Ancient TL

www.ancienttl.org · ISSN: 2693-0935

Ancient TL, 2007. *Thesis Abstracts.* Ancient TL 25(1): 29-31.
https://doi.org/10.26034/la.atl.2007.405

Thesis Abstracts

Author: Matt Telfer
Thesis Title: Late Quaternary aeolian activity and palaeoenvironments of the southwestern Kalahari: Advances from an intensive chronometric investigation at Witpan, South Africa
Grade: PhD
Date: April 2007
Supervisor: David Thomas, Mark Bateman
Address: University of Sheffield, Department of Geography, UK

The southwestern Kalahari is a semi-arid dryland characterized by a range of landforms which have been interpreted as evidence of past environmental and climatic conditions different from those of today. These include currently inactive linear dunes, closed basins known locally as 'pans', and the crescentic lunette dunes which often accompany the pans on their lee side. However, palaeoenvironmental interpretation of these landforms has been hampered by incomplete understanding of their development and the difficulty in dating such sediments.

Witpan is an hourglass-shaped, 5 km long pan with a well-developed lunette dune, and is set amongst a linear dune field. This study applies a variety of physical and geochemical sedimentological analyses to the range of aeolian deposits found within the locale, set within a detailed timeframe provided by 113 Optically-Stimulated Luminescence (OSL) dates.

The current lunette at Witpan has accumulated predominantly within the past 2000 years, in a spatially complex manner reflecting differences in local sedimentary sources. The discovery of such complex sedimentation within a single landform has implications for future studies which attempt to use lunette sediments in palaeoenvironmental reconstruction. The linear dunes at Witpan are considered to respond primarily to variations in aridity forced by atmospheric circulation changes, and record sedimentary accumulation of different intensities dating back to around 100 ka. Most notable in the record is a period of particularly intense accumulation following the last glaciation, and culminating at around 9-16 ka. The Holocene has seen much reduced linear dune accumulation. The basin at Witpan contains a limited sedimentary record which is suggested to have accumulated during conditions wetter than those at present. The alkaline sediments are not conducive to the preservation of biogenic proxies, but OSL dating has potential for constraining a palaeoenvironmental record derived from physical and geochemical proxies.

Author: Helena Rodnight
Thesis Title: Developing a luminescence chronology for late Quaternary fluvial change in South African floodplain wetlands
Grade: PhD
Date: November 2006
Supervisor: Geoff Duller, Stephen Tooth
Address: Institute of Geography and Earth Sciences, University of Wales, Aberystwyth, UK

Owing to variation in the extent to which sediment grains transported in water are exposed to daylight, problems have been encountered in applying optically stimulated luminescence (OSL) dating to fluvial deposits. This thesis develops the OSL technique so that ages for heterogeneously-bleached fluvial samples can be derived based on the analysis of well-bleached grains. The ages calculated are then used to establish the timing and rates of different channel change processes. For two mixed bedrock-alluvial rivers with extensive floodplain wetlands located in the eastern Free State, South Africa, OSL sample collection was designed to investigate the lateral migration rates, meander cutoff ages, and avulsion frequency on the Klip River, and incision rate on the Schoonspruit.

Heterogeneous bleaching is evident in the majority of the samples and investigation shows that at least 50 equivalent dose (D_e) values are necessary to obtain reproducible dose distributions for these samples. Analysis of samples from palaeochannels of the Klip River demonstrates that the finite mixture model is the most appropriate for calculating the burial dose; replicate samples from the same palaeochannel reach give generally consistent ages, and comparison with radiocarbon ages for overlying organic-rich sediment gives good agreement. Using OSL dating, average lateral migration rates of ~0.05 and ~0.16 m/a over the last ~1.4 ka are obtained for

two meander bends on the Klip River, and five avulsions are identified as occurring since ~30 ka. On the Schoonspruit, the average incision rate has been ~2-3 mm/a since ~1.2 ka.

No clear link between these channel change processes and palaeoclimatic records from South Africa is evident. The results from this thesis, therefore, indicate that channel change processes on the Klip River and Schoonspruit result primarily from autogenic controls, rather than allogenic controls such as climate change.

Author: Christina Ankjaergaard
Thesis Title: Electron emission from natural minerals: Implications for charge movement and dosimetry
Grade: MSc
Date: September 2006
Supervisor: Andrew Murray
Address: Nordic Laboratory for Luminescence Dating, Department of Earth Sciences, Aarhus University, Risø National Laboratory, DK-4000 Roskilde, Denmark

Exo-electron signals from crystalline materials can be used to give insights into charge movement within crystals. This thesis investigates whether exo-electrons can be detected from natural insulating minerals such as quartz and feldspar, and uses comparisons with simultaneously measured luminescence to investigate the stimulation and recombination of charge trapped as a result of exposure to ionizing radiation. These investigations lead to a consideration of the potential use of these exo-electron signals for measurement of absorbed doses in retrospective dosimetry.

A Geiger-Müller electron detector was developed for this work as an attachment to the existing automated Risø TL/OSL reader, such that thermally and optically stimulated electron emission and luminescence can be detected simultaneously, and sample treatment (i.e. irradiation, heating, light stimulation) undertaken without moving the sample from the detector volume. Using this equipment, both thermally and optically stimulated luminescence (TL, OSL) and exo-electron emission (TSE, OSE) were recorded from common salt, quartz and feldspar. An experiment is described which allows the conclusion that the dosimetric behavior of surface traps and bulk traps is indistinguishable. This simplifies the interpretation of the comparison of exo-electron (surface) with luminescence (bulk and surface) phenomena. Using quartz and feldspar, the relative OSE and OSL dose response is then examined, followed by the relative thermal stability of the two signals from quartz. In a preliminary comparison of infrared stimulated signals from feldspar, it was found that the OSE signal was not detectable, despite a strong OSL signal. These results are discussed in terms of published models of charge movement in quartz and feldspar.

Occasional unstable detector behavior gave rise to infrequent noise pulses in the exo-electron data. This led to a redesign of the detector and electronics. The new design gave an improvement in sensitivity of 10 to 20 times, and allowed a preliminary study of the OSE characteristics of more exotic materials such as paper, cotton, keratin, and coral. To confirm the validity of the most important earlier results, experiments on the thermal stability of quartz, and the effect of prior infrared stimulation on feldspar were revisited in more detail.

The use of exo-electron signals in retrospective dosimetry and the possible advantages they offer compared to luminescence were investigated by simultaneous measurement of exo-electron and luminescence dose response curves from different samples, (i) to illustrate the large variability in relative behavior between these curves, and (ii) to determine how the growth curve shape depends on preheat temperature. After these initial examinations, exo-electron emission and luminescence dose recovery tests using quartz were used to demonstrate that dose given before any laboratory heating could be measured accurately. Finally, preliminary investigations of the use of natural exo-electron signals in chronometry are presented. This important potential application is illustrated by an example showing the use of OSE to estimate a natural dose which could not be measured using OSL.

It is concluded that exo-electron signals from natural minerals can be measured easily, are stable in time, and survive aggressive chemical surface cleaning. Together with luminescence signals, they can be used to provide important new insights into charge movement in insulators, and seem to have considerable potential application in both accident dosimetry and chronometry.

Author: Mirko Ballarini
Thesis Title: Optical dating of quartz from young deposits – from single-aliquot to single-grain
Grade: PhD
Date: May 2006
Supervisor: Jakob Wallinga, Adrie Bos
Address: Netherlands Centre for Luminescence Dating, Delft University of Technology, The Netherlands

Optically Stimulated Luminescence (OSL) dating showed to be a robust and reliable tool for dating quartz samples in the age range of 1,000 up to 150,000 years. However, optical dating below and beyond these limits remains a challenge. OSL dating relies on the assumption that the luminescence signal of grains is fully reset to zero by sunlight exposure before deposition. If this requirement is not fulfilled (i.e. grains were “poorly-bleached"), ages may be grossly overestimated. In particular, poor-bleaching can significantly affect age estimations of young sediments, for which the remnant signal may be large relative to the signal built up during burial. One way to investigate poor-bleaching within a sample is to measure the OSL signal from individual grains rather than from aliquots made up of several thousands of grains.

The aim of this thesis is to determine the feasibility of optical dating techniques to individual grains of quartz from deposits formed within the last 300 years.

The standard single-aliquot (SA) technique has been validated on aeolian coastal-dune quartz samples, for which heterogeneous bleaching was not a significant issue. This gave us knowledge of the limits of standard luminescence techniques. The study site is the south-west of the island of Texel (The Netherlands), whose development of sand-dune deposits for the last 300 years is very well documented by means of maps. It was found that aeolian samples as young as 10 years old could be dated by quartz single-aliquot dating. One sample (<1 yr), which was known to have experienced poor-bleaching before deposition, gave an OSL age of 73±24 years, making it a good candidate for further single-grain (SG) analysis.

Before attempting any sort of SG age estimation, we focused at improving both instrumentation and dating procedures. This need arose from the fact that luminescence signals from young samples are weak and noisy. We found that the light detection efficiency can be increased by choosing an alternative set of detection filters to be used with the photomultiplier tube. As a result, a greater percentage of grains could be used for our analysis. We also investigated the homogeneity of our beta-sources, finding that for two sources out of four the irradiation of sample disks was not uniform. This could be seen from 3-D graphs, where the dose rate delivered to each individual grain was plotted against the position of the grain on the disk.

The single-aliquot-regenerative (SAR) protocol, commonly used in single-aliquot quartz measurements, was also modified to be used on individual quartz grains. The most important changes were focused on two issues: a) further increase of the percentage of grains that could be accepted for dose analysis and b) selection of the OSL component that is more representative of the last depositional event that is to be dated. We tested this protocol on two well-bleached samples of 300 years, previously dated by single-aliquot means. We found that SG ages were comparable to SA ages if our modified SAR protocol was used.

Such a modified protocol was finally applied on two more samples from Texel, one being less than one year old and the other the 73-year-old sample whose age was overestimated by standard single-aliquot methods. With the first sample we tested our ability to date extremely young individual grains; with the second, our ability to cope with poor bleaching occurred to young quartz grains. We found that the zero-age sample could be correctly dated (within errors) but very large uncertainties are associated with the final dose. For the poorly-bleached sample, no satisfactory dose estimate could be provided. However, in this last case, poorly-bleached grains responsible for the SA age overestimation could be identified.

The work presented in this thesis shows the feasibility and great potential of SG dating of young quartz samples – and a suitable protocol is proposed. Despite encouraging results further investigations and additional innovative approaches are needed in order to make optical single-grain dating a robust and reliable tool.