American Mineralogist, Volume 76, pages 1759–1760, 1991

BOOK REVIEWS

MANUAL OF MINERALOGY, twentieth edition. By C. Klein and C. S. Hurlbut, Jr. John Wiley and Sons, New York, 1985. xi + 596 pages, $48.95

The twentieth edition of the *Manual of Mineralogy* is greatly expanded over the previous edition, published in 1977. This one is not only in a larger format but contains more pages, more thorough treatment of several topics, improved figures, and an additional chapter, "Minerals as Gems." With the exception of "Minerals as Gems," the topics covered in this edition are the same as in the previous edition, but their organization is different. Crystallography is now covered in two chapters, the first of which is devoted to morphological crystallography and the second to internal order and crystal structure. With the exception of a slightly expanded discussion of stereographic projections, the introduction of the Fedorov system of naming forms and additional well-chosen illustrations, the authors' treatment of morphological crystallography differs little from that found in the previous edition. The following chapter (3), "Crystallography: Internal Order and Structure" represents a considerably improved treatment of this subject. The reader is introduced to the concept of order and is then led through a well-illustrated development of plane and space groups. The relationship of crystal structure to space and point group symmetry is nicely shown through the use of mineral examples. Perhaps a more appropriate location for the section "The Determination of Crystal Structures," which is found near the end of this chapter is in chapter 6 on X-ray crystallography. Both chapters on crystallography benefit from the use (unfortunately sparing) of M. C. Escher's stimulating drawings.

Although expanded considerably over the previous edition, the authors' treatment of crystal chemistry remains elementary, repetitive of some of the simpler concepts of general chemistry (normally a mineralogy course prerequisite). Inclusion of a section on crystal field splitting, for example, would give the student a better understanding of mineral coloration and would complement the chapters on optical mineralogy and gems. Expansion of the sections on crystal chemistry could come at the expense of the approximately seven pages devoted to blowpipe and bead tests.

The chapters on X-ray crystallography and optical mineralogy are light on theory, but do provide the student with an understanding of the application of these determinative techniques in mineralogy. While the brief introduction to reflected light microscopy is a welcome addition, the authors should consider adding a section on X-ray fluorescence (i.e., the XRF spectrometer and the electron microprobe) and its application in quantitative chemical mineral analysis.

The organization of the descriptive mineralogy portion is similar to that found in other texts with the native metals, sulfides, and sulfosalts, oxides and hydroxides, minerals with anionic complexes, and silicates treated in separate chapters. The chapters are well illustrated with diagrams showing the structures, morphology, and some of the more important compositional and phase relations, and excellent photographs of the more important mineral species. Important silicate structural features are shown in numerous HRTEM, TEM, and SEM photographs. The determinative tables in Appendix 1 are more comprehensive and useable than those found in most mineralogy texts, and the diagnostic features section for each mineral is designed to be used in conjunction with them.

The authors do a reasonably good job of introducing the student to phase equilibria, phase diagrams, and the phase rule without the aid of elementary thermodynamics in the chapter "Mineral Associations: An Introduction to Petrology." The remainder of the chapter is a brief introduction to petrology and serves adequately to bridge the gap to later petrology courses.

The authors have achieved their goal of a balanced coverage of concepts and principles with systematics and description. Consequently, this text serves student needs quite well, which is why we use it in our course in mineralogy. Students find the chapter "Minerals as Gems" with its beautiful color plates by the VanPelts a pleasant diversion from the rigors of phase equilibria.

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MINERALS AND ROCKS: EXERCISES IN CRYSTALLOGRAPHY, MINERALOGY, AND HAND SPECIMEN PETROLOGY. By Cornelis Klein. John Wiley and Sons, New York, 1989. x + 402 pages plus 10 cardboard inserts. $29.95.

It has been at least 20 years since the Freeman (Ohio State University) *Laboratory Studies in Mineralogy* went out of print. In the intervening years those of us who teach sophomore-level mineralogy for geology majors (and the occasional chemist) have had to create from scratch or otherwise jury-rig between 15 and 25 exercises in crystal morphology, closest packing, bonding, phase diagrams, etc., that would challenge and teach our students without boring them or requiring hours of work much in excess of the time required for reading, studying specimens, and reflection. I can recall obtaining "for future use" several exercises from Jim Papike when we were at Stony Brook together in the early 1970s, and one of my favorite exercises (relating the stability of closest-packed minerals to crystal field stabilization energy and stoichiometry) comes directly from a much-too-hard hour test I was sure the students would find interesting. Others are reworked examples or problem sets taken from a diversity of crystallography and mineralogy texts in ways that wouldn't make me liable to charges of plagiarism. Such self-generated exercises are often creative and are certainly dear to our hearts. Typically, however, they also lack the polished graphics and careful explanatory notes found in published examples.

Case Klein and John Wiley have solved the problem of finding a good collection of published exercises in crystallography and mineralogy by creating *Minerals and Rocks: Exercises in Crystallography, Mineralogy, and Hand Specimen Petrology,* a very worthy grandchild whose antecedents include Klein's text with C. S. Hurlbut, exercises from Klein's own store of practical teaching experience, some (I suspect) from that gray literature of exercises passed from friend to friend, and a dash of spirit from the old Freeman collection. My best recommendation is to reveal that I am writing this review as I incorporate this lab man-

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ual into my syllabus for 1990–1991. I like what it offers, and I expect my students will appreciate both its clarity of presentation and the more formal organization it will bring to our lab meetings and out-of-class problem sets.

The manual consists of 35 exercises in three categories: crystallography (16), mineralogy (14) and hand-specimen petrology (5). These exercises are carefully and clearly written, and should be accessible to any intelligent college sophomore, given some guidance on the instructor's part and an introduction in lecture to the topics covered. The print is easy to read, the explanations generous, and the illustrations large and strikingly clear. Printed on pages 21.7 cm wide by 27.8 cm high, the book is well-made, relatively handsome in appearance and only moderately expensive if purchased with the Klein and Hurlbut text ($65.95 for both, vs. $78.90 when the text and manual are purchased separately).

The five exercises on stereographic projection, four on translational symmetry and space groups, and three on basic crystal chemistry are particularly good and represent a real pedagogic improvement over previously published student exercises on the same topics. (I've searched for years trying to find a set of unified exercises presenting basic concepts of space group symmetry simply but accurately, and I must thank Professor Klein in print for providing just what I've craved: clear, straightforward explanations that students can understand independently; well-illustrated lists of space group properties, lattice types and unfamiliar symmetry operators (e.g., glides); and carefully executed drawings and structural projections for selected space groups and suitable minerals, all in an enlightening, unified sequence.)

The exercise in classification, associations and origins of ore minerals and that on plotting mineral assemblages on ternary diagrams as a function of grade are unusual but welcome additions to a course in mineralogy, and can be used nicely in conjunction with reading from, say, chapter 5 of Mason and Berry (1968; "The Genesis of Minerals"), to illuminate some principles of mineral genesis in short order (the time usually available). Although the coverage in petrology is much less detailed than that in mineralogy, the exercises on rock classification are positioned somewhat above the level usually encountered in introductory geology courses. They can be read profitably as part of any mineralogy course, and included for study if the instructor wishes to emphasize paragenesis and mineral occurrence.

Certain exercises in the manual are designed around supporting materials—wooden or plaster morphologic models, a ball-and-stick lattice model using colored balls to show sets of planes, a contact goniometer, and of course suitable hand specimens. Fortunately for departments lacking these resources, the manual provides substitutes (excepting the hand specimens). Thirteen patterns for morphologic models are printed on heavy paper at the end of the book, giving students an opportunity to build some important crystal forms (5 isometric, 1 hexagonal, 3 rhombohedral, 2 tetragonal, 1 orthorhombic, 1 triclinic) and keep them for study at home. These models can also be used with a protractor and ruler to determine interfacial angles. The figures given in the exercise on Miller indices are perfectly adequate to illustrate the principles of naming planes (saving $180 on a model to represent Miller indices).

The shortcomings of the book fall into two categories: things that ought to have been included but weren't, and things that should have been left out. The nine exercises on mineral properties and systematics belong in the latter group. Given that most—probably all—instructors adopting this lab manual will also use Klein and Hurlbut (1985; KH) as the principal text for their courses (and that some will even require additional texts with mineral photographs—like the Audubon Guide or Simon and Schuster's excellent *Guide to Rocks and Minerals*—for identifying hand specimens), there is little reason to include reviews of mineral habits, twins, or physical properties (see KH, 199–219) and no reason at all to include 34 pages (seven exercises) of systematic mineral descriptions (cf. KH, 254–467). The species descriptions in the distillation provided in the manual are certainly not as informative as those in the KH text, and the list of minerals selected, while including the most important rock-forming types, omits a few (e.g., heulandite, willemite, chondrodite, franklinite, cobaltite, tetrahedrite, and nickeline) that may be part of our student collections. Moreover, the manual does not have a page index for minerals and does not give the chemical compositions. Thus, most students will have to revert to their texts for proper characterization and detailed study of the species assigned.

Topics omitted that should be included in this manual, either as separate exercises or as subjects presented to augment and enrich existing sections (perhaps as optional activities), are (1) crystallographic calculations (e.g., matrix transformations of axes), (2) practice in converting formulas to weight percents and vice versa, (3) determination of cell contents or density, (4) binary and ternary phase diagrams, and (5) electrostatic bonding.

Of course most practiced teachers of mineralogy will have sets of favorite topics or exercises that they feel ought to be included. We should, perhaps, let Professor Klein know what we want and encourage him to revise the manual so as to make it even more useful and appreciated. Failing this, we can always supplement the exercises in *Minerals and Rocks* with our old standbys.

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