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A nanoscale STXM study of the Murchison CM2 chondrite

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Many studies have described petrographic evidence for *in situ* aqueous alteration on the asteroid parent body(ies) of CM chondrites [1]. However, the origin of fine-grained rims (FGRs) of phyllosilicates that surround pristine anhydrous fragments in CM chondrites remains controversial. The textures of FGRs suggest that they formed through accretion onto their host objects, but it's not clear whether hydration of the dust occurred in a nebula [2] or asteroid [3] environment. The settings of aqueous alteration in the early solar system may be inferred from crystal-chemical variations within the sub-micron mineralogy of FGRs and matrix within the CM chondrites.

Using synchrotron μXANES we observed systematic variations in $Fe^{3+}/\Sigma Fe$ across FGRs but not within the matrix [4]. To identify the source of this variation we used STXM and nanoscale XRF to compare the crystal-chemical relationships of the matrix mineralogy with that of the FGRs. Changes in Fe L- and O K-edge spectral detail from matrix areas can be attributed to oxide and phyllosilicate minerals. For the FGRs, small changes in the relative intensities of the main peaks in the Fe L_3 edge suggest variations in the $Fe^{3+}/\Sigma Fe$ ratio. More grain-scale chemical variability is observed in the FGR than in the matrix, and Fe-sulphides are detected in the FGR but not in the matrix.

Our data suggest that the composition of the FGR is mineralogically distinct from the matrix, showing it was surrounding the chondrules in their nebular sojourn prior to accretion and sampled a different reservoir of dust to the matrix. A possible explanation for the data is the incorporation of ice and/or carbonaceous grains into the FGR, which would cause local variability in redox states when these phases reacted on the asteroid parent body.

[1] Brearley A. J. 2002. In: *Meteorites and the Early Solar System II* [2] Lauretta D. S. et al. 2000. *GCA* 64:3263 [3] Trigo-Rodriguez J. M. et al. 2006. *GCA* 70:1271 [4] King A. J. et al. 2014. *MAPS* 49: #5151.