American Mineralogist, Volume 108, pages 826–831, 2023

High-temperature phase relations of hydrous aluminosilicates at 22 GPa in the $AlOOH$-$AlSiO_3OH$ system

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Abstract

The stabilities of the minerals that can hold water are important for understanding water behavior in the Earth's deep interior. Recent experimental studies have shown that the incorporation of aluminum enhances the thermal stabilities of hydrous minerals significantly. In this study, the phase relations of hydrous aluminosilicates in the $AlOOH$-$AlSiO_3OH$ system were investigated at 22 GPa and 1400–2275 K using a multi-anvil apparatus. Based on the X-ray diffraction measurements and composition analysis of the recovered samples, we found that the $AlSiO_4H$ phase Egg forms a solid solution with δ-AlOOH above 1500 K. Additionally, at temperatures above 1800 K, two unknown hydrous aluminosilicates with compositions $Al_{2.03}Si_{0.97}O_6H_{2.03}$ and $Al_{2.11}Si_{0.88}O_6H_{2.11}$ appeared, depending on the bulk composition of the starting materials. Both phases can host large amounts of water, at least up to 2275 K, exceeding the typical mantle geotherm. The extreme thermal stability of hydrous aluminosilicates suggests that deep-subducted crustal rocks could be a possible reservoir of water in the mantle transition zone and the uppermost lower mantle.

Keywords: Water, hydrous phase, mantle transition zone, phase Egg, phase transition; Physics and Chemistry of Earth's Deep Mantle and Core