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ZERO-GLOW MONITORING (ZGM)

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In the evaluation of equivalent dose by means of the additive dose technique a frequent difficulty is that of normalization between the different portions of the sample - the essence of the additive dose technique being that the equivalent dose is derived from first-glow measurements. This note reports a technique for normalization that has been found highly satisfactory with calcite, whether in the form of 100-micron grains or as thin slices; it was earlier considered by Wintle in this context (private communication). It seems likely that it is applicable to some other materials too, e.g. quartz, fluorite; indeed, utilization in respect of quartz has already been made by Bowman (D.Phil. thesis, Oxford 1977).
The procedure is as follows:-

1) Administer monitor dose of beta-radiation. This should be small compared to the expected equivalent dose.

2) Measure TL of peak I (see figure); stop at 100°C.

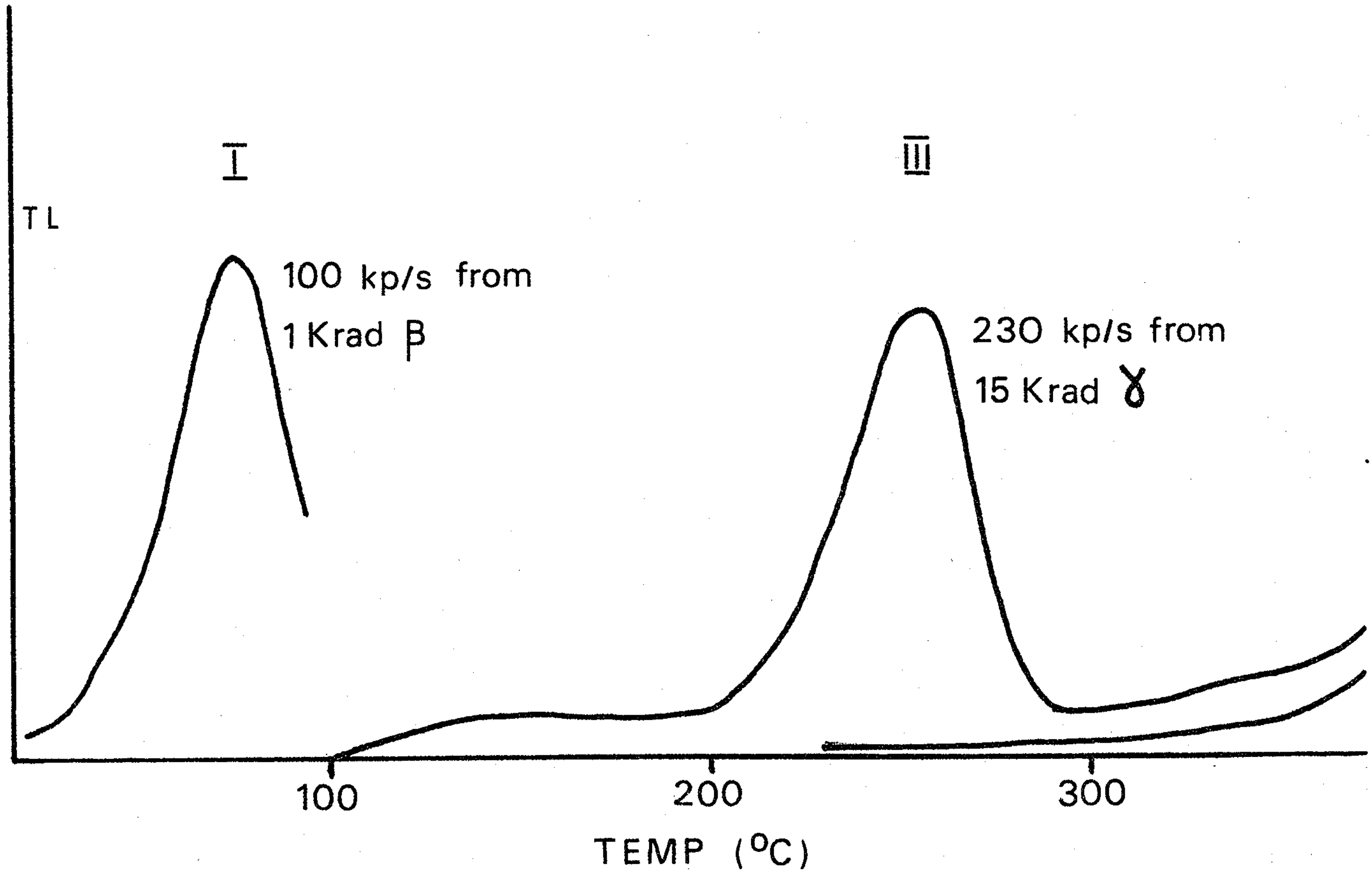
3a) In the case of a portion being used to determine the natural TL, continue glow-curve to 500°C.

3b) In the case of a portion being used to determine (N+β), administer the additive beta dose and then glow to 500°C.

The first-glow growth characteristic is then obtained by plotting the ratio (3)/(2) against beta dose, and the intercept gives the equivalent dose in the usual way (except that if significant the value of the monitor dose needs to be subtracted from it).

The great advantage of the technique is that the portion is monitored before it has had any appreciable heating and before it has had any additive dose. Thus interference by pre-dose effects is avoided, as well as transparency changes on heating, with calcite at any rate the latter tend to be irregular from portion to portion, particularly in the case of slices. It is quicker and much less tedious than weighing, as well as being more accurate; also, if the irradiations are done on-plate, optical effects associated with sample presentation are normalized out (as long as such effects are the same for both peaks; this is likely to be the case unless there is a strong difference in wavelength).

The technique has been tested for 100-micron grains using calcite which had been given a 15-kilorad gamma irradiation and for thin slices which had been given a 50-kilorad gamma irradiation. In both



cases the monitor dose was one kilorad. In these tests the gamma irradiation simulates the archaeological dosage and the objective was to see if the technique gave accurate normalization from portion to portion (or from slice to slice); the monitor dose was of course given with the portion on-plate immediately before measurement of TL (beta-TL from peak I, gamma-TL peak III with a small beta contribution). For six portions of grains, approximately 7 milligrams presented dry in a 0.005"-walled 7-mm diameter silver planchette, the standard deviation in the ratio of peak III/peak I was 4%. For an approximate monolayer of grains on a 0.018" thick 10-mm diameter silver disk, the standard deviation was 2%; the monolayer was obtained by the Murray technique by giving the disc a prior coating of Silspray and then tapping off grains which did not adhere. For eight 400 micron slices with areas between 6 and 16 mm^2 the standard deviation was 5%; use of area and mass normalization gave standard deviations of 8% and 10% respectively. Using 14 slices of equal area, and thickness from 290 to 980 microns ZGM gave a standard deviation of 4% for the ratio peak III/peak I, whereas the standard deviation for mass normalization was 29%. The failure of mass normalization in this case is attributed to the increasing importance of optical attenuation with increasing slice thickness; zero glow monitoring is not subject to this limitation unless the optical attenuation coefficients for the two peaks differ widely.

Because peak I occurs at about 75°C it is important to keep a strict routine, e.g. administration of the monitor dose should not commence until the plate has cooled from the previous glow-curve to 25°C, and commencement of the glow-curve for measurement of peak I should commence at a fixed time, say 3 minutes, from the end of the monitor irradiation.

The greater scatter observed for the method of grain presentation in which the thickness was more than a monolayer suggests interference by portion-to-portion variations in beta build-up and attenuation effects (Wintle and Aitken 1977, Int. J. Radio Isotopes 28, 625-627). A brief attempt to reduce such effects by interposition of a 100-micron thick aluminium scatterer produced an inexplicable broadening of peak I; this line of development was not persued.

The tests show that the ZGM technique should give accurate normalization as far as natural TL is concerned; utilization in respect of true rather than simulated archaeological dosage has confirmed this. Similar utilization has confirmed that accurate normalization is also obtained in respect of additive on-plate beta dosage. Of course difficulties encountered in the absolute calibration of beta sources, such as the sample dependence reported by Bell and Mejdahl at the 1979 London Archaeometry Symposium remain.

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