

Changes in the cell parameters of antigorite close to its dehydration reaction at subduction zone conditions

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ABSTRACT

The unit-cell parameter a of antigorite (usually expressed as the polysome m value) has been determined as a function of temperature (T) and pressure (P) in the range of 600–650 °C, 25–45 kbar in weeklong piston-cylinder experiments. A well-characterized natural antigorite (with $m = 16$ and less abundant $m = 15$) was used as a starting material that coexisted with olivine, chlorite, Ti-humite, and aqueous fluid at run conditions. Transmission electron microscope (TEM) measurements on selected focused ion beam (FIB) wafers showed that antigorite m values after the experiments varied between 14 and 22. More than 40 punctual analyses for each run condition were acquired to determine the range and the primary m value. The most frequent antigorite m -value decreased systematically from 17–19 at 600 °C to 15–16 at 650 °C. The spacing of the m -isolines is getting narrower as the antigorite breakdown reaction is approached. The topology of the m -isolines is similar to that previously characterized for the simple MgO-SiO₂-H₂O (MSH) system. However, the isolines are shifted to about 50–100 °C higher temperatures due to the incorporation of Al into antigorite. Powder samples and FIB wafers of natural antigorite from the Tianshan UHP belt (China) with peak metamorphic conditions of ~35 kbar, ~520 °C were also investigated with TEM. Low Al-antigorite formed at peak metamorphic conditions displays a peak m value of 20–21, whereas high-Al antigorite formed during isothermal decompression displays a lower m value of 19. Combination of our results with the published data of m values from metamorphic antigorite that experienced various conditions allowed construction of a P - T - m diagram that can be used in future studies to better constrain formation conditions of serpentinites. The decrease of m values and the increase of Al in antigorite with increasing temperature result in small, continuous dehydration whereby the H₂O content of antigorite changes from 12.4 to 12.1 wt%. Therefore, it is expected that a pore fluid is present during the prograde deformation of serpentinites. TEM observations showed that antigorite adjusted its Al content by segregation of chlorite at the nanoscale. Together with the observation that multiple m values are always present in a single sample, this result indicates that full equilibration of antigorite at the micrometer-scale is rare, with important implications for the interpretation of geochemical signatures obtained by in situ techniques.

Keywords: Antigorite, polysomatism, TEM, high-pressure experiments, serpentinite