Geophysical Research Abstracts, Vol. 7, 02690, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02690

Hydrogen incorporation in a ringwoodite analogue: Mg_2GeO_4 spinel

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Single-crystals of Mg_2GeO_4 spinel, a stable analogue to mantle ringwoodite at atmospheric pressure up to 800˚C, were synthesized from Mg_2GeO_4 olivine in hydrous conditions at 1.9 GPa and $\sim$ 1000˚C. Mg_2GeO_4 spinel has been extensively used for the study of phase transformations [1] and rheological properties [2]. However, the hydrous phase and hydrogen incorporation has not yet been considered.

IR spectra show sharp O-H stretching peaks at 3531 and 3502 cm^{-1}. Quantification of IR spectra reveals hydrogen in the order of 5 to 10 ppm wt H_2O. A complete hydrogen/deuterium exchange was achieved at 700 ˚C leading to a diffusion coefficient of deuterium of about $3{\cdot}10^{-14}$ m^2/s. This value is of the same order than diffusion coefficients observed in other mantle minerals, such as garnet or diopside.

The O-O distance of $\sim$ 2.9 Å calculated from the spectra of Mg_2GeO_4 spinel is consistent with the GeO_4 tetrahedra edge length known from crystal structure data. In IR spectra of hydrous mantle ringwoodites the O-H peaks appear at 3105 cm^{-1} [3], correlating to an O-O distance of $\sim$ 2.7 Å [4] which is the SiO_4 tetrahedra edge length in the ringwoodite structure. Whereas the hydration mechanism and the site occupancies involved are still in discussion for mantle spinel [3,5], the IR measurements on Mg_2GeO_4 confirm the idea of protonation at the tetrahedral edges [6].

This study was supported by the EU through a Marie Curie fellowship HPMF-CT-2002-2098.

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