CHEMICAL AND MINERALOGICAL PROPERTIES OF COMETARY SAMPLES CAPTURED BY STARDUST.

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Introduction: Dust particles from comet Wild 2 were collected by the Stardust mission and returned to Earth in 2006 [1]. Low-density silica aerogel was used as primary capture medium to gently decelerate impacting dust particles in an effort to preserve them as intactly as possible. However, at a sampling velocity of 6.1 km/s, most particles fragmented and most cometary material was heavily altered. Understanding the effects of aerogel capture on Wild 2 dust is a prerequisite to relate the properties of the material collected by Stardust to their cometary origin.

Samples and Analytical Techniques: Time-of-flight secondary ion mass spectrometry (TOF-SIMS) and transmission electron microscopy (TEM) were used to study fragments of cometary matter extracted from tracks in Stardust aerogel [2–4]. Sections of nine cometary fragments from five different tracks have been studied by TOF-SIMS so far. Four samples are so-called terminal particles, while the remaining five fragments were extracted from the walls in the aerogel along the tracks. Samples, terminal particles as well as track wall material, from two other tracks are presently under investigation.

Results: TOF-SIMS results show that all Wild 2 fragments extracted from the walls along tracks are dominated by Si, with Si/Mg ratios between 40 and 64, but have CI-like abundances of major and minor elements relative to Mg. TEM measurements revealed that during the capture process the cometary material melted and mixed with aerogel that also partially melted. These samples consist of silica-rich glass with varying Fe, Mg, and Si contents and small FeNi and FeS spherules.

Two of the four terminal particles in this study survived the capture process with less alteration. Their Si/Mg ratios of 1.2 and 1.0, respectively, are close to CI (0.93). They have thin coatings of compressed and melted aerogel with some adhered material similar to the capture-melted fragments. However, both samples were primarily single- to coarse-grained crystalline mineral phases (enstatite) in contrast to the mixed glasses in track walls.

However, not all terminal particles survived the impact into aerogel intact. The other two terminal particles in this study showed melting and mixing with aerogel (Si/Mg ratios of 20 and 70, respectively) like all fragments from along the tracks.

Conclusions: The results suggest that Wild 2 particles, prior to their encounter with Stardust aerogel, consisted of a mixture of single and multi-mineralic grains, embedded in a fine-grained, porous matrix, which is probably similar to chondritic porous interplanetary dust particles [5]. During impact into the aerogel, the matrix was stripped from the larger mineral grains, melted and mixed with aerogel, and deposited along the track walls. The more compact mineral grains survived as terminal particles.