American Mineralogist, Volume 96, pages 1207–1214, 2011

The 3.65 Å phase in the system $MgO\text{-}SiO_2\text{-}H_2O$: Synthesis, composition, and structure

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ABSTRACT

The 3.65 Å phase, a member of the family of dense hydrous magnesium silicates (DHMS) in the system $MgO\text{-}SiO_2\text{-}H_2O$, was synthesized in a 77 h multi-anvil press experiment at conditions of 10 GPa and 425 °C by using a gel of composition $MgSiO_3$ plus water in excess as starting materials. From our multi-methodical study including SEM, TEM, EMP, IR, and Raman analysis, we determined the composition of the 3.65 Å phase to be $MgSi(OH)_6$. Powder XRD combined with Rietveld refinement revealed the 3.65 Å phase to be isostructural with $\delta\text{-}Al(OH)_3$. The 3.65 Å phase can be described as a hydrous A-site vacant perovskite with probably long-range random distribution of Si and Mg at octahedral sites. Locally, some ordering of Mg and Si might exist, as indicated from the spectroscopic measurements. The 3.65 Å phase represents the second DHMS with exclusively sixfold-coordinated Si, the other being phase D. The 3.65 Å phase is stable at pressures above about 9.0 GPa and temperatures below 500 °C. This limited *P-T* stability together with its high water content makes the 3.65 Å phase an unrealistic mantle component. If at all, it might only occur under hydrous conditions in the coldest parts of deeply and extremely fast subducted old oceanic slabs.

Keywords: 3.65 Å phase, dense hydrous magnesium silicates, DHMS, high-pressure synthesis, crystal structure, octahedral-coordinated Si