INVESTIGATING CARBONATE SURVIVAL IN STARDUST ALUMINUM FOILS.

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Introduction: Hydrous meteorites and interplanetary dust particles commonly contain carbonates believed to result from parent body aqueous alteration. Such alteration requires the prolonged presence of liquid water, and comets, generally believed to have remained frozen since their accretion, were not expected to contain these minerals. Intriguingly, the presence of carbonates in cometary nuclei was inferred from VEGA 1 and 2 mass spectrometry data obtained from comet 1P/Halley [1] and Spitzer space telescope spectra obtained from comet 9P/Temple 1 [2]. Recently, carbonates were positively identified in samples of comet 81P/Wild 2 collected in Stardust aerogel [e.g. 3,4]. However, the authors recognized concerns over aerogel pre-mission purity and post-mission contamination. Confirmation of cometary carbonates may be provided by analyses of Stardust Al foils. However, collection by impact at 6 km s^{-1} likely caused alteration requiring impact analogue investigations to assess the effects.

Method: Powdered calcite was fired in light gas gun shots at flight spare Al foils under Stardust encounter conditions. Scanning electron microscopy with energy dispersive X-ray analysis (SEM EDX) was used to locate regions of residue. Focused ion beam (FIB) microscopy was used to prepare sections from pre-impact projectile and post-impact crater residues for analysis and comparison by transmission electron microscopy (TEM).

Results and Discussion: TEM analyses show calcite residues in craters >50 µm are a mixture of crystalline and amorphous material. Crystalline materials exhibit close to pre-impact projectile compositions and polycrystalline structure. This material is interpreted as surviving impactor. Amorphous material is vesiculated and contains Al suggesting a melt origin and loss of volatiles. Although calcite decomposes releasing CO_2 at high pressures [e.g. 5], the amorphous residue chemistry is depleted in C but not O relative to the original projectile, possibly as a result of incorporating and oxidizing Al as observed in previous studies of phyllosilicate residues [6]. We conclude that where surviving material is not found, carbonates may be identified by their amorphous vesiculated residues which retain original cation to O ratios but have incorporated Al. The Al foils therefore represent a valuable sample set for investigation of cometary carbonates.

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