

Thermoluminescence and terrestrial age of the Estacado meteorite

THE terrestrial age of a meteorite is the number of years which has elapsed since the meteorite fell to Earth. The terrestrial ages of most meteorites are not known directly, as most are 'finds' rather than observed 'falls'. Here we discuss the various methods which have been suggested to determine the terrestrial age of the 'finds', and these may be conveniently divided into two categories: (1) those which use the decay of spallation-produced radioactive isotopes¹⁻⁴; (2) those which use the thermal drainage of thermoluminescence (TL) from the material^{5,6}.

Boeckl¹ has calculated the terrestrial ages of 19 stony meteorites from a derivation of their radiocarbon content. Among the meteorites studied was Estacado (H-group chondrite) for which Boeckl calculated a terrestrial age of $6,800 \pm 3,000$ yr. Recently, McKeever and Durrani⁷ have carried out some TL studies of Estacado, the results of which are not consistent with such a large terrestrial age. After a meteorite falls, it is shielded from cosmic rays by the Earth's atmosphere. The TL induced in the meteorite by cosmic-ray bombardment in space will thus slowly drain from the meteorite as it rests on the Earth's surface, the high-temperature ($\approx 400^\circ\text{C}$) region of the TL glow decaying much more slowly than the low-temperature ($\approx 200^\circ\text{C}$) region. The high-temperature region of Estacado's TL glow seems to be far too high to be consistent with a terrestrial age of 6,800 yr.

Figure 1 shows the high-temperature (HT) TL of 14 meteorites of known terrestrial age (that is, 'falls') and the high-temperature TL of five 'finds'. The TL is plotted either against known terrestrial age, or against deduced age from ^{14}C measurements^{1,4}. Clearly, Estacado is 'anomalous' in that the intensity of the high temperature TL is not consistent with a ^{14}C age of 6,800 yr. Indeed, the TL data suggest a true terrestrial age of 100 yr.

Further evidence is available to support a terrestrial age ≈ 100 yr for Estacado. First, its appearance is one of a reasonably 'fresh' fall. Besides resting on the surface, the interior of the meteorite was very fresh looking (a pale grey) which, when the meteorite is compared with meteorites such as Dimmit or Potter, implies that it has a much lower terrestrial age than 6,800 yr.

Second, there is some strong circumstantial evidence to indicate that Estacado fell in 1882. Howard and Davison⁸ have given a detailed account of the find of Estacado. In 1882, a bright fireball was seen by the residents of the colony of Estacado, Hale County, Texas. The meteor was seen to fall north-west of them. In 1883 several cowboys came across the meteorite in the vicinity of the conjectured fall of the meteor. As this is a stoneless region, the inhabitants considered the meteorite to have been the cause of the fireball seen in 1882.

Viewed in the light of the account reproduced by Howard and Davison, the TL data clearly support the view that Estacado's

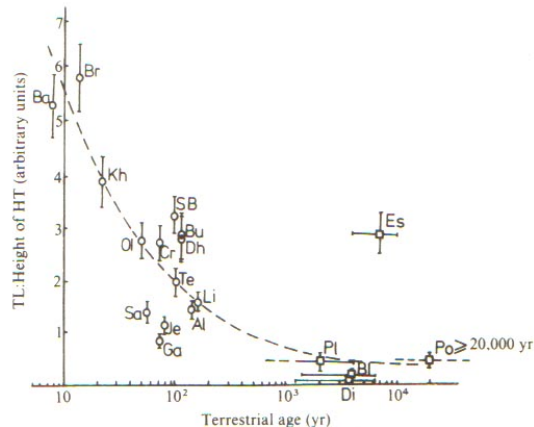


Fig. 1 The decay of the intensity of the high-temperature TL region from 14 'falls' (○) and five 'finds' (□). The ^{14}C age for Potter is from Suess and Wänke⁴. The uncertainty in the TL is estimated from the standard deviation of the high-temperature TL within a sample, based on 75 measurements of the natural TL in Estacado. The dotted curve is an estimation of the decay curve. Ba, Barwell; Br, Bruderheim; Kh, Khanpur; SB, Soko Banja; Bu, Butsura; Ol, Olivenza; Cr, Crumlin; Dh, Dhurmsala; Es, Estacado; Te, Tennesilm; Li, Limerick; Al, Aldsworth; Sa, Saratov; Je, Jelica; Ga, Gambat; Pi, Plainview; Bl, Bluff; Di, Dimmit; Po, Potter.

terrestrial age is only ≈ 100 yr and not several thousands of years as deduced by Boeckl.

This discussion of Estacado's terrestrial age suggests that a useful check of a deduced ^{14}C age would be to carry out some TL measurements in order to check the consistency of the ^{14}C age with the TL properties. Similar inconsistencies have been highlighted in earlier work⁵.

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