
Structural Charge Site Influence on the Interlayer Hydration of Expandable Three-Sheet Clay Minerals

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Abstract: Previous investigations have demonstrated the influences of interlayer cation composition, relative humidity, temperature, and magnitude of interlayer surface charge on the interlayer hydration of montmorillonites and vermiculites. It has been suggested that the sites of layer charge deficiencies may also have an influence upon the amount of hydration that can take place in the interlayers of expandable clay minerals. If the interlayer cation-to-layer bonds are considered as ideally electrostatic, the magnitude of the forces resisting expansion may be expressed as a form of Coulomb's law. If this effect is significant, expandable structures in which the charge-deficiency sites are predominantly in the tetrahedral sheet should have less pronounced swelling properties than should structures possessing charge deficiencies located primarily in the octahedral sheet.

Three samples that differed in location of layer charge sites were selected for study. An important selection criterion was a non-correlation between tetrahedral charge sites and high surface-charge density, and between octahedral charge sites and low surface-charge density.

The effects of differences in interlayer cation composition were eliminated by saturating portions of each sample with the same cations. Equilibrium (001) d values at controlled constant humidities were used as a measure of the relative degree of interlayer hydration.

Although no correlation could be made between the degree of interlayer hydration and total surface-charge density, the investigation does not eliminate total surface-charge density as being significant to the swelling properties of three-sheet clay-mineral structures. The results do indicate a correlation between more intense expandability and predominance of charge deficiencies in the octahedral sheet. Conversely, less intense swelling behavior is associated with predominantly tetrahedral charge deficiencies.

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