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THE ORBITS OF ORDINARY CHONDRITE METEOROID BODIES CONTRIBUTING TO THE METEORITIC FLUX.

P. H. Benoit and D. W. G. Sears, Cosmochemistry Group, Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville AR 72701, USA.

The orbits of meteoroid bodies are our best source of information regarding the placement of their parent bodies in the solar system. In view of the absence of direct observational data of meteoroid bodies in space, the connection between meteoroid bodies and large Earth-crossing or Earth-approaching asteroids being at best tenuous [1], our knowledge of the orbits of meteoroid bodies contributing to the meteorite flux is largely limited to indirect measurements. With the exception of four photographed meteorite falls [2], the database is limited to the less-constrained data of ~50 visually observed meteorite falls and the large dataset of photographed fireballs and meteors, which almost certainly contains many nonmeteoritic objects [e.g., 3]. The time-of-fall ("AM/PM distributions") of large groups of meteorites can also be of some use in constraining their general orbital distribution [4]. In this paper we use natural thermoluminescence (TL) measurements on modern falls among the equilibrated ordinary chondrites to constrain one orbital element, namely perihelion, for individual meteorites and hence individual meteoroid bodies.

Natural TL levels of modern falls reflect the degree of heating they have experienced while in space, usually from solar heating but in some cases possibly from impact heating [5]. Natural TL levels reach "equilibrium" levels fairly rapidly (~10^5 yr) and can thus be considered saturated in view of the long cosmic ray exposure ages of most ordinary chondrites. We have assembled a database of 120 L, LL, and H chondrites.

We find that, as a whole, ordinary chondrites among the modern falls exhibit a single major peak in their TL distribution. Using realistic assumptions for albedos of meteoroid bodies, we can calculate the approximate "average" perihelion of each meteorite in our database. We find that most meteorite bodies had perihelia of approximately 1 AU, with only a small fraction (about 15%) having orbits with perihelia < 0.85 AU, consistent with other direct and indirect databases [1,3]. There are no strong differences in the TL distributions of H, L, and LL chondrites. There is also no apparent difference in natural TL levels between AM and PM falls for ordinary chondrites as a whole. If we confine our analysis to only equilibrated H chondrites, however, we find differences in natural TL distributions of AM and PM falls (Fig. 1). While the PM H chondrite falls show a broad spread of natural TL levels between 10 and 100 krad (corresponding to perihelia between 0.85 and 1.2 AU), the AM falls show a very tight cluster, with a mean TL level of 45 krad, corresponding to a perihelion of about 0.95 AU. One possible interpretation of these data is that, while the PM meteorites come from a number of different sources reflecting different degrees of orbital evolution, most of the AM H chondrites are derived from an Earth-crossing asteroid(s). Wetherill performed orbital calculations for fragments from some current Earth-crossing asteroids and found that their fragments should reach Earth predominantly in the AM [4]. These data accentuate other data that find evidence for individual stochastic events in the H chondrites, such as the suggestions of "streams" in the modern flux [6] and evidence for changes over the 100,000 yr represented by the Antarctic meteorite collection [7].

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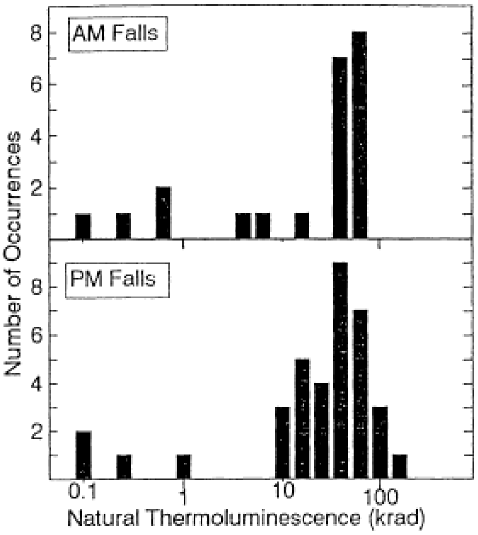

Fig. 1.