Clays and Clay Minerals, Vol. 36, No. 5, 480, 1988.

BOOK REVIEW

Chemistry of Clays and Clay Minerals, edited by A. C. D. Newman. Wiley-Interscience, New York, Mineralogical Society Monograph 6, 1987. 469 pp., hardbound, US$110.00 (ISBN 0-471-01141-X.

This reference work on clay chemistry has been published by the Mineralogical Society as a companion volume to "Crystal Structures of Clay Minerals and their X-ray Identification," edited by G. W. Brindley and G. Brown. The book is a compilation of detailed presentations of various subjects in clay chemistry by individual authors or groups of authors. Unfortunately the delayed publication of this volume has adversely affected presentations of subjects that are undergoing active research. Relatively recent publications are not cited in some chapters, meaning that these chapters are already out-of-date.

The first chapter, by A. C. D. Newman and G. Brown, constitutes about one quarter of the book and details the wide variation in chemical composition possible in these primary and secondary phyllosilicate minerals. Many of the minerals discussed are not clays in the strict sense, but occur in fairly large grains in metamorphic and igneous rocks. Because this chapter has little to say about mineral occurrence, the relative importance of the numerous subgroups of minerals in the natural environment is difficult to assess. One is left to glean some of this information from the last chapter of the book. This initial chapter presents an excellent compilation of structural formulae for the silicate minerals and will be useful to the specialist because it provides a critical evaluation of published structural formulae.

Chapter 2, by R. M. Taylor, describes the structure and properties of oxide and hydroxide minerals of soils. It is written in the style of a literature review, and, as such, it is somewhat cumbersome to read, inasmuch as the detail tends to obscure the general principles. Awkward grammar often confuses the intended meaning. A more critical evaluation and interpretation of the literature would have benefited the reader here. The presentation is incomplete, insofar as many significant studies of surface bonding by modern spectroscopic techniques have been omitted from the sections on adsorptive properties. The author relies heavily on classical adsorption studies to infer bonding mechanisms. This may reflect in part the fact that most of the research papers cited were published prior to 1980. In summary, the chapter is an impressive, but selective, compilation of the scientific literature on oxide and hydroxide structure and reactivity; it will be particularly valuable to geochemists, soil scientists, and environmental scientists.

Chapter 3, by H. van Olphen, presents the now familiar, classical theory of colloidal stability based upon the diffuse double layer model. Unfortunately, very little attempt was made in this chapter to update the theory in light of more recent studies of clay particle interactions and the clay-water interface. For example, the failure to recognize direct evidence that face-to-face interactions in suspensions of swelling clays are dominant is a serious weakness in van Olphen's model of clay aggregation and flocculation. It is becoming increasingly apparent, after more than thirty years of useful application in clay science, that the double layer model needs to be reevaluated as modern methods portray the clay-water interface in increasing detail.

Chapter 4, by H. Laudelout, describes the thermodynamic approach to cation exchange in clays, closely following the Gaines-Thomas derivation. While breaking no new ground, this review is clear and concise; however, it is too brief, given the importance of ion exchange in the fields of science that are likely to use this book. No ion-exchange data are actually presented to demonstrate the use of the developed equations, and important subjects, such as ion selectively and its cause, are not developed.

Chapter 5, by A. C. D. Newman, details the study of water adsorbed on clays as determined by classical techniques and more recent spectroscopic and particle-scattering methods. An excellent critical assessment of the utility of the B.E.T. equation in describing water sorption isotherms on various clay types, as well as a useful discussion of the value of measured heats of immersion, is presented. Although numerous very good reviews of the behavior of water on clays have now been written, this particular chapter is sufficiently different in emphasis to be of value to researchers and students of clay science.

Chapter 6, by J. P. Rupert, W. T. Granquist, and T. J. Pinnavaia, surveys the rapidly growing field of catalysis by layered aluminosilicates. Although the science of zeolitic catalysts is relatively mature, catalysis by layer silicate clays has not heretofore enjoyed a well-developed theoretical basis. This needed review provides a chemical foundation for the numerous types of catalyzed organic reactions observed on layer silicates. The emphasis is on reactions of interest in synthetic organic chemistry, with no discussion of the potential for reactions catalyzed under ambient conditions that might be of interest to environmental scientists. Therefore, although its scope is limited by design, this chapter reveals the surface properties of clays that make them effective catalysts in controlled environments.

Chapter 7, by the late G. W. Brindley and J. Lemaitre, details the high-temperature dehydroxylation, oxidation, and reduction reactions of the important phyllosilicates and further describes the relationship between phyllosilicate composition and the high-temperature materials formed by thermal decomposition of these minerals. In recent years, little work seems to have been carried out on this subject, but with increasing interest in clays as high-temperature catalysts, an understanding of decomposition reactions becomes essential. This chapter, then, fills an apparent gap in the description of clay chemistry and will be of particular interest to geologists and those interested in the use of clays for the preparation of high-temperature catalysts and ceramics.

A detailed review of the chemical mechanisms involved in organic bonding by clay minerals is presented by J. A. Rausell-Colom and J. M. Serratosa in Chapter 8. In many respects, the review is not very different from earlier reviews of this topic, but the importance of this subject to clay science mandates that a chapter covering clay-organic reactions be present. To some extent, the authors are uncritical in interpreting the literature as shown, for example, by their explanation of the difference in affinity of clays for paraquat and diquat, which is now known to be chemically unsound. In addition, the sentence structure is awkward in places, sometimes confusing the meaning. Nevertheless, the chapter should be an excellent reference for clay chemists interested in a detailed description of clay-organic interactions.

The final chapter, by B. Velde and A. Meunier, provides a thermodynamic description of clay mineral chemistry, using phase equilibrium diagrams to depict trends in mineral precipitation and dissolution during processes of diagenesis, weathering, and soil development. This chapter uses numerous specific examples of mineralogical assemblages which appear to be at equilibrium in soil, sediment, and rock materials. This subject will be of interest to soil scientists, geochemists, and geologists, and provides a means of representing complex details of clay mineral composition in a logical manner, which makes trends in chemical or mineralogical data understandable from a thermodynamic point of view.

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