Thesis abstract

Thesis title: The form of the optically stimulated luminescence signal of quartz : implications for dating
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Optically stimulated luminescence (OSL) signals measured from natural sedimentary quartz vary significantly in form depending upon a variety of factors, including the irradiation/illumination/thermal history of the sample and laboratory measurement conditions. An attempt has been made in this thesis to understand the factors responsible for the observed variation in decay form and to exploit this understanding for the benefit of optical dating. The origin of the observed non-exponential OSL decay and the issue of single versus multiple signal components were found to be of paramount importance.

Empirically constrained analytical and numerical modelling of charge transfer (through the conduction band) within an electronic system analogous to that of quartz indicates that the OSL stimulated from a single trap is expected to decay exponentially (to a very good approximation) with time. The empirically observed OSL signal (measured at 160°C) was found to be adequately fitted using a sum of two exponentials, the 'fast' and 'medium' components, plus a third non-exponential ('slow') component, best fitted using a ln(t) decay in most cases.

Isothermal decay analysis suggests that both the fast and medium components are associated with the TL region centred on 330°C. The third 'slow' component signal is extremely thermally stable, present after heating to 500°C. A thermo-optically stimulated direct donor-acceptor recombination pathway was inferred for the slow component. Further differences between each OSL component were observed in, for example, dose response and thermal assistance in detrapping. The conclusion drawn was that the observed OSL most likely comprises three physically distinct signals.

Two aspects of quartz optical dating that may benefit from analysis of the identified signal components have been addressed in some detail; these are (i) the identification of partially bleached sediments, and (ii) the possible extension of the dateable age range.