MINERAL COMPOSITION OF THE CLAY FRACTION OF SEVERAL COASTAL PLAIN SOILS OF SOUTHEASTERN UNITED STATES

R. Coleman and M. L. Jackson

Mineralogical studies have been made of soil clays from several sections of the United States, but very few have been made of those from the Red and Yellow soil region of southeastern United States. Little is known of the clay minerals which have developed in extensive areas of these soils.

The purpose of the present investigation was to identify and characterize the minerals in the clay fraction of several representative soils of the Coastal Plain soil region of Mississippi, and adjacent areas. Most of the study was centered on Houston clay loam, Oktibbeha clay loam, Susquehanna clay loam, Grenada silt loam, and Orangeburg sandy loam. Data are presented on the mechanical analysis of the A, B, and C horizons of each of these soils, together with cation exchange capacity, specific gravity, chemical analysis, and X-ray diffraction analysis of the fine clay (particles less than 0.2 μm diameter) and coarse clay (particles 2 to 0.2 μm diameter) extracted from each horizon. To make the study more representative, a number of individual horizons of other soils were included in the X-ray diffraction analyses and certain other of the physical and chemical studies.

REVIEW OF LITERATURE

A rather limited amount of information is available on the identity of clay minerals in soils of southeastern United States. Numerous studies have been reported on the chemical composition and other properties displayed by colloids extracted from soils of the region, but positive identification has awaited the advent of X-ray diffraction methods.

Hendricks and Fry (7) reported X-ray analyses of six soil colloids from that region. In three of the colloids, derived from Cecil soil (two locations), kaolinite (or halloysite) predominated. Kaolinite also predominated in the colloid from Vega Baja clay loam (P. R.). Montmorillonite predominated in the colloid from Sharkey soil (Miss.) from Tredell subsoil (N. C.) and also from Houston black clay (Tex.).

Kelley, et al. (12) showed the clay of a Cecil profile (Ala.) to be primarily kaolinite in all horizons even in the weathered granite parent material at a depth of 24 feet. They found principally kaolinite in the clay of a Susquehanna profile (Ala.) except that a horizon rich in montmorillonite occurred at a depth of 11 feet.

Alexander, et al. (2) reported mineralogical analyses of five Red and Yellow Podzolic soils, and indicated 60 to 90% kaolinite, 10 to 20% hydrous mica, and 8 to 15% free iron oxides, montmorillonite being reported as zero.

In general, kaolinite appears to predominate in the more mature profiles; however, the present study demonstrates the presence of montmorillonite in several widely occurring soils in the region.

Experimental Procedure

A description of the soils, showing the depth of samples, and the locality from which samples were taken is given in Table 1.

Mechanical analyses were made according to the procedure of Truog, et al. (16, 17). This procedure involved removal of organic matter with H2O2, reduction of the free iron oxides. Each clay sample was suspended in water to give a concentration of 1 gram aliquots. Duplicate aliquots were precipitated with cation exchange capacity. Cation exchange capacity studies were made with the 1 N nitrobenzene method described by Bates.

Chemical analyses were made in duplicate for TiO2, Al2O3, CaO, MgO, and K2O in nearly all samples. In preparation for analysis, the 100-mg sample was saturated with hydrogen by treatments with 0.05 N HCl, then washed with ethanol and one washing at 110°C, weighed, and fused in anhydrous K2O after reduction with the Jones reductor; TiO2, KMnO4 after reduction with the Jones reductor; R2O3, and MgO by titration as MgNH4PO4 with HCl. The K2O was determined on clay aliquots and fused, the K2O being determined as Na-K-cobaltinitrite precipitate with K3[Fe(CN)6].

Mineralogical analysis of each fine clay by X-ray diffraction method, employing cation exchange-saturation with Ca (11), cont. and comparison with diffraction pattern of synthetic mixtures (6).

Results

Mechanical Analyses of Soils

The results of the mechanical analyses of the percentage sand, silt, coarse of sample are shown in Table 1. The organic matter of each soil was oxidized by H2O2 and excluded from the sample. The percentage of each constituent was based on the oven-dry weight of the sample, and thus the percentages are especially those in the A horizon, than on the basis of weight of total soil.

The results of mechanical analysis show that the fine horizon of each of the five profiles is more fine clay and more sand than the...