
Swelling Components of Compacted Ca-Montmorillonite

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Abstract: Intracrystalline water adsorption of Ca-montmorillonite was calculated as the product of one-half the interlayer spacing from X-ray powder diffraction analysis and the difference between the desorption surface area determined with ethylene glycol-monoethyl ether and BET surface area determined by N₂ adsorption. Osmotic adsorption was calculated as the product of the N₂ surface area and theoretical double layer thickness. Measured water adsorption of P₂O₅-dry clay, compacted to initial densities (γ_0) from 0.52 to 1.59 g/cm³ and submerged in 0.01 N CaCl₂ was 2.4 to 4.2 times greater than intracrystalline plus osmotic adsorption due to the occurrence of pores exceeding double layer dimensions. The increase in expansion caused by reducing electrolyte concentration to 0.001 N was equal to the predicted increase in double layer volume, verifying the existence of an osmotic component to swelling.

Measured expansion following submersion in 0.01 N CaCl₂ increased continuously with γ_0 from 0.53 cm³/g at $\gamma_0 = 0.52$ g/cm³ to 1.17 cm³/g at $\gamma_0 = 1.59$ g/cm³, while estimated osmotic plus intracrystalline expansion was constant at 0.30 cm³/g. This discrepancy is attributed to swelling caused by gas pressures developing ahead of advancing wetting fronts. The effect of compaction on expansion is explained by reductions in pore size, as measured by N₂ desorption, which accompany compaction. Reduced pore size should increase entrapped air pressures, whereas gradual wetting should favor their dissipation. Accordingly, slow wetting reduced the expansion of a sample where $\gamma_0 = 1.06$ g/cm³ from 0.77 to 0.37 cm³/g. Swelling due to entrapped air pressures produced a large increase in the number of pores >10⁴ Å in diameter, as determined by Hg intrusion porosimetry.

Key Words: Compaction • Double layer theory • Montmorillonite • Pore-size distribution • Swelling • Water adsorption.

Clays and Clay Minerals; April 1980 v. 28; no. 2; p. 135-141; DOI: [10.1346/CCMN.1980.0280210](https://doi.org/10.1346/CCMN.1980.0280210)

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