experiment to try to better understand food processing techniques. In addition, a first attempt was made to assess the potential of absorbed organic residue analysis in the study of pottery from Southwest Iran and Northern Syria. Absorbed and surface residues were investigated using state-of-the-art chromatographic techniques (HTGC, GC-MS and GC-C-IRMS) to provide a new dimension to this study and generate a range of new questions concerning food processing in 4th millennium Mesopotamia.
Assessing dietary variability in South American hunter-fisher-gatherers: collagen stable isotopic analysis of human remains from Brazilian Sambaquis

Colonese A.C.¹, Collins M.¹, Eustace M.¹, DeBlasis P.², Figuti L.², Wesolowski V.², Plens C.³ Egger S.⁴, Farias D.⁵, Gledhill A.⁶, Craig O.¹

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The Brazilian coastline traverses a variety of terrestrial and marine ecosystems and has been a focus for human activity since the early Holocene. The coastal shell middens of this region (Sambaquis) provide a long term record of human interaction with these productive complex littoral ecotones. The dietary consequences of these interactions and their implications for understanding subsistence strategies have been difficult to study using conventional methods. To directly study diet, here we present carbon and nitrogen isotopic results of collagen from humans and associated faunal remains from two coastal (Jabuticabeira II, Piaçaguera) and one riverine (Moraes) Sambaquis of south Brazil, dated from ~5 to ~1.3 cal ka BP. Generally, isotopic differences between individuals buried in each midden reflects variation in the resource possibilities offered by local environmental conditions. However a more complex dietary picture emerged within the humans buried at the coastal site. Here, other factors such as coastal-inland mobility, specialisation and cultural differences in food choices are required to explain the observed data.
Mediterranean hunter-gatherer diets in the Late Pleistocene: an isotopic study of the Gravettian and Epigravettian humans buried at the Arene Candide cave in Liguria (Italy).

Marcello A. Mannino¹, Antonio Tagliacozzo², Sahra Talamo¹, Vincenzo Formicola³, Elisabetta Starnini⁴, Angiolo Del Lucchese⁴, Michael P. Richards¹⁺

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³ Dipartimento di Etologia, Ecologia, Evoluzione – Unità di Antropologia, Università di Pisa, Italy
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⁵ Department of Anthropology, University of British Columbia, Vancouver, Canada

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Late Pleistocene hunter-gatherers diversified their subsistence strategies by broadening the range of taxa exploited, including a wider array of marine resources. The role played by marine and plant foods in the Mediterranean is, however, poorly understood. Carbon and nitrogen isotope analyses have been undertaken on the bone collagen of Upper Palaeolithic (Gravettian and Epigravettian) humans buried at the Arene Candide cave (Italy) to evaluate the contribution of terrestrial, freshwater and marine protein to their diets. Analyses on the individual known as ‘The Prince’, and of contemporary fauna, show that this Gravettian hunter-gatherer obtained a significant proportion of dietary protein from aquatic foods. On the other hand, fifteen Epigravettian humans from the Arene Candide acquired most of their animal protein from medium- to small-sized terrestrial herbivores. The results presented here, interpreted in the light of published isotopic and zooarchaeological data, suggest that humans living in the Mediterranean during the Late Pleistocene/Holocene transition relied heavily upon the resources from a relatively narrow, terrestrial, ecological niche, while marine foods had a marginal role in their diets. Our findings have important implications for the understanding of hunter-gatherer adaptations and of the adoption of agro-pastoralism in the Mediterranean Basin.
Integrating isotopes and zooarchaeology: An holistic approach towards understanding past marine resource use in the North Atlantic Islands.

Jennifer R. Jones, Jacqui Mulville and Richard P. Evershed

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The insular environments of the North Atlantic presented a wealth of resources available to these communities. Isotopic studies have demonstrated that despite widespread consumption of marine resources in the islands during the Mesolithic period, when farming is introduced to the islands in the Neolithic marine resources ceased to be eaten, despite fish bones being present in Neolithic assemblages. This paper uses a combination of traditional zooarchaeological methods alongside isotopic analysis of humans and animals to explore the changing role of marine resources through time from the Neolithic period through to the Norse period in the North Atlantic Islands. Integrating these two very different lines of evidence enables a clearer understanding of the relationship that the ancient coastal communities of Orkney and the Outer Hebrides had with the sea.

The results show that in the Neolithic and Bronze Age marine foods appear to play a minor role in dietary behaviour in both Orkney and the Outer Hebrides. During the Iron Age stable isotope evidence demonstrates that marine foods were being used as animal fodder in the Western Isles, yet in Iron Age Orkney marine resources are not utilised to any great extent, indicating diverging economic strategies between these two island groups. The arrival of the Vikings in the Norse period marks the beginnings of a trade in marine resources in both island groups as demonstrated by the isotopic and zooarchaeological evidence, with herring being a major focus of trade in the Outer Hebrides, and cod and saithe being utilised in Orkney. The diverging strategies in marine resource use between the islands and during each time period, resulting from social, economic and cultural factors, demonstrates that past North Atlantic Island populations had highly dynamic relationships with the sea.
Strategic and sporadic marine consumption at the onset of the Neolithic: increasing temporal resolution in the isotope evidence

J. Montgomery¹, J. Beaumont², M. Jay¹,²,³, K. Keefe⁴, A.R. Gledhill⁵, G.T. Cook⁵, S.J. Dockrill⁵, N.D. Melton¹,²

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Stable isotope analyses of Mesolithic and Neolithic human bone collagen from northern and western Europe demonstrate a sharp shift away from the consumption of marine foods at the onset of the Neolithic (Tauber 1981; Richards et al. 2003). However, there is an apparent contradiction between the isotope data and the archaeological record as some coastal sites contain thousands of marine ecofacts (Richards & Mellars 1998; Schulting & Richards 2002; Bailey & Milner 2003; Hedges 2004; Milner et al. 2004; Richards & Schulting 2006; Bonsall et al. 2009). Previous work has utilised adult human bone collagen which represents an average of many years diet and provides only blurred temporal focus.

This study reconstructs the diet of the earliest Neolithic agriculturalists from the Shetland Isles, northern Scotland: the most remote island group to be colonized by Mesolithic and Neolithic people. Using progressively higher-resolution δ¹³C and δ¹⁵N measurements of bone, bulk dentine and incremental dentine samples, we found short-term periods of marine resource consumption, possibly in response to crop failure, rather than long-term supplementation. We conclude that these early agriculturalists consumed marine foods as a sporadic strategy, which may explain the paradox between previous human terrestrial dietary isotope studies and the evidence for marine food consumption at Neolithic sites.
Dental palaeomicrobiology: A new way to explore past diet and health.
Adler CJ\textsuperscript{1,2*}, Dobney K\textsuperscript{3}, Weyrich L\textsuperscript{1}, Kaidonis J\textsuperscript{4}, Walker AW\textsuperscript{5}, Haak W\textsuperscript{1}, Bradshaw CJA\textsuperscript{6,7}, Townsend G\textsuperscript{4}, Sołtysiak, A\textsuperscript{8}, Alt KW\textsuperscript{9}, Parkhill J\textsuperscript{5} & Cooper, A\textsuperscript{1}.

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\textsuperscript{6}The Environment Institute and School of Earth and Environmental Sciences, The University of Adelaide, Australia, 
\textsuperscript{7}South Australian Research and Development Institute, Henley Beach, Australia, 
\textsuperscript{8}Department of Bioarchaeology, Institute of Archaeology, University of Warsaw, Poland. 
\textsuperscript{9}Institute for Anthropology, Johannes Gutenberg University of Mainz, Germany.

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The importance of commensal microbes for human health is increasingly recognised, yet the impacts of evolutionary changes in human diet and culture on commensal microbiota remain almost unknown. Two of the greatest dietary shifts in human evolution involved the adoption of carbohydrate-rich Neolithic (farming) diets (beginning \textasciitilde10,000y BP), and the more recent advent of industrially processed flour and sugar (\textasciitilde1800 AD). In this paper, we show that calcified dental plaque (dental calculus) on ancient teeth preserves a detailed genetic record throughout this period. Data from 34 early European skeletons indicate that the transition from hunter-gatherer to farming shifted the oral microbial community to a disease-associated configuration. The composition of oral microbiota remained surprisingly constant between Neolithic and Medieval times, after which (the now ubiquitous) cariogenic bacteria became dominant, apparently during the Industrial Revolution. Modern oral microbiota are markedly less diverse than historic populations, which might be contributing to chronic oral (and other) disease in post-industrial lifestyles.
Lying Through Your Teeth: Strontium Diagenesis in Archaeological Enamel
Jamie Lewis¹, Christopher, D. Coath¹ and Alistair W. G. Pike²

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The use of strontium isotopes in archaeology has greatly contributed to our understanding mobility and migrations in past populations, strontium isotope studies have now become a routine tool in archaeology. However the development of the method has been complicated by the effects of diagenetic alteration.

Initially bone was the primary sample material, but through much work it has been shown to be unreliable for retaining biogenic strontium isotope signal and is susceptible to contamination by strontium from the burial environment. Relative to bone, tooth enamel is much more resistant to the effects of diagenetic alteration. However it has been shown that enamel is susceptible to uptake of trace metals from the burial environment such as uranium why therefore should it be completely immune to strontium diagenesis?

We present the results of a study using laser ablation multi-collector plasma mass spectrometry to investigate the strontium isotope profiles in a set of mammal teeth recovered from the North Sea. We find that gradients of strontium isotopes in the tooth enamel are consistent with diagenetic uptake of strontium consistent with a model of diffusion with simultaneous adsorption.
The diet-body offset in human nitrogen isotopic values: a controlled dietary study

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The ‘trophic level enrichment’ between diet and body results in an overall increase in nitrogen isotopic values as the food chain is ascended. Quantifying the diet–body δ¹⁵N spacing has proved difficult, particularly for humans. The value is usually assumed to be +3-5‰ in the archaeological literature. We report data from humans on isotopically known diets, comparing dietary intake and a body tissue sample, that of red blood cells. Samples were taken from 11 subjects on controlled diets for a 30-d period, where the controlled diets were designed to match each individual’s habitual diet, thus reducing problems with short-term changes in diet causing isotopic changes in the body pool.

The δ¹⁵N diet-RBC was measured as +3.5‰. Using measured offsets from other studies, we estimate the human δ¹⁵N diet-keratin as +5.0-5.3‰, which is in good agreement with values derived from the two other existing studies using individual diet records. We also estimate a value for δ¹⁵N diet-collagen of ≈6‰, again in combination with measured offsets from other studies.

A δ¹⁵N diet-collagen of ≈6‰ is larger than usually assumed in palaeodietary studies, which suggests that the proportion of animal protein in prehistoric human diet may have often been overestimated in isotopic studies of palaeodiet. We reconsider a number of key palaeodiet datasets from prehistory, and reassess what the isotopic data may suggest for human diet.
Are bone and intra-antler collagen $^{13}\text{C}$ and $^{15}\text{N}$ equivalent?

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The flexible behaviour displayed by many cervid species has allowed them to adapt to virtually every ecological context across the globe. Throughout prehistory humans have extensively interacted with cervids; they were prey for hunter-gathers, a source of material for use as tools, and in more recent period were kept as an expression of wealth. Thus cervid skeletal remains are found at archaeological and palaeontological sites from many time periods across large regions of the world. Carbon and nitrogen isotopes signatures of bone and antler are now often used to reconstruct the ecological conditions in which ancient deer lived, to track past habitat changes in the vicinity of the site of recovery, and to infer past human exploitation strategies or management practices. They are also used to define isotopic baselines to which human isotope signatures can be compared. Researcher often considers antler and bone isotope $^{13}\text{C}$ and $^{15}\text{N}$ collectively, however at present the question of whether bone and antler isotope signatures are equivalent and directly comparable has yet to be fully addressed. We measured the bone collagen isotope signatures of six red deer stags. For each stag, antlers from five different years were also sampled. Each antler was sequentially sampled along its length, with up to 12 samples taken per antler (264 samples in total) in order to obtain a chronological record of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures over the period of antler formation. A comparison of bone and intra-antler isotopic variations will be presented. The influence of side and length of antler, stag age, cast versus uncast, year of sampling, climatic parameters, dietary intake, and mobility on the pattern of intra-antler isotopic variation will also be discussed.
Season to taste – Infant feeding practices of the Pitted Ware Culture in the central Baltic.

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From around six months of age the nutritional demands of infant growth outstrip that which breast milk alone can supply, and supplementation of the diet becomes necessary. The quality of foods introduced at this time will affect infant health and survival outcomes. In many hunter-gatherer societies the choice of supplementary foods is liable to be limited by seasonal variations in resource availability. The Pitted Ware Culture inhabited the central Baltic region during the Middle Neolithic and had an economy based primarily on seal hunting; however fishing and the hunting of terrestrial animals were also seasonally important activities. Carbon and Nitrogen stable isotope analysis of human bone and dentine collagen from the site of Ajvide on Gotland has revealed that although breastfeeding durations were relatively homogenous, there was some variety in the weaning diet. It is suggested that the choice of supplementary foods was probably dependent on the season of weaning, and if so infant growth and development would likely have been affected by the season of birth. Comparison to other Pitted Ware sites also reveals slight dietary variation within a broadly similar economy, giving the impression of a shared regional cuisine that was adapted to local environmental conditions.
Session 3: Populations and Relations

DNA Dog Tales: Reconsidering the dispersal of Lapita societies into Remote Oceania through the genetic signatures of dogs

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The peopling of Oceania started over 45,000 years ago when modern humans migrated out of Southeast Asia into the realm of the continent of Sahul and beyond into the Bismarck archipelago and the Solomon Islands. 3,500 years BP, this colonisation process continued as the Lapita Cultural Complex expanded into Remote Oceania, introducing domestic animals including pigs, chickens and dogs.

The dispersal route(s) remain(s) however controversial and various models have been suggested. A recent study by Oskarsson and colleagues suggests Polynesian dogs were introduced through Mainland Southeast Asia.

Here, we present evidence from newly sampled locations including the Bismarck Archipelago and the Solomon Islands. Combined with previously published data, this mitochondrial and nuclear dataset aims to further discern the dispersal of Austronesians into Oceania using dogs as proxies.
Of mice and ocean-going men

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Due to their remarkable adaptability and close association with humans, the house mouse \textit{Mus musculus} is now one of the most successful and ubiquitous invasive mammals, occupying all kinds of habitats outside their natural bounds. The transition from hunter-gatherers to sedentary societies with a lifestyle based on agriculture and husbandry is commonly accepted as a key factor in this evolving commensal relationship between mice and men.

Using patterns of genetic variability in commensal animals as proxies to explain wider social and cultural processes in prehistory is a valuable approach, especially where archaeological or historical records are lacking. Hence, the research project presented here uses a phylogeographic method to reconstruct patterns of translocation in commensal species and elucidates pathways of human migration, trade, and exchange throughout the mainland and islands of the Indian and Pacific Ocean. Therefore, a 870bp fragment of the mitochondrial control region was analysed in about 200 modern and museum specimens of \textit{Mus musculus}. In order to link haplotypes between transported individuals we especially focused on samples from important trade and migration posts, or stopping points of human expansion routes across the area of interest.
The Basque of ‘Butus’: life at a 16th century whaling enterprise in the New World.

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For a seventy-five year period in the 16th century, Basque whalers operated the first major industrial enterprise in North America at the site of ‘Butus’, or Red Bay as it is now known. The focus of this endeavour was the hunting and processing of whales to support the lucrative European oil market. While much is understood about the legal and business aspects of the Basque whaling industry, considerable less is known about the lives of individual whalers. The archaeological excavation of Red Bay in the 1980s, which included a cemetery of 140 individuals in 60 graves, has provided a unique opportunity to add considerably to our understanding of the diet, health and likely origin of these Basque whalers. Here will be presented the results of bone chemistry (stable isotopes) and osteological analyses from a sample of 20 individuals from Red Bay to help better understand the life of a 16th century Basque whaler.
Interpreting Village Settlement Variability in the North Pacific Salish Sea

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The nature of village occupation has been a widely investigated research theme in the archaeology of the Pacific Northwest Coast. In recent years, however, results of the study of village sites have primarily been generated in support of analyses of cultural change or development. This paper instead examines the archaeological evidence of villages – in the Salish Sea – in order to test various interpretations of the seasonal character of these settlements. Establishing a baseline of well-documented village occupations using zooarchaeological and spatial analysis strengthens landscape scale inferences, many of which rely on site-specific conclusions. I begin this research with a detailed description of three contemporaneous village sites, including the results of fine-screen faunal analysis. An assessment of people’s use of these places in the past has implications for our understanding of pre-European contact Coast Salish social interaction. These relationships are not limited to economic practices, but also include spiritually mediated engagement.
Skeletal Analyses Allow To Retrieve Valuable Data Of Early Medieval Ancestors Of The Spanish Royal Family: An Interdisciplinary Approach.

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Skeletal exploration of an Early Medieval Spanish necropolis located in the Pyrenees area (North-Spain) and belonging to early members of the Royal dynasty of the Medieval Kingdom of Aragon of was carried out by an interdisciplinary team. The survey integrated different archaeological techniques, X ray and scanner studies; DNA typing; radiocarbon dating and stable isotopes ($^{13}$C, $^{15}$N) analyses, etc. Six female skeletons and a number of isolated bones belonging to a total of ten individuals were individualized. All but two individuals were from the X\textsuperscript{th} to XII\textsuperscript{th} century AD, and the others were from the XIII\textsuperscript{th} to XIV\textsuperscript{th} century AD. Genetic information was obtained by using three different multiplex STR systems: AmpF\textsuperscript{®}STR MiniFiler, AmpF\textsuperscript{®}STR Identifiler Plus and AmpF\textsuperscript{®}STR NGM (Life Technologies). Radiology (Scanner) and morphological analyses showed interesting findings and stable isotope analyses gave useful information about the diet of this privileged medieval group. The results supported the belief that this Royal burial site was restricted to females of Royal lineage and the combination of DNA and non-DNA scientific procedures allowed to retrieve valuable ancestral data. Results also are indicative of the relevance of interdisciplinary contributions.
A mobile elite of the society? – Stable isotope analysis on Iron Age human and faunal remains from Central Asia

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In the course of the 1st Millennium BC the West Eurasian steppes were inhabited by the Scythians and multiple communities culturally related to them. A highly mobile lifestyle can be inferred from similarities in the archaeological remains distributed across the vast steppe area as far as Eastern Europe, a hypothesis that is also supported by written sources.

A number of sites in southern Siberia and north-eastern Kazakhstan dating to the Scythian period are well known for their extremely well preserved archaeological finds and large quantities of golden burial objects. A couple of these sites, including Berel', Justyd, and the outstanding burial mound 2 at Arzhan, were selected for $^{87}$Sr/$^{86}$Sr and $\delta^{18}$O analyses to gain insight into the lifestyle and the social order of these people. In addition to conventional TIMS $^{87}$Sr/$^{86}$Sr analyses, a small number of humans and horses were selected for laser ablation ICP-MS analyses thus allowing an investigation into seasonal movements connected to transhumance, a lifestyle that is discussed as a potential economic basis for these societies. In this paper we will present the results from four Central Asian Iron Age sites and highlight social as well as gender related differences.
River Dynamics and the Neolithic of the Lower Danube Catchment
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This paper contributes to new archaeological and geomorphological research in the lower Danube catchment (LDC) that is transforming our understanding of prehistoric river-society interactions, particularly the environmental context in which farming first developed in the area at around 6100 cal. BC. Using a new Late Pleistocene and Holocene fluvial chronology from the Teleorman Valley (TV), southern Romania, we examine the interplay between river dynamics and the local Neolithic (c. 6000 - 3800 cal. BC) archaeological record from two perspectives: 1) the likely impacts of rapid, climate-related changes of floodplain environments on communities; and 2) the effects of river erosion and sedimentation on the preservation of archaeological sites within river valleys. The well dated TV fluvial record allows more precise relationships to be established between changes in river dynamics and prehistoric settlement patterns, particularly between the so called 6600 - 6200 and 4000 - 3200 cal. BC rapid climate change events. Our research suggests the continuity of Neolithic sites in particular riparian locations may have been facilitated by more than 2000 years of relative river quiescence. While this new model of Holocene river valley development needs to be tested and further refined elsewhere in the region, it does suggest a radical re-thinking of the Neolithic record in the LDC may be required.
Palaeoenvironments and sea-level change from inter-tidal and sub-tidal sediments of the Isles of Scilly

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The Isles of Scilly are a group of around 200 islands and rocks lying 45km south west of Lands End, Cornwall. The islands have a rich archaeological heritage but rather little is known of palaeoenvironmental changes associated with changing human settlement. Between the main islands there are large expanses of shallow waters which were submerged as a result of Holocene sea-level rise and inter-tidal peats and organic silts outcrop on some of the beaches. Previous work on exposed inter-tidal sediments suggested there was potential for developing a better understanding of both palaeoenvironmental context of human settlement and rates of past sea-level rise for the islands. The English Heritage-funded Lyonesse Project has aimed at addressing three key issues concerning the islands: 1) The extent of the inter-tidal and sub-tidal palaeoenvironmental resource, 2) The nature of vegetation change in relation to human occupation, 3) Rates of past sea-level change and the changes in palaeogeography of the islands. The question of past sea-level change was particularly important to resolve because of very rapid rates of sea-level rise which have been previously suggested with significant implications for the nature of human settlement and activity during both prehistoric and later periods.

The results from the project show that organic sediments extend to sub-tidal areas and sequences of early and mid-Holocene vegetation change have been recovered from these zones. The new sea-level data, constrained by both radiocarbon and optically stimulated luminescence dates, provide a much more secure basis than previously existed for reconstructing the evolution of the archipelago over the Holocene.
Geoarchaeological investigations on the Dogger Bank, North Sea.

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Wessex Archaeology are currently undertaking archaeological investigations in advance of the world’s largest planned offshore wind project located between 125 and 290 kilometres northeast of the Yorkshire coast on the Dogger Bank, North Sea. The survey area is very large measuring 8660km$^2$ in water depths ranging between 18 and 63 metres. Geophysical, geotechnical and environmental surveys have included the provision for archaeological, geoarchaeological and palaeoenvironmental input. A collaborative approach towards data gathering and interpretation between geologists, geotechnical engineers, geophysicists and archaeologists has enabled the identification and investigation of submerged prehistoric deposits and landscape features across the Dogger Bank survey area. The geoarchaeological work is ongoing and has included sedimentary and stratigraphic analyses of core samples with scientific dating ($^{14}$C) and identification and interpretation of macrofossil (waterlogged plant remains and molluscs) and microfossil (pollen, diatoms, foraminifera and ostracods) palaeoenvironmental indicators.
Tales of the river bank: Prehistoric Environments and Occupation along the River Eden, Carlisle, Cumbria.

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Archaeological evaluations prior to the construction of a new road around the western edge of Carlisle (Carlisle Northern Development Route) revealed a highly significant archaeological site situated on an early Holocene terrace above the present floodplain of the River Eden. The site, now known as Stainton West, comprised a palaeochannel with a complex sequence of deposits dating from the early Mesolithic period through to the late prehistoric period, which produced Neolithic wooden tridents and other wooden artefacts, lithic and ceramic cultural material, and particularly well preserved environmental remains. Adjacent to the channel was an extremely rich assemblage of worked lithics, of early Mesolithic to early Bronze Age date, associated with features including tree throws, hearths, possible structures and burnt mounds.

A comprehensive program of palaeoenvironmental analyses is currently being carried out on the deposits from the channel sequence, and this paper will present the preliminary results, which have identified some significant changes in the local environment. Specifically, changes associated with declines in elm pollen, and major clearance from the late Bronze Age onwards. The extended sequence of preservation and activity at the site makes Stainton West one of the most important prehistoric sites investigated within the North West since Ehenside Tarn in 1873 and Williamson’s Moss (C20th). Given its rarity, Stainton West should also be considered to be of international importance.
How new documentation can shed light on a 1930’s digging methodology: The case of Muge shell middens (Portugal).

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The Mesolithic shell middens of Muge (Tagus Valley, Portugal) are one of the major Portuguese and European Prehistoric archaeological sites. Research on these sites has been carried out by various teams and this year we celebrate the 15th anniversary of its discovery in 1863 by Carlos Ribeiro (1813-1882).

In the 1980s was found a new and abundant document collection (correspondence, photographs, drawings and sketches) saved from destruction by A. Huet B. Gonçalves, regarding archaeological excavations in Muge shell middens conducted by Professor Doctor Correa Mendes during the 1930s. His investigations were aimed at obtaining new specimens for the study of Homo afer taganus.

This presentation aims to show the results obtained with the study of this new documentation that were part of a Master Thesis. It revealed the motivations, strategies, programming, development work and field work techniques of the time. This area is usually poorly described, considered important for the knowledge of the development of archaeological practice in the country. It is hoped in this way to contribute to the study of archaeological research with special emphasis on the study of the work conducted in the Mesolithic shell middens of the Tagus Valley.
The cave site of Grotte des Pigeons, Taforalt, holds evidence of a recurrent human presence over the last 80ka, with the Iberomaurusian cultural levels being the most recent. These archaeological levels are known as the Yellow and Grey series. The transition between Yellow and Grey is a clear shift in the mechanism and rate of sediment accumulation that appears to indicate a change in the type and intensity of human activity within the cave. The timing of this transition coincides with the amelioration of environmental conditions at the termination of the LGM in the northern hemisphere, and recent studies have shown strong linkages between climatic events in the Atlantic Ocean and the Mediterranean Sea. This study seeks to investigate whether fluctuating environmental conditions may have played a role in determining human behaviour. Initial carbon and oxygen isotope data from sequential samples of enamel taken from the molar teeth of *Ammotragus lervia* (the Barbary Sheep) show that environmental conditions did fluctuate throughout the Yellow and Grey Series, and there appears to be a clear difference between the two series. It seems possible that environmental change may have been a contributing factor in the way that the site was used over time.
Animal husbandry in the Flemish Coastal Plain, 1st to 15th century AD: A stable isotope approach

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In a proof-of-concept study, Britton et al. (JAS 35, 2008) demonstrated that the specific isotopic composition of halophytic ('salt-loving') plants can be traced in the skeletal tissues of their animal consumers. Carbon and nitrogen stable isotope analyses of herbivore bone and dentinal collagen therefore have the potential to illuminate animal husbandry strategies in coastal zones, beyond the means available to traditional zooarchaeological techniques.

The project introduced here tests this proposition, by applying the method to domestic herbivore remains (n>250) from nine archaeological sites in or near the Flemish coastal plain. Prior to embankments, this part of the North-West European coast offered extensive pasture grounds for domestic herbivores in form of salt-marshes and -meadows. Sites investigated span a period of ~1,500 years (Roman to late medieval period), during which the coastal landscape was progressively transformed from a little managed and regularly inundated littoral zone to a fully embanked polder area, through a combination of natural, geological processes and human activities. This paper presents the results of the bulk collagen analyses and discusses the utility of faunal stable isotope data for the characterisation of coastal husbandry strategies in the context of regional economic and environmental changes.
Radiocarbon dating and isotopic analysis of Pleistocene fauna from Project 23 at Rancho La Brea: A novel method for tar (asphalt) removal from bone collagen by ultrafiltration

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The Rancho La Brea “tar pits” located in Los Angeles, California contain one of the largest concentrations of flora and fauna remains from the late Pleistocene. Here we describe a novel protocol for collagen purification from asphalt impregnated skeletal remains recovered from a new area of excavation known as Project 23 (n = 11) and from previously dated pits (n = 5). This method uses a simple solvent soak and sonication treatment and a higher gelatinizing temperature to break down collagen strands to the point that they can be separated by ultrafiltration. The traditional method of ultrafiltration for bone collagen is reversed here and the high molecular weight fraction (>30 kDa) contains mainly the asphalt, while the lower molecular weight fraction (<30 kDa) contains the collagen. A further ultrafiltration (>3kDa) step is then performed on the <30 kDa fraction to remove the lower molecular weight contaminants. The middle fraction (3-30 kDa) is freeze dried to produce white collagen with atomic C:N of 3.1-3.4. The processes involved in the design of protocol will be discussed in detail and the first radiocarbon dates and stable isotope ratios from the Project 23 site will be presented.
Integrating multiple data sources to investigate pottery uses among hunter-fisher-gatherer communities: a case study from the Eastern Woodlands of North America.

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Among hunter-fisher-gatherers, the number of food resources that could have been processed in ceramic cooking pots and the potential mixing of these resources are almost infinite. The interpretative power of organic residue analysis in such contexts relies on the multiplication of data sources capable of documenting past subsistence strategies, cooking practices, and culinary choices. Here we combine archaeological, ethnographic and environmental information with molecular and isotopic data from archaeological potsherds and modern reference samples to evaluate different scenarios for pottery adoption in the Eastern Woodlands of North America. Results obtained thus far suggest that the first ceramic containers produced in this part of the world were generalized cooking tools used to process a variety of different resources rather than specialized tools invented to process one specific type of foods. This trend is seen both within and between sites. Nevertheless, the concentration of early pottery sites in coastal and riverine environments, the presence of aquatic biomarkers in a significant portion of the potsherds and sites analyzed, and the isotopic values obtained through GC-c-IRMS suggest a particular focus on the processing of fish resources.
Past water management practices, such as irrigation, have often been linked to socio-economic changes, but evidence remains elusive. A promising, relatively new technique in this respect is carbon (and nitrogen) stable isotope analysis of archaeobotanical remains. This method is based on the well-established correlation between water availability and plant isotopic composition. However, the latter has also been shown to be affected by various other environmental factors. Therefore, this research sought to identify such effects, in order to refine the application of the method in archaeology.

Cereal crops were experimentally grown under five different irrigation regimes at three different sites in Jordan. For wheat and barley, but not for sorghum, a correlation was present between water input and grain $\delta^{13}$C (but not $\delta^{15}$N). However, this correlation was site-specific, due to the effect of other environmental factors, such as temperature and rainfall patterns. Nonetheless, broad levels of crop water status could be defined.

This paper will therefore argue that the method can be applied to archaeological samples for the reconstruction of past water availability, but with limitations. It will illustrate this using two archaeological case studies from Jordan, Tell esh-Shuna and Tell es-Sa’idiyeh.
Traditional views of the Roman Empire suggest that it incorporated ‘people like us’ – people with towns, developed social hierarchies and market economies. If this were always the case, then the conquest of Britain would have stopped at the Fosse Way, separating lowland SE from upland NW Britain. But the conquest pushed on through the whole of Wales and northern England and up to northern Scotland via the east coast. Although the initial conquest was probably driven by a desire for military prestige, the ‘socio-economic’ perspective predicts that the Empire’s administration should have withdrawn to more comfortable SE England. But it never did: instead, a large military garrison was paid to stay for a further 350 years in the northern area. Tens of thousands of soldiers stationed here every year needed food, clothing, accommodation, equipment and weapons. This paper combines archaeological evidence from animal bones and charred plant remains with modern agricultural data. It then looks at distributions of metal ores, Roman villas and small towns, and PAS coin data, to consider how the Roman army coped and why they stayed.
Rice rats of the Caribbean: Human impact on rice rat colonization in the Lesser Antilles

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Island colonization events provide the ideal conditions to study both cultural and biological evolution, and particularly the process of adaptive radiation. One extensive yet under-studied island chain is the Lesser Antilles, part of a volcanic arc that forms the West Indies. Little is known about the timing or events that led to the colonization of these islands by mammals. In this project, we have focused on a key component of the region’s endemic fauna, the Antillean rice rats (Muroidea: Sigmodontinae: Oryzomyini), which became completely extinct within the recent historical period.

Rice rat material has been recovered in zooarchaeological contexts from nearly all of the Lesser Antillean islands, but almost nothing remains known about this extensive evolutionary radiation, even the number of species is unclear. We are employing ancient DNA techniques and next generation sequencing technology to investigate the number of rice rat species present, the number of colonization events that occurred and the timing of these events. Our aim is to develop a greater understanding of these extinct rodents and the Amerindian populations that exploited them as a key food source, and to determine whether human intervention or earlier geological processes were predominant in shaping the Antillean mammal fauna.
A Multi-proxy reconstruction of townscape and landscape at Late Iron Age Calleva Atrebatum (Silchester, Hampshire, UK)

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Late Iron Age \textit{oppida} have variously been interpreted as proto-urban sites, royal centers and special places, yet our understanding of their urban palaeoecology and palaeoenvironmental setting is very limited. Waterlogged organic deposits were excavated from a well within the oppidum of \textit{Calleva Atrebatum} (Silchester) during the Insula IX excavations. A multiproxy approach was used to analyse the deposits, including palynology, anthracology, palaeoentomology, plant macrofossil and phytolith analysis.

Despite the complex taphonomy of the deposits, this study provides some key insights into the Late Iron Age townscape, including settlement vegetation and on-site agricultural activities such as animal stabling. A range of crops were being cultivated in the wider area, including the new crops of flax and hay, whilst a major change in the previously wooded landscape took place. These new results allow the agricultural basis of \textit{oppida} to be reappraised and suggest that new agricultural practices evidenced in the Late Iron Age and Early Roman period may be directly related to \textit{oppida}.
An alternative approach to studying Indus agricultural strategies: the combination of macrobotanical and phytolith analysis from rural sites in Haryana.

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This paper outlines a preliminary study combining macrobotanical and phytolith analysis from two sites in Haryana. Current understanding of the agricultural strategies in the Indus Civilisation of Bronze Age South Asia (3200-1900BC) has been derived from very few systematic macrobotanical studies. Species presence/absence lists have dominated these, with the use of other evidence types and statistical analysis being scarce. In this study, the macrobotanical analysis has allowed for a comparison of crop proportions which demonstrates that despite traditional models suggesting wheat and barley were the main crops, millet and rice were as important in these rural sites as were a range of tropical pulses. Phytolith analysis of the same contexts has complimented these findings but has also allowed for a study of crop processing which would otherwise have been impossible due to poor chaff survival. The phytolith analysis suggests that crop processing aims and organisation differed over time in the two villages with one retaining household daily processing and the other showing increasingly centralised bulk processing. This paper argues that by combining different types of evidence a greater understanding of the complexity and nuances of Indus agricultural strategies can be achieved.
Pastures new? Molecular and isotopic evidence for plant processing in pots in the Holocene Libyan Sahara.

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Although the late domestication of plants in Prehistoric Africa is well documented, in Egypt and Libya considerable evidence exists for the early intensive exploitation of wild plants. In the shelters and caves of the Tadrart Acacus Mountains, Libyan Sahara, archaeobotanical evidence has identified a wide range of herbaceous species, grasses from the tribe subfamily Panicoideae and remains of edible tree fruits. Remarkably, excavations at the Uan Afuda and Takarkori rock shelters revealed considerable assemblages of exceptionally well-preserved plant and vegetal macro-remains. Here, a lipid biomarker approach using molecular and isotopic analyses of absorbed food residues is used to identify extensive processing of plant material within the earliest pottery excavated from these rock shelters, dating from the Late Acacus semi-sedentary hunter-gatherer period (8100 BC) through to the Late Pastoral period (2600 BC). These are compared to both modern and archaeological reference material to attempt to identify plants to species and isotopic determinations are used to identify C_3 and C_4 distributions, perhaps suggestive of differing environmental conditions prevailing temporally.
Ancient amino acids: dating for a long time, until death do them part (and beyond).
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The analysis of chiral amino acids from the intra-crystalline fraction isolated from ancient biominerals has revealed its enormous potential as a geochronological tool (amino acid racemization dating, AAR). Our research has focused on building chronological frameworks on a wide spatial and temporal scale: beginning from the Lower Palaeolithic in Northern Europe, we are making our way down to the Mediterranean rim and to South Africa and exploiting the wealth of biomolecular information trapped inside mollusc shells, ostrich eggshell, coral and other biominerals.

However, AAR in biominerals is moving beyond dating: by coupling AAR and state-of-the-art mass spectrometric techniques we are beginning to understand the complex network of factors driving protein breakdown and allowing the exceptional persistence of some proteins in the archaeological record; by conducting in vitro experiments we are evaluating the role of amino acids in driving and controlling biomineralization itself, and by combining this knowledge with the global climate signal we are investigating the potential of AAR as an environmental indicator.

Here we present an overview of the successes and pitfalls in ancient amino acid and protein geochronology studies at York over the past decade and highlight future avenues of research in archaeological, Quaternary and environmental sciences.
Fading Star: Understanding accelerated decay of organic remains at Star Carr

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Star Carr is acknowledged as one of the most important Mesolithic wetland sites in Northern Europe and has been the subject of a great deal of research. However, recent excavations have uncovered alarming evidence suggesting that rapidly changing site conditions in the last 50 years may be causing accelerated damage to organic remains yet to be uncovered. (Milner et al., 2011. JAS 38 2818-1832).

This research focuses on understanding this decay and its contributing factors. It aims to answer critical questions: what is the rate of current decay? What can we expect to happen to the site in the coming years? Can anything be done to slow, or stop this decay?

The key to this is the assessment and quantification of degradation in organic artefacts uncovered in the different excavation phases. We have employed a variety of complementary analytical techniques (microscopy, spectroscopy and chromatography) to elucidate maximum information regarding degradation mechanisms; some commonly used in archaeological science and some novel approaches. By analysing both modern and archaeological material and relating the observations to the unique geochemical environment at Star Carr, we will develop a better understanding of organic degradation, which will inform decisions regarding the future of the site.
Rags which once were riches: identifying traded wool textiles in archaeological deposits

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Light stable isotope analysis is widely applied to keratinous tissues, including mammalian hair and bird feathers, for geographical provenancing in ecological and forensic studies. This presentation describes the use of carbon (δ¹³C), nitrogen (δ¹⁵N), non-exchangeable hydrogen (δ²H) and oxygen (δ¹⁸O) isotopic analysis to investigate the origin of samples of sheep wool preserved by anoxic waterlogging in medieval archaeological deposits from Northern Europe (c. AD 600–1600). These objects represent a wide range of textile types and qualities, from both domestic and specialist production, and are of importance because production and trans-European movements of raw wool and wool textiles were a cornerstone of economic and political development in the Middle Ages.

This presentation integrates isotopic composition data with elemental and amino acid compositions, to understand the processes of keratin diagenesis during burial, and how these changes affect the resolution of the provenancing technique. Scientific results are also combined with artefactual methods of understanding textile origin (e.g. textile type, dye identification and fleece type analysis), to distinguish between movement of finished textiles, movement of textile technologies and skills and movement of raw wool. Implications for both artefactual and isotopic approaches to artefacts are discussed.
‘The semblance of immortality’: a molecular-based approach to the identification of resinous materials in late Roman mortuary contexts in Britain and evaluation of their significance.

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There is increasing evidence for complexity in mortuary practices in Britain during the Roman period. A number of burials appear to demonstrate an association between inhumation in substantial stone sarcophagi or lead-lined coffins, plaster body coatings and the presence of textiles and natural resins. It has been suggested that this ‘package’ represents a deliberate attempt at body preservation and has been linked to the spread of Christianity. This is disputed, however, and connections with high social status or other religious cults proffered as alternative explanations. Molecular-based investigations of organic substances, principally using gas-chromatography mass-spectrometry, have served to illuminate a wide range of archaeological questions. As part of a systematic study, this ‘biomarker’ approach has provided the first chemical confirmation for resinous materials in this proposed class of late Roman burials in Britain. These include both ubiquitous diterpenoid resins (Pinaceae) and exotic triterpenoid-containing exudates from the Mediterranean region (Pistacia spp.) and Southern Arabia (Boswellia spp.). These findings help position burial practices in the remote province of Britannia in the wider context of the Roman world and place these ‘special’ burials within a corpus of high status and, in some instances, Christian inhumations now attested throughout the Empire.
The ancient Egyptian civilization intentionally mummified a wide variety of animals including many avian species. Research into animal mummification has been underway since 2000 at the KNH Centre and was formalized in 2010 with the establishment of the Ancient Egyptian Animal Bio Bank project. This project utilizes international museum collections to investigate the practice of animal mummification and has established a centralized database and image bank for the mummies to act as a conservation and study resource for the future.

The research underway at Manchester relies heavily on non-invasive techniques to learn as much as possible about these irreplaceable artefacts. A collaborative partnership with the Central Manchester NHS Trust has enabled 200 mummies to be radiographed using state-of-the-art medical imaging facilities. The use of imaging technology (X-ray and CT) has enabled details of the internal contents and mummification techniques used to produce these mummies (many of which are wrapped) to be investigated without compromising the integrity of the artefacts themselves.

Experiential mummification of a sparrowhawk (*Accipiter nisus*) has been conducted using techniques witnessed through the imaging of ancient specimens. This presentation will discuss and evaluate this experiential research and highlight the future aims and objectives of the Bio Bank project.
Casting a wider net: portable X-ray Fluorescence and Anglo-Saxon non-ferrous metalwork.

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Between 1987 and 2005 Suffolk County Council Archaeological Service excavated three Anglo-Saxon cemeteries in advance of re-development at RAF Lakenheath (Eriswell, Suffolk). The burials (dated from the late 4th to early 7th Century AD) contained a plethora (minimum number 783) of non-ferrous objects. This paper focuses on the scientific analysis of these as part of a program of post-excavation analysis which seeks to understand the objects in both a technological and archaeological context.

The primary technique used in this study is portable X-ray fluorescence (pXRF) using a Bruker Tracer III-SD, a method that allowed for the rapid gathering of qualitative data. pXRF has been the subject of recent debate on issues such as reproducibility and methodological issues presented by its use in heritage science. Consequently this paper will discuss some of the procedural issues encountered and the applicability of pXRF to large non-ferrous assemblages within the context of the initial results.

Traditionally analysis on Anglo-Saxon non-ferrous burial assemblages has focussed on cast dress accessories (particularly brooches). Results from these studies show that quaternary copper alloys (copper alloys containing tin, zinc and lead) were the most frequently used, suggesting that Anglo-Saxons were recycling Roman metalwork. The ‘mixed’ nature of the metals has led to suppositions that Roman metalwork was not sorted before melting, perhaps indicating a subsistence metallurgy. Yet how secure are these interpretations when they appear to come at the expense of analysis on sheet and more utilitarian metalwork? Analysis of the Eriswell assemblage has therefore presented an opportunity to increase our understanding of Anglo-Saxon metallurgy by placing cast dress accessories in a broader context with the inclusion of a wide variety of sheet metal and utilitarian cast implements.
The PIXE analysis of glass inlays from the Staffordshire Hoard

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The Staffordshire Hoard was discovered in July 2009 in a field near Lichfield, Staffordshire, and is the largest hoard of Anglo Saxon gold and silver metalwork ever found in England.

The majority of the objects in the hoard are military in origin, sword fittings etc., rather than domestic. They fall within a date range from the mid-sixth to early eighth century AD. Many of the objects are decorated with garnets, and a much smaller number with glass inlays. Many of these pieces exhibit similarities with those found in the Sutton Hoo ship burial.

10 glass inlays from six objects from the Staffordshire Hoard have been subjected to quantitative compositional analysis by proton induced X-ray and gamma ray emission (PIXE and PIGE) at AGLAE, Paris. The data collected has shown that while some of the glasses are of purely natron-based composition and probably Roman/Eastern Mediterranean in origin, others are of a composition which suggests remelting and the addition of further ingredients.

This paper will discuss the findings of this project and how they can be used to suggest the production of complex glass inlays by Anglo Saxon glassmakers.
Investigating technological knowledge in the production of Attic Early Iron Age finewares: a scientific approach.

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This paper explores the potential of various analytical techniques in the investigation of Early Iron Age (c.900-600 B.C.) ceramics from Attica (Greece). It focuses on the results of a microscopic pilot project performed on a small ceramic assemblage from the Athenian Agora in 2011, and it discusses issues of technological knowledge and technological change across four chronological periods. Techniques discussed include simple ones, such as an examination of weight and proportions of vessel, and more ‘scientific’ ones, such as thin section analysis (ceramic petrology). The ideas presented in this paper are connected to a broader PhD study under the title “The correlation of technological and stylistic changes, and society in the Greek Geometric and Orientalising pottery”. It is suggested that social changes observed in the archaeological record of the Attic Early Iron Age could have caused technological changes in the broader ceramic chaîne opératoire. These would have manifested in core manufacturing processes such as clay manipulation, tempering and firing, and they would have left visible traces on the ceramic products. The aim of this paper is to demonstrate that analytical techniques can be used to examine such technological changes and provide useful information on the social role of ceramic technologies.
Was Roman Glass Produced in Italy?

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Raw natron glass was traded throughout the Roman Empire as chunks, remelted, coloured if desired, and shaped into finished objects in secondary workshops. If 4th to 8th century AD primary production centres were identified in Egypt and Syro-Palestine \(^{1,2}\), the location of primary production centres in the Hellenistic and early Roman world is still up for intense debate. Suggestions have been made that such process took place also outside the eastern Mediterranean \(^{3-6}\). A combined approach of trace elements patterns, alumina contents and Sr-Nd radiogenic isotopes has proved to be a powerful tool in provenancing the raw materials used in glass making and determining the location of primary production centres.

176 natron glass samples excavated in the Roman towns of Augusta Praetoria \(^{7}\), Potentia, Pompeii and Herculaneum, and discovered in the Iulia Felix \(^{8,10}\) and Embiez \(^{10,11}\) shipwrecks are the subject of this study. Their isotopic composition is compared to a sand database \(^{12}\) of relevant sands from the entire Mediterranean region and of primary glass from the known 4th to 8th centuries AD Syro-Palestinian production centres. Results do not exclude the use of raw materials from a different area than the Syro-Palestinian coasts, and possibly could point to Southern Italy.

Quantifying post-excavation corrosion of archaeological iron to develop management strategies for long-term storage of site archives

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The long-term storage of archaeological iron poses a problem due to its prodigious quantity and inherent instability. To develop long-term preservation and management strategies that are evidence based and cost-effective, it is essential to identify corrosion mechanisms and routes for iron, as well as determine corrosion rate as a function of intrinsic and extrinsic object variables. An AHRC/EPSRC Science and Heritage funded research programme at Cardiff University is quantitatively determining the corrosion rate of hundreds of archaeological iron objects as a function of selected corrosion drivers; ambient relative humidity, object chloride content and the physical impact of corrosion on heritage value of the object. This will begin to deliver data that has potential for developing a model to predict corrosion rate and its outcomes as a function of environment, thereby allowing management to link expenditure on controlled storage to the value it delivers in terms of object longevity. This will eventually lead to choices that will allow managers to attach life span to objects according to the level of environmental control they provide. The experimental study uses a novel oxygen consumption measurement technique to quantify corrosion and a preliminary investigation that has studied the use of neutron techniques to detect chloride. Progress to date is reported and contextualised within the goal of the project.
Use wear of copper artifacts from Crasto de Palheiros (Portugal).
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At the archaeological site of Crasto de Palheiros (Vila Real, northern Portugal) dated from I Iron Age, various metal artifacts of diverse types were found. The copper alloy adornment objects were studied on an archaeometry perspective with the aid of a research grant given by Santander Totta and the Young Researchers Investigation at University of Porto.

The study was developed by non-destructive methods at CEMUP – Centro de Estudo de Materiais da Universidade do Porto – in University of Porto using SEM-LVMSEM/EDS analysis and microvisualisation to detect possible manufacturing marks. On this presentation we will focus on the use wear marks detected by micromorphology picturing with scanning electron microscopy on the adornments analysed. We were able to detect variations on the damages caused by use which may have implications on the interpretation of the archaeological site.

Lipid biomarker evidence for the preparation of meat, fish and vegetables in Anglo-Saxon coarseware from Hamwic, UK

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Absorbed lipid residues from 24 seventh- to ninth-century coarseware potsherds from the major Anglo-Saxon trading centre of Hamwic (Southampton, UK) were analysed by gas chromatography – mass spectrometry (GC–MS) in order to reconstruct the dietary habits of its population. The results show that the vessels were used for preparing ruminant fats and leafy vegetables. In addition, evidence was found for a minor contribution of aquatic foods. Beeswax was found once and most probably relates to a sealing function or to honey. Remarkable features were: (i) the isomeric mixture of octadecenoic and hydroxyoctadecanoic acids, and (ii) the co-occurrence of C17:1, C19:1 and isoprenoid fatty acids. These features were proposed as biomarkers for ruminant and aquatic food sources, respectively. Furthermore, the carbonyl position distribution in midchain ketones was used to identify mixtures of animal- and plant-derived ketones. The paper highlights the difficulty in interpreting complex lipid signatures that show a mixture of various foods, as observed in the majority of the samples. This was linked to the preparation of stews or the recycling of vessels. The results are considered alongside ceramic usewear data and existing data relating to environmental remains recovered from the Hamwic excavations.
Timelines in Teeth: the report

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Human teeth act as a mini-archive of the elements in the food and drink ingested during the period of formation. Because the timing of tooth development is well-established and enamel has been shown to be extremely resistant to diagenetic alteration, they are an extremely useful resource for researchers seeking information about diet, migration and climate. As techniques for sampling and analysis have improved, tiny amounts of tissue can yield elemental and isotopic data. This has led to attempts to improve temporal resolution by following the incremental lines (lines of Retsius) in enamel or on the tooth surface (perikymata). However the process of human enamel mineralization is complex, with successive phases, meaning that the elements may not be directly related to the incremental structures.

Here we present the results of more than 200 micro-CT scans of developing human teeth using 2D and 3D images to illustrate the complexity of enamel mineralization. Synchrotron x-ray diffraction to examine crystal texture, and electron microprobe and Raman scans to test for diagenesis of selected teeth are also discussed. Recommendations are made for successful sampling strategies for researchers to follow a temporal sequence in human teeth.

Analysis of Archaeological and Environmental Materials by LA-ICP-MS

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Compositional analysis of archaeological materials is a fundamental step for provenancing. Bulk compositional analysis of major and minor components can provide basic information to aid characterisation of the artefacts investigated. However, trace element data can provide a greater assistance in identifying origin, the raw materials employed, and in shedding light on the possible batch preparation methods.

Laser Ablation Inductively Coupled Plasma Mass spectrometry (LA-ICP-MS) allows the determination of almost all elements of the periodic table during a single analysis, with very low limits of detection. Laser ablation is a high resolution sampling technique both laterally and in depth. During analysis a microscopic crater is produced which is virtually invisible to the naked eye, and thus the integrity of the sample is preserved. Coupling the laser ablation system to an ICP-MS provides fast, multi-elemental, trace-level, quantitative analyses, which are applicable to a wide range of materials, making it the ideal analytical tool for the thorough investigation of precious and sparingly available samples.

This paper will first introduce the instruments and the technique. Examples of its application to provenancing and characterization of archaeological and environmental materials will be given.
A Papua New Guinean Recipe for a ‘Cool Smoke’

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This poster presents the results of a biomolecular study of the contents of a native Papua New Guinean palm packet. The artefact was collected by Beatrice Blackwood in 1930 and is housed in the Pitt Rivers Museum, Oxford. The item was recorded as “Gum from the canarium almond tree. Mixed with tobacco to produce a cool smoke. Wrapped in a native packet of palm leaf”. The analysis of the ‘gum’ mixture by gas chromatography-mass spectrometry (GC-MS) identifies the taxonomic botanical source of the resin, and the presence of other significant compounds and their likely sources. This information is presented within an ethnographic context of Papua New Guinea and its geographical surroundings, considering local flora, trade, the collector herself and highlighting implications for archaeological investigation.

Proteomic Analyses of Dental Calculus

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Whilst it has long been recognised that dental calculus is repository for a range of macroscopically invisible compounds and elements – such as food debris, starch grains, and phytoliths – there has been little investigation into the possibility that archaeological proteins may also be found to survive within calculus too. In this paper we present recent findings which have revealed that calculus is also a rich source of proteomic data; not only from the human individual, but also from commensal and pathogenic oral microbial species. The application of high-throughput metaproteomic sequencing to human dental calculus from two Victorian populations, on individuals of known identity, has also revealed the possibilities of calculus as material through which we can study disease virulence and immune response in the past. By studying biomolecular markers within dental calculus, it is possible that studies of this kind may revolutionise the current field of palaeopathology. Furthermore, by comparing the proteomic data obtained with the unique written documents available for the two sites studied, this work aims to provide information on health, diet and disease in a post-medieval context.
Identification of heated ostrich eggshell (OES) samples from South Africa, and its importance for Amino Acid Racemisation (AAR) Geochronology.

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Ostrich eggshell (OES) is an exceptional substrate for AAR dating (e.g. Brooks et al. 1990; Miller et al., 1992; Miller et al., 1999; Crisp et al., 2011) and can provide robust age information for a range of early modern human sites which lie beyond the range of radiocarbon dating. We have analysed hundreds of OES samples from Pinnacle Point (PP) and Elands Bay Cave (EBC) in South Africa (up to ~150 ka). Evidence of anthropogenic fire has been found as early as ~164 ka at PP (Brown et al., 2009) and there are numerous hearth deposits throughout the PP and EBC sequences (Cartwright and Parkington 1997; Marean et al., 2007; Brown et al., 2009; Marean et al., 2010). Proximity of OES to fire, either before or during burial, would result in some eggshells from these cave deposits having been heated, artificially increasing the extent of protein degradation and therefore the apparent AAR age (Brooks et al. 1991; Miller et al., 1999). It is therefore imperative that artificially aged OES samples can be identified. We have compared the archaeological data to an extensive dataset of artificially heated OES fragments; this has enabled us to identify samples which have been exposed to high temperatures and that must therefore be excluded from the dataset used for dating. Furthermore, identification of “burnt” eggshell may yield interesting insights of the activities at the site.

A three-dimensional geometric morphometric study of sexual dimorphism in the orbital morphology of European Neolithic human crania.

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Determination of biological sex from human crania involves the subjective assessment of many morphological characteristics according to a sliding scale of hyper-masculine to hyper-feminine expression, with the majority of individuals falling somewhere between the two extremes. The degree of inter-observer error varies with the morphological characteristic assessed, often being quite large, suggesting much subjectivity in the application of these scales. By focusing on the quantification of orbital shape, this study aimed to objectively assess the degree of sexual dimorphism in the morphology of the orbits of 35 early Neolithic individuals from the central European sites of Nitra Horné Krškany (Slovakia) and Vedrovice (Czech Republic) whose sex had been previously determined. The assumption that males display more quadrangular, and females more rounded, orbits was also tested.

Orbital outlines were digitised using a Microscribe G2X and resulting male and female curves compared using multivariate statistics. Results showed a low degree of dimorphism in orbital shape in the study populations, suggesting that, for the purposes of determining biological sex from human skeletal remains, orbital morphology is not particularly informative and should be employed only with caution in conjunction with other methods.

Biomolecular Codicology: more than just skin deep

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From both an aesthetic and a practical viewpoint, parchments hold vast quantities of information that can enlighten us about the past. Codicologists explore aspects of the materiality of books, and sometimes the zooarchaeological significance of the sheer number and type of animal skins used. How aware were the scribes of the animals on which they wrote their religious texts, accounts and laws? Knowing the animal origin of a particular parchment can add a deeper level of understanding to the manuscript, but this has often proved difficult to decipher. Morphological analysis of follicle patterns is often inconclusive, leading to speculation and unresolved questions. In collaboration with conservation staff at the Borthwick Institute for Archives we have developed a non-destructive method for species identification of parchment. Using an electrostatic solid phase extraction method we are now able to ‘dry sample’ parchment in the archives obtaining sufficient quantities of collagen for analysis by mass spectrometry. The collagen peptides enable us to determine the species that the parchment was made from without causing damage to the manuscript itself. Finally we are in position to add a new level to the materiality of the text. Codicology is now more than skin deep.
Sulfur combined with carbon and nitrogen stable isotope ratios as a means to better understand marine diet and migration patterns on the islands of Ibiza and Formentera, Spain.

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Formentera and Ibiza are located in the western portion of the Mediterranean Sea off the eastern coast of Spain and are part of the archipelago known as the Balearic Islands. As a result of their strategic location, Formentera and Ibiza have been important for trade and commerce and have been conquered and settled by numerous societies through history. The goal of this research is the reconstruction of diet and migration patterns from five sites dating to four chronological periods (Chalcolithic, Punic, Late Antiquity-Early Byzantine, and Islamic) using a combination of sulfur and carbon/nitrogen stable isotope ratios to better understand and reconstruct diet and migration patterns. Sulfur isotope ratio analysis is presented on bone collagen from 75 animals and 120 humans along with the corresponding carbon/nitrogen stable isotope results to determine if marine protein contributed a significant portion to the diet of these individuals through time. In addition, the sulfur isotopic results will be used to identify migrants vs. individuals likely born on the islands and how these patterns varied over the four chronological periods of study.

Re-dating the oldest burial mound in North America: the challenges of archaeological conservation for radiocarbon dating bone.

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The L’Anse Amour burial mound (EiBf-4) is located on the east coast of Canada and represents the oldest purposeful burial in North America. It contained a single individual and an assortment of bone and stone artefacts. Based on one charcoal sample the site was initially dated to 7530 ± 140 BP (I-8099), and culturally affiliated with the early Maritime Archaic Indian tradition. Unfortunately, the skeletal remains were poorly preserved and required stabilizing conservation treatment. Additionally, the original records of the conservation protocol are unavailable so the precise compounds used to treat the remains are unknown. As such, it was long assumed these remains could not be directly dated. The main objective of the present study is to determine the date of the burial through an AMS carbon-14 measurement of bone collagen taken directly from the human remains. Here we present our approach to obtain an accurate date and comment on the biochemical integrity of the extracted collagen. The new date has helped to further establish the significance of this site as the oldest burial feature in North America. This study also demonstrates how consolidated archaeological bone can be effectively used as a source material for carbon-14 dating.
Swine Husbandry and Pork Flavour at an English 17th C. Fishing Station in Newfoundland: An Intraindividual Stable Carbon and Nitrogen Isotope Analysis of Pig Diet

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From the 16th C. onwards, various European nations seasonally visited or settled the shores of Newfoundland to fish cod in the rich waters off Canada's east coast. Swine and pork products were a significant dietary component for these seafarers and fishermen. Pork products consumed at the 17th C. English settlement of Ferryland derived partly from locally husbanded swine that were raised largely on a marine diet most likely deriving from fish offal. Historical and folk accounts from Newfoundland describe pork flavour as variable and mainly influenced by swine diet, particularly the foods consumed several weeks before slaughter. In this poster I present a reconstruction of the last several months of dietary intake for an individual pig raised primarily on fish offal at the Ferryland settlement using stable carbon and nitrogen isotope analyses of serial samples (n=17) from tooth dentine collagen. This case study demonstrates an isotopic approach to indentifying human intentionality in animal husbandry as it relates to sensorial preferences for pork flavour.

Early Life Histories of a Population Living in Poverty: Stable Isotope Analysis of Incremental Dentine Samples

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This poster explores the early life histories of a Post-Medieval population from Southwark, South London, using carbon and nitrogen stable isotope analysis of the dentine in first molars. The assemblage is associated with an almshouse and is believed to represent a population which would have experienced nutritional stress. The methodology builds on the development of incremental dentine sampling, allowing the early life histories of these people to be explored without the presence of any infants in the cemetery and removing the bias of studying individuals who would have died in infancy. The high resolution of the technique and the large sample size raises a number of points, potentially with wider implications beyond this assemblage. It is suggested the results either represent a difference in diet between males and females between the ages of 0-8 years old or alternatively, a physiological difference between the sexes, which has not been possible to observe without such a high resolution methodology.
A novel approach for the study of health and diet in the transatlantic slave trade

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In a recent pilot it was established that dental calculus is a reservoir of biomolecular information. As an ectopic material, dental calculus may offer a less obtrusive way to study human tissues, and a remarkable vehicle for preservation of the oral microbiome. This opens up a new chapter in biomolecular archaeology, giving us access to not only human biomolecules but a sample of the microorganisms that live in and on us. In light of this successful pilot study this poster outlines how these novel methods will be applied to study of health and diet in the transatlantic slave trade era. Current knowledge on slave health and diet is based on contemporary accounts, which are limited by contemporary medical knowledge and are not detailed. Through the extraction of microscopic, genomic and proteomic information we hope to identify pathogens, study their associated diseases and identify dietary markers. This research is part of the EUROTAST network, a multidisciplinary research group which seeks to examine the origins, lifeways and legacies of the transatlantic slave trade. In conjunction with other EUROTAST projects, we hope to greatly improve our knowledge of health and diet of enslaved Africans during this period.

The information potential of metal-protected organics: Two case studies

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Poorly preserved human remains were found within a Viking Age burial mound at the site of Tjora (Norway). The burial environment was corrosive, leading to the complete loss of most skeletal material. Within the mound the presence of copper-alloy brooches had induced preservation of a few bone fragments. A similar set of brooches was uncovered in the remains of a burial at another site in the same region. Again, preservation conditions were poor. No bone was preserved but leather/skin was recovered. In addition, remains of feathers, textiles, animal hair, insects and plant material were found. As surviving organic material is rare in this region, it is desirable that sampling of remains is minimalist and that success rate of analyses is high. Our aim is to investigate these materials in order to get a detailed understanding of the material and state of preservation. The two case-studies illustrate the potential information value of these types of finds. The approach employed here can be used as a basis to set up a practical analytical scheme going from simple/non-destructive to more complex analyses. Work on this material is ongoing and includes DNA analyses (bone) and analysis of protein sequences (leather) for species identification. The poster will report the first results of microscopic and biomolecular analyses.

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Little factual information is available on the history of the European population during the transition from the Late Roman to the Merovingian period. Nineteenth-century historiography created an image of large scale migrations of ethnic groups during this period. Recent archaeological studies have provided evidence that this image needs to be moderated. Multidisciplinary studies of burial sites from this period provide the opportunity to study the mechanisms by which sites become inhabited, what was the provenance of the individuals and how they were related. On the floodplain of the River Meuse close to Maastricht two burial sites have been excavated. The Borgharen-Daalderveld burial site consists of 11 graves dating from the late 4th and the 5th century AD. Nearby the Borgharen-Pasestraat cemetery was situated on top of the remains of a Roman villa. Twenty-three graves of this cemetery have been excavated and they date from the second half of the 6th and the 7th century AD. Dental enamel of 15 individuals was sampled for Sr isotope analysis, aDNA samples of five individuals were analysed. Isotope analyses reveal large isotopic differences between the buried populations of both investigated burial sites. Preliminary results show direct child-parent relationships in at least two burials. Moreover, strontium isotope analyses point to different geographical birthplaces for a father versus daughter. In addition, isotope analyses also reveal large isotopic differences between the buried populations of both investigated burial sites, indicating a possible shift in population composition between the 5th and 6th century AD.

Pigs, Bones and Holy Cones, an improved protocol for 87Sr/86Sr by laser ablation plasma mass spectrometry using oxide reduction and collision reaction techniques

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Strontium isotopes have made an invaluable contribution to our understanding of mobility and migrations in past societies. To date most strontium isotope studies have focused on bulk measurements of tooth enamel, this is precise, accurate and reliable. However this method is less satisfactory when trying to understand mobility over short time scales by examining intra-tooth strontium isotope variation. This is especially true when considering populations where mobility during life can be assumed. Laser ablation plasma mass spectrometry offers the possibility to make strontium isotope determinations with high spatial resolution. Despite this, development of the technique has been hampered by isobaric interferences on various masses of interest. The most insidious of these has proven to be 40Ca31P16O formed from the calcium phosphate tooth matrix, and which is isobaric to 87Sr. This interference causes an offset between 87Sr/86Sr by laser ablation compared to traditional techniques (e.g. by TIMS). We present an improved protocol for 87Sr/86Sr by laser ablation plasma mass spectrometry. Our method combines machine and plasma conditions to reduce oxide formation coupled with a helium ‘collision cell’ to reduce molecular interferences. The improvement in accuracy is such that 87Sr/86Sr by laser ablation agrees with TIMS data with typical analytical precisions of 50ppm (2σ).
The recovery of lipids from Japanese late glacial pottery

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The record of hunter-gatherer pottery in Japan which dates back to the end of the last glacial period and through the early and middle Holocene offers a unique opportunity for studying pottery use through a period of climatic, environmental and cultural change. Here we report a preliminary study of charred surface deposits adhering on pottery shreds dating to the Incipient Jōmon period (15,000-11,200 BP) from sites across the Japanese archipelago. Using a modified extraction technique, we show that organic molecules, derived from the use of these vessels, can be readily recovered from associated charred surface deposits despite the very early date of these pots. Furthermore, GCMS analysis shows the presence of aquatic biomarkers (ω-(o-alkylphenyl)alkanoic and isoprenoid acids) and is supported by bulk carbon and nitrogen isotope analysis (IRMS) and carbon isotope analysis of individual fatty acids (GCcIRMS), providing strong evidence that aquatic organisms (freshwater and marine) were processed in the majority of these pots. These results show that lipid residue analysis is applicable to some of the earliest hunter-gatherer ceramic assemblages and is a suitable tool to study pottery innovation and dispersal in the late Pleistocene and early Holocene.

Providing a meaningful palaeogeographical context for archaeological interpretation: the evolution of the lower River Lea.

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The recent focus of commercial construction and regeneration projects along the lower River Lea valley, centred around Stratford, eastern London, UK, has led to developer funded archaeological and palaeoenvironmental investigations being undertaken on a large scale. Geotechnical datasets associated with these developments has enabled a detailed reconstruction of the buried landscape across an area of 3.3km² to be made. Using this deposit model, it has been possible to target key areas for palaeoenvironmental investigations. These have been able to provide a detailed understanding of the vegetation and river dynamics across the study area for the Holocene period, and the improved integration of the archaeological record within this buried wetland-dryland landscape. The approach presented here provides a greater ability to understand the evolving wetland landscape. This study demonstrates the important role that developer funded analysis can play in understand the Holocene development of wetland environments situated within modern urbanised areas.
Reconstructing environment and human impact during 1500 years of mining activity around Falun Copper mine, Sweden, through a multidisciplinary approach

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Mining impact on the surrounding environment is one of the most severe human activities. The time the mining has been lasting is usually proportional to and increases the impact on the surrounding environment. In the interdisciplinary project presented in this paper, “Falun above from Falun under”, is the earliest history from around 1300-1500 BP studied together with the increasing environmental impact of growing mining activity around Falun Copper mine. The environmental and cultural development is followed forward until the mine is lastly abandoned in 1992.

The projects aim is to study the area unbiased and explore previous reference as well as initiating new investigations. The project use the British project “Great Yarmouth Archaeological map project” as a model. Falun Copper mine have a central and in time long part in Sweden and was 2001 established as a UNESCO World Heritage and is therefore in some parts rather well studied – primarily in archaeology, earth science and history. Within the project today is several methods used and under development: sedimentological mapping, reconstruction and analysis; insect and pollen analysis; dendrochronology; GIS; archive material and previous archaeological and geotechnical reports etc. There are also studies connected to preservation (World Heritage) and environmental history pedagogy and didactics.

Past Agricultural Practices In The Western Isles Revealed By Sub-Fossil Mollusc Shells

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The shells of molluscs are often extremely well-preserved in the calcareous wind-blown sand plain, known as the machair, which dominates the low-lying west coast of the Western Isles. The machair plain also provides fertile, free-draining soils in a generally damp and acidic environment, and so has been the focus of agricultural activity in the islands since the later half of the third millennium BC. This poster demonstrates how assemblages of sub-fossil mollusc shells are contributing to a greater understanding of the development of agricultural practices in a challenging environment.
The case for digital reference collections in environmental archaeology

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Digital technology presents the opportunity to revolutionise the way we carry out archaeological research, especially by removing barriers of access to datasets, new research and reference material. A growing number of freely-accessible digital reference collections are being developed and published online. Although they are not substitutes for comparison to physical material, we argue that the creation of open digital reference collections allows wider access to archaeological material, especially examples of rare, under-recorded and poorly-preserved specimens. It also enables standardisation of archaeological recording. To optimise the potential of these resources, a culture of sharing should be fostered among the wider environmental archaeology community, in which participation is encouraged and rewarded. We present a brief overview of digital participation in environmental archaeology, highlighting successful case studies, and offer a challenge: to create a more inclusive and participatory digital environmental archaeology.

Exploring the Urban Environment at Songo Mnara, Tanzania, through Phytolith Analysis.

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Research at Songo Mnara - a Swahili stonetown off the coast of Tanzania - is broadening our understanding of the archaeological potential of phytoliths, not only in tropical East Africa, but also within the wider tropical region. This work is building an extensive reference collection exploring the production of diagnostic phytoliths within a wide range of plant species, and is assessing the potential for intra-site studies of plant use. Phytolith research is becoming increasingly relevant in African archaeology as the potential contributions of the technique become clear, although there is a recognised need for reference material (Sulas and Madella 2012).

Traditionally phytolith research in Africa has focussed on environmental reconstruction; in contrast, research at Songo Mnara seeks to explore the use of space, including interior and exterior, public and private spaces within a settlement area. Systematic sampling during the 2011 excavations produced phytolith samples from exterior domestic spaces, ritual spaces and open spaces (Fleisher & Wynne-Jones 2013). The preliminary results of the second phase of phytolith analysis, presented here, afford visibility to the presence and potential use of plant materials within these areas, further exploring the use of space at Songo Mnara.
Investigating palaeodiets and subsistence strategies of Chinchorro populations through LC/IRMS analysis of mummy hair

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Analysis of hair samples represents a way of investigating dietary changes over a short period of an individual’s life, as hair keratin records the diet sequentially as it grows. Hair samples can provide more information than bone collagen, such as seasonal changes in diet, exploitation of multiple resources temporally, or even infer movement patterns.

The present study will investigate the δ¹³C values from amino acids of keratin acid hydrolysates by liquid chromatography – isotope ratio mass spectrometry (LC/IRMS). The distinction between essential and non-essential amino acids provides information about different elements of the diet (e.g. protein vs carbohydrate/lipid sources), metabolic characteristics and physiological factors (breastfeeding and weaning, nutritional stress etc).

We have applied this method to investigate prehistoric subsistence strategies in pre-Columbian populations of Chile in order to reconstruct palaeodiets and local mobility of Chinchorro hunter-gatherers. This research is an attempt to clarify high resolution of dietary changes in Chinchorro individuals. The initial results of this project show that a diet on a fortnightly scale can be virtually inferred by compound-specific stable isotope ratio analysis of hair samples of approximately 0.5 cm in length from a single hair.

To ZooMS or not to ZooMS that is the question; a comparative study of taxonomic identification techniques: ancient DNA analysis and Zooarchaeology by Mass Spectrometry.

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The use of morphological traits in the taxonomic identification of archaeological and palaeontological samples can prove problematic for certain taxa. Over the years a number of alternative biomolecular identification techniques have been developed to address this problem, including ancient DNA (aDNA) analysis and more recently Zooarchaeology by Mass Spectrometry (ZooMS). ZooMS, a technique that utilises collagen peptide markers to identify bone samples, has been suggested as an alternative to aDNA for the identification of archaeological bone, as it possesses fewer contamination concerns, and should be more time and cost effective. However, as seen here, the taxonomic resolution of ZooMS is in some cases not sufficiently specific to make it an alternative to aDNA analysis. We propose that, whilst these individual techniques both possess their own merits and drawbacks, the greatest benefit can be obtained by using them in conjunction with one another, creating an enhanced biomolecular profile of archaeological and paleontological material.
Kingsmead Quarry, Horton: an approach to understanding persistent use of place, habitation and landscape dynamics.

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This paper reflects on 10 years of excavations in advance of gravel extraction at Kingsmead Quarry, Horton, Berkshire, and presents the story so far. It also discusses the geoarchaeological and palaeoenvironmental strategy adopted during the excavations and the scientific techniques employed, which have yielded some exciting results.

Extensive ‘strip, map and record’ investigations, located on the floodplain of the Colne Valley, have revealed a busy and varied archaeological landscape in persistent use throughout prehistory, with activity recorded as far back as the Late Glacial period.

Archaeology recorded so far includes Early Neolithic buildings, a Middle Neolithic oval barrow, Middle Bronze Age farmsteads and burials, and Iron Age settlement. Several palaeochannels have been recorded and sampled, ranging in scale from shallow streams to a substantial channel system.

The long term nature of the project has provided the opportunity to develop the research framework as work progresses, whilst its large scale has permitted the investigation of settlements and monuments in their wider landscape setting, and allowed the spatial characterization of related foci and zones of activity (e.g. settlements, funerary zones, fields) with the dynamics of landscape change (e.g. the Colne channel system).

Antlers and isotopes: assessing short-term dietary change from 13C and 15N stable isotope analysis of fallow deer antlers

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The fallow deer was reintroduced into Britain by the Romans, after its retreat south into Europe at the last glacial maximum (Sykes et al. 2006) and the existence of breeding populations has been established at Fishbourne Roman palace, Sussex, and Monkton on the Isle of Thanet, Kent (Sykes et al. 2011). While fallow deer remains are rare from Iron Age and Roman sites in Britain, attempts are being made to locate finds reported in the literature in order to obtain samples for carbon-13 and nitrogen-15 stable isotope analysis which will be used to assess diet as well as evidence for long-distance trade in shed antler. In a parallel study of modern fallow antlers of known provenance, 13C and 15N stable isotopes have been measured in samples taken along the length of the antler. This allows the examination of high temporal resolution changes in diet during antler growth. It is hoped that these results will show whether antler demonstrates short-term variation in isotopic signatures from dietary changes or consistency from bodily isotopic averaging.

Early Anglo-Saxon Glass Beads: Composition vs. Chronology.

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A large number of glass beads have been recovered during recent excavations of the early Anglo-Saxon (5th–7th centuries AD) cemetery complex at RAF Lakenheath (Eriswell) in Suffolk. Chemical analysis of a range of these has revealed a number of distinct groups of soda-lime-silica glass produced in the ‘Roman’ glassmaking tradition, which are ultimately likely to have their origins in the Near East. Comparison of the compositional data with distribution patterns for particular bead types has made it possible to speculate as to which bead types were imported and which bead types were insular products. The results suggest that many of the bead types were produced locally using a supply of scrap glass from the preceding Roman period. However, the ‘Continental’ bead types appear to have been produced using a fresh supply of raw glass chunks imported from the Near East. It seems likely that a large number of beads were produced on a local scale in Britain during the 5th and 6th centuries. However, bead production in Britain appears to have largely ceased by the late 6th or early 7th century, by which time the Anglo-Saxon population had become largely dependent upon imported beads from the Continent. The deposition of beads with the dead was no longer generally practiced by the late 7th century, following the conversion of Britain to Christianity.

A comparison of pretreatment methods for the analysis of phosphate oxygen isotope ratios in bioapatite

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The recovery of biological phosphate oxygen isotope (δ¹⁸O_p) signal in bioapatite is thought to be dependent upon the complete removal of competing sources of oxygen such as associated organic matter. In the literature, there is range of pre-treatment methods to purify phosphate material from organic components, with contradictory evidence of the usefulness and efficiency of one or another. We will present the results of a systematic comparison in which chemical and thermal pre-treatment techniques were tested for the effectiveness at removing organic matter and the likelihood that they modify original δ¹⁸O values.

We employed inorganic (synthetic apatite; phosphorite rock) and organic (bone and tooth tissues) phosphate materials and performed nitrogen content (wt. %) analysis, Scanning Electron Microscopy (SEM) and Fourier Transform Infrared (FTIR) spectroscopy.

Variable efficiency at removing organics was observed, with no correlation to any specific structural/mineral change. δ¹⁸O_p results show large variability between samples differently pre-treated and untreated ones. Almost no variation was instead found in tooth enamel, phosphorite rock and inorganic apatite. Additionally, untreated samples seem to show values closer to the expectations. According to our results, pre-treatment is completely unnecessary in highly mineralized tissues.

We recommend caution when comparing δ¹⁸O_p data treated with different pre-treatment protocols.
The great henge complexes of southern Britain have long been recognised as ceremonial sites for large-scale feasting by gatherings of people who probably came from far and wide. Recent excavations at Durrington Walls have uncovered a well-preserved Neolithic settlement with surviving house floors and middens identifiable to particular houses. Together with the monumental structures already identified at this site, these constitute a unique resource to examine variation in activity patterns occurring in different household and public spaces. Here we present the results from organic residue analysis of Grooved Ware vessels, to investigate variation in food preparation (cuisine) and consumption between these areas. Lipids were extracted from a large number of vessels, which were used over a relatively short timescale (<100 years), and were analysed by GC, GCMS and GC-c-IMRS. The results indicate significant variation in the use of animal products between the different contexts, which is interpreted as reflecting different social practices related to the use and deposition of pottery. Dairy products in particular seem to have been used selectively in smaller vessels that are more frequently deposited in the public areas of the site.

A Burning Question: Structural and Isotopic Studies of Cremated Bone in Archaeological Contexts

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The study of cremated bone is of crucial importance for periods and regions in which cremation was the main burial practice. Cremated bone has, however, been excluded from isotopic studies until now as it is believed that the very high temperatures reached during cremation alter or even destroy any isotopic information contained in bone. Since 2001, cremated bone fragments have nonetheless been radiocarbon dated, and, as a consequence, the potential for isotopic study of cremated bone is currently being re-investigated.

In order to understand cremated bone, it is crucial to study what happens when bone is burned. In addition to colour changes, there are a number of structural and isotopic changes that beg further enquiry. In the proposed paper/poster, I present the first results of my doctoral research. Preliminary results indicate that bone structure changes drastically and that bone exchanges large amounts of carbon and oxygen with its surrounding environment during cremation: burned with coal, a modern lamb bone appeared to be 4,000 $^{14}$C years old. Further results strongly suggest that cremated bone could be used for strontium mobility studies. The paper proposes some implications of these results for radiocarbon dating and bioarchaeology.

This research is funded by the Wiener-Anspach Foundation
Landscape and subsistence reconstruction for Ibida settlement (IVth-VIth centuries, Dobrudja, Romania)

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This paper discusses faunal assemblages recovered during excavations in the Ibida settlement (IV-VIth centuries AD). Temporal analyses of several characteristics, including taxonomic frequency, indicate changes in local landscape and subsistence strategies that took place in the settlement. The archaeozoological quantification (number of identified specimens, minimum number of individuals) aimed at evaluating the relative frequencies of species in order to estimate the animal resources and subsistence practices (animal husbandry, hunting, fishing) such as animals used as food. The majority of animal remains are from mammals and fish, and few pieces from birds. The settlements of Ibida have a large faunal spectrum, 27 species being identified in the archaeozoological samples: 8 domestic mammals, 9 wild mammals, 7 bird and 13 fish. The hunting (4.6%) has less importance compared to animal husbandry (95.4%); between wild mammals the forest species are dominant (red deer, wild boar). Red deer and bear were identified in the settlement but today they are not found in area. The subsistence economy was dominated by domestic mammals, cattle (41%), followed by Ovis/Capra (26%) and pig (16%), a pattern similar to other roman and post-roman settlements in the region.

The study was supported by Romanian project CNCS–UEFISCDI PN-II-RU-TE-2011-3-0146.

Watching bone degrade - one glutamine residue at a time.

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Currently, bone material can be dated to around 50,000 years BP using radiocarbon analysis; the secure dating of samples older than this has proved challenging. As bone material ages, its major protein, collagen, undergoes chemical diagenesis. One of the ways in which collagen can degrade is via deamidation of the amino acid residues asparagine and glutamine, to aspartic acid and glutamic acid respectively. We have been developing approaches using mass spectrometry (MALDI-MS) to measure the conversion of glutamine to glutamic acid, and compare levels of glutamine deamidation in collagen from a number of independently radiocarbon dated bone samples. Collagen from radiocarbon-dated samples from the Leibniz radiocarbon dating laboratory in Germany, along with bison bone material from securely dated ash layers (dated using tephrachronology) from the Klondike region of Canada have been analysed. In parallel, high-temperature time course (kinetic) experiments have been performed on Roman cow bone material to assess the rates of deamidation at different temperatures. With the data obtained we hope to assess the potential of deamidation as a novel method for dating Middle and Lower Palaeolithic bone material.
Single amino acid δ¹³C investigation of serial dentine sections: Investigating diet and metabolism in childhood

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Stable isotopic analysis of bone collagen is an invaluable tool for palaeodietary reconstruction, providing a general dietary signal. Recently, serial sampling of tooth dentine for stable isotopic analysis has been successfully applied to archaeological samples, in order to gain insight into dietary changes within the lifetime of individuals. These studies have revealed (in some cases) remarkable changes in both bulk δ¹³C and δ¹⁵N values of dentine collagen during childhood, some related to known changes in diet, and possibly breastfeeding/weaning and/or dietary stress. In some instances deviations in nitrogen and carbon are not easy to rationalise in terms of known likely dietary changes hinting at metabolic effects and decoupling of nitrogen and carbon isotopic signals. We analysed the amino acid δ¹³C of these dentine collagen samples using LC-IRMS to investigate how the carbon skeletons of essential and non-essential amino acids behave in these situations in order to determine the role of dietary routing and metabolic functions in these individuals. Can the amino acid approach provide further dietary/metabolic interpretations? How much do changes in certain amino acids affect the bulk δ¹³C values? Can the amino acid approach provide a clear stress marker? These were all questions that we have considered in this analysis.

Application of matrix-assisted laser desorption/ionisation – mass spectrometry for rapid screening of lipid extracts from archaeological pottery

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Lipid analysis of archaeological artefacts is a well-established method used for obtaining information on the artefacts and their use.¹ The detection of triacylglycerides (TAGs) is particularly important because TAG distributions can be used to help identify animal species, and to differentiate between dairy and adipose fats.² Current techniques include solvent extraction of the lipids followed by derivatisation and gas chromatography (GC) and GC-mass spectrometry (GC-MS); alternatively, liquid chromatography (LC)-MS approaches have proved successful.³ However, GC- and LC-MS analyses are time-consuming thus for large ceramic assemblages, and where only a small proportion of extracts contain detectable levels of analytes, a medium-throughput screening technique to identify extracts for further analyses would be a great advantage. Direct mass spectrometric methods can address this issue. Matrix-assisted laser desorption/ionisation (MALDI)-MS provides a convenient method for analysing lipid extracts from multiple samples relatively quickly, and is capable of detecting TAGs from archaeological extracts. Through the use of tandem mass spectrometry, it can also provide information about the specific fatty acids present on each of the TAG species. Presented here is its application to lipid extracts from potsherds from the Neolithic site of Durrington Walls in Wiltshire.

We gratefully acknowledge studentship support for RKS from the Analytical Division of the RSC and the NERC.

¹ R. P. Evershed, Archaeometry, 2008, 50, 895-924
Contributions of bimolecular archaeology to marine resource conservation and management

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Over the last century, marine and freshwater ecosystems have witnessed dramatic declines worldwide due to industrial overharvesting and human-induced environmental degradation. Resource managers are increasingly turning to archaeological data to provide baseline information on the past abundance and distribution of aquatic species, and to mitigate anthropogenic effects on marine and freshwater ecosystems. Biomolecular techniques have broadened the applications of environmental archaeology by combining the specificity of molecular analyses with the time depth of archaeology. As conservation biology becomes more reliant on molecular markers, ancient DNA data from archaeological remains can provide a direct link between past and present populations. Using three case studies, this poster will illustrate how biomolecular archaeology has been applied in the Pacific Northwest to: 1) assess the pre-industrial genetic diversity and population structure of Pacific Herring; 2) guide the restoration of salmonids in the Klamath Basin, Oregon; and 3) assess the recovery of Pacific whale populations following industrial whaling declines. The exceptional biomolecular preservation in archaeological faunal remains from the Pacific Northwest provides enormous potential for zooarchaeology to contribute essential information for the conservation, management and restoration of modern aquatic ecosystems.

Investigating cattle birth seasonality at Pool, Orkney: a new approach using $\delta^{13}$C and $\delta^{18}$O profiles in first and second molar enamel

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Cattle (Bos taurus) are biologically able to breed year-round, potentially giving farmers the freedom to choose a calving strategy to best meet their economic goals. Thus, an accurate method to determine cattle birth seasonality from archaeological remains would prove a valuable tool when investigating a prehistoric farming community. One possible approach, still at an early stage of development and requiring more extensive testing, focusses on the isotopic patterning ($\delta^{13}$C, $\delta^{18}$O) recorded within the enamel of cattle first and second molars. The shape of the $\delta^{13}$C intra-tooth profile appears to reflect the physiological changes to a calf’s digestion occurring in the first weeks of life. It is proposed that birth seasonality may be determined through direct comparison between $\delta^{13}$C and $\delta^{18}$O intra-tooth data. The method has been applied to a number of cattle molars from Pool, Orkney, from the Scandinavian Interface period (c. 800 AD – c. 950 AD). The results suggest that calving occurred during three seasons of the year. A possible impetus for multiple-season calving, which requires additional husbandry effort, may have been the continuous supply of milk. This would support the conclusion, from age-at-death analysis, that the economic focus of Pool during the Interface period was dairying.
Reconstruction of diet during the Neolithic of Northern Greece using Stable Isotope Evidence from Lipid Residues in Archaeological Potsherds.

Helen Whelton¹, Melanie Salque¹, Kostas Kotsakis², Dushka Urem-Kotsou² and Richard P. Evershed¹

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The transition to a settled, agricultural way of life has been the subject of considerable research in prehistory. It is suggested that in the European Neolithic early farming practices may have developed in varying ways in different regions, depending on local conditions and cultural practices. However, dietary and subsistence patterns in Neolithic Greece are poorly understood. In northern Greece faunal bone evidence indicates the predominance of domesticated sheep, goat and pigs, with cattle being minor components, and kill-off patterns for the former suggesting that herd structures maximised the availability of meat rather than milk. Archaeobotanical remains imply a reliance on cereal grains and pulse crops. Conclusions so far suggest a predominately terrestrial diet, although fish bones have been recovered from at least one coastal site. This project aims to investigate subsistence patterns and dietary changes throughout the Neolithic of northern Greece both chronologically and spatially, through investigations of organic residues preserved in pottery vessels. Our approach is to chemically determine, via gas chromatography and mass spectrometry, the components of absorbed lipid residues. Molecular and isotopic compositions are then used to characterise the origins of lipid classes present, providing new insights into food acquisition and culinary practices. Here we report results from six sites dating to the Middle and Late Neolithic, whose localities span a range of inland and coastal environments of northern Greece.

A Micromorphological and Inorganic Geochemical Investigation of Roman and Prehistoric Graves.

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The study of archaeological human burials is fundamental to understanding past societies (Parker Pearson, 2003). Both macro and micro scale techniques have been to to investigate and interpret burials. Macroscale studies are more common, but can pose some limitations as they focus on skeletal and artefactual remains, this can limit the exploration of graves where there is extensive degradation, and biases investigation and interpretation towards artefacts which survive well within the archaeological record. Soil formation processes and depositional pathways are also difficult to establish using macroscale techniques. Microanalytical techniques such as organic geochemistry (Shillito et al., 2011) and phytolith studies (Ryan, 2011) have been applied to grave contexts highlighting the future potential of applying such techniques to grave deposits. InterArChive is an interdisciplinary research project that is investigating prehistoric and historic burial contexts, using a combination of thin section micromorphology, inorganic geochemistry and organic chemistry (InterArChive, Unpublished). Using these microanalytical techniques InterArChive aims to develop and test a comprehensive sampling strategy to investigate human burials in order to reconstruct past soil formation and body degradation processes particularly in instances where macroremains are no longer present. This poster will present the initial findings of the micromorphological investigation of Roman graves highlighting where the technique has been successful and indicating areas of future research.

INTERARCHIVE Unpublished. Interred with their bones - linking soil micromorphology and chemistry to unlock the hidden archive of archaeological human burials.


The Egyptian desert village Balat is a traditional architecture reflects how the Islamic thought treated with the surrounding environment.

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The choice of location of the village Balat shows the genius of its inhabitants, this location has contributed to the cultural interaction between them and the commercial convoys and convoys of pilgrims which were going through the village, to this, effect was evident in its architecture .The traditional architecture of Balat Reflects interaction of human traditions and arts with the varied potential environmental conditions in that it bears unusual unique evidence of cultural traditions and prevailing cultural traditions, or which has disappeared, it represents an outstanding example of the type of buildings or groups of architectural showing one of the phases of architecture in human history. The architecture was characterized by maintaining the privacy associated with the customs and traditions and the teachings of Islam, and is worth mentioning that this type of architecture has completely disappeared now that was overshadowed by modern civilization, and therefore being to preserve the traditional architecture. The architectural genius of thought emerged in the selection of the high plateau to be adopted by the village for fear of the wind and to secure from attacks by Bedouins.

Because UNESCO is working to preserve the World Heritage protection and rescue, and because the village of Balat based oasis within the desert of Egypt's Western was where some criteria nominated for World Heritage List of monuments of historical and groups of buildings and sites, the organization included it in the World Heritage List.

The research will address the study and analysis of Balat buildings as a kind of traditional architecture that reflect the interaction of Islamic architectural thought in the Middle Ages with the desert environment. And demonstrate the importance of maintaining an integrated model of traditional mud architecture because of its contents of popular architectural arts and rare inscriptions.
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