



Stability of hydrous ringwoodite in the $(\text{Mg}_1\text{Fe}_1)\text{SiO}_4 - \text{H}_2\text{O}$ system

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High-pressure experiments revealed that nominally anhydrous magnesium-rich ringwoodite and wadsleyite can accommodate up to 2-3 wt% H_2O , suggesting that the transition zone of Earth has an enormous water storage capacity. For more iron-rich compositions in the $(\text{Mg},\text{Fe})_2\text{SiO}_4$ system, it is however less known about the solubility and incorporation mechanism of H_2O and its effect on phase stabilities.

Therefore, we have conducted a series of multi anvil experiments in the $(\text{Mg}_1\text{Fe}_1)\text{SiO}_4 - \text{H}_2\text{O}$ system. First experiments cover a wide pressure range from 6 to 23 GPa at variable temperatures between 500°C and 1150°C . A powder starting material with a nominal Fo50 composition was prepared by mixing the following starting materials: $2 \text{Mg}(\text{OH})_2 + \text{Fe}_2\text{SiO}_4 + \text{SiO}_2$. Recovered samples were examined using electron microprobe (EPMA), analytical transmission electron microscopy (TEM), RAMAN and FTIR spectroscopy.

Phase identification reveals ringwoodite as dominant mineral phase under various experimental run conditions ($15\text{-}18 \text{ GPa}$ and $750^\circ - 1150^\circ\text{C}$). The three phase assemblage Ringwoodite (rw) + Magnesiowüstite (mw) + Stishovite (st) was observed at 18 GPa and 1150°C , which is located at lower pressure than predicted in the water-free $(\text{Fe}_1\text{Mg}_1)\text{SiO}_4$ system. FTIR spectroscopy measurements show that ringwoodite (15 GPa , 1150°C) with a nominal Fo50 composition incorporates $0.28 \text{ wt}\% \text{H}_2\text{O}$, which is an order of magnitude lower than the water content of endmember Mg_2SiO_4 ringwoodite. The incorporation mechanism of H_2O into the ringwoodite structure was approached by measuring Fe L_{32} electron energy loss spectra, revealing that iron is

purely ferrous. Thus, it is likely that the water is accommodated by the common substitution mechanism, which involves the replacement of Mg^{2+} or Fe^{2+} by 2H^+ .

Our results suggest that the uptake of water in ringwoodite is considerably reduced for iron-rich compositions. This implies that the water storage capacity of the Martian transition zone is eventually lower than that of Earth. The addition of water to the $(\text{Fe}_1\text{Mg}_1)\text{SiO}_4$ system has also the effect to stabilize the three-phase assemblage $\text{rw} + \text{mw} + \text{st}$ at lower pressure. Thus the mineralogical structure of Mars would be distinctly different than currently assumed, if the Martian mantle were a water-bearing.