*American Mineralogist, Volume 88, pages 99–108, 2003*

# The stability of antigorite in the systems $MgO\text{-}SiO_2\text{-}H_2O$ (MSH) and $MgO\text{-}Al_2O_3\text{-}SiO_2\text{-}H_2O$ (MASH): The effects of $Al^{3+}$ substitution on high-pressure stability

**GEOFFREY D. BROMILEY* AND ALISON R. PAWLEY**

Department of Earth Sciences, University of Manchester, Oxford Road, Manchester, M13 9PL, U.K.

## ABSTRACT

The high-pressure stability of antigorite in the systems MSH and MASH was investigated using two structurally and chemically well-constrained natural samples. Careful sample selection and characterization ensured that the only significant difference between the samples was Al content, one sample being essentially Al free, and the other containing 3.06(2) wt% $Al_2O_3$. In the system MSH, the reaction antigorite = forsterite + clinoenstatite + water was bracketed, under water-saturated conditions, between 630 and 650 °C at 1.6 GPa, between 620 and 660 °C at 2.5 GPa, between 620 and 660 °C at 3.9 GPa, and between 4.5 and 5.0 GPa at 520 °C. In the system MASH, the reaction antigorite = forsterite + clinoenstatite + chlorite + water was bracketed, under water-saturated conditions, between 660 and 700 °C at 2.0 GPa, between 660 and 680 °C at 2.9 GPa, and between 5.0 and 5.5 GPa at 600 °C. At pressures above 5.8 GPa, intersection of this reaction with the reaction chlorite + clinoenstatite = pyrope + forsterite + water leads to an additional reaction whereby the Al component of the antigorite is transferred to pyrope upon antigorite breakdown. The addition of a few weight percent $Al_2O_3$ into antigorite is shown to stabilize the antigorite structure to significantly higher temperatures and pressures, possibly by minimizing structural misfit among the component octahedral and tetrahedral sheets. This effect partially explains the considerable discrepancies noted between previous studies on the stability of antigorite at high pressure. In addition, antigorite breakdown in the system MASH transfers a significant volume of water to chlorite-bearing assemblages, thereby greatly increasing the range of temperatures over which water is tied up in hydrous phases relative to the system MSH.