LITHIUM AND BORON ISOTOPIC RATIOS OF OLIVINE GRAINS FROM THE ITOKAWA ASTEROID.

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Introduction: The Hayabusa spacecraft returned surface materials from asteroid Itokawa to the Earth. They contain implanted solar wind (SW) [1]. Fujiya et al. [2] found a ~16 % enrichment in ^{10}B compared to chondrites within the top 110 nm from the surface of one Itokawa grain, RA-QD02-0167. Although the authors attributed the observed low ^{11}B/^{10}B ratio to implanted SW B, cosmogenic B could also result in ^{10}B excesses. In this study, we measured Li and B isotopic ratios of two Itokawa grains. These grains were embedded in resin and polished so that we analyzed inner parts of the grains without SW contribution.

Experimental: Two olivine-rich grains, RA-QD02-0019 and RA-QD02-0066 were allocated for this study. To minimize surface contamination, we cleaned the sample surface with pure ethanol (with <20 ppb B) and milli-Q water. Lithium and B isotope analysis was performed with the NanoSIMS 50 at the MPI. ^{6,7}Li$^+$, ^{10,11}B$^+$, and ^{30}Si$^+$ ions, produced by an O$^-$ primary ion beam (~3 nA) with 10 × 10 μm^2 raster, were recorded simultaneously. San Carlos olivine (with 3.1 ppm Li and δ^7Li = 3.4 ‰) and NBS 611 glass (with 350 ppm B and δ^{11}B = –0.48 ‰) were used as standards for Li and B analyses, respectively. Olivine grains in the DaG 989 LL6 chondrite were also analyzed for comparison.

Results and discussion: RA-QD02-0019 has δ^7Li = 9.1 ± 6.4 ‰ and Li abundance of 4.1 ppm, and δ^{11}B = –5.1 ± 19.8 ‰ and B abundance of 0.41 ppm (errors are 2σ). RA-QD02-0066 has δ^7Li = 0.1 ± 9.1 ‰ and Li abundance of 3.9 ppm, and δ^{11}B = –6.3 ± 29.6 ‰ and B abundance of 0.42 ppm. Previous studies have shown significant variations in Li and B abundances in chondrules from the Semarkona LL 3.0 chondrite [3,4]. In contrast, the analyzed two Itokawa grains have homogeneous Li and B abundances, which are also similar to those of DaG 989 olivine. Furthermore, Li abundances of the Itokawa grains are much higher than those in the most Li-rich chondrule from Semarkona [3]. These observations suggest that Li and B were mobilized during thermal metamorphism, likely in an original parent asteroid of Itokawa. Both analyzed grains have Li and B isotopic ratios consistent with those of bulk LL chondrites [5,6] and chondrules in Semarkona [3,4]. No evidence for cosmogenic Li and B was found, supporting the hypothesis that the large ^{10}B enrichment observed in RA-QD02-0167 is due to SW B implantation. The lack of cosmogenic Li and B is consistent with inferred short exposure ages of Itokawa grains (~1.5 Myr or less [1,7]), resulting in only ~3 to 4 × 10^{-3} ‰ excesses of ^{6}Li and ^{10}B. In order to further explore SW B, we plan to analyze lunar soil, which was irradiated by SW for much longer time than Itokawa grains.

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