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THE STRUCTURE AND PROPERTIES OF NATURAL AND SYNTHETIC MINERALS

An invitation conference on the above theme was held at the College of Mineral Industries, The Pennsylvania State University, from July 5 to 8, 1957. Five sessions were held on the following subjects:

Polymorphism and polytypism
Calcium silicate hydrates, serpentines and chlorites
Feldspars and micas
Ferroelectric and ferromagnetic materials
Zeolites and phase-equilibrium investigations

The first, second and fourth sessions will be reported in the *Bulletin of the American Ceramic Society*, while the third and fifth sessions are reported here.

Third Session:

Dr. W. F. Bradley (Illinois Geological Survey) proposed a structure for muscovite in which the deviation from the ideal hexagonal layers was obtained from a consideration of the geometrical restrictions imposed by the necessity for a fit between the tetrahedral and octahedral groups. The resulting distortion was in good agreement with the observed geometry of muscovite. Dr. Bradley pointed out that this idea could be extended to other minerals and might well prove to be an an important principle in crystal chemistry.

Two contributions to the long-standing problem of the structure of the intermediate plagioclases were given. *X*-ray photographs reveal pairs of reflections whose separation varies with the An-content and whose sharpness varies with the thermal and petrological history. Their origin is as yet unexplained though some sort of ordering and/or segregation is thought to be responsible. Dr. F. Chayes (Geophysical Laboratory) described the results obtained from a simple diffraction apparatus in which a grating containing "ordered and disordered" points was used. This gave the doubled pairs of reflections seen in photographs of plagioclase and promised to give a rapid check of any models proposed for the plagioclase structure. In addition, Dr. Chayes applied his statistical skill to an analysis of the different ways, the runs and the sequences obtained when two types of atoms are placed on a single array of points. Dr. H. D. Megaw (University of Cambridge, England) has used the mathematical theory of A. J. C. Wilson to approach the problem and obtained fairly good agreement by using a different model for each of the three principal axes. The two approaches paralleled each other and the partial success so far achieved leads to the hope that a complete solution of this intriguing phenomenon will not be far waay.

Professor J. Wyart (Paris, France) described experiments in which alkali feldspars had been subjected to heat treatment in the presence of mixtures of NaCl and KCl under dry and aqueous conditions. The products were indentified by *x*-ray powder patterns. Under dry conditions low albite and adularia (orthoclase) could be interchanged, as could sanidine and analbite (high albite). Under wet conditions the low feldspars were transformed into high feldspars. The experiments under dry conditions promised to lead to a determination of the extent of solid solution, for discontinuities were observed in the plots of NaCl:KCl ratio versus composition of the alkali feldspar deduced from the powder patterns. Discussion centered on the question of whether the conversion of the low feldspars to the high feldspars under aqueous conditions at the comparatively low temperatures of experimentation (~400° C.) represented equilibrium conditions or merely solution of the feldspar in the fluid with recrystallization in the disordered state (as observed by Goldsmith for microcline).

Dr. H. S. Yoder, Jr. (Geophysical Laboratory, Washington D. C.) described the phase equilibrium studies on alkali and ternary feldspars carried out by himself, and Drs. D. B. Stewart and J. R. Smith. Under the high pressure of water used in the bombs (5000 bars), the unmixing solvus of the alkali feldspars intersected the liquidus-solidus curves at $Or_{34}Ab_{66}$ $Or_{58}Ab_{42}$ and 698° C. The crest of the solvus differed by 40° C. from that obtained by Bowen and Tuttle and this was attributed to the effect of pressure. Dr. Tuttle, however, suggested that it may be the result of a change in the structural state of the feldspar. Dr. J. V. Smith (Penn. State) described the studies carried out in collaboration with Dr. Wm. Scott MacKenzie (University of Manchester, England) on alkali feldspars from igneous rocks, selected to represent the trend from volcanic through hypabyssal to plutonic conditions. A series of phase diagrams for the various cooling rates was proposed.

Dr. F. Laves (Zürich) described the results obtained by the application of infra-red absorption methods to alkali feldspars. The low temperature feldspars show a multiple set of absorptions near 11μ in contrast to the more uniform change of absorption for the high-temperature feldspars.

Fifth Session:

Dr. D. W. Breck (Linde Air Products Company, Tonawanda, N. Y.) reported on recent studies on the zeolites. About thirty zeolites are known to occur in nature and about twenty more have been synthesized in the Linde and other laboratories. Some of the zeolites have large inter-connected cavities in the framework of Si, Al tetrahedra, which lead to remarkable absorption and sieve-like properties. In particular, Dr. Breck described the properties of the Type-A synthetic zeolite whose synthesis and crystal structure were recently established at Linde. It contains large cavities 11.4 and 6.6 Å in diameter interconnected by openings 4.2 Å in diameter. Among its capabilities is the power of separating straight chain from branched chain hydrocarbons.

Professor W. Nowacki (Bern, Switzerland) described the structure of faujasite, another zeolite that contains large cavities. Professor H. O'Daniel and Dr. K. Fischer (Frankfurt, Germany) in a written communication described recent work in which faujasite has been assigned the formula $(Ca, Mg, Na_2)Al_2Si_4O_{12} \cdot 8H_2O$, herschelite has been found to be twinned chabazite with one-dimensional disorder and the structure of gmelinite has been determined.

Mr. P. Saha (Penn. State) described syntheses of analcite and other zeolites from compositions ranging from albite to nepheline. His discovery that analcite can be formed with the composition $NaAlSi_3O_8$ (albite) led to the suggestion that some authigenic albite might represent the breakdown of analcite solid solution. Dr. L. Sand (University of Utah) mentioned the occurrence of enormous deposits of mordenite-ptilolite in the western United States.

Dr. R. Roy (Penn. State) discussed the nature of the polytypic changes in mica and examined the experimental evidence for the existence of a difference in free energy between different polytypes. Mr. F. Dachille (Penn. State) described results obtained from high-pressure squeezer type equipment: P, T data for the coesite form of BeF_2 and the high-pressure form of B_2O_3 among others were presented. There has been some controversy concerning the effective cross-section between the pistons of the apparatus and Mr. Dachille suggested that the pressure must be carried by the whole cross section in runs made at high T and P because the metal of the jaws was found to be deformed after the runs. An attempt to determine the nature of infra-red absorption patterns, and in particular their suitability for the estimation of ionic coordination, by the use of model structures and polymorphs was described.

P. Saha and J. B. Smith