

Dose Normalization in Fine Grain Dating of Loess

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In fine grain dating it is usually assumed that a series of fine grain discs does not need to be normalized because the disc to disc scatter in the TL intensity is better than $\pm 5\%$ (Aitken, 1985). However it has recently been observed that in a group of eight discs prepared from fine-grain loess the natural TL showed a scatter such that the standard deviation was $\pm 11\%$ of the mean and this was reduced to $\pm 4.5\%$ after a dose normalization procedure commonly used for coarse grains.

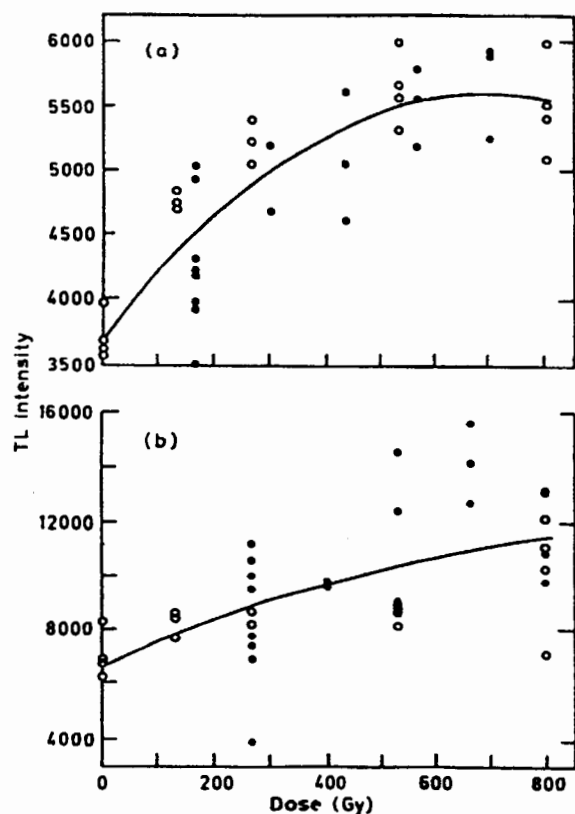


Figure 1

Relationship between the TL generated by the normalizing dose of 6 Gy and the total radiation dose received by the sample prior to normalization. The solid line represents a best-fit quadratic function. Data points are indicated by black circles for natural samples and open circles for bleached samples. N.B. the suppressed zero on the TL intensity axis.

In the Adelaide TL laboratory it has been the practice in dating sediments using 100 μm quartz to dose-normalize all the discs used in the natural and bleached growth curve determinations. After the discs have been glowed they are all given the same normalizing dose, routinely chosen as 6 Gy. The TL so generated in the 350°C peak, the one which is used in the equivalent dose analysis, is then determined. Since the discs in each series have received varying amounts of radiation and there is usually a small amount of pre-dosing, this TL will also vary with dose, and when plotted against the total radiation dose received (Fig. 1) can be fitted by a suitable function. The normalization factor for a given sample at each increment of radiation dose is calculated as the fitted value divided by the sample value. This factor is then a function of dose.

The loess samples came from the Belan Valley in India and were estimated to be about 30,000 years old. The material was predominantly present as fine grains from which discs were prepared by the standard techniques, each disc holding about 1 mg of powder. The total bleach procedure was carried out and the data were analysed by the slide technique (Prescott et al., 1993).

A preliminary determination of the equivalent dose without normalization gave 170 Gy for sample 1. In plotting the TL generated by the normalizing dose against the total radiation received, it was assumed that the naturals had received the equivalent dose of 170 Gy with further increments up to 600 Gy. In the case of the bleached samples, it was assumed that bleaching had set the dose to zero, with increments up to 800 Gy. (In fact three days of bleaching in full sun had reduced the TL to 15% of the natural.) The plot was best fitted with a quadratic relationship as shown in Fig. 1a. The downturn in the function at the highest dose plotted has no physical basis, but is an artifact which does not affect the general conclusions. A full analysis of the normalized data yielded an equivalent dose of 200 Gy as shown in Fig. 2a. There was a very convincing equivalent dose plateau in the region of the glow peak.

For the second sample, the standard deviation in the raw data was 17% of the mean and this was reduced

to 6.5% by the normalization process described. The normalization TL intensities are plotted in Fig.1b and the growth curve in Fig.2b.

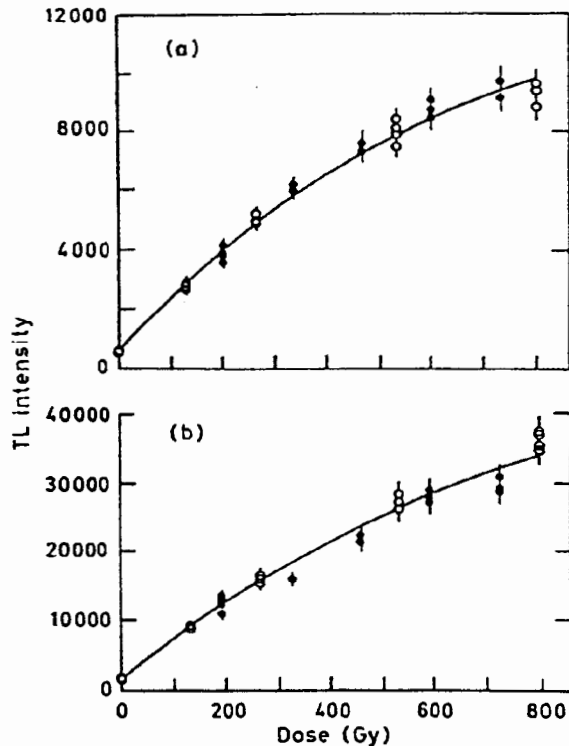


Figure 2

Growth curves generated from the (N+dose) data, denoted by black circles, and the (B+dose) data, denoted by open circles, using the slide technique. The data refer to the two samples of loess from Belan taken from the region of the peaks in the respective glow curves. The solid line represents the best-fit saturating exponential function.

It is not known why the scatter in the TL of these fine grains is greater than might be expected. It does not appear to be associated with varying masses of powder on the discs. As this is a mixture of minerals, it is possible that most of the TL is coming from a small number of grains belonging to one mineral, presumably quartz, which is not present as the major constituent. Dose normalization should work for this

situation, as it does here. The fact that the normalization TL plotted against radiation dose follows a quadratic relationship may indicate some degree of saturation. In both samples the growth curve obtained in the age analysis was exponential, also showing a tendency to saturate.

The scatter in luminescence data from coarse grain feldspar samples has been discussed in a recent paper by Huntley and Berger (1995) who attribute some of the inter-sample variation to two external causes, different radiation doses and different extents of bleaching at deposition. As the dose normalization worked well for the Belan loess when differences in total radiation dose were taken into account, using the total bleach assumption, it is concluded that incomplete bleaching is not a factor here. This result is to be expected for samples of loess which should be completely bleached in transit.

References

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