SYMPOSIUM 2017

HORIZONS IN AUSTRALASIAN ARCHAEOMETRY

AAA2017 Pre-Conference Workshop

DATE Tuesday, 5 December 2017
TIME 9.00 am – 5.00 pm
VENUE Delacombe Room,
Pullman Melbourne on the Park

ARCAS was officially launched at the Australian Archaeological Association (AAA) meeting in Cairns, in December 2014. ARCAS' key objectives include the re-establishment of the Australasian Archaeometry/Archaeological Science Conferences, and the creation of links among the various archaeological science groups within Australia and internationally. ARCAS has remained an informal association but with strong ties to AAA.

The ARCAS website, currently hosted by the University of Wollongong, provides a searchable list of members and current research specialties and services on offer. There are also automatic news updates from the Journal of Archaeological Science (JAS).

This Symposium is being held as a Pre-Conference Workshop, on the day before the AAA2017 Conference begins. We hope many people will attend both. The Symposium theme 'Horizons in Australasian Archaeometry' aims simply to showcase recent research and new directions. The format also aims to highlight new discoveries and current research by the youngest generation of scholars.

The format for the Symposium includes:

- 11 x 10 min time slots for short presentations; and
- 6 x 30 min time slots for keynotes by invited Early Career Researchers.

Discussion has been spaced to accommodate all the offered presentations. Details of the program are attached and note that Abstracts are in order of first author's surname. The first author is listed first in bold upper case under the presentation title. Co-authors follow in sequence down the columns and across to the adjacent column.

The presentations are grouped under seven themes that reflect the diversity of studies in the Australasian region. The sequence follows:

1. Sourcing and artefact characterisation
2. Chemistry of bones, teeth, tendon and hair
3. Conservation
4. Modelling sea levels
5. Stone tool function
6. Microbial fingerprinting
7. Dating, seasonality and rock art

In keeping with our original aim to circulate ARCAS administration and future Symposia among participating institutions, we ask all ARCAS members to consider hosting ARCAS and the next Symposium. During lunch, there will be an opportunity to discuss ARCAS succession.

We welcome all speakers and participants!

Richard (Bert) Roberts

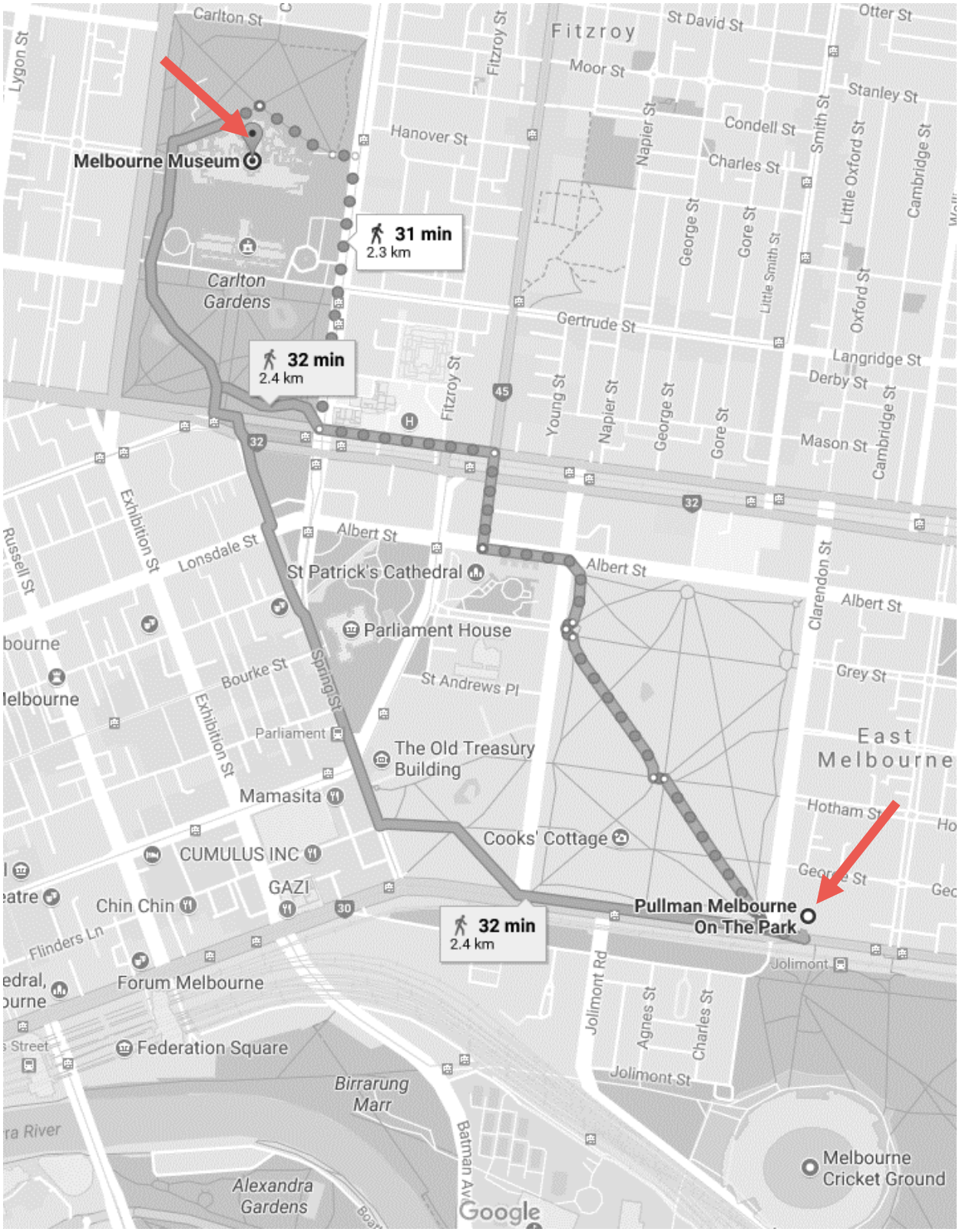
Richard Fullagar

ARCAS SYMPOSIUM PROGRAM 2017

TUESDAY, 5 DECEMBER 2017			
Time	**Activity**	**Speaker**	**Topic**
9.00-9.10	Welcome	Richard Fullagar & Bert Roberts	–
THEME 1: Sourcing and Artefact Characterisation			
9.10-9.40	*Keynote 1*	Anne Ford	Tracing the Footsteps of Lapita
9.40-9.45	Discussion	–	–
9.45-9.55	Short Talk	Michelle Richards	Adzes and Pounders as Evidence for Colonisation and Specialisation
9.55-10.05	Short Talk	Liesel Gentelli	Analysis of 16th to 19th Century Silver Coins
10.05-10.15	Short Talk	Marie Orange	Obsidian Provenance Studies
10.15-10.30	Discussion	–	–
MORNING TEA			
THEME 2: Chemistry of Bones, Teeth, Tendon and Hair			
10.50-11.20	*Keynote 2*	Tanya Smith	Dental Perspectives on Nursing and Weaning
11.20-11.25	Discussion	–	–
11.25-11.35	Short Talk	Alice Mora	Amino Acid δ13C Analysis of Archaeological Proteins
11.35-12.05	*Keynote 3*	Jillian Garvey	Extracting New Information from Ancient Animal Bones
12.05-12.10	Discussion	–	–
THEME 3: Conservation			
12.10-12.20	Short Talk	Holly Jones-Amin	Adhesives in Archaeology
12.20-12.30	Discussion	–	–
LUNCH			
THEME 4: Modelling Sea Levels			
1.30-2.00	*Keynote 4*	Conor Mcadams	Site Formation Processes in Southeast Asian Caves
2.00-2.05	Discussion	–	–

THEME 5: Stone Tool Function			
2.05-2.15	Short Talk	Elspeth Hayes	The Use of the SEM-EDS for the Documentation and Characterisation of Tool Residues
2.15-2.25	Short Talk	Luc Bordes	Determining Micro-Residue Origins on Stone Tools with Raman Microscopy
2.25-2.35	Short Talk	Richard Fullagar	Breaking Bones at the 130,000 Year Old Cerutti Mastodon Site
2.35-2.40	Discussion	–	–
THEME 6: Microbial Fingerprinting			
2.40-2.50	Short Talk	Rachel Popelka-Filcoff	Microbial Composition Analyses by 16S rRNA Sequencing
2.50-3.00	Discussion	–	–
AFTERNOON TEA			
THEME 7: Dating, Seasonality and Rock Art			
3.20-3.50	*Keynote 5*	Amy Prendergast	Early Modern Humans in the Levant
3.50-3.55	Discussion	–	–
3.55-4.05	Short Talk	Justine Kemp	Dating Stone Arrangements Using OSL
4.05-4.35	*Keynote 6*	Helen Green	Dating Mineral Accretions at Rock Art Sites
4.35-4.45	Short Talk	Mathieu Duval	High Resolution µCT-Scanning of Hominin Fossil Remains
4.45-4.55	Discussion	–	–
4.55-5.00	Close	Richard Fullagar & Bert Roberts	–

LOCATION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Langridge St
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Mason St
Albert St
Lonsdale St
St Patrick's Cathedral
Parliament House
St Andrews Pl
Bourke St
Spring St
Exhibition St
Parliament
The Old Treasury Building
Mamasita
CUMULUS INC
GAZI
Chin Chin
Cooks' Cottage
East Melbourne
Hotham St
Pullman Melbourne On The Park
Flinders Ln
Forum Melbourne
Federation Square
Birrarung Marr
Alexandra Gardens
Batman Av
Jolimont
Jolimont St
Jolimont Rd
Agnes St
Charles St
Melbourne Cricket Ground
Google

Determining micro-residue origins on stone tools with Raman microscopy: Use-related and contamination micro-residues on Liang Bua artefacts

LUC BORDES
lfb437@uowmail.edu.au
University of Wollongong

Elspeth Hayes
ehayes@uow.edu.au
University of Liège/University of Wollongong

Linda Prinsloo,
lprinslo@uow.edu.au
University of Wollongong

Thomas Sutikna
thomasutikna@gmail.com
University of Wollongong

Richard Fullagar
fullagar@uow.edu.au
University of Wollongong

Richard (Bert) Roberts
rgrob@uow.edu.au
University of Wollongong

Usewear and analyses of preserved residues on prehistoric stone artefacts can potentially provide detailed information about hominin behaviours. Microscopic usewear analysis is an essential technique to determine use of stone tools, but it needs to be complemented by residue analysis for more robust functional interpretations. Conventional usewear analysis identifies residues in the first stages of optical microscopy, followed by targeted analysis of residues, which often need to be removed. However, optical recognition of in situ, amorphous micro-residues is difficult.

Raman microscopy offers an alternative initial approach to residue analysis because it is a fast, non-destructive analytical technique, with high spatial resolution (beyond the limits of optical microscopy); and it can rapidly identify a wide range of organic and mineral residues (bone, lipids, proteins, cellulose, lignin, starch and iron oxides). With the development of new methodologies, Raman analysis has potential for discriminating use-related residues from contaminants, and has the capacity to provide interpretations both independent of, and complementary to, conventional usewear analysis. Indeed, micro-residues on prehistoric stone tools can arise from diverse origins that may be incidental to tool-use, naturally occurring in sediment, and arising from post-depositional processes and from other sources including ancient and modern contamination.

In this presentation, Raman analysis of in situ residues indicates origins of modern contaminants from the archaeological context, artefact packaging, post-excavation handling, airborne particles and laboratory environment. A case study of stone tools from Liang Bua cave (Flores, Indonesia), provides useful criteria for constraining the range of archaeological micro-residues that have higher probability of being use-related and identifies important relationships between the distributions micro-residues and use-polish.

In which extent high resolution µCT-scanning of hominin fossil remains may impact ESR dating results?

MATHIEU DUVAL
m.duval@griffith.edu.au
Griffith University

Laura Martín-Francés
lauramartinfrancesmf@gmail.com
Université de Bordeaux

Fossil human teeth are nowadays almost systematically µCT-scanned by palaeo-anthropologists prior to any further analysis. It has been recently demonstrated that this non-invasive technique has in most cases virtually no influence on ancient DNA preservation. However, it may nevertheless have an impact on other analytical techniques, like Electron Spin Resonance (ESR) dating.

To thoroughly assess this impact, we µCT-scanned several modern enamel fragments following the standard analytical procedure used at CENIEH (Spain) for the Atapuerca fossil remains. Dose values were then evaluated using the Multiple Aliquot Additive dose method on enamel powder commonly employed in ESR dating of fossil teeth. We found that high resolution µCT-scanning introduces a non-negligible X-ray dose to the tooth enamel, of between 15 and 30 Gy depending on the parameters used. Additional experiments carried out without a metallic filter and using another µCT-scan instrument show that the dose variability may be even higher.

The impact on the ESR age results is directly dependant on the magnitude of the geological dose measured in the corresponding fossil enamel sample, but µCT-scanning could potentially lead to an age overestimation of up to 40% for Late Pleistocene samples. In contrast, the impact on Early Pleistocene teeth may be quite limited (<5%). Although we advise in first instance to avoid any previous µCT-scanning of fossil remains if the sample is initially intended to be dated by ESR, we nevertheless understand this may not be always possible given the value of those remains. Therefore, we recommend scanning a modern tooth with the same device and acquisition parameters to those used for the human fossil. This is the best option to obtain a fair estimation of the X-ray dose given to the fossil sample, and then subtract it from the total dose measured by ESR in the laboratory.

Tracing the footsteps of Lapita: New archaeometric research on the South Coast and Massim region of Papua New Guinea

ANNE FORD
anne.ford@otago.ac.nz
University of Otago

One of the advantages of the geochemical sourcing of artefacts is the possibility to trace the footsteps of archaeological cultures across a landscape. New archaeometric research using pXRF on obsidian artefacts from Lapita sites on the south coast of Papua New Guinea has shown them to originate from the West Fergusson sources in the D'Entrecasteaux Islands of the Massim region. Apart from a single West Fergusson obsidian artefact in the Reef/Santa Cruz islands, this is the earliest demonstration of Lapita use of these sources. Yet no archaeological research has been completed on Fergusson Island, and little analysis completed of these important obsidian sources. This paper will present on how archaeometry has led to the establishment of a field programme on West Fergusson Island and new understandings on the physical and geochemical nature of the obsidian sources, with subsequent implications for future sourcing programmes.

The stone tool evidence for breaking bones at the 130,000-year-old Cerutti Mastodon site, California

RICHARD FULLAGAR
fullagar@uow.edu.au
University of Wollongong

Elspeth Hayes
ehayes@uow.edu.au
University of Liège/University of Wollongong

The Cerutti Mastodon (CM) site has evidence of in situ hammerstones and stone anvils in association with the bones of a single mastodon (*Mammut americanum*). The CM site contains spiral-fractured bone and molar fragments, indicating that breakage occurred while fresh. Several of the bone fragments also preserve evidence of percussion, including notches, cones and cone flakes typically associated with human activities to produce bone tools or to extract bone marrow. The occurrence and distribution of bone, molar and stone refits suggest that breakage occurred at the site of burial. All of the five large cobbles at the site display traces of use and percussion impact, and are hydraulically anomalous relative to the low-energy context of the enclosing sandy silt stratum. 230Th/U radiometric analysis of bone specimens using diffusion–adsorption–decay dating models indicates a burial date of 130.7 ± 9.4 thousand years ago.

Extracting new information from ancient animal bones: Advances in Australian zooarchaeology

JILLIAN GARVEY
j.garvey@latrobe.edu.au
La Trobe University

Richard Cosgrove
R.Cosgrove@latrobe.edu.au
La Trobe University

Mike Buckley
University of Manchester

Georgia Roberts
gl.roberts@federation.edu.au
La Trobe University/Federation University

Animal remains in archaeological assemblages can be used as a proxy to understand past human subsistence, people's use of landscapes and the prevailing palaeoecology. Recent advances in archaeological science techniques, such as stable isotope examination of marsupial fauna, bone collagen fingerprinting and nutritional analyses, have allowed us to broaden our understanding of the human, palaeoenvironmental and animal interactions in Australian zooarchaeology. These developments have given us the ability to identify seasonality, measure economic return rates, develop nutritional profiles for different species, and provide a more precise identification of human prey animals. This talk will present examples of these new approaches, their methodologies and how they are providing a greater understanding of human hunting and subsistence strategies than previous bone taphonomic analyses.

Analysis of 16th to 19th century silver coins

LIESEL GENTELLI
liesel.gentelli@research.uwa.edu.au
University of Western Australia

This presentation demonstrates the application of a number of analytical techniques on a selection of silver coins from the Western Australian Museum. Results of analysis are used to appraise the applicability of surface analytical techniques on samples that have corroded. Analysis has also been used to determine when, where and how coins too heavily corroded to visually identify were minted.

Four hundred shipwreck silver coins and a selection of silver artefacts were provided for analysis from the collection of the Western Australian Museum. The coins represent 22 mints in Spain, Spanish America, the United Netherlands, Germany, and the Spanish Netherlands, minted between 1560 and 1816.

Samples were analysed using non-destructive analytical techniques: inductively coupled plasma mass spectrometry (ICP-MS) and scanning electron microscopy (SEM). These non-destructive techniques were chosen in order to demonstrate their effectiveness in gleaning further information from items of cultural heritage significance, than is possible through a visual analysis alone. Silver coins and artefacts were chosen for analysis due to the large assemblage of silver coins held by the Western Australian Museum, making it possible to create a database of analytical results from coins of both known and unknown mint of origin and year of minting for the sake of effective comparison.

This research gives new information about economic networks, including trade between the Americas, Europe and the Far East during the 16th, 17th and 18th centuries, the height of the great maritime empires, and more specifically, the procurement, manufacture and trade of silver as a global commodity at this time. Further, the techniques used in this study are applicable to many other items of cultural heritage significance for future analysis.

Dating mineral accretions at rock art sites in the Kimberley, North West Australia

HELEN GREEN
helen.green@unimelb.edu.au
University of Melbourne

Damien Finch
University of Melbourne

Andrew Gleadow
gleadow@unimelb.edu.au
University of Melbourne

Mineral coatings, fringes, glazes and skins forming at the interface between the atmosphere and host rock on the surfaces of sandstone rock shelters in Western Australia's Kimberley region, offer the potential to provide datable materials to bracket ages of rock art motifs with which they are often spatially associated. An increased understanding of complex processes behind the formation and long-term preservation potential of these mineral deposition systems has been achieved by combining detailed wet and dry season field observations with multiple mineralogical and geochemical characterisation techniques. In turn, the different characteristics of each deposition system have been used to assess their suitability for the application of radiometric dating methods. Coherent internal stratigraphies are identified in several of the depositional systems, essential for the reliable application of uranium-series dating techniques, whilst floor glaze mineralogy, identified as dominated by carbon-bearing calcium oxalate minerals, provides radiocarbon dating opportunities. Trace element pre-screening maps are used to identify areas of high uranium and layers likely to contain oxalate within the accretion stratigraphies, allowing suitable material to be identified and targeted for the application of different dating techniques.

This study provides a rigorous basis for establishing targeted sampling and analysis strategies essential for reliable and replicable rock art dating as well as having implications for rock art conservation.

The use of the SEM-EDS for the documentation and characterisation of tool residues: Recent research and future directions

ELSPETH HAYES
ehayes@uow.edu.au
University of Liège/University of Wollongong

Dries Cnuts
dries.cnuts@ulg.ac.be
University of Liège

Veerle Rots
veerle.rots@ulg.ac.be
University of Liège

Residue analysis can be a useful way to determine the past functions of archaeological tools, particularly when it is teamed with other functional investigations such as usewear and technological analyses. The most common approach for residue analysis is through the use of various optical microscopes, which can be used to visually identify in situ residues directly from the tool surface (with reflected light microscopes), as well as in water extractions sampled from the utilised tool edges (with transmitted light microscopes). Recently, the scanning electron microscope with energy dispersive X-ray spectroscopy (SEM-EDS) has shown great potential for archaeological residue analysis as it can provide high resolution images of very high magnifications as well as elemental analysis of adhering material. A major advantage of this instrument is that it is capable of operating in low vacuum or "environmental" mode, meaning that specimens are able to be examined uncoated and without additional preparation. This enables residues to be documented and analysed in situ on the stone without having to permanently alter or damage the artefact.

In this paper, we discuss the benefits and challenges of the SEM-EDS for residue analysis and present a modified residue sampling protocol in which adhering residues can be removed, platinum coated and analysed with the SEM under high vacuum mode. Such analysis can provide more accurate elemental data of constituent residues that are uncomplicated by the stone substrate as well as very high-resolution images that show excellent surface relief under even higher magnifications. We also describe the results of a set of recent experiments that were designed to evaluate the ability of this instrument to characterise mechanically damaged, fragmented or scarce residues that may not be easily identified with optical microscopy.

Adhesives in archaeology: What to use and what not to use

HOLLY JONES-AMIN
Monash University/University of Melbourne

People have been repairing objects with materials available to them for as long as objects were made. For the past 180 years, conservators and archaeologists have used synthetic adhesives, many of which have properties that can damage or discolour objects, contaminate biomolecular residues, or become impossible to remove. Before applying an adhesive, it is thus important to ask: why, what will it achieve? Will it compromise future research? What will the artefact look like after treatment? How can the adhesive be removed if sometime down the track it needs to be?

Considerable effort has been made in the fields of polymer science, conservation and material science to identify the ideal adhesive for use in archaeology. As a general rule, commercial adhesives available at hardware and Do-It-Yourself stores should not be used on archaeological objects, so what should we use? There is not a single, universal adhesive that can be used on all archaeological objects for all storage and display locations. Criteria for choosing an appropriate adhesive can include, but is not limited to: the time it takes to set; its optical properties once on the object; its strength; the retreatability/reversibility of treatment; its durability and suitability to climate conditions; its ease of use; and the health and safety considerations associated with both its application and post-application presence on the object.

This paper discusses 1) how to select an appropriate adhesive as informed by the field of materials conservation; 2) how to adapt adhesives to a range of environments and artefact material types; and 3) issues relating to the blending of conservation adhesives such as Paraloid B-72 and Paraloid B-48N, as ways of improving their working properties.

Dating stone arrangements in Australia's Channel Country using optically-stimulated luminescence

JUSTINE KEMP
j.kemp@griffith.edu.au
Griffith University

Jon Olley
j.olley@griffith.edu.au
Griffith University

Justin Stout
j.stout@griffith.edu.au
Griffith University

Barry Riddiford
ceo@mithaka.com
Mithaka Aboriginal Corporation

Aboriginal stone arrangements have been described in rocky landscapes in several parts of Australia, and are recognised as built structures, modest architectural features of pre-European Aboriginal societies. Some of these are known from collapsed remains and ethnographic accounts to have been roofed with wood. Others are single stone structures in lines, circles or groups. Their functions are thought to have been numerous, including ceremonial and utilitarian uses for shelter or storage. Stone arrangements are predominantly inorganic with typically shallow infill, so their antiquity is presently unknown.

Here, we present single-grain optically-stimulated luminescence ages for stone arrangements in the southern Diamantina River catchment that forms part of the Mithaka Peoples Native Title area in SW Queensland. The elaborate groups of broadly circular stone arrangements can be found on hillslopes below Aboriginal quarries along the edge of a silcrete mesa. The structures are at least two stones high with a matrix of fine sand. The top stones were removed from two locations at night and the surficial sands were collected with adhesive tape to determine the time of emplacement. Samples of rock and sand were collected for gamma analysis of the environmental dose rates and moisture contents. Preliminary results from the two stones are consistent, and suggest an emplacement age close to the time of European pastoral settlement of the Channel Country. We conclude that single-grain OSL techniques can give reliable ages for the most recent phase of stone construction in inland Australian settings.

Site formation processes in Southeast Asian Caves: Understanding the potential of deeply problematic records

University of Wollongong

CONOR MCADAMS
cm065@uowmail.edu.au

Southeast Asia increasingly forms a major focus of human evolutionary research. Understandings of the region's Quaternary record are impacted by a range of poorly constrained, taphonomic processes, specific to humid tropical environments. These processes make data recovery from many traditionally targeted contexts difficult, or impossible. Caves form the major archaeological resource in this region, mitigating, to some extent, the tropical weathering processes which remove archaeological material in the wider landscape. While the complex biogeochemical environments which form in caves and their distinct effects on assemblage taphonomy have been extensively studied in higher latitude zones, it is apparent from the small-but-growing body of related research that cave sediments in tropical environments display unique suites of features.

To develop reliable, high-resolution narratives of hominin-environment interactions in this region, it is imperative to understand the post-depositional processes active in tropical caves, and their effects on the taphonomy and molecular taphonomy of buried material. This research incorporates a sophisticated geoarchaeological toolkit, combining thin-section micromorphology, vibrational spectroscopy, scanning electron microscopy and a range of further sedimentological and soil science techniques, comprehensively interrogating the Pleistocene sedimentary records at a number of key sites in Mainland Southeast Asia. Building upon field observations, a series of laboratory experiments are conducted, generating much-needed reference data, related to the effects of climatic conditions on guano decomposition, recognised as a key driver of diagenetic change in caves.

Amino acid δ13C analysis of archaeological proteins by liquid chromatography- isotope ratio mass spectrometry: Methodological advances and new perspectives

ALICE MORA
a.mora@latrobe.edu.au
La Trobe University

Colin Smith
colin.smith@latrobe.edu.au
La Trobe University

Since the pioneering studies of the 1970s, stable carbon isotope analysis of archaeological human proteins has proven to be a powerful tool for reconstructing aspects of past lifeways. During approximately the last 15 years, attention has moved from the traditional 'bulk' approach, which targets the whole protein, to the novel compound-specific methods that measure the stable isotope composition of each constituent amino acid.

Single amino acid d13C analysis offers numerous advantages over the traditional bulk technique, especially regarding sample amount, resolution of complex diets, and estimation of protein intake. Investigating proteins at the amino acid level provides the possibility of inferring the various sources of the fδood macronutrients (marine, freshwater, terrestrial C3, terrestrial C4) because different amino acid groups are synthesised via different metabolic processes. This means that some amino acids are assimilated directly from dietary proteins to body tissues, while others may be synthesised through metabolic pathways involving all the three macronutrients (proteins, carbohydrates, lipids).

This study describes the methodological improvements achieved in amino acid d13C analysis, proposing a chromatographic method ideal for small amounts of protein, that allows fine-grained analysis through sequential sampling. By applying this novel technique to proteins extracted from human body tissues rarely selected in palaeodietary studies, such as hair and tendon, we demonstrate that it is possible to achieve the detailed reconstruction of the dietary habits and subsistence strategies characterising the recent life history of pre-Columbian individuals. Although this study has focussed on archaeological human proteins, this novel method has an extensive range of applicability, including archaeological materials typical of the Australasian contexts, such as animal bones and mollusc shells.

Obsidian provenance studies: 5 years of research in a nutshell

MARIE ORANGE
marie.orange@scu.edu.au
Université Bordeaux Montaigne/Southern Cross University

François-Xavier Le Bourdonnec
francois-xavier.le-bourdonnec@u-bordeaux-montaigne.fr
Université Bordeaux Montaigne

Ludovic Bellot-Gurlet
ludovic.bellot-gurlet@upmc.fr
Pierre and Marie Curie University

Renaud Joannes-Boyau
renaud.joannes-boyau@scu.edu.au
Southern Cross University

Our international research group has established multi-disciplinary collaborations, combining several laboratories across the world (IRAMAT-CRP2A, UPMC-Monaris, Southern Cross GeoScience), with the specific aim of improving our understanding of prehistoric human societies. Precisely, our research focuses on the study of archaeological lithic materials, with a special interest in obsidian artefacts. Combined with a well-defined archaeological question, obsidian consumption behaviours provide valuable insights into past population movements and exchange patterns, human/environment relationships and – more generally – ancient ways of life.

Nonetheless, the exhaustive and non-destructive characterisation of each assemblage requires the development of an analytical strategy that relies on the use of complementary methods such as benchtop ED-XRF, portable XRF, LA-ICP-MS, PIXE, or SEM-EDS. Subsequently, sourcing results are combined with data from typo-technological analysis to further our interpretation. This joint approach, developed in close collaboration with the archaeologists, led to broaden our knowledge of various Prehistoric Cultures across the peri-Mediterranean area, from the Western Mediterranean (Corsica) to the Near East (Syria), and most recently extended to the Caucasus (Nakhchivan, Iran). Here, we offer to present a concise review of the research we have conducted over the past 5 years, as well as introduce our newest, and most exciting research project.

Microbial composition analyses by 16S rRNA sequencing for provenance determination of archaeological ochre

RACHEL POPELKA-FILCOFF
rachel.popelkafilcoff@flinders.edu.au
Flinders University

Claire Lenehan
claire.lenehan@flinders.edu.au
Flinders University

Shanan Tobe
tobes@arcadia.edu
Arcadia University

Renee Smith
renee.smith@flinders.edu.au
Flinders University

A fundamental question in archaeological studies is the concept of "provenance", where the origins of a material or artefact can be characterized and determined. Ochre is a complex mineral pigment frequently observed in archaeological sites worldwide, and is often of unknown provenance. Recent studies using DNA profiling of bacteria have been used for the forensic determination of soils, towards determination of geographic origin. This paper presents a novel approach to the provenance of archaeological minerals and related materials through the use of 16S rRNA sequencing analysis of microbial DNA. Data from 16S rRNA sequencing studies provide profiles of ochre sources that are both independent of and complementary to elemental and mineralogical analyses. Through the microbial DNA characterization from ochre and multivariate statistics, we have demonstrated the clear discrimination between four distinct Australian cultural ochre sites.

The role of environmental change in the expansion of early modern humans in the Levant – what we can learn from mollusc shells

AMY PRENDERGAST
amy.prendergast@unimelb.edu.au
University of Melbourne

Marjolein Bosch
University of Cambridge

Marcello Mannino
Aarhus University

Bernd Schöne
University of Mainz

Ofer Marder
Ben-Gurion University of the Negev

Omry Barzilai
Israel Antiques Authority

Israel Hershkovitz
Tel Aviv University

Tasmin O'Connell
University of Cambridge

Frank Wesselingh
Naturalis Biodiversity Centre

Jean-Jacques Hublin
Max Planck Institute for Evolutionary Anthropology

Daniella Bar-Yosef Mayer
Tel Aviv University

Humans respond to changes in their local environment on daily to seasonal timescales. Therefore, a robust assessment of the impact of environmental change on human behaviour requires an understanding of local environmental change at seasonal to sub-seasonal resolution. Stable isotope records from mollusc shells provide one of the few sub-seasonal resolution palaeoenvironmental proxies in the Mediterranean. Obtaining these records from food-refuse archaeological specimens enables the reconstruction of a more detailed picture of how humans responded to changing climatic regimes in the past.

Here we present sub-monthly resolved environmental reconstructions from stable isotope analyses of mollusc shells from the Middle to Upper Palaeolithic archaeological sites of Ksar Akil in Lebanon and Manot Cave in Israel. These highly resolved environmental records, coupled with well-dated archaeological sequences provide a framework for assessing the complex interplay between early modern humans and their local environments. We found evidence for fluctuating temperature, rainfall and seasonality regimes throughout marine isotope stages (MIS) 4 to 2, some of which appear to be linked to northern hemisphere millennial-scale climate oscillations.

The archaeological records show human occupation of these sites occurred during both warmer and cooler phases and during both high and low seasonality regimes, indicating that modern human populations were somewhat resilient to the resource uncertainty that would have accompanied these changing temperature and seasonality regimes. These paired cultural-environmental records have enabled an examination of hominin-environment interactions during critical periods of the late Pleistocene in a region with comparatively few high-resolution climate records.

Adzes and pounders as evidence for colonisation and specialisation: Comparing portable XRF results across Central East Polynesia

MICHELLE RICHARDS
Michelle.Richards@anu.edu.au
Australian National University

Since it is non-destructive, portable x-ray fluorescence (pXRF) opens up a whole new world of geochemical analysis for archaeology, including important museum collections that have long been neglected. Results from pXRF analysis of basalt objects in Pacific collections from Central East Polynesia held in The British Museum (London), Pitt Rivers Museum (Oxford), Museum of Archaeology and Anthropology Cambridge, Kon Tiki Museum (Oslo), Museè Tahiti et des Ilès (Papeete), and the Bernice Pauahi Bishop Museum (Honolulu) are used within two case studies relating to colonisation and craft specialisation. Typological studies of basalt adzes, many collected over 100 years ago, underlie hypotheses for how people first migrated through the Pacific islands and maintained social connections, but the nature of the relationship between 'type' and geological source needs to be evaluated with reliable elemental data.

Basalt poi pounders have received much less attention than adzes in archaeological research in Central East Polynesia. However, when compared with recent geochemical analyses of basalt sources and basalt adzes, the pXRF results enable an evaluation of whether a favoured source was used to produce these decorated pounders. This helps test ideas about whether they were chiefly, prestige or highly valued goods manufactured in a specific material and location by specialist craftsmen – or mass-produced for the European market.

The calibration methods used and issues for comparing this dataset with other published datasets will also be discussed.

Dental perspectives on nursing and weaning

TANYA SMITH
tanya.smith@griffith.edu.au
Griffith University

Weaning is a fundamental aspect of human life history that has changed from a prolonged ape-like process to a foreshortened one in recent humans. Anthropologists are increasingly employing knowledge of tooth chemistry and development to document the weaning process. During lactation, mammals produce calcium-rich milk by drawing on skeletal reserves. Low-level non-essential elements such barium and lead follow the movement of calcium in the body because they share certain transport pathways. These elements are concentrated in mothers' milk, although barium passes through a filtering system, making it proportionately less common than calcium.

My colleagues and I have shown that barium/calcium (Ba/Ca) trace element ratios in teeth accurately reflect barium intake via mother's milk, which can be used in concert with growth lines to accurately age early life diet transitions. Barium distributions are determined with laser ablation-inductively coupled plasma-mass spectrometry, and accentuated lines in the enamel are spatiotemporally mapped from incremental features formed after the neonatal (birth) line. Elemental maps of human infants of known dietary histories reveal Ba/Ca transitions close to the neonatal line, demonstrating that milk consumption can be identified without a marked delay. We have also documented early-life diet transitions in captive macaques, including birth, exclusive nursing, solid food supplementation, and the cessation of suckling. This approach has also been extended to a juvenile Neanderthal, which appears to have nursed exclusively for 7 months, weaning abruptly at 1.2 years of age. Finally, we've documented the nursing histories of wild-shot orangutan juveniles, revealing that orangutan lactation reflects seasonal resource availability. Two orangutans continued suckling beyond 8 years of age, exceeding the oldest documented weaning ages in any non-human primate or mammal. Ongoing studies will apply this approach to test theories about the evolution of human development.