3D MEASUREMENT OF FINE-GRAINED RIMS IN CM MURCHISON USING XCT

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Introduction: Previous work using X-ray computed tomography (XCT) of a 44 g sample of CM Murchison (USNM 5487) has revealed an impact-derived foliation and weak lineation defined by partially altered POP chondrules [1]. The coarse scan resolution (29-58 μm per voxel) did not allow for the discrimination of fine-grained rims (FGRs) around the chondrules but BSE imaging of sections from the sample suggest that the rim thickness around the chondrules is irregular and that the shape and orientation of deformed chondrules differs when including the FGR [1]. If the FGR thickness is variable around each chondrule and correlates with the macroscopic foliation or lineation, it may suggest that the FGRs were initially uniform in thickness but had a different strain response to the impact stress than the interior chondrule. Alternatively, if the thickness of FGRs are found to be variable with no correlation to the macroscopic petrofabric, it will suggest that geometry of the rim is an inherited property related to the origin of the rim or perhaps subsequent alteration.

The origin of FGRs in CM chondrites is intensely debated with arguments and evidence for both nebular [2,3] and parent body [4,5] formation. In particular researchers have argued whether there is [2] or is not [4] a correlation between rim thickness and the size of the enclosed object, with the former scenario argued as evidence of a nebular origin of formation. These measurements were made using 2D thin sections and therefore only a portion of the rim and chondrule were measured. Further, any deformational strain would have altered the shape of the chondrule and/or the rim and therefore complicate the interpretation of the rim thickness and geometry. In our study we will test for a correlation between average rim thickness and the size of the enclosed object in 3D and will also determine if the rim has any regular relationship to macroscopic petrofabric.

Methods: A high-resolution (5.5 μm pixel) XCT scan of a 0.143 g chip of USNM 5487 at low energy (70 kV) has allowed discrimination of the FGRs around the deformed chondrules. Using Avizo we are manually segmenting each chondrule twice: both with and without the FGR. The segmented data is then imported into the Blob3D program that measures the chondrule size and orientation as well as the rim thickness in 3D [6,7].

Results: Preliminary results suggest that the FGRs are variable in thickness around each chondrule. The orientations of the deformed chondrules are generally the same regardless of inclusion of the FGRs but the measured 3D aspect ratio and elongation of the chondrule is on average lower when including the FGR. This could indicate that the FGRs are thicker in the direction perpendicular to the foliation or that the variability in rim thickness is much less than the size of the enclosed object. In addition, we see evidence for a moderately strong positive correlation between rim thickness and the size of the enclosed chondrule.

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