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Incorporation of tetrahedral ferric iron into hydrous ringwoodite

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Abstract

Hydrous Fo_{91} ringwoodite crystals were synthesized at 20 GPa and high-temperature conditions using a multi-anvil press. Recovered crystals were analyzed using electron microprobe analysis, Raman spectroscopy, infrared spectroscopy, synchrotron Mössbauer spectroscopy, single-crystal X-ray diffraction, and single-crystal Laue neutron diffraction, to carefully characterize the chemistry and crystallography of the samples. Analysis of the combined data sets provides evidence for the presence of tetrahedrally coordinated ferric iron and multiple hydrogen incorporation mechanisms within these blue-colored iron-bearing ringwoodite crystals. Tetrahedral ferric iron is coupled with cation disorder of silicon onto the octahedrally coordinated site. Cation disorder in mantle ringwoodite minerals may be promoted in the presence of water, which could have implications for current models of seismic velocities within the transition zone. Additionally, the presence of tetrahedrally coordinated ferric iron may cause the blue color of many ringwoodite and other high-pressure crystals.

Keywords: Ringwoodite, high *P-T* synthesis, single-crystal diffraction, Mössbauer spectroscopy