The Fractionation and Properties of Clays from the Surface Soils of the Pearman and Maury Series

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Behavior of plant nutrients in soils is regulated to a large extent by the composition and properties of the clay fraction. Studies dealing with the fixation and release of such nutrients as phosphorus and potassium are usually facilitated by separating the clay fraction from the soil. Chemical or mineralogical studies can be made by separating and fractionating the clay from comparatively small samples of soil. Where larger quantities of clay are needed for more extensive studies of clay properties, the separation and fractionation process becomes more arduous.

In an investigation designed to study the properties of clays from some Kentucky soils, it was necessary to separate comparatively large quantities of clay and make several rather fine separations within the clay fraction. This report gives the method of separation of surface soils of the Pearman and Maury series and some preliminary data on the properties of the clay fractions.

SOILS USED

Surface soils of Pearman silt loam from the Campbellsville Soil Experiment Field and of Maury silt loam from the Lexington Soil Experiment Field were used in this study. The Pearman silt loam, originating from a mixture of calcareous shale, sandstone, and limestone, has a pH of about 5.5 with a base exchange capacity of 6.8 me. per 100 grams and a total phosphorus content of 680 pounds per 2 million pounds of soil. Pearman is the field name given this soil and it has not been correlated with other soil series. The Maury silt loam is derived from Lexington limestone and has a pH of 5.5 with a base exchange capacity of 16.3 me. per 100 grams and a total phosphorus content of 6,700 pounds per 2 million pounds of soil.

PRETREATMENT AND DISPERSION OF SOILS

Fifty-gram portions of 20-mesh air-dry soil were handled in each flask in the process of pretreatment. Eight of these portions were carried along together in separate flasks. In this way, when the process was complete, 400 grams of soil could be dispersed and handled in the separation.

The Pearman and Maury soils varied considerably in phosphorus content and since eventually the clays were to be used in phosphorus studies, the more readily soluble phosphorus was removed as part of the pretreatment. In the case of the Maury soil, this was also necessary to get good dispersion. The phosphorus was removed from the Pearman soil simply by extracting with 2% acetic acid, but the Maury soil had to be extracted a number of times with N/20 H₂SO₄.

Remaining organic matter. Organic matter was removed largely subdued. The Pearman soil contained 3.1% organic matter. After the last treatment, 10 ml of 0.05 N H₂SO₄ per gram of soil was added to the flasks, and after shaking for 1 hour the extract was separated by centrifuging. Phosphorus was determined and considered as a measure of the phosphorus content of the soil. The organic phosphorus of the Maury soil was 222 ppm and of the Pearman 206 ppm. These results check quite closely with data from more conventional methods for the same soils.

At this stage one set of Pearman samples was washed with the method of Truog, et al. (6) to remove free iron and aluminum oxides. This soil will hereafter be referred to as treated Pearman.

Saturation with sodium ions. After treatment with phosphorus released by the peroxide treatment, oxalic acid-hydrochloric acid washing in removing aluminum oxides, the soils were washed and centrifuged four times with 10% NaCl and two times with 1 N NaOH adjusted to pH 7.0. Excess of sodium salts was removed by washing and centrifuging three times with neutral free 95% ethanol and once with pure acetone. Then allowed to dry and removed from the tubes, it was ready to weigh and disperse. Four hundred grams of soil treated as described above were dispersed immediately into an 18-liter bottle with water, adjusting to pH 5 and 6.8 with NaOH, and stirring with a power stirrer for 4 hours or overnight.

REMOVAL OF SAND AND SILT FROM SOIL

Sand and silt were separated from the clay fraction in 18-liter bottles. Time of sedimentation of 30 cm for particles larger than 0.002 mm in diameter was determined by calculations based on Stokes law and specific gravity of 2.65 for the settling particles. (≤0.002 mm) above this plane were then separated. The bottle was refilled, stirred, and the soil allowed to settle. Three or four sedimentations were usually necessary. The clay fraction became clear. Sand and silt particles were centrifuged down, washed with acetone, and then dried and weighed.

The clay fraction between 0.002 and 0.001 mm was separated in the manner described above, allowing the appropriate time for the settling of the particles below 0.001 mm. In this case the specific gravity of 2.65 was actually determined instead of assuming the value of 2.65.

FRACTIONATION OF CLAY

All clay fractions less than 1 micron were separated by means of an electrically driven Sharples supercentrifuge. Conditions for the Sharples centrifuge to separate particle size were calculated by assuming that Stokes law held for dilute suspensions and that flow in the