

The behavior of Li and B during planetary basalt crystallization

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ABSTRACT

Light-lithophile-element zoning patterns in pyroxene in the Shergotty and Zagami martian basaltic meteorites have previously been presented as evidence for pre-eruptive martian water. We investigate the partitioning of Li and B in martian igneous minerals experimentally, using a composition approximating that of the Queen Alexandria Range (QUE) 94201 martian basalt in one-atmosphere gas-mixing furnaces. Partition coefficients obtained for pyroxene ($D_{\text{Li}} = 0.2$, $D_{\text{B}} = 0.023$), plagioclase ($D_{\text{Li}} = 0.37$, $D_{\text{B}} = 0.024$), olivine ($D_{\text{Li}} = 0.27$, $D_{\text{B}} = 0.007$) and merrillite ($D_{\text{Li}} = 0.7$, $D_{\text{B}} = 0.03$), measured using Secondary Ion Mass Spectrometry of experimental charges, demonstrate that Li and B are incompatible in these minerals. As a test of our experimentally determined, anhydrous partition coefficients, we analyzed pyroxene in the Pasamonte eucrite, an asteroidal basalt with an anhydrous petrogenesis. Coupling of the partition coefficients with Pasamonte pyroxene analyses gives B parental melt concentrations in relative agreement with bulk rock analyses; however, Li parental melt concentrations and bulk analyses do not agree, suggestive of post-crystallization modification of Li zoning trends. Our results demonstrate that Li and B zoning patterns in pyroxene in martian basalts cannot be explained by the uptake of Li and B by co-crystallizing plagioclase, olivine, or merrillite, and suggest that the petrogeneses of Shergotty and Zagami involved something other than simple, one-atmosphere, anhydrous crystallization.