^{26}Al-^{26}Mg SYSTEMATICS OF THE UNGROUPED ACHONDRITE NORTHWEST AFRICA 11119: TIMING OF EXTRATERRESTRIAL SILICA-RICH MAGMATISM

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Introduction: Achondrites are relics from the earliest stages of planetesimal formation and differentiation. Therefore, studying the chronology of achondrites is important for understanding the timescales of igneous activity in the early Solar System. Ungrouped achondrites are classified as such because of their distinctive geochemical, mineralogical, and/or O-isotope compositions when compared to other more commonly known types of achondrites, such as the Howardite-Eucrite-Diogenite (HED) group. These samples are invaluable for understanding the diversity of igneous processes operating in the early Solar System. Northwest Africa (NWA) 11119 is a recently classified ungrouped achondrite with an andesite-dacite bulk composition (although it is depleted in alkalis compared to terrestrial andesites and dacites) and a modal mineralogy of ~39% pyroxene, ~38% plagioclase, ~22% silica, and ~1% ulvöspinel, ilmenite, troilite, and zircon [1]. As such, this achondrite is distinct from all known achondrites in its silica-rich mineralogy and bulk composition; however, its O-isotope composition is similar to that of NWA 7325 and some ureilites [1].

The ^{26}Al-^{26}Mg system ($t_{1/2}$ ~0.705 Ma) has been extensively applied as a chronometer for constraining high-resolution timescales of early Solar System events, including planetesimal accretion and differentiation (e.g., [2] and references therein). In this study, we have investigated the ^{26}Al-^{26}Mg isotope systematics in NWA 11119 to constrain the timing of silica-rich magmatism on its parent body.

Methods: A clean, interior piece of NWA 11119 (~500 mg) was obtained from the collection at the University of New Mexico (UNM). All sample handling and processing was performed under clean laboratory conditions in the Isotope Cosmochemistry and Geochronology Lab (ICGL) at Arizona State University (ASU). A ~50 mg fragment was powdered to obtain a whole-rock (WR) and another ~200 mg fragment was processed for mineral separation. One pyroxene separate, one silica-rich separate, and two plagioclase-rich separates were obtained. The WR and mineral separates were digested and brought into solution; a 5% aliquot was reserved for elemental abundances while the remainder was processed for Mg separation. The Al/Mg ratios and Mg isotopes were measured using methods described by [3]. Excesses in ^{26}Mg from the decay of ^{26}Al are reported as $\mu^{26}Mg^*$, defined as the non-mass dependent excesses in the $^{26}Mg/^{24}Mg$ ratio relative to the terrestrial (DSM3) standard in ppm. Errors on $\mu^{26}Mg^*$ values are either internal 2SE errors from repeat analyses of the sample or the 2SD long-term external reproducibility (±6 ppm), whichever is larger. The ^{26}Al-^{26}Mg internal isochron was calculated using ISOPLOT [4].

Results/Discussion: The NWA 11119 WR and mineral separates show a spread in $^{27}Al/^{24}Mg$ ratios from ~0.08 (for pyroxene) to ~30 (for plagioclase). The $\mu^{26}Mg^*$ values are well correlated with these $^{27}Al/^{24}Mg$ ratios; in a plot of $\mu^{26}Mg^*$ versus $^{27}Al/^{24}Mg$ ratios, the data define a slope corresponding to a $^{26}Al/^{27}Al$ ratio of $(1.72 \pm 0.09) \times 10^{-6}$ (MSWD = 1.7) and an initial $\mu^{26}Mg^*_0$ of 18 ± 9 ppm. The NWA 11119 WR (with $^{27}Al/^{24}Mg$ ~1.7) has a positive $\mu^{26}Mg^*$ of 36 ± 11 ppm that is similar to that of eucrite whole-rocks [5]. Relative to the D'Orbigny angrite age anchor [6,7], the $^{26}Al/^{27}Al$ ratio of NWA 11119 corresponds to a ^{26}Al-^{26}Mg internal isochron age of 4564.9 ± 0.3 Ma. This ancient age for NWA 11119 is slightly older than the ^{26}Al-^{26}Mg internal isochron age of the oldest reported achondrite, Asuka 881394 [8]. There is evidence that NWA 11119 formed on a distinct parent body than other more common achondrites like the HEDs, but that it may share a parent body with another ungrouped achondrite, NWA 7325 [1]. Comparison of their ^{26}Al-^{26}Mg systematics indicates that NWA 11119 crystallized almost ~2 Ma before NWA 7325 [9,10]. If they originated on the same planetesimal (as is suggested by their O-isotope compositions), this time difference requires a complex geochemical/thermal evolution on this parent body. In conclusion, the ^{26}Al-^{26}Mg systematics of the ungrouped achondrite NWA 11119 record the oldest known episode of silicic magmatism in the early Solar System.

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