The use of an image intensifier to study the TL intensity variability of individual grains

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When using 100µm quartz grains in TL dating a difficulty commonly experienced is poor disc-to-disc reproducibility, a major cause of which is intrinsic sample variability. Because this occurs when there are several hundred grains per disc, it can be deduced that most of the TL must arise from only a few per cent of the grains.

In order to test this deduction we have constructed a simple apparatus that gives a semi-quantitative light intensity distribution of a large number of grains and permits sorting the grains for further study.

The apparatus is shown in Figure 1. The sample chamber was an Oxford-style glow oven with a Wild BG-38 filter (pass band 320-630nm) to remove the incadescence emission. Above this an f1.4 camera lens was mounted with a reverse adapter on the bottom of a bellows unit. At the top of the bellows an image intensifier was placed and its position adjusted so that an image of the sample was focused on its input. The glowing grains were readily visible at the upper phosphor surface of the intensifier and could easily be photographed with the camera shown in the upper part of the figure.

The image intensifier used was a Varo model 3603 from Varo Inc. 2203 W. Walnut St., P.O. Box 469014, Garland, Texas 75046-9014, U.S.A. It had a gain of $\gtrsim 10^5$ from 400-800nm, operated on two 1.5V cells and cost ~US$2000.

Small chips of CaF_2:Dy dosemeter crystals were used for set-up and focusing. After being given a large dose (> 1kGy) their phosphorescence was visible for over two weeks.

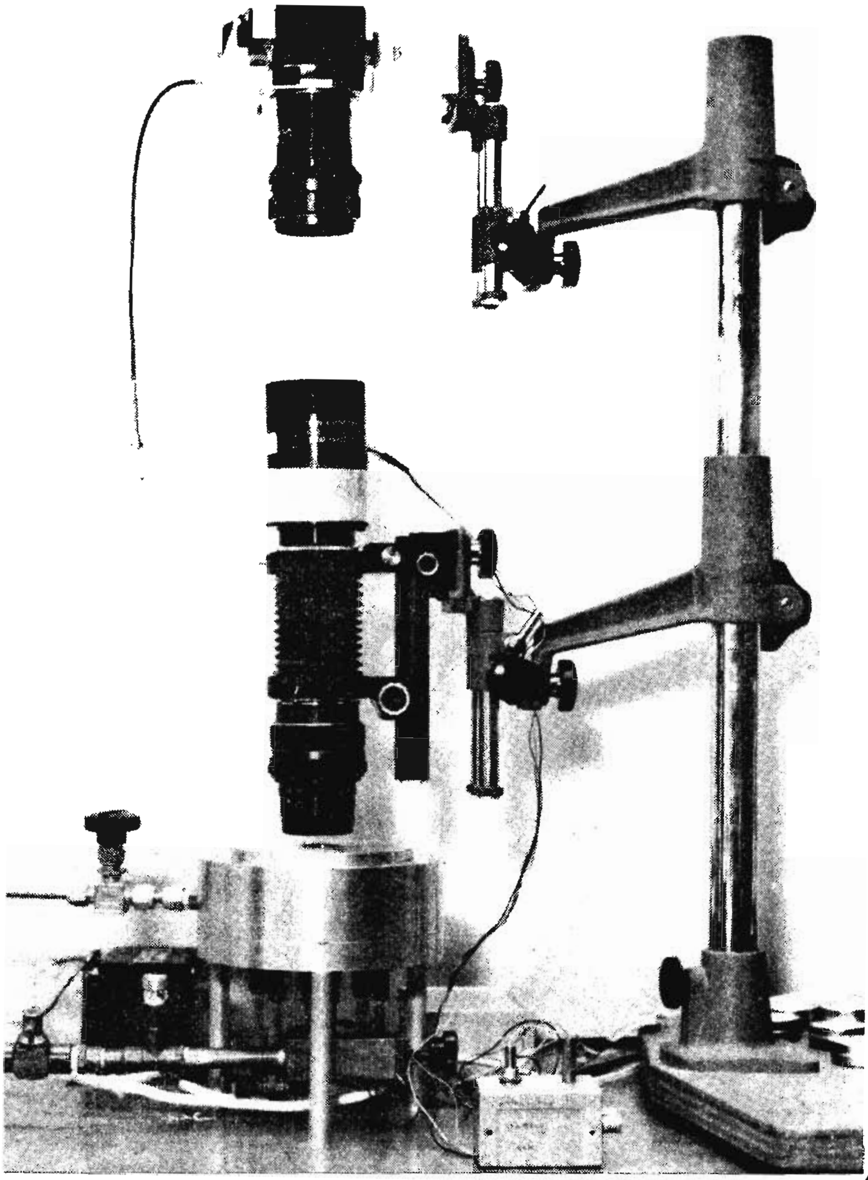

Figure 1

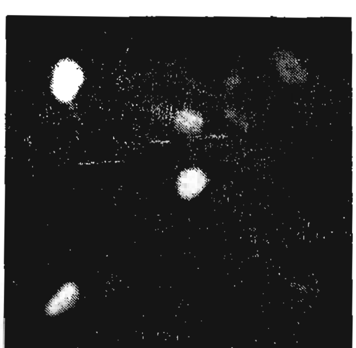

Figure 2a

Figure 2b

Figures 2a and 2b are photographs of the intensified natural TL of 25 quartz grains, 0.5-1mm in diameter, extracted from a 120ka South Australian beach dune. Figure 2A is the TL from 250-400°C and Figure 2b the TL from 400-450°C. Although many grains are visible, most of the light is coming from 2 or 3 grains. It is also interesting to note that the brightest grain (upper left) in the first picture is barely visible in the second one. Photographs of discs containing several hundred 100µ quartz grains of the same sample also indicate that the TL is dominated by a few bright grains.

We know of only two previous attempts to determine an intensity distribution, those of McKerrell and Mejdahl (1981) and Benko (1983) who measured the TL of individual grains. Because of the small number that they measured they could have missed the important bright grains. The idea that only a small percentage of the grains contribute significantly to the measured TL was put forth several years ago by D. Zimmerman (D. Stoneham, private communication, 1983) yet has received little discussion in the literature. The cause and implications of this variability remain to be investigated.

A sensitive apparatus for photographing TL has been described previously by Debenham and Walton (1982); our system is much cheaper, simpler to construct and easier to use.

Acknowledgements

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Reviewer's Comments (M. J. Aitken)

This follow-up of the pilot work with Alan Walton shows an important new facet. This is that grains which are bright in one temperature range may be dim in another range. This presumably explains why Zero Glow Monitoring (ZGM) using the 110° peak is often found to be unsatisfactory as a way of normalizing the high temperature TL of different portions of 100-micron quartz grains.

Another aspect of single grain investigations is grain-to-grain variability in anomalous fading. Relevant reports have been made by Hoyt et al. (1972), Sutton and Zimmerman (1976, 1979) and Templer (1985).

References

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