PRESERVATION OF GEMS AND PRESOLAR SILICATES IN AN ULTRACARBONACEOUS CLAST IN LAPAZ ICEFIELD 02342 (CR).


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Introduction: In general, chondritic porous interplanetary dust particles (CP-IDPs) preserve a higher abundance of minimally processed nebular and interstellar material than do even the most primitive meteorites. GEMS, discrete, 150 to 500 nm amorphous silicate grains with nm-scale embedded Fe, Ni metal and sulfides, are a characteristic feature of CP-IDPs [1], but have been identified in only one meteorite: Paris (CM) [2]. Similarly, the abundance of presolar silicate grains is typically several hundred ppm or more in CP-IDPs, but only tens to a few hundred ppm in primitive chondrites [3]. One explanation for the underrepresentation of presolar silicates and GEMS in meteorites is that aqueous alteration was more pervasive on the asteroid parent bodies of chondrites than on the parent bodies of CP-IDPs, possibly comets. However, differences in the nebular and interstellar components delivered to the respective parent bodies also could have contributed to this disparity. In addition, the recovery of pristine ultracarbonaceous Antarctic micrometeorites (UCAMMs), which are up to 90% organic carbon but also contain well-preserved GEMS, raises the question of the role of carbonaceous coatings in protecting primitive silicates against hydrothermal alteration [4]. A newly discovered ultracarbonaceous clast contained in LaPaz Icefield (LAP) 02342 (CR) [5], for which the presolar silicate abundance is 100 to 400 ppm, compared to 30 ppm in the matrix [6], lends credence to the protective role of carbon. Here we report the results of scanning transmission electron microscopy (STEM) and x-ray absorption near edge spectroscopy (XANES) analyses of the clast and matrix, which reveal that abundant GEMS are preserved in the C-rich clast and not in the matrix.

Experimental: Optical petrography, SEM and NanoSIMS H, C, N, and O data have been reported [5,6]. Five ultrathin sections, three from the C-rich clast and two from matrix areas, were prepared with an FEI Nova 600 FIB-SEM at NRL. STEM imaging, EELS and EDX were performed with the NRL Nion UltraSTEM 200. C K edge XANES of two clast and one matrix section were measured at beamline 5.3.2.2 of the Advanced Light Source.

Results and Discussion: The difference in overall carbon abundance between the clast and the matrix was readily observed in SEM, SIMS, STEM and XANES measurements. In the matrix, the organic matter (OM) was mostly in individual sub-micron blebs, and comprised a few percent of the total area analyzed. In the C-rich clast, the OM accounted for >50% of the area, and the general mineralogy was very similar to reported observations of UCAMMS [4]. However, both sections analyzed showed similar functional group chemistry in the C XANES spectra, with prominent features typical of prior studies of organic matter in CRs [7], consistent with moderate levels of hydrothermal alteration. STEM analysis of sections from both areas revealed amorphous silicates, sulfides and carbonate. Only the clast contained preserved GEMS, which appear to survive alteration due to the protection of abundant organic matter. The similarity of this ultracarbonaceous clast to the UCAMMs and CP-IDPs suggests it may have a relationship to cometary materials, perhaps as a preserved fragment of the primordial building blocks of comets.


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