ISOTOPIC AND RARE EARTH ELEMENT STUDIES OF A FUN-LIKE FORSTERITE-BEARING INCLUSION FROM ALLENDE.

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Introduction: So called FUN (*Fractionation* and *Unknown Nuclear effects*) is a minor group of refractory inclusions characterized by large mass-dependent fractionation in many elements (e.g., O, Mg, Si, etc.), unknown isotopic anomalies (e.g., in ^{48}Ca and ^{50}Ti), and very low initial abundance of short-lived nuclides such as ^{26}Al [e.g., 1]. We found in Allende meteorite (CV3, oxidized) a forsterite-bearing inclusion, AL1B-F, which shows petrographic evidence of a vigorous evaporation event. Here we report ion microprobe data for O and Mg isotopes and abundances of Rare Earth Elements (REEs) for AL1B-F. Isotopic analyses of Si, Ca and Ti are in progress.

Petrography: In the central part of AL1B-F (2.4 mm x 1.1 mm in size), large forsteritic olivine grains (50-100 μm in size) and some spinel grains are embedded in fassaite. The outer part is spinel-rich. Some spinel grains show zoning in Al/Mg ratios from ~2 up to ~3, and sometimes show lamellae of hibonite (and corundum in rare case), suggesting a strong evaporation event in which Mg was largely lost. Between the forsterite-rich core and spinel-rich outer part are filled with abundant secondary minerals such as nepheline, sodalite, hedenburgite, and so on.

Results: Oxygen and Mg isotopes and REE abundances were measured using a CAMECA ims-6f ion microprobe with analytical conditions similar to those described elsewhere [e.g., 2].

Oxygen isotope data for forsterite, spinel and fassaite are plotted far right-hand side of the CCAM line with δ^{18}O from -23 to -5 permil and Δ^{17}O of -22 to -24 permil. They form a slope ~0.5 line, which crosses the CCAM line at $\delta^{17,\,18}$O ~-47 to -48 permil, consistent with the compositions of typical refractory inclusions. One perovskite grain shows a ^{16}O-poor composition (δ^{17}O ~0 and δ^{18}O ~+7 permil).

All the minerals so far measured show heavily fractionated Mg isotopes with Δ^{25}Mg ~+24 to +29 permil/amu for forsterite in the core, ~+27 permil/amu for spinel in the core, and ~+37 to +41 permil/amu for coexisting spinel and hibonite, respectively. So far, no excess ^{26}Mg was observed even for hibonite (^{27}Al/^{24}Mg ~33) within experimental uncertainty.

Fassaite in the core shows an almost flat REE pattern (50-70 x CI) with a large depletion in Ce (~5 x CI) (and smaller depletions in Eu and La). Such Ce depletion is similar to those observed in experimentally produced evaporation residue [3, 4].

All the data suggests a vigorous evaporation event occurred on AL1B-F. Further analyses on Si, Ca and Ti isotopes are important to see if AL1B-F has a UN signature and to understand the formation condition of such rare type of inclusions in the early solar system history.

References: [1] MacPherson et al. 1995. *Meteoritics* 30: 365-386. [2] Ushikubo T. et al. 2007. *Earth and Planetary Science Letters* 254: [3] Floss C. et al. 1996. *Geochimica et Cosmochimica Acta* 60: 1975-1997. [4] Davis A.M. and Hashimoto A. 1995. *Meteoritics* 30, Suppl.: 500-501.