

## **Pyribole evolution during tremolite synthesis from oxides**

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### **ABSTRACT**

The formation mechanisms of tremolite in a time series of hydrothermal experiments at 850 °C and 6.1 kbar were studied using transmission electron microscopy (TEM), analytical TEM, and X-ray diffraction. The starting materials were unseeded mixtures of reagent-grade oxides. After the first 8 min of reaction, the synthesis products were diopside, enstatite, clinoenstatite, quartz, and minor C-centered and primitive monoclinic amphibole (13 wt% total). The compositions of the first-formed amphiboles vary considerably, from essentially pure cummingtonite (Ca/Mg = 0) to nearly ideal tremolite (Ca/Mg = 0.4). Three groupings of amphiboles with successively higher Ca/Mg ratios were identified, respectively 0.1, 0.22, and 0.35. Over a period of 97 h, the proportions of Mg-rich amphibole gradually decrease, and the average Ca/Mg ratios of all amphiboles steadily increase from about 0.22 to 0.35. Other changes include: (1) a decrease in the aspect ratio of amphibole crystals with increasing time; (2) a decrease in the number of non-amphibole chain multiplicity faults (CMFs), from early A'(2) values as low as 0.81 to a final value of 0.94; and (3) a distinct change in the rate of amphibole growth after 1 h of synthesis. These observations suggest that two mechanisms of amphibole formation are dominant: (1) formation of pyroxene modules with subsequent hydration and arrangement into the double-chain amphibole structure and (2) direct nucleation and growth of amphibole from hydrothermal solution. A third mechanism involving formation of talc-like modules, followed by their breakdown into double-chain modules, incorporation of Ca, and ordering into the amphibole structure, may also occur but probably only at the lamellar or unit-cell scale, because these syntheses were performed outside the stability field of talc.