STARDUST: Composition of Wild-2 Samples

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On Jan. 2, 2004 NASA's Stardust spacecraft flew through the coma of comet Wild-2, capturing particles in a low-density silica aerogel collector. The objective was to capture >1,000 particles >10 micrometers in size. Stardust delivered the samples to Earth on Jan. 15, 2006. A description of the collection and the capture cells is in Tsou et al. [1]. Wild-2 is a short-period comet, believed to have originated in the Kuiper Belt. Thus, analysis of Wild-2 dust provides the first opportunity to probe conditions in the Kuiper Belt during dust formation and compare them with conditions in the asteroid belt, as inferred from primitive meteorites.

In preparation for the Stardust return, F. Hörz (NASA JSC) shot dust from the Allende meteorite and a microprobe standard "unknown" into aerogel cells. Samples of both were provided to each group participating in Stardust composition preliminary examination. Allende provides an indication of the elements each instrument can detect in a chondritic sample while the "unknown" insures consistency in analyses among the laboratories on 4 continents that are participating in the examination.

In the ideal case, aerogel capture results in gentle deceleration, giving a single terminal particle at the end of a conical track whose length is a few hundred times the diameter of the particle. However, weak material, e.g., the Murchison carbonaceous meteorite, shot into aerogel at ~6 km/s, comparable to the Stardust encounter with Wild-2, frequently leaves many fragments along the track. Capture results in accretion of a silica coating on the particle [1], suggesting contact with liquid silica, which could mobilize moderately volatile elements during collection. Thus we expect shedding or evaporative loss of material as the particle moves down the track.

The Composition Analysis Team is employing x-ray and proton microprobes to map the distribution of elements along whole entry tracks that were extracted as "keystones," described by Westphal et al. [2], from the aerogel, in order to determine the pre-capture composition of Wild-2 particles. Once the particles have been extracted from the aerogel, the team will employ TOF-SIMS and SEM-EDX to determine the compositions of the extracted particles and employ a Nuclear Microprobe and EELS to determine the C and N content of terminal particles.

References: [1] Tsou, P. et al. (2003) JGR, 108, E10, 3.1-3.21. [2] Westphal, A. et al. (2004) Meteor. Planet. Sci., 39, 1375-1386.