MASS SPECTUM IMAGING OF ORGANICS INJECTED INTO STARDUST AEROGEL BY COMETARY IMPACTS.
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Introduction: Comets have largely escaped the hydrothermal processing that has affected the chemistry and mineralogy of even the most primitive meteorites. Consequently, they are expected to better preserve nebular and interstellar organic materials. Organic matter constitutes roughly 20-30% by weight of volatile and refractory cometary materials [1,2]. Yet organic matter identified in Stardust aerogel samples is only a minor component [3-5]. The dearth of intact organic matter, fine-grained and presolar materials led to suggestions that comet 81P/Wild-2 is composed largely of altered materials, and is more similar to meteorites than the primitive view of comets [6]. However, fine-grained materials are particularly susceptible to alteration and destruction during the hypervelocity impact. While hypervelocity capture can cause thermal pyrolysis of organic phases, some of the impacting organic component appears to have been explosively dispersed into surrounding aerogel [7]. We used a two-step laser mass spectrometer to map the distribution of organic matter within and surrounding a bulbous Stardust track to constrain the dispersion of organic matter during the impact.

Methods: Stardust track #147 is a type B/C bulbous track, 4600 μm long with 7 terminal particles [8,9]. A cube of aerogel, ~3 mm in size and encompassing one hemisphere of the track bulb was removed for organic analysis. The sample was photo-documented by optical and fluorescence imaging before being analyzed by microprobe two-step laser desorption / photoionization mass spectrometry (μ–L^2MS). To anchor the aerogel in place during analysis it was sandwiched between a Teflon disc (below) and a stainless steel electroformed mesh (above). The distribution of organic species was mapped at 10 μm spatial resolution using a vacuum ultraviolet (VUV) photoionization source capable of non-resonant single photoionization of virtually all types of organic species.

Results & Discussion: In aerogel proximate to the track bulb we found a complex and highly variable distribution of organics, including both aliphatic (e.g., pentane C_5H_{12}) and aromatic species (e.g., C_2-phenanthrene $C_{16}H_{14}$) as well as alkyl fragments and heteroatom species (e.g., ammonia NH_3). From the spatial distribution pattern it appears that the organic matter radiate outward from a source in the track bulb. We have previously observed that hypervelocity impact of organic-rich projectiles into aerogel can lead to entrapment of organic species outside the physical extent of the impact. Previous analysis of Stardust tracks by infrared spectroscopy has also suggested the injection of volatile organics into surrounding aerogel [4]. From our results it seems possible that a significant fraction of the organic matter present in Stardust aerogel tracks may lie in halos extending beyond their boundaries.

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