
Effects of Acidification on the Chemical Composition and Layer Charge of Smectite from Calcareous Till

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Abstract: The objectives of the study were to determine the chemical composition and layer charge of smectite found in calcareous till of the Interior Plains region of western Canada and to examine the effects of acidification on alteration of the smectite. Samples of acidified and non-acidified (calcareous) late-Wisconsin till were obtained from four soil pits located immediately adjacent to an elemental sulfur block located in southern Alberta. Samples of the surface material (0– 10 cm depth) had been subjected to extreme acidity for 25 years due to the oxidation of elemental sulfur and displayed pH values of about 2.0. Samples of the till obtained at depth (65– 75 cm) remained calcareous with pH values between 7.3 and 7.6. A combination of analytical methods was used to determine the chemical composition of the smectite found in the samples. The layer charge of the smectite was determined independently using X-ray diffraction data for n-alkylammonium saturated specimens. Smectite found in the non-acidified calcareous material was characteristic of montmorillonite with a low content of Fe and very little substitution of Al for Si in the tetrahedral sheet. The smectite had a structural formula of $M^{+}_{0.40}(Si_{3.96}Al_{0.04})(Al_{1.56}Fe^{3+}_{0.10}Mg_{0.33})O_{10}(OH)_2$, which compared well with a mean value for layer charge of 0.399 mol(-)/O₁₀(OH)₂ determined using X-ray diffraction data for n-alkylammonium treated specimens. Smectite remaining in the till material subjected to extreme acidity underwent incongruent dissolution with a net loss of layer charge and preferential loss of octahedral Mg.

Key Words: Layer charge • Smectite • Soil acidity • Structural formula • Weathering

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