Composition of some Smectites and Diagenetic Illitic Clays and Implications for their Origin

P. H. Nadeau and D. C. Bain

Department of Mineral Soils, The Macaulay Institute for Soil Research Craigiebuckler, Aberdeen AB9 2QJ, Scotland, United Kingdom

Abstract: Chemical analysis by X-ray fluorescence (XRF) and calculated structural formulae of clay-size fractions of smectites from Cretaceous bentonites and illitic clays from Cretaceous, Devonian, and Ordovician bentonites and Jurassic and Permian sandstones indicate the nature and extent of various types of ionic substitution. The determination of tetrahedral (Al, Si) and octahedral (Al, Mg, Fe) composition shows the variable chemistry of these materials. Structural formulae of the illitic clays show that they have tetrahedral charges between 0.4 and 0.8 per half unit cell, and can be divided into phengitic types having octahedral charges of 0.2 – 0.4 and muscovitic types having octahedral charges <0.2. Evaluation of the formulae in the light of X-ray powder diffraction (XRD) and transmission electron microscopy (TEM) data shows that the occupancy of non-exchangeable interlayer sites (predominantly K) varies from 47% to 90% of that of ideal muscovite. In some minerals as much as 20% of these sites is occupied by ammonium ions (determined independently). The amount of surface silicate charge balanced by non-exchangeable cations versus that balanced by exchangeable cations has been examined in conjunction with TEM data and suggests that in most samples the charges are about equal. The octahedral composition of smectites in Cretaceous bentonites precludes their having served as transformation precursors for most of the Cretaceous illitic bentonites. The results suggest that these illitic clays originated by neoformation.

Key Words: Bentonite • Chemical composition • Illite • Interstratified • Layer charge • Potassium • Smectite • X-ray fluorescence

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