

PRISTINE X-RAY COMPUTED TOMOGRAPHY IMAGING OF STONES RETURNED FROM ASTEROID BENNU. S. A. Eckley¹, N. G. Lunning², E. W. O’Neal¹, J. Plummer¹, R. C. Funk³, C. Calva⁴, J. Ferdous¹, N. Hernandez³, G. Lugo¹, S. Martinez¹, M. Montoya¹, E. V. Rivera⁵, D. J. Rohmer⁴, H. C. Connolly Jr.^{6,7,8} and D. S. Laurretta⁷, ¹Amentum, JETS2, NASA JSC, Houston, TX (scott.a.eckley@nasa.gov), ²NASA JSC, Houston, TX, ³GeoControl Systems, Inc., JETS2, NASA JSC, Houston, TX, ⁴Barrios Technology, Inc., JETS2, NASA JSC, Houston, TX, ⁵Mclaurin Aerospace, JETS2, NASA JSC, Houston, TX, ⁶Department of Geology, Rowan University, Glassboro, NJ, ⁷Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, ⁸Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY.

Introduction: NASA’s OSIRIS-REx mission collected 121.6 g of material from the surface of asteroid Bennu and returned it to Earth in September 2023 [1]. The Bennu sample is kept in a curation-pristine environment—that is, under gaseous nitrogen (GN₂)—by the Astromaterials Acquisition and Curation Office at NASA JSC (JSC-Curation) [2]. A goal of JSC-Curation’s preliminary examination is the characterization of the bulk sample using nondestructive methods, including X-ray computed tomography (XCT) [3]. Here we discuss the acquisition of XCT data under curation-pristine conditions and show some of the textural variability in the returned sample.

Sample Holders: We designed and built custom curation-pristine sample holders for XCT scanning that are made of curation-compliant materials, air-tight [4], sufficiently X-ray transparent, and compatible with the XCT instrument configuration. A sample is sealed in the sample holder then the entire sample holder assembly is placed into a Teflon bag and sealed with a clip before removal from the glovebox. The Teflon bag remains on and closed during transfer to and from the XCT lab and during the entire XCT scanning process, which requires using tape to conform the bag as closely to the sample holder as possible in order to minimize the outer diameter of the sample holder and bagging (Fig. 1).



Figure 1: Curation-pristine sample holder in XCT instrument (left) and the same holder with outer Teflon bag and clip tightly taped (right).

XCT Data Acquisition: XCT scanning is performed in the Astromaterials X-ray Fluorescence and Computed Tomography (X-FaCT) Laboratory at NASA JSC using a Nikon XTH 320 scanner equipped with a high-resolution 180 kV transmission target source. The X-ray tube is set to 110 kV and 3.0 W for all scans. Each scan lasts from around 4.5 to 7.0 hours and reconstructed voxel sizes vary from 5.50 to 13.00 $\mu\text{m}/\text{voxel}$ edge.

Results: At the time of abstract submission, we have imaged 52 stones with a combined mass of 15.20 g, representing 12.5% of the total returned sample mass. The XCT data reveal a diversity of textures and phases.

The most obvious textural characteristic is that several stones have a single lithology that is apparent in the XCT data, whereas others have multiple three-dimensional texturally coherent domains that vary in size, abundance, and roundedness (Fig. 2).

Other unique features include: veins and filled fractures of different materials, size, and shapes; macrovoid spaces; mm-sized pyrrhotite assemblages; single-phase crystals up to around 1 mm; and several chondrule-like features.

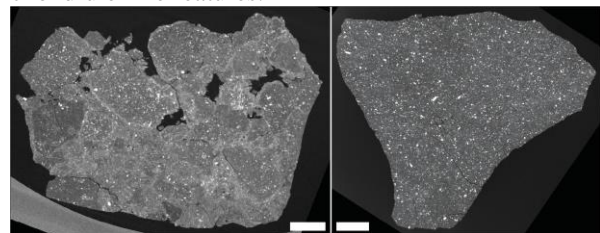


Figure 2: Grayscale XCT slices of OREX-800089-0 (0.313 g; voxel size = 9.50 μm) with multiple 3D texturally coherent domains (left) and OREX-800098-0 (0.150 g; voxel size = 6.25 μm) with a single apparent lithology (right). Scale bars are 1 mm.

References: [1] Laurretta D.S. & Connolly H.C. Jr. et al. (2024) *MAPS* 59, 2453–2486. [2] Lunning N.G. et al. (2025) *LPSC* 56, Abstract #1496. [3] Righter K. et al. (2023) *MAPS*. 58, 572–590. [4] Montoya, M. et al. (2024) *Hayabusa Symposium*.