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Diffusion in Allende Components: Delineating Parent-Body Processes in Fractured Olivines

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Chondrules found in carbonaceous chondrite meteorites are among the oldest solids to have condensed from the protoplanetary nebula. While Allende is a CV chondrite (distinguished by large refractory inclusions, mm-sized chondrules, and over 40% matrix by volume) with minor hydrous alteration, previous work has discussed issues of how secondary processes in the parent body could affect chondrules [1]. Here, we use Scanning Electron Microscopy (SEM) and Axioscan petrographic imaging to examine both chondrules and the surrounding matrix within two thin-section slides from Allende. This was done to identify structural indicators of parent-body processing on the chondrules.

Here, we report results of EDS analyses of Ca, Cr, Al within transects across olivines away from crystal cracks. Precision determinations on analyses were estimated by repeat analyses of a Mn-Hortonolite standard. Spectra were collected adjacent to cracks intersecting forsterite grains in Allende chondrules. Transects followed a linear path perpendicular to the crack in the forsterite grain. Results indicate systematic profiles of these elements over distances of 10-20 μm. Our findings suggest that a fluid slightly enriched in Ca, Cr, and Al (and depleted in Mg) flowed through the cracks in the forsterite grain, allowing these elements to be incorporated into the grain. The largest variability in the Wt % of these elements is over a space of approximately 4-5 μm directly adjacent to the crack in the grain.

Furthermore, larger-scale SEM-BSE and EDS maps were taken of chondrules and correlated with images in XPL and PPL to relate chondrule textures to compositional changes seen by EDS analyses. This was done in an attempt to relate composition to textures to temperature and pressure conditions reported for type 1a chondrules in previous studies [2]. We are working to conclusively determine that trace element variability in Allende olivines is the result of fluid diffusion. For now, this is our hypothesis. Future work includes vacuum-chamber experiments testing incorporation of trace elements in olivine grains in simulated protoplanetary disk conditions, as well as laser ablation on Allende olivines.

[1] Brearley (2014), *Treatise on Geochemistry* 1.9

[2] Nittler & Ciesla (2016), *Annual Review of Astronomy and Astrophysics* 54, 53-93