O-ISOTOPE MAPPING OF FINE-GRAINED MATERIAL COLLECTED FROM COMET 81P/WILD 2.

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Introduction: Most mineralogical and isotopic studies of particles returned by the Stardust Mission have thus far focused on the coarse (> 2µm) terminal particles, which were largely shielded from capture heating due to their thermal inertia. The capture process does, however, tend to sort sub-grains of polycrystalline aggregates, and Wild 2 fines (< 2µm) are concentrated in the upper portion (hypervelocity regime) of impact tracks [1,2]. These grains have been thermally altered, melted, and mixed with surrounding silica aerogel to varying degrees [1,2] such that aerogel and comet dust cannot be readily separated.

Minor elements (Mn, Cr, Ca, Al) in olivine/low-Ca pyroxene from coarse-grained terminal particles indicate that these silicates in Wild 2 are predominantly derived from chondrules and amoeboid olivine aggregates (AOAs) [3], primary components in chondritic meteorites. In general, high-temperature, inner solar system material is characteristic of Wild 2 terminal particles [e.g. 3-7]. Compared with these coarser grains, Wild 2 fines have a wider range of δ17O and δ18O, spanning the entire range of known solar system materials [8]. The isotopically light and heavy (relative to chondrules) fines in Wild 2 may represent the more-primitive, outer solar system component of comets [8]. We presume that Wild 2 fines are derived from a mixture of chondrite matrix (chondrule fragments and other nebular components) and Kuiper Belt condensates. The fines may also include elusive presolar grains, which have a poorly constrained abundance in Wild 2.

Samples and Methods: Melted/compressed silica aerogel from the Stardust Mission collectors can have opaque inclusions and appear granular, and the existence of cometary material in these wall grains generally cannot be determined optically. We separated aerogel fragments that harbor opaque assemblages from the walls of tracks with micromanipulators operated both automatically and manually. The resulting ~10-20µm2 particles were then embedded with Embed-812 epoxy, mounted at the tips of epoxy bullets, and ultramicrotomed to expose the grains. The bullets were then examined by SEM (Fig. 1) for resolving Mg- and Fe- rich particles > ~100nm. We measured the aggregates in scanning ion imaging mode with the University of Hawai’i Cameca ims 1280. For these measurements, the bullets are mounted in our reversible sample holder [8]. We use a ~1pA Cs+ ion beam, yielding ~0.4 µm spatial resolution. The mass resolving power of ~5000x minimized the interference from 16OH on 17O and 16OH was monitored so that we can make. We measure FeO and MgO as tracers of cometary material in addition to 16O, 17O, and 18O.

Results: Our preliminary results show that some Fe- and Mg-bearing regions do not have resolvable O-isotope anomalies relative to terrestrial oxygen. This may reflect heavy dilution with melted aerogel. Although [8] found 0.056 analyzable grains per µm2 dispersed in track walls, our partly melted aggregates had < 0.014. This may also reflect melting of the smallest grains as well as heterogeneous emplacement of Wild 2 fines in track walls. Although O-isotope measurements of Wild 2 fines may be hindered by dilution, cometary material in track walls is abundant.


Figure 1: BSE image of track wall grain after ultra-microtomy. Note the fluffy, vesiculated texture that characterizes upper track wall material. Grains with a likely cometary origin appear as small (~100-200nm) bright spots.

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