A FLUORESCENCE STUDY OF WYOMING BENTONITE

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Abstract

It was found that a water solution of zinc uranyl acetate upon contacting certain clays such as Wyoming swelling bentonite and Colorado beidellite caused them to fluoresce under the ultraviolet light, whereas other clays such as attapulgite and illite do not so respond. It was noted that there were appreciable differences in effect with several Wyoming clays of the bentonite family. An experiment was set up to determine whether or not this difference in effect was a truly measureable quantity and if it could be correlated with the known physical properties of the bentonitic clays. Results indicated a qualitative field test based on the technique.

Introduction

It was noted in the course of research on Wyoming clays that a water solution of zinc uranyl acetate upon contacting the swelling bentonites (hydrophilic clays) caused them to immediately fluoresce in a short gamma ultra-violet radiation; whereas, other clays, such as kaolin, did not so fluoresce when equally treated, and that members of the bentonite family characterized as non-swelling bentonites (inaptly called fuller's earths) fluoresced but slightly or not at all.

It was the purpose of this study to determine if the difference in the intensity of the effect experienced with various swelling clays was a measurable quantity, and whether or not it could be correlated in any way with the known physical properties of the clay determined by standard clay testing methods.

Procedure

The samples used in this study were picked at random from clays previously studied at the Natural Resources Research Institute and reported in its No. 2 Bulletin (1). The fluorescent agent used was a water solution of zinc uranyl acetate prepared after the manner of a sodium determination (2), and checked under the ultraviolet light for negative fluorescence by placing a drop of solution on diatomaceous earth.

The technique used was as follows: Approximately 5 grams of each dry clay sample, prepared as for bentonite testing, were placed in uniform porcelain crucibles. The sample numbers were marked on the under side of the crucibles so as not to be known by the operator while making the test. Next, the crucibles were shuffled and assigned a letter for reference. The samples were checked for negative fluorescence and a single drop of the zinc uranyl reagent was placed on each sample. The intensity of fluorescence for each sample was rated on the basis of 10 with the strongest being assigned that numerical value, and the others correspondingly relative values. The sample numbers were then determined and the numerical fluorescence value reassigned to its respective sample.

The contaminated spot was removed, the samples again checked for residual fluorescence, again shuffled and a second run was made using two drops of reagent on each clay. This procedure was then repeated a third time with a third shuffle, using three drops of reagent.

The results of all three tests were averaged for each clay and this was used as a basis for correlation with the physical properties of each.

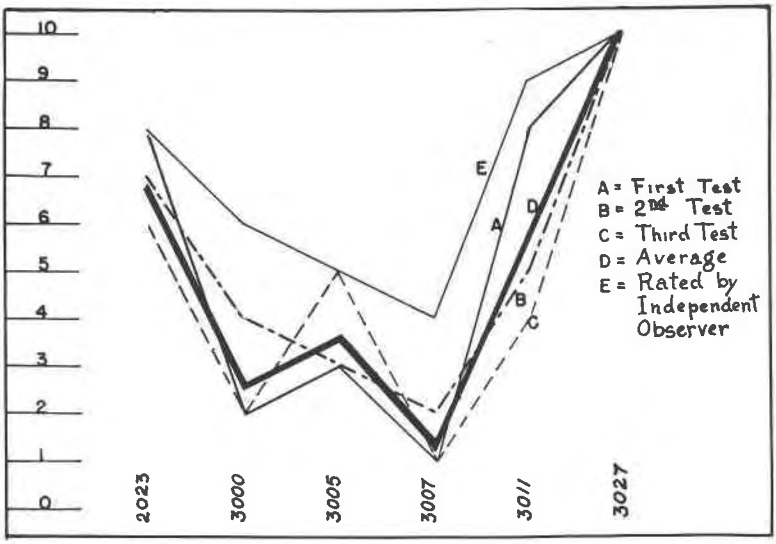

FIG. 1

REPRODUCIBILITY

Six samples picked at random from the clays reported (1) were treated by the zinc uranyl technique. The results were graphed in Fig. 1. Curve *E* is the intensity curve as reported by an independent observer who had no previous knowledge of the study. The relative agreement was found to be good between extremes but not reliable for small differences. It is anticipated that with further practice in the technique and averaged observations closer reliability can be attained. The reliability found would be sufficient for a field test concerned with rapid determination of bentonitic deficiencies.

CORRELATION WITH KNOWN PHYSICAL PROPERTIES

A resume of the predetermined physical properties of the zinc uranyl studied clays was made to learn whether or not the technique could be applied as a rapid field test for these properties. The results of this resume are reported in graphic form in Fig. 2.

It will be seen from Fig. 2 that there is a definite correlation trend between the zinc uranyl test and the properties of green compressive strength, viscosity, and initial gell strength (shear). It will also be noted that the agreement is not entirely consistent for major differences but has sufficient reliability in its correlation with green strength properties and viscosity to indicate these in a qualitative way.

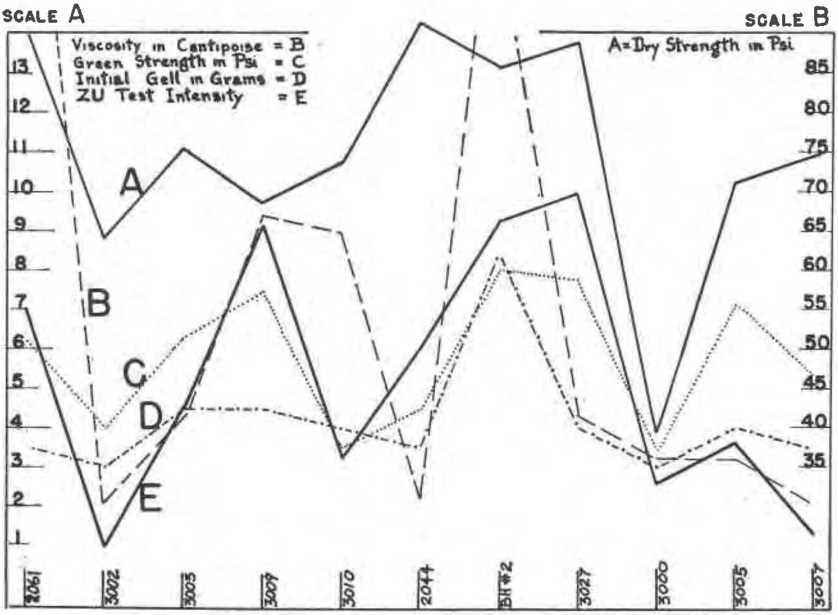

Fig. 2

Theory

It is doubtful if lattice substitution (as measured by base exchange capacity) is operative in this effect. It was thought at first that uranyl ions might enter into base exchange forming hydrophobic fluorescent salts at the interface. This thought was abandoned when it was found that attapulgite, illite, and kaolinite which have appreciable base exchange capacities (3) did not enter into the effect.

It is, also, doubtful if capillarity (Van der Waal's adsorption) has any influence on the effect. Diatomaceous earth, a highly adsorptive capillary medium, does not respond to zinc uranyl treatment.

A more reasonable explanation is to be found in the dehydrating powers of the clay involving free energy levels of the order chemisorption. Grim has held that the swelling of the montmorillonite is motivated by expansion in the lattice of discrete hydrates (4). Whether or not the hydrates are discrete, it is generally believed that the swelling properties of the bentonites are due to interplanar hydration of one sort or another between the silicate layers (5).

The part the sodium ion plays in this effect was not determined but it may prove to be considerable.

If there is adequate spacing in the lattice, hydration may proceed without consequent swelling. Colorado's pink beidellite is a non-swelling member of the montmorillonite group with a comparable structure (6). As would be expected, beidellite responds to this test with beautiful fluorescence, whereas Florida fuller's earth (attapulgite), halloysite, and the very platey illite do not. These later three clays are representatives of distinct groups and are considered structurally different from clays in the montmorillonite-beidellite group (7).

Conclusions

It is concluded from the results here shown that a quick qualitative field test could be designed, involving the interfacial dehydration of zinc uranyl acetate and ultra violet fluorescence of the anhydrous salt. This test would roughly estimate certain physical properties of the *swelling* bentonites which would normally require lengthy laboratory procedures, and with a degree of accuracy that should be adequate for field work.

References

(1) H. Fisk, "Bentonite," *University of Wyoming Natural Resources Research Institute,* Bulletin No. **2** (1946).
(2) Snell and Biffen, "Commercial Methods of Analysis," p. 223.
(3) R. E. Grim, *Ill. State Geol. Surv.,* **R.I. 80,** 251.
(4) *Ibid.,* p. 242.
(5) *U. S. Geol. Survey,* Professional Paper, **205-B,** 52.
(6) *Ibid.,* pp 44, 45.
(7) R. E. Grim, *Ill. State Geol. Surv.,* **R.I. 80,** 231–234.