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Significant peak enhancement of the natural TL signal observed after short term storage at 75 °C

M.L. Clarke† and A.G. Wintle§

† Department of Geography, University of Leicester, University Road, Leicester, LE1 7RH.
§ Institute of Earth Studies, University College of Wales, Aberystwyth, Dyfed, SY23 3DB.

Introduction

Loess samples found to exhibit anomalous fading have, in the past, been subject to inconveniently long post-irradiation storage periods to await complete removal of the unstable TL component. Various pre-heat procedures have been developed, following experimental studies on zircon by Templer (1985), and they have been critically discussed by Berger (1988). Berger (1987) has reported that storage of up to 8 days at an elevated temperature of 75 °C removes the unstable signal equivalent to 160 days at room temperature. This paper describes a series of measurements in which the natural TL signal exhibited a significant peak enhancement of up to 36% over a period of 1-8 days relative to the natural TL signal stored at room temperature (25 °C). Obviously a temperature-induced sensitivity change has serious implications for reliable dating.

Experimental observations

Polymineral fine-grain loess samples from Gold Hill, near Fairbanks, Alaska, were found to exhibit severe anomalous fading at room temperature. Fading has previously been reported in Alaskan loess samples from Halfway House (Berger, 1987), within 10km of the Gold Hill locality. Fading in the Gold Hill samples was observed in the green region of the spectrum with a Corion S40-550 band pass filter, whereas. Berger (1987) looked at the TL emission in the blue part of the spectrum using a Corning 5-58 filter. The occurrence of anomalous fading in both the blue and the green emissions implies that fading is not related to a specific luminescence centre.

As Berger (1987) had proposed that short-term storage periods of up to 8 days at 75fC removed a large proportion of the unstable TL component, a series of measurements were carried out on discs left at 75 °C for 1-8 days prior to glowing. An equivalent set of discs were left at room temperature (25 °C) for the same period. The discs were glowed immediately after storage with the entire experiment repeated in three different spectral regions (UV, blue and green) using a Daybreak Bandpass Filter System. The filters used were a Schott UG11 combined with a BG38 (UV), a Corion S40-400 (blue) and a Corion S40-550 (green). The choice of filters was determined with reference to the emission spectrum obtained by Huntley et.al. (1988) on a sample of Alaskan loess from the Fairbanks area. The principle emissions occurred in the blue and green region.

Surprisingly, none of the irradiated discs showed any significant fading after storage at 75 °C. However, the natural TL discs exhibited a marked peak enhancement, of up to 36% over 1, 2, 4 and 8 day periods at 75 °C with respect to those at 25 °C. This enhancement occurred over the entire glow curve suggesting that it is not a function of trap depth (figure 1). It was visible with all three filters and with four different samples.

Further experiments were then conducted to test whether the natural signal from Alaskan loess was therefore temperature dependent. Discs were glowed immediately after being taken from an oven where they had been stored for intervals of 1, 2, 4 and 8 days at various temperatures ranging from -15 °C to +110 °C. Only the natural discs left at 75 °C showed an increase in signal intensity. The natural glow curves for the other temperatures were identical to those at 25 °C, except for those held at temperatures above 90 °C which exhibited a slight loss of signal on the lower temperature side of the glow curve.

The enhanced natural TL signal was also found to be relatively unstable, in that leaving the natural discs at 75 °C for 1 day and then for 18 hours at room temperature prior to glowing causes the enhanced signal to decay back to its original (room temperature) level.

The effect of such a signal enhancement on calculation of the ED was tested by substituting the natural response at 75 °C into a set of regeneration data from the same sample left at room temperature. The ED obtained at room temperature with the original data was 60 Gy; however, by substituting just the naturals with the peak enhanced signal the ED obtained was 138 Gy. Obviously an apparent increase of 78 Gy has serious implications for dating by the regeneration method. Such problems are unlikely to be encountered by the total- or partial-bleach methods (as used by Berger, 1987) because of the delay imposed by subsequent optical bleaching procedures.

Conclusions

Although the behaviour exhibited by these samples is difficult to understand and interpret, the possible implications are serious enough to warrant further investigation. The lack of fading observed for irradiated

samples stored at 75 °C may be due to the enhanced signal cancelling out the decrease caused by fading over the 8 day period. It is clear that readout immediately after storage at 75 °C will lead to erroneous results and at least 24 hours should pass before the glow curves are measured. Such a precaution was taken by Berger (1987) as evidenced by data in figure 2 of his paper; he also stated that the TL from unirradiated sub-samples was unaffected by storage intervals of up to 8 days at 75 °C.

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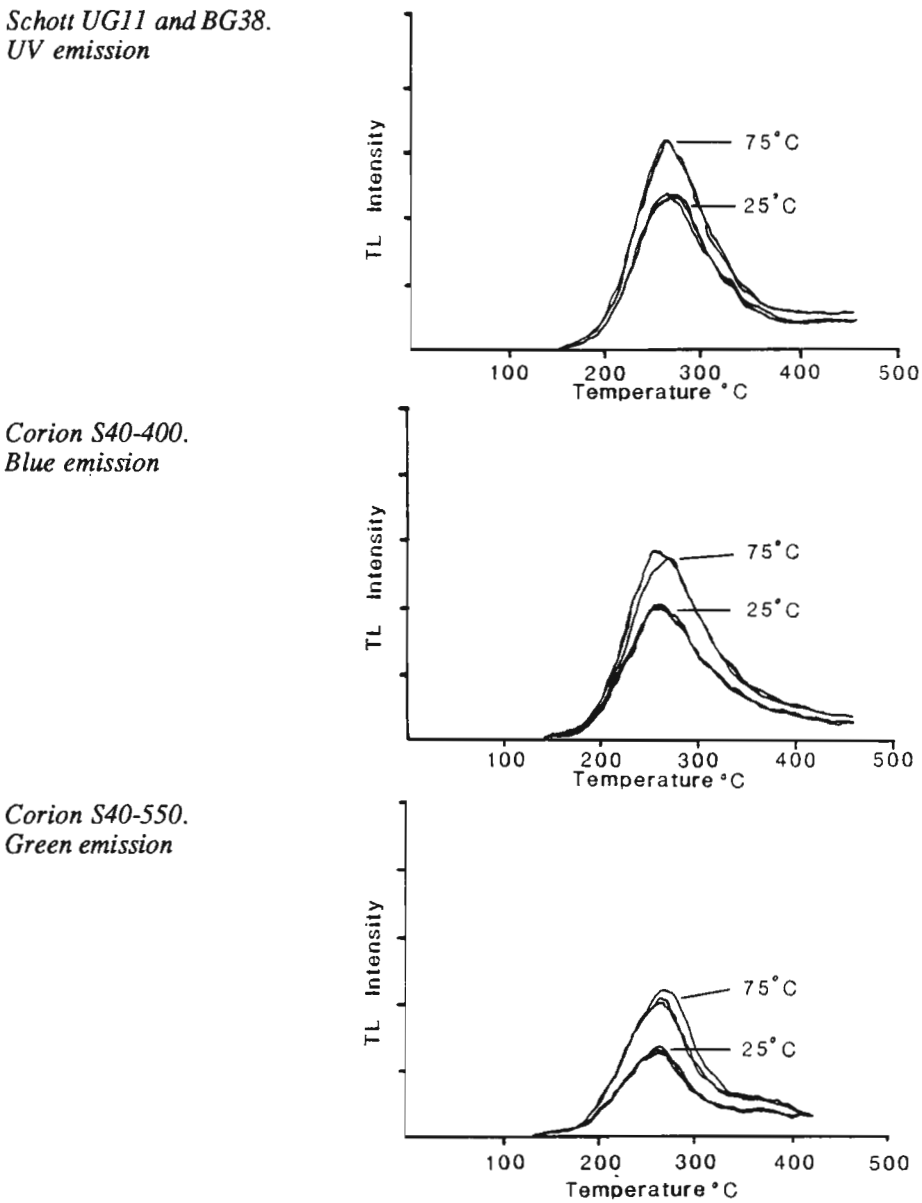

Figure 1.
Glow curves obtained from natural discs of sample GHC27 using three different colour filters. The discs were glowed after one day storage period. The natural glow curves for temperatures ranging from - 15 °C to +110 °C were identical to those at 25 °C, except that those held at temperatures above 90 °C exhibited a slight loss of signal on the lower temperature side of the glow curve.