A UNIQUE ULTRA-REFRACTORY INCLUSION-BEARING AOA FROM Y-793261 CR CHONDRITE

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Introduction:

Amoeboid olivine aggregates are an important class of refractory objects that have escaped from extensive melting and preserve evidence for condensation from solar nebula gas (e.g., [1]). They are composed of fine-grained (typically ≤15 μm in thin section), granular olivine crystals, and refractory minerals such as spinel, high-Ca pyroxene and anorthite. The petrology of AOAs is in general agreement with thermodynamically predicted condensation sequences. Models of nebular condensation indicate that AOA mineral assemblages are stable in a temperature range near 1100 to 1400K, somewhat lower than temperatures of CAI formation [2, 3, 4].

We have found an AOA that encloses an ultrarefractory (UR) CAI in Y-793261 CR chondrite. UR CAIs are rarely observed in carbonaceous chondrites [e.g.,5], and only three UR CAIs in AOAs have been identified so far [5,6,7]. UR CAIs can provide information on crystallization processes at very high temperatures in the early solar nebula. Here we describe preliminary results on this newly discovered AOA enclosing a UR CAI.

Results and Discussion:

CR chondrite Y-793261 is composed of chondrules, AOAs, CAIs, mineral fragments, and matrix. AOAs and CAIs are more abundant in Y-793261 than in other CR chondrites we have examined; at least eight AOAs are present in the Y-793261 thin section, whereas the other CR thin sections tend to have only 0 to 3 AOAs. Phyllosilicates are observed in the matrix, but the chondrules in Y-793261 appear less altered than those of other CRs, suggesting that Y-793161 experienced low degree of aqueous alteration with little thermal metamorphism.

<u>High temperature signature of AOA:</u> AOA#4 consists mostly of fine-grained olivine, which often encloses segregations of Al-diopside and anorthite in a texture typical of carbonaceous chondrite AOAs (Fig. 1). In one of these segregations, Al-diopside is in contact with Sc-rich pyroxene and a Zr-rich phase, similar to Sc-Zr-rich phases observed previously in UR CAIs [e.g., 5]. The UR inclusion has a concentric texture with a Zr,Sc-rich pyroxene core surrounded by Sc-rich pyroxene. The presence of the UR inclusion indicates that condensation of AOA #4 started at higher temperature than other AOAs in CR chondrites.

<u>Enrichment of SiO_2 at lower temperature:</u> AOA #4 also contains ~5 μm sized, nearly pure SiO_2 grains with low-Ca pyroxene grains. It is not clear whether the SiO_2 is crystalline or amorphous. In previous studies, pod-like SiO_2 grains are found in the chondrule margins in CR chondrite PCA 91082 [8]. Krot et al. [9] found that many Type I chondrules in CR chondrites contain silica-rich igneous rims (SIR), and suggested that SIR are formed either by gas-solid condensation of silica-normative materials onto chondrule surfaces and subsequent incomplete melting, or by direct SiO (gas) condensation into chondrule melts.

We have not observed SiO_2 grains in AOAs in any other carbonaceous chondrites before this study. SiO_2 grains in AOA #4 are associated with low-Ca pyroxene, probably indicating formation at temperatures below typical AOA olivine condensation temperatures [8]. AOA #4 in Y-793261 apparently preserves evidence of condensation at unusually high temperature (indicated by the UR CAI), combined with low-T interaction with gas (indicated by SiO_2 + low-Ca pyroxene). The preservation of such a wide T-range in a single AOA is an issue to be investigated in future work.

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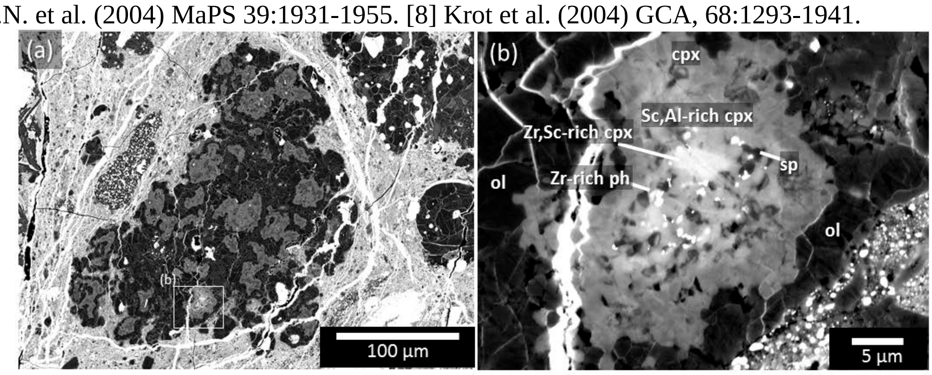

Fig.1. BSE images of AOA #4. ol=olivine, cpx=high-Ca pyroxene, sp=slinel, Zr-rich ph=Zr-rich phase, Zr, Sc-rich cpx=Zr, Sc-rich high Ca pyroxene, Sc, Al-rich cpx=Sc, Al-rich Ca pyroxene.