GEOPHYSICS

The Frequency of Meteorite Falls throughout the Ages

IN a recent article[1] Prof. H. Pettersson describes his investigations of samples of deep-sea deposits in which were found metallic spherules, mostly less than 250μ in diameter, to which it is reasonable to ascribe a meteoric origin. These occurred in several geographical regions and in layers of various geological ages, and among the conclusions reached is the following: "In general, the number of spherules is greatest in the more recent sediments. Nevertheless, substantial numbers of spherules were found in layers of Tertiary age: this contradicts the assertion made by some authorities that no meteors fell on the Earth during that time". A reference identifies the "authorities" mentioned as the late Prof. F. A. Paneth, who, in a paper in *Vistas in Astronomy*[2], wrote: "The result of our discussion is that *glass meteorites fell on our Earth only during the late Tertiary and early Quaternary; that iron and stone meteorites did not fall before the late Quaternary; that centuries ago the fall of iron meteorites was a much more common phenomenon than to-day; and that even since 1800 meteorite falls seem to have become noticeably rarer*".

It is clear from Paneth's paper that he is discussing meteorites only, and the evidence which he gives for his statement can refer only to those bodies. He consistently emphasized the lack of evidence that meteors and meteorites have a common origin[3], and there is nothing in his conclusions that is inconsistent with Pettersson's findings. Pettersson uses the counts from his samples to generalize for the whole Earth, and concludes that the present rate of accretion is 1,000–5,000 tons per annum. Such a generalization from any sample of meteorite falls would clearly be quite invalid. It follows that Paneth's conclusions regarding the fall of meteorites in past times are unaffected by Pettersson's important observations.

In view of the recent revived interest in the analysis of meteorites[4], it might be timely to point out that Paneth's considerable collection of meteorites is now, by his wish, available for experimental study. The secretary of the "Paneth Meteorite Trust", who would welcome applications from qualified investigators, is Dr. H. Wänke, Max-Planck-Institut für Chemie, Mainz, Germany.

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[1] *Endeavour*, **19**, 142 (1960).
[2] *Vistas in Astronomy*, **2**, 1686 (1956).
[3] See, for example, *The Origin of Meteorites* (Halley Lecture, 1940, Clarendon Press, Oxford).
[4] See, for example, Bernal, J. D., *Nature*, **190**, 129 (1961).

Murray's and Renard's interpretation of the "cosmic spherules" found in deep-sea deposits[1] that they are of cosmic origin, and were probably derived from iron meteors heated to superficial melting during flight through the atmosphere, seems to be generally accepted at present. Having myself studied hundreds of such spherules, extracted from deep-sea cores taken by the Swedish *Albatross* Expedition (1947–48), I have found Murray's description of their external structure confirmed. In addition, analyses of the composition of individual spherules by the Castaign microanalyser[2] has confirmed that they contain, besides iron, also nickel and cobalt, which supports their extra-terrestrial origin as well as Murray's hypothesis that they are derived from meteors of the nickel-iron type.

The resemblance between their surfaces and that of the iron meteorites seems to support the view that they may be derived from meteorites as well as from meteors which have not reached the surface of the Earth. The presence of cosmic spherules in deposits of Tertiary age (recently confirmed by Germans investigating the "Buntsandstein" in north-west Germany) certainly supports the view that they indicate meteoric activity long before the Quaternary.

Whether the origin of meteorites and ordinary meteors is different seems to be an open question. Whipple assumes most meteors to be of cometary origin, whereas meteorites are usually assumed to be derived from planetary fragments like the asteroids. It seems to me that the origin of the meteorites and, still more, of the tektites is still under debate, whereas the origin of the cosmic spherules is that announced by Murray.

My calculation that the accretion of cosmic spherules to the Earth is 1,000–5,000 tons annually is, of course, due to extrapolation from the counts made by myself and my co-workers in a limited number of cores. I hope to obtain a more dependable figure from the much longer cores to be raised by the Moho-Project.

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[1] *Proc. Roy. Soc. Edin.*, **9**, 258 (1876–77). *Challenger Rep.*, **4**, *Deep Sea Deposits*, 327.
[2] Castaign, R., and Fredriksson, K., *Geochim. Cosmochim. Acta*, **4**, 114 (1958).

RADIOPHYSICS

Scintillations and the Latitude Distribution of Ionospheric Irregularities

KENT[1] has reported a series of observations on the 40 Mc./s. transmissions from *Sputnik* 1 made at Cambridge during October 1957. He found that the transmissions always underwent rapid fading (scintillation) when the satellite was north of Cambridge but only occasionally when south of Cambridge. He concluded that the scintillations were due to ionospheric irregularities which are north of the observing station but not south of it. Further, since the southward extent of the scintillation region was greater for satellite passes to the west of Cambridge than to the east, he postulated that the density of the irregularities is controlled by the magnetic rather than geographic latitude (Cambridge's declination is about $-9°$). Mawdsley[2] objected to Kent's seemingly arbitrary assumption that the irregularities do not occur south of the observer, on the grounds that radio star scintillations are observed at lower latitudes than that of Cambridge. He suggested an alternative interpretation of Kent's results in terms of preferential forward scattering by the irregularities, assumed to be field aligned, when the line of sight from the observer to the source is normal to the field lines. Afterwards, Bain[3] and Frihagen and Tröin[4], working at Slough and Kjeller respectively, observed scintillations when the satellite under observation was south of the observing station. However, they both found that the scintillation activity increased for geomagnetic