Ancient TL

Recent addition of potassium: a potential source of error in calculating TL ages

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Introduction

Determination of the dose-rate is an important step in the determination of TL ages. This is commonly done directly by means of TL dosimetry, or indirectly by measuring isotopic activities or elemental concentrations, and calculating the dose-rates. In all cases, however, dose-rates are estimated from the contemporary composition of a sample and its surrounding sediment.

Consequently, the ideal setting for a TL dating sample is one in which the sample was buried quickly (or not at all) after deposition and the sedimentary circumstances have remained unchanged since then. Unfortunately, this situation is often not the case. Most surface and near surface geological environments are not closed, but are subject to various soil forming (Jenny, 1941; Brady, 1974; and Greenland and Hayes, 1980) and fractionation processes (Ivanovich and Harmon, 1982). Consequently, the suite and amount of materials at any particular location is a transitory phenomenon and relevant to no time other than the present. In some circumstances, soil forming processes are of minor importance. When the sediments have been transported long distances they lose most of the weatherable materials; in these cases soil development is slight beyond the addition of organic matter at the surface. In most cases the effects of soil forming and fractionation processes are difficult to assess; however, there is one compositional change pertinent to the dose-rate which is relatively predictable and frequently documented by historical records.

Potassium, an essential macronutrient for plant growth, is a constituent of general agricultural fertilizers. When soils are identified as deficient in K, or when particular crops known to have high K requirements are grown, a K-specific fertilizer (e.g. muriate of potash) may be applied. Regular application of such fertilizers is a relatively recent phenomenon, but it may contribute substantially to the abundance of K in contemporary samples taken from agricultural areas. Overestimating the past concentration of K will obviously lead to systematic underestimation of TL ages where K contributes a significant component of the overall radiation dose. The problem is not limited to the agricultural ploughzone. K is introduced in highly mobile forms so as to be available to plants, and it leaches relatively rapidly downwards.

In order to gain an appreciation of the magnitude of the problem, consider 'typical' pottery and soil with 1% K, 50 ppm Rb, 10 ppm Th, 3 ppm U, $D_C = 150$ $\mu Gy/a$ and b=1.95 (Aitken, 1985). For fine grain dating K accounts for 25% of the dose, while for quartz inclusion dating it accounts for 36% (Readhead, 1988). If, in addition to the 1% natural K, an additional 0.2, 0.6 or 1% agricultural K were added to the pottery and the soil, then the age underestimation that would occur in ignoring its effect would be 5, 13 and 20%, respectively, for fine grain dating, and 7, 18 and 27%, respectively, for quartz inclusion dating.

Sources of potassium

The principal sources of K in sediments are the rock forming minerals, especially feldspars, and their weathered derivatives, clays. Thus, apart from the effects of sedimentary sorting and soil forming processes, sediments from the same source materials should typically display modest variations in the amount of insoluble K.

Two other sources of K are of biogenic and agricultural origin. The former includes K released by tree burning during land clearance, and although of high initial concentration, the K is released in highly soluble forms that do not persist as major anomalies over long periods of time (Ritchey, 1979). The K concentrated at archaeological loci by prehistoric human activities, such as wood burning, is transitory for the same reasons.

Agricultural K must be introduced in compounds available to plants (usually KCl, KSO_4 and sometimes KNO_3). Compounds used for fertilization do not have to be strictly water soluble as extraction by plants is mediated by enzyme-like carrier proteins (Leonard, 1985). Consequently, agronomists determine the amount of K available to plants as plant-available K (McLean and Watson, 1985).

Estimating the magnitude

A measurement of plant-available K establishes boundary conditions on the potential contribution of agricultural K to the total K observed in samples, by assuming that all plant-available K is of agricultural origin. To assess its importance the following two-step programme is suggested:

1) Compare the plant-available K with the total K, and if

    a) there is a significant plant-available K component to the total K, and

    b) the total K is a significant part of the dose; then

2) attempt to estimate how much of the plant-available K has been acquired through fertilization.

If Step 1 shows there to be an insignificant component to the total K from the plant-available form, then it is not necessary to proceed to Step 2, since fertilization will not have made a difference to the dating calculations.

All pottery and sediments do, of course, contain some naturally occurring K that will be extracted as plant-available K. Consequently, it is desirable to compare nearby pottery and sediments, which are known not to have been subject to fertilization, with those that have been so altered, in order to estimate more closely the agricultural contribution when the boundary conditions indicate that agricultural K is a potentially measureable source of error.

A further complication is that the K added by fertilizer is sometimes converted to non-available forms (Buchholz and Brown, 1985) and so would show up in total K measurements but not plant-available K measurements. The magnitude of this conversion can be gauged by subjecting the same pottery and sediments collected from unfertilized land, to fertilizer in the laboratory and comparing the total and plant-available K before and after application of the fertilizer.

Samples

We have begun to investigate the effect of agricultural K as part of a larger study in Southeast Missouri on the Malden Plain. The Malden Plain is composed of relatively coarse braided stream deposits of Late Pleistocene and earliest Holocene age. Because the source of the sediments lies in the headwaters of the Ohio and Mississippi River systems, feldspars have largely been destroyed, producing a quartz-rich sedimentary environment. Thus far, samples from three localities in this region have been examined.

Five samples originate from the Robards site. Sediment sample Rob 332-52 came from the ploughzone of a field which has been undergoing cultivation for the past 100 years, and which has been subject to fertilization since about 1945. A sediment sample which lies 50±5 cm below Rob 332-52 and about 19 cm below the ploughzone was taken from Robards Feature A, an undisturbed pit filled in during prehistoric times. Two pottery samples, Rob 825-35 and Rob 825-38, were also examined from Feature A. These samples from Feature A allow one to see the effect that the use of fertilizers has on the surface and on sediment and pottery samples 50 cm underground. The final sample examined from Robards was taken from the surface of a wooded area some 220 m distant. These woods have not been subject to fertilization for at least 30 years, and probably have never been fertilized.

Two other samples were obtained from the Cummins site. One came from the base of Cummins Mound, a feature raised 4 m above the surrounding countryside, and which had never been fertilized. The second sample, collected some 10 m away, came from the ploughzone of the adjacent field, which is routinely fertilized.

Additionally, five samples were collected from the County Line site. These were all taken from the ploughzone of a field under cultivation since at least 1893. The sediment samples are identified as 568/524 and 616/524, and the pottery samples as CL 179, CL 179-7 and CL 347.

As we did not have any pottery collected from land not subject to fertilization, we used some brickettes which had been fired to 500 °C in the laboratory from clay collected from a ditch by the side of a road at the Langdon site, and from a roadside on Crowley Ridge, about 30 km away in northeast Arkansas. The brickettes were placed in soil collected from McHaney field, which is adjacent to the Robards site. The water content of this soil was raised to 20%, a value typical of the available water capacity of Southeast Missouri soils (Gurley, 1979), by the addition of a 3.3% soluble K solution obtained from a commercial K fertilizer. Although the brickettes were recovered after only six days in the periodically watered and partially drained soil, they had been subject to a highly concentrated K solution, equivalent to 6000 kg/ha, compared to about 40 kg/ha/yr which have been added by farmers in the Missouri study area (Garrett et al., 1978).

Extraction procedure

1. Total K.

The approach taken to measure the total K of a sample was that which is commonly used in K-Ar dating. Here it is common to measure total K by atomic emission spectrometry, which requires that the sample be completely dissolved. This dissolution was achieved using procedures similar to those of Abbey and Maxwell (1960), Ellestad and Horstman (1955), Ingamells (1962) and Shapiro and Brannock (1962). A 0.1 g mass of sample was placed in a teflon evaporating dish and wetted with deionized water. Five ml of 35% H_2O_2 was added and the dish was heated at about 100 °C until evaporation was almost complete. Twenty ml of a $HF/H_2SO_4/HNO_3$ solution (two parts 28.9 N HF, one part 36 N H_2SO_4 and one part 16 N HNO_3) was added and left for at least 8 hr, then heated at about 100 °C until evaporation ceased. A further 10 ml of 28.9 N HF was then added and the evaporation repeated, then 40 ml of deionized water was added and heated at about 100 °C for 30 min. Finally, 20 ml of a 5000 ppm Cs^+ stock solution was pipetted into a 100 ml volumetric flask, the sample solution was added and the flask was filled to the mark with deionized water.

2. Plant-available K.

Twenty ml of 0.5 N $NaC_2H_3O_2$ was added to 0.1 g of sample and shaken in a polyethylene centrifuge tube for 2 hr. The material was centrifuged and 10 ml of the resulting solution was placed in a 100 ml volumetric flask, into which had been pipetted 20 ml of a 5000 ppm Cs^+ stock solution. The flask was filled to the mark with deionized water. This procedure is similar to the Morgan method (Greweling and Peech, 1965), one of several extraction methods recommended by the Council on Soil Testing and Plant Analysis (1974).

Measurements

Potassium concentrations were measured using the atomic emission mode of an Instrumentation Laboratory 551 Atomic Absorption/Atomic Emission Spectrophotometer. Due to the differing K concentrations produced by the two extraction procedures, the total and available K were measured using different wavelengths, these being 404.4 and 769.9 nm, respectively. K concentrations were measured by comparison with standards prepared from K_2SO_4. The results are shown in Table 1.

Discussion

The results from Cummins Mound and Robards Woods indicate that only a small amount of the naturally occurring K was extracted as plant-available K, which gives us confidence in ascribing any significant plant-available K measured in the other samples as being due to fertilizers.

The measurements on the samples collected from the fertilized fields show that the use of fertilizers has indeed added a plant-available K component to the total K content of both the soil and the pottery. For the sandy soils used in this study, the increase in the total K content due to the fertilizers is about 4% and would make only a minimal difference to the gamma dose received by a sherd. However, for the pottery about 18% of the total K content was due to K from fertilizers. This would make a significant difference to the beta dose.

We ascribe the difference between the soil and pottery in the uptake of K from fertilizers to be due to the greater number of sites for the retention of K in a clay matrix than in a sand matrix. This suggests that the uptake of K from fertilizers would be more of a problem for the gamma dose when pottery is collected from clayey soils, than it was in this study.

Comparison of the results for the pottery and soil from the Robards site shows that the effect of the K from fertilizers is similar at a depth of 50 cm and within the ploughzone. This confirms that the K added by fertilizers does move down from the ploughzone.

The controlled laboratory experiment on the brickettes confirms that the pottery and soil both do take up K from fertilizers and the pottery does so more readily than the sandy soil. Comparison of the total K in the brickettes and soil both before and after the addition of

the fertilizer also shows that only a small amount of the naturally occurring K was extracted as plant-available K and that under the conditions of the experiment little of the K from the fertilizer was converted to non-plant-available K.

Overall, these results confirm that the use of fertilizers can increase the total K content beyond that which would have pertained to pottery and sediments over most of their burial time. The results also indicate that the procedure outlined in **Estimating the Magnitude** is an appropriate way of dealing with the problem.

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Reviewer's Comments (M. J. Aitken)

This paper speaks for itself and gives further emphasis to the desirability of having available a routine technique for dating zircon grains extracted from the pottery, which because of their high internal thorium and uranium content would be immune to the extra potassium.

A possible interference along similar lines is from radioactive fallout; according to Liritzis (1987) this may be significant in some parts of Greece as a result of the Chernobyl accident, though it should be noted that the dose-rates he quotes are for ground level rather than subsurface.

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Liritzis, Y. (1987). The Chernobyl fallout in Greece and its effects on the dating of archaeological materials. *Nuclear Instrum. Methods,* A 260, 534-537.

Table 1

Sample	Total K (%)	Plant-available K (%)	
Rob 825-35 pottery	1.172 ± 0.006	0.154 ± 0.007	
Rob 825-38 pottery	1.707 ± 0.010	0.345 ± 0.002	
Rob 332-52 sediment	1.402 ± 0.039	0.066 ± 0.002	
Robards Feature A sediment	1.410 ± 0.023	0.057 ± 0.010	
Robards Woods sediment	1.434 ± 0.026	0.021 ± 0.007	
CL 179 pottery	1.570 ± 0.014	0.326 ± 0.002	
CL 179-7 pottery	1.490 ± 0.026	0.305 ± 0.002	
CL 347-8 pottery	1.734 ± 0.006	0.287 ± 0.002	
CL 616/524 sediment	1.362 ± 0.011	0.049 ± 0.007	
CL 568/524 sediment	1.386 ± 0.006	0.057 ± 0.004	
Cummins Mound sediment	1.468 ± 0.032	0.008 ± 0.007	
Cummins Field sediment	1.492 ± 0.001	0.055 ± 0.002	
McHaney sediment	1.382 ± 0.023	0.008 ± 0.005	Before
Langdon brickette	1.712 ± 0.006	0.060 ± 0.002	adding
Crowley Ridge brickette	1.699 ± 0.018	0.058 ± 0.002	fertilizer
McHaney sediment	1.596 ± 0.045	0.346 ± 0.026	After
Langdon brickette	2.270 ± 0.009	0.739 ± 0.015	adding
Crowley Ridge brickette	2.080 ± 0.029	0.511 ± 0.007	fertilizer

A source of variability in the thermoluminescence of quartz

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Variability in the TL of quartz extracted from sediments is well known, and is now widely attributed to the presence of a small proportion of "bright" grains (for example: Benkö (1983), Huntley and Kirkey (1985)). Following the quantification of this "disc-to-disc" scatter for samples of Australian sedimentary quartz (see Fig. 1) a search was conducted to locate and , if possible , characterise the reasons for the effect.

Previously, examination by X-ray fluorescence spectrometry of the purity of different samples of separated 100 μm quartz grains (following TL measurement) had revealed the presence of levels of K, Al, and Zr significantly above those found for pure silica. This result suggested that contaminant grains of feldspar or zircon were surviving the separation steps. Subsequently, a scanning electron microscope study of the loose, separated 100 μm quartz fraction showed no grains other than quartz, so demonstrating that the disc-to-disc variability was not due to inadequate separation.

As the irregular surfaces of the loose grains prevented more detailed examination, thin sections of various samples were prepared - this mode of sample presentation permits the application of electron microprobe techniques. Individual sectioned grains were inspected using an electron microprobe analyser for features capable of accounting for the levels of K, Al, and Zr detected by the earlier X-ray fluorescence analysis. Many "microinclusions" of various accessory minerals, some of which were of species normally expected to contain radionuclides, were detected. These microinclusions may or may not contain radionuclides - the detection limits of approximately 0.1 wght. % were insufficient to resolve this question. Nonetheless , this suggests the existence of a natural thermoluminescence (NTL) component induced by radioactivity contained in microinclusions and absent in artificially induced thermoluminescence (ATL). A consequence of this may be reduced disc-to-disc scatter of ATL. This supposition is consistent with behaviour shown in Fig. 1 , where statistical testing (F test, 95% confidence level) confirms the significance of the reduction in distribution variance from NTL to ATL. Further details will be given in Spooner and Hutton (in preparation).

Conclusion

The disc-to-disc TL variability in the separated quartz samples considered here was shown as not attributable to contamination by grains of other minerals surviving the separation procedure. Electron microprobe analysis subsequently revealed microinclusions of accessory minerals inside sectioned quartz grains from these samples. Microinclusions were found not to be uncommon in the samples examined, though generally representing a small fraction of the grain volume. However, it is probable that in cases where abundant microinclusions possess high concentrations of radionuclides or high intrinsic TL sensitivity, they will be troublesome in TL dating applications.

Further work on grains bright in luminescence is planned using an image-intensifier-camera set similar to that of Huntley and Kirkey (1985) .

Notes on experimental procedures

1. Sample preparation procedure : digestion in warm dilute HCl; 5 minute wash with dilute NaOH , ultrasonic bath ; dry sieved for the 90-125 μm fraction; magnetic separation (Franz magnetic separator); etched for 40 minutes at ~20 °C in 50% HF acid .

2. Preparation of thin sections : ~100mg sample embedded in araldite disc (2 parts LC191 resin, 1 part LC177 hardener); disc base ground flat and glued to glass substrate ; excess araldite cut from the disc leaving ~0.5mm layer of araldite and grains attached to substrate; grinding wheel, then progressively finer grades of emery paper reduce this to ~30 μm. Thickness during final grinding (grade 600 emery paper) is monitored by polarising microscope; polishing is by progressively finer diamond grits (6 μm, 3 μm, 1 μm) on three separate laps for ~20 minutes/grade. Each finished thin section is ~30 μm thick,   20 mm diameter and displays polished sections of ~12,000-14,000 90-125 μm grains.

3. Electron microprobe analysis.
Instrument: JEOL 733 Superprobe electron microprobe analyser, with attached KEVEX 7000 series energy dispersive system.
Conditions: accelerating voltage 15kV, electron beam current 5nA.
The X-ray spectra were acquired with a take-off angle of 40°, "live" counting time of 60 seconds and detection limits of ~0.1 wght.%. Data was corrected using standard ZAF procedures (Z - backscatter effect, A - absorption of radiation in the sample, F - fluorescence). Analyses were with beam diameters ranging from 20 μm to spot, and the effective beam penetration depth was ~3 μm. The thin sections received a 20 nm carbon coating prior to examination.

Acknowledgements

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PI. Reviewer's Comments (M.J. Aitken)
The identification of microinclusions likely to have a radioactive component carries us one step further in quartz TL technology. Of course the writing has been on the wall ever since Sutton and Zimmerman (1978) made fission track studies of etched quartz grains (obtained by heavy liquid separation), and found uranium-rich areas (~several hundred ppM) of less than 10 microns in size. However, they found anti-correlation with cathodoluminescence sensitivity and hence presumed the resultant TL would not be substantial.
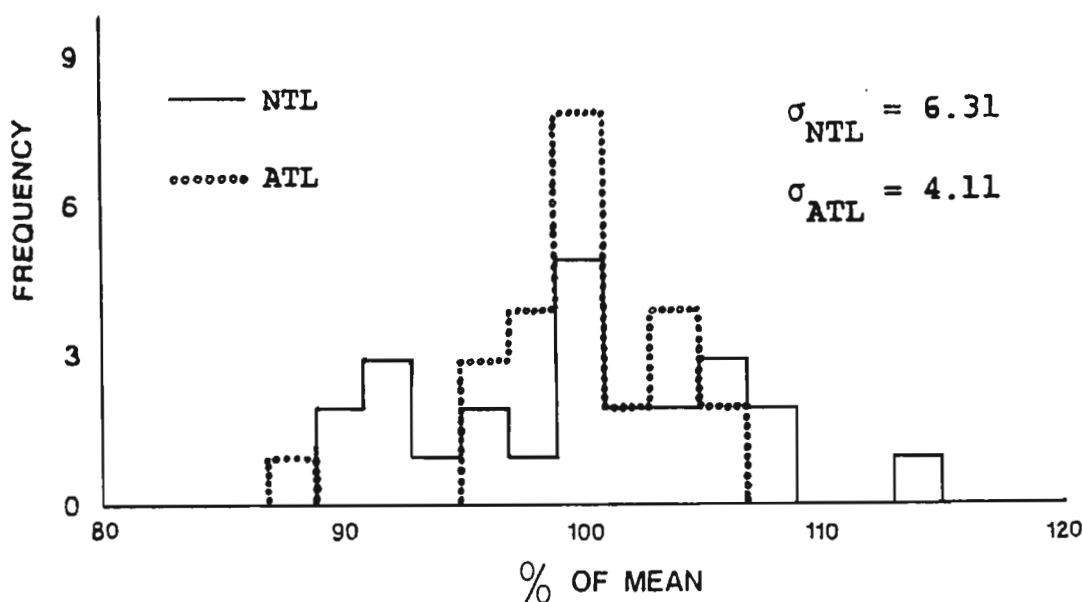

Figure 1. Distributions of the NTL and ATL of the 325 °C peak of Lake Woods quartz (laboratory reference Lake Woods (site 3, toe of dune , 1m) - further details may be found in Hutton , Prescott and Twidale, (1984), Aust. J. Soil Res., 22, 15-21.). The data is from a set of 24 similar sample discs, mean mass quartz/disc ~7 mg. The summation interval is 44 °C centered on the peak, and all TL measurements were made at 5 °K/second to 550 °C maximum, with reheats subtracted. Sample ED ~50 Gy. ATL induced by a 21.7 Gy ^{90}Sr - ^{90}Y β-dose administered following NTL measurement, and measured one day after irradiation. Quartz separation was as described in Note 1 above.

Stopping power and range for alpha particles in SiO$_2$

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Of great importance in computing the alpha fluxes in ceramics and flint fragments are the data dealing with the range-energy relation in SiO$_2$. Aitken and Bowman (1975) have used some interpolations between Ne and Na from the range of data given in Northcliffe and Schilling (1970), and Williamson et al. (1966). Zimmerman (1971) used the experimental data for aluminium from Marion and Young (1968) to predict the energy spectrum of alpha particles in ceramics, using the expression $1 + 0.29E$ (E = energy in MeV) for the derivative of the alpha range as a function of E.

We hope that the use of the results published by Ziegler and his co-workers (1977) should allow a better estimate of the stopping power and range in SiO$_2$ (in fact strong discrepancies exist between data below 5 MeV for the above referenced papers by Northcliffe and Schilling, Williamson et al., Zimmerman, and Ziegler et al.). From the best-fit of all the available data, these authors have derived the following formula for the stopping power, S,

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{S_2} \qquad (1)$$

where:

$$S_1 = A_1 E^{A_2} \qquad (2)$$

$$S_2 = \frac{A_3}{E} \ln(1 + \frac{A_4}{E} + A_5E) \qquad (3)$$

and A_1........A_5 are numerical coefficients tabulated for each element.

We have computed the stopping powers for SiO$_2$, $S(SiO_2)$, and the corresponding ranges using the formula:

$$S(SiO_2) = \frac{28}{60} S(Si) + \frac{32}{60} S(O) \qquad (4)$$

where $S(Si)$ and $S(O)$ represent the s.p. of silicon and of "solid" oxygen, respectively. The latter have been estimated from the effective

charge found for He stopping in B, C, Al and Si (Ziegler, 1977).

Although there is some evidence that the Bragg additivity rule relating the stopping power of a compound to that of its contsituents does not strictly hold, the deviations from the rule are not large and have been observed mainly in the stopping power of hydrocarbons for protons.
Northcliffe and Schilling, 1970

Values of S and R for energies ranging from 0.05 to 10 MeV are shown in Table I.

Table I

E	R	S.10^{-2}
0.05	0.198	5.42
0.1	0.272	8.03
0.15	0.328	9.97
0.2	0.374	11.47
0.3	0.454	13.51
0.4	0.525	14.64
0.6	0.657	15.39
0.8	0.787	15.21
1	0.921	14.66
2	1.698	11.33
3	2.690	9.10
4	3.893	7.67
5	5.294	6.68
6	6.885	5.94
7	8.657	5.37
8	10.60	4.92
9	12.72	4.54
10	15.01	4.22

E= energy in MeV;
R= range in g/cm^2;
S= stopping power in MeV cm^2/g.

Let Φ be the annual (omnidirectional) alpha flux in silica for a weight concentration of 1 ppm of natural uranium or thorium. We have:

$$\Phi = N \, \Sigma \, R_i \qquad (5)$$

where; N is the disintegration rate of the parent of the considered series assumed at equilibrium, and R_i the track lengths of its different nuclides. F is given for the three radioactive series in Table II.

If the values of F are increased by 3% for a better correspondence to the chemical composition of pottery they are 4 to 5% higher than the fluxes deduced from the results of Bowman (1982).

Concerning the energy derivative of the range, we obtain for silica:

$$1 + 0.43E \quad \text{for } 1 < E < 5 \text{ MeV}$$
$$1 + 0.30E \quad \text{for } 5 < E < 9 \text{ MeV}$$

Table II

Parent	N $(y^{-1} g^{-1})$	ΣR_1 $(g\,cm^{-2})$	Φ $(y^{-1}cm^{-2})$	
^{238}U	$3.897.10^5$	$47.53 \, .10^{-3}$	$1.852.10^4$)	
^{235}U	$1.82 \, .10^4$	$48.20 \, .10^{-3}$	$8.77 \, .10^2$)	$1.94. \, 10^4$
^{232}Th	$1.276.10^5$	$42.10 \, .10^{-3}$	$5.377.10^3$	

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PI. Reviewer's Comments (M.J. Aitken).

This update on alpha particle ranges represents a small, but just significant, revision in the alpha particle contribution to the annual dose when any of the three track-length systems are used (see Aitken, 1985) in combination with determination of parent concentration for evaluation of alpha activity. On the other hand, if the alpha activity is evaluated by means of thick-source alpha counting, as is implicit in either the *a*-value or the *b*-value systems, there is a compensatory increase in the alpha count-rate per unit concentration.

Reference

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More cautions on laboratory illumination

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Many TL laboratories are illuminated by colour filters wrapped around fluorescent tubes, and over the past decade several filters have been recommended as suitable (Sutton and Zimmerman 1978, Jensen and Barbetti 1979, Spooner and Prescott 1986). However, it should be noted that colour filters can vary from batch-to-batch and it is important to measure the transmission spectra before they are used.

An example of this is shown in figure 1, which gives the transmission of *Cinemoid* No. 1 for the sheet reported by Jensen and Barbetti (1979) and purchased in 1978, compared with the spectrum for a sheet purchased in 1983. It is obvious that the large UV window in the 1983 version makes it totally unacceptable. A sheet purchased by the Oxford laboratory in the intermediate years shows 2% transmission at 320 nm. The manufacturers, Rank Strand Ltd., changed the dye a number of times between 1978 and 1983 (as well as completely changing the manufacturing process) and had not monitored the performance below 400 nm.

The *Chris James and Co.* filters reported by Spooner and Prescott (1986) appear to be the same as the colour effect filter range manufactured by Lee Filters Ltd. (Central Way, Walworth Industrial Estate, Andover, Hants. SP10 5AN, U.K.). These are currently used at Oxford for TL and optical dating illumination and cost about £4 for a 1.22 x 0.55 m sheet.

For the optical dating laboratories two or three layers of Lee 106 (primary red) are used, while for TL work three or four layers of Lee 158 (deep orange) provides more comfortable lighting (see Spooner and Prescott, 1986 for the transmission characteristics of these). Three or four layers of Lee 158 are necessary because there is a small window in the UV and a single layer transmits about 3% at 370 nm. We prefer it to the Lee 179 (chrome orange) recommended by Spooner and Prescott because there is less transmission in the 500 nm region. To minimize fire risk the filters are mounted on an enclosure around the fluorescent tubes so as to give an air space of several centimetres between the tube and filter. The Lee 106 and 158 spectra have remained uniform for sheets and rolls ordered at intervals over the past two years.

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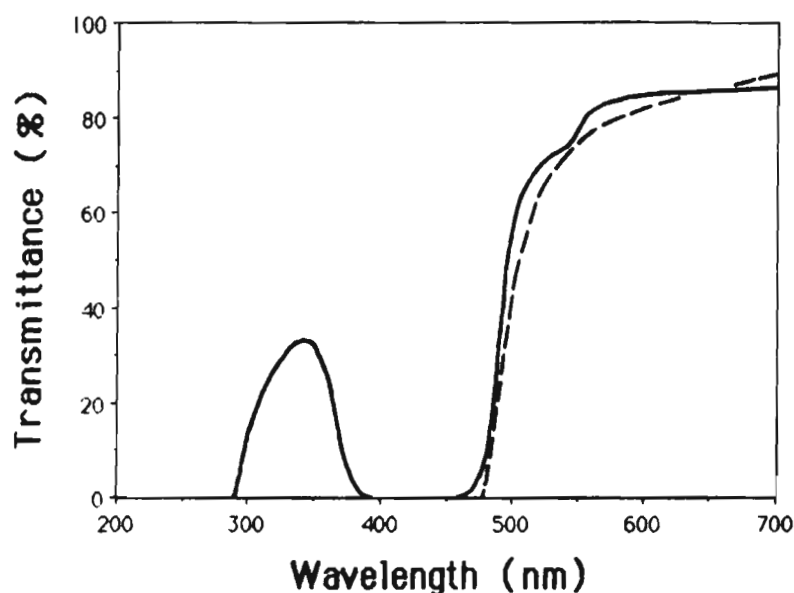
PI. Reviewed by Sheridan Bowman

Figure 1.   The transmission of a single layer of Cinemoid No. 1, purchased in 1983. The 1978 version did not contain a window in the UV, and is shown by the dashed line (from Jensen and Barbetti, 1979)

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Compiled by Ann Wintle

Notices

Positions Available

University of Washington - Thermoluminescence Dating Laboratory

The University of Washington seeks a research associate for a 2-3 year appointment in its thermoluminescent dating facility, operated jointly by the Departments of Materials Science and Engineering and Anthropology. Duties of this research associate will include conducting research in TL dating techniques, managing the overall operation of the laboratory, and supervising graduate students, along with occasional teaching. Principal research objectives include technique development in signal characterization and discrimination, autoregenerative zircon inclusion dating, bone and shell dating and optically stimulated luminescence. The starting date for this appointment has not yet been determined but is expected to be between July 1988 and January 1989. The appointment is contingent upon renewal of current National Science Foundation funding; the appointee is expected to develop additional outside funding by the second year of appointment. Candidates should have a PhD and a minimum of 2 years' experience in TL dating. Interested parties should address a current resume and statement of interest to: Drs R.C. Dunnell and T.G. Stoebe, FB-10, University of Washington, Seattle, WA 98195, USA.

Editorial Notes

Electronic Mail Networks

If you are a user of a mainframe computer which can access international network systems such as BITNET, and would like to participate in an experiment to form a TL/ESR/... information network, please send me a brief message to that effect to my computer address at Durham:

RKM2 @UK.AC.RL.DUR.MTS

As a first step, we could publish a directory of addresses, which would provide a means of more rapid (and perhaps easier) links between laboratories. Readers suggestions welcome.

Delay in publishing AnTL 6(i)

The Editor apologises for the delay sending this issue; copy has been in short supply, presumably arising from the preparation of papers for the TLS proceedings.