

OXYGEN ISOTOPE DISTRIBUTION IN FASSAITE OF ALLENDE CAI;

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Calcium, aluminium-rich inclusions (CAIs) from carbonaceous chondrite are believed to be among the first solids to have formed in the early solar system and thus to preserve a record of conditions and processes that prevailed early in the solar nebula. We have measured inter- and intra- crystalline oxygen isotope distribution of fassaite in Type B1 CAI of Allende meteorite.

Secondary ion mass spectrometry (SIMS) using negative Au⁻ primary ion was applied to *in situ* oxygen isotope ratio analysis on an polished thin section of the CAI. Preliminary data and interpretation were given in Yurimoto et al. [1]; the more extensive data presented herein lead to more definitive conclusions than those in our earlier work.

Samples and Experimental Methods: The sample used in this study was a polished thin section (HN3-1c) from Allende HN3-1 Type B1 CAI. Petrological characteristics of the inclusion is described by NAGAHARA et al.[2]. The polished thin section was coated with ~30 nm of gold film for SIMS analysis. Oxygen isotope ratios were measured by the Tsukuba University CAMECA IMS-3F SIMS instrument equipped with BLAKE-V ion source [3]. All O isotopic measurements were made with a focused negative primary ion beam of gold. Primary beam currents were adjusted for each run to obtain a ¹⁶O⁻ count rate of ~3 × 10⁵ counts s⁻¹. The beam size was 10~20 μm in diameter. A mass resolution power was set to ~2,000 (1% valley), which was sufficient to resolve all significant interferences. Measurements were made by cycling through the mass sequences 16 and 18 in a magnetic peak jumping mode. After the magnetic peak jumping, a precise peak centering of each mass was made by electrostatic peak switching scan. Secondary ion signals were detected with electron multiplier operated in a pulse counting mode. Signals measured in the electron multiplier were corrected for the counting system dead time. The isotopic composition measured by the SIMS differs from true isotopic composition of the sample by the matrix dependent instrumental mass fractionation. In order to correct the instrumental mass fractionation, a terrestrial augite single crystal was prepared as an standard. Oxygen isotope-ratios relative to SMOW for the standard were determined by conventional mass-spectrometry method.

Results and Discussion: Oxygen isotope data for individual minerals after mineral separation in this inclusion were reported by Mayeda et al. [4]. The data were plotted on the slope one Allende mixing line in oxygen three isotope diagram. The δ¹⁸O value of spinel was -40 ‰, whereas melilite and anorthite were around 0 ‰. The δ¹⁸O value of fassaite was -24 ‰ which plot was intermediate from the ¹⁶O-enriched spinel position to the melilite/anorthite position. If the CAI was formed originally with ¹⁶O-enriched O distributed homogeneously and then O isotopes in minerals were later replaced by heating, diffusion profiles may be observed in the fassaite crystals.

Two distinguished types of fassaite were observed in the CAI. One is the large, blocky fassaite crystals, the other is the fassaite crystals enclosed in melilite in the interiors of the CAI. Fig. 1 shows a blocky fassaite single crystal measured in this study surrounded with anorthite crystals and alteration products. The right bottom part of the fassaite grain was lacked in the thin

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section. Oxygen isotope analyses were made on solid circles in the fassaite crystal. The $\delta^{18}\text{O}$ data of white and shaded regions in the crystal scatter over the range of -25 to -20 ‰ and -30 to -25 ‰, respectively. The average value of present results is consistent with the previous data of separated fassaite crystals determined by conventional method [4]. The results indicate that there are no evidence of diffusion profile as a result of oxygen isotope exchange after CAI solidification.

In conclusion, present data indicate that O isotope composition is nearly homogeneous inside of fassaite grains in the HN3-1 CAI. The results suggest that the fassaite grains in CAI acquired the peculiar O isotope ratio at crystallization and may be precursor materials like spinel grains.

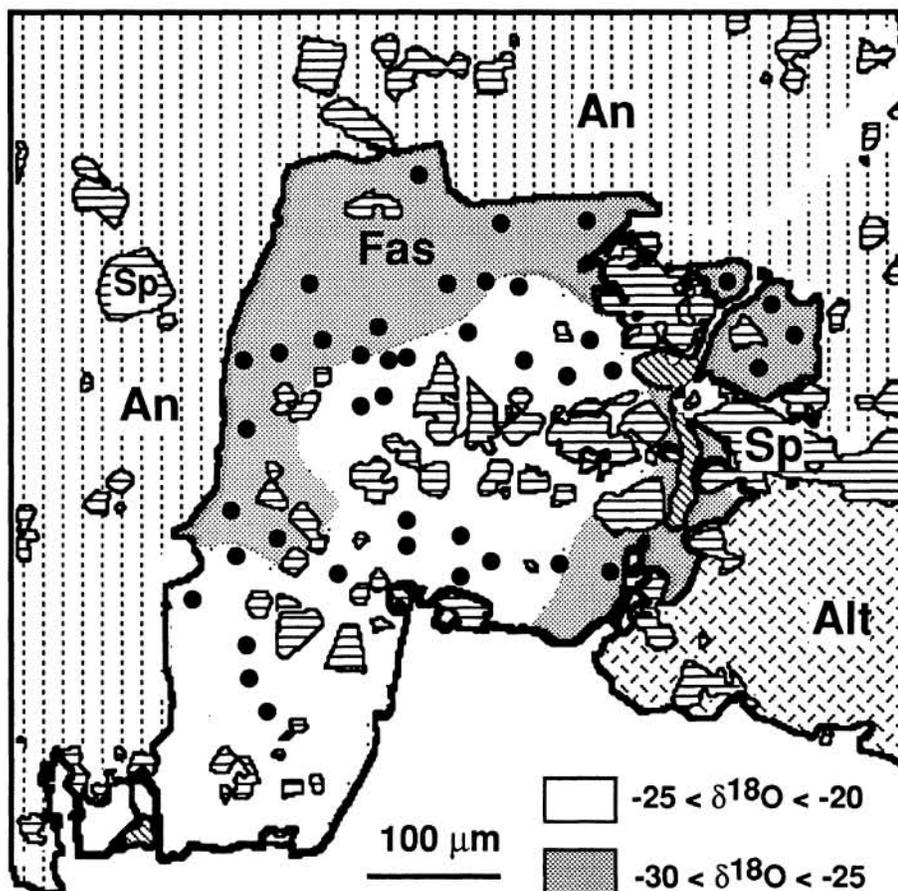


Fig. 1. A large, blocky fassaite single crystal in HN3-1 CAI. Locations of the O isotope analysis by SIMS are shown in solid circles.

- References:** [1] Yurimoto, H., Nagasawa, H., and Mori, Y. (1993) *Lunar Planet. Sci.* XXIV, 1565-1566. [2] Nagahara, H., Nagasawa, H., Nakamura, N., and Matsui, T. (1987) *Lunar Planet. Sci.* XVIII, 694-695. [3] Yurimoto, H., Mori, Y. and Yamamoto, H. (1993) *Rev. Sci. Instrum.* 64, 1146-1149. [4] Mayeda, T. K., Clayton, R. N., and Nagasawa, H. (1986) *Lunar Planet. Sci.* XVII, 562-563.