

## BOOK REVIEWS

Ramdohr, P. *The Ore Minerals and their Inter-growths: Second Edition* (English transl. of 4th German Edition). Oxford and New York (Pergamon Press), 1981. xxii + 1205 pp., 637 figs. (two volumes). Price £90.00.

Professor Ramdohr is the world authority on ore mineralogy and this new edition of his major work will be welcomed. In a four-page preface, the author gives a personal essay on the snags that still arise from quantitative data, from measurements that can be carried out much more accurately than are significant considering the variations within the same polished section, using the same polish and the same method; careful microscopic observation is still the best primary method.

After two lengthy chapters on the genetic systematics of ore deposits, the ore textures, and the principles of the classification of ore intergrowths (pp. 1–232), the remaining part of volume one begins the descriptive section of this classic work by covering the elements, intermetallic compounds, alloy-like compounds, and tellurides, leaving the sulphides and sulphosalts, oxides, gangue minerals, and non-opaque oxide ore minerals to the 765 pages of vol. 2. Each mineral is described in a standard format, including general data, polish, reflection behaviour, etching, fabrics (texture), diagnostic features, paragenesis, references, and the strongest lines in the X-ray powder diffraction pattern. There is a 24-page annex in a pocket at the back of vol. 1 containing tables of recently published reflectivity values and vol. 2 includes a locality list of some 3000 typical occurrences, a bibliography with over 1300 references, a brief general index, and a mineral index.

The style throughout is stamped with the Ramdohr viewpoint, and here the thirty-two translators have clearly done great service. The observations from polished sections are enlightened with reference to microprobe determinations and to experimental work or synthetic systems. The preliminary remarks to many doubtful species give a useful pen-picture of the status of the mineral and whether or not there are sufficient grounds for discrediting it. One is never left in much doubt as to available data: thus under the physicochemistry of arsenopyrite it is stated 'not much known'. The author's strictures on the use of methods too accurate for the variations due to complex mixed crystals are applied particularly to hardness measurements. Thus the Talmage hardness using a scale of seven letters for scratch hardness, with the addition of + or – to signify a little above or below the average value, is preferred to the indenta-

tion tests. For useful reflectivity data, values need to be obtained across the whole visible spectrum. It is emphasized also that whoever shuns the use of oil immersion misses an important diagnostic tool and will never see hundreds of details described in this book.

In this monumental work, one man who has travelled widely and collected and examined material from orebodies from all parts of the world, gives us his unrivalled experience and immense knowledge and sets them down together with his own photomicrographs and observations. Every laboratory concerned with the study of ores in reflected light (or indeed under the microprobe) will need these two volumes and all libraries concerned with earth sciences should have them as a standard reference.

R. A. HOWIE

Craig, J. R. and Vaughan, D. J. *Ore Microscopy and Ore Petrography*. Chichester and New York (John Wiley and Sons Ltd: Wiley-Interscience), 1981. xiv + 406 pp., 163 figs. Price £17.95.

It is twenty years since Cameron's *Ore Microscopy* was published and thirty-four years since Edwards's *Textures of the Ore Minerals* appeared (the 1954 revision was not very extensive). For the study of ore microscopy and ore textures these were the best books this reviewer felt he could recommend for purchase by undergraduate students. Craig and Vaughan have now produced an excellent undergraduate/graduate textbook that both combines these two subjects and goes on to provide studies of the principal ore mineral associations with brief discussions of their origins. It has one major drawback from the undergraduate point of view—only a hardback version is on sale at such a high price that many students will rely entirely on their library's copy. The publishers have informed me, however, that a cheaper soft cover edition will be published, but it will not be available for some time.

The book starts with a useful summary of the optics of the ore microscope. This could be improved by including a short discussion on the blooming of lenses and their care and cleaning especially as the book is aimed at students some of whom will, despite warnings, huff on lenses to clean them thus helping in the removal of inorganic blooming compounds! More important is the need for a section on the setting up procedure for optimum illumination—far too many students tend to be satisfied with 'lazy man's illumination'. In

this chapter one receives the impression that the authors assume that they are writing for students already well instructed in the use of polarizing microscopes for thin section work. As this reviewer has found to his cost in teaching students at the M.Sc. level, who have come from many different teaching establishments, instruction in the proper setting up procedure for microscopes appears to have been negligible in some institutions! A minor criticism of this chapter is that the footnote to table 1.1 is misleading in suggesting that all oil immersion objectives have high magnifications, whilst quoting data for a  $5\times$  oil immersion objective in the table itself.

Chapter 2 on the preparation and polishing of samples is briefly but clearly written and has enough detail to acquaint the user of polished sections with the manner in which his samples have been prepared. The polishing of any substance is still more an art than a science and this chapter is no substitute for a week or so of training under a technician long experienced in the techniques and pitfalls of polishing methods. For example no mention is made of the frequent destruction during polishing of the anomalous anisotropism which can be seen in all carefully polished pyrite and other cubic sulphides and arsenides of similar crystal structure. The effects of tarnishing and the need for students to hand-buff sections in the laboratory are not given sufficient emphasis. Indeed the word tarnish does not appear in the index. Structure etching and filming techniques are sketchily outlined at the end of this chapter. These techniques are important for textural studies, identification, and modal analyses and if this section is not enlarged in subsequent editions then adequate references to the literature should be given.

Chapter 3 deals with qualitative methods of identification and the constant occurrence of the spelling color reminds one that the spelling in this book follows (the often better) American usage. There are, however, a number of American idioms which may be confusing to some readers, e.g. the statement that '... most [minerals] are only weakly colored and may appear to the beginner as white through various shades of gray.'

Ignoring small points of this sort, however, it can be said that this chapter, like all the others, is well written. I was particularly glad to see that a clear distinction is drawn between bireflectance and reflection pleochroism—phenomena that are often confused and treated as one and the same thing by some writers. Unfortunately the statement is categorically made that all cubic minerals behave isotropically between crossed polars. This is far from being the case as Stanton showed many years

ago and as has been mentioned above. Polishing hardness is described and is included in the identification tables. Students tend to make too little use of this aid to identification and it is pleasing to see it included. Scratch hardness is barely touched on and, perhaps deliberately, the student is not informed of the time-honoured method of using a bent steel needle. Undoubtedly this will save many teaching sets from being unnecessarily scratched! (The Talmage scale itself only receives a one sentence note later in the book.)

In chapter 4 a good summary of the theory of reflected light optics is available for the inquiring student. I would not have thought this to be compulsory reading for the ordinary student who can apply all the standard identification techniques without much knowledge of reflected light optics. However, the book would not be complete without this topic being well explored.

Next there follows a chapter devoted to reflectance measurement but which also includes sections on quantitative colour and the correlation of electronic structure with reflectance variation. I doubt very much whether the last two subjects will be dealt with in undergraduate courses and the authors appear to tacitly admit this as they do not explain the methods of making quantitative colour determinations. Microindentation hardness is well covered in chapter 6 with the notable omission that the reader is not warned against measuring diagonals in polarized light.

The above chapters form the first one-third of the book. The remaining two-thirds are devoted to the study of textures and mineral associations. A good introductory chapter on textures sets the scene followed by three detailed examples of paragenetic studies. This is followed by discussions of the opaque mineral associations of the principal types of ore occurrences in igneous, vein, sedimentary, and metamorphic rocks. Good use is made of phase diagrams (in the relevant sections) to explain the evolution of both the minerals present and the textures they display. Weathering and supergene effects are given some attention for those mineral associations in which these processes can produce important changes of mineralogy and grade, but more emphasis might well have been placed on this economic aspect of ore petrography, e.g. in the section on porphyry copper deposits. Strangely enough the word supergene does not appear in the index and supergene processes only receive cursory attention in connection with vein deposits. There is a brief discussion of the genesis of each type of ore deposit.

The section on vein deposits contains a short section on gold placer deposits which would surely be more aptly placed in the chapter describing

opaque mineral assemblages in sediments, particularly as that chapter contains a section on Precambrian gold-uranium-bearing conglomerates. Placer is another word that does not occur in the index and on the whole this type of deposit, which is fast coming into increasing importance especially in the form of beach placers, receives very scant treatment in this book.

A missing feature in this part of the book is a note of typical run-of-the-mill ore grades of the ores described in detail. As most of the photomicrographs mainly or wholly display ore minerals the young undergraduate may well develop the notion that the ores are much higher in grade than is actually the case.

Turning to the section on iron and manganese ores it is disappointing to find that deposits of the most important metal in our civilization receives rather short shrift and there are no photographs showing clearly the most prominent feature of BIF, i.e. its banding. Also in this section the reader unversed in these deposits might well be left with the erroneous impression that minette, Clinton, and Lahn-Dill iron deposits are one and the same thing. Another disappointing section is that on gossans which is far too brief and contains no mention of how their textures can be used to forecast the economic minerals which may be found in the primary deposits below them.

This part of the book also contains a section on fluid inclusions. This is too short to be of use to any potential worker in this field and it is so condensed that several somewhat inaccurate statements are made. It is perhaps inappropriate in a book dealing with opaque minerals and I would suggest it be omitted in favour of giving more space to emphasizing the importance of the electron probe microanalyser in identifying minerals in ores and mill products, and in providing invaluable information on the amenability of ores to milling, the inaccessibility of portions of the total contents of wanted elements and the presence and distribution of deleterious elements.

The last formal chapter is a useful summary of applied ore microscopy in mineral technology which surprisingly omits one of the most important references in this field, i.e. Freund, H. (ed.) *Applied Ore Microscopy*, Macmillan, New York. It also lacks a section on the point counter and its use in preparing modal analyses of ores. I feel that a small section on this topic similar to that in Cameron's book with references to Chayes's fuller exposition is desirable.

The book ends with several appendices. The first is an excellent series of tables giving the properties of about one hundred opaque minerals. The second has the same minerals arranged in increasing order

of reflectance and microindentation hardness. The third consists of all-too-brief expositions of the use of X-ray powder diffraction and the electron-probe microanalyser. The fourth appendix is what could be a very useful plot of reflectance of the principal opaque minerals at 546 nm plotted against VHN. Unfortunately the diagram is too small and so congested with information that this reviewer found it almost impossible to read it even with the aid of a reading lens. In future editions it would be wise to provide enlarged drawings of the more congested parts of the figure, a technique used successfully by Galopin and Henry to deal with the same problem.

Errors are infrequent. On p. 9 the use of a blue filter will give a change in colour balance not temperature, on p. 56 'displayed' should I think be 'displaced', on p. 66 it is the ocular not the objective which must be removed for conoscopic work (if no Bertrand lens is available) and dates of references often vary between text and reference list e.g. chapter 5. On p. 144 the secondary pyrite has exsolved *from* (not 'of') primary pyrrhotite. On p. 160 the reference to fig. 8.11b should presumably read stannite not sphalerite and on p. 178 the wrong figure number is given in the text. There are some spelling mistakes, e.g. fluviatile, spacial and the word crystalline is used where presumably the authors mean crystallized.

Many unusual opaque minerals are mentioned in this book and even figured in the photomicrographs without their formulae being given. A useful appendix for the undergraduate would be a list of minerals and their formulae. Thus the exsolution of matildite from galena would be much better appreciated by the student reader if he could look up the formula of matildite in an appendix. The book is well endowed with black and white photomicrographs which give the reader a good coverage of the textures and ores described in the text.

As I remarked at the beginning of this review, this is an excellent textbook suitable for both undergraduates and graduate work and many research workers will find a copy to be a useful addition to their bookshelves. We shall certainly use it at Leicester for instruction in ore microscopy at all teaching levels.

A. M. EVANS

Phillips, W. J. and Phillips, N. *An introduction to mineralogy for geologists*. Chichester and New York (J. Wiley and Sons), 1980. xiv + 352 pp., 450 figs., 8 colour pls. Price: soft cover £6.95, cloth £17.50.

This book is based on a first-year university course in mineralogy (presumably at Aberystwyth). A