OXYGEN ISOTOPES AND HIGH ^{26}Mg EXCESSES IN A U-DEPLETED FINE-GRAINED ALLENDE CAI.

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Introduction: CAIs are thought to be among the first solids formed in the early Solar System (ESS). As such, they are prime samples to study when (1) investigating ESS high-temperature processes, and (2) searching for evidence of short-lived radionuclides at the time of formation of the SS. A recent systematic study of fine-grained CAIs characterized by a Group II REE pattern from Allende [1], found an extremely large ^{235}U excess (δ^{235}U >50 ‰ rel. to CRM-112a) in one sample: ME-3364 3.2. The discovery of this large ^{235}U excess provides definite evidence of the existence of live ^{247}Cm in the ESS, as previously suggested by [2]. In this study, we analyzed the oxygen isotope compositions and Al-Mg systematics of CAI ME-3364 3.2 to constrain the conditions of its formation.

Method: Petrologic and mineralogical studies were carried out by SEM equipped with EDS at UCLA. Secondary minerals such as nepheline, sodalite, Fe-rich pyroxene, and Fe-rich spinel were observed in ME-3364 3.2. Analyses for oxygen isotopes and Al-Mg systematics were performed on the IMS 1270 ion probe in UCLA. The instrumental mass fractionation for both oxygen and Mg isotopes was corrected by comparison to San Carlos olivine, pyroxene and Burma spinel. Excesses in ^{26}Mg (δ^{26}Mg*) were calculated by adopting an exponential law with a mass fractionation exponent of 0.516 obtained from the analysis of standards.

Results and Discussion: Despite being U-anomalous and full of secondary phases, the oxygen isotopic compositions of this fine-grained CAI are not too different from those of other non-FUN CAIs. The Δ^{17}O values of sodalite and nepheline range from -20‰ to -5‰, similar to values previously obtained on Efremovka fine-grained CAIs [3]. Oxygen isotopes are fractionated slightly along a mass dependent fractionation line at Δ^{17}O~ -7‰, which could be caused by imperfect corrections for instrumental mass fractionations due to the lack of proper standards for fine-grained CAIs. Large excesses in ^{26}Mg have been identified in ME-3364 3.2 over a large range of ^{27}Al/^{24}Mg values (from 42 to 667), yet the data do not define an isochron. Instead, the ^{26}Mg excess is approximately uniform across all spots analyzed. All the spots are characterized by large but variable negative δ^{25}Mg (from ~ -9‰ to -19‰).

The elevated, yet homogenous, δ^{26}Mg* and negative δ^{25}Mg in ME-3364 3.2 indicates Mg isotope exchange must have taken place in a closed system to avoid dilution with chondritic Mg, although our data cannot constrain a reliable timescale of formation of the secondary phases. Further investigation is required to explain ^{26}Mg excesses and negative δ^{25}Mg associated with U depletion in this fine-grained inclusion.

References: [1] Tissot F.L.H. et al., (2015) Lunar and Planetary Science Conference #2819. [2] Brennecka G.A. et al., (2010) Science, 327, 449-451. [3] Aléon J. et al., (2005) Meteoritics & Planetary Science 40: 1043-1058.