AL-MG ISOCHRON STUDY COMBINED WITH OXYGEN ISOTOPE ANALYSIS OF THE ALLENDE TYPE B CAI, GOLFBALL.

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Introduction: Oxygen isotopic compositions are heterogeneously distributed within and between minerals in coarse-grained CAIs, suggesting crystallization from different generations of melt [1]. These minerals often plot on a straight line [2] or multiple lines [3] on an Al-Mg isochron diagram. A large Allende type B inclusion, Golfball, has a typical bulk composition [4] and a unique structure: a fassaite-rich mantle enclosing a melilite-rich core. From petrographic study [5], this CAI has experienced at least two melting events. Here, we report preliminary results of oxygen and Al-Mg isotopic measurements of spinel and melilite in Golfball to determine ages of the multiple melting events and the O-isotopic composition of each melt.

Results and discussion: Oxygen and Al-Mg isotopic analyses were performed with a Cameca ims-1270 SIMS instrument at Hokkaido University. These analytical procedures are described in detail elsewhere [6, 7]. Spinel and melilite in this CAI have oxygen isotopic compositions that plot on the CCAM line. δ^{18}O= -50 to -40‰ for spinel, and the oxygen isotopic composition of melilite is distinct in each petrographic occurrence [5]: δ^{18}O= -20 to -10‰ for gehlenitic core melilite, δ^{18}O= -5 to 0‰ for blocky melilite in the core, and δ^{18}O= ~0‰ for melilite in the rim. The different oxygen isotopic values may correspond to the composition of the host melt during each crystallization event.

Two isochrons are defined by the Al-Mg data. The gehlenitic core melilite and rim melilite yield initial ^{26}Al/^{27}Al ratios of 4.9±0.8 and 1.9±1.2 x 10^{-5}, respectively. The age difference between the two isochrons is calculated to be about 1 My. The spinel plots on the gehlenitic melilite isochron, whereas the blocky melilite is on the rim melilite isochron.

From chronological and previous petrographic [5] studies, we propose the following crystallization history of Golfball. In Step 1, spinel and other minerals crystallized from an ^{16}O-rich CAI melt or vapor. In step 2, after a relatively brief interval not resolved by our data, either gehlenitic melilite (but not spinel) of step 1 underwent isotopic exchange with a relatively ^{16}O-poor vapor (δ^{18}O = ~-15‰) or this melilite crystallized from a melt that had done so. In step 3, ~1 My later, the CAI of step 2 was incompletely melted; and blocky melilite crystallized from the resulting melt which had become relatively ^{16}O-poor (δ^{18}O =~ 0 - -10‰) by isotopic exchange with a vapor during melting. In step 4, after a relatively brief interval not resolved by our data, the CAI of step 3 was melted except for spinel and melilite with $Åk_{<40}$, and then new melilite crystallized from a melt that had become more ^{16}O-poor (δ^{18}O =~0‰) by isotopic exchange with a vapor. The melilites of Steps 3 and 4 could have crystallized in the same step if homogenization of oxygen isotopes in the melt was incomplete during crystallization.

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