INFORMED SAMPLE SECTIONING GUIDED BY X-RAY COMPUTED TOMOGRAPHY.

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Introduction: Preparation of thin/thick sections is typically the first step in the investigation of astromaterials using light microscopes, electron beam techniques, ion microprobes, etc. This process typically results in a randomly oriented section whose three-dimensional (3D) spatial context within the larger sample is unknown. These randomly oriented sections may not expose a "representative" surface, especially for samples that have large objects sparsely distributed in a finer-grained groundmass (e.g., porphyritic rocks). For example, a recent X-ray computed tomography (CT) study of Martian meteorites showed the modal abundance of olivine phenocrysts on any given plane within a single sample varied from 0 to 31% [1]. Without characterization prior to sectioning, unique and rare features may be missed altogether, and thus go unstudied. In this abstract we demonstrate how the curation facilities at NASA-JSC utilize X-ray CT to achieve sectioning of astromaterials along predetermined planes-of-interest.

Methodology: X-ray CT is a non-destructive technique to image the interior of opaque objects in 3D. The Astromaterials X-ray CT Laboratory at JSC is equipped with a Nikon XT H 320 scanner that is capable of imaging a wide range of sample types and sizes from ~0.5 mm to 15 cm [2]. As part of a larger shergottite investigation, we CT scanned ~5 g chips of olivine-phyric shergottites Larkman Nunatak 12011, Larkman Nunatak 12095, and Elephant Moraine 79001 (lithology A). The CT data were then used to inform subsequent sample sectioning.

The sectioning process followed this procedure: (1) We identified the largest olivine crystal that did not touch the sample boundary; (2) we oriented a plane that cut directly through the central section of the olivine-of-interest; (3) we extrapolated the targeted plane to a digital rendering of the sample's exterior surface; (4) by correlating fiducial markers on the digital surface to the actual stone, we were able to mark where a thick section was to be made; (5) we cut the sample and prepared the thin section. The targeted CT plane and the CT plane re-oriented to match the thick section surface are nearly identical (Figure 1). Similar results were obtained for samples LAR 12011 and EETA 79001.

Conclusions: This technique has many uses for the curation and research of astromaterials:

- To create a 3D digital record of where thin/thick sections are produced from the larger sample
- To ensure that thin/thick sections or larger aliquots are "representative" of the whole sample
- To enable thin/thick sections to be cut at specific orientations to apparent or measured fabrics
- To establish that core-to-rim traverses are from true central sections (Figure 1)

This technique allows collection managers to maximize the scientific output by "looking" inside their samples before allocating and tailoring sections to individual investigators' needs.

Future Work: Currently, we have produced targeted sections using internally derived CT data for relatively large features. Soon we will attempt this process using external CT data from a PI to make a targeted section to expose an individual trace-element phase. We are developing a procedure to CT scan a sample, then create a 3D printed holder with systematic fiducial markers that will make sectioning along a specific plane more accurate. Targeted sectioning is only one way that CT scanning can be leveraged to improve astromaterials sample processing. We have also used the technique to subsample glass melt veins for a PI across a large sample, providing lithologic context for samples prior to destructive analyses and verifying that the allocated sample had the necessary phases needed for an isochron study prior to disaggregation.

References: [1] Eckley, S. A. et al. *in prep*. [2] Eckley, S. A. et al., (2020) 51st LPSC, abstract # 2182.

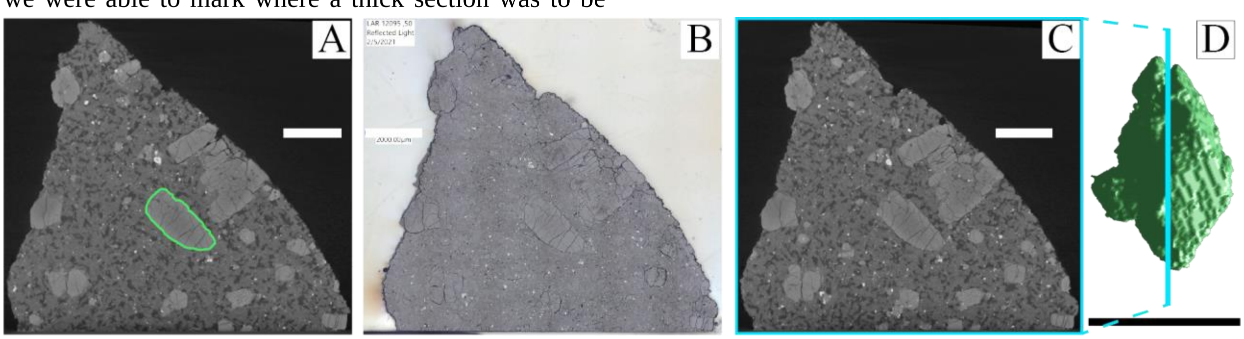

Figure 1: (A) Targeted CT plane through central section of olivine-of-interest (green). (B) Reflected-light image of resulting thick section. (C) CT plane (from original scan) re-oriented to match thick section surface. (D) Re-oriented CT plane of thick section surface (blue line) through volume rendering of olivine-of-interest. All scale bars are 2 mm.