Structural and morphological transitions of asbestos minerals under moderate pressure and temperature

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Asbestos refers to six unique substances that belong to the serpentine and amphibole mineral families. The serpentine minerals are one of the major constituents of hydrated portion in the upper mantle and the wedge overlying subduction zones. Amphiboles occur in many metamorphic rocks and are constituents in a variety of plutonic and volcanic igneous rocks. Tremolite is a hydrated calcium magnesium silicate belonging to the amphibole group of minerals. Tremolite has been useful for commercial products because they are strong, flexible, heat-resistant, and can be spun and woven into cloth. Chrysotile belongs to the serpentine group of minerals, characterized by a 1:1 layer structure consisting of octahedral and tetrahedral sheets. Chrysotile characteristically forms cylindrical fiber crystals that give the characteristic properties of asbestos. Chrysotile is the main constituent of commercial asbestos, a material with outstanding electric, thermal, and phonic insulation properties, but its fine dust is thought to be deleterious to human health. Detoxification of asbestos has been an important issue and is being conducted by physical, chemical and thermal treatments that lead the formation of non-fibrous mineral particles or phase transitions. In order to explore alternate detoxification means as well as to understand the geochemical role in the hydrated upper mantle conditions, we have studied representative asbestos minerals, tremolite and chrysotile, under moderate pressure and temperature conditions using in-situ synchrotron X-ray powder diffraction and ex-situ scanning electron microscopy. At 2.5 GPa, after heating at 170℃ we observed significant changes in the diffraction patterns in chrysotile. The morphologies of tremolite and chrysotile are both changed to non-fibrous shape after compression up to 5.0 GPa and heated to 220℃ using CO_2 as a pressure-transmitting medium.