Boron isotope fractionation upon formation of evaporates from boric acid solutions

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Introduction

It is well known that the boron isotopic composition varies largely in nature. The fundamental boron isotope exchange reaction giving rise to natural boron isotope fractionation is : $^{11}B(OH)_4^- + {}^{10}B(OH)_3 = {}^{10}B(OH)_4^- + {}^{11}B(OH)_3$. The exact value of the equilibrium constant (K_B) of this reaction is still in dispute, although the theoretical value based on the spectroscopic data is given to be 1.0194 at 25°C. In this study, we attempt to determine the K_B value by measuring the boron isotope effects upon formation of boron evaporates from aqueous boric acid solutions.

Experimental

Solutions of alkali metal and alkaline earth metal borates were concentrated by water evaporation to form evaporates at 25°C. The boron isotopic ratios of the solution and evaporate phases ($(^{11}B/^{10}B)_{sol}$ and $(^{11}B/^{10}B)_{cry}$) are measured mass spectrometrically to determine the separation factor for the boron isotopes defined as $S = (^{11}B/^{10}B)_{cry} / (^{11}B/^{10}B)_{sol}$.

Results and Discussion

We obtained two lithium borates, two sodium borates, two potassium borates, one magnesium borate, two calcium borates and sassolite. S is plotted against pH of the solution in Figure 1. For a given mineral, S tends to increase with pH. It is also seen that minerals with the same BO_3 unit to BO_4 unit ratio in their polyborates tend to fall on a similar S - pH line except the magnesium borate. The K_B value obtained by analysing the data in Figure 1 based on the isotope two-phase distribution theory is slightly larger than 1.0194, depending on the BO_3-to-BO_4 ratios in the polyborates.

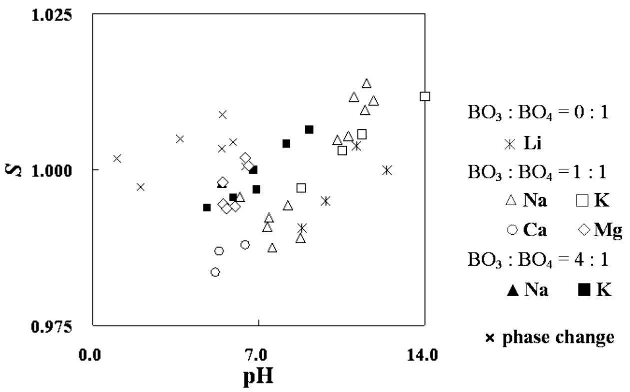

Figure 1:Relation between *S* and pH

Fossil pressures of fluid inclusions in mantle xenoliths: Implications for geobarometry of mantle minerals using micro Raman spectroscopy

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The internal pressure of fluid inclusions in mantle-derived minerals can serve as a messenger from the deep Earth. Micro-Raman spectroscopic analysis allows us to reveal multiple internal pressures of the small fluid inclusions by one-by-one pressure analysis (Yamamoto et al., 2002). We applied this method to CO_2-dominated fluid inclusions in mantle-derived xenoliths.

Intensity ratio and frequency separation of the Fermi diad components in the Raman spectra of CO_2 increase with pressure. We determined a relationship between density of CO_2 and the frequency separation of the Fermi diad components using the Raman data on artificial CO_2 fluid with densities from 0.1 to 1.21 g/cm^3, including super critical fluids at 58-59°C (Kawakami et al., 2003).

From experiments by cryogenic microthermometry, density of the CO_2 is estimated approximately to be 1.14 g/cm^3. This indicates that the internal pressure is at least 1 GPa at the temperature of 1000˚C, which are lithostatically comparable to the depth of up to 40 km. This confirms that these rocks and fluids are of uppermost mantle-origin. This method will work as a useful geobarometer requisite for discussions on the origin of mantle-derived minerals.

References

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