Short-lived Li-Be-B isotope systems in CAIs and chondrules

DER-CHUEN LEE, YUNG-HSIN LIU, KUO-FANG HUANG

Institute of Earth Sceinces, Academia Sinica, Taipei, Taiwan

Short-lived Li-Be-B isotope systems consist of two short-lived nuclide systems, ^{7}Be-^{7}Li ($t_{1/2}$ ~ 53 days) and ^{10}Be-^{10}B ($t_{1/2}$ ~ 1.6 myrs), and have been studied in CAIs via SIMS. While the presence of ^{7}Be has yet to be reproduced from the initial result, the presence of ^{10}Be has been well-established, and the results have been used to constrain the early evolution of the solar system, e.g., physical conditions of the energetic young sun. Ion probe was used exclusively in all the previous studies, due mainly to the difficulties getting precise Li and B isotopic measurements from such a small amount of silicate samples. Consequently, the uncertainties of SIMS Li and B isotopic measurements were quite substantial, and can only be applied to rare CAIs with large fractionations of Be and B (and Li).

In order to extend the study of Li-Be-B isotopes to normal CAIs and chondrules, we have been setting up column-based B and Li separations out of individual chondrules and mineral separates of CAIs for MC-ICPMS measurement. Due to the small amounts of B and Li in each sample, we have settled with two small columns plus micro-sublimation procedures for the final separation of Band Li. Several standard rocks, from ultramafic to andesitic, were tested for the experimental set up, and the recovery of B and Li were all close to 100%. Thermo Finigan Neptune, was used for Li and B isotopic measurements, while a fraction of the sample solution was used to obtain the Li-Be-B elemental concentrations via an ICPMS. For a typical measurement consuming ~ 3 ng of NBS951 B and ~ 1 ng of IRMM-016 Li, our long term reproducibility was around ± 0.3 ‰ and ± 0.3‰, respectively.

Four individual chondrules extracted from Allende have been studied so far, and the preliminary B isotopic analyses exhibited a very small variation of ^{9}Be/^{11}B from 0.005 to 0.02, and ^{10}B/^{11}B of 0.246 to 0.248, entirely consistent and more precise relative to the ion probe results. NBS951 B was analyzed between each sample, and the analytical uncertainty of ^{10}B/^{11}B for each chondrule was similar to, or slightly better than the long term reproducibility of ± 0.3 ‰. Although Li isotopic analysis is still underway, no significant Li isotopic variation is expected, due to the limited ^{9}Be/^{6}Li ratio of less than 0.1 in these four chondrules. Initial results of B for these chondrules are encouraging, suggesting that our experimental set up is mature and adequate, and we are in the process of analyzing different phases of CAIs from Allende.