Thesis Abstracts

Author: Claire Boulter
Thesis Title: Reconstructing the palaeoenvironmental history of East Central Texas since the last glacial maximum
Grade: PhD
Date: October 2007
Supervisors: Mark Bateman, Charles Frederick
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Prevailing opinion holds that thick, unconsolidated, largely homogeneous sand deposits located in East Central Texas were formed by *in situ* weathering of the underlying friable sandstone bedrock combined with pedoturbation. This being the case, archaeological and palaeoenvironmental work in the region would have little or no value. An extensive series of one hundred and twenty-nine samples from twenty sites in summit, hillslope and palaeogully settings were collected to assess the veracity of such claims. A protocol for assessing the presence and extent of post-depositional disturbance was developed using a range of indicators derived from optically-stimulated luminescence (OSL) results, as well as down-profile changes in magnetic susceptibility and particle size. Application of this protocol to the sites studied showed that, whilst many sites had experienced a significant degree of reworking, mixing was generally not of sufficient magnitude to preclude the extraction of a viable chronology or meaningful palaeoenvironmental information. The resulting data show unequivocal evidence for numerous pulses of aeolian and colluvial activity spanning the last 100 ka. Enhanced sedimentation occurred during the Mid- to Late Holocene generally, and specifically at around 8-5, 4-2 and 1-0 ka.

To assess whether such pulses were driven by climate, pollen analysis of a peat core retrieved from a rare upland bog was undertaken. This provided an 18.7 ka record of vegetation and, by proxy, climate change in the region. Broadly speaking, climate was characterised by cool, moist conditions at the Last Glacial Maximum, followed by increases in both temperature and precipitation during the deglacial period, then progressive warming and drying, interrupted by small-scale returns to cooler and/or moister conditions, throughout the Holocene. Comparison of this record with those from neighbouring regions highlights the existence of an east-west precipitation gradient, which fluctuated in position and steepness during the Holocene. This caused pronounced shifts from mesic to xeric conditions in the study region, which have not been observed elsewhere. Integration of records of climate and geomorphic activity reveals that linkages between the two are not clear-cut, but appeared to show that phases of instability are controlled primarily by sediment availability and small-scale (possibly single event) changes in climate (e.g. storms, droughts). Complex interactions exist between different geomorphic settings and modes of deposition.

Author: Alicia Huntriss
Thesis Title: A Bayesian analysis of luminescence dating
Grade: PhD
Date: October 2007
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Luminescence dating is a widespread dating method used in the fields of archaeology and Quaternary science. As an experimental method it is subject to various uncertainties in the determination of parameters that are used to evaluate age. The need to express these uncertainties fully, combined with the prior archaeological knowledge commonly available, motivates the development of a Bayesian approach to the assessment of age based on luminescence data. The luminescence dating procedure is dissected into its component parts, and each is considered individually before being combined to find the posterior age distribution. We use Bayesian multi-sample calibration to find the palaeodose in the first stage of the model, consider the problem of identifying a plateau in the data, and then use this, along with the annual dose, to estimate age. The true sample age is then modelled, incorporating any prior information available, both for an individual sample and for a collection of samples with related ages.

Author: Mathieu Duval
Thesis Title: Evaluation du potentiel de la méthode de datation par Résonance de Spin Electronique (ESR) appliquée aux gisements du Pléistocène inférieur: étude des gisements d'Orce (bassin de Guadix-Baza, Espagne) et contribution à la connaissance des premiers peuplements de l'Europe
(Evaluation of the potential and limits of electron spin resonance dating applied to the Lower Pleistocene sites of Orce (Guadix-Baza basin, Spain), and a contribution to the understanding of the first human settlements of Europe)
Grade: PhD
Date: November 2008
Supervisor: Christophe Falguères
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This work presents an evaluation of the potential and limits of the Electron Spin Resonance (ESR) dating method for ancient periods (Lower Pleistocene) in archaeological and/or geological contexts. ESR was used to analyse samples from the Orce sites (Fuente Nueva III, Barranco León and Venta Micena), located in the eastern part of the Guadix-Baza intramontane basin (Andalusia, Spain). These are considered key sites for the understanding of the first settlements of Europe.

Two types of material were analyzed: dental enamel and quartz extracted from sediments. The methodological study focused on: (1) an inventory of the error sources and uncertainties associated with the calculation of the equivalent dose (D_e); (2) the non-destructive ESR analysis of enamel fragments, with an extraction of the main components of the ESR signal of hydroxyapatite in order to check their influence on the D_e value; (3) the 3-D mapping of uranium series isotopes in dental tissues by laser ablation ICPMS (LA-ICPMS) to establish the spatial distribution of the radioelements, and to evaluate the impact of the tissue preservation on the diffusion processes.

The combined ESR-US method applied on tooth enamel shows that the dose rates of the dental tissues are the most crucial parameters for the age calculation of samples from old sites (>700 ka). Because of high $^{230}Th/^{234}U$ ratios, implying U-leaching, most of the samples could not be dated. When age calculations were possible, the results were generally in agreement with independent age estimates, implying that ESR can be successfully applied on Lower Pleistocene samples. An alternative to ESR-US, the US_e model, was developed to calculate a theoretical maximum ESR-US age and to account for uranium leaching from the dental tissues.

ESR dating of optically bleached quartz extracted from sediments was tested on the fluvio-lacustrine deposits of the 20 m thick sedimentary sequence of Barranco León. ESR ages calculated on more than twenty samples show some good reproducibility and are overall coherent, even though several problems were encountered (necessity of an *in situ* dosimetry, disequilibrium in the ^{238}U decay chain). The chronological results confirm that the sedimentary sequence covers the whole Lower Pleistocene period.

ESR ages calculated for the two types of material were overall in agreement with the chronostratigraphical framework already established by other independent methods such as biochronology and palaeomagnetism, and confirm the chronological positioning of the Orce sites within the Lower Pleistocene. The results obtained in this work show that the ESR dating method can be applied to the Lower Pleistocene period.

Author: Asger Habekost Nielsen
Thesis Title: On the evolution of beach ridge plains: Luminescence dating, geomorphology and soil development at the Jerup beach ridge plain, Denmark
Grade: PhD
Date: October 2008
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Beach ridges are important coastal features, marking ancient coastlines and acting as sediment archives. This thesis focuses on the Jerup beach ridge plain in Northern Jutland, Denmark. The Jerup beach ridge plain contains 161 ridges plus two foredune ridges that are included as modern pseudo-analogues. A beach ridge chronology is constructed by collecting and analysing 90 samples from the beach ridge plain and the surrounding region. The samples are dated using Risø reader equipment, a SAR protocol and dose rate calculations based on gamma

spectrometry of the samples. The luminescence signal consistency is checked by dose recovery tests and SAR-specific consistency tests. Luminescence ages are validated against independent age control (mainly radiocarbon ages). With OSL dates at hand, the rates of soil development in the ridges can be assessed. The soil development is analysed by collecting 134 samples from 14 soil pits. The soil samples have been analysed for organic C content, pH (H_2O) and extractable Fe, Al and Mn concentrations.

The overall luminescence-based chronology of the Jerup beach ridge plain is ~10 to ~4000 years before AD 2005, if the modern dune ridges are included. The dose recovery test had a mean test ratio of 1.007±0.004, and the luminescence ages are in good agreement with independent age controls. The mean luminescence error margin is ±6.28%. According to the luminescence chronology, the beach ridges formed every 24 years on average and the mean coastal progradation rate is 1.6 $m.a^{-1}$. Judging from the GPR survey and ridge transect observations, the ridges are initially formed as marine berms or debris lines, but the ridges are reinforced by aeolian deposition shortly after the incipient ridge formation. The aeolian deposits magnify the original 1–1.5 m high marine ridge to a 2–4 m high ridge. Later aeolian deposition has occurred in at least three different periods that correlate with known periods of cold and windy climatic spells. Spodosols have been discovered found in a ~1,500-year old ridge, indicating an intermediate podzolization rate. Finally, soil development interference with luminescence dates is assessed by evaluating radionuclide distributions in three podzolised soil profiles. Radionuclide activity concentrations from 100 samples collected in five podzolised areas in Jutland (including the Jerup beach ridge plain) are correlated against soil physical and chemical parameters using the Kendall's Tau-b method. These experiments revealed no correlation of soil chemical parameters and radionuclide distributions.

Based on the results from the Ph.D. project, the luminescence chronology improves the chronological resolution of the Jerup beach ridge plain by more than an order of magnitude. Luminescence dating in young sediments is also tested at a large scale, allowing a detailed error analysis on a large sample set. The effects of podzolisation on luminescence dating is also tested systematically, and reveal that, under the local conditions, the podzol-related redistribution of iron, aluminium and organic compounds do not affect the dose rates (and, in turn, the luminescence ages).