

Al₂O₃ in stishovite determined by forward and reversal high pressure experiments

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Stishovite is one of the dominant phases for a subducted MORB material and its physical and chemical properties might be very important to the geodynamic process between the subducted MORB material and the mantle material. Recent researches have suggested stishovite as a potential water-carrier and substantial amount of water can be brought down with it to the deep interior of the earth (Pawley et al., 1993; Chung and Kagi, 2002; Panero et al., 2003). In order to achieve charge balance, the hydrogen in stishovite is supposed to be mainly coupled with Al₂O₃ (Chung and Kagi, 2002; Panero et al., 2003) and its abundance, therefore, might be limited by the solubility of Al₂O₃ in stishovite. Clearly a systematic study about the solubility of Al₂O₃ in stishovite is of high value. In addition, the Al₂O₃ in stishovite might substantially change the elastic and electrical properties of stishovite.

In this study, multi-anvil experiments with WC and sintered diamond second stage anvils are carried out under nominally anhydrous condition with two different starting materials: one is a mechanic mixture of Al₂O₃ and SiO₂ in an 1:1 mol ratio while the other is pure kyanite (Al₂SiO₅) previously sintered at 8 GPa and 1400 oC. In all these experiments stishovite coexists with corundum only and the solubility of Al₂O₃ in stishovite is maximized. Due to the sluggish nature of this chemical system (Irifune et al., 1995; Schmidt et al., 1997), we bracket the equilibrium between stishovite and corundum using both forward experiments with the mechanic mixture and reversal experiments with kyanite. Moreover, we run our experiments with long duration and at temperatures as high as possible. The experiment products are checked with electron microprobe in a WDS mode and micro-focus X-ray diffractometer.

With this data set, the effects of pressure and temperature on the solubility of Al₂O₃ in stishovite are critically assessed. Some interesting observations shed lights on the way how kyanite breaks down to stishovite and corundum. It is clear from our study that Al₂Si₂O₇ is just an unstable half-way product of the breakdown of kyanite, in agreement with recent ab initio calculations (Oganov and Brodholt, 2000) while in disagreement with early experimental observations (Ahmed-Zaid and Madon, 1991; Schmidt et al., 1997).

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