ACCRETIONARY GROWTH OF IMPACT SPHERULES

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Introduction: Within an impact plume, liquid silicate droplets that later form spherules can grow or shrink due to condensation or evaporation, respectively, of vapor in the plume. Although it is rarely discussed, spherule growth can also occur by accretion, as smaller droplets combine to form larger droplets. Our study of Eltanin impact spherules indicates that growth by accretion is a common process that is a primary growth mechanism for at least some spherules. Most Eltanin impact spherules are observed to have smaller spherules (in extreme cases, hundreds) attached to their surfaces. This shows that these spherules formed in an environment with a high density of droplets that was probably very turbulent, causing numerous collisions. In polished sections, spherule accretion is easily documented as most droplets had oxidized surfaces, resulting in a micron-sized surface layer of magnesioferrite spinel. As spherules combine, old droplet surfaces are preserved as lines of spinel within a larger droplet to delineate the edges of accreted droplets. Microprobe analyses of different spinel-delineated zones within a spherule show that accreted droplets have heterogeneous compositions. In this study we examine the abundance of Eltanin spherules with clear evidence of accretionary growth. We compare these to similar examples in impact spherules from the late Eocene and KT boundary, as well as recent deep-sea cosmic spherules.

Methods: We examined backscatter electron images of 504 Eltanin spherules from three size fractions: 250-500, 125-250, and 63-125 µm with populations of 80, 159, and 265 spherules respectively. Spherules were counted as having grown by accretion when there was clear evidence of a droplet with a spinel rim incorporated into another droplet. We did not count spherules with external, attached droplets. We also counted the number of pure glass spherules (i.e., no spinel) for which it was impossible to tell if accretionary growth had occurred. We examined images of 128 Eocene cpx spherules (ODP Hole 709C, W. Indian Ocean), 165 KT boundary spherules (DSDP Site 577, NW Pacific), and 87 silicate cosmic spherules (Cosmic Muck Rake) that crystallized from droplets. For the non-Eltanin spherules obvious tracers such as spinel rims were not usually present, so inclusions (often spherical) with distinct compositions or crystallization textures were taken as evidence of accretion.

Results: Of the 504 Eltanin spherules, 130 were pure glass and accretion could not be determined. Of the remaining 374, 173 or 46% of the spherules had signs of accretionary growth. Surprisingly, as many as 15% of the Eocene cpx spherules and 10% of the KT boundary spherules had accretion. Only one (or 2?) cosmic spherules might be interpreted to have grown by accretion. Variables that might influence the observed difference in abundances of accretionary spherules: the most abundant such spherules occur in the smallest impact, at localities closest to the impact site (i.e., with lowest ejecta velocities). Accretion resulted in some large, irregularly shaped spherules formed from multiple droplets that did not reform as a sphere. Similar irregular objects reported in a Jurrasic hardground [1] might be evidence of an impact origin for that deposit.

Reference: [1] Jehanno C. et al., 1988, Proc. 18th LPSC, 623-630.