FINE-GRAINED RIM POROSITY STRUCTURE IN CM MURCHISON – FORMATION OR ALTERATION SIGNATURE?

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Introduction: Fine-grained rims (FGRs) in primitive carbonaceous chondrites are hypothesized to form by the attachment dust or dust aggregates onto chondrule surfaces in the early solar nebula [e.g., 1-4]. They often have a complex structure in regards to texture, composition, and porosity, with some evidence of layering of these properties within the FGR thought to arise from varying nebular conditions [e.g., 5-7]. Modeling studies of FGR formation also suggest that layers of varying porosity can occur due to compaction of grains during accretion [8.9]. We have been investigating fine-grained rims within CM Murchison to determine details on their formation conditions and how they have been modified on the parent body. Our previous work established that the FGRs in CM Murchison formed by accretion of dust in a weakly turbulent nebula and that they were physically compressed (i.e., thinner) in the direction of impact strain [3]. We are now investigating their porosity structure.

Methods: We have recently developed a technique to examine the 3D distribution of porosity within carbonaceous chondrites using the heavy noble gas xenon, which is highly attenuating to X-rays [10]. We imaged a 50 mg chip (~ 3 mm in diameter) of CM Murchison (Chip A of [3]; USNM 5487) on a Zeiss Versa 620 XRM at 90 kV and 12 W with the 0.4X detector, 1601 views, and 2 frames per view. The sample was scanned twice: once infiltrated with xenon at 400 PSI with a 15 s aquisiton time per frame, and once in atmospheric air with a 10 s acquisition time per frame. The two scans were manually aligned in ImageJ and the air scan rescaled so that non-porous materials (olivine, sulfide, metal, closed pore) had a similar CT value to that of the Xe scan. The air data volume was then subtracted from the Xe data volume to derive a volume of relative xenon infiltration. This was converted to a 3D porosity volume by using the average bulk porosity (21.9 ± 2.2 %) of Murchison measured using He pycnometry [11].

Results: We find that the vast majority of the microporosity within CM Murchison is located in the matrix which is 22-34% porous. Several FGRs within Murchison have a higher porosity than the nearby matrix, up to 38%. Further, many FGRs have a complex porosity structure showing regions of higher porosity within the rim iteself. These are not contiguous porosity layers as seen by previous studies [e.g., 14], but rather isolated patches of high porosity. One explanation for these varied porosity regions is that they represent dust aggregates with different porosity that originally accreted to the rim. Alternatively, they could represent areas of varied secondary processing on the parent body.

Ongoing Work: We are now examining whether the FGR areas which show the greatest physical compaction (i.e., thinnest areas of the rims) are coincident with the lowest porosity regions. If so, this would suggest that the porosity variation within CM Murchison FGRs is a parent body alteration signature due to impact compression, rather than a nebular signature.

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