

1.2.P04

$\delta^{11}\text{B}$ values of silicate geochemical reference materials - A contribution towards well characterized reference materials

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Isotopic fractionation during sample preparation and mass spectrometric measurement is a serious problem for the determination of isotope ratios of light elements like lithium, boron, or chlorine [1]. Well characterized reference materials for geochemical bulk and in-situ analysis of boron are essential to check the accuracy of data and their limits for geological interpretation.

We present boron isotopic compositions and concentration data of well distributed reference materials of the GSJ, USGS, ZGI, MPI and of recently introduced geological materials by the IGG and IAEA [2]. The investigated standards are mainly rock powders, which cover a spectrum of different matrices, but the sample set also includes three artificial glasses and one tourmaline sample. Boron isotopic compositions and concentrations were determined by PTIMS and ICP-OES, respectively [3].

The obtained boron concentrations of the reference materials range from 2 to 159 $\mu\text{g g}^{-1}$, whereby the carbonate show the lowest and the rhyolite the highest concentration. The majority of the mean concentration values are reproducible within 5 % (1RSD) and overlap within 14 % published values. The obtained mean $\delta^{11}\text{B}$ values cover a range of -12.6 to +13.6 ‰ and agree within error published data. Replicate analyses of individually processed silicate materials yield an overall external reproducibility for the whole analytical procedure of better than 0.7 ‰ (1RSD).

References

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1.2.P05

Is there a matrix effect in SIMS boron isotope analysis?

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Boron isotopes were analysed using a Cameca ims 3f secondary ion mass spectrometer with a modified (faster) magnet. A $^{16}\text{O}^-$ primary ion beam was used with an energy of 14.5 keV and – depending on the sample – a beam current of 1–30 nA; the secondary ions had an energy of 4.5 keV. The energy window of the mass spectrometer was set to 50 eV and the mass resolution was $m/\Delta m \approx 1000$. Precision (2σ) of the $\delta^{11}\text{B}$ results is 1 ‰ for tourmalines and < 2 ‰ for the SRM610 glass (~360 $\mu\text{g/g B}$).

Which reference material(s) to use for SIMS B isotope analysis remains an open question. Another unanswered question is whether the measured $\delta^{11}\text{B}$ values are matrix dependent, although most authors report not to have found a significant matrix effect. We used three tourmalines (elbait 98144, $\delta^{11}\text{B} = -10.4$ ‰; schorl 112566, $\delta^{11}\text{B} = -12.5$ ‰ and dravite 108796, $\delta^{11}\text{B} = -6.6$ ‰ [1]) and the SRM610 glass ($\delta^{11}\text{B} = -1.0$ ‰ [2]) as reference materials and tested them for possible matrix effects.

The measured $^{11}\text{B}/^{10}\text{B}$ ratio R of the three tourmalines was consistent within ± 0.8 ‰, although their composition differs widely. For the SRM610 glass R deviated by -5 ‰ from the reference value when using the tourmalines as reference. The deviation of the SRM610 can be caused by (i) its different composition (chemical matrix effect), (ii) the difference between crystal vs. glass (structural matrix effect) and (iii) the higher primary beam current (30 nA vs. 1 nA) required to compensate for the much lower B content.

We analysed the SRM610 glass with a wide range of primary beam currents. The measured ratio R varied from 3.853 ± 0.005 (2σ) at 1 nA to 3.842 ± 0.003 (2σ) at 30 nA; the $\delta^{11}\text{B}$ value was 3.1 ‰ lower at 30 nA. Within the limits of error, R correlates linearly with the square root of the beam current, so that R might actually depend on the beam diameter. Until now, no corresponding dependency was found for the tourmalines. The reason for the dependency of R on the beam current as observed for SRM610 is not yet understood, but this effect seems to be the major reason for the discrepancy between SRM610 and the tourmalines.

References

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