LOW INITIAL ABUNDANCE OF ^{26}AL IN A COMETARY CAI

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Introduction: ^{26}Al is a short-lived radionuclide that decays to ^{26}Mg with a half-life of 0.717 Myr [1]. It was present in the early solar system and was an important heat source of early accreted planetesimals [2]. The initial distribution of ^{26}Al in the early solar system remains controversial. Recent analyses of the U-Pb and Al-Mg ages of the andesitic achondrite Erg Chech 002 show that ^{26}Al was homogeneously distributed within the accretion regions of meteorites [3]. Measured variations in the initial ^{26}Al/^{27}Al of CAIs can be interpreted as either ^{26}Al variability in the CAI forming region or prolonged (0.4 Myr) thermal processing [4]. The ^{26}Al distribution in outer solar system objects is not well constrained. Comets, thought to have accreted beyond the orbit of Neptune, contain CAIs at the 2-3% level [5]. Previous measurements of the Al-Mg system in cometary samples (Stardust samples from comet Wild 2, or giant cluster interplanetary dust particles which are probably from comets) show no resolved initial ^{26}Al/^{27}Al [6-9]. All of the previously measured initial ^{26}Al/^{27}Al upper bounds were below the 5.2×10^{-5} canonical value. Here we report measurements of the ^{26}Al-^{26}Mg system in particle P3-4, a CAI fragment from U2-20 GCP, a giant cluster IDP of likely cometary origin [5].

Methods: Initial characterization of the CAI fragment P3-4 TEM was performed at the University of Washington. The particle was embedded in an epoxy cylinder where it was microtomed, creating ~70 nm thick microtome sections and a potted butt. Measurements of the Al-Mg system on P3-4 in the potted butt were made using the Cameca NanoSIMS 50 and Hyperion plasma source at Washington University in St. Louis. We collected scanning ion images of $^{24}Mg^+$, $^{25}Mg^+$, $^{26}Mg^+$, $^{27}Al^+$, $^{28}Si^+$ in multi-collection mode using electron multipliers. The mass-resolving power for all species was >5000, sufficient to resolve all interferences. A primary O^- beam of ~7.5 pA with a spot size of ~200 nm was used to resolve the targeted Al-rich phases from Mg-rich phases surrounding them. During the analyses, the beam was rastered over a 10×10 μm area to include the entire particle in the scanning frame. Prior to the analyses, a larger 20×20 μm area was presputtered to remove the carbon coat.

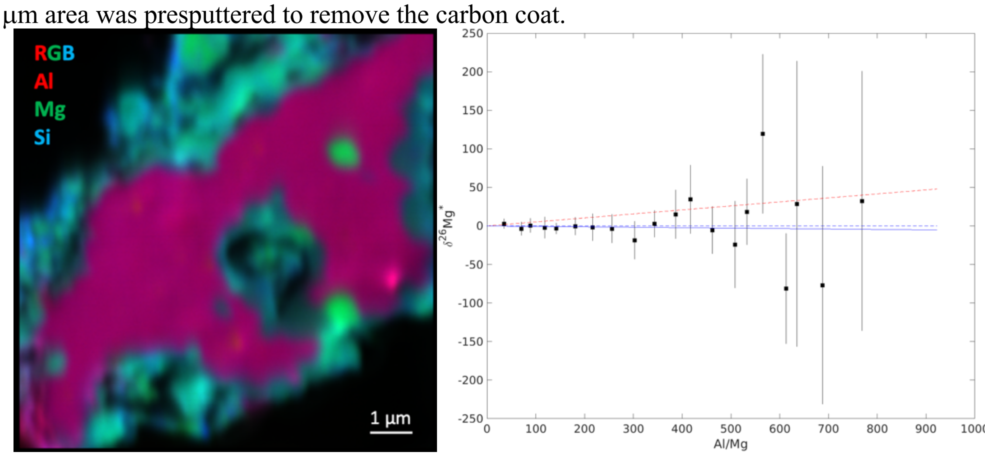

Fig. 1. (Left) Composite RGB element map of the CAI fragment P3-4. (Right) Al-Mg internal isochron plot for P3-4. Dashed red line is canonical, dashed blue line is zero, solid blue line is this measurement.

Results & Discussions: The $(^{26}Al/^{27}Al)_0$ value obtained from P3-4 is $(-0.56 \pm 3.12) \times 10^{-5}$ (2σ). The 2σ upper bound for initial ^{26}Al/^{27}Al is 2.56×10^{-5}. This upper bound corresponds to about 1 Myr after CAI formation. Similar to other cometary particles, P3-4 shows no evidence for the incorporation of live ^{26}Al during its formation or a subsequent heating event. There are three possible explanations for lower than canonical ^{26}Al in P3-4 and other cometary particles: they may have formed (or were altered) 1) before ^{26}Al was injected into the solar nebula, 2) in a region where ^{26}Al was less abundant, or 3) after ^{26}Al decayed.

References: [1] Norris T. L. et al. (1983) *Journal of Geophysical Research*: *Solid Earth* 88.S01: B331-B333. [2] Dauphas N. and Chaussidon M. (2011) *Annual Review of Earth and Planetary Sciences* 39:351-386. [3] Reger P. M. et al. (2023) *Geochimica et Cosmochimica Acta* 343: 33-48. [4] Kawasaki N. et al. (2020) *Geochimica et Cosmochimica Acta* 279: 1-15. [5] Joswiak D. J. et al. (2017) *Meteoritics & Planetary Science* 52.8:1612-1648. [6] Ishii H. A. et al. *41st Annual Lunar and Planetary Science Conference*. No. 1533. 2010. [7] Nakashima D. et al. (2015) *Earth and Planetary Science Letters* 410: 54-61. [8] Ogliore R. C. et al. (2012) *The Astrophysical Journal Letters* 745.2: L19. [9] Ogliore R. C. et al. (2020) *Geochimica et Cosmochimica Acta* 271: 116-131.