

Geologic Origin and Physiochemical Characterizations of Tertiary Bentonitic Clays in the North Western Desert of Egypt for Some Industrial Applications

By

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I dedicate this work

To

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ABSTRACT

Sixty two side-by-side duplicates (124 total) of Paleogene and Neogene bentonitic clays were collected from 12 quarries in the North Western Desert of Egypt. Thicknesses of the bentonitic clays varied between 1m and 20m. The mineralogy, cation exchange capacity, origin, and physical properties were studied.

A discriminant function analysis (DFA) of quantitative mineralogical data provided an objective procedure for grouping the samples at three distinctly recognizable, but partially overlapping, levels of classification. These levels were province or geographic region, geologic age, and quarry. DFA was successful in identifying statistically significant differences amongst the groups.

Reconstructing the origin of bentonitic clays is a challenging and rather complicated undertaking, but the use of certain predictor clay minerals is provided an innovative, excellent method to simplify this process. The abundance changes of five X-ray diffraction (XRD) predictor minerals was used to determine the relative contributions of weathering and parent-rock changes to the origin of clay minerals in Egyptian bentonitic clays. The minerals in the Egyptian bentonitic clays formed as weathering products of basic and/or acidic parent rocks and have been transported by north-flowing streams and rivers to the sites of accumulation under variable climate regimes.

A multiple sample AgTU ion exchange method was applied to the Egyptian bentonitic clays utilizing 0.15 and 0.3 g sample weights to characterize the exchange properties (AgTU-CEC, TEB, ECEC, Na, Ca, Mg, K, and Si). The method afforded a measure of sample repeatability and the ability to assess contributions from soluble

minerals. Variability of cation exchange capacities could be used to supplement geologic history interpretations or serve as a tool to guide industrial exploitation. Cation exchange fingerprints provided clues to the pore fluid compositions in the environment of sedimentation. The presence of halite, calcite, and bischofite contributed to the overall sample fingerprint. Correlation analysis produced equations relating the independent XRD mineral variables to each dependent cation exchange variable (AgTU, ExchK, ExchNa, ExchCa, and ExchMg). Mineralogically calculated CECs for the Egyptian bentonitic clays could provide a predictive tool to estimate exchange cation contents without actual measurement.

These samples have a good potential for foundry sand and drilling mud applications as suggested by selected physical property tests. The specific surface area was greatly influenced by CEC, Exch Mg, expandable minerals, and finely crystalline kaolinite. Swelling index of raw samples showed poor relationships with mineralogy and exchangeable cations. After Na-activations, the relationships were more significant particularly with the grade of the samples. Some of the Egyptian bentonitic clays showed high compressive strengths and rheological properties that satisfied the international standards for their use.