

Thesis Abstracts

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Victoria Fitzgerald

Chronology of gypsum dunes at Knolls, Utah: refining OSL techniques and timing of Holocene eolian processes

December 2019

Kansas State University, Manhattan, USA

Degree: M.Sc.

Supervisor: Dr. Joel Q. Spencer

This study examines eolian samples from post-Lake Bonneville gypsum dunes in Knolls, UT, primarily to determine suitability of optically stimulated luminescence (OSL) dating protocols for gypsum geochronology. Sedimentologists often rely on proxies to understand geologic timescales, OSL may eliminate that need in environments with gypsum. Using OSL we aimed to identify the ages of punctuated climatic events that are linked to deposition of the gypsum rich dunes found in the study area. To accomplish this pursuit, systematic research of gypsum preparation protocols were required. Multiple experiments were undertaken to assess the effectiveness of mineral isolation and etching. Knowledge of gypsum behavior is of particular interest, as it is found in both lacustrine and marine environments and is typically less soluble than other evaporites found in both settings, such as sodium chloride. Gypsum has also been observed at several hundred meters water depth in the alkaline environment of the Arctic Ocean. Additionally, gypsum sand grains are accessible to researchers in geomorphic features like unconsolidated to semi-consolidated dunes, making them easier to sample for OSL analyses than gypsum or quartz found in an outcrop. Sampling strategy can be quickly determined for dunes that are exposed on all sides.

The focus of this study seeks to resolve discrepancies observed in the small body of literature on gypsum as an OSL chronometer. Relatively homogenous eolian gypsum sand grain samples with grain sizes ranging from $> 63 \mu\text{m}$ to $< 250 \mu\text{m}$ from two adjacent paleodunes (KNP-A and KNP-B) and one coppice dune (CD-5) were used to determine best preparation practices and identify if punctuated climatic events during the Holocene could be detected using gypsum. The sample site was selected for a case study on OSL dating

techniques because previous work has constrained the maximum age of post-Lake Bonneville dune formation ($\sim 12 \text{ ka BP}$).

Preparation protocols, independently checked using various methods, were selected with minimal mineralogical impact and OSL sensitivity considerations in mind. Bulk composition and mineralogy of the sediment at various steps in sample preparation have been analyzed using X-Ray Diffraction, bulk elemental extraction, particle size analysis, Scanning Electron Microscopy and binocular microscopy. Etching experiments indicate that an air-dried, dry-sieved, and gypsum-rich fraction ($90 - 125 \mu\text{m}$) can be effectively isolated and etched in $\sim 36 \text{ wt\% HCl}$ for 40 minutes. Of the various OSL measurement protocols attempted, we confirmed a modified single-aliquot regenerative-dose protocol produces detectable luminescence signals and equivalent doses (D_e) that are usable in age calculations. Age results are likely to be underestimated by approximately $0.5 - 0.8 \text{ ka}$, based on comparison to a single quartz OSL sample (KNP-A1) with an age of 2.2 ka and its equivalent gypsum sample of 1.4 ka . This is the oldest age sampled from the stratigraphically lowest section of either KNP-A or KNP-B. Samples from KNP-B identify this smaller dune was deposited after KNP-A began developing. Age results from the stratigraphically lowest sample collected, KNP-B1, indicate deposition occurred at 0.88 ka . The active coppice dune (CD-5) gypsum OSL age is 0.09 ka . This study recommends further investigation into why the apparent discrepancy between gypsum and quartz OSL chronology exists.

A PDF of this thesis can be downloaded from: <http://hdl.handle.net/2097/40275>

Amber G. E. Hood

New Insights into Old Problems: The application of a multidisciplinary approach to the study of early Egyptian ceramic chronology, with a focus on luminescence dating

January 2017

University of Oxford, Oxford, UK

Degree: Ph.D.

Supervisors: Jean-Luc Schwenninger, E. Christiana Köhler, Christopher Bronk Ramsey

This thesis takes a multidisciplinary approach to the study of ancient Egyptian ceramics by applying scientific dating techniques alongside more traditional methods. It is the first study to apply OSL dating to an Egyptian ceramic assemblage, and it has done so by developing the minimum extrac-

tion technique (MET), which has made it possible to use OSL to sample, and thus analyse, ceramics housed in museums.

The MET is at present essential to the success of OSL dating of Egyptian ceramics, as the exportation ban on antiquities has prevented OSL analysis of field material.

For this thesis, using this new sampling technique, OSL has been applied to several assemblages from the Predynastic to the Early Dynastic period. Ceramics from Bêt Khalaf have been examined, with three phases being established: late Naqada III, First Intermediate Period, and the mediaeval Islamic period. Absolute dates have been determined for each phase and, where comparison is possible, have been found in good agreement with the historical chronology.

A set of vessels from Naqada, Ballas, and the Tomb of Djer at Abydos have been examined using OSL in conjunction with radiocarbon dating. Again, three phases of activity were discerned: late Naqada II, early Naqada III, and the first scientifically determined dates for a burning event in the Tomb of Djer (the New Kingdom).

The thesis also demonstrates how OSL can be used as a relative dating technique by analysing a collection of Wavy-Handled ceramics and wine jars from Turah and Hierakonpolis, finding that the OSL results agree well with the established relative chronology.

Finally, this thesis has also examined the applicability of cladistic analysis to the study of Egyptian ceramics. Cladistics is a technique borrowed from the biological sciences which offers a complimentary way to examine the evolution of ceramic types and forms, in particular the development of beer and wine jars.

A PDF of this thesis can be downloaded from: <https://ora.ox.ac.uk/objects/uuid:508818b7-930b-4e06-890c-5c2dbb12fe42>

Yue Hu

Lithic industries and chronology of Middle Paleolithic sites in Southwest China

July 2019

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Degree: Ph.D.

Supervisors: Bo Li, Ben Marwick, Richard Fullagar, Sam Lin, Richard G. Roberts

The characteristics and development of Palaeolithic in China and more broadly in East Asia have been hotly debated. At the centre of the debate is whether there were lithic technological changes in East Asia during the Middle and Late Pleistocene. It has been argued that the lithic industries in this region were dominated by simple core-flake production system until the Late Pleistocene when Upper Palaeolithic forms appeared. The lack of advanced stone tool technology in East Asia would imply that hominin populations in this region were possibly culturally and genetically isolated during the early and middle Pleistocene. One of the main reasons

that caused such a debate is the scarce of well-defined ‘Middle Paleolithic’ sites in East Asia, because many of these sites were excavated decades ago and, hence, lacked reliable chronology and detailed and systematic lithic study. To contribute to our understanding of Paleolithic culture in East Asia during the late Middle Pleistocene period, this study presents detailed lithic analysis and chronological study on two Paleolithic sites in Southwest China, Guanyindong and Tianhuadong caves.

In order to establish reliable chronological frameworks for the sites, the recently developed single-grain optically stimulated luminescence (OSL) techniques were applied to date quartz grains extracted from the artefact-bearing sediments from the sites. Since a part proportion of the quartz grains have saturated OSL signal, the standardised growth curve (SGC) method was applied to avoid underestimation in age due to truncated equivalent dose distribution. It shows that the SGC method can be successfully applied to date sediments from this region. OSL ages of 170–80 and 90–50 thousands years ago were obtained for the Guanyindong and Tianhuadong sites, respectively, which suggests that both sites should be assigned to Middle Palaeolithic period.

Evidence of complex systems of lithic production from the two studied sites are reported. Based on detailed analysis of over 2000 stone artefacts from the Guanyindong assemblage, a total of 45 stone artefacts were identified to be made with Levallois concept, including 11 cores, 31 flakes and 4 tools. Apart from Levallois, the lithic assemblages from the sites provide evidence of diverse lithic production systems, including Quina, Kombewa, and discoid systems, which shows that the late Middle Pleistocene inhabitants in this region had used a variety of tool-making strategies to adapt to climatic and ecological conditions, raw material availability and demographic contexts. These new findings are similar and contemporary to those typically found in west Eurasia, suggesting that during late Middle Pleistocene hominins in this area had the comparable abilities as those in Europe and Africa, and, thus, challenge the longstanding view that there is a lack of distinct progress in lithic technology during the Early and Middle Palaeolithic period in East Asia.

Jack Arthur Johnson

Case Studies in Geoarchaeometry

December 2018

University of Washington, Seattle, USA

Degree: Ph.D.

Supervisor: James K. Feathers

This dissertation consists of four standalone papers. Each paper addresses a distinct geoarchaeological challenge through the application of specialized technical methods and experimental data. New approaches to data gathering are developed, and familiar approaches are combined with new archaeological applications and software tools to yield new

lines of evidence useful for the examination of significant archaeological questions. The first paper uses portable X-ray fluorescence (PXRF) to measure elemental concentrations in sediments and ceramics, but identifies several serious issues with common instrumentation and practice, then develops novel protocols and software tools to address these issues. The second paper describes a successful test application of PXRF to the relative dating of rock varnish accumulations atop petroglyphs at Hole-in-the-Ground in southeastern Oregon. The third paper details the use of luminescence dating and Bayesian depositional modeling to create a robust multi-proxy site formation history at Bear Creek in Redmond, Washington. The fourth paper uses luminescence dating of sediments and Bayesian modeling to document over 2000 years of changes in El Niño- and earthquake-driven depositional activity in the Santa and Chao Valleys of Perú, and discusses the implications of these patterns for archaeological research in the region.

A PDF of this thesis can be downloaded from: <http://hdl.handle.net/1773/43285>

Anna A. Romanyukha

**Retrospective and Real-Time Semiconductor Dosimetry:
Applications to Geological Dating and Brachytherapy
Quality Assurance**

June 2019

University of Wollongong, Wollongong, Australia

Degree: Ph.D.

Supervisors: Richard G. Roberts, Anatoly Rosenfeld

In this thesis solid state semiconductor dosimetry is applied to the improvement of luminescence dating techniques (part 1) and quality assurance in high dose rate (HDR) brachytherapy (BT) cancer treatments (part 2).

The aim of part 1 is the development, testing, and application of a novel method to measure spatially resolved dose rates in sediment samples using the Timepix pixelated detector. The Timepix contains an array of 256×256 pixels, each $55 \times 55 \mu\text{m}$ in size and with its own preamplifier, discriminator and digital counter, and is able to provide the position and pixel-by-pixel count rate of the incident radiation. The development of a method to measure sediment samples and derive spatially resolved dose rates is described, followed by its application to sediment samples from Liang Bua and Denisova Cave archeological sites.

Part 2 focuses on the application of real time in vivo dosimetry for HDR BT treatment verification. MOSkin dosimeters were selected due to their small size and capability of measuring steep dose gradients, such as those characteristic of the HDR source. Three MOSkins were placed on a rectal probe to verify doses to the rectal wall in gynecological BT treatments. A feasibility study and the in vivo application of the proposed method to patient treatments at the Istituto Nazionale dei Tumori (INT) are described. Furthermore, a system for real time tracking of the HDR source is proposed

by embedding epitaxial diodes on the surface of a multichannel vaginal cylinder (MVC). The ability of the developed system to verify positions and dwell times of the HDR source was tested using simple dwell positions and dwell times, followed by the retrospective delivery of 10 clinical plans previously delivered to patients undergoing adjuvant vaginal cuff BT after hysterectomy at INT.

A PDF of this thesis can be downloaded from: <https://ro.uow.edu.au/theses1/561/>