MICROSTRUCTRAL CONSTRAINTS ON THE ORIGIN OF AOAs IN THE ALHA 77307 CO3.0 CARBONACEOUS CHONDRITE

Jangmi Han and Adrian J. Brearley, Department of Earth and Planetary Sciences, MSC03-2040, 1University of New Mexico, Albuquerque, NM87131, USA. (E-mail: jmhan@unm.edu)

Introduction: Amoeboid olivine aggregates (AOAs) are the most common type of refractory inclusion in carbonaceous chondrites and have preserved evidence for condensation, evaporation, melting and annealing within the solar nebula [1, 2]. Despite extensive study, there are still several outstanding questions relating to the origins of these inclusions that remain unresolved.

In order to characterize the primary mineralogy of AOAs in CO3 chondrites and understand their aqueous alteration and thermal metamorphism history, we have commenced a detailed FIB/TEM study of AOAs from the least altered CO3 chondrite, ALHA 77307 (subtype 3.0).

Methods: The selected AOA was sectioned using focused ion beam (FIB) techniques and then examined by scanning electron microscope (FEI-SEM) and transmission electron microscope (TEM) to determine its microstructure and mineralogy.

Results and Discussion: The AOA in ALHA 77307 investigated in this study is an irregularly-shaped, 0.2 mm-sized object composed of mainly forsteritic olivines and minor interstitial high-Ca pyroxenes. A few rounded Fe, Ni-metal blebs and Fe, Ni-oxide grains (altered metals) occur as inclusions within the forsterites and along grain boundaries. Numerous small pores are seen throughout the object and seem to be indigenous.

The FIB section is dominated by fine-grained olivines (0.5 - 6 μm) with a composition close to pure forsterite. The olivine grains show no evidence of strain and are almost completely free of defects or dislocations. Microstructurally, the AOA consists of closely packed anhedral forsterite grains typically with 120˚ triple junctions, separated by straight or slightly curved grain boundary segments. Curved grain boundaries are more commonly associated with short grain boundary segments. These microstructures collectively indicate that the olivines have close to an equilibrium grain boundary microstructure showing that the AOA experienced significant annealing before accretion into the CO3 parent body.

The FIB section also contains two texturally distinct Al, Ti-diopsidic pyroxene grains which probably record different formation histories. One is oval-shaped and lies on a grain boundary between two olivine grains, while the second occurs as an interstitial phase between several olivine grains. These two grains have different compositions and both grains show heterogeneous compositions with minor variations in Al, Ti and Mg. [5] suggested that Al-diopside in some AOAs may have been formed by melting of anorthite + forsterite. The interstitial texture of one of these grains appears to be most consistent with such an origin.

In summary, the microstructures of the AOA are consistent with this object being aggregates of nebular condensates that have undergone annealing and very limited partial melting at high temperature within the solar nebula [2-5].

References: [1] Chizmadia L. J. et al. 2002. *Meteoritics & Planetary Science* 37: 1781-1796. [2] Krot A. N. et al. 2004. *Chemie der Erde* 64: 185-239. [3] Komatsu M. et al. 2001. *Meteoritics & Planetary Science* 36: 629-641. [4] Sugiura N. et al. 2009. *Meteoritics & Planetary Science* 44: 559-572. [5] Komatsu M. et al. 2003. *Japanese Geosciences Union*, pp. 066-004.