

CLAYS and CLAY MINERALS

at a glance

Volume 16

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January 1969

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PEDOGENIC FORMATION OF MONTMORILLONITE FROM A 2:1-2:2 INTERGRADE CLAY MINERAL

R. L. Malcolm, W. D. Nettleton, and R. J. McCracken 405
Montmorillonite was found to be the dominant clay mineral in surface horizons of certain soils of the North Carolina Coastal Plain whereas a 2:1-2:2 intergrade clay mineral was dominant in subjacent horizons. In all soils where this clay mineral sequence was found, the surface horizon was low in pH (below 4.5) and high in organic matter content. This data is in contrast to data from studies of other soils of this region. It is theorized that the montmorillonite in the surface horizon of the soils studied originated by pedogenic weathering of the 2:1-2:2 intergrade clay mineral. The combined effects of low pH and high organic matter content in surface horizons are believed to be the agents responsible for this mineral transformation. The protonation and solubilization (reverse of hydrolysis) of Al-polymers in the interlayer of expansible clay minerals will occur at or below pH 4.5 depending on the charge and steric effects of the interlayer. A low pH alone may cause this solubilization and thus mineral transformation, but in the soils studied the organic matter is believed to facilitate and accelerate the transformation. The intermediates of organic matter decomposition provide an acid environment, a source of protons, and a source of water-soluble mobile organic substances (principally fulvic acids) which have the ability to complex the solubilized aluminum and move it down the profile. This continuous removal of solubilized aluminum would provide for a favorable gradient for aluminum solubilization. The drainage class or position in a catena is believed to be less important than the chemical factors in formation of montmorillonite from 2:1-2:2 intergrade, because montmorillonite is present in all drainage classes if the surface horizon is low in pH and high in organic matter.

SEALING PROPERTIES OF BENTONITE SUSPENSIONS

M. B. Rollins

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Sealing with waterborne clays is a rapid and low cost method of controlling seepage through porous media whenever the clay source is within economical shipping distance of the sealing site. But more must be learned about this method of sealing before it can be fully utilized. Water impedance of waterborne bentonites, as measured by water loss in the filter press test, was correlated with their physical, chemical and mineralogical properties. A multiple linear regression analysis showed clay content and exchangeable sodium percentage (ESP) were most highly correlated with water impedance. Swelling, viscosity and gelation of these clays play only a secondary role in forming a water barrier when used as dilute waterborne sealants. There were strong positive correlations between water loss and samples high in silt-sized cristobalite, quartz and feldspar and negative correlations between water loss and samples high in clay-sized montmorillonite, chlorite, and illite. Predicted minimum clay contents (of prospective sealers) were found to be 65-75 per cent clay at 70 and 20 per cent exchangeable sodium, respectively.

THE NATURE OF ANAUXITE

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Anauxite crystals are reported to contain a higher SiO₂:Al₂O₃ ratio than the 2:1 ratio found in kaolinite. A structure proposed for anauxite places the excess silica in double silica sheets, but an exact structure for anauxite has never specifically been determined. Many workers believe that anauxite is kaolinite associated with some extremely fine-grained excess silica which is not a part of

the structure. Eight specimens studied in this work included portions of type materials from Bilin, Czechoslovakia, and the Ione formation in California. Amorphous silica and alumina are readily soluble in boiling N/2 NaOH. Kaolinite is only slowly soluble in this reagent, but becomes readily soluble after dehydroxylation. Weight loss, differential solution rate, kinetic and X-ray diffraction studies were used to establish that the kaolinitic clay fraction in the anauxite specimens had the composition of: $2.01 \pm 0.04 \text{ SiO}_2 : \text{Al}_2\text{O}_3 : 2.09 \pm 0.09 \text{ H}_2\text{O}$. Some of the anauxite grains are single crystals, while others are aggregates. The latter appear to be bound together by an amorphous silica phase. Hot caustic leaching extracts the amorphous silica and breaks up the aggregates producing "fines". Improved characterizations of minor impurities were obtained when the residues from hot caustic treatments were studied with X-ray diffraction techniques.

PROPERTIES OF VERMICULITES AND SMECTITES: EXPANSION AND COLLAPSE

M. E. Harward, D. D. Carstea, and A. H. Sayegh 437

Samples of smectites and vermiculites were evaluated to (1) determine the effects of source and amount of charge, (2) determine if a continuum of properties exists, and (3) improve the basis for differentiating criteria for identification.

The montmorillonite expanded to the equivalent two-layer complex upon solvation by condensation of ethylene glycol or glycerol vapor. Beidellite exhibited the one-layer complex with glycerol vapor and the two-layer complex with ethylene glycol. The vermiculite samples did not yield regular two-layer complexes regardless of saturating cation, prior moisture, or solvating agent. A number of different complexes of vermiculite were obtained depending on conditions of solvation. These corresponded to spacings of approximately 13.6, 14.0, 14.3, 15.0, and 15.3 Å. Two or more of the complexes may be present in the same sample. Potassium-saturated vermiculites and smectites both exhibited collapsed layers in a dry atmosphere. Hydration of smectites occurred at humidities above 20 per cent and resulted in poorly ordered diffraction maxima of 11–12 Å. The K-saturated vermiculites tended to retain the collapsed lattice and exhibited diffraction maxima of 10–10.6 Å with integral higher orders. Some hydration occurred as evidenced by peak asymmetry or the appearance of a small 14.3 Å line at higher humidities, although the collapsed spacing predominated. Differences in properties can be related to both source and amount of charge. Nevertheless, a continuum in the properties of expansion and collapse between the smectites and vermiculites was not observed. The data indicate two discrete populations. These properties may be used as differentiating criteria for identification.