1.1.P05

Hydrogen incorporation in Mg_2GeO_4 spinel

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Ringwoodite (γ-) and wadsleyite (ß-) $(Mg,Fe)_2SiO_4$, the two most abundant minerals in the mantle transition zone, are able to incorporate several percent of water in their structures [1,2]. Mg_2GeO_4 spinel, a stable analogue to mantle ringwoodite at atmospheric pressure up to 800°C, represents the opportunity to study *in situ* the mechanism of hydrogen incorporation and the nature of hydrogen defects in a mantle mineral structure. γ-Mg_2GeO_4 has been extensively used for the study of phase trans-formations [3] and rheological properties of spinel [4]. However, the hydrous phase has not yet been considered.

Mg_2GeO_4 spinel single-crystals were synthesized from oxides in hydrous conditions at 1.3 to 1.9 GPa and ~ 1000°C. IR spectra show O-H stretching peaks at ~ 3530 cm^{-1}. Quantification of IR spectra revealed hydrogen contents between 10 and 70 ppm. Hydrogen/deuterium exchange at 700°C lead to complete exchange after 50 h and a diffusion coefficient of ~ $8\cdot10^{-13}$ m^2/s was calculated, which corresponds to the diffusion coefficients observed for other mantle minerals, such as garnet or olivine [5].

Pure magnesian mantle ringwoodites synthesized at ~ 22 GPa and 1500°C [2] can incorporate up to ~ 7400 ppm H_2O. In IR spectra of these hydrous mantle ringwoodites the O-H peaks appear at 3105 cm^{-1}, correlating to an O-O distance of ~ 2.7 Å [6]. This distance is consistent with the SiO_4 tetrahedra edge length known from crystal structure data. Consistently, the O-O distance of ~ 2.85 Å calculated from the spectra of Mg_2GeO_4 spinel corresponds to the GeO_4 tetrahedra edge length. Whereas the hydration mechanism and the site occupancies involved are still in discussion for mantle spinel, the IR measurements on Mg_2GeO_4 suggest a protonation of the tetrahedral edges.

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

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1.1.P06

Hydrogen evolution: Consideration from microscale distribution to macroscale evolution

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Hydrogen is an important element in the solar system. In the earth, it is a significant component of atmosphere, hydrosphere, biosphere, even lithosphere. More recently, with the development of analysis technologies, the distribution and speciation of hydrogen in hydrous minerals and nominal anhydrous minerals has become a hot spot. This paper mainly aims to compare the behaviors of hydrogen in microscale, mesoscale, and macroscale, further to indicate the systematical similarity on various scales.

The evolution of early earth is an important project in earthsciences, while hydrogen plays a significant role in the evolution process. The present earth is strongly zoned with solid core, liquid core, lower mantle, upper mantle, crust, hydrosphere, biosphere, atmosphere, which contain various levels of hydrogen concentration. The zoning feature is similar to some strongly zoned granitic pegmatites. The similarity may indicate their similar evolution processes. According to the evolution process of granitic pegmatite along water-unsaturated magmatic stage, water-saturated magmatic-hydrothermal transitional stage, and water-saturated hydrothermal stage, the atmosphere, the hydrosphere, and the biosphere can be considered as a consequence of fractionation of the early hydrogen-bearing earth. on the crystal microscale, the distribution of hydrogen within individual mineral crystals may be zoned [1]. The similarity on various scales may be a common feature of nature. Other similarity on various scale has been discussed in the previous investigations [2]. However, detailed and systematical investigations are still recommended, because little on earth system sciences was known in the past.

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