Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.22025

Presolar and Interstellar Carbonaceous Matter in Asteroid Bennu

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Introduction. The delivery of samples from asteroid (101955) Bennu by NASA's OSIRIS-REx mission gives us a new opportunity to elucidate the formation mechanism(s) and evolution of presolar and interstellar carbonaceous matter, including presolar grains and organics. Whereas presolar grains provide insight into the building blocks of our Solar System, studying organics can help us understand the origin of life on Earth [1, 2]. These organics might have contributed to ingredients that helped life emerge [2]. Here, we report on our ongoing work to characterize the isotopic and chemical compositions, microstructure, and abundance of insoluble organic matter (IOM) and presolar grains in Bennu samples.

Samples and Methods. The materials included in this work were collected from the exterior of the Touch-and-Go Sample Acquisition Mechanism (TAGSAM) on the avionics deck of the return capsule as part of the "quick-look" analyses [3]. We analyzed a polished mount with eight hummocky particles (OREX-501080-0) and two aggregate samples prepared by pressing particles into high-purity gold foils (OREX-501045-0 and OREX-501049-0). We conducted all the analyses in the University of Arizona's Kuiper-Arizona Laboratory for Astromaterials Analysis (K-ALFAA). Each sample was first characterized using a Keyence VHX-7000 digital 4K optical microscope and a Hitachi TM4000Plus tabletop scanning electron microscope (SEM). We then searched for search for isotopically anomalous diffuse IOM and presolar carbonaceous materials (e.g., SiC, graphite) using the CAMECA Next-Generation Nanoscale Secondary Ion Mass Spectrometer High-Resolution (NanoSIMS-HR).

Results and Discussion. Initial characterization of the three samples showed that they are mainly composed of magnetite, hexagonal Fe-sulfide grains, carbonaceous matter (both as discrete nanoglobules and more diffuse C-rich areas), anhydrous silicates (e.g., olivine and pyroxene), Mg-phosphates, and carbonate grains in a groundmass of Mg-rich phyllosilicates.

In addition to at least 34 presolar grains with C isotopic anomalies, we identified numerous C and/or N isotopically anomalous regions associated with C nanoglobules and more diffuse IOM regions.

Acknowledgments: Supported by NASA under award NNH09ZDA007O and contract NNM10AA11C.

References: [1] Glavin D. P. et al. (2018) doi: 10.1016/B978-0-12-813325-5.00003-3. [2] Floss C. & Haenecour P. (2016) doi: 10.2343/geochemj.2.0377. [3] Zega et al. (2024) 55th LPSC, abstract #2348.