PETROLOGIC STUDY OF CALCIUM-ALUMINUM-RICH INCLUSIONS FROM ASUKA 09003 AND 09535.

N. Matsuda[1], M.-C. Liu[1], K. D. McKeegan[1]. [1]Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, CA 90095, USA (nozomi32@ucla.edu).

Introduction: Calcium-aluminum-rich inclusions (CAIs) are the oldest objects in the solar system that formed 4.567 Ga ago [1,2] and experienced complex evolutionary histories before their accretion into the parent bodies. It is generally accepted that the largest, centimeter-sized CAIs are found in CV and CK chondrites, with CAI sizes in all other chondrites being smaller [3]. CAIs typically comprise 0.5–3 vol% in carbonaceous chondrites (CCs) that formed far from the Sun, but only < 0.1 vol% in enstatite and ordinary chondrites, collectively known as non-carbonaceous chondrites (NCs), that formed closer to the Sun [4]. Because CAIs are generally thought to have formed in the inner solar system, the fact that they were preferentially incorporated into CCs is puzzling.

Asuka (A)-09003 and A-09535 represent a new type of carbonaceous chondrite, designated CA [5]. These CA chondrites have unique features: they share similarly high chondrule/matrix ratios with ordinary chondrites but resem-ble CO and CV chondrites in terms of the abundances of refractory inclusions (4−6 vol%) and oxygen isotopic com-positions [5]. With characteristic features of both NCs and CCs, the CA chondrites are in some sense transitional between materials that accreted in the inner solar system and those from the outer solar system. Here we present preliminary results of petrological characterizations of CAIs in CA chondrites.

Methods: CAIs studied were identified in polished thin sections of Asuka 09003 and 09535, on loan from the National Institute of Polar Research. The petrographic observation and chemical analysis were performed by scanning electron microscopy (SEM, Tescan Vega) equipped with an energy dispersive spectrometer (EDS) at UCLA.

Results: CAIs in both A-09003 and A-09535 are typically fine-grained inclusions (FGIs) up to several hundred micrometer in size. Based on mineralogy, the FGIs can be classified into four groups: (1) spinel-melilite-pyroxene inclusions, (2) hibonite-spinel-melilite inclusions, (3) hibonite-spinel-melilite-grossite inclusions, and (4) pyroxene-rich inclusions.

Spinel-melilite-pyroxene inclusions are irregularly-shaped and the most abundant type of CAIs in both A-09003 and A-09535 samples. Most of these inclusions have a spinel-rich core enclosed in melilite, both of which are rimmed by a complete or discontinuous layer of Ca-pyroxene. The inclusions contain fine-grained mixtures of Na-rich miner-als which appear to be alteration products replacing melilite.

Hibonite-spinel-melilite inclusions are characterized by two types of morphologies. One has lath-shaped hibonite grains that are embedded in spinel and are subparallel to one another. Melilite occurs on the exterior of the inclusions. This morphology is similar to hibonite-spinel CAIs in the ALHA77307 (CO3.0) chondrite [6]. The other type is a layered structure of irregularly shaped nodule centers consisting of spinel that encloses hibonite and melilite that, in some nodules, has been partially converted into alteration products.

Hibonite-spinel-melilite-grossite inclusions are either irregularly-shaped or round. These inclusions have similar mineralogy and texture to hibonite-spinel-melilite inclusions. MgO-rich and FeO-rich (Fe# (100 × molar Fe/(Mg + Fe) > 75) spinel are both present in this type of inclusions. FeO-rich spinel shows a porous texture, while MgO-rich spinel does not. This type of inclusion has been found in the Kainsaz (CO3.2) chondrite [7].

Pyroxene-rich inclusions are rare and consist of Ca-rich pyroxene, anorthite, low-Ca pyroxene, and olivine. These observations are consistent with previous reports which showed similar types of inclusions in CO chondrites [7,8]. Thus, CA-CAIs and CO-CAIs may share similar formation histories. Further details will be presented at the conference.

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