Micrometeorites – what they can and can't tell us

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Micrometeorites (MMs) are those particles of interplanetary dust that survive atmospheric entry to be recovered on the Earth's surface or in the atmosphere [1]. Since they can be studied in the laboratory MMs allow characterisation of physical and mineralogical properties with little uncertainty, however, collections of MMs are not without biases.

Bias in Micrometeorite Collections

Excluding the inherent bias imposed by atmospheric entry, all MM collections are biased by concentration and alteration. Concentrating mechanisms can relate to natural processes or collection technique and often favour dense or magnetic particles such as cosmic spherules. Even Antarctic snow collections are affected by concentration of denser particles by wind transport and erosion. Bias owing to collection technique strongly favours spherules, and magnetic particles however, targeted separation can also bias collections [2]. Terrestrial alteration is a particularly important bias [3] and significantly effects deep sea collections and those sites where exposure to water has occurred. The most extreme examples are fossil micrometeorites where mostly I-type cosmic spherules survive [4; 5]. It is argued here that absolute abundances of MMs cannot provide a high precision means of testing flux models.

Interpretation of Atmospheric Entry Processes

The most reliable data on MMs is mineralogical and textural data from individual particles. Particularly useful is constraints on atmospheric entry that reveal the importance of dehydration reactions in mediating surface temperature [6,7], fragmentation [8], volume change on melting [9]. The textures of some particles can also reveal entry velocity [10]. Finally the nature of particles can also be used as a proxy for atmospheric composition [5].

Parent Bodies of Micrometeorites

Perhaps the most significant implications of MMs are for the sources of interplanetary dust. Particles with cometary affinities are most abundant at sizes <30 microns, whilst asteroidal dust comprise >98% of MMs >50 microns [11, 12]. This contrasts strongly with models of the interplanetary dust population that suggest that Jupiter Family comets as the dominant source (50-70%) with only a minor contribution (<10%) from asteroids [13]. Furthermore evolution of cometary dust into low eccentricity orbits means the large abundance of asteroid dust cannot be explained by evaporative loss of cometary particles [14]. Resolution of this significant contradiction is important to address.

References:

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