

## BOOK REVIEW

**X-ray Diffraction and the Identification and Analysis of Clay Minerals**, by D. M. Moore and R. C. Reynolds, Jr., Oxford University Press, New York, 1989. 332 + xvi pp., soft cover, \$24.95.

Since its development as an analytical tool in crystallography and mineralogy, X-ray powder diffraction (XRD) has been the principal means of identification and structural analysis of clay minerals. Their small particle size and layered crystal structure make them particularly suitable for study by powder diffraction methods, and much of our understanding of clay minerals has been derived by direct comparison of their XRD characteristics with those of true micas. Students of clay mineralogy have benefitted in recent years from an increased variety of textbooks, computer software, and review papers on clays, but have continued to rely on lecture notes and standard references on XRD in order to develop insight and understanding of this important analytical method. Moore and Reynolds have thus moved to fill a major gap by producing a combination textbook and lab manual designed to introduce XRD identification of clay minerals. They have succeeded marvelously. This book is a user-friendly text whose goals are to: (1) develop a historical context for X-ray powder diffraction of clays, (2) achieve a realistic understanding of the workings of X-ray diffractometers, and (3) identify both the limitations and applications of data acquired by diffraction. The style of the text is informal and conversational and remarkably lacking in jargon. Provocative questions are scattered throughout to stimulate thinking, and frequent references to more extensive treatment of the topics are given for the serious student.

Chapter 1 is an engaging summary of the historical development of both X-ray diffraction and clay mineralogy and is designed to bring even the casual reader up to speed for the following chapters. Chapter 2 begins with an always appropriate note of caution about the need for vigilance and safety when working with high-voltage electronic equipment, and then proceeds with brief introductions to continuous radiation, characteristic radiation, and absorption. This is followed by a guided tour through the working parts of a diffractometer and an accompanying checklist of procedures for operating one of the more commonly used models. The authors' point, of course, is that once you have learned to operate one system, understanding other systems is a much easier task.

Chapter 3 deals with the diffraction of X-rays and proceeds from a very straightforward discussion of scattering and interference, including an introduction to the mathematics of

interference, to the components of Bragg diffraction that contribute to peak shape and position. The reader is introduced to the notion of computer modeling at the end, and the stage is set for later chapters on the role of computer modeling in the interpretation of XRD data. Chapter 4 returns to clay mineralogy with a discussion of ideal and non-ideal structures and their nomenclature. Emphasis is placed on the geological and mineralogical characteristics of clays. The excellent discussion of mixed-layering at the end includes a review of four illite/smectite models, which attempt to explain a phenomenon that is widespread in clay-rich rocks and sediments. Chapter 5 is a practical guide to the laboratory preparation of clay mineral samples for X-ray powder diffraction and includes most of the commonly used methods for making oriented and random powder mounts, as well as a discussion of their relative advantages and disadvantages. The identification and interpretation of diffraction patterns of clays and associated minerals is covered in Chapter 6, along with a summary of polytype determination. Chapter 7 deals solely with the identification of mixed-layer clay minerals and serves as a primer for the NEWMOD computer program of Reynolds and the graphical techniques of other authors. In the absence of a clear understanding of the nature and origin of mixed-layering in clays, computer simulation of XRD tracings for comparison with experimental tracings provides the best method for their interpretation. Further applications of the NEWMOD algorithm are described in an appendix. Chapter 8 on quantitative analysis will be, in many ways, the most valuable to active researchers and practitioners in clay mineralogy. Conventional methods of semi-quantitative estimation based on comparisons of weighted peak intensities, which are widely used to report clay mineral percentages with often unwarranted claims of precision, are here updated with equations that relate diffracted X-ray intensity to instrumental, geometric, and crystallographic factors. The use of internal standards, computer calculation of reference intensities, and measurement of peak intensity are discussed and evaluated.

Although intended as a text for students, this book will clearly serve all workers in clay mineralogy who use X-ray powder diffraction for mineral identification. For a first edition, there are relatively few typographical and production errors. Spiral binding and author-prepared camera ready copy have kept the price at a very reasonable level, all of which should guarantee this book a place on the desk or in the lab of every serious clay worker.

WARREN D. HUFF