MINERALOGY AND PETROLOGY OF AL-RICH OBJECTS IN THE CH CARBONACEOUS CHONDRITE NORTH WEST AFRICA 739.

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Introduction: The CH carbonaceous chondrites are primitive meteorites, which appear to have escaped post-accretion thermal metamorphism and aqueous alteration, and can potentially provide important constraints on the nature of high temperature nebular processes [1-3]. Ca,Al-rich inclusions (CAIs) in the previously studied CH chondrites ALH85085 and Acfer 182 show several unusual characteristics: (*a*) small sizes (5-80 μm in ALH85085 and up to 450 μm in Acfer 182), (*b*) commonly spherical shapes, (*c*) fine-grained textures, (*d*) refractory mineralogy dominated by hibonite, grossite, perovskite, and melilite, (*e*) rarity of isotopic anomalies in Ca and Ti, (*f*) general lack of ^{26}Mg excesses (^{26}Mg*) in the hibonite-rich and grossite-rich CAIs, (*g*) bi-modal distribution of O-isotopic compositions, and (*h*) lack of O-isotopic heterogeneity within an individual CAI [4-7].

There are several fundamental questions concerning the origin of CAIs which remain to be answered: (1) Is there any relationship between CAIs and Al-rich chondrules? (2) Do CAIs show evidence for thermal processing during chondrule formation? (3) Did CAIs and chondrules from a chondrite group experience size-sorting together or separately? (4) Is the lack of ^{26}Mg* in many CH CAIs due to heterogeneous distribution of the ^{26}Al in the solar nebula or dur to the late stage formation? (5) Do the ^{26}Mg*-free CH CAIs contain ^{10}B excesses due to decay of ^{10}Be? In order to answer these questions, we started a systematic survey of Al-rich objects in CHs. Here we report the mineralogical and petrologic studies of the CAIs, AOAs, Al-rich chondrules and isolated grains in the recently discovered CH chondrite North West Africa (NWA) 739.

Results: The Al-rich objects in NWA 739 include CAIs, amoeboid olivine aggregates (AOAs), Al-rich chondrules, and isolated grains of spinel, plagioclase, and glass (Fig. 1).

Refractory inclusions: Based on the major mineralogy, 54 refractory inclusions found in about 1×1 cm polished thick section of NWA 739 can be divided into hibonite-rich (16%), grossite-rich (26%), melilite-rich (28%), spinel-pyroxene-rich (16%) CAIs, and AOAs (17%). Most CAIs are rounded, 25 to 185 μm (average = 70 μm) in apparent diameter, contain abundant, tiny perovskite grains, and typically are surrounded by a single- or double-layered rim composed of melilite and/or Al-diopside; occasionally, layers of spinel+hibonite and forsterite are observed. The AOAs are irregularly shaped, 100-250 μm (avg = 175 μm) in size, and consist of forsterite, Fe,Ni-metal, and CAIs composed of Al-diopside, anorthite, and minor spinel. One AOA contains rounded melilite-spinel-perovskite CAIs and low-Ca pyroxene replacing forsterite (Fig. 1e).

Al-rich chondrules: The Al-rich (bulk Al_2O_3 > 10 wt%) chondrules can be divided into Al-diopside-rich (Fig. 1f) and plagioclase-rich (Fig. 1h). The Al-diopside-rich chondrules, 50-310 μm (avg = 165 μm) in apparent diameter, consist of Al-diopside, skeletal forsterite, spinel, ±Al-rich low-Ca pyroxene, and ±mesostasis. The plagioclase-rich chondrules, 120-455 μm (avg = 285 μm) in apparent diameter, are composed of low-Ca and high-Ca pyroxenes, forsterite, anorthitic plagioclase, Fe,Ni-metal nodules, and mesostasis.

Isolated grains: The isolated spinel occurs as coarse, 50-125 μm in size, subhedral grains, which are probably the fragments of Al-diopside chondrules. The isolated plagioclase grains are too coarse (60-120 μm) to have been produced by disintegration of chondrules or CAIs; they range in composition from nearly pure anorthite to nearly pure albite.

Discussion: The Al-rich objects show no evidence for Fe-alkali metasomatic or aqueous alteration; the only exception is an Al-rich chondrule with anorthite replaced by nepheline (Fig. 1g). They are texturally and mineralogically similar to those in other CH chondrites (Acfer 182, ALH85085, PAT91467, NWA 770), but are distinct from the Al-rich objects in other chondrite groups (CM, CO, CR, CV). The CH CAIs are dominated by very refractory minerals, such as hibonite, grossite, perovskite and gehlenitic melilite, and appear to have experienced very low degrees of high-temperature alteration such as replacement (*i*) of grossite by melilite, (*ii*) of melilite by anorthite, diopside, and spinel, and (*iii*) of forsterite by low-Ca pyroxene. Only a few CAIs show evidence for melting and multilayered Wark-Lovering rims. These observations suggest that CH CAIs experienced a rather simple formation history and escaped extensive recycling. In order to preserve the high-temperature mineral assemblages, they must have been efficiently isolated from the hot nebular region, like some chondrules and the zoned Fe,Ni-metal grains of CH chondrites [8,9].

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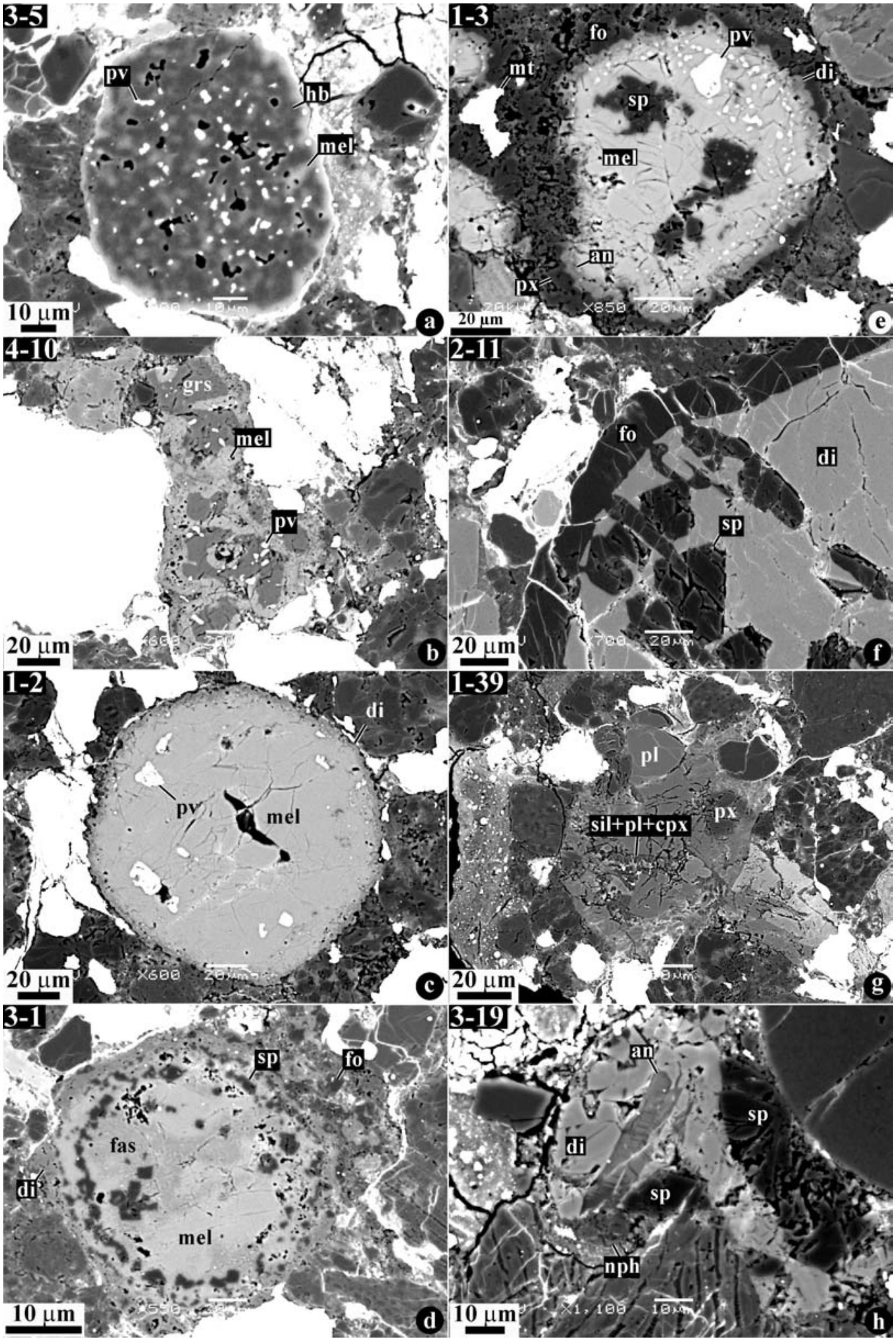

Fig. 1. BSE images of Al-rich objects in NWA 739. a - Porous, hibonite-rich CAI. b - Porous, grossite-rich CAI; grossite is replaced by melilite. c - Melilite-rich CAI. d - Igneous, melilite-fassaite CAI. e - AOA with compact, melilite-rich CAIs surrounded by a rim of Al-diopside; forsterite in the outer portion of AOA is replaced by low-Ca pyroxene. f - Al-diopside-rich chondrule. g - Plagioclase-rich chondrule. h - Al-diopside-rich chondrule with secondary nepheline. cpx = high-Ca pyroxene; di = diopside; fas = fassaite; fo = forsterite; grs = grossite; hb = hibonite; mel = melilite; nph = nepheline; pv = perovskite; px = low-Ca pyroxene; sil = silica; sp = spinel.