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SIMS Oxygen 3-Isotope Analyses of Particles in Bulbous Aerogel Tracks of Comet 81P/Wild 2

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Crystalline silicate particles recovered from silica aerogel tracks of comet 81P/Wild 2 provided important insights on the nature of solids in outer regions of the protoplanetary disk [1]. Large bulbous tracks containing numerous small (<10 μm) fragments were likely produced by weakly bounded fine-grained particles, analogous to cluster IDPs and chondritic matrix. The fragments are unequilibrated minerals displaying a wide range of mineralogy, chemistry, and oxygen isotope signatures [e.g., 2-3].

For SIMS oxygen isotope analyses, aerogel track keystones are flattened and embedded in acrylic resin, which were cut into ~100 μm cubes and ultramicrotomed to expose individual particles [3]. However, in the case of aerogel tracks containing numerous fragments in the bulbous region like track 220 [4], only a small number of fragments could be exposed by ultramicrotomy, while the majority remain under the surface of resin blocks and could not be analyzed by SIMS or other in-situ techniques.

We developed a new procedure to analyze the mineralogy and oxygen-3 isotopes of subsurface Wild 2 fragments [4]: (1) expose subsurface fragments by ion sputtering using a 22 μm circular homogeneous Cs^+ ion beam of IMS 1280, while monitoring the major element signals (such as $^{24}Mg^{16}O^-$), (2) confirm the exposure of fragments by secondary ion imaging with 1 μm lateral resolution, (3) determine major element compositions using FE-EPMA (12 kV, 0.5 nA), and (4) mark the analysis locations using FIB and obtain their oxygen-3 isotope ratios using a 1.5-2.0 μm-sized ion beam (for >2-3 μm fragments, 2SD of $\Delta^{17}O$ is ~2-3‰) or a submicron beam (0.8 ×0.5 μm, for <1-2 μm fragments, 2SD of $\Delta^{17}O$ is ~4-8‰) [5]. The procedure was tested in-parallel with San Carlos olivine and 7244-Aug augite standards, demonstrating its reliability and efficiency of mining tiny fragments within 6 μm below the surface.

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