

Structural effects of hydrogen on the density and the compressibility of hydrous ringwoodite

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Structural effects of hydrogen on the density and the compressibility of hydrous ringwoodite were studied based on the data of crystal structure of hydrous ringwoodite at ambient pressure (Kudoh et al., 2000) and at high pressures up to 7.9 GPa (Kudoh et al., 2004). The amount of increase of the unit cell volume was little with the incorporation of the hydrogen atoms into the structure. This fact strongly suggests the existence of vacancy at the octahedral M-site which has the longer edge lengths than those of the tetrahedral T-site. In the hydrous ringwoodite, there are two types of replacement, Mg to 2H and Si to 4H. The Si to 4H replacement was considered to be favorable at high pressure because the Si to 4H has less effect on the density decrease than the 2Mg to 4H replacement. The partial occupation of Mg atoms at the tetrahedral T-site was considered to be due to migration of Mg atom in association of the Si to 4H replacement. The linear relation was observed between the bulk modulus values (Weidner et al., 1984; Hazen, 1993; Meng et al., 1994; Inoue et al., 1998; Yusa et al., 2000; Kudoh et al., 2004) and the number of hydrogen atoms in the structure. The results of Ni₂SiO₄ silicate spinel up to 3.8 GPa (Finger et al., 1979) and hydrous ringwoodite up to 7.9 GPa (Kudoh et al., 2004) indicate that the M-O distance decrease significantly with pressure while the T-O distance stays almost constant. In the silicate spinel structure, the distance ratio of (M-O)/(T-O) is larger than the ideal value based on the c.c.p. of oxygen atoms. The (M-O)/(T-O) distance ratio approaches to the ideal value with increasing pressure.