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THERMOLUMINESCENCE OF TEN METEORITES WITH GREATER THAN 4.0 AEON ARGON 40/ARGON 39 AGES

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Liener and Geiss (1968) and Komovsky (1963) have claimed that thermoluminescence (TL) sensitivity – the TL produced by a sample which has been drained of its natural TL and given a standard test dose of radiation in the laboratory – shows a positive correlation with K-Ar age in meteorites. In the meteorite case, K-Ar ages lower than 4.6 aeons are interpreted as the result of degassing by shock reheating. When the degassing is complete – this can be assessed by the ^{40}Ar-^{39}Ar technique – the subsequent build up of ^{40}Ar can be used to measure the time of degassing.

The purpose of the present study – of which this paper constitutes the first phase – is to determine the extent to which the situation for TL resembles that for the K-Ar system. If the situation is analogous we would expect meteorites with "high" K-Ar ages (greater than 4.0 aeons) to be fairly uniform in TL sensitivity, and that those which have "low" K-Ar ages (say

500 million years) had their TL sensitivity lowered by shock and/or reheating. If the TL sensitivity then remained unchanged, the currently observed sensitivity level is a measure of the magnitude of the degassing event. If, however, TL sensitivity was capable of building up again after the shock event – there are many instances of this in other applications of TL to dating – then the situation is perfectly analogous to K-Ar dating. The present TL sensitivity is then a measure of both the magnitude of the shock/reheating event and the time since that event. In this paper we have examined the TL of ten meteorites with argon 40/39 ages greater than 4.0 aeons according to the data of Turner *et al.* (1978). It has been found out, when care is taken to remove the effect of a number of "trivial" factors, the expectation that they should have very similar TL sensitivity has largely been fulfilled.

Figure 1a compares the TL sensitivity of our ten samples when measured in the normal way – using 10 mg of 50 μm sieved powder from which the metal and sulphide had been removed with a magnet. The most striking feature is that Tieschitz, the only petrologic type 3 meteorite, has a lower TL sensitivity by a factor of 15 – a similar observation was made by Liener and Geiss (1968). This is not surprising because the luminescent species in most ordinary chondrites is feldspar, while in type 3 meteorites this is replaced with feldspathic glass. The remaining meteorites show a wide range of sensitivities, over a factor of six, and have a large standard deviation, 83% of the mean.

A major contributor to this apparent range in TL sensitivities must be different grain size distributions resulting from the sample preparation procedures; some meteorites are notably more friable than others. Secondly, the meteorites lowest in TL sensitivity are dark coloured, often they have a brown colouration due to weathering even though these meteorites are all observed falls. It was thought that both these problems could be circumvented using fine-grain discs and acid washing. Fine-grain discs are used in pottery TL dating and a variation of the technique developed for that purpose was used here (Zimmerman, 1971). Twenty mg of 50 μm sieved powder was washed in strong (but not concentrated) hydrochloric acid and then suspended in acetone. All the powder that falls after 2 minutes, but within 20 minutes, was re-suspended in 5 ml of acetone. One ml aliquots were then placed in vials which contained a 20 thou thick, 1 cm diameter aluminium disc. After evaporation of the acetone, each disc was coated with 1 ± 0.2 mg of grains, roughly 1-10 μm in diameter. The repeatability so far achieved is rather poor ($\pm$ 10%, compared with $\pm$ 5% for 10 mg powders) but there are several reasons for believing this can be considerably improved. It was found (Fig. 2) that acid washing caused a six-fold increase in the measured TL sensitivity of the certain powders, but made little difference when the TL sensitivity was measured on discs – when fine-grain discs are used the acid washing step could be omitted. It seems that the lower

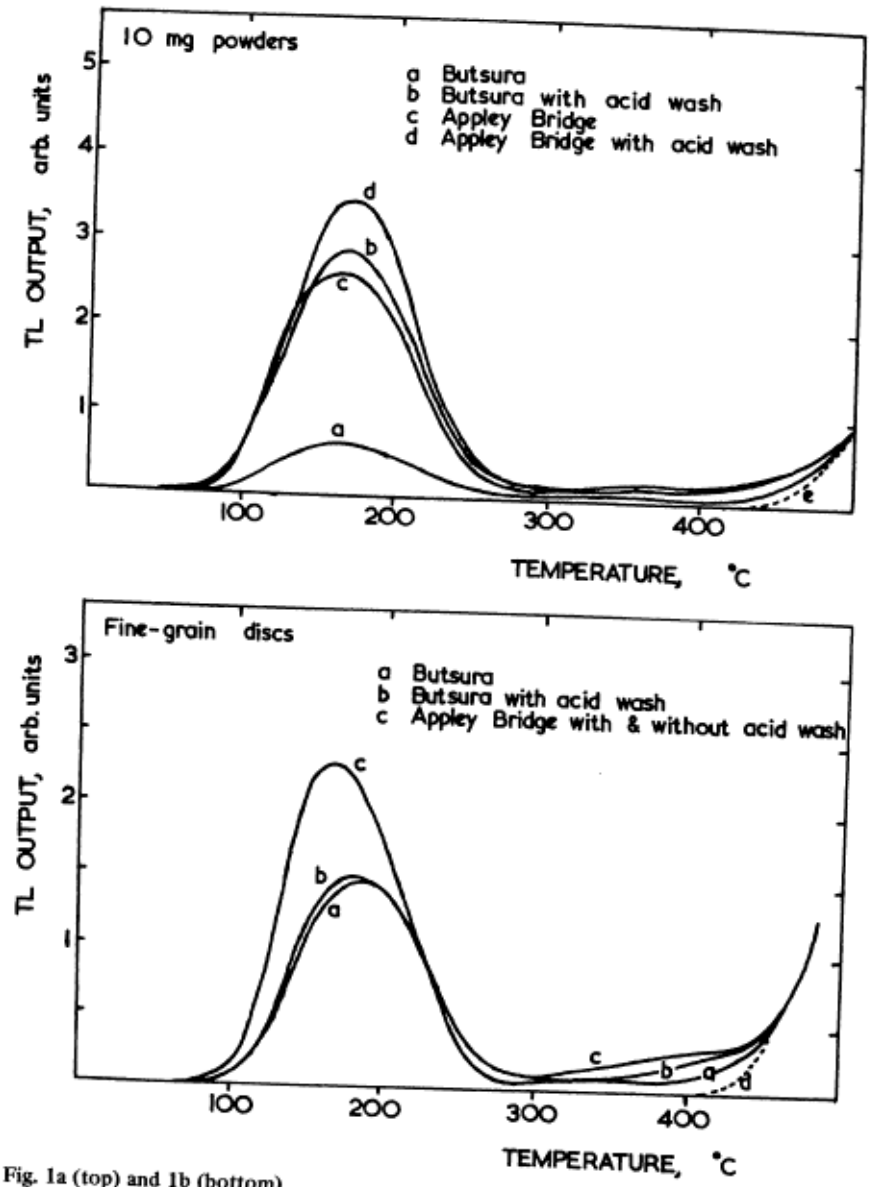

Fig. 1a (top) and 1b (bottom)
Thermoluminescence of ten meteorites with greater than 4.0 aeon ^{40}Ar-^{39}Ar ages (Turner *et al.*, 1978). The TL is that measured after the sample had been heated to 500 °C, to drain its natural TL, and then given a standard test dose of 5 krad of ^{60}Co γ rays. When the samples are prepared as fine-grain discs the apparent range in TL sensitivity is less than when sieved powders are used. This is because fine-grain discs are less affected by differences in grain size distribution or albedo (see Fig. 2).

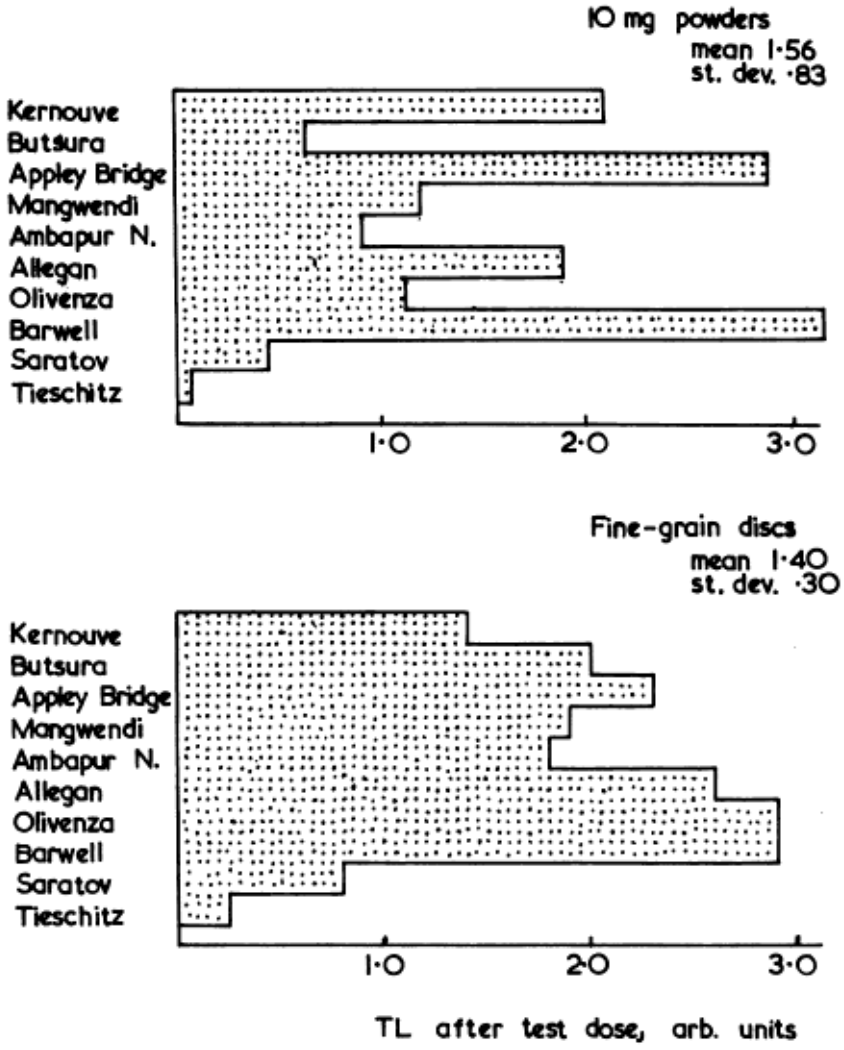

Fig. 2a (top) and 2b (bottom)

Detailed comparison of the TL of meteorites prepared for measurement in different ways. The glow curves (TL *vs.* temperature) are for powders which have been drained and given a standard test dose of 5 krad of ^{60}Co γ radiation. Curve 'e' in the upper figure, and curve 'd' in the lower figure, are for black body radiation. Butsura is an H chondrite and is brown coloured, presumably due to weathering of the abundant metal. Appley Bridge is a pale grey LL chondrite, with very little metal. Acid washing considerably increases the TL from powders, whereas with discs, containing essentially a monolayer, this is not so. It seems that the change is an albedo effect rather than a filtering effect, since filtering would be the same in both instances.

sensitivity measured for the darker powders is an albedo effect, rather than a filtering effect.

The range of TL sensitivity measured on discs is much lower (now only a factor of two is covered and the standard deviation is 21% of the mean) than when powders are used for the measurements (Fig. 1b). For eight of the ten meteorites the variation from the mean is less than the repeatability of the measurements. When the reproducibility in the disc measurements is improved, this range may well decrease further. It seems that if grain size and albedo effects are eliminated, TL sensitivity is much the same for meteorites which are largely unshocked and unreheated. The only major exceptions are Tieschitz which, being type 3, has a different luminescent phosphor, and Saratov, for which a low K-Ar age has also been reported.

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