MINERALOGICAL SOCIETY (LONDON)

A meeting of the Society was held on Thursday, November 4th, 1954, at 5 P.M., in the apartments of the Geological Society of London, Burlington House, Piccadilly, W.1 (by kind permission).

The following papers were read:

(1) *The determination of composition and thermal history of plagioclase by the x-ray powder method*

By J. GOODYEAR AND W. J. DUFFIN

Heat-treatment of eight natural plagioclases covering the composition ranges 0–65% and 80–100% anorthite is found to produce changes in the *x*-ray powder patterns which indicate that states of partial inversion are possible.

In the range 0–65% anorthite, the changes which take place as anorthite content increases are identical with those occurring on heat-treatment, and this limits the assignment of a definite composition and thermal history to a plagioclase in this range on the basis of its powder pattern alone.

In the range 80–100% anorthite, composition can be obtained from *x*-ray data without a knowledge of thermal history, and an estimate can then be made of the degree of inversion.

(2) *A note on albite twinning in plagioclase feldspars*

By P. GAY

Previous work by Donnay on the basis of the geometrical theory of twinning related the width of albite twin lamellae to the composition of the plagioclase. The curve derived by Donnay has been recalculated for both high and low feldspars from *x*-ray data; the two curves differ markedly only in the region between 0 and 20% Ab. Some experimental evidence supporting the deductions which can be made is given.

(3) *Experimental and theoretical studies of the mica polymorphs*

By J. V. SMITH AND H. S. YODER, JR.

An experimental and theoretical study has been made in order to determine the number and the structure of the possible polymorphs and to determine the structural relations between them. The simplest structures are *1M*, $2M_1$, $2M_2$, *3T*, *2O* and *6H* polymorphs and more complicated types can be developed. Some of the previously described polymorphs were not contained in the theroetical list and were re-examined. The *6M* structure was found to be a $2M_2$ polymorph, the 6-layer triclinic type was found to be a $2M_1$ polymorph, and the *3M* structure was shown to be a *3T* type. The 24-layer triclinic structure could be described on a simpler 8-layer cell. This type together with a new 12-layer monoclinic structure, as well as other structures of higher periodicity, presumably consists of complex stacking and results from spiral-growth mechanism. Two extreme types of layer-disordered crystals may be built and a disorder of individual ions may also occur. Single stacking faults result in twinned crystals. A new twin relation (180° rotation about the [100] axis) has been recognized.

Twenty specimens from extreme geological environments have been examined in order to evaluate the control of environment on the stacking. The type of stacking could not be attributed solely to the influence of pressure and temperature. Composition appears to play a dominant role in the type of stacking and semi-quantitative structural arguments appear to support this contention. The influence of growth mechanism is discussed.

A scheme for the identification of the mica polymorphs by *x*-ray powder and single-crystal methods is given.

(4) *The hydration of larnite* (β-Ca_2SiO_4) *and bredigite* (α_1-Ca_2SiO_4) *and the properties of the resulting gelatinous mineral plombierite*

By J. D. C. McConnell

An account is presented of the hydration of larnite and bredigite as observed in contact metamorphic rocks from Ballycraigy, Larne, N. Ireland. The results are also given of a detailed study of plombierite, the gelatinous hydration product of the natural dicalcium silicates.

The mechanics of the hydration process and of gel formation from β-Ca_2SiO_4 in hydrating portland cement are discussed.

(5) *A suggested igneous origin for the banded granular hornfelses within the hypersthene-gabbro of Ardnamurchan, Argyllshire*

By G. M. Brown

The development of the banded granular hornfels inclusions within the hypersthene-gabbro of Ardnamurchan has recently been attributed to the metasomatism of sediments, the evidence being textural and compositional. It is suggested that such evidence favors, rather, the thermal metamorphism of layered basic or ultrabasic igneous rocks.

The following papers were taken as read:

(1) *The occurrence of palygorskite near Ipswich, Queensland*

By L. E. Rogers, A. E. Martin, and K. Norrish

The mineral palygorskite has been found associated with dolomite in the Ibis Dolomite Quarry near Mt. Flinders, Queensland. *X*-ray, chemical and thermal methods were used to identify the mineral. The palygorskite occurs pure and mixed with dolomite and other minerals. It was also found as a dominant mineral of the cores from a bore situated (at Cribb's Estate), about 17 miles from the above quarry, suggesting that palygorskite occurs extensively in the area. A systematic study of the area would probably reveal clay deposits suitable for commercial use. The dolomite and palygorskite may have been formed in freshwater lakes which existed between successive Tertiary basalt flows. Sepiolite occurs as hard cores in the clayey palygorskite veins; it is suggested that palygorskite is an alteration product of sepiolite.

(2) *An accessory to the polarizing microscope for the optical examination of crystals*

By H. C. G. Vincent

A sphere, with the crystal grain mounted at its centre, rotates upon a triple support, allowing selection of orientation. When measurements are required, a direction, such as that of an optic axis in the interference figure, is adjusted to the cross hairs of the microscope and the corresponding point of emergence is plotted on the sphere itself by means of an automatic marking device. Great circle distances between points thus plotted may be measured, and angles may be set off, by simple methods described, and auxiliary stereographic projection is unnecessary. The sphere with plotted data represents a working model of the indicatrix of the mounted crystal, furnishing cardinal observation directions for refractive index and other optical determinations.

(3) *Rammelsbergite from the southern uplands of Scotland*

By A. K. Temple (communicated by W. Q. Kennedy)

Rammelsbergite as thin borders on niccolite (this on galena), from the Glencrieff mine, Wanlockhead, has been identified by the *x*-ray powder spacings and by etching tests. Three doubtful occurrences in the southern uplands are mentioned.

(4) *The significance of tridymite in igneous and metamorphic petrogensis*

By G. P. Black

The presence of tridymite in a rock indicates that relatively low pressures obtained during its formation. Closer limits to the pressure and hence to the depth of formation can be estimated when some other pressure- or temperature-indicating mineral is associated with tridymite. The maximum thicknesses of cover under which various tridymite-bearing members of the Tertiary complexes of Skye, Rhum, and Ardnamurchan were emplaced can be determined in this way; in the case of the Rhum complex, the thickness of cover consistent with the physico-chemical data is shown to have been less than 3850 and probably less than 2650 metres, figures very much lower than the 8500 metres recently envisaged by Wager (1953).

(5) *Rodingite from the Girvan-Ballantrae complex, Ayrshire*

By T. W. Bloxham

Titles and abstracts kindly submitted by G. F. Claringbull, General Secretary.)

SUMMARIES OF PAPERS PRESENTED BEFORE THE CLAY MINERALS GROUP OF THE MINERALOGICAL SOCIETY (LONDON), NOV. 5, 1954

J. Endell: *Clays in coals and their ashes*

Clay minerals occurring in brown and bituminous coals have been identified by *x*-rays as illites and kaolinites. These are the constituents of primary ashes, i.e., the minerals originally associated with the coals. Besides these there are the secondary ashes, formed from inorganic constituents, such as lime and sulfides, on burning the coal. The reaction between the clay minerals and the other constituents in ash formation is described, as well as the influence of clays in coking and on slag formation. Clays raise the viscosity of slags. In bituminous coals the setting point is raised and in brown coals lowered by the presence of clays. Examples in industrial firing practices are given.

P. Gallitelli: *Mineralogical composition of some clays of the clay-schist formation in the Modenese Appenines*

Examination of some of the above clays from Varana, Sassamorello and Castelvecchio has been carried out using usual optical, *x*-ray, and differential thermal methods. The clays examined contain illite, a kaolin mineral, and chlorite, and have the following characteristics: (*a*) the kaolin mineral is poorly crystallized; (*b*) the illitic mineral is highly hydrated; (*c*) the chloritic mineral has a mixed-layer structure with random interstratification of a swelling layer—being similar in some respects to minerals previously described as occurring in England and in Germany; (*d*) the sand fraction contains small amounts of basic glass of andesitic type.

P. Franzen: *X-ray analysis of an adsorption complex of montmorillonite with cetyltrimethyl ammonium bromide (lissolamine)*

The method of van Olphen for determination of the cation-exchange capacity of small samples of clays uses lissolamine and is based on the fact that at the equivalence point the clay is simultaneously oleophilic (at the micelle surface) and hydrophilic (at the micelle edges) and therefore can act as an excellent emulsifier for oil-water systems. *X*-ray analysis has confirmed the adsorption of lissolamine ions. It has proved possible, however, to adsorb still more lissolamine, in quantities up to 2.4 times the cation-exchange capacity. The *x*-ray powder photographs of this adsorption complex show a large number of orders of the basal reflection, and enable its general structure to be evaluated.

R. Greene-Kelly: *An unusual montmorillonite complex*

A highly regular complex of pyridine and montmorillonite with a basal spacing of 23.3 Å has been investigated by one dimensional Fourier syntheses, and the structure has been partly determined. The effect on the stability of the complex of traces of water, the nature of the exchange cation, and the substitution of pyridine by picolones is discussed.

P. Murray and J. White: *A kinetic study of the dehydration reaction in clays and its bearing on differential thermal analysis*

The isothermal decomposition of several clays has been investigated and it has been found that the decomposition can be treated to a first approximation as a first order reaction. Rate constants and energies of activation for the reaction have been evaluated. The results have been used to predict the form of the thermal analysis peak and the effect of heating rate upon it. An attempt has been made at a formal analysis of the results in terms of the theory of rate processes.

E. B. Allison: *The determination of specific heats and heats of reaction of clay minerals by thermal analysis*

Vold's mathematical analysis of the *d.t.a.* curve has been applied to Murray's thermal data on the dehydration of clay minerals. Owing to experimental uncertainties, values for heats of dehydration are lower than those determined by other methods. The first order law is obeyed and activation energies of dehydration are of the same order as those derived from other data; rates of dehydration are, however, higher. Smith's constant-heat-flow method has been used to determine specific heats and heats of dehydration of clays, and the effects of sample porosity upon the results has been determined. The thermal data is also used to estimate the amount of clay mineral present. The kinetics of the dehydration process evaluated from the *apparent specific heat-temperature* curves follow a first-order-reaction curve. The activation energies obtained are, however, higher than those derived from other data.

F. Vaughan: *Energy changes when kaolin minerals are heated*

Activation energies have been experimentally determined for the dehydration of various kaolin minerals. The fireclay mineral is distinctive and it is suggested that it does not form part of a halloysite-kaolinite series. It is further thought possible that there is a series of fireclay minerals. From thermochemical and thermodynamic considerations the heat of formation of kaolinite has been approximately calculated. Estimated enthalpy and free energy changes for the exothermic reaction at 980° C. indicate that, if a compound is produced during dehydration, the most probable explanation of the exothermic reaction is the simultaneous production of mullite, γ-Al_2O_3 and SiO_2. Finally, the lattice energies of kaolinite and its thermal decomposition products have been calculated.

E. C. Sewell: *The consequences for d.t.a. of assuming a reaction to be first-order*

Isothermal experiments of Murray and White led to the conclusion that the dehydration reactions of clays are first-order. The problem of a specimen heated at a constant rate throughout is recalled, particular attention being drawn to the effect of heating rate on the temperature at which the maximum rate of reaction occurs. To apply to *d.t.a.*, this analysis must be extended to take account of thermal gradients. The most important result concerns the effect of the size of the specimen and of dilution on the position of the turning-point. A disagreement with the results of experiments on kaolinite is pointed out and it is argued that only a small part of this disagreement is due to simplifications made in developing the theory. It is concluded that the hypothesis that the clay reactions are first-order is only approximate.

R. F. YOUELL: *Chamosite variability and iron-ore petrology problems*

There appears to be a variation in composition and perfection of crystallization of chamosite with the source from which it is extracted. Specimens from the Northamptonshire Sand Ironstone show that all the chamosites from the Main Oolitic Ironstone are of the ordered hexagonal type with high iron concent, while all chamosites from the Chamosite-Kaolinite beds are of the disordered form with lower iron content. Enrichment of the Chamosite-Kaolinite beds subsequent to deposition has in some areas rendered them indistinguishable from the plain Ironstone beds, and it has been very difficult to delineate the two deposits. An attempt has been made to use the chamosite type as a "label" for differentiation in ores from the Easton Neston area.

G. BROWN: *The effect of chemical composition upon* (00*l*) *intensities of micas and chlorites*

In the micas (including illites) variations in diffracted *x*-ray intensities occur due to differences in the octahedral cations and in the interlayer cations, and the calculations deal with the compositions which lie within the field whose corner members are: $K_2(Al, Si)_8(Al_4)O_{20}(OH)_4$, $K_2(Al, Si)_8(Fe_4)O_{20}(OH)_4$, $(H_2O)_2(Al, Si)_8(Al_4)O_{20}(OH)_4$ and $(H_2O)_2(Al, Si)_8(Fe_4)O_{20}(OH)_4$. Similar calculations have been made for trioctahedral micas. In the chlorites the composition of both the talc sheet and the brucite sheet can vary. The intensities of the (00*l*) reflections of chlorites with compositions between $(Mg_{12})(Si, Al)_8O_{20}(OH)_{16}$ and $(Mg_4Fe_8)(Si, Al)_8O_{20}(OH)_{16}$ have been calculated allowing for both symmetrical and asymmetrical distribution of the octahedrally coordinated cations between the two types of octahedral sites.

R. C. MACKENZIE, *Hon. Secretary*