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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 (clinochlores). 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 clinochlores were found using the melt solution calorimetry method to be: –8806 ± 16 kJ/mol for composition $(Mg_{4.9}Fe^{2+}_{0.3}Al_{0.8})[Si_{3.2}Al_{0.8}O_{10}](OH)_8$ and –8748 ± 24 kJ/mol for composition $(Mg_{4.2}Fe^{2+}_{0.6}Al_{1.2})[Si_{2.8}Al_{1.2}O_{10}](OH)_8$. The experimental data for natural samples allowed calculating the enthalpies of formation for end-members and intermediate members of the clinochlore $(Mg_5Al)[Si_3AlO_{10}](OH)_8$ and chamosite $(Fe_5Al)[Si_3AlO_{10}](OH)_8$ series. An important feature of the clinochlore 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 clinochlore structure were determined as: 53 ± 20 kJ/(mol·H_2O) and 131 ± 10 kJ/(mol·H_2O), respectively. These obtained first thermodynamic characteristics of Mg-Fe clinochlores can be used for quantitative thermodynamic modeling of geological and industrial processes including clinochlores of different composition.

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