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tion of brain regions. Grossman's<sup>3</sup> two-factor theory of motivation provides for the elicitation of non-homoeostatic drives by specific external stimuli as opposed to the generation of homoeostatic drives by internal stimuli. Dominance of the non-homoeostatic reward of intracranial self-stimulation over homoeostatic rewards is well known<sup>4</sup>. The present studies suggest that non-homoeostatic drives may arise from the non-specific need of central structures (probably limbic) for sensory input. This supports the view that normal drives are nonspecific, sensation-seeking activities and that pathologically reduced reactivity of central mechanisms to peripheral stimulation leads to psychopathic activity<sup>5</sup>.

H. J. CAMPBELL

Institute of Psychiatry, De Crespigny Park, London.

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<sup>1</sup> Campbell, H. J., Acta Endocrinol., Suppl. 119, 105 (1967).

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<sup>3</sup> Grossman, S. P., in Textbook of Physiological Psychology, 605 (John Wiley, London, 1967). <sup>4</sup> Falk, J., J. Exp. Anal. Behav., 4, 213 (1968).

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## APPLIED SCIENCE

## **Electrical Potential Measurements** on Clays

THIS communication describes the application in research on clay minerals of an electrical potential method, first used for research on glass-crystalline systems<sup>1</sup>. Clay minerals undergo a number of changes during heating, resulting in changes in the electrical potential at the contact surface between the clay and a suitable reference material. The changes are caused by one or more of the following: (a) loss of interlayer or crystalline water; (b) breakdown of the clay mineral lattice; (c) disappearance or formation of crystalline phases; (d) formation of glassy phases.

Fig. I is a sketch of the system of measurement, essentially the same as that used by Borisov and Zadumin<sup>1</sup>. Thin sintered alumina substrates (98 per cent  $A1_2O_3$ ) approximately 0.4 mm in thickness were used as the inert reference material and similar plates were prepared from the clay slips. The dried clay and alumina plates were placed together and clamped between two platinum electrodes. To avoid induction effects from the furnace windings, the electrodes were shielded with earthed platinum foil. The temperature and the E.M.F. were recorded on a compensating recorder.

Because of the high internal resistance of the holder assembly, it was necessary to use a diode amplifier with a high input resistance in the circuit (input resistance  $10^{12}$  ohm and voltage amplification 1:1). The changes in electrical potential between sample and alumina during heating at a heating rate of 6° C per min were recorded.







ig. 2. Differential thermal analysis and potential difference analysis curves of standard montmorillonite from Wyoming (A.P.1. No. 26). Fig. 2.

Several clay minerals were examined, but only montmorillonite will be considered here. The potential difference analysis curve is shown in Fig. 2, together with the differential thermal analysis curve. The curves were obtained with a standard montmorillonite sample from Wyoming (A.P.1. No. 26).

Below 350° C the curve shows a sharp drop in potential as a result of the removal of interlayer and sorbed water. Loss of crystalline water begins at about 480° C. The expulsion of the crystalline water for the temperature range in which dehydroxylation takes place seems to be a stepwise process, judging from the appearance of several small peaks on the curve. The last dehydration step starts only at about  $760^{\circ}$  C. From about  $850^{\circ}$  C the E.M.F. increases, indicating a transition from a more ordered to a less ordered structure. The formation of spinel results in a decrease in E.M.F. above 980° C. From about 1,130° C, glass is formed. The solution of the spinel in the glass phase results in another decrease in Е.м.F. at 1,210° С.

Thus it seems that the measurement of potential differences between clays and an inert reference material can be applied to the study of the physical and chemical changes of clays during heating. The method can also be used for the identification of various clay minerals.

The sensitivity of the method surpasses, in some respects, that of differential thermal analysis and it can detect the steplike dehydroxylation of montmorillonite. The use of the method for quantitative purposes is as yet uncertain. A small difference in sample thickness, for example, changes peak heights and if the sample is too thick, the resulting curve is flattened out. Better sample preparation and instrumentation will therefore be necessary for quantitative determinations.

K. A. G. TÄUBER E. R. SCHMIDT

National Building Research Institute, CSIR,

Pretoria, South Africa.

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<sup>1</sup> Borisov, A. F., and Zadumin, V. I., Steklo i Keramika, 21, No. 3 (1964).