Hydrothermal Synthesis and Characterization of Cobalt Clays

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Abstract: Reaction of mixtures of cobalt nitrate, colloidal silica, and a metal hydroxide (MOH) under hydrothermal conditions produced a range of cobalt hydroxysilicates, the components of which depended upon the identity of M, temperature, and reactant ratios. At 250 ° C, if M = Na, a smectite of composition $Na_{0.06}Co_{3.07}Si_{3.95}O_{10}(OH)_2$ (I) was produced. If M = K, either a mica, $KCo_{2.5}Si_4O_{10}(OH)_2$ (II), intermediate between di- and trioctahedral, or a Si-deficient mica, $KCo_3Si_{3.75}O_{10}(OH)_2$ (III), was formed depending upon the reactant ratios. Similarly, if M = Cs, either a vermiculite or a 2:1 layer silicate intermediate between a mica and a brittle mica was produced. If M = Li, only the non-clay mineral Li_2CoSiO_4 was formed. Tetraalkylammonium hydroxides (NR_4OH, R = methyl, ethyl, or propyl) yielded chrysotile. All phases were characterized by elemental analysis, transmission electron microscopy, and X-ray powder diffraction. Further characterization of smectite I was undertaken by diffuse reflectance, infrared, and X-ray photoelectron spectroscopy. The layer charge in these clays appears to stem from cation vacancies within an almost trioctahedral sheet and, possibly, within the tetrahedral sheets. Some of the cobalt present had tetrahedral coordination geometry, but its location was not determined.

Key Words: Chrysotile • Cobalt • Mica • Smectite • Synthesis • Talc • Tetraatkylammonium ion • Vermiculite

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