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Effect of pressure on the crystal structure of hydrous ringwoodite, γ-$Mg_{1.97}SiH_{0.03}O_4$

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The specimen used in this study was a single crystal of hydrous ringwoodite synthesized by Ohtani and Mizobata (1998)[1] using a multi-anvil apparatus at conditions of 1680°C and 22 GPa. Electron microprobe analysis showed a chemical composition of 42.83wt% SiO_2, 56.42 wt% MgO, yielding a total wt% of 99.25 (H_2O excluded) with Mg/Si being 1.97. The H_2O content measured by SIMS was 0.2(0.004) wt %. The unit cell content is calculated to be $Mg_{1.97}SiH_{0.03}O_4$. Sets of X-ray diffraction intensities up to 7.9 GPa to $\sin\theta/\lambda$ = 0.87 Å^{-1} were measured with a single crystal of 35×35×24 m using synchrotron radiation of wave lengths 0.6998 Å, 0.7017 Å, 0.6958 Å, 0.6961 Å and 0.7019 Å at ambient pressure, 3.2 GPa, 5.0 GPa, 6.2GPa and 7.9 GPa, respectively at the beam line BL-10A, Photon Factory, High Energy Accelerator Reasearch Organization, Tukuba, Japan. The wave lengths were alibrated by the unit cell constants of a ruby standard crystal. The modified Merrill-Bassett type diamond anvil pressure cell [2] was used. The 4:1 fluid mixture of methanol and ethanol was used for pressure medium and SUS301 plate was used for gasket. The pressure was calibrated using the ruby fluorescence method. The unit cell parameters obtained using 18~36 reflections with 2 from 16° to 50° are given in Table 1. The calculated isothermal bulk modulus using the unit cell volumes at ambient pressure, 3.2 GPa, 5.0 GPa, 6.2GPa and 7.9 GPa with the third-order Birch-Murnaghan equation of state assuming K'=4 was K_0=184(6) GPa and is compared with those of anhydrous ringwoodite (Table 2). The density calculated with the unit cell content $Mg_{1.97}SiH_{0.03}O_4$ and the unit cell volume at ambient pressure was 3.544 gr/cm^3. The 3.544 value is 0.5% smaller than the 3.563 gr/cm^3 value of anhydrous ringwoodite (Sasaki et al., 1982)[6]. The density and bulk modulus of hydrous ringwoodite $Mg_{1.97}SiH_{0.03}O_4$ gave 7.2 km/s bulk sound velosity of seismic wave which is equal to that of anhydrous ringwoodite, implying that hydrous ringwoodite is invisible to seismic wave. According to Weidner and Wang (2000)[7], half of the C layer of the earth's mantle is thought to be composed of ringwoodite. The 0.2 wt% of H_2O of hydrous ringwoodite imply that approximately ten times as much water can be stored in the lower part of the earth's mantle as entire ocean keeps. Analyses of crystal structures up to 7.9 GPa are in progress.

Table 1. Unit cell parameters

P(GPa)	a (Å) *	V (Å^3)	λ(Å)
0.0	8.065(1)	524.6(1)	0.6998
3.2	8.014(1)	514.6(3)	0.7017
5.0	7.996(2)	511.2(3)	0.6958
6.2	7.993(2)	510.6(4)	0.6961
7.9	7.962(1)	504.8(3)	0.7019

Table 2. Kulk moduli (K_0) of anhydrous and hydrous ringwoodite

H_2O(wt%)	K_0 (GPa)	K_0'	Reference
0.0	184(3)[a]		Weidner et al. (1984)[3]
0.0	184(2)	4.8[b]	Hazen (1993)[4]
0.0	182(3)	4.2(3)	Meng et al. (1994)[5]
0.2	184(6)	4[b]	This study

[a]Diabatic, [b]Fixed

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