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The spin state of Fe^{3+} in lower mantle bridgmanite

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Abstract

Iron- and aluminum-bearing $MgSiO_3$ bridgmanite is the most abundant mineral in the Earth's interior; hence its crystal chemistry is fundamental to expanding our knowledge of the deep Earth and its evolution. In this study, the valence and spin state of iron in well-characterized Al-free Fe^{3+}-rich bridgmanite were investigated by means of Mössbauer spectroscopy to understand the effect of ferric iron on the spin state. We found that a minor amount of Fe^{3+} is in the low-spin state above 36 GPa and that its proportion does not increase substantially with pressure up to 83 GPa. This observation is consistent with recent experimental studies that used Mössbauer and X-ray emission spectroscopy. In the Earth's deep lower mantle, Fe^{3+} spin crossover may take place at depths below 900 and 1200 km in pyrolite and MORB, respectively. However, the effect of spin crossover on physical properties may be small due to the limited amount of Fe^{3+} in the low-spin state.

Keywords: Bridgmanite, lower mantle, spin state, ferric iron, high pressure, Mössbauer, diamond-anvil cell