

## BOOK REVIEWS

**Chemical Equilibria in Soils**, by Willard L. Lindsay. Wiley-Interscience, New York, 1979. 449 pp., Cloth, \$25.00.

This book by a veteran teacher and graduate research director in soil chemistry at Colorado State University seeks to utilize the equilibrium thermodynamics of heterogeneous aqueous systems for understanding and predicting the chemical reactions that take place in soils at 25°C and 1 atm. Following 28 pages of introduction and definition of chemical principles, are chapters on chemical substances of importance in normal soils (Al, SiO<sub>2</sub>, aluminosilicates, Ca, Mg, Na and K, Fe, Mn, phosphates, Zn, Cu, N, S, Mo) and harmful metals (Ag, Pb, Cd, Hg), as well as several on processes (organic transformations, chelate equilibria, carbonate equilibria). Problems involving both discussion and numerical calculation are presented after each chapter. An appendix of selected standard free energies of formation compiled by Muhammad Sadiq and the author is included.

Readers are put in touch with a sizeable number of publications in soil chemistry, physical chemistry, and geochemistry, including many from the 1970s. The redirection of the basic Eh-pH relationships toward the particular chemical systems and processes of concern to soil chemists should result in these concepts being assimilated much more readily by the students and professionals in this field. There are many worked examples, albeit at a very simple level.

Measured against the competition, e.g., Garrels and Christ's *Solutions, Minerals and Equilibria* or Stumm and Morgan's *Aquatic Chemistry, Chemical Equilibria in Soils* is a truncated and frequently unsubtle book. Although one chapter is devoted to chelation, and complex-ion equilibria are discussed in several chapters, nothing is included about adsorption equilibria. The author relies very heavily on a single type of diagram that displays solubilities of several substances against another variable, such as pH, so that at a particular pH one can identify the thermodynamically stable substance as the one with the lowest solubility. The quantity *pe* appears as the variable on an axis of four diagrams; elsewhere, the hybrid parameter, *pe* + pH, whose usefulness still escapes this re-

viewer after an admittedly brief exposure, is used where redox reactions are involved. Proton activity and electron activity are still hard to beat as plotting variables for such systems.

If the reader wants to know why a particular free energy value listed in the appendix is deemed the best value, or how it was calculated, he must obtain *Colorado State University Experiment Station Technical Bulletin 134*, by Sadiq and Lindsay (1979). This bulletin is apparently thick and expensive, and Colorado State, understandably, does not include it in its usual publication exchanges. It must be ordered separately which may explain why my university library does not own a copy.

There is great variation in the extent to which principles are explained. Problem 2.1 on page 31 asks the student, among other things, to stipulate meaningful standard state conditions for HCO<sub>3</sub><sup>-</sup>, a difficult assignment when there has been no discussion about the intricacies of standard state definition for aqueous ions, imperfect gases, etc. On the other hand, there are separate sections for elements, such as Ca and Na, in which the *pe* necessary for Ca, say, to be stable relative to Ca<sup>2+</sup> is calculated and found to be extreme, so that one concludes that calcium is not sensitive to redox variations. In addition, nonstandard uses of symbols must be learned—ionic strength is  $\mu$ , activities are denoted by parentheses and concentrations by brackets, K<sup>0</sup> is an equilibrium constant expressed in terms of activities, MF is mole fraction, etc.

This book may well be a boon to soil chemists, and geochemists will probably find the references from the soils literature useful, although the subject matter covered is so broad that the chapter bibliographies can only hope to be samples. Serious users of this book had better get hold of a copy of Sadiq and Lindsay and repeat a few of the calculations in detail to be sure they understand the particular thermodynamic conventions and assumptions being used.

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**Atlas of Zeolite Structure Types**, by W. M. Meier and D. H. Olson. International Zeolite Association, 1978. 99 pp. Distributed by Polycrystal Book Service, P.O. Box 11567, Pittsburgh, Pennsylvania 15238. (soft cover). \$4.00.

For several years the computer-drawn zeolite structures of W. M. Meier (Institut für Kristallographie und Petrographie der ETH, Zürich, Switzerland) and D. H. Olson (Mobil Research & Development Corporation, Princeton, New Jersey) have been admired and used extensively by zeolite workers in many countries. Now, based on their 1971 paper entitled "Zeolite Frameworks" (Molecular Sieve Zeolites: *Adv. Chem. Ser.* 101, 155–170), stereo pairs of nine synthetic and twenty-seven natural zeolite structure types have been assembled in this handy atlas, which has been published by the Structure Commission of the International Zeolite Association. After a brief explanation of the topology of zeolite frameworks, each structure type is depicted on a separate page with a blank facing page, along with pertinent information on framework density, space group, channel dimensions, secondary building units, fault planes, and unit cell. Unfortunately the general chemical formulae listed for the natural species are typical of zeolites as they occur in igneous envi-

ronments and are not necessarily representative of their more siliceous and alkaline counterparts in sedimentary rocks, which clay mineralogists and non-crystallographers are apt to encounter.

Most of the structure types are easily seen from the stereodiagrams; however, some (e.g., phillipsite) structures might be more easily understood if the framework had been viewed from another direction or if two different views had been presented. More than 100 references are included in the bibliography in the "less informative" manner of the chemical literature, i.e., without titles or complete pagination. On the whole, the *Atlas of Zeolite Structure Types* is a short, concise, informative work that is unquestionably a valuable contribution to the zeolite literature and one that will be a must for everyone who deals with zeolites in his teaching or research, especially at the low price of \$4.00.

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