

# Ancient TL

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"Dans les champs de l'observation, l'hasard ne favorise que les esprits prepares (In the field of observation, chance only favours those minds which have been prepared)." Louis Pasteur

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## SUMMARY OF READER RESPONSE

The previous issue of Ancient TL (number 8) carried a request for reader response in an effort to solicit suggestions for improving the newsletter. The kind letters that have been received are much appreciated. Following is a summary of the comments and suggestions:

- Ancient TL continues to provide a valuable source of information for TL practitioners.
- Readers are urged to submit more helpful hints and suggestions. (In this regard, a new feature of the newsletter is being introduced, "Readers' Clues and Queries", which will contain short letters from readers and will aid the distribution of minor, but valuable, information. This issue's edition is found on page 16.)
- Readers are encouraged to advertise available positions/fellowships.
- Brief abstracts would be valuable for some entries in "Some Recent Bibliography".

The editor would be pleased to receive additional comments and ideas you may have concerning Ancient TL.

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## THE ALPHA PARTICLE RESPONSE OF FLUORITE

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For the interlaboratory source calibration kit (Ancient TL no. 5, p.6) a substantial number of fine-grain discs were prepared from MBLE Super 'S' calcium fluoride. It was expected that these would all have the same  $a$ -value but it was found that there were occasional high values - by around 10%; this necessitated measurement of the  $a$ -value of all the discs that were sent out for calibration of an alpha source on the basis of comparison with the recipient's beta source. The purpose of this note is to warn against the use of unchecked discs for this purpose. The cause of the variation has not been identified and it is to be noted incidentally that it may also be present with other materials - including pottery.

### Experimental

The fine grains were deposited from suspension in acetone on to  $\frac{1}{2}$ -mm thick aluminium discs (10-mm diameter) in the usual manner; the grains used were those that settled between 2 and 20 minutes so the presumed size range was 1-8 microns. The fluorite had been provided by MBLE in 1969; prior to use it had been washed in hot aqua regia and heated to 650<sup>o</sup>-700<sup>o</sup>C in nitrogen to reduce sensitivity to light. Three batches of discs have been used so far, no deliberate changes in the conditions of deposition being made. The anomalous  $a$ -values were found only in Batch 2. Between batches 2 and 3 the starting material was further annealed in order to improve its insensitivity to light. Before this second anneal the TL induced in peak III (circa 300<sup>o</sup>C) by 1000 lux-minutes of light from an incandescent source (1 minute at 18 inches from a 60-watt bulb) had been the equivalent of 1 $\frac{1}{2}$  millirads whereas afterwards it was about 0.1 millirads.

The alpha sources used were 0.5 mCi Am-241 foils in a six-seater irradiator (see Ancient TL, no. 3, p.5) the exposed area of each being a circle of 11-mm diameter. The beta sources used were of the SIP type from RCC Amersham with an active diameter of 12 mm; routinely irradiations were carried out with disc on the nichrome heater plate and a source-sample distance of 0.62 inches. The photomultiplier used was an EMI type 9635 with a Corning filter (either 7-59 or 7-51) and a Chance Pilkington HA3.

For 'strong dose' measurements, corresponding to the dosages given on sending-out, the beta dose was 100 rads and the alpha dose 0.8 micron<sup>-2</sup>; for the latter the source-sample distance was 15 mm. For 'weak dose' measurements the beta dose was 3 rads and the alpha dose 0.024 micron<sup>-2</sup>, the source-sample distance being increased to 40 mm for the latter.

## Results

In the 4 sets, each of 6 discs, used for alpha calibration from Batch 1, all but 3 discs had a Peak III a-value within 1% of the average for the set; these 3 were within 2.5%. The set averages were 0.085, 0.088, 0.090 and 0.090. No rogue a-values were noted among the random dozen beta source calibration discs that were tested. (On the other hand discs prepared from material that had been annealed against light sensitivity on a different occasion showed a-values between 0.10 and 0.11.) In Batch 2 there were 15 rogues, having a-values higher than average by 5-15%, among 50 that were tested. In Batch 3 there were no rogues among the 24 that were tested; all a-values were within 2% of the overall average. The average values for the batches, excluding rogues, are given in Table 1.

Table 1

	<u>a-values</u>	
	<u>peak II</u>	<u>peak III</u>
Batch 1	0.121	0.089
Batch 2	0.113	0.086
Batch 3	0.111	0.085

The discs were usually measured in weak dose geometry. Some were measured also in strong dose geometry; there was no significant difference in a-value.

The ratio of the a-values for peaks II and III showed no significant difference between rogues and non-rogues.

## Absorption effects

In case the rogue discs were abnormal in the thickness of the fluorite layer that they carried a number of the discs from batches 2 and 3 were tested for the effect of interposing 12.5 microns ( $3.5 \text{ mg cm}^{-2}$ ) of aluminium in the path of the alpha particles. For the weak dose source-sample distance of 40 mm this caused a reduction in TL by a factor of between 0.86 and 0.91 for all of the batch 3 discs. For batch 2 the reduction factors lay in the range 0.62 to 0.88. Of the 10 which had a factor of 0.75 or less, 7 had an anomalously high a-value; there was only one rogue a-value among the discs showing a reduction factor which was numerically greater than 0.75.

Absorption measurements were also made for some discs in the strong dose geometry, the source-sample distance then being 15 mm. The results are summarized in Table 2.

Table 2Absorption factors due to interposition of aluminium foil

Disc ref.	<u>bQ1</u>	<u>bQ2</u>	<u>bQ3</u>	<u>bQ4</u>	<u>bQ5</u>	<u>bQ6</u>	<u>bW3</u>	<u>bW4</u>
a-value	0.089	0.088	0.093	0.093	0.088	0.089	0.088	0.098
<u>40 mm sep.</u>								
12.5 $\mu$ foil	0.62	0.87	0.63	0.81	0.81	0.82	-	-
<u>15 mm. sep.</u>								
6 $\mu$ foil	0.90	0.93	0.86	0.94	0.93	0.95	-	-
12.5 $\mu$ foil	0.48	0.78	0.48	0.74	0.71	0.70	0.67	0.45
wt. of $\text{CaF}_2$	-	-	-	-	-	-	0.7 mg	0.5 mg

The straightforward interpretation of the reduction in TL due to interposition of the foil is that due to energy loss in the foil not all of the emergent alpha particles are able to achieve full penetration of the fluorite layer. The effect is greater when the sample is close to the source because of the greater obliquity of the particle paths. Thus a stronger than average absorption effect presumably indicates a thicker than average fluorite layer, or, grain diameters that are larger than average. One would expect either of these alternatives to give rise to too low an a-value - whereas the opposite is observed. Also the two discs that were weighed give no credence to the notion that the rogue discs were too thick. On the other hand it is to be noted that if foil had been interposed for the a-value measurements it would have tended to bring the rogue discs into line.

Some 'ultra-fine' discs were prepared by using settling time limits of 60 to 100 minutes. As expected, these showed a weaker absorption effect than the standard discs: for the 15-mm separation the numerical value of the absorption factor was higher by about 10%.

Neutral density filters

An incidental observation from the practical point of view concerns the use of Kodak Wratten celluloid filters for cutting down the TL intensity to a manageable level. The reproducibility obtained, using these taped onto the base of the photomultiplier housing was not as good as with glass filters. This was traced to the warming that occurred during the glow-curve; a gradual decrease in transmission occurred, reading around 7% after several glows.

No such effect occurred with smoky glass filters (Chance Pilkington ON 30, obtainable from Precision Optical, 158 Fulham Palace Road, London W6 9ER). It may be useful to note that the absorption coefficient of these for the ultra-violet TL emitted by fluorite is about 1.43 times the coefficient for the light from a blue 'betalight', the

detector being an EMI 9635 photomultiplier with Corning 7-59 and Chance Pilkington HA3 filters interposed. Hence if  $T$  is the transmission factor for a smoky glass filter measured with a betalight, the transmission factor,  $T^*$ , for fluorite TL is given by

$$\log T^* = 1.43 \log T$$

### In Conclusion

Although it is possible to postulate that the rogue  $a$ -values are due to the chance presence of abnormal fluorite grains this does not square with the absorption observations.

### Acknowledgements

The fine-grain discs were kindly prepared by Joan Huxtable. The extensive measurements involved were carried out by Bob Curtis and Gill Spencer, to both of whom I am grateful for their meticulous work as should be the recipients of the discs also.

## EVEN MORE ON FILTERS FOR LABORATORY ILLUMINATION

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In the report of Sutton and Zimmerman (1978) on UV filters from Solar Screen Co., they did not include the information that this company also makes pink screens in addition to white and amber. Considering the fact that the EMI 9635 photomultiplier is effectively "blind" at wavelengths greater than 630nm, it was thought that exposing this type of photo cathode to "pink" light (when the high voltage is removed) may induce less dark current pulses when the high voltage is subsequently put on. In addition, this light color should reduce short wavelength bleaching effects in TL samples.

Figure 1 shows the light transmission through a single thickness of Solar Screen pink. When compared to the Solar Screen amber, it is obvious that the pink screen transmits more in the violet-green wavelength region (400-500nm) but less in the orange-red region (575-700nm). This evidence would certainly damage the argument for the use of pink filters with an exposed EMI 9635 photo cathode and indicate that it may be more harmful than amber filters for bleaching in the shorter wavelength region.

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It appears that the filter described by Jensen and Barbetti (1979) is the best compromise when regarding the response of the human eye, short wavelength bleaching and use with bialkali type photo multipliers.

Jensen, H. and Barbetti, M., Ancient TL #7, p. 10, 1979  
Sutton, S. and Zimmerman, Ancient TL #5, p. 58, 1978

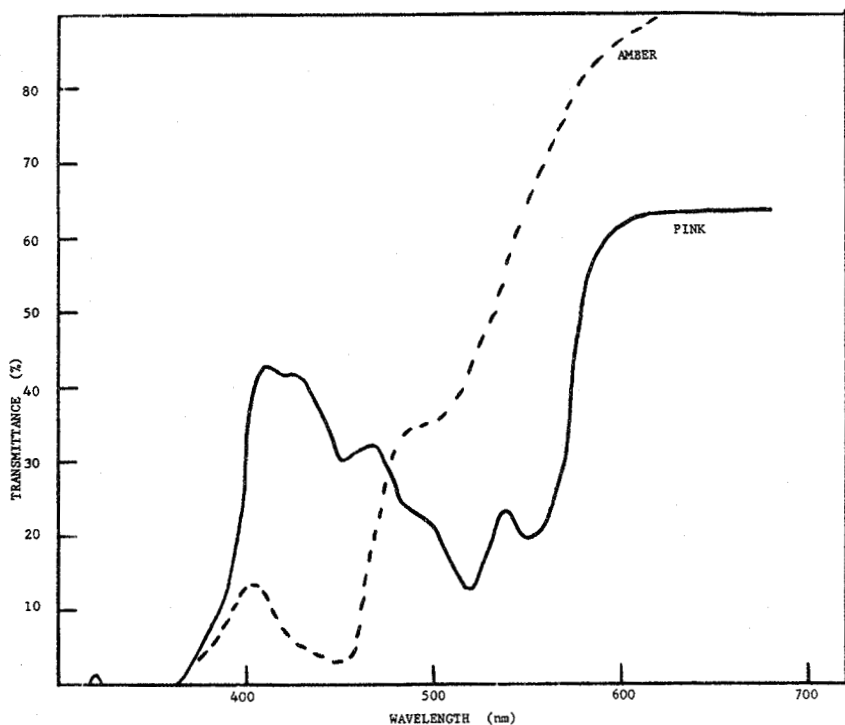


Figure 1: Light transmission through a single thickness of Solar Screen "Pink" (solid line) and "Amber" (broken line, after Sutton and Zimmerman, 1979). Measured with a Cary recording spectrophotometer model 14, Chemistry Department, Brookhaven National Laboratory.

## A CONVENIENT DOSIMETER FOR MEASURING THE ENVIRONMENTAL RADIATION DOSE RATE AS IT APPLIES TO THERMOLUMINESCENCE DATING

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Knowledge of the environmental radiation dose rate,  $R_e$ , is generally essential to an application of the usual methods of thermoluminescence dating. While it is possible to eliminate it from the calculations using the subtraction technique, which requires the application of both the fine grain and inclusion methods to the same sample, this is time consuming and subject to substantial errors unless great care is exercised.

Measurement of  $R_e$  may be made using samples of the burial soil or, in the field, using sensitive phosphors. The former does not take account of possible additional radiation due to nearby rocks and the latter commonly requires placement periods in the field of many months. Also there is a problem of read-out of the phosphors. If it is not done in the field there are problems with in-flight radiation pick-up and border customs inspectors.

A small self-contained radiation dosimeter has recently become available which gives promise of measuring the environmental radiation dose in the field in as little as two weeks. Furthermore zeroing and read-out can be made in the field, doing away with the particular problems just described.

The dosimeter is a pocket-sized halogen quenched GM counter device known as RAD-21 manufactured by Wallac Control Instruments, PL10 20101 Turku 10 Finland (supplied in Australia by ANAC Pty. Ltd., P.O. Box 515, Hurstville, N.S.W. 2220, for around \$Aust 300). It features an exposure range from 0.1 mR to 999.9 mR and has a button activated digital display reading down to 0.1 mR. Here mR stands for milli Röntgen. Normally supplied with three rechargeable 1.25 V NiCd dry cells the unit can also be operated from non-rechargeable 1.5 V cells.

The energy dependence of the filtered GM tube is stated to be  $\pm 20\%$  from 50 keV to 3 MeV. The accuracy of the dose measurement is stated to be  $\pm 15\%$  of indicated dose excluding energy dependence. The energies of the decay produced gamma rays in the field situation lie in this range.

The dosimeter is zeroed in the field and then sealed in two polythene bags, the outer bag with some desiccant present to prevent condensing moisture affecting the unit. The loaded bags are then placed in the burial situation where the background gamma and cosmic radiation level needs to be known. After about two weeks (the batteries have a life-time of three weeks) it is extracted and read out on the spot. In an actual case where the environmental dose rate in a small museum was being measured the corrected total exposure (a correction based on exposure to a calibrated  $^{137}\text{Cs}$  source is supplied by the manufacturers with each unit) was 7.8 mR after 17 days, corresponding to an annual dose rate of 0.15 rad/yr. This was much as expected. The dose rate just quoted is to air.

Of great practical significance is the small physical size of the dosimeter. This means it may be easily and discreetly inserted totally into the same burial situation from which the test potsherds (say) have been removed. By being back covered with earth it is then out of the sight of any curious local natives. Also, by accumulating over a period of two weeks there is an averaging effect which is not present in a single background reading with a dose-rate meter of sufficient sensitivity. Admittedly averaging over a longer period can take account of any seasonal variations, but this particular effect could be judged to be small in appropriate cases, e.g. low rainfall areas.

Strictly, to be used in calculating the absorbed dose to quartz it would first be necessary to expose both the dosimeter and some quartz to the same uniform gamma radiation field. This field should be of the same quality as that met in typical field situations. The quartz should then be glowd out in a TL apparatus and the apparent absorbed dose calculated in the usual way using a calibrated laboratory radioactive source. This is then compared to the dosimeter reading. An additional correction factor, which may be close to unity, can then be calculated and applied to the dosimeter reading. For this test the quartz can of course be appropriately replaced by a more sensitive phosphor such as  $\text{CaSO}_4:\text{Dy}$ .

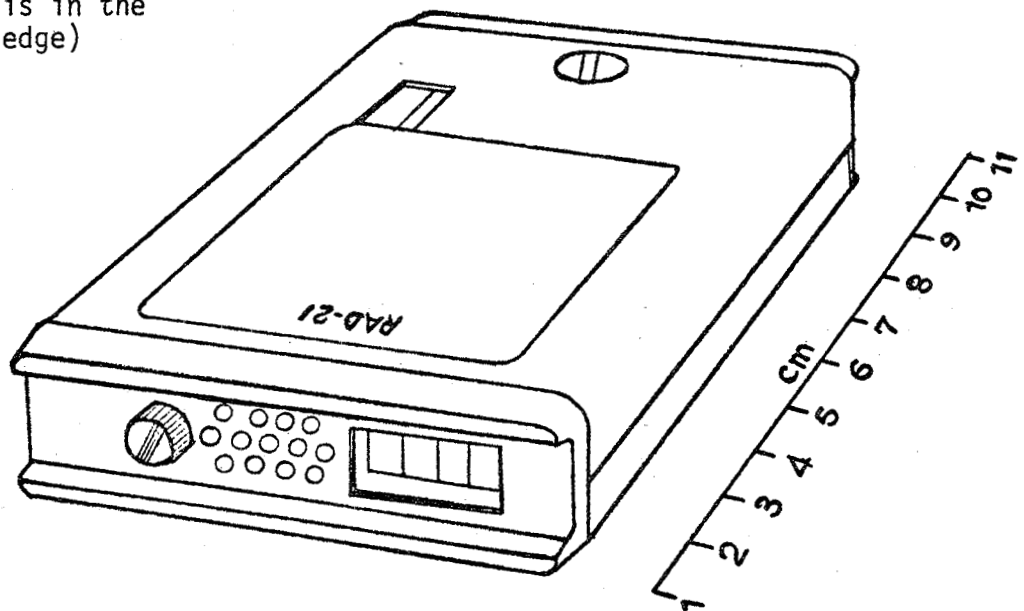
In a series of four two-week long runs with one of these dosimeters in a constant background situation the maximum individual deviation from the calculated mean annual dose rate was approximately 2%. In a separate similar series in a different location, the maximum individual deviation from the mean was approximately 3%. These figures indicate the variation to be expected in a single run of this duration.

Another series of in-ground tests showed that the dosimeter was able to sense the presence of nearby rocks by an increased reading, presumably due to the radioactivity of these rocks being greater than that of the surrounding soil.

The help of Mrs. Glenys Gardner and Mr. David Price in carrying out the test measurements is gratefully acknowledged.

#### The Wallac RAD-21 Radiation Dosimeter

(the digital display is in the window on the front edge)





## DOSE RATE EFFECTS IN QUARTZ, SOME OBSERVATIONS

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Recent interest in dose rate effects in quartz and other materials has stimulated the publication of some data collected five years ago in this laboratory.

The quartz grains used were in the size range 90/125  $\mu\text{m}$ , etched for 40 minutes in hydrofluoric acid as routinely prepared here for quartz inclusion dating. The two sherds used had been excavated in N. Africa, and were subsequently dated. The sources used for the artificial irradiations were  $^{90}\text{Sr}$  SIP plaque  $\beta$  sources of nominal strengths 2  $\mu\text{Ci}$ , 20  $\mu\text{Ci}$  and 40 mCi. The natural TL was drained from the quartz and then  $\beta$  doses were administered using the sources as follows

Sample b1, a total dose of 140 rad was given

- a) over 1½ minutes (40 mCi), 93 rads/minute.
- b) over 10 days (2  $\mu\text{Ci}$ ), .0097 rads/minute. Results in Figure 1.

Sample k3, a total dose of 65 rad was given

- a) over 40 seconds (40 mCi), 97 rads/minute.
- b) over 18 hours (20  $\mu\text{Ci}$ ), .060 rads/minute. Results in Figure 2.

As can be seen from the figures no dose rate effect was observed, the peak heights being the same in all cases.

One  $\beta$  source in this laboratory was calibrated by comparison with a  $^{60}\text{Co}$   $\gamma$  source of known strength using 100  $\mu\text{m}$  grains of  $\text{CaF}_2$ , all other  $\beta$  sources are intercompared to this "standard" source. If there is a dose rate effect in  $\text{CaF}_2$  which exactly corresponds to that in quartz then this method of calibration would of course lead to the results obtained.

Fig. 1

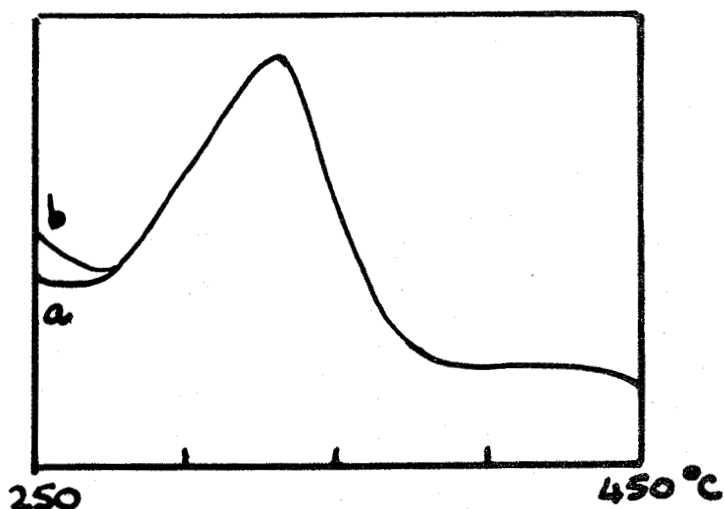
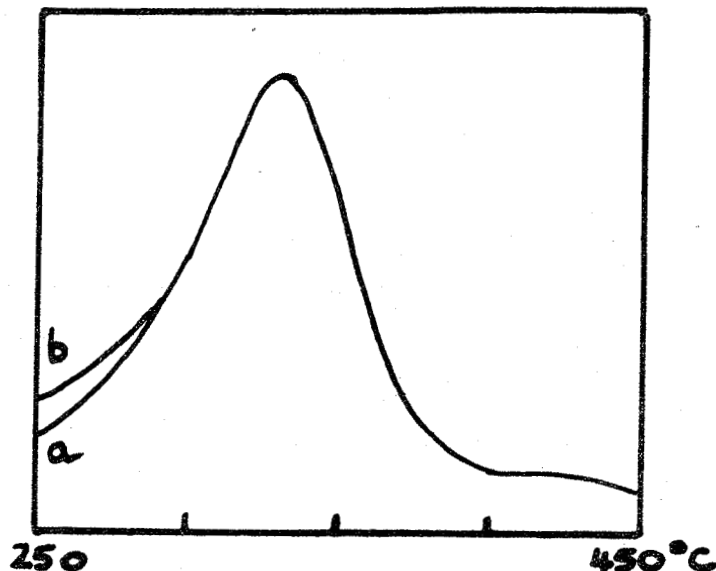


Fig. 2



# A MODIFIED ALPHA COUNTING SYSTEM

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## Introduction.

Papers by Huntley (1977 and 1978) discussing the effect of reflectivity of samples and by Sasidharan et al. (1978) discussing the Th/U ratio indicate some of the current problems in thick-source alpha counting of pottery. This paper describes a modified alpha counting system which is being used to avoid the former problem and investigate the latter.

## Apparatus.

A conventional single channel system, similar in many respects to that described by Huntley (1977) has been modified by the addition of a four channel counter in parallel with the existing discriminator. This means that the count-rates at different electronic thresholds can be measured simultaneously. The unit comprises four discriminators and counters operating in parallel and multiplexed to the same seven segment display. Switching has been incorporated to move all four counting thresholds by a preset amount, giving a further set of four points. A pairs counter was also built into the unit. Schematic diagrams of the unit are shown in figures 1 and 2. In one set of measurements we are able to obtain the count-rate at five discriminator settings. The zero threshold count-rate is obtained by extrapolation of a least squares fit to the data.

## Results.

Figure 3b shows the effect of variation of photomultiplier EHT on the count-rate observed. Figure 3c shows the effect of using phosphors with different light yields. The count-rate axis intercept is independent of both these factors.

The unit is currently undergoing tests with standard radioactive sands (figure 3a; NBL dunite-based standard sands kindly supplied by Dr. M.J. Aitken). As with Huntley, we found good agreement (within several percent) between our measured and theoretical count-rates. (Internal Lab. Report No. 9).

In addition, we attempted to manufacture a series of thorium sources (ranging in thorium concentration from 0.2% to 4.5% by weight) utilizing a support matrix with an effective Z nearer to that of pottery. The sources were manufactured by the evaporation of a solution of aged thorium nitrate onto a form of powdered silica. The correlation between thorium concentration and count-rate was not good enough (linear within  $\pm 15\%$  limits) to distinguish any systematic difference between measured and theoretical count-rates. We attribute the scatter in the results to the difficulty in producing a homogeneous source.

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The counter is being used to investigate a method of determination of Th/U ratio proposed by Pierson (1951). In studying a number of radioactive ores he found a linear correlation between a 'count-ratio' function (derived from the gradient of a count-rate vs discriminator voltage plot) and Th/U ratio. Using such an energy discrimination method he was able to determine Th/U ratio's within  $\pm 5\%$  in normal counting periods. Our preliminary results from pottery samples indicate that there is a correlation between Th/U ratio and intercept on the discriminator voltage axis.

### Conclusion.

The four channel counter can be built at moderate cost ( $< \pounds 100$ ) and uses components readily available. The results are independent of electronic gain and figure 3c indicates that the method is independent of sample reflectivity as would be expected.

### References.

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 Pierson, D.H. 1951, Proc. Phys. Soc. LXIV 10-B, 876-88  
 Sasidharan, R. Sunta, C.M. and Nambi K.S.V., 1978, Ancient TL 2, 8-11

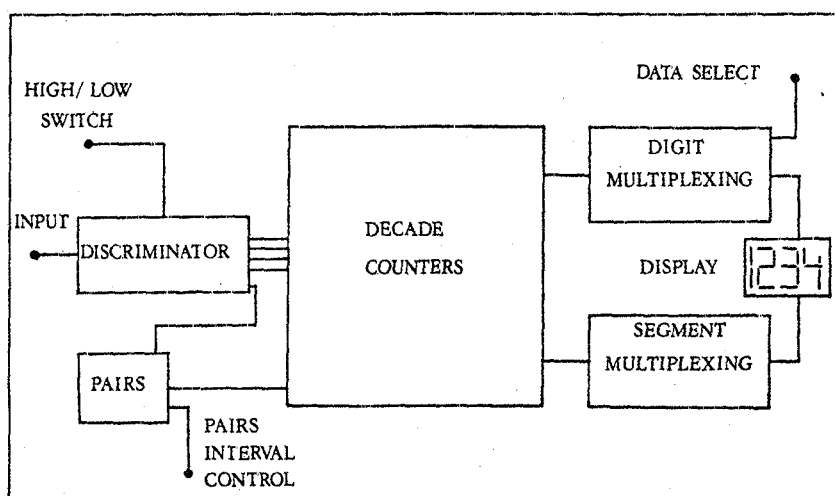


Figure1 Schematic diagram of Four Channel Counter

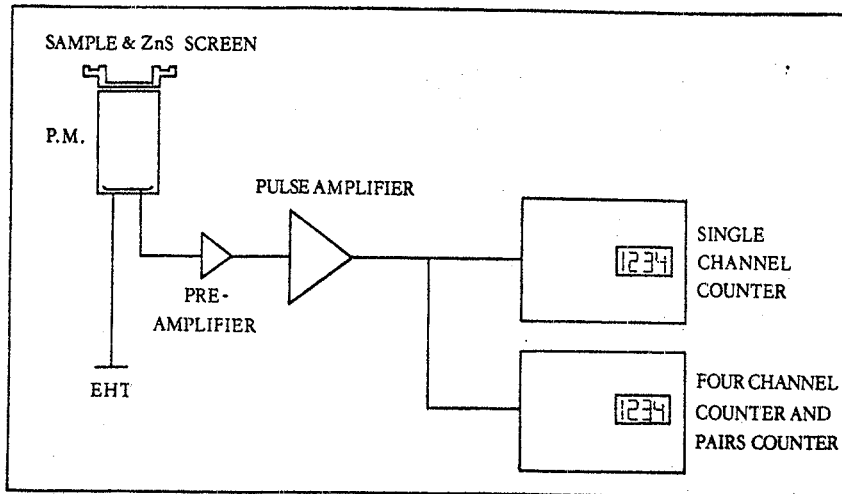
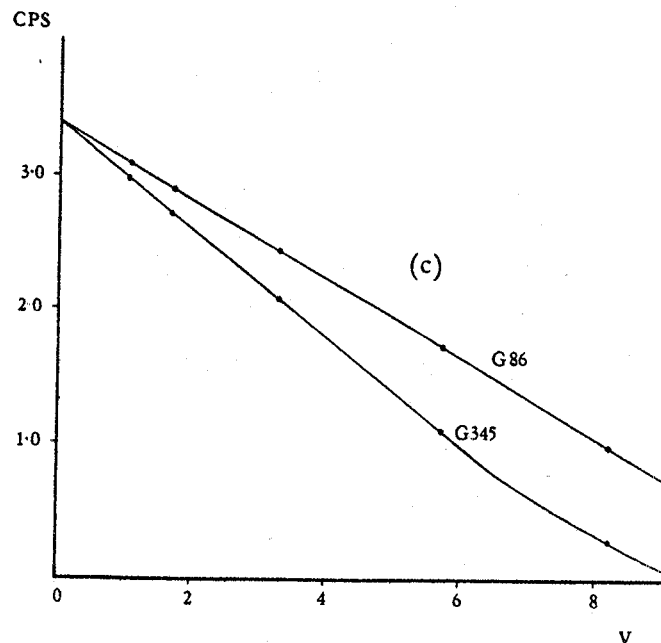
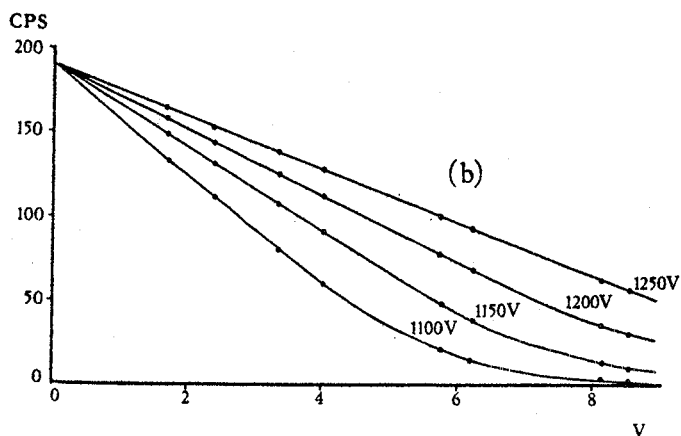
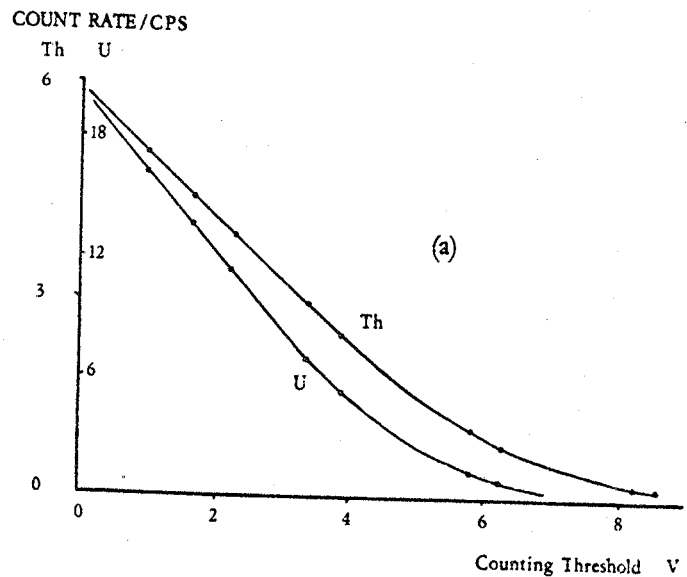


FIGURE 2 The modified Alpha counting system

Fig. 3.

- (a) Thorium and uranium spectra from standard sands using Levy-West G345 ZnS on sellotape.
- (b) The effect of E.H.T. changes in the photomultiplier supply: thorium source.
- (c) Different phosphors have different light yields: a comparison of Levy-West G345 ZnS using an epoxy resin encapsulated thorium source.



## ZERO-GLOW MONITORING (ZGM)

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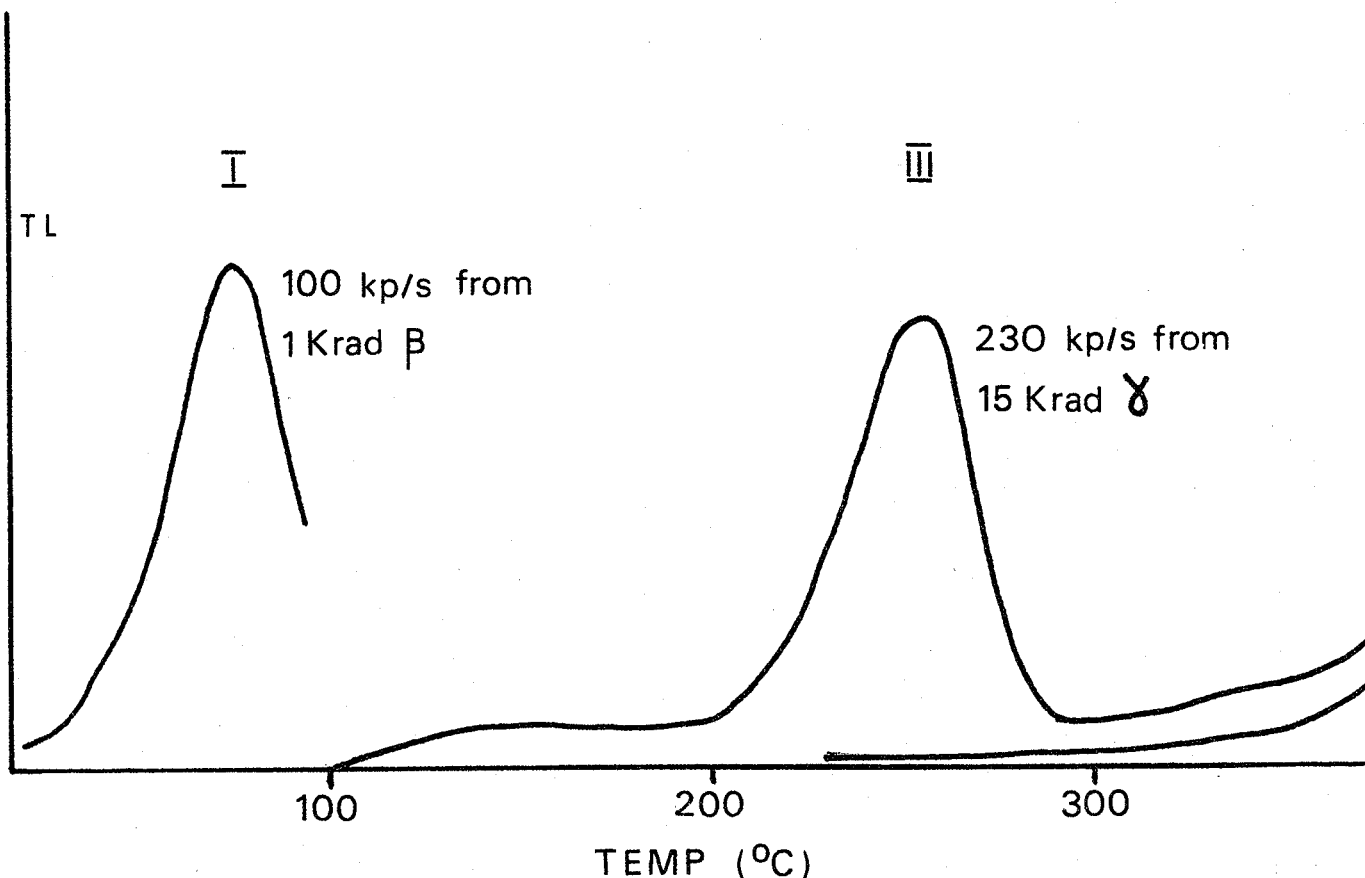
In the evaluation of equivalent dose by means of the additive dose technique a frequent difficulty is that of normalization between the different portions of the sample - the essence of the additive dose technique being that the equivalent dose is derived from first-glow measurements. This note reports 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 Sil-spray and then tapping off grains which did not adhere. For eight 400 micron slices with areas between 6 and 16 mm<sup>2</sup> 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 pursued.

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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The Possible Variation of C-14 Predicted from Thermoluminescent Dating of the Japanese Ancient Pottery, Proceedings of the 16th International Cosmic Ray Conference (Kyoto, Japan) 2, 263, 1979.

Abstract: In order to investigate the variation of the cosmic ray intensity in the past, the TL dating of Japanese ancient pottery is compared with C-14 dates in the period 1,000 to 8,000 B. P. TL age agrees with C-14 data until about 6,000 years B. P. It seems probable that a large variation in C-14 density occurred before about 6,000 years B. P.

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Part 1 - Principles, # 9, p. A273

Part 2 - Instrumentation, #10, p. A303

Part 3 - Application to Archaeological Dating, #11, p. A341.

ERRATUM, Some Recent Bibliography: The authors of the second entry are are S. Miono and M. Ohta.

## READERS' CLUES AND QUERIES

"Readers' Clues and Queries", a new feature of Ancient TL, is being introduced to allow readers to communicate through the newsletter. Each edition will contain short letters and notes from readers. Anticipated topics of interest include queries (on techniques, manufacturers, etc.), helpful hints and suggestions (on sample preparation, etc.), sample requests, announcements and responses to previous newsletter contributions.

One of the major purposes of this feature is to distribute all of those experimental tidbits which never find their way into published articles. Send you letters, queries, hints and comments to the editor at the letter-head address.

And now for this issue's letters . . . . .

### SAFETY MANUALS

I would like to publish a list of appropriate safety manuals in Ancient TL. If you are aware of publications on radiation, chemical and/or electrical safety which are particularly valuable, please send the reference to me, along with a brief abstract. Stephen Sutton, Center for Archaeometry, Washington University, St. Louis, Missouri 63130.

### A COMMENT ON CLEANING QUARTZ CRYSTALS

In a recent report by Wright (Wright, 1979, Ancient TL #8, p. 13), the use of an  $\text{AlCl}_3$  treatment with  $\text{HF}$  etching was mentioned. His comment "the solution did not clear completely" leads me to believe that I have not made myself completely clear in my original explanation of the treatment (Carriveau, 1977, Ancient TL #1, p. 6).

When using this technique, one must add an  $\text{AlCl}_3$  solution to the  $\text{HF}$  acid at the completion of etching. Normally, when using a boiling water bath, the  $\text{AlCl}_3$ - $\text{HF}$  solution becomes clear after a few minutes stirring. If it does not, one must continue the treatment until it does, to eliminate precipitated fluorides. This may be done by simply adding additional  $\text{AlCl}_3$  solution (if beaker volume permits) or alternatively, removing the beaker from the water bath, pouring off the  $\text{AlCl}_3$ - $\text{HF}$  solution after the grains have settled, and repeating the  $\text{AlCl}_3$  treatment on the remaining grains (again using a boiling water bath).

I have found that the solution must be clear, to eliminate the problem of fluoride precipitation from uncomplexed ions.

Gary W. Carriveau, Research Laboratory, Metropolitan Museum of Art,  
New York, New York 10028.

### SAMPLE REQUEST

For a continuing project on the measurement of radon losses using gamma ray spectrometry, I would like to hear from anyone that has material that exhibits measurable radon (and/or thoron) loss.

Gary W. Carriveau, Building 555, Brookhaven National Laboratory,  
Upton, New York 11973.