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BOOK REVIEWS

Nuclear Methods in Mineralogy and Geology. By Attila Vértes, Sándor Nagy and Károly Süvegh. Plenum Press, 233 Spring Street, New York, N.Y. 10013, U.S.A., 1998, 555 pages. US$135 hardbound (ISBN 0-306-45832-2).

I looked forward to the opportunity to review this book, as I have been searching for a textbook for a graduate-level course that introduces the fundamentals of nuclear physics with good descriptions of environmental and earth science applications. Unfortunately, this book only partially meets these needs. Still, this book can serve as a good reference for many of these topics.

The book begins with an introductory chapter (over 100 pages) on the basics of nuclear science. The sections of this chapter that deal with radioactive decay, nuclear reactions, the interactions of radiation with matter, and radiation detectors are well done and provide the reader with the essential fundamentals. The discussions of subatomic particles, fundamental forces and nuclear potential are less necessary and may, in fact, discourage students from pressing ahead to more relevant discussions and information. Sections on the nucleosynthesis of the elements and stable isotope geochemistry are out of place in this introductory chapter and deserved treatment as separate chapters.

The remaining chapters focus on analytical techniques that utilize nuclear properties: neutron activation analysis, nuclear reaction prompt gamma-ray analysis, energy dispersion X-ray fluorescence analysis, characterization of geological materials using ion and photon beams, nuclear magnetic resonance, Mössbauer spectroscopy, radioactive dating methods, methods of dating groundwater, and isotopic paleoclimatology. The chapter on X-ray fluorescence is not consistent with the general "nuclear" theme of the book, and discussions of equal quality and detail can be found in many other textbooks on analytical methods. Each of the chapters are contributed by different authors; hence, there is considerable variation in the quality and completeness. The chapter on ion-beam techniques does not discuss the full range of ion-beam techniques (*e.g.*, Rutherford backscattering). Still, each chapter provides a concise introduction to the techniques presented, and most of the chapters can serve as a good starting point for a beginning graduate student. Some subjects of great geological importance are treated much too briefly, *e.g.*, fission-track dating is discussed in less than two pages (the index incorrectly indicates ten pages). The chapters include extensive lists of pertinent references, but without the titles of the papers, it is difficult to take advantage of these compilations. In some instances, important references are not included, *e.g.*,there is no reference to McDougall's and Harrison's *Geochronology and Thermochronology by the* $^{40}Ar/^{39}Ar$ *Method* in the discussion of Ar/Ar dating. There is no book-wide author index, and this will hamper the readers' ability to identify leading and important workers in the field of interest.

I kept this book on my desk for several months and used it as a reference to determine how various subjects were addressed and to assess the book's general usefulness. I found the subject index to be adequate, but not always complete in its listings. There are important omissions, *e.g.*, no discussion of the metamict state, perhaps the most important example of radiation damage in mineral structures. The compilation of "most important radionuclides" (Table 3 of the appendix) does not include important anthropogenic nuclides such as the transuranium elements, plutonium and neptunium. The standard chart of the radionuclides is of much greater value than these selective appendices. In fact, one would expect that the reader would have been introduced to the chart of radionuclides and how it can be used as part of the first chapter and the discussion of radioactive decay. These omissions reflect a broader failure to discuss the environmental impact of radionuclides generated by the nuclear fuel cycle. Although this may be beyond the scope of the book, this is probably one of the most important environmental issues related to nuclear processes. Additional anthropogenic radionuclides, such as tritium and ^{36}Cl, are important tracers in studies of hydrologic systems.

Finally, any textbook that deals with nuclear processes and techniques owes its readers a careful discussion of radiation-dose measurements and exposure limits. Such a discussion must include a review of possible health effects, and radiation exposure must be placed into the context of typical background exposure. This subject is covered in less than a single page. The continued and successful application of nuclear science techniques requires that scientists and the public be well informed on the relationship between dose and health effects.

The reproduction of figures is of generally poor quality. In many cases the figures appear to have been "scanned in" from the original references and too faintly reproduced in the book. The font is small and a challenge to the eyes of this reader.

In summary, I will ask my library to purchase a copy of this book, as it is one of a small number of textbooks that summarizes nuclear methods as applied to mineralogy and geology; hence, it is a useful reference. I would not require students to purchase this text for a graduate-level course in nuclear methods, as it is uneven in its treatment of fundamental principles. The chapters on the different techniques serve as a good reference chapters, but much of this information is available from other sources. I do not recommend this book for a personal professional library.

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Low-Temperature Geochemistry. Edited by Tu Guangzhi. Science Press, 16 Donghuangchenggen North Street, Beijing, 100717, China, 1996, 202 pages. Codistributed by VSP, P.O. Box 346, 3700 AH Zeist, The Netherlands. US$75 (ISBN 7-03-005444-X/P.924).

In the preface, low-temperature geochemistry is defined as "a branch of geochemistry dealing with the geological and chemical processes and the geochemical evolution of elements in nature below 200°C, including the geochemical behaviors of elements in the process of their extraction, remobilization, transport and mineralization at room temperature and below 0°C". The material presented in subsequent chapters is generally consistent with this definition, although it has a more specific focus on geochemistry related to the genesis of low-temperature mineral deposits.

In the introductory chapter written by the editor, it is claimed that recent contributions of studies in low-temperature geochemistry have resulted in the recognition that low-temperature mineral deposits are much more widespread than previously considered. Although it is true that the increased use of fluid-inclusion and stable-isotope methods has improved the understanding of P–T conditions of formation, some of the cited examples of deposits that should be considered low-temperature deposits are equivocal. For instance, it is suggested that the Hemlo Au deposit in northern Ontario formed, "at least in part", under low-temperature conditions based on the occurrence of cinnabar, stibnite, realgar and orpiment in the mineralization. The occurrence of these minerals at Hemlo has recently been attributed to cooling and exsolution processes following peak metamorphism [Powell & Pattison (1997): *Econ. Geol.* **92**, 569-577].

The second chapter contains five sections that provide mostly a descriptive summary of the geochemical characteristics of deposits in China that contain Tl, Hg, F, Au, Ag and Sb. With the exception of the first section on Tl occurrences, the approach to describing the mineral deposits is generally well organized. The authors deal first with the distribution of deposits, then move on to discuss classification, timing, mineralogy, and geochemistry (T, P and source of fluid and metals), followed by a discussion of an ore-deposit model. Given that this volume was compiled as a contribution to the 30th International Geological Congress in Beijing, it is surprising and unfortunate that the descriptions of mineral deposits do not provide an adequate introduction to the geographic and geological setting of the deposits for readers unfamiliar with China. In the 46 pages of chapter two, there is only one map, which is a schematic representation of regional structures in Guizhou Province. Descriptions of the geological setting of the deposits are either not presented or lack sufficient detail.

The third chapter contains two sections describing the behavior of major elements and rare-earth elements (*REE*) during burial and low-temperature metamorphism. The discussion of major-element geochemistry is based on studies of mineral paragenesis and mineral chemistry within sandstone reservoir rocks (3000 to 5000 m depth) in the T Oilfield. The age of the sandstone is not explicitly stated, except that it occurs within a basin ranging in age from the Cretaceous to the Quaternary. Numerous statements are made about the evolution of pore-fluid temperature, pressure and pH, and their effect on element mobility and mineral dissolution–precipitation reactions. These statements are largely unsupported by the data that are presented and are either based on data that the authors have not included, or are derived from analogies with studies obtained from the vast literature on this subject. An entire subsection, III.1.3 Geochemical behavior of the reactive elements during diagenesis, relates the major-element composition of pore fluids to the concentrations of corresponding element impurities in secondary-mineral phases such as quartz and anhydrite, obtained by neutron-activation and electron-microprobe analyses. This is not an acceptable approach since, for any particular secondary mineral, it does not account for the variation in distribution coefficients for the major elements.

Chapter four contains three sections that describe experimental studies designed to investigate the complexation mechanisms that facilitate the transport of Au and Ag, as well as the role of adsorption onto sulfide minerals in concentrating Au and Ag from hydrothermal fluids. One short section discusses the possible role of naturally occurring H_2O_2 in enhancing the solubility of Au in the supergene environment. In two additional sections, the authors discuss, respectively, the effects of adsorption and precipitation on the mobility of *REE*, and the complexation mechanisms responsible for transporting platinum and palladium in hydrothermal solutions. In general, I found that the content of this chapter corroborates studies that have been reported previously, such as investigations of Au complexation [Seward (1973): *Geochim. Cosmochim. Acta* **37**, 370-390; Henley (1973): *Chem. Geol.* **11**, 73-87], and Au adsorption [Jean & Bancroft (1985): *Geochim. Cosmochim. Acta* **49**, 979-987]. However, in most cases the experimental methods for studies reported in this chapter are poorly described. A section on the effects of silica complexation on Au mobility was interesting. The authors begin by commenting on the common association between Au mineralization and silica metasomatism. Their experimental work was designed to test the potential for enhancement of Au solubility and transport through the formation of Au–silica aqueous complexes. The results indicate that Au–silica complexes may dominate chloride and thio complexes, particularly at temperatures below 200°C and low ratios of S/H_4SiO_4. I am not aware of any other work that has been done that would either support or refute these results.

The fifth chapter contains four sections that deal with mass transfer and metal mobility during water–rock interaction. An experimental approach was used to study the partitioning of Au between differently strained zones in samples subjected to triaxial loads. The rates of dissolution of chalcocite, chalcopyrite and bornite were measured under varying pH, temperature and Cl concentration. In one section, the authors describe the common occurrence of high-purity Au rims around Ag-rich gold cores in grains recovered from overburden. Experimental studies of Au solubility in water and humic acid solutions were conducted in order to test the hypothesis that the Au accumulated on the surface of the grains by precipitation from groundwater. Finally, the reaction-path modeling are presented using a computer code based on models such as the well-known EQ3/EQ6 [Wolery *et al.* (1990): *Am. Chem. Soc., Symp. Ser.* **416**, 104-116].

A brief overview of the contents of this book suggested to me that it could provide significant insight into the geology and geochemistry of Chinese mineral deposits. With more detailed reading, it became apparent that the book achieves limited success in this regard, for several reasons. Geochemical data and descriptions of deposit mineralogy are presented without the necessary geographical and geological context. In addition, most of the experimental work is not unique to Chinese mineral deposits, and in most cases the methods are poorly documented, leaving the reader with little confidence in the results. The book will be of interest to those with strong interests in Chinese mineral deposits. I believe that those interested in more generic aspects of mineral-deposit geochemistry would do better to follow the current journals.

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Encyclopedia of Mineral Names. By William H. Blackburn and William H. Dennen, with artwork by Peter I. Russell. Mineralogical Association of Canada – Association minéralogique du Canada, Special Publication 1, 1997, 360 + iv pages, $40, hardbound (ISBN 0-921294-45-x).

The *Encyclopedia* here under review is published by the Mineralogical Association of Canada, as is the journal that you are now holding in your hands. The liaison of the two is intimate, and this review cannot claim an arms-length relationship. Rather than a review, perhaps what follows ought to be termed an "infoview".

The *Encyclopedia of Mineral Names* is a beautifully produced, large-format book (21 × 30 cm, A4) with a pleasing cover featuring color photographs of six attractive mineral samples. From the outside, it resembles a "coffee-table" book. Inside, however, is a scholarly and perhaps indispensable reference work.

The heart of the *Encyclopedia* is an alphabetical listing of minerals accepted formally by the IMA's Commission on New Minerals and Mineral Names through 1996, recent enough to include all the newly established amphibole end-members. The 3700-plus entries are compiled on 338 pages, from abelsonite to zykaite. A standard and practical format is adhered to. Each entry opens with the mineral name in bold face. Some 51 entries of group names (*i.e.*, garnet), mineral names in common use but not accepted by the Commission (*i.e.*, limonite) and doubtful species (*i.e.*, turanite) are shown in plain face. Each name is followed by a chemical formula and crystallographic data: system and space group. The few lines that follow, the raison d'être of the *Encyclopedia*, give the etymology of the mineral name and the type locality where known. Many of the names indeed have fascinating origins. On page 5, in a summary, we learn that 45% are named in honor of a person (example: cordierite), 23 after discovery localities (gaspéite), 14 for their chemical composition (manganite), 8 for distinctive physical properties (enstatite), 8 for combinations (phyllotungstite), and 2 following other criteria (galaxite). Each entry concludes with from one to four references, commencing with the mineral's initial citation.

The *Encyclopedia* opens with a short Preface by Ernest Nickel, and an 8-page Introduction that deals with the history and modern concepts of naming minerals. It closes with two appendices: A Brief Etymology of the Chemical Elements (6 pages), and List of Abbreviations for Journal References (also 6 pages).

What's wrong with this book? Very little. I was sorry, however, to see omitted from "species not presently accepted by the Commission ... but in common use" such old and useful friends as hypersthene, bronzite, salite, crossite (and several others) which, although formally banished by IMA Subcommittee, will probably live on indefinitely in the jargon of mineralogists and petrologists. Will members of the plagioclase series eventually suffer the same fate? In the *Encyclopedia* they are all in plain face. Is the next step to replace oligoclase by "calcic albite", labradorite by "sodic anorthite"? Another point: Would it not have been helpful to have identified silicates with their groups? Yes, elbaite "forms a series with dravite", but perhaps more pertinent is that elbaite belongs to the tourmaline group. Spessartine belongs to the garnet group, omphacite is a clinopyroxene, gedrite is an orthoamphibole, muscovite is a dioctahedral mica, chamosite is a chlorite, and so on. Each alphabetical listing (A, B, C .... Z) is a sort of mini-chapter that opens with a mineral sketch by Peter I. Russell. These are unsatisfactory in my view. Most bear little resemblance to their subject. The artist is not to be blamed: he had a hopeless task. It is just not possible to depict light-colored or transparent minerals in black-line illustrations. Better would have been to use crystal drawings. Splendid examples are offered in Dana's 7th and earlier editions. Finally, I found the large format of the *Encyclopedia* awkward; it is too high to fit in a standard bookcase.

What's right about this book? Just about everything! It is an extraordinarily useful reference to get a quick fix on any mineral: to verify its formula, to tie down crystallographic data, and to find pertinent references. It is user-friendly, beautifully produced, and free of typos. Printing and binding are outstanding. At $40 (Canadian or US), it is an unrivaled scientific bargain in today's marketplace. If you deal with mineralogy or petrology on any level, buy this book. If you teach, encourage your students to buy their own copies. It will serve them throughout their professional careers and, because yearly updates are to be published in *The Canadian Mineralogist*, the *Encyclopedia* will not become obsolete.

In closing, let me point out that the *Encyclopedia of Mineral Names* is the first "Special Publication" of *The Canadian Mineralogist*. What will be the second of this new series? The *Encyclopedia* is a hard act to follow.

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Backscattered Scanning Electron Microscopy and Image Analysis of Sediments and Sedimentary Rocks. By D.H. Krinsley, K. Pye, S. Boggs, Jr. and N.K. Tovey. Cambridge University Press, 40 West 20th Street, New York, N.Y. 1001-4211. 1998, 193 p; US$80. Hardcover (ISBN-0 521-45346-1).

This text is well written, but the thinness and extremely wide outer margins make for extremely quick reading. The introduction to backscattered electron imaging (BSE) and image analysis are particularly skimpy (21 and 28 pages, respectively). The material is accurate, but somewhat dated. For example, the BSE introduction makes repeated references to Goldstein *et al.* (1981), although the second edition was published in 1992. Similarly, the primitive graphics in the image-analysis section are hold-overs from technology of the previous decade. Readers who would like more information on BSE should refer to Goldstein *et al.* (1992), whereas a more complete and contemporary introduction to image analysis is provided by Russ (1990).

The most glaring flaw of this book is the nearly complete omission of the relationship between BSE and the other imaging and analytical methods provided by analytical SEM instrumentation. I have never thought of BSE as an independent analytical method, but rather an imaging mode used in concert with secondary electron imaging and X-ray microanalysis. Admittedly, the text deals specifically with BSE, but at least a mention of the capabilities of other analytical methods usually available on the same instrument (possibly even cathodoluminescence) would be a benefit to the intended audience, which I presume is sedimentologists in search of examples of what this sort of instrument can do for them. Still, for those searching for a very brief introduction to BSE imaging and image analysis, particularly as it relates to sedimentary geology, the book serves its purpose. The bulk of the text (105 pages) provides good examples of BSE applied to a range of samples, and should provide clues to the applicability of the technique to samples of interest to the reader. Further reading, however, will undoubtedly be required for those wishing to use all the available techniques on their own samples.

A recent search at www.amazon.com provided a quote of $59.50 for the latest edition of Goldstein *et al.* (1992) and $50 for Russ (1990). Readers should at least examine these books before committing $80 to the reviewed text.

References

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