Be-B systematics of refractory inclusions in CO and CH chondrites

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Observations of solar-type Young Stellar Objects (YSOs) have shown enhanced and frequent X-ray flares accompanied by intense flux of accelerated particles [1]. The powerful X-ray activity around newborn stars suggests that intense irradiation from the proto-Sun has also occurred in the early solar nebula. Be-B systematics of refractory inclusions, the first solids in our solar system [2, 3], can potentially shed light on irradiation processes in the early solar system.

Previous studies have demonstrated that a short-lived radionuclide ^{10}Be, which decays to ^{10}B with a half-life of 1.4Myr [4], was present in the early solar system with initial ^{10}Be/^{9}Be ratios ranging from 10^{-4} to 10^{-2} [5-13]. However, most of the data come from refractory inclusions in CV3 chondrites. To further investigate the distribution of ^{10}Be and irradiation conditions in the early solar system, we conducted Be-B isotopic measurements using a NanoSIMS 50 (at AORI, Univ. of Tokyo) on compact melilite-rich CAIs in primitive chondrites, Y81020 (CO3.05) and SaU290 (CH3).

The melilite-rich CAI in Y81020 yields an isochron with the initial ^{10}Be/^{9}Be ratio comparable to those of CV CAIs within uncertainties. The results suggest that CO CAIs have also experienced irradiation processes similar to CV CAIs. In contrast, a melilite-rich CAI in SaU290 shows no resolvable excesses in ^{10}B from the terrestrial value. Previous studies have demonstrated that hibonite-rich inclusions in CMs and FUN inclusions in CVs typically show lower ^{10}Be/^{9}Be ratios than those of most normal CAIs [7, 9, 12, 13]. In addition, these inclusions are known to have low ^{26}Al abundances, which is interpreted as their formation prior to the injection of ^{26}Al into the solar system [e.g., 14]. These observations may suggest that FUN-like inclusions record irradiation history in the protosolar molecular cloud [9, 15] and/or heterogeneous distribution of ^{10}Be in the early solar system [12, 13]. A substantial fraction of CH CAIs also has little ^{26}Al [16], suggesting possible relevance to FUN-like inclusions. The low ^{10}Be/^{9}Be ratio of the CH CAI observed in this study could, therefore, support the above hypothesis.

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