

and corresponding sections of the *Handbook of Geochemistry*, which also deal with low  $T/P$  aqueous systems. Presentation of the relatively sophisticated inorganic chemistry of processes and provision of a systematic reference text is not attempted here, however. Instead the book is based upon a geochemical classification scheme (following in the Russian tradition of Mendeleev, Vernadski and Fersman) devised for the behaviour of elements in the supergene environment. It comprises a relatively short introductory section (39 pages) in which basic principles and concepts are presented followed by several chapters dealing with the geochemistry of seven groups of elements which include, for example, one group of active aerial migrants (O, H, C, N, I) and one of weakly mobile cations (K, Ba, Rb, Li, Be, Cs, Tl). A total of twenty-eight elements are included but unfortunately iron and manganese, which are particularly important in supergene processes, are omitted (although some aspects of the geochemistry of iron are discussed in considering oxidation-reduction).

The first chapter on physicochemical parameters of the elements is the weakest part of the book as it is too condensed to aid students or provide new information for practising geochemists. The English is not so clear as in later sections and four paragraphs are wasted in quoting Lebedev's 1969 views on systems of ionic radii in which the politics are more apparent than the science (a few short sentences by the author describing different theories which affect ionic radii would have been preferable).

The three chapters which follow present the basis for the classification given at the end of Section One and although they include much information familiar to western geochemists, many of the concepts discussed provide a fresh viewpoint. For example, typomorphic elements are described as elements with high clarkes which migrate easily and thereby determine the geochemical environment. This procedure could prove useful in normalizing geochemical data before statistical analysis, since the different levels at which elements occur can affect the results obtained.

Many coefficients are presented to describe, for example, the tendency of elements to concentrate in living matter (biophilic) or to be useful in industry (technophilic) and formulae are given which describe the tendency of elements to migrate in aqueous systems and to concentrate at geochemical barriers. The importance attached to the clarkes of elements in the lithosphere both as a philosophical basis of geochemistry (Fersman is quoted as indicating that it provides a new constant of the universe) and in quantifying information is striking. For example the concentrations of elements in

rocks or minerals are normalized by dividing by the clarkes in the lithosphere.

The most important sections of the book are those dealing with the geochemistry of elemental groups where the author's extensive knowledge is fully displayed. The principles of the geochemical cycles are described in relation to the coefficients and other parameters discussed earlier in the text (when their application is more readily apparent). Information is presented clearly and simply with quantitative information and many interesting examples. Inter-relationships between elements and geochemistry, biology (and sometimes sociology) are particularly interesting, for example radium is discussed with regard to its geochemical migration, technological impact, biological absorption and environmental significance (carcinogenic properties, contents in water). There are also some interesting speculations—for example that selection of radiation-tolerant biological species is greatest following periods of orogenesis, and acid magmatism when arid climatic conditions prevail—conditions which favour accumulation of high levels of radium. These sections are very readable and thought-provoking although the basis of some of the ideas is lacking.

Overall the book is well presented and attractively bound although more suitable diagrams would be preferred (a few are barely legible). The English is generally clear and the use of italics to emphasize points is helpful. When the first section has been absorbed the remainder is easy to follow. Many sections of the book would be useful in introductory courses of geochemistry, however it is also recommended to researchers and professional geochemists in environmental or economic fields. One of the striking aspects is the duplication of research in the West and in Russia and this publication is particularly valuable in providing a better understanding of Russian geochemistry.

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Picot (P.) and Johan (Z.). *Atlas des Minéraux métalliques*. Paris (Mem. Bur. Rech. Géol. Minières, 90), 1977. 403 + ii pp., 328 photographs (of which 219 are in colour). Price 320 F; \$64.00.

This book has 403 pages (21 × 21 cm) all of heavy paper, 340 of them containing microscopic descriptions of 350 ore-mineral species. For practically all of the anisotropic species there is a colour photograph, and in practically all of these it is taken between two polars so that it shows the colours of the anisotropic-rotation effect in white light. For covellite, in addition to such a photograph, there are also three colour photographs in ordinary light.

Exceptionally a mineral that is isotropic, such as gold, is shown in colour photograph in natural light; otherwise there is no photograph or else one in black-and-white.

The remaining pages contain: preliminaries (7); principles and interest of reflected-light microscopy (4); preparation of polished surfaces (3); practice of the method of reflected-light microscopy (7); paragenetic types (5); table of reflectances in white light (1); table of reflectances at four wavelengths (not those of the COM), namely 420, 540, 600, 700 nm (4); certain features and the minerals showing them (5); table of determinative observations for the chief sulphides and sulpho-salts of Pb, Cu, Ag, and Sn (2); recapitulation and advice on reflected-light study (2); black-white photographs of structures (11); notes on apparatus (2); notes for the description of species (1). At the end there is a list of the ore-mineral species (3), which needs no page reference since the descriptions are in alphabetical order.

In transmitted light the use of optical data in determinative work is a century old, but in reflected light it cannot yet be said that there is an agreed approach to the problem. In recent years many measurements of spectral reflectance have been made with the aim of providing quantitative values of this property and of its dispersion. The tactic developed is to use such values to reduce the possibilities to a small number, among which the determination is made by applying the criteria appropriate to the case. Of course, this depends on the accumulation of good data, and the authors of the present book have supplied spectral reflectances from 420 to 700 in steps of 20 nm for some 350 ore minerals. This is a splendid contribution, and those who believe in the quantitative approach will be very grateful.

The authors accept that reflectance is an element in determinative work, but they qualify this by saying (p. 18): 'Pour cela il ne faut pas tabler sur une valeur absolue fictive et sans réelle signification, mais sur la valeur relative par rapport à des espèces

connues et très communes.' They use eight such—pyrite, mispickel, galena, pyrrhotine, chalcopyrite, hematite, magnetite, and goethite. The authors set up an imaginary opponent who bases his determination solely on reflectance. They point out that reflectance measurement depends on a crowd of factors, among which they mention two—the state of polish and, above all, the orientation of the mineral when it is anisotropic. Much effort has been devoted in recent years to improving the procedure of polishing, and we have reached the stage where this is not a serious factor any longer. As for anisotropy we turn this to good account by measuring the two extreme vibrations, so that we have also the bireflectance and its dispersion. Further, in uniaxial minerals, the ordinary and extraordinary vibrations can be identified and the sign of the bireflectance determined, except where the bireflectance is very small. This is something that is lacking in the otherwise splendid set of spectral reflectance measurements provided by the authors in this book.

The authors describe their micro-indentation hardness apparatus and state that they make much use of it (p. 20) but only for very small grains. However, not a single micro-indentation hardness value is given in the whole book; they quote (p. 20) the formula for turning Vickers micro-indentation values into Mohs scale values, and it is the latter that are given in the descriptions, curiously enough under the heading of Colour.

As the authors state (p. 7) this book emphasizes the use of chromatic phenomena between two polars (anisotropic-rotation colours) and that is why they have put such an effort into the provision of colour photographs. This use of photographs is certainly new, and with their twenty years of experience to back it, the approach deserves to be thoroughly tried out. Although not every colour can be well reproduced, the quality of these photographs is very good indeed.

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