MESQUITE: PETROLOGY, ALUMINUM-26 CHRONOMETRY, AND BE-B SYSTEMATICS OF AN UNUSUALLY LARGE MELILITE-RICH CAI FROM THE NORTHWEST AFRICA (NWA) 7892 CO3.0 CHONDRITE. A. T. Hertwig1, E. T. Dunham2, M.-C. Liu1, and M. Wadhwa1 Department of Earth, Planetary, and Space Sciences, University of California-Los Angeles, Los Angeles, CA 90095, USA (hertwig@ucla.edu), 2Center for Meteorite Studies, School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287, USA.

Introduction: Calcium-aluminum-rich inclusions (CAIs) are one of the oldest solids in the Solar System and therefore record information about processes in the solar nebula. For instance, the Be-B systematics of CAIs informs about the irradiation environment [e.g., 1, 2] because short-lived 10Be (decays to 10B) is exclusively formed by energetic particle spallation [e.g., 3]. On the other hand, the Al-Mg systematics in CAIs provides a relative timeframe for condensation or heating events during the Solar System’s early evolution.

While most chondrite groups contain them, CAIs differ between groups in their size distribution, abundance, and relative proportion [e.g., 4]. Most isotopic investigations, including studies of Al-Mg and Be-B systematics [e.g., 2, 5], have been focused on CAIs from CV3 chondrites due to large inclusion sizes and high abundances of CAIs in this chondrite group. Just a few studies have focused on CAIs from other groups, e.g., CM or CO chondrites [6–8].

CAIs from CO chondrites make up ~1 vol.% of the meteorite and are usually small in size (up to 500 µm) [4, 8]; melilite-rich, spinel-pyroxene, and hibonite-hercynite types dominate [8]. A previous study demonstrates that some CAIs from CO chondrites show evidence for having incorporated 26Al, with most CAIs being characterized by an initial 26Al/27Al ratio of ~5×10^{-5} [8], consistent with the canonical value of 5.2×10^{-5} within errors [5]. Lower 26Al/27Al have also been reported for other CO3 chondrite CAIs [6]. The incorporation of short-lived 10Be in CO CAIs has been demonstrated so far for one mineralogically pristine inclusion in Dominion Range (DOM) 08006; it records (10Be/9Be)=(15.0±0.7)×10^{-4} [9]. This falls within the range of inferred initial 10Be/9Be in CV3 CAIs [10, refs therein]. However, more CO3 CAIs need to be measured to understand the distribution of 10Be/9Be in CAIs of this chondrite group.

Here we report the petrological characterization of CAI Mesquite from the CO3 Northwest Africa (NWA) 7892 and its initial 26Al/27Al and 10Be/9Be ratios to better understand this CAI’s formation history.

Methods: The thin section containing the Mesquite CAI was imaged by standard electron microscopic techniques (SE, BSE) using the JEOL JXA-8530F at ASU. Mineral chemistries of melilite, hibonite, and spinel were determined with the JEOL JXA-8530F at ASU.

Be-B and Al-Mg systematics were analyzed on the UCLA CAMECA ims-1290 ion microprobe using a 16O− primary ion beam generated by the Hyperion-II plasma ion source. Primary beam intensities were 7 nA and 10 nA (< 4 µm beam size) for Be-B analyses. The Be-B systematics of melilitite and hibonite were determined following the method described in [9]. At the beginning of the analytical session, the relative sensitivity factor (RSF) affecting the 11B/10B ratios of unknowns was determined by measuring the NBS614 glass standard which was also used for determining the instrumental mass fractionation affecting the 10B/11B ratios.

Primary beam intensities ranged from 1 to 15 nA (1-5 µm) for Al-Mg analyses. Al-Mg systematics of spinel and hibonite were measured in multi-collection mode using Faraday cups on the multi-collection array by following the method described in [11]. RSFs for accurate 27Al/26Mg ratios were obtained by measuring terrestrial standards whose 25Mg/26Mg and 26Mg/27Mg ratios are assumed to be those of [12]. We used an exponential fractionation law (β=0.5128) and express the excess of 26Mg produced by the decay of 26Al after correction for mass-dependent fractionation as Δ26Mg (‰). Isochrons were calculated using the Isoplot macro collection [13] (Model 1 fit).

Petrography and mineralogy: The CAI is about 5 × 3 mm and by far the largest object in the section (Fig. 1). Melilitite is the most abundant mineral followed by hibonite, spinel, and perovskite. The inclusion has a...
compact, prismatic shape with rounded edges, is mineralogically zoned (concentric), and is surrounded by a fine-grained rim (FGR). The center zone is dominated by melilite, whose grain size is less than 200 µm, and enclaves of hibonite. Spinel or perovskite are absent. Layers of hibonite-spinel, hibonite-melilite, hibonite-perovskite-melilite, and spinel surround the center melilite; boundaries between layers are in general parallel to margins. The chemical composition of hibonite (MgO = 2.6±1.1 wt.% 2SD, n=37) does not vary systematically from layer to layer; melilite seems to be slightly more Mg-rich in the center (Ak=3±4, 2SD, n=32) relative to the outer layer (Ak=1.3±1.0, 2SD, n=11). Secondary minerals identified by EDS measurements are calcite, which fills voids and fissures, and phyllosilicates.

**Al-Mg and Be-B systematics:** Hibonite and spinel show resolvable excess $^{26}\text{Mg}$, with $\Delta^{26}\text{Mg}^*$ values of up to 16‰ (for hibonite). The slope of the resulting isochron translates to an initial $^{26}\text{Al}/^{27}\text{Al}$ ratio of $(5.0 \pm 0.2) \times 10^{-5}$ (MSWD = 4.3, 95%-conf.). The $\delta^{26}\text{Mg}$ values of hibonite (~ −6‰, n=10) and spinel (~ −3‰, n=2) in the hibonite-spinel layer are negatively fractionated; spinel in the outermost layer show positively fractionated $\delta^{26}\text{Mg}$ values (~ +3‰, n=1). We note that these results are of preliminary nature due to the small number of measurements. Melilite and hibonite were analyzed for Be-B and show evidence for having incorporated live $^{10}\text{Be}$. Isochron regression yields $^{10}\text{Be}/^{9}\text{Be}=(10.0\pm6.6)\times10^{-4}$ and $^{10}\text{B}/^{11}\text{B}=0.248\pm0.009$ (MSWD=0.8, 2σ errors).

**Discussion:** With a maximum length of 5 mm, Mesquite is larger than most CAIs in CO chondrites [4, 8]. Considering the inclusion size, shape, and mineralogy, Mesquite could be best described as a compact Type A (CTA) inclusion; however, melilite does not appear blocky and grains are smaller than those in a typical CTA [14]. Another distinct feature of this CAI is the concentric layering that resembles Wark-Lovering rims [15].

The initial $^{27}\text{Al}/^{26}\text{Al}$ ratio of $(5.0 \pm 0.2) \times 10^{-5}$ is indistinguishable from the canonical value [5]. Interestingly, all hibonite grains and spinel in the hibonite-spinel zone are negatively fractionated which might point to a condensation origin. On the contrary, spinel in the outermost zone has a positive $\delta^{26}\text{Mg}$ value, implying that the rim of the inclusion could have been once molten and undergone evaporation. We will perform more measurements on the rim phases to confirm this.

The initial $^{10}\text{Be}/^{9}\text{Be}$ ratio $(10.0\pm6.6)\times10^{-4}$ for CAI Mesquite is within the range of previously measured CAIs [10, refs therein]. This implies that most CAIs were irradiated with a similar dose of energetic particles.

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**References:**