ALUMINUM-MAGNESIUM CHRONOLOGY OF THE RIM OF A MURCHISON TYPE A CAI.

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Wark-Lovering (W-L) rims are a ubiquitous feature surrounding CAIs with distinct isotopic compositions and mineralogy that likely record the dynamic physiochemical environments of the early solar nebula. Recent work [1] determined that anorthite in the rim of 2 CV CAIs formed at least 700 ka after CAI growth, a time difference of formation more than twice that reported by previous studies. The significance of this relatively young age is complicated by widespread evidence for high-temperature thermal metamorphism on the CV parent body and leaves open the possibility that this age represents parent body alteration. Here we present new Al-Mg isotope data from the W-L rim of a rare Type A CAI from Murchison, a CM2 chondrite that has experienced only low-temperature aqueous alteration. Previous oxygen isotope measurements of this CAI and its W-L rim are uniformly ^{16}O-rich, including anorthite in the rim [2].

The petrography of MUM-1 (MUrchison Melilite) was previously described by MacPherson et al. [3], who reported that it is one of three small angular fragments that are similar in mineralogy and composition to Allende compact Type A CAIs. The interior of MUM-1 consists primarily of blocky melilite crystals that enclose spinel, hibonite and perovskite. A 25-30 μm-thick, layered W-L rim mantles the inclusion, and consists of the following minerals (from inside to outside): spinel, melilite, anorthite and clinopyroxene grading outward in composition from Ti-, Al-rich to Ti-, Al-poor.

Al-Mg isotope measurements were made in anorthite, melilite, and spinel from the rim of MUM-1 using the NanoSIMS 50 at the Lawrence Livermore National Laboratory. We used an ~100 pA O^- primary ion beam focused to an ~500 nm spot and rastered over 5 μm × 5 μm areas using the Hyperion II ion source. Secondary ions of $^{27}Al^{2+}$, $^{24}Mg^+$, $^{25}Mg^+$, and $^{26}Mg^+$ were measured simultaneously in four electron multipliers at a mass resolving power of ~3600. The measured ratios were corrected for deadtime and instrumental mass fractionation using terrestrial standards.

Anorthite analyses in the rim have ^{26}Mg excesses that are well-resolved from the canonical $(^{26}Al/^{27}Al)_0$, and fall along a slope corresponding to $(^{26}Al/^{27}Al)_0 \geq 2.0 \times 10^{-5}$. Existing data from melilite and spinel in the interior of the inclusion form a correlation line with slope corresponding to $(^{26}Al/^{27}Al)_0 = (4.88 \pm 0.48) \times 10^{-5}$ [2, 4]. The difference in $(^{26}Al/^{27}Al)_0$ suggests that anorthite could have formed up to 1 Ma after CAI formation. The preservation of the ^{16}O-rich signature of the rim minerals, including anorthite, suggests that this anorthite formed in the nebula. The extended nebular history shown by MUM-1 is consistent with recent studies showing CAIs were reprocessed in the nebula long after primary CAI formation had ceased [e.g. 5].

References: 1] Mane P. et al. 2015. Abstract #2898. 46th Lunar & Planetary Science Conference. [2] Matzel J. et al. 2013. Abstract #2632. 44th Lunar & Planetary Science Conference. [3] MacPherson G. et al. 1983. *Geochimica Cosmochimica Acta*, 47:823-839. [4] Tanaka T. et al. 1980. 11th Lunar & Planetary Science Conference. pp. 1122-1124. [5] MacPherson G. et al. 2012. *Earth and Planetary Science Letters.* 331–332:43–54.