American Mineralogist, Volume 72, pages 1029–1030, 1987

BOOK REVIEWS

MICROTEXTURES OF IGNEOUS AND METAMORPHIC ROCKS. By J. P. Bard. D. Reidel Publishing Company, Kluwer Academic Publishers Group, Boston and Dordrecht, Holland. 1986. 264 pages. $74.50.

This book is the enlarged and updated from the original French edition that was published in 1980, translated into English by Marianne Mareschal.

The book is in three parts: (1) Nucleation and Crystal Growth, (2) Order of Crystallization in Igneous and Metamorphic Rocks, and (3) Examples of Microtextures. The first section addresses the theories of nucleation, crystal defects, the nature of grain boundaries, types of growth on a molecular and microscopic scale, liquid-solid and solid-solid transformations, crystal form, and crystal size. The coverage is largely nonmathematical, though a few formulas for free energy are included. Illustrative material is generally clear and easily understood.

The second section deals with the criteria for determining the order of crystallization of minerals. It discusses the textures formed during eutectic and peritectic crystallization, making comparison between those in experiments and in natural rocks, emphasizing the simplest kinds of systems and largely leaving it up to the reader to extrapolate to more complex systems. Various aspects of cumulate and spinifex textures are also discussed. However, it does not consider other igneous processes such as magma mixing or liquid immiscibility. Sketches in this section are generally very well done, illustrating important points clearly and simply.

The second section also considers the determination of order of the crystallization of minerals in metamorphic rocks. It addresses the textures formed during reaction, including various reaction rims and skeletal growths, the textures formed during deformation and following it, and various types of interaction between mineral growth and deformation. It discusses differences in the nature of deformation and growth of grains of different minerals.

The third section, examples of microtextures, consists of full-page detailed drawings of specific igneous and metamorphic textures of real rocks in thin section, with the name of the texture and an explanation of how it apparently forms. In many respects this is the most useful part of the book for practical laboratory use. The reader is thereby permitted to identify the texture and read about how it relates to the origin of the rock in one of the previous sections. In some cases, igneous textures are related to specific positions on binary or ternary phase diagrams. Some metamorphic textures are related to sequence and spans of crystallization of the minerals illustrated.

The book is generally well organized and easy to follow. Theory is integrated quite well to the textures. The content is reasonably modern, though references end at 1978. The level of discussion is appropriate for use by advanced undergraduate and graduate students in petrographic and related study. My students found the book practical and useful in their own study of thin sections. It is easy to read and understand and easier to use than some of its competitors. Mylonitic textures and S/C surfaces are not discussed though two or three are illustrated.

The book could be useful as a text in a specialized course on the same subject, even more so as a lab manual in courses concerned with petrographic aspects of igneous or metamorphic petrology.

Ninety-five references help to document the discussion of textures. Unfortunately, however, titles of the papers are not included.

Except for main headings and running heads, the type style and layout appear to be the photographic reproduction of a double-spaced manuscript without justified right margins. If one can get over the initial negative reaction to such a production approach in a book costing $74.50 for 264 pages, the content should be found useful by students who can afford it and, to some extent, even seasoned researchers.

DONALD W. HYNDMAN
University of Montana

GEOLOGY AND GEOCHEMISTRY OF CENOZOIC TOPAZ RHYOLITES FROM THE WESTERN UNITED STATES (Geological Society of America Special Paper 205). By E. H. Christiansen, M. F. Sheridan, and D. M. Burt. Published by Geological Society of America, P.O. Box 9140, Boulder, CO 80301, U.S.A. 1986. Paperback, v + 82 pages. $16.00.

GSA Special Paper 205 is a compact and timely review of the occurrence, mineralogy, and geochemistry of topaz rhyolites of the western U.S. Because of the sometimes spectacular presence of vapor-phase minerals (e.g., topaz, garnet) lining vugs and cavities in rhyolite, these unusual rocks have been known since the late nineteenth century. The fact that they may be associated with ore deposits (Be, U, F, Sn, Li, and possibly Climax-type Mo) has also provoked interest.

The bulk of this Special Paper is a methodical review of 26 occurrences of topax rhyolites in Utah, Nevada, Idaho, Montana, Colorado, New Mexico, and Arizona. These rocks are all Cenozoic in age, ranging from 50 to 0.06 Ma, although the majority are younger than 30 Ma. The emplacement of all topaz rhyolites was coincident with extensional tectonism. Their magmatic affinities are less straightforward, however, as topaz rhyolites may be associated with calc-alkaline suites (andesite-dacite-rhyolite), with potassic basalts of tholeiitic or alkaline affinities, and with alkaline to peralkaline tuffs and lavas.

Chemically, these rocks are high-SiO_2 rhyolites showing enrichment in F, Na, K, Fe/Mg, and the incompatible lithophile elements (Rb, U, Th, Ta, Nb, Y, Be, Li, Cs). Depletion in Ti, Mg, Ca, P, Sr, Eu, Ba, Co, Ni, Cr, Zr, and Hf is also characteristic. The authors present a welcome amount of geochemical information that includes both a review of the literature and new data obtained in collaboration with a large number of investigators. Included are major- and trace-element analyses; Sr- and Pb-isotope ratios; two-feldspar and Fe-Ti oxide geothermometry; compositions of biotite, hornblende, and garnet; and REE patterns. Also, a number of trace-element discriminant diagrams are presented. The chemical characteristics of topaz rhyolites are compared with those of calc-alkaline and peralkaline rhyolites and with the ongonites of Mongolia, which they resemble in many aspects.

On the basis of chemical and isotopic data, the authors propose that topaz rhyolites may be the extrusive equivalents of anorogenic (A-type) granites and that they may be derived by the partial melting of granulite source rocks in the lower or middle crust. Melting may have been initiated by the passage of contemporaneous mafic magmas through the lower crust. The enrichment in F was attributed to melting of small amounts of F-rich biotite in the crustal parent rocks, and the distinctive trace-element patterns are explained by extensive fractionation of sanidine, quartz, plagioclase, biotite, and Fe-Ti oxides.

Although the last word has yet to be written on topaz rhyolites, the authors are to be commended on a useful and up-to-date review. The very extensive reference list (more than 350 entries) is especially valuable.

James L. Munoz
University of Colorado

THE QUANTITATIVE DATA FILE FOR ORE MINERALS OF THE COMMISSION ON ORE MICROSCOPY OF THE INTERNATIONAL MINERALOGICAL ASSOCIATION, second issue. Edited by A. J. Criddle and C. J. Stanley. British Museum (Natural History), Cromwell Road, London SW7 5BD, 1986. XLIX plus 420 pages. £45.00.

The first issue of the *Quantitative Data File* (QDF) for ore minerals appeared in 1977. It was edited by N.F.M. Henry and consisted of 204 cards with more or less complete data on some 155 minerals. It was out of print already in 1982 in spite of widespread lack of reliable standards and at a time when there was a scarcity of instrumentation for reflectance measurements.

At the present time, reflectance theory is essentially understood, standards are available, measurement techniques are much improved, and computer-assisted microscope photometers routinely can measure spectra at selected wavelengths from 400 to 700 nm in a matter of minutes. Thus, when reference spectra are available, identification of a mineral is feasible with reflectance-measurement methods in a time period much shorter than that required for microprobe or X-ray powder-diffraction analyses.

This second issue of QDF for ore minerals contains the data from 420 sets of cards, 327 for individual species and 93 for compositional and structural variants. The common ore minerals are represented as are a large number of less common and rare species.

The format of the book (roughly 6 in. high by 8 in. wide) is determined by the shape of the reflectance data cards. In this volume, individual data sets are arranged alphabetically by mineral name (acanthite first and zinckenite last), one set to a page. Each page is arranged in essentially three major columns, of which the first lists (from top to bottom) chemical formula, symmetry, sample provenance, reflectance standard, monochromator type, and $\Delta\lambda$, photomultiplier, effective numerical aperture (N.A.) of the objective, chemical composition with method of analysis, and X-ray data. The second column lists the results of reflectance measurements performed in air and oil immersion at 19 selected wavelengths between 400 and 700 nm. The third column lists color values in air and oil immersion relative to two (A and C) illuminants, Vickers micro-indentation hardness number and the weight of the load with which it was obtained, polishing methods, and references.

The book offers a one-page introduction, a two-page section on historical background, a one-page editorial policy statement, a three-page description of the format of the second issue, a two-page section on keys for identification, and a two-page bibliography. An eight-page (Key 1) COM wavelength list presents reflectance data in air only in the sequence 546, 470, 589, and 650 nm where the order of the minerals is based on the ascending order of reflectance at 546 nm. This list also gives with each mineral name the page in the book that carries the full set of data on the mineral in question. Another eight-page table provides the color value (Key 2) for all minerals. The color values obtained in air only are presented relative to the C illuminant, and the minerals are organized in ascending order of luminance and are cross-referenced as in Key 1. A 15-page table (Key 3) lists air and oil data at 440, 500, 600, and 700 nm. The minerals are organized in ascending order of reflectance starting at 440 nm. The minerals are again cross-referenced as in Keys 1 and 2.

This data file represents a large amount of carefully performed measurements. The editors have generously contributed a lot of their own unpublished data to make this a very worthwhile and up-to-date compilation.

Leafing through these tables, one readily notices that the chemical formulas given do not always agree with those in the standard literature. For instance, mackinawite is assigned the formula FeS. Minerals such as troilite and hexagonal pyrrhotite are missing. Next to pyrite, pyrrhotites are the most common sulfides in ores, so the lack of hexagonal pyrrhotite is a drawback.

It would be useful in a compilation such as this one to show variations in reflectivity as a function of composition of certain common minerals such as the hexagonal pyrrhotite series, which displays Fe omission, and sphalerites having increasing substitution of Fe for Zn.

It was also noted that, whereas chromite is given the formula $FeCr_2O_4$, the specimen that was measured contained only 23.1 wt% FeO and 34.7 wt% Cr_2O_3, the balance of the composition being accounted for by MgO, MnO, NiO, Fe_2O_3, and Al_2O_3.

This book constitutes a rich source of information for the increasing number of researchers who, in a variety of fields, have access to the required equipment for reflectance measurements and who need the best available reflectance data on ore minerals.

Gunnar Kullerud
Purdue University