CHONDRULE PYROXENE EMBEDDED IN CORES OF AMOEBOID OLIVINE AGGREGATES FROM ALLENDE: EVIDENCE OF OVERLAPPING FORMATION TIMES OF AOAS AND CHONDRULES.

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Introduction: Amoeboid olivine aggregates (AOAs) share with Ca-Al-rich inclusions (CAIs) their ^{16}O-rich isotopic compositions and formation histories involving high-temperature condensation/evaporation [see reviews of 1,2]. Thus, even though AOAs have lower equilibrium condensation temperatures than CAIs, they are often grouped with CAIs representing together an ^{16}O-rich component of chondrites that formed at relatively high base temperatures [3]. Many chondrules formed on the order of ~2 Ma later than CAIs and AOAs [4-6], but at least some chondrules formed contemporaneously with CAIs [8,9]. In this study, we report two AOAs from Allende having coarse, low-Ca pyroxene, apparently of chondrule origin, in the AOA cores. If the coarse pyroxene crystals are in fact from chondrules, these textural occurrences indicate an overlap in time and place of formation in the solar nebula for chondrules and AOAs preserved in CV chondrites.

Methods: X-ray elemental maps of a polished thin section (pts F07-07) of Allende were prepared using a JEOL JXA 8900 electron microprobe (EPMA) at Waseda University (WU). Four sets of elemental maps of Na, Mg, Al, Si, S, K, Ca, Ti, Cr, Mn and Fe, and BSE were collected using a 1μm spot size and 11 μm step size, and then were mosaicked together. More detailed elemental and BSE images were collected using the same EPMA and a Hitachi S-3400N SEM also at WU. Quantitative analyses of olivine and pyroxene were collected using the WU EPMA.

Results and Discussion: Most of the AOAs in pts F07-07 consist of granular olivine grains on the order of 10 μm across with fine grains of high-Ca pyroxene and feldspathoids and variable abundances of troilite, as reported in previous studies of Allende AOAs [2,10,11]. Individual olivine grains are zoned with Mg-rich cores (Fo~90-95) and Fe-rich rims (Fo50-80), with the thickness of the Fe-rich rims increasing toward the margins of AOAs. However, two of the AOAs from pts F07-07, labelled SW-07 and NE-27, are cored by coarse low-Ca pyroxene crystals in excess of 200 μm in length (Fig. 1). The coarse pyroxene crystals in these two AOAs are an order of magnitude coarser than the examples of low-Ca pyroxene identified previously in AOAs, and occur in AOA cores rather than along AOA margins [11,12]. Formation histories of these AOAs are interpreted as: (1) crystallization of coarse pyroxene in a porphyritic chondrule; (2) fragmentation or corrosion of the chondrule; (3) formation of an AOA-olivine-rich layer mantling the relict pyroxene; (4) Allende parent body metamorphism resulting in Fe-rich rims on olivine grains, fracturing of relict pyroxene and crystallization of Fe-rich olivine (Fo~60) in veins. An overlap in the formation times of chondrules and AOAs in the solar nebula is implied.

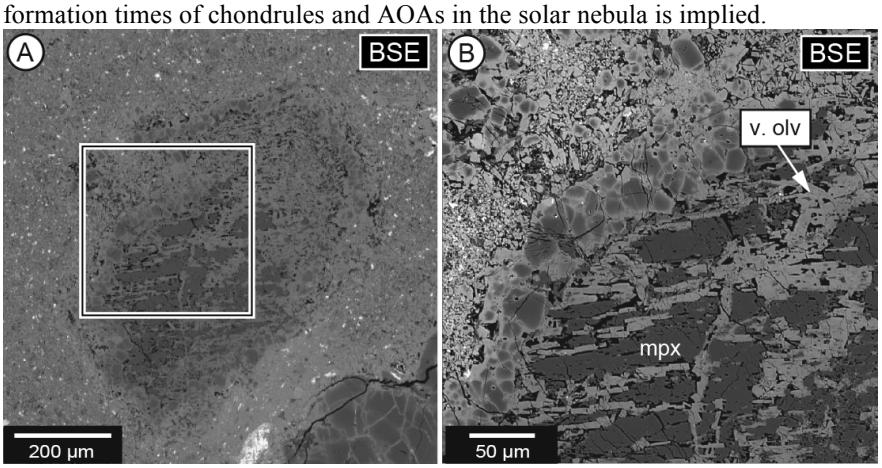

Fig. 1. BSE images of Allende AOA F07-07_NE-27, with coarse, chondrule-like pyroxene (mpx) in AOA core, Fe-rich vein olivine (v. olv), AOA-olivine mantle (to left and above mpx), and Allende matrix (farthest left).

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