DECIPHERING MULTIPLE ALTERATION EVENTS IN ALLENDE Ca-Al-RICH INCLUSIONS.

T. J. Fagan, G. J. MacPherson and G. L. Kim. Dept. Mineral Sciences, Smithsonian Institution, Washington, DC 20560-0119. E-mail: fagan.tim@nmnh.si.edu

Introduction: It is well-known that Ca-Al-rich inclusions (CAIs) from the oxidized CV3 Allende have undergone more extensive alkali- and FeO-rich metasomatism than their counterparts in the reduced CV3s [1,2,3]. Allende CAIs also experienced a stage of recrystallization to secondary grossular and monticellite [4]. We have identified yet another form of secondary reprocessing in the Allende CAIs: inclusion trails in melilite crystals. It is not known if the inclusion trails, Ca-Mg-Al-silicate veins, and iron-alkali metasomatism formed at the same time or during independent events. In order to assess relationships between these types of alteration and implications for nebular and parent body evolution, we have initiated a comparative study of the different secondary mineral assemblages in Allende CAIs. Here, we present a preliminary report mineralogy and textures in 4 type B1 CAIs, 4 type B2s, one compact type A and six fluffy type A (FTA) inclusions.

Textural types of alteration: *Alkali- and FeO-rich metasomatism.* The alkali-FeO-rich zones are concentrated interior to Wark-Lovering rims in all CAI types. This type of alteration is manifested by the occurrence of grossular fringes along primary melilite, fine laths of anorthite, nepheline and sodalite, and FeO-bearing spinel.

Ca-Mg-Al-silicate veins. The veins occur along melilite grain boundaries, and are dominated by fine-grained (<5 m) grossular and monticellite. Where the veins merge with alkali-FeO-rich rims, the grossular has a similar composition in both settings.

Inclusion trails. Tiny (≤1 m) crystallites decorate irregular surfaces within melilite crystals, and apparently represent healed fractures. These surfaces typically are 100 to 200 m long, and occur with simple planar, curved planar, and anastamosing planar geometries. In most cases, the individual crystals are equant, but some trails have vermicular, branching inclusions that are elongate in the plane of the healed fracture. Multiple phases may be present, but so far only spinel has been positively identified. Some of the inclusion trails pinch out in the interior of a melilite crystal, but most of the trails have at least one end that terminates at a Ca-Mg-Al silicate vein.

Alteration events: Whereas the Ca-Mg-Al-silicate veins could have formed by closed-system breakdown of melilite+anorthite [4], the alkali-FeO-enriched rims require ingress of volatile components. This implies that the vein-forming and alkali-FeO metasomatic events may have been separated in time or place of formation. If the veins post-date the metasomatism, as suggested by the constant grossular compositions where the veins intersect metasomatized regions, then the veins may have formed in a parent body setting. If so, their paucity in reduced CV3 CAIs, like that of Ca-Fe-rich silicates [5], may be related to locally very low porosity on the parent body. The inclusion trails may be related to flow of fluid along fractures, but the nature of the fluid remains to be determined.

References: [1] Sylvester P. J. 1993. *Geochim. Cosmochim. Acta* 57: 3763-3784. [2] Krot A. N. et al. 1998. *Meteorit. Planet. Sci.* 33: 1065-1085. [3] Komatsu M. et al. 1998. *Meteorit. Planet. Sci.* 36: 629-641. [4] Hutcheon I. D. and Newton R. C. 1981. 12th Lunar Planet. Sci. Conf. pp. 491-493. [5] MacPherson G. J. and Krot A. N. 2002. *Meteorit. Planet. Sci.* 37: A91.