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In situ high-temperature Raman and FTIR spectroscopy of the phase transformation of lizardite

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Abstract

A temperature-dependent in situ micro-FTIR and micro-Raman spectroscopic investigation was performed on powdered (FTIR, Raman) and single-crystal (Raman) lizardite-1*T* samples between room temperature and 819 °C. Between room temperature and 665 °C, the OH stretching bands shift to lower wavenumbers, demonstrating a weak expansion of the O3-H3···O2 interlayer distance. Band deconvolution of FTIR and Raman spectra at room temperature show differences in the number of bands in the OH stretching region with respect to group theory: four (FTIR) and six (Raman) OH stretching bands, respectively. This number reduces to four (Raman) at non-ambient temperatures either caused by LO-TO splitting, the presence of non-structural OH species or the presence of different lizardite polytypes and/or serpentine polymorphs as well as defects. During dehydroxylation, the evolution of the integrated intensity of the OH bands suggests a transport of hydrogen and oxygen as individual ions/molecule or OH^-. A significant change in Raman spectra occurs between 639 and 665 °C with most lizardite peaks disappearing contemporaneously with the appearance of forsterite-related features and new, non-forsterite bands at 183, 350, and 670 cm^{-1}. A further band appears at 1000 cm^{-1} at 690 °C. The long stability of Si-O-related bands indicates a delayed decomposition of the tetrahedral sheet with respect to the dehydroxylation of the octahedral sheet. Moreover, evidence for a small change in the ditrigonal distortion angle during heating is given. In general, all appearing non-forsterite-related frequencies are similar to Raman data of talc and this indicates the presence of a talc-like intermediate.

Keywords: Lizardite, dehydroxylation, Raman, and FTIR spectroscopy, talc-like intermediate