Swelling Pressure Calculated from Mineralogical Properties of a Jurassic Opalinum Shale, Switzerland

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Abstract: Nineteen drill core samples of lower Dogger opalinum shale from wells drilled in connection with a tunnel project near Brugg, northern Switzerland, were investigated. The shale is a well known swelling rock that has caused problems in underground construction work. Swelling pressures determined under constant volume conditions to obtain maximum values were 0.7 to 2.2 N/mm^2. The samples contained 37 – 59% clay-size material and about 35% quartz, 7 – 18% carbonate minerals, and about 5% feldspar, pyrite, and organic matter. In addition to kaolinite, illite, and chlorite, the clay-size fraction also contained mixed-layer illite/smectite with about 30% swelling layers.The specific surface area of the clay fraction was 135 m^2/g. The specific surface charge of the clay (6.7×10^4 esu/cm^2), the ion concentration in the pore fluid of the specimen after the swelling test (10^{-2} mmole/cm^3), the valence of the ions in the double layer of the clay particles (+1), and the half distance between the clay plates in the specimen (8 – 15 Å) allowed the calculation of the swelling pressure for each sample according to the Gouy double layer theory.

The mean value of the calculated swelling pressures was found to be of the same order of magnitude as the measured values, indicating that the technique can be used where cylindrical or rectangular specimens are not available for direct measurement.

Key Words: Gouy double layer theory • Mineralogical composition • Shale • Soil mechanics • Surface area • Surface charge • Swelling pressure

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