

Natural Mg-Fe clinochlores: Enthalpies of formation and dehydroxylation derived from calorimetric study

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ABSTRACT

This paper presents the results of the first experimental thermochemical investigation of two natural trioctahedral chlorites (clinocllores). The study was performed with the help of a high-temperature heat-flux Tian-Calvet microcalorimeter. The samples were characterized by X-ray spectroscopy analysis, X-ray powder diffraction, thermal analysis, and FTIR spectroscopy. The enthalpies of formation of clinocllores were found using the melt solution calorimetry method to be: -8806 ± 16 kJ/mol for composition $(\text{Mg}_{4.9}\text{Fe}_{0.3}^{2+}\text{Al}_{0.8})[\text{Si}_{3.2}\text{Al}_{0.8}\text{O}_{10}](\text{OH})_8$ and -8748 ± 24 kJ/mol for composition $(\text{Mg}_{4.2}\text{Fe}_{0.6}^{2+}\text{Al}_{1.2})[\text{Si}_{2.8}\text{Al}_{1.2}\text{O}_{10}](\text{OH})_8$. The experimental data for natural samples allowed calculating the enthalpies of formation for end-members and intermediate members of the clinocllore $(\text{Mg}_5\text{Al})[\text{Si}_3\text{AlO}_{10}](\text{OH})_8$ and chamosite $(\text{Fe}_5\text{Al})[\text{Si}_3\text{AlO}_{10}](\text{OH})_8$ series. An important feature of the clinocllore structure is the presence of two distinct hydroxyl-containing octahedral layers: the interlayer octahedral sheet and octahedral 2:1 layer; the enthalpies of water removal from these positions in clinocllore structure were determined as: 53 ± 20 kJ/(mol·H₂O) and 131 ± 10 kJ/(mol·H₂O), respectively. These obtained first thermodynamic characteristics of Mg-Fe clinocllores can be used for quantitative thermodynamic modeling of geological and industrial processes including clinocllores of different composition.

Keywords: Clinocllore, chlorite, thermochemistry, microcalorimetry, enthalpy of dehydroxylation, enthalpy of formation