Zero thermoluminescence for zero age

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Introduction

Among the criteria set down by Wintle and Huntley (1982) in the review paper with which they discussed their application of thermoluminescence (TL) to the dating of sediments, was the requirement that very recent deposits should have zero TL age. In practical terms this does not necessarily mean that the sample should have zero TL in an absolute sense but that the procedures used in dating should yield zero age. Nevertheless the requirement of zero age is closely bound to the degree of resetting of the TL clock by exposure to sunlight during the time that the sediment was being laid down. Doubts always exist because the samples being dated may not have been exposed to sunlight for "long enough" to reset the clock.

The literature (see e.g. past TL/ESR Workshop proceedings) has many examples of ambiguities due to uncertainty in the degree of zeroing of the samples and there has been considerable study of the bleaching process itself and of methodology designed to minimise the uncertainty in bleaching. A representative list of references would include: Wintle and Huntley, 1982; Singhvi et al, 1982; Huntley, 1985; Redhead, 1984, 1988, Spooner et al, 1988; Bailiff and Poolton, 1989, Berger, 1990, and Robertson et al, 1991.

In recent articles in this journal, Franklin and Hornyak (1990) and Prescott and Fox (1990) have suggested the use of new procedures to overcome some of these uncertainties when quartz is concerned. These authors suggest the use of the 325 °C glow-curve peak which emits at 380 nm and is very rapidly bleached. The bleaching time of this peak to effective zero intensity depends to some extent on the sample but is of the order of minutes of full sunlight. Other quartz glow-curve peaks may require times of the order of days to be fully zeroed (Spooner et al 1988, Prescott and Fox 1990). The use of optical filters can distinguish between the "rapidly bleaching peak" (using the nomenclature of Franklin and Hornyak) and the slowly bleaching peaks in the glow curve. The former is selected by the use of a UG2 or UG11 filter and the latter by first removing the rapidly bleaching component with a short exposure to sunlight through a filter with a short wavelength cut-off at, say, 475 nm. This then gives the baseline from which 325 °C peak rises. We refer to this as "*selective bleach*". In the course of TL dating of a range of Australian sediments we have encountered some examples for which the conventional *total bleach* method of Singhvi et al (1982) has given apparently anomalous results: in particular, in giving non-zero ages for zero age deposits (Prescott 1983, Tejan-Kella et al 1990). In these cases, the discrepancy can now be shown be due to insufficient bleaching for the *total bleach* methods to work. i.e., to the sample's not having been set sufficiently to zero when it was originally deposited.

Results

We report here tests of the "selective bleach" technique, designed to show whether or not it avoids the discrepancies for zero age samples that were noted at the time of the original published measurements (Prescott 1983, Tejan-Kella et al 1990). The emphasis is on identifying zero age. Revised dates for other samples will be reported elsewhere.

For these "modern" samples the method used was to compare the glow curve for the "natural" sample with the glow curve for the same material after bleaching by 30 minutes of natural sunlight filtered by a 475 nm filter (cutoff to 1% at 475 nm). If these glow curves are the same, it indicates that there was no 325°C component in the original sample and that, regardless of the apparent age found by conventional total bleach methods, the TL age is zero within the sampling errors.

Figure 1 shows this for sample CA20S/1, modern dune sand from the Carlo Blow near Cooloola in Queensland, Australia (Tejan-Kella et al 1990). This sample comes from a depth of 1 m in the toe of an actively mobile dune. The time since the sample was last exposed to light can scarcely exceed a decade because the dune is currently encroaching on living vegetation. This sample gave an age of several thousand years when dated by conventional *total bleach* methods. From figure 1 it is clear that there is little or no 325 °C component *per se* in the glow curve although there is a substantial amount of light in the glow curve in the corresponding temperature region. It was found that 20 hr of full sunlight reduced the TL of this sample by about half. The conclusion drawn is that the revised procedures now give a "modern" age to this sample, which is consistent with its geomorphology.

TL dating of sand dunes from the Roonka prehistoric archaeological site has been described in Prescott (1983). In that reference it was shown that surface samples, which would therefore be zero TL age, could be bleached to about 50% of their "natural" level in the temperature region 300-400°C and had apparent ages significantly different from zero. We have remeasured one of these surface samples, EB1S/02, and the natural glow curve is compared with the selective bleach curve in figure 2. Since these curves are the same within the reproducibility errors, the new technique has recovered modern age for a sample which previously gave an age of some 400 years.

In both cases, limited tests show that a true ED of about 0.1 Gy would be detectable. It may be noted that the glow curve for EB1S/02 differs from that for CA20S/1 because of the presence of a large 280 °C component in the latter.

It is concluded that the proposed ***selective bleach*** technique gives zero age for modern samples for which *total bleach* methods give non-zero ages and satisfies at least this criterion of Wintle and Huntley. An expanded

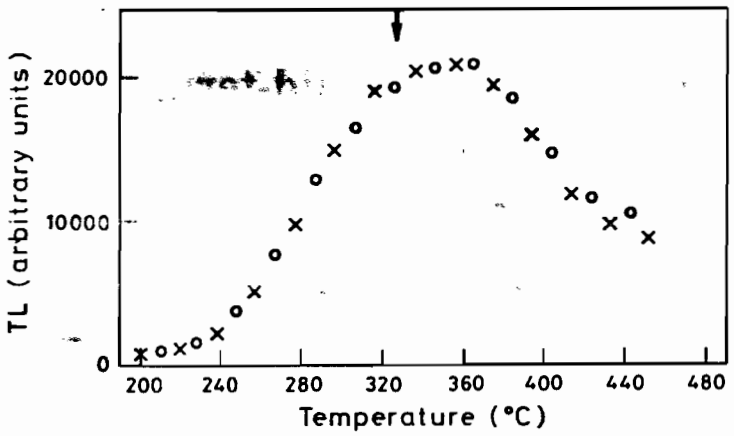

Figure 1.
Comparison of natural (crosses) and selective bleach (circles) glow curves from Carlo Blow (sample CA20S/1). The place where the 325 °C peak would be found is indicated by the arrow. The absence of such a peak demonstrates the modern age of the sample. In this figure and in figure 2 the curves have been glow-normalised and the error due to counting statistics lies within the symbols.

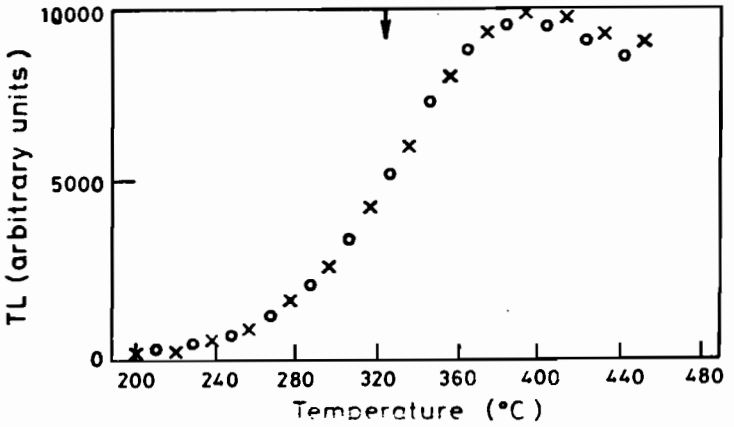

Figure 2.
Comparison of natural (crosses) and selective bleach (circles) glow curves for surface material from Roonka (sample EB1S/02). The place where the 325 °C peak would be found is indicated by the arrow. The lack of any difference between the two curves shows that this currently mobile dune surface is modern.

version of this note will appear in *Proceeding of the Fourth Australasian Archaeometry Conference.*

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