COSMIC-RAY TRACKS versus ^{60}Co : A STRONG DISCREPANCY IN SHIELDING DEPTHS. M. Bourot-Denise, P. Pellas and C. Perron, Lab. de Minéralogie du Muséum (U.A. 286 du CNRS), 61 rue Buffon, 75005 Paris (France).

A large number of data on radioactive spallogenic isotopes have defined for Jilin meteorite a 2nd stage exposure (4π) of $\sim$0.4 Ma as an object of 85cm in radius (1), according to model calculations (2,3). There is, however, a dissonance in this chorus line : a careful study of 10 selected samples with low ^{60}Co activities (50-100 dpm/kg Fe) corresponding to a depth of 5-16 cm, did not show any evidence of c.r. track densities (CRTDs), although 0.6-22 $\times 10^3/cm^2$ were expected (4). However, CRTDs were found in 2 small samples from the strewnfield for which no ^{60}Co values were available (4). Preliminary ^{60}Co and ^{22}Na values have recently been obtained by G. Heusser (5) from the original stones of these two specimens. The CRTD records of the two stones and their radial variation within the meteoroid are presented here.

Olivines from 10 samples of stone VI-21-057 and 5 samples of stone VI-42-04 have been studied. The results are shown in Fig. 1, where the highest CRTD of each stone ($P9_4$ and n° 5) have been used for normalization on the semi-empirical curve of (6), drawn for a meteoroid radius of 100 cm. The other samples were positioned according to the actual distances measured on both stones. It is clear that all samples (except P5) are on the curve defining the radial gradient, allowing to locate the two stones at a shielding depth between $\sim$4 and $\sim$13 cm. Stone VI-21-057 has been cut into three pieces and the ^{60}Co activity was found to decrease from 15 to 4 dpm/kg towards the surface, along a distance of $\sim$4 cm (5), at variance with the model calculations (2,3). The ^{22}Na activity decreases in the outermost specimen to 0.6 of the constant level observed in all other parts of Jilin meteorite (1). A similar effect was observed in the most external part of the St Séverin core AIII for the ^{21}Ne content (7). This confirms that stone VI-21-057 comes from the most external layer of the meteoroid. From the above data a strong discrepancy is observed between depths inferred from ^{60}Co and those estimated from CRTDs. This is obvious in Jilin for shallow depths ($\lesssim$ 20 cm) where for # VI-21-057 a bulk ^{60}Co value of $\sim$50 dpm/kg would be expected (2,3) while 8.6 dpm/kg are measured (G. Heusser, 1984) (5). Similarly, a ^{60}Co value of $\sim$ 60 dpm/kg would be expected for # VI-42-04 whereas 21.8 dpm/kg are actually measured (G. Heusser, 1984). Such an effect was already observed to a minor extent in Allende (R_o = 60 cm) (8).

P. Eberhardt (pers.comm., October 1985) has suggested that the "surface roughness" could explain these discrepancies. A special roughness can indeed account for the above data. A small protuberance would give a low ^{60}Co activity and high CRTDs. It has, however, to be voluminous enough (effective radius $\gtrsim$15 cm) in order to produce the CRTD radial dependence observed in Fig. 1. Otherwise, the CRTD values would flatten well above the curve of Fig. 1. Moreover, this implies that in six other locations (with varying ^{21}Ne contents) no CRTDs were detected because the studied samples were in the central locations, or deeper, of large protruding edges (with an effective radius $\gtrsim$ 18 cm), in order to be totally shielded from the iron nuclei of GCR. Although this explanation can be appropriate in some cases - e.g. the fragment D of St Séverin (9) - it seems difficult to accept it because it requires too many ad hoc conditions of Jilin surface geometry which would have to be a very special raspberry.

For lack of a better explanation, we suggest that production rate models of ^{60}Co (2,3) are not appropriate to estimate depths within a near-surface layer ($\sim$25cm for Jilin, $\sim$7cm for Allende) in large meteoroids, and that the actual ^{60}Co gradient near the surface is much less steep than calculated.

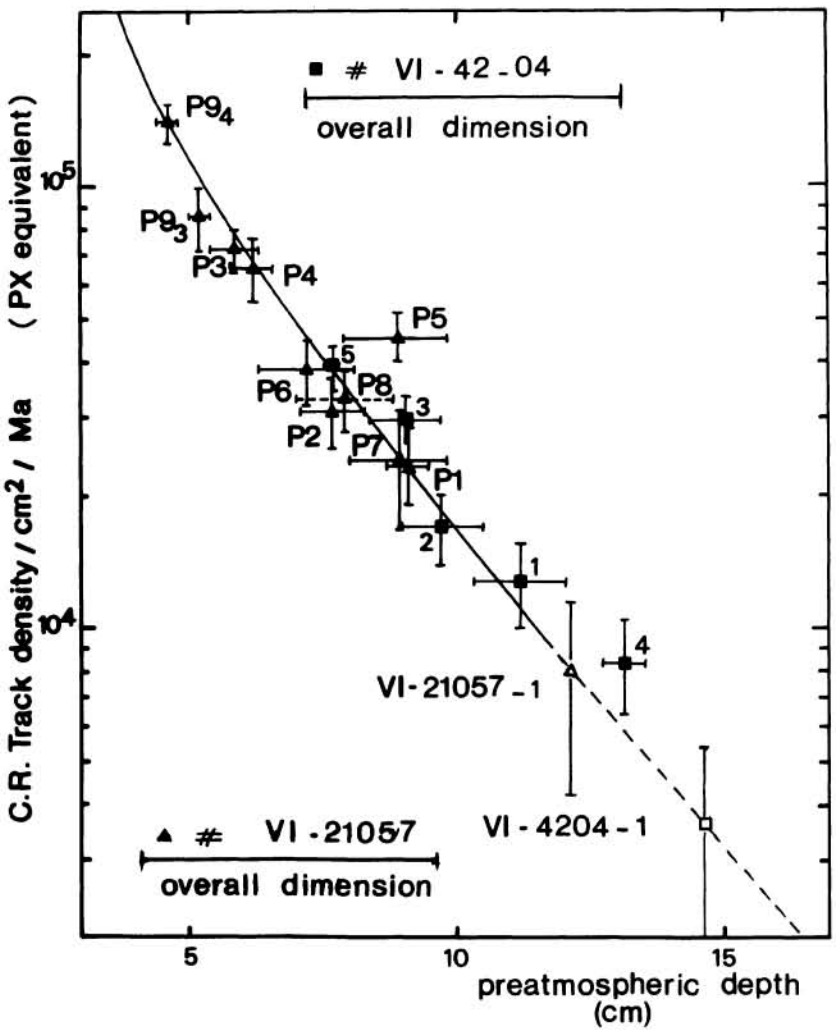

Fig.1. Cosmic-ray track densities in 2 near-surface stones of Jilin meteorite. CRTDs in olivines have been multiplied (x2.4) to get the equivalent values for pyroxenes (10). The curve corresponds to the track-density profile for R_o=100cm according to (6). Open square and open triangle represent samples whose position in the respective stone is not known. A spontaneous fission contribution of 150 ± 100 tracks(cm^{-2}) has been subtracted to all track-density values, according to (4).

References

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