

The elasticity change of Na-contained silica according to the post-stishovite phase transition in the Earth's lower mantle

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Introduction

Stishovite is considered to be an important constituent of subducted oceanic basalts and sediments in the Earth's deep interior. It has the tetragonal rutile structure and transforms to an orthorhombic CaCl₂ structure at around 60 GPa in the pure SiO₂ system. According to theoretical models, the phase transition is triggered by the lattice instability of a soft transverse acoustic mode associated with the shear elastic constant and it has been suggested that this elastic softening could relate to several distinctive seismic structures in the Earth's lower mantle (e.g., [1], [2]). This possibility was denied by the phase study of pure SiO₂ at high pressure and high temperature [3], however, natural stishovite in subducted basalts and sediments may contain several impurities, such as Al, Mg, and Na. Therefore, the effect of impurities on the phase transition and elastic properties of stishovite should be clarified. In this study, we investigated elastic properties of sodium contained stishovite by simultaneous measurements of acoustic velocity and X-ray diffraction across the post-stishovite phase transition at room temperature.

Results

Simultaneous measurements of Brillouin scattering and X-ray diffraction on polycrystalline stishovite with 3 wt.% sodium as impurity were conducted at room temperature and the pressure range of 0-70 GPa using a combined system of Brillouin scattering and synchrotron X-ray diffraction at SPring-8/BL10XU, Japan [4]. The phase transition from rutile-structure to CaCl₂-structure was observed at around 35GPa with X-ray diffracton and a dipping of transversal velocity was also observed at the transition pressure.

[1] Karki *et al.* (1997) *GRL* **24**, 3269-3272. [2] Kaneshima & Helfrich (1999) *Science* **283**, 1888-1891 [3] Ono *et al.* (2002) *EPSL* **197**, 187-192. [4] Ohishi *et al.* (2008) *HPR* **28**, 163-173.

Effects of fluorine on the solubility of Nb, Ta, Zr and Hf in highly fluxed water saturated haplogranitic melts

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The effect of fluorine on the solubility of MnNb₂O₆, MnTa₂O₆, ZrSiO₄ and HfSiO₄ was determined for highly fluxed, water-saturated haplogranitic melts at 800 °C and 2000 bars. The melts correspond to the projection of the granite minimum to the intersection of the Ab-Or tieline in the Q-Ab-Or system (Ab₇₂Or₂₈) and also contain 1.1, 1.7 and 2.02 wt % of Li₂O, P₂O₅ and B₂O₃, respectively. Up to 6 wt% fluorine was added as AgF in order to keep the ASI of the melt constant. The nominal ASI of the melt is close to 1, so that Li is considered to be an alkali element, the melts are alkaline. The experiments were conducted using cold seal pressure vessels with water as a pressure medium.

The solubility products [MnO]*[Nb₂O₅] and [MnO]*[Ta₂O₅] are nearly independent of F content, approximately 17x10⁻⁴ and 70x10⁻⁴ mol²/kg², respectively, although there may be a weak negative dependence on F. These data are in agreement with [1] conducted on Li-B-free and P-poor melts. By contrast, there is a positive dependence of zircon and hafnon solubility, which increase from 0.25 wt% ZrO₂ and 0.85 wt% HfO₂ for melts with 0 wt % F to 0.38 wt% ZrO₂ and 1.16 wt% HfO₂ for melts with 6 wt % F, in agreement with [2]. However, the overall conclusion is that fluorine is less important than previously thought for the control on the behaviour of high field strength elements in highly evolved granitic melts.

[1] Fiege *et al.*, (2011), *Lithos* **122**, 165-174 [2] Keppler, (1993), *Contrib. Mineral. Petrol.* **114**, 479-488.