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BOOK REVIEWS

The Surface Chemistry of Soils, by Garrison Sposito. Oxford University Press, New York, Oxford, 1984. 234 + xiii pages, hardbound, $29.95.

This advanced text concentrates on the mechanisms of surface chemical reactions of common constituents of soils, i.e., phyllosilicates, oxides, oxyhydroxides, and hydroxides. The central theme of the book is the concept that surface reactions in hydrous systems can be described in terms of coordination chemistry, i.e., of the formation of surface coordination complexes between surface functional groups fixed in the solid particle framework and dissolved species. For example, a calcium clay contains surface complexes between the cavity in the siloxane surface (the functional groups) and a hydrated calcium ion (the dissolved species). The author mentions that this approach was inspired by the work of Werner Stumm and his school on hydrous oxides. Sposito's text is a consequent development of these views to which the author, as well as others, have contributed in recent years.

In the first chapter the structure of inorganic and organic soil constituents, primarily of phyllosilicates, is discussed with emphasis on the analysis of the kinds of functional groups present in the particle surfaces. A set of operational definitions of surface area and surface charge is presented as well as the experimental measurements of these quantities.

Chapter 2 gives an excellent critical discussion of the structure of water near particle surfaces and surveys the various physical methods for the determination of the physical condition of water in this region.

The third chapter, on the electrified interface "in soils," is in part a more or less classical treatment of charge and potential at the interface. As such, one is inclined to wonder whether this subject has perhaps been covered more clearly in existing textbooks on electrochemistry—admittedly covering many more pages. In any case, a fair part of the material covered is not specific at all for solid-liquid interfaces in soil. The extensive discussion of the different definitions of PZC for triple layer models may serve as a necessary warning for soil scientists not to oversimplify; regrettably (in this connection) the statement that the PZCs are characteristic pH values is not in line with a later remark that many ion species may serve as pot. det. ion. Also, the identification of IEP with PZC remains questionable. The last four pages of this chapter, on negative adsorption, appear a bit out of line with the chapter as a whole; the limiting value of co-ion exclusion at half the countercharge was already mentioned in Overbeek's contribution to Kruyt's *Colloid Science* in 1952.

The fourth chapter treats adsorption phenomena. To these reviewers, section 4.2 describing the pitfalls faced when attempting to interpret adsorption/precipitation phenomena in soil is one of the highlights of the book. Similarly, the following sections on metal cation, oxyanion, and organic matter adsorption present a good insight in the principles involved. Here the (regretted) brevity is probably related to the scanty experimental information available to test the hypotheses forwarded.

In chapter 5 many of the foregoing concepts are brought together. The first section reiterates diffuse double layer theory; to these reviewers it appears that too many equations are used to indicate the simple truth that "linear Poisson-Boltzmann" behavior is obviously limited to regions where the predicted total molarity of counterions is less than only a few per liter. Also the existence of at least an "empty Stern layer" seems a foregone conclusion. Section 5.2 forms the backbone of the present attempt to lift the theory of surface complexation above the introduction of a semi-empirical pair formation constant applicable to the IHP as was initiated by Heald *et al.* in 1964. The following sections present again more familiar material and show the development of the constant-capacity and triple-layer models. As an afterthought, these reviewers venture the remark that it could be seen as a matter of personal preference whether to present the now generally accepted triple (or quadruple) layer adsorption models as an extension of the old Stern-Gouy concept or consider them as surface applications of the theory of complex formation with a diffuse tail added.

For completeness a final chapter on colloid stability is added which is, however, somewhat sketchy.

The book contains a considerable number of literature references as well as suggestions for further reading. Unfortunately, an author index is missing. Also, a list of symbols would greatly facilitate studying more involved sections on their own merit. In conclusion, Sposito's book is a valuable and thought-provoking treatise for the advanced reader, a must for those interested in theoretical backgrounds.

G. H. BOLT
H. VAN OLPHEN

Micas, Reviews in Mineralogy, Volume 13, edited by S. W. Bailey. Mineralogical Society of America, Washington, D.C., 1984. 584 pages, paperback, $13.00. ISBN 0-939950-17-0.

In 1974 the Mineralogical Society of America began publishing paperback books in association with their yearly "short course" on a particular aspect of mineralogy. The first book was titled *Sulfide Mineralogy*; succeeding books have dealt with feldspars, oxides, zeolites, orthosilicates, marine minerals, pyroxenes, mineral kinetics, amphiboles, metamorphism, carbonates, fluid inclusions, and, in 1984, micas. These books have been assembled by experts in their respective fields and are generally the most scientifically up-to-date reviews that are available in mineralogy today.

Volume 13 on *Micas* is edited by S. W. Bailey, well known to most of us as the leading expert on the crystal structure of micas and chlorites. Bailey contributed the first two chapters. Chapter 1, "Classification and Structures of the Micas," covers chemical and structural classifications, polymorphism, and polytypism. "The Crystal Chemistry of the True Micas" is the subject of chapter 2 and includes discussions on sheet configurations, structural distortions, limits of strain, calculated structual models, and order-disorder of cations. A large amount of analytical data is also presented in this chapter. In chapter 3 Stephen Guggenheim reviews the nomenclature, classification, crystal chemistry, and phase relations of "The Brittle Micas," those micas rich in calcium and barium. These three chapters present the best review of mica crystal structures that has come to my attention, including the excellent, but shorter, review given by Bailey in the well-known *Crystal Structures of Clay Minerals and Their X-ray Identification,* Mineralogical Society, London, 1980.

A discussion of "Electrostatic Energy Models of Micas" is presented by R. F. Giese, Jr. in chapter 4. Giese points out

that such model calculations are very difficult to make because of the numerous structural complexities encountered in real micas. Predictions of hydroxyl orientations, however, are potentially useful and successfully explain mixed tri- and dioctahedral mica structures. George R. Rossman continues in chapter 5, "Spectroscopy of Micas," with a discussion of the relationships between optical spectra and the presence of the optically active cations, Fe^{2+}, Fe^{3+}, Ti^{3+}, Mn^{2+}, Mn^{3+}, Cr^{3+}, and V^{3+}. Qualitative relationships between chemical composition, color, and pleochroism have been made, but much work needs to be done. Rossman also discusses use of Mössbauer spectra in determining the content of ferrous and ferric iron in the tetrahedral and octahedral sites, electron spin resonance spectra in determining the coordination of Mn^{2+} and Fe^{3+} ions, nuclear magnetic resonance spectra in studying structural role of hydrogen, X-ray spectroscopy in verifying the presence of Fe^{3+}, Ti^{3+}, and Mn^{2+} ions, and infrared spectra to examine hydroxyl ion positions. He points out that some of these techniques have not been sufficiently tested to see if they have real potential to solve mineralogical problems. In chapter 6, "Optical Properties of Micas," Ray E. Wilcox gives six pages of optical data for identification of the micas and related phyllosilicates and six figures showing relationships between various optical properties and chemical compositions.

Chapter 7, "Experimental Phase Relations of the Micas," coauthored by D. A. Hewitt and David R. Wones, brings a sad note. Dave Wones died in an automobile accident just before this volume was published. This chapter is an epitaph to his important contributions to our understanding of the phase equilibria of micas. This chapter, which includes 41 phase diagrams, reviews subsolidus phase relations of the di- and trioctahedral micas and melting equilibria of micas.

Very complete and detailed reviews of the occurrences of micas in pegmatites (Petr Černý and D. M. Burt), in igneous rocks (J. A. Speer), and in metamorphic rocks (C. V. Guidotti) are presented in chapters 8, 9, and 10, respectively. Chapter 8 gives a particularly useful method of plotting mica compositions using vector space. Chapter 9 describes studies of naturally occurring micas which have contributed to an understanding of the origin, emplacement, and crystallization history of igneous rocks. Guidotti gives a long and thorough review of micas occurring in metamorphic rocks, including an impressive treatment of muscovite and paragonite occurrences, chemical compositions, and physical properties. The occurrence of micas in hydrothermal ore deposits and the treatment of F-OH and Cl-OH exchange is presented by J. L. Munoz in chapter 11.

The last two chapters (12) on "Illite" (by Jan Środoń and D. D. Eberl) and (13) on "Glauconite and Celadonite Minerals" (by I. E. Odom) will probably be of the most interest to clay mineralogists. The chapter on illite is most informative. It includes discussions of X-ray diffraction analysis, identification of polytypes, mixed layering, chemical variations, synthesis, and occurrence. Odom's chapter presents discussions on nomenclature, occurrence, structural characteristics, X-ray analysis, chemical composition, and mode of origin of the enigmatic micas glauconite and celadonite. A very useful appendix lists X-ray powder diffraction data for 37 micas.

I highly recommend this volume to anyone interested in the mineralogy of layer silicates. Its low cost should also make it very attractive to students.

MALCOLM ROSS

Editor's note: The Clay Minerals Society has published a set of ten colored slides and accompanying text, prepared by A. C. Rule, that treats polytypism in micas. The slides and text were designed to accompany the *Mica* volume of *Reviews in Mineralogy*. Information on the price and availability of the slide set may be obtained from the CMS Society Office, P.O. Box 2295, Bloomington, Indiana 47402, U.S.A.