質量依存同位体分別から考察するアエンデ隕石 F(UN) CAI 前駆物質の化学組成
Chemical composition of a precursor material of an Allende F(UN) CAI estimated from a mass dependent fractionation

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Calcium-aluminum-rich inclusions (CAIs) are considered to be the oldest solid materials in the solar system [e.g., 1, 2]. Some CAIs show mineralogy, texture, and isotopic signature that have experienced melting, evaporation and recrystallization [e.g., 3, 4]. These CAIs have lost primordial chemical compositions caused by evaporative loss of less refractory elements such as magnesium and silicon from the melt. Hence, in order to understand the origin and evolution of such 'igneous' and isotopically fractionated CAIs, estimations of primordial compositions of these CAIs are required.

Estimations of primordial compositions of 'normal' igneous CAIs have been conducted by determination of mass dependent isotopic fractionation degrees in Mg and Si [5, 6], but those of igneous CAIs with *F*ractionation and *U*nknown *N*uclear effects (FUN [e.g., 7]) have been poorly carried out. FUN CAIs are amongst solar system materials with extreme mass dependent isotopic fractionations in Mg, O, and Si. The origin of FUN CAIs is still not well understood, but they must have information about an earliest stage of the solar system evolution. Here we report chemical and Si isotopic compositions of a CAI from Allende, called AL1B-F. AL1B-F is a forsterite-bearing CAI which shows large mass dependent isotopic fractionations in oxygen and magnesium [8]. These fractionation signatures indicate that AL1B-F is related to FUN CAIs.

FEG-EPMA (JEOL JXA-8530F, the Univ. of Tokyo) was used for petrologic studies. Silicon isotopic compositions have been measured by the NanoSIMS installed at Atmosphere and Ocean Research Institute, the Univ. of Tokyo.

AL1B-F is composed of two parts, a forsterite-rich core and a spinel-rich mantle. Among these two parts are filled with abundant secondary minerals (e.g., sodalite and nepheline). Silicon isotopes of forsterites and Al-Ti-rich pyroxenes in AL1B-F show a large mass dependent isotopic fractionation of up to $\sim$22 ‰/amu.

In order to estimate the primordial composition of AL1B-F, we combined Si and previously measured Mg and O isotopic data [8]. If we assume that mass dependent isotopic fractionations in AL1B-F were resulted from simple one-stage evaporation event, $\sim$80% of Mg and $\sim$75% of Si must have been lost (evaporated) from the molten precursor of AL1B-F based on the experimentally determined isotopic fractionation factors [9]. Because of the presence of abundant secondary minerals, it is not possible to precisely determine the bulk chemical composition of the present AL1B-F. If we assume, however, that secondary minerals in AL1B-F are alteration products of primary melilites with Ak mole% of, e.g., $\sim$89, which is a composition of melilites in the Vigarano forsterite-bearing FUN CAI 1623-5 [10], the estimated precursor composition for AL1B-F would be $\sim$34 wt% MgO and $\sim$50 wt% SiO_2. The result suggests that the precursor of AL1B-F also have a Mg- and Si-rich composition like C1, 1623-5, and CMS-1 FUN CAIs [9, 11].

References: [1] Bouvier A. and Wadhwa H. (2010) Nat. Geosci, 3, 637-641. [2] Connelly et al. (2012) Science, 338, 651-655. [3] MacPherson G. J. and Davis A. M. (1993) GCA, 57, 231-243. [4] MacPherson G. J. et al. (2012) EPSL, 331-332, 43-54. [5] Grossman L. et al. (2008) GCA, 72, 3001-3021. [6] Bullock E. S. et al. (2013) MAPS, 48, 1440-1458. [7] Clayton R. N. and Mayeda T. K. (1977) GRL, 4, 295-298. [8] Hiyagon H. and Hashimoto A. (2008) MAPS, #5128. [9] Mendybaev R. A. et al. (2013) GCA, 123, 368-384. [10] Davis A. M. et al. (1991) GCA, 55, 621-637. [11] Williams C. D. et al. (2014) LPS XXXXV, #2146.

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