

MAGNESIUM ISOTOPE MASS FRACTIONATION OF FINE-GRAINED INCLUSIONS FROM CV3 METEORITES

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Introduction: Although excesses of ²⁶Mg from the decay of ²⁶Al have been well-documented in CAIs, there has been less focus on the mass fractionation of Mg in refractory inclusions. Clayton et al. (1988) showed that the degree of Mg isotope fractionation in CAIs varies by >10 per mil/amu [1]. While a subset of CAIs are isotopically light with respect to magnesium isotopes, most CAIs measured are isotopically heavy compared to terrestrial values, with FUN CAIs and hibonite-bearing CAIs showing the highest degrees of fractionation [1,2]. Recent high precision MC- ICP-MS data have confirmed that Mg in igneous CAIs is typically isotopically heavy, and often show heterogeneities of a few ‰/amu between the cores and rims [3,4,5,6].

The majority of work to date including the recent ICP-MS studies have focused on igneous, coarse grained, CAIs. We have expanded this study to include three fluffy, fine-grained CAIs, that have never experienced extensive melting, from the CV3 meteorites Allende and Vigarano, in order to clarify the relationship between these inclusion types. Measurements were made at UCLA by LA-MC- ICP-MS with a precision of ~0.2‰.

Samples and results: Vigarano V9 is a fluffy Type A CAI, 3mm in maximum dimension, that is very irregular in shape. It is composed of spinel nodules surrounded by gehlenitic melilite and each nodule has a thick (up to 10 μm) forsterite rim. The magnesium isotope composition varies from ²⁵Mg = -0.1 to -1.0 ‰, with a mean value of -0.6 ‰. The olivine rims appear to be isotopically lighter than the cores.

Vigarano V10 is a rounded CAI 1.5mm across composed of spinel intergrown with melilite and surrounded by a diopside rim. Part of the inclusion is highly fragmented and porous. The ²⁵Mg varied between -2.2 to +0.1‰, with a mean value of -1.1‰. The non-porous part of the inclusion is isotopically heavier than the porous part.

Allende MRS5 is an unzoned, fine-grained, irregularly shaped melilite rich inclusion composed of melilite and spinel nodules surrounded by a thin diopside rim, with minor secondary nepheline and andradite. The ²⁵Mg varied between -1.2 to 0.0‰, with a mean of -0.6‰.

The 3 CAIs all contained ²⁶Mg* consistent with ²⁶Al decay.

Discussion: Each of the fine-grained inclusions analysed to date exhibited some isotopic heterogeneity, of the order of 1-2 ‰/amu, and all are isotopically lighter than bulk chondrites. In the latter respect the inclusions differ from most previously analysed, isotopically heavy coarse-grained CAIs. The isotopic difference is unlikely to have been caused by evaporative loss of Mg during melting of fine-grained CAIs to form compact CAIs, since the bulk Mg abundance is not systematically lower in igneous CAIs. Instead, some fine-grained CAIs may have formed by recondensation of previously evaporated material, as also implied by their typically Group II REE patterns [e.g. 7].

References: [1] Clayton et al., (1988) Phil. Trans. Roy. Soc., A325. 483-501 [2] Ireland et al., (1986) GCA 50 1413. [3] J. Simon et al., LPSC 2004 abstract #1668. [4] Ash et al., LPSC 2002 abstract #2063. [5] Young et al., (2002) GCA 66 683-698. [6] S. Simon et al., (2004) LPSC abstract #1684. [7] Russell et al. (2003) LPSC abstract #1631.