

SILICON ISOTOPE FRACTIONATION IN MELILITE WITHIN TYPE B2 CAIS

E. S. Bullock¹, F. M. Richter², T. Ushikubo³, N.T. Kita³, A. M. Davis^{2,4}, and G. J. MacPherson¹. ¹US National Museum of Natural History, Smithsonian Institution, Washington, D.C., 20560 USA. E-mail: BullockE@si.edu. ²Dept. of the Geophysical Sciences, Univ. of Chicago, Chicago, 60637 USA. ³Dept. of Geosciences, Univ. of Wisconsin, Madison, WI 53706, USA. ⁴Enrico Fermi Institute, Univ. of Chicago, Chicago, 60637 USA.

Introduction: Although it is generally agreed that Type B CAIs crystallized from melt droplets [1], the origin of the thick continuous melilite mantle surrounding Type B1 inclusions – and its absence from Type B2s – remains unclear [1]. Both B1 and B2 CAIs have isotopically heavy Mg and Si in bulk, suggesting evaporation and loss of Mg and Si from a melt prior to or during crystallization. However the mantle formed, [2] proposed that once it did the resultant melilite “shell” effectively suppressed evaporation of Mg and Si and subsequent melilite growth occurred in a closed system. The subsequent isotopic composition of the melilite should be uniform. Type B2s, lacking a mantle, continued to evaporate Mg and Si from the melt and as a result melilite became increasingly isotopically heavy throughout progressive crystallization. We tested this idea by measuring Si isotopes in two Type B2 CAIs, looking for correlations between isotopic composition vs. distance from rim and/or melilite composition.

Method: Quantitative element maps of Mg, Al, Si, Ca and Ti collected using the JEOL JSM-5800LV SEM were used to create melilite zoning maps of grains in two different B2 CAI (Allende TS33 and Vigarano F1), which helped guide the selection of locations for analysis. The Cameca ims 1280 at the University of Wisconsin was used to simultaneously measure isotope ratios of (³⁰Si/²⁸Si) and the (²⁷Al/²⁸Si) ratios for melilite matrix correction.

Results & Discussion: Melilite in F1 shows a range in $\delta^{30}\text{Si}$ from 4.0 to 8.6‰, but does not show a strong correlation with mol % åkermanite. Some analyses at the rim are isotopically heavy (up to 8.6‰). The interior shows a limited range of enrichment from 4.0 to 6.7‰. Melilite in TS33 shows a range in $\delta^{30}\text{Si}$ from 1.3 to 3.8‰. One grain that crystallized from the rim inwards shows no correlation between Si isotopes and distance from the rim or mol% Åk. A grain that crystallized out towards the rim however becomes isotopically heavy with progressive crystallization, as would be expected if evaporation occurred during crystallization.

Previous work has shown Mg isotopes in melilite within B1s and B2s to be isotopically heavy, with flat profiles across the interior that become isotopically lighter at the rim [3-5], Si isotopes in a B1 and a B2 CAI show different trends [3]; Si in the B1 shows a flat, isotopically heavy profile in the interior but becomes heavier at the rim, whereas Si in the B2 showed a flat profile across the entire inclusion. In F1 and TS33, melilite becomes isotopically heavy at the rim, consistent with the B1 of [3], but not with the B2. This suggests some Type B CAIs retain signatures of late-stage evaporation in Si isotopes, whereas Mg isotopes record post-crystallization exchange with an external reservoir. The isotopic signature is not simply a function of the presence (or absence) of the melilite mantle.

References: [1] Stolper E. and Paque J. M. (1986) *GCA* 50 1785-1806. [2] Mendybaev R. A. et al. (2006) *GCA* 70 2622-2642. [3] Knight K. B. et al. (2009) *LPS XL*, #2360. [4] Bullock, E. S. et al. (2010) *LPS XLI*, #2356. [5] Bullock, E. S. (2010) *unpublished*.