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Optical dating chronologies of dune reactivation in the south-eastern Arabian Peninsula

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Abstract

The optically-stimulated luminescence (OSL) signal within quartz can be enhanced by thermal transfer during pre-heating. This may occur via a thermally-induced charge transfer from low temperature traps to the OSL trap. The effect, as empirically measured via recuperation tests is observed to be negligible for old samples but may be a significant problem for younger deposits. The prospect of thermal transfer remains a major concern in the dating of young samples as the process of thermal decay and transfers of geologically unstable traps (typically in the TL range 160-280ºC) may in result be incomplete. Upon pre-heating such a sample might undergo thermal transfer to the dating trap and result in a De overestimate. As a result, there has been a tendency for workers to adopt less rigorous pre-heats for young samples.

We have investigated the pre-heat dependence of numerous samples from various depositional environments at five temperature pre-heats (200ºC, 220ºC, 240ºC, 260ºC, 280ºC), employing a single aliquot regeneration (SAR) protocol. SAR De,s were also calculated for 45 modern/young samples of different depositional environments and compared with previous multiple aliquot additive dose (MAAD) data. Results demonstrate no significant De dependence upon pre-heat temperatures, indicating that thermal transfer is negligible. A close correspondence between MAAD data and the current SAR data for these samples is also illustrated, reinforcing the applicability of SAR for the determination of modern and young sediment De,s.

We describe the results of a detailed analysis of a suite of samples collected from Sahelian West Africa as a demonstration of the potential of optical dating for young (i.e. contemporary) aeolian sediments. The Sahelian Margin of West Africa is an area of recent environmental catastrophe and human suffering via the food shortage and land degradation consequences of prolonged drought. The propensity of this region to suffer drought has been related, using environmental data collected during the period of instrumental records, to a combination of low mean annual rainfall levels and significant departures from the mean which relate to sea surface temperature anomalies in the adjacent tropical Atlantic Ocean. The potential impact of increasing population density in the area has also been identified as a potential contributing factor to the desertification of the region which has occurred over the last c. 30 years. Despite the significant environmental and human consequences of such droughts there is a paucity of long term environmental data for this region. Aeolian dune reactivations in this area are a potentially highly useful environmental archive of past periods of extended drought conditions which may have resulted in localised or widespread dune reactivation. Here we describe the initial results from an ongoing programme of research which seeks to develop a detailed record of past dune reactivations in Mali and Nigeria. We find evidence for repeated Holocene dune reactivation events and a significant number of reactivations which commenced at the time

of onset of the last major drought cycle in the early 1970s. We obtain ages as young as 20-30 years for some significant dune units (thickness up to 1m) and describe the results of a series of experiments to establish the significance of pre-heat temperature on Single Aliquot Regeneration (SAR) equivalent dose determinations and recycling ratios. Optical dating of sand sized quartz could provide a very useful tool for palaeogeographical mapping of ancient and historical dune reactivations in this region and elsewhere.