CORRELATED TWO- AND THREE-DIMENSIONAL MINERALOGY AND PETROGRAPHY OF THE C3.00-UNGROUPED CHWICHIYA 002 AND C2- UNGROUPED TARDA CARBONACEOUS CHONDRITES

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Introduction: Chwichiya 002 (total mass of 779g) is a meteorite that was found close to Houza village by Elho Sbiti on June 10, 2018. Initial characterization showed that it is composed of 73.4 vol% of fine-grained matrix, 12.9 vol% of chondrule, 7.8 vol% magnetite, 4.9 vol% sulfides, and no calcium-alumnum-rich inclusions (CAIs) were observed [1-3]. While its bulk O isotopic composition suggests affinities with CM chondrites, it was classified as a type 3.00 ungrouped carbonaceous chondrite due to its very low abundance of hydrous phases and larger chondrules (average diameter = 480 ± 300 μm). Raman measurements also indicated that it experienced less thermal processing than Semarkona, the least heated type 3 ordinary chondrite [1]. Recently, Irving et al. [3] suggested that Chwichiya 002 might be part of a new distinct CT chondrite group (named after the Telakoast 001 meteorite).

Tarda (total mass of 4 kg) was observed falling through the Earth's atmosphere on August 25th, 2020, and fragments were recovered close to the village of Tarda in southern Morocco. Initial characterization of Tarda showed that it is a brecciated carbonaceous chondrite predominantly consisting of an optically opaque fine-grained matrix (~80 vol.%) with a large abundance of hydrous phases [1]. Its bulk mineralogy is consistent with a petrologic grade 2, and its bulk oxygen isotopic composition shows a bimodal distribution consistent with both CI and CY chondrites [1, 4]. Based on all these observations, Tarda was classified as a Type 2 ungrouped carbonaceous chondrite. Recent studies showed similarities between Tarda and another C2-ungrouped chondrite, Tagish Lake, and suggested a potential origin from the same outer solar system asteroid [5-7].

We are reporting initial results on our ongoing project to correlate three-dimentional (3D) observations from micro-X-ray computed tomography (μXCT) of carbonaceous chondrites with high-resolution two-dimentional electron (secondary and backscattered) and energy dispersive spectrometry (EDS) mapping of slices produce by microtomy.

Samples and Methods: A chip of the Chwichiya 002 meteorite was first embedded into the tip of an epoxy bullet. A small fragment of the Tarda meteorite and the epoxy tip with Chwichiya 002 were then scanned using micro-X-ray computed tomography (μXCT) with a Zeiss Versa 620 XRM microscope at the University of Texas High-Resolution X-ray CT (UTCT) Facility in Austin, Texas. The samples were scanned using the following scan parameters: Chwichiya 002 (total slices = 1659): 0.4X detector, 100kV, 14W, 2.75s acquisition time, 3001 views, LE3 filter, and dithering (to prevent ring artifacts). Tarda (total slices = 1166): 0.4X detector, 100kV, 14W, 10s acquisition time, 3001 views, LE1 filter, and dithering. The scans have been reconstructed using Xradia Reconstructor and then visualized using ImageJ and Dragonfly™ image processing softwares. The scans produced a 3D volumes with final reconstructed voxel sizes of 3.83 microns/voxel and 1.75 microns/voxel, respectively for Chwichiya 002 and Tarda.

Following the μXCT scanning, the embedded samples will be sliced into serial sections using a Leica ultramicrotome in the Lunar and Planetary Laboratory at the University of Arizona (UA). The slices will be deposited onto TEM Cu grids for imaging using the Hitachi TM4000Plus II tabletop secondary electron microscope (SEM) and Hitachi HF5000 transmission electron microscope (TEM) in the UA Kuiper Materials Imaging & Characterization Facility.

Results and Discussion: : Initial qualitative analysis of the two μXCT scans showed that Chwichiya 002 has a much higher abundance of chondrules than Tarda, and many chondrules in both samples are surrounded by well-defined fine-grained rims (FGRs). Compared to Chwichiya 002, small bright grains (likely Fe sulfides and metal grains) are observed throughtout the fine-grained materials and surrounding many FGRs in the Tarda sample. Variations in the X-ray attenuations across slices in the Chwichiya 002 scan indicate the presence of multiple lithologies, suggesting that Chwichiya 002 is also a breccia. To aid our interpretation of the petrology of the two meteorites, we will extract quantitative 3D information from the μXCT scans and compare those results to our study of 2D meteorites thin sections [8, 9] and microtome slices.

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