SIMS study of $^{11}B/^{10}B$ in immiscible borosilicate glasses

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Samples and objectives

In silicate melts B can form trigonal and tetrahedral species. Isotopic effects due to changes in B speciation are poorly constrained at high, magmatic temperatures. Our recent study of liquid immiscibility in the SiO_2-B_2O_3-Al_2O_3-CaO-Na_2O system (Veksler et al., 2002) at 900-1350 °C employed centrifuge phase separation. Two immiscible melts were separated in distinct layers and quenched to glasses. According to electron microprobe analyses, one of the melts is composed mostly of SiO_2 with 12-20 wt% B_2O_3, while the other is enriched in CaO and Na_2O, and contains 25-35 wt% B_2O_3. Raman spectroscopy revealed strong differences between the conjugate melts in polymerisation and B speciation. The goal of the SIMS study was to evaluate the effects of two-liquid immiscibility and B speciation on $^{11}B/^{10}B$ in the conjugate glasses.

Analytical method

The centrifuged samples were analysed using the Cameca IMS 6f at the GFZ Potsdam. They were sputtered with a O^- primary beam ~10–15 µm in diameter, at 12.5 kV and ~0.3-0.5 nA. Secondary ions of $^{11}B^+$, $^{10}B^+$ and $^{30}Si^+$, accelerated at 10 kV, were analysed at a mass resolution $M/\Delta M$ ˜ 1650–1700 using a 150 µm contrast aperture. A 750 µm field aperture restricted the analysed area to the central part of the sputtered crater. Most measurements included 50 cycles. Typical internal precision (1σ counting statistic) was 0.5‰ for $^{11}B/^{10}B$ ratios, and 0.1% for $^{10}B/^{30}Si$ and $^{11}B/^{30}Si$ ratios. The external reproducibility assessed by replicate measurements of NBS610 and GB4 reference glasses was on average 1.1‰ for $^{11}B/^{10}B$, and 2.5% for $^{10}B/^{30}Si$ and $^{11}B/^{30}Si$. SIMS results were checked by comparison with TIMS data for two selected samples

Matrix effects

We observed strong matrix effects, which showed correlation with the molar (Na+Ca)/(B+Al+Si) of bulk glass compositions. The matrix effects were effectively suppressed by using –60 V offset.

Conclusions

With matrix effects removed, $^{11}B/^{10}B$ in all the glasses were the same, within the analytical uncertainty. We did not observe any significant two-liquid ^{11}B-^{10}B fractionation.

References

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$\delta^{44}Ca$, $\delta^{18}O$ and Mg/Ca ratios Reveal Sea Surface Temperature (SST) and Sea Surface Salinity (SSS) Variations during the Emergence of the Central American Isthmus

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$\delta^{18}O$ values increased by about 0.5 ‰ relative to the equatorial East Pacific values since about 4.6 Ma as a consequence of the emergence of the Central American Isthmus and the restricted surface water exchange through the Panama Strait the Caribbean. This increase in $\delta^{18}O$ can be interpreted either as an increase in Caribbean sea surface salinity (SSS) or a decrease in sea surface temperatures (SST) (Haug et al 2000).

In order to evaluate this problem we measured the $\delta^{44}Ca$ and Mg/Ca ratios on *G. sacculifer* (Site 999) as two independent SST proxies. Although differences concerning absolute temperature calibration exist, the general pattern of both SST proxy records is very similar indicating a SST decrease of about 2 to 3 °C between 4.4 and 4.3 Ma followed by an increase of about 2 to 3 °C between 4.3 and 4.0 Ma.

Correcting the $\delta^{18}O$ record for this temperature change and assuming that changes in ice volume are negligible, the planktonic $\delta^{18}O$-salinity signal decreases by about 0.4 ‰ between 4.5 and 4.3 Ma and increases by about 0.9 ‰ between 4.3 and 4.0 Ma in the Caribbean. We interpret therefore that the salinity of the Caribbean increased by about 1 ‰ in response to the emergence of the Isthmus. However, today the salinity contrast between the Caribbean and the Pacific is about 2 ‰. This larger difference can be explained by a decreased salinity of the East Pacific by about 1 ‰, due to enhanced precipitation after the closure of the Isthmus.

References

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