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ON THE LOCAL AND INTERNATIONAL CALIBRATION OF BETA SOURCES FOR TL DATING

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Samples for interlaboratory β -source calibration have been available in the last couple of years from both M. Aitken (Oxford) and E. Pernicka (Austria). Both of these have been used for comparison with the Adelaide source, which had previously been calibrated by gamma-irradiated $\text{CaSO}_4\text{:Dy}$ (Harshaw).

The original calibration was made using CaSO_4 grains in the size range 75-180 μm . After annealing, the CaSO_4 sample (in bulk form as described later) was given 84.6 rad from a ^{60}Co source at the Royal Adelaide Hospital. A graphite parallel plate ionization chamber was used to measure the exposure to an accuracy of "better than" $\pm 2\%$. In order to achieve secondary electron equilibrium the sample was surrounded by a 3 mm layer of selenite (CaSO_4) which lends itself to cleavage into slabs of uniform thickness. Standard calculations such as those described in Attix and Roesch (1968) were then used to obtain the dose delivered to the grains.

There were three main peaks in the CaSO_4 glow curve. The first (i.e. lowest temperature) peak is susceptible to rapid fading and the third peak shows a pre-dosing effect. Hence irradiations with the β -source were aimed at matching the second peak at about 230°C . While this peak also shows a small predose effect on the high temperature side, it is possible to choose a range of 20° covering the top of the peak which is virtually free of predosing. There was no fading over a six-week period. About 3 mg of the irradiated CaSO_4 was sprinkled uniformly on to each 1 cm diameter stainless steel disc. Silicone spray was used to secure the sample. Measurements were made on twelve separate sample discs, with a sample standard error less than 1%. The relative stopping powers of CaSO_4 and SiO_2 suggest that the dose to quartz is a factor 1.02 ($\pm 2\%$) higher than the dose delivered to calcium sulphate at an electron energy of 0.8 MeV. This is about the mean energy from our ^{90}Sr source type SIPI from the Radiochemical Centre, Amersham. For the standard "high-mount" "on plate" source geometry that we use, the dose rate from the 5 mCi β -source was determined to be $22.2 \pm 0.6 \text{ rad min}^{-1}$ to quartz on stainless steel discs.

For the second calibration, eleven discs were prepared from the coarse grain fluorite (90-150 μm) supplied by Oxford and both peaks II and III were used for matching (Murray and Wintle, 1978 and Aitken, 1978). As Oxford does not quote an error for the gamma-irradiation, we assumed that it was 2%. An error of 2% was also used for the uncertainty in the conversion from dose-to- CaF_2 to dose-to-quartz (a factor of about 1.05). For our source geometry the dose to coarse grain quartz on stainless steel discs was determined to be $21.1 \pm 0.6 \text{ rad min}^{-1}$.

The final calibration involved the use of coarse grain (70-150 μm) quartz obtained from Dr. E. Pernicka. Once again, measurements were made according to instructions (Pernicka and Wagner, 1979). At least four discs were prepared from each of the five samples provided, each of which had had a different irradiation. Another four were prepared for each corresponding β -irradiation of the un-irradiated quartz. Our 40 mCi source was used for this calibration, so there is an additional error in the conversion to the 5 mCi source dose rate. The resulting calibration for the 5 mCi source was $21.9 \pm 0.5 \text{ rad min}^{-1}$. Bell (1980) suggests that this value may be about 5% too high. The weighted average calibration for the 5 mCi Adelaide source is $21.7 \pm 0.4 \text{ rad min}^{-1}$ when only the fluorite and CaSO_4 measurements are considered. This would suggest that the quartz calibration does not need to be reduced by 5%, although such a reduction would also be within the error limits.

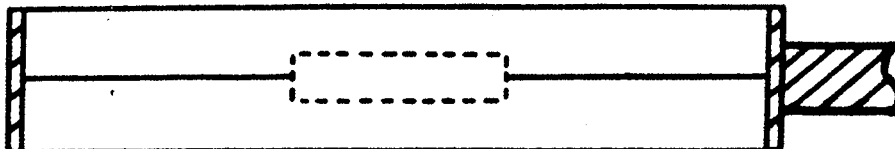
The results are shown in the accompanying table. The three separate calibrations agreed well, indicating that the use of any of the materials should provide an adequate measurement of the β -source dose rate. The Oxford-Adelaide comparison was included in M.J. Aitken's review of dosimetry calibrations at the 1980 Specialist TL Seminar in Oxford.

<u>Calibration By</u>	<u>Place of Irradiation</u>	<u>rad. min⁻¹</u>
CaSO_4	Adelaide	22.2 ± 0.6
Fluorite	Oxford	21.1 ± 0.6
Quartz	Vienna	21.9 ± 0.5

All strengths have been corrected to give the dose rate in February 1980.

In view of the issue raised by Bell above, it is worth enlarging on a couple of points connected with our gamma-ray calibration. Our irradiation cells (figure 1) are flat cylinders, 5 cm in diameter and 9 mm thick. They are made in two demountable halves with a 3 mm cavity in the middle to contain the material to be irradiated and are made of that same material: viz. selenite for CaSO_4 , pure silica sand mixed with a minimum quantity of silicone potting compound for SiO_2 and powdered natural fluorite bound with silicone for CaF_2 . (Our measurements with CaF_2 and SiO_2 are not reported here.) This construction automatically ensures that the sample dose is obtained under the correct conditions of electron-photon equilibrium.

The cells are symmetric and double sided so that they can be irradiated from two sides in turn by a ^{60}Co teletherapy unit. In this way the precise location of the sample with respect to the gamma-ray beam is not critical since the mean of the "up" and "down" readings is independent of small departures from the mean position to second order.



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REFERENCES

- Aitken M.: Specialist Seminar on TL dating, PACT 3, 443, 1979.
 Attix F. and Roesch W. eds.: Radiation Dosimetry Vol. 1, 2nd Edition, 1968. Academic Press. New York.
 Bell W.: Ancient TL No. 11, 1980.
 Murray A. and Wintle A.: Specialist Seminar on TL dating, PACT 3, 419, 1979.
 Pernicka E. and Wagner, G.: Ancient TL No. 6, 1979.

A METHOD FOR THE DETERMINATION OF TH-U CONCENTRATION RATIO

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One of the main problems in calculating the annual dose rate in pottery by thick-source α -counting (Tite and Waine, 1962) is due to the effect of sample reflectivity. Lack of information on the Th/U ratio may be another source of error, mainly in calculating β and γ contributions to annual dose-rates (Sasidharan et al., 1978). This work is intended to investigate the influence of reflectivity and to determine indicatively the Th/U ratio by a new method that needs only two single channel analyzers. The method is similar to that suggested by Pierson (1951) and Sanderson (1979), but we found it to work only by eliminating the influence of reflectivity.

Reflectivity

Huntley (1977) and Huntley and Wintle (1978) showed that reflectivity influences the height of pulses arriving to the photo-multiplier, so that a poorly reflecting sample gives pulses much smaller than a highly reflecting one. The discriminator setting adjusted so that the count rate is 85% of the zero-extrapolated count-rate of a Th sample (or 82% of U sample) could then be affected by reflectivity.