X-Ray Computed Tomography of Diogenite Meteorites to understand their formation and Improve Sample Processing Techniques

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Diogenite meteorites are a group of orthopyroxene-rich cumulate rocks commonly believed to originate from the asteroid 4 Vesta. They have been studied extensively in 2D and here we present one of the first 3D investigations using X-ray CT. We imaged 5 diogenites at the Astromaterials X-Ray Fluorescence and Computed Tomography (X-FaCT) Lab at NASA JSC using a Nikon XTH 320 scanner with a 180 kV transmission target source. Reconstructed voxel sizes varied from 6.57 to 9.87 µm/voxel edge. To confirm the mineralogy of the phases present in the XCT data, we performed Raman analyses on exterior surfaces through each sample's Teflon™ bagging, thereby maintain sample pristineness. We used *Dragonfly's* (Comet Tech.) deep learning capabilities to automatically segmented resolvable phases to (1) determine their whole-rock abundances and (2) measure the shape and orientation of isolated minerals and void spaces. We also found new and unique features, such as a large dunitic/xenolithic clast in LaPaz Icefield (LAP) 031381,0 (Figs. 1A and 1B) and a chromite-plagioclase intergrowth in Miller Range (MIL) 090107,27 (Figs. 1C and 1D), that are related to the petrogenetic evolution of the meteorites. We used the X-ray CT data to prepare polished thick sections along a specific plane that maximizes exposure of these features. This preliminary X-ray CT investigation of diogenite meteorites has: (1) allowed for measurements of whole-rock mineral abundances, (2) shown that there is no (or very weak) mineral shape preferred orientation, and (3) revealed new features that have been strategically exposed on polished sections for subsequent in-situ geochemical analyses.

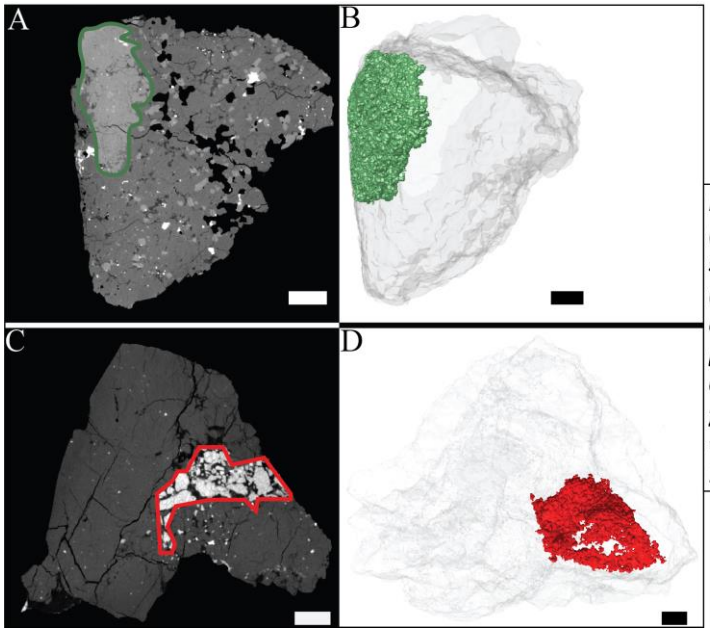

Figure 1: (A) XCT dunitic/xenloithic clast (green outline) in LAP 031381,0. (B) 3D surface rendering of dunitic/xenloithic clast (green) orientated along the same viewing direction as (A). (C) XCT slice of chromite-plagioclase feature (red outline) in MIL 090107,22 (D) 3D surface renderings of feature (red) orientated along the same viewing direction as (C). All scale bars are 1mm