American Mineralogist, Volume 92, pages 179–192, 2007

Structure of mixed-layer kaolinite-smectite and smectite-to-kaolinite transformation mechanism from synthesis experiments

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ABSTRACT

A smectite and a rhyolitic obsidian specimen were subjected to hydrothermal alteration for 4 months at 150 °C in two solutions having different $AlCl_3$ concentrations. The solids were analyzed by means of X-ray diffraction, thermogravimetry, electron microscopy (with microanalysis), and Fourier transform infrared spectroscopy. The solutions were chemically analyzed and the ion activities were plotted on activity diagrams. They are broadly coherent with the reaction products. The smectite specimen produced mixed-layer kaolinite-smectite (K-S), with a higher kaolinite proportion for the solution with higher Al content. The glass specimen produced glass + boehmite + kaolinite in the low-Al solution, and kaolinite in the high-Al solution. Thus, K-S probably forms only from smectite precursors. The formation of K-S follows the same mechanism of stripping of one of the tetrahedral sheets from smectite described for natural specimens by Dudek et al. (2006). Comparison of the synthetic and natural K-S indicates great similarity, although the arrangement of the kaolinite layers in the synthetic specimens is more ordered and some of their kaolinite infrared bands are more intense. The results of Dudek et al. (2006) and this study show a wide range of chemical and structural "maturity" of kaolinite in K-S, as kaolinization proceeds, that varies depending on the reaction conditions.

Keywords: Crystal synthesis, kaolinite, kaolinite-smectite, DTA, TGA, mixed-layering, electron microscopy, IR spectroscopy, XRD data