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STXM studies of samples from Asteroid Bennu

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As part of the comprehensive plan to investigate samples of asteroid (101955) Bennu[1], we have performed STXM (scanning transmission X-ray microscopy) studies of sections of returned particles thinned by FIB (focused ion beam). These particles have also been investigated by transmission electron microscopy and micro–Fourier transform infrared spectroscopy[2]. STXM (Advanced Light Source beamline 5.3.2.2) provides spatially resolved X-ray absorption near-edge structure (XANES) spectra at the C-K, O-K, and Fe-L-edges. These results help us understand the minerals and organics of Bennu in the context of other aqueously altered bodies.

Carbon XANES provides information about the presence and distribution of organic functional groups[3], which can be used to assess the diversity of carbonaceous species within and between nanoglobules, as well as carbon dispersed throughout the phyllosilicate matrix, as was done in previous studies of chondrites and asteroid (162173) Ryugu samples[3,4]. We find a variety of nanoglobule chemistries in Bennu, both within and between individual FIB sections and particles. Fe L-edge XANES can be used to map Fe oxidation states[5] such that they can be spatially compared with the local mineralogy and C chemistry. We find, for instance, that in the phyllosilicate matrix, Fe is generally mixed-valent, with the coarser-textured material being richer in Fe^{3+}.

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