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EXPERIENCES WITH AN ALPHA COUNTER

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The alpha counter was constructed for determining the alpha particle emission rates from samples for thermoluminescence dating, and for determining uranium and thorium contents.

The basic technique is described by Aitken (1974). The sample is prepared by spreading a covering of the powder on a ZnS screen which in turn is placed in a sealed lucite container on a photomultiplier tube. Each alpha particle causes a large scintillation pulse in the ZnS which is easily detected and counted. Figure 1 shows a diagram of the overall apparatus.

The discriminator setting on the SCA was determined by plotting count rate vs. setting for a 1.02% U sample (Canadian Certified Reference Material BL-3 known to be within 90% of secular equilibrium) and adjusting the setting so that the count rate was 82% of the extrapolated zero-pulse height value. The data for this is shown in Figure 2. The 82% figure is used so that the conversion factors of Aitken and Bowman (1975) can be used later.

The corresponding figure for a sample of USAEC pitchblende No. 6 was determined to be 80.9 ± 0.3%.

In order to determine what kind of effects the upper and lower discriminator may have pluse height spectra were taken for several samples; these are shown in Figure 3. We attribute the differences in the spectra mainly to different reflectivities of the samples, thus a highly reflecting sample will give larger pulses than a poorly reflecting one. It would appear from this that it is necessary to determine what discriminator setting is necessary for each sample (one possible way to do this would be to measure the reflectivity since for most samples counting statistics and an unknown U/Th ratio would make the present method difficult).

To establish whether or not the counter was working as expected count rates were determined for several samples of known composition and converted to U and Th contents using the conversion factors of Aitken and Bowman (1975). These results were then corrected for variations of alpha-particle range with atomic number (A) using the Bragg-Kleeman rule (range $\propto \sqrt{A}_{eff}$, $\sqrt{A}_{eff} = (\Sigma Y_i/\sqrt{A}_i)^{-1}$ where Y_i are the weight fractions, Evans, 1955).

The results are shown in Table 1 where it is seen that for the two Canadian ore standards the agreement between the stated values and those we determined is excellent. For the U. S. standard which has a very high U content there is a discrepancy which we attribute to non-uniformity of the U distribution and/or inadequacy of the Bragg-Kleeman rule.

Table 1 also contains results from two obsidian samples which happened to be available. For one the results are satisfactory while for the other there is a disagreement, the cause of which is unknown.

I find it very pleasing that without any arbitrary adjustments one can

construct such a simple device for determining U and Th contents so accurately.

Dr. M. J. Aitken gave much useful advice which is very gratefully acknowledged.

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TABLE I.

SAMPLE	Stated U	Stated Th	Measured Sample Count Rate	Measured Pair Count Rate per ks-cm^2
BL-2	0.453±0.005%	16 ppm.	572±4	---
BL-3	1.02 ± 0.01%	15 ppm.	1261±7	---
DL-1	41 ppm.	83 ppm.	7.58±0.04	0.44±0.01
#6	45.4%		60,200±1400	---
NCCC	5.6 ppm.	14.2 ppm.	1.10±0.03	.023±.004
NCWE	5.4 ppm.	13.6 ppm.	1.43±0.02	.021±.002

SAMPLE	Calculated U (uncorrected)	Calculated Th (uncorrected)	A_{eff}	Corrected U%
BL-2	0.471±.004%	---	21.56	0.454±0.004
BL-3	1.038±.005%	---	21.74	0.996±0.005
DL-1	≥38±2 ppm.	81±6 ppm.		
#6	49.5±1%	---	43.6 30.4	33.5 (A from stated U) 36.5 (A self-consistent)
NCCC	≥5.3±0.3 ppm.	12.7±2.0 ppm.		
NCWE	≥8.7±0.6 ppm.	10.3±1.5 ppm.		

NOTES FOR THE TABLE

BL-2, BL-3, DL-1 are Canadian Certified Reference Materials obtained from the Mines Branch, 555 Booth Street, Ottawa K1A 0G1 who also supplied detailed composition data for calculation of A_{eff}.

BL-2 and BL-3 are stated to be within 90% or better of equilibrium. The equilibrium status of DL-1 is not known.

No. 6 pitchblende is from the New Brunswick Laboratory of ERDA, Box 150, New Brunswick, New Jersey, 08903, U.S.A. This was assumed to have A_{eff} = 20 apart from uranium oxide.

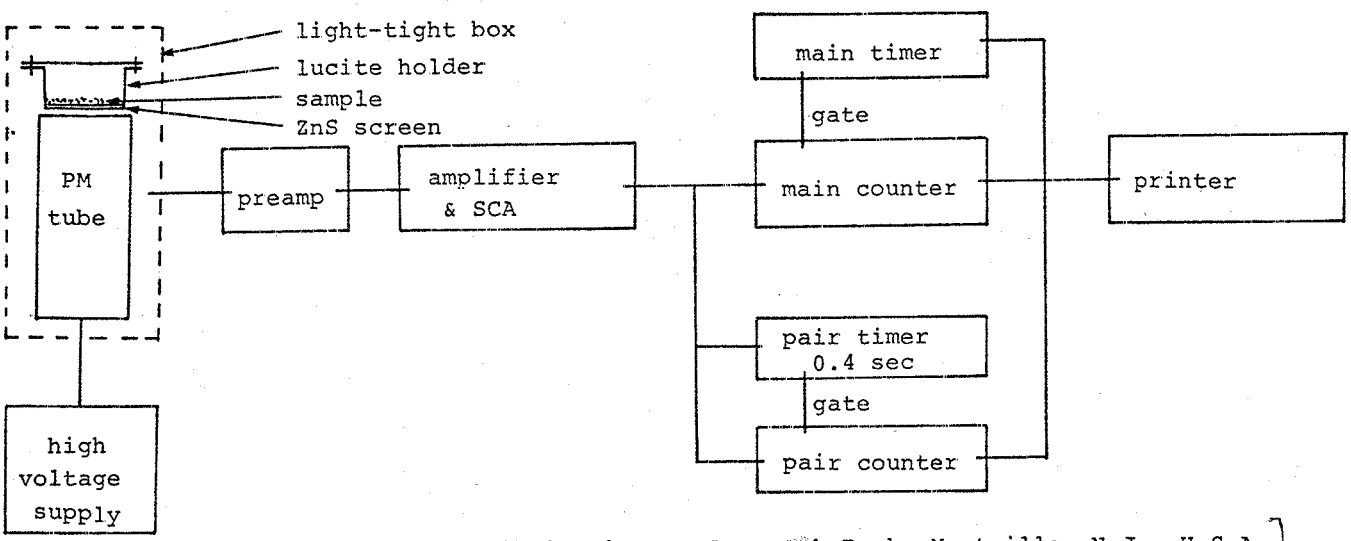
NCCC and NCWE are obsidian from Newberry Caldera, Oregon, Cindercone and Western East Lake flows respectively. U and Th contents are from Laidley and McKay (1971).

Uncertainties quoted are associated with counting statistics and sample areas; no account is taken of the (unknown) uncertainties in the conversion factors.

The pair count rate measured includes a significant portion of random pairs; the Th count rate is determined by subtracting these and multiplying the remainder by 26.9. The latter figure is calculated allowing for geometry, the random emission time, a random (up to 0.1s) delay time inherent in the 719 timer, and the 6 α particles in the Th chain.

A measured background count rate of 0.11±0.02 c/ks for the 13.6 cm^2 ZnS discs has been allowed for; this was measured with a clean lucite disc laid on the ZnS screen. Without this disc the rate was five times larger, presumably due to radon in the air of the chamber.

When a sample is not determined to be in equilibrium only a lower limit on the U content can be calculated and this is so indicated.



components and settings used

ZnS screen	Wm.B.Johnson, Research Park, Montville, N.J., U.S.A.	
HV power supply	Hewlett Packard 6515A	(900v)
PM tube	EMI 9656B	
Preamp	Ortec 113	(C=0)
Amp & SCA	" 490A	(gain=3x4, disc LL=0.4, UL=10)
Main timer	" 773	
Pair timer	" 719	(0.4s)
Counters (2 of)	" 772	
Printer	" 777	
Nim Bin	" 701/2	

Figure 1
The Alpha Counting Apparatus

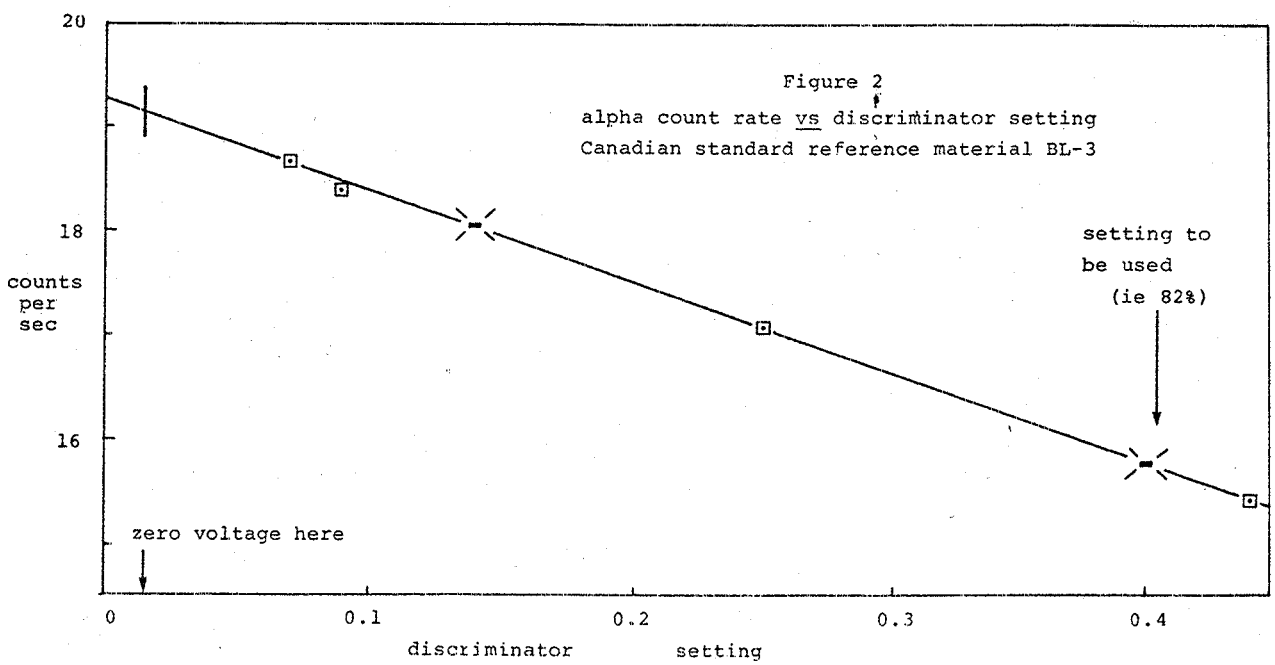
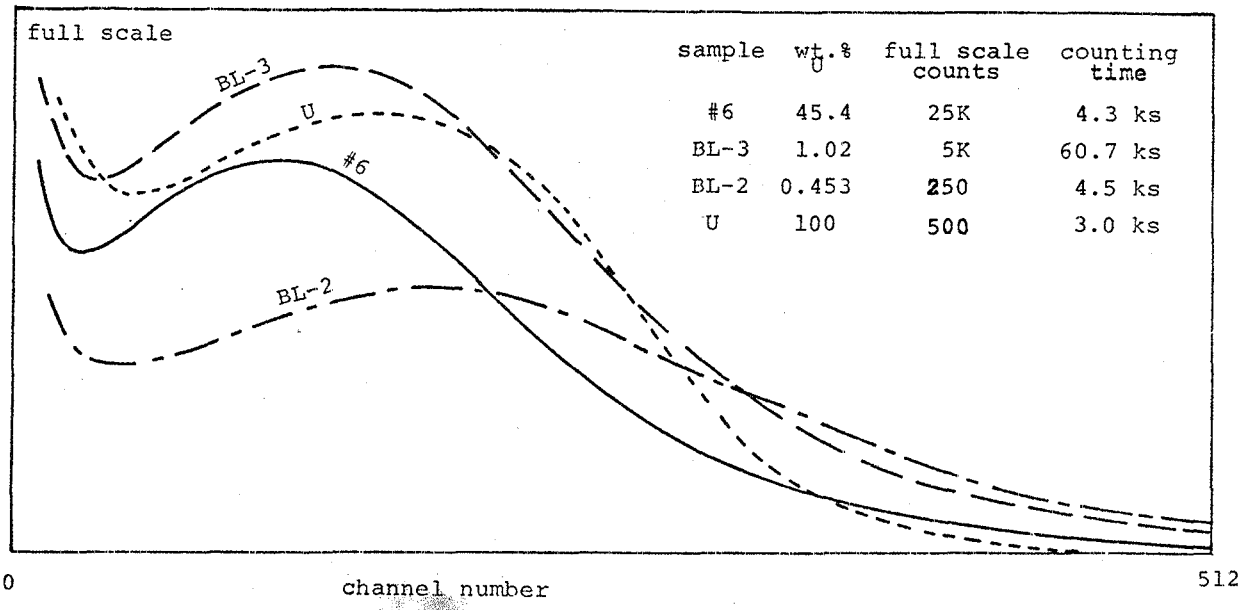


Figure 2
alpha count rate vs discriminator setting
Canadian standard reference material BL-3

Figure 3: Pulse-height analysis



CLEANING QUARTZ GRAINS

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A simple method of cleaning quartz grains using HF acid is described in the following note (see also, Langmyhr and Sveen, Anal. Chem. Acta, 32, 1, 1965). This technique is quite useful as it allows one to use only a single beaker, thereby reducing the chance of losing crystals. Furthermore, when etching is completed, addition of an $AlCl_3$ solution pacifies the harsh HF solution and eliminates the problem of precipitated flourides.

Sieved grains (up to a few hundred milligrams) are placed in the bottom of a dry 100 ml Nalgene polypropylene beaker. Approximately 5 ml of 49% HF acid is slowly added. The mixture is carefully swirled and then allowed to sit at room temperature for 30 minutes. At the end of this time, approximately 50 ml of 25% $AlCl_3$ solution is added. (This solution is easily prepared by placing the contents of a standard one pound jar of $AlCl_3.6H_2O$ crystals in a one litre bottle and filling it with distilled water.) After swirling, the beaker is placed in a boiling water bath and the solution is slowly stirred using a Teflon covered stirring bar with a hot-plate stirrer.

After a few minutes the cloudy solution will become clear (sometimes slightly yellow), and the cleaned grains can be retrieved by filtering with a glass frit and vacuum apparatus. When the last of the solution has been drawn off, the crystals are washed twice using distilled water and acetone. After drying, the grains can be loosened and removed from the frit by gently tapping over a piece of weighing paper.

The procedure may be changed for larger or smaller samples by simply scaling the listed quantities.