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Pressure-induced structural phase transition of the iron end-member of ringwoodite (γ-Fe_2SiO_4) investigated by X-ray diffraction and Mössbauer spectroscopy

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Abstract

We have carried out X-ray diffraction and Mössbauer spectroscopy measurements on the spinel phase γ-Fe_2SiO_4 (ringwoodite) at ambient temperature and pressures up to 66 GPa using diamond anvil cells. At pressures above 30 GPa, a previously unknown structural phase transition to a rhombohedrally distorted spinel phase has been observed (space group $R\bar{3}mR$). Mössbauer spectroscopy measurements reveal two different Fe^{2+} sites at high pressure with an abundance ratio of 3:1, in agreement with the two crystallographic sites occupied by the iron in this distorted spinel structure. The unit-cell volume of the low-pressure spinel phase as a function of pressure results in a bulk modulus of K_0 = 197(3) GPa using the second-order Birch-Murnaghan equation of state, and K_0 = 201(8) GPa and K' = 3.7(7) when using a third-order equation of state. The pressure evolution of the unit-cell volume and the Mössbauer hyperfine parameters are in good agreement with previous studies, which were limited to a lower pressure range.

Keywords: High pressure, phase transition, ringwoodite, XRD, Mössbauer