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BOOK REVIEW

Crystal Structures of Clay Minerals and Their X-ray Identification, edited by G. W. Brindley and G. Brown. Mineralogical Society, Monograph No. 5, London, 1980. 495 pages. $52.50 (members) and $70.00 (non-members).

This third edition of the book previously entitled *The X-ray Identification and Crystal Structures of Clay Minerals* represents a complete revision of the 1961 version by covering thoroughly the great advances made in clay mineralogy during the last twenty years, especially in regard to the crystal structures and their characterization by X-ray diffraction. As before, X-ray powder diffraction remains as the most powerful and practical method for characterizing clays and clay minerals. To take full advantage of this method, a fundamental understanding of clay mineral structures and the details of X-ray diffraction methods and instruments is required. This monograph successfully treats these two aspects of X-ray diffraction investigation of clay minerals by illustrating the *real* structures of clay minerals and the optimum conditions for the practical analysis of clays with X-ray diffraction.

The monograph comprises seven chapters which are authoritatively written by six leading experts in the field. Chapter 1, by S. W. Bailey, 124 pp., is devoted to the fundamentals of the crystal structures of layer silicates. Structural features of individual layers in these minerals are first described in detail. Subsequently, the different stacking sequences (polytypes) of the layers are explained. The method and notation used to describe the polytypes simplifies this complex matter, and Bailey's treatment is the clearest and most precise account of the crystal structures of layer silicates that has been published to date.

Chapter 2, on order-disorder in clay mineral structures by G. W. Brindley, 70 pp., presents the *real* structures of the clay minerals with all of their imperfections. First, the types of disorder are described (thermal, cationic distribution, stacking, mechanical, long range-short range, etc.); the basic X-ray diffraction effects of disordered structures are then given; and finally, order-disorder in the structures of individual clay minerals is described. Brindley's account is authentic and brilliantly reveals the complexity of poorly crystalline materials, however, it is unclear to this reviewer why the structures of allophane and imogolite were not discussed in this chapter.

Chapter 3, on interlayer and intercalation complexes of clay minerals by D. M. C. MacEwan and J. J. Wilson, 51 pp., deals with clay-water and clay-organic complexes, hydration-dehydration reactions, and swelling phenomena. It provides background information on these reactions and on how they can be utilized in the characterization of clay minerals. Well-selected examples of such complexes are given, and major factors governing their stability are described. Extremely useful data are tabulated, mostly for purposes of identification, on clay-organic complexes as well as on hydration states of clay minerals saturated with various inorganic cations. This is not an exhaustive treatment of organic derivatives of clay minerals, but an excellent introduction which enables those without a strong background in organic chemistry to use clay-organic complexes in the identification and characterization of clay minerals.

Chapter 4, on interstratified clay minerals by R. C. Reynolds, 55 pp., describes modes of interstratification of layers leading to various mixed-layer assemblages (random, partially regular, and regular). Methods for the interpretation of X-ray diffractograms of mixed layers are discussed, and a large number of calculated diffraction patterns are shown for two-component systems and for some three-component systems with various modes of mixed layering. These calculated patterns are useful in recognizing the nature of mixed layering in many natural samples. Reynolds does a commendable job of clarifying the various diffraction effects and the factors involved in the X-ray diffraction analysis of mixed-layer materials.

Chapter 5, by G. Brown and G. W. Brindley, 54 pp., deals with established procedures for X-ray diffraction analysis of clay minerals. Details of instrumental conditions and those of sample preparation are discussed by explaining the basic principles behind the methods, rather than by prescribing a single technique. A few minor criticisms of this chapter may be raised: Considering its increasing popularity today, the section on automated X-ray diffractometry and related data processing requires more discussion along with more references (e.g., Jenkins *et al.*, 1979). Also, a reference is made (p. 314) to a work published in 1977 without mentioning the author's name (perhaps not to embarrass him).

Chapter 6, by G. Brown, 50 pp., gives X-ray diffraction data on the detrital and authigenic minerals commonly associated with clays. The data are well organized and well selected, except for the feldspars, where some useful references, such as "The Identification of Detrital Feldspars" by L. van der Plas, Jr. (1966) and the Mineralogical Society of America's short course notes "Feldspar Mineralogy" (Ribbe, 1975) are missing.

In Chapter 7, by G. W. Brindley, 28 pp., the available methods on quantitative X-ray mineral analysis of clay minerals in the literature are critically evaluated. Both practical and theoretical factors affecting the precision and accuracy of these techniques are discussed. The prerequisites for a reliable quantitative X-ray diffraction analysis are well explained, and both the limitations and the indispensability of the method are made clear.

In the Appendix to the monograph, 2θ to d conversion tables are compiled for the $K\alpha$ and $K\beta$ radiations of Cu, Co, and Fe. These tables do not seem to be very useful because the selected increments (0.02° for $K\alpha$ and 0.05 for $K\beta$ radiations) would require many interpolations in practice. The subject index is well prepared and greatly facilitates the use of the monograph. The paper, printing (except for the Appendix which is too light), and the illustrations are all excellent, and each chapter has a well-selected list of references up to and including 1978 or 1979.

In summary, this monograph is a monumental work which acquaints us with the *real* structures of the clay minerals and provides sound methods of X-ray diffraction analysis of clays and clay minerals. It will undoubtedly be an indispensable book in any laboratory involved in either the routine or advanced analysis of clays.

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REFERENCES

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