

BOOK REVIEWS

Sulfate Minerals: Crystallography, Geochemistry, and Environmental Significance. C.N. Alpers, J.L. Jambor and D.K. Nordstrom, editors. Reviews in Mineralogy and Geochemistry, volume 40, Short Course, Mineralogical Society of America, Washington, D.C., U.S.A. and The Geochemical Society, St. Louis, Missouri, U.S.A. 608 pages. Price US\$32 for non-members, US\$24 for members. ISBN 0-939950-52-9.

This book is one of the year 2000 editions of the well-known series Reviews in Mineralogy, published since 1972 by the Mineralogical Society of America. As the second volume prepared and published with the Geochemical Society, *Sulfate Minerals* covers a wider scientific spectrum than the earlier numbers of the series. Sulfur is an abundant element, and in the form of sulfate has immense importance in mineral resources, mineral processing, and environmental considerations. There are approximately 4000 named mineral species. *Sulfate Minerals* treats 293, or about 7.3% of this number. This is, therefore, an ambitious project, fortunately successful.

Chapter 1, Crystal chemistry of the sulfate minerals, by Hawthorne, Krivovichev and Burns, offers a detailed summary of the structural families, and draws appropriate parallels with the structures of silicates or other groups. This chapter is up-to-date and includes reports of the most recent determinations of crystal structure. I confess that I do not quite respond to the chapter as the authors would like, as I do not find fibroferrite to have a magnificent structure (p. 33), although it is interesting.

Chapter 2, Spectroscopy, by Myneni, reviews in detail a range of spectroscopic methods and their applications to sulfate, either in solids or in solution. Although these techniques have been little applied to sulfate minerals to date, their applications in future studies seem certain.

Chapter 3, Evaporite deposits, by Spencer, describes the occurrences of sulfates in evaporites using a systematic approach based on evaporation paths. This is a straight review of the state of knowledge, and one might suspect a mature scientific field with little active research, since the most recent reference in this section is one from 1998, with almost no other citations from the 1990s.

Chapter 4, Barite – celestine, by Hanor, provides a comprehensive review of the chemistry, isotopic systematics and occurrences of Ba and Sr sulfates and their solid solution. This broad treatment includes geological descriptions of occurrences and the metallogeny of deposit types. However, I doubt that the Hemlo gold deposit is either a barite-bearing VHMS or Early Archean as Hanor suggests on the basis of a selective list of publications.

Chapter 5, Precipitation and dissolution kinetics, by Hina and Nancollas, approaches the crystallization of sulfates from the point of kinetics and measured rates. The principal applications exposed in the chapter are industrial: scale formation and wallboard manufacture. The importance of heterogeneous crystallization is emphasized. Estimation of interfacial angles and thus the search for techniques to inhibit crystallization are discussed.

Chapter 6, Metal-sulfate salts from mineral oxidation, by Jambor, Nordstrom and Alpers, opens the subject of secondary minerals from the weathering of sulfides and leads to environmental considerations. This is a subject of immediate and growing importance in the control of mine wastes. The authors explain the occurrence and significance of the more soluble minerals, and their place in the cycle of metals in the environment.

Chapter 7, Iron and aluminum hydroxysulfates from acid waters, by Bigham and Nordstrom, explores the environmental side of sulfates, from mine wastes to acid soils. The mineralogy of these materials is not yet well known, so given the importance of the subject, we can expect much research here over the next few years.

Chapter 8, Jarosites in hydrometallurgy, by Dutrizac and Jambor, illustrates the practical applications in metallurgy (after a discussion of the nomenclature and occurrences of the minerals of the jarosite family). This is a new subject of great interest to many geologists and mineralogists, given the environmental considerations explained here.

Chapter 9, Alunite – jarosite, by Stoffregen, Alpers and Jambor, reviews these mineral groups, their occurrences and thermodynamics, concluding with a review of applications of jarosite in geochronology. The pres-

ence of K, S, and O in this mineral offers temporal and stable isotope environmental data from the same mineral species.

Chapter 10, Solid solution thermodynamics, by Glynn, provides a rigorous review of the applications of thermodynamic theory to low-temperature minerals such as sulfates. The possibilities are interesting, and Glynn outlines the sort of data required to apply the models to natural systems.

Chapter 11, Solubility in concentrated waters, by Ptacek and Blowes, describes the ion-interaction model applied to sulfate-bearing solutions. The results are applied to a variety of field settings; comparisons with nature and the requirements for improved parameters are discussed.

Chapter 12, Stable isotope systematics, by Seal, Alpers and Rye, is a wide-ranging review of the applications of stable isotopes involving sulfates. After a brief introduction to terminology, it covers every possible field from evaporites to metallic mineral deposits to acid mine drainage. The emphasis of this chapter is on determining the environment of crystallization of the minerals through stable isotopes.

In reviewing this book, I quickly became information-overloaded. There is relatively little overlap among the chapters (7 and 8 more than others), and the scope and depth are enormous. As is now expected for the series *Reviews in Mineralogy*, the list of references following each chapter is an extensive and essential starting point for the researcher. Despite the obvious strengths of this volume, there are some areas where I would have preferred a different approach. Thermodynamics proposes, kinetics disposes. As with many collections of chapters, the most valuable aspect of this work could have been the interactions among the various approaches to sulfate minerals. There is a disconnection between the treatments of the solution chemistry of the minerals and the reality of biologically mediated reactions. Economic geologists interested in the sulfate minerals associated with epithermal gold deposits will have to search through various sections for the information they seek. Those seeking references concerning the sulfate phenocrysts that are present in some modern volcanic rocks will find them by accident in Chapter 12. The order of the chapters does not seem to have been optimized. Chapter 11 could well have preceded Chapter 3 because the prediction of crystallization is central to Spencer's review. Similarly, Chapter 9 could have preceded Chapter 8, and duplication in the descriptions of the alunite supergroup eliminated. Overall, however, the book is well edited and relatively free of typographical errors. The editors of this volume, who were also the convenors of the short course, cast their nets widely

and harvested richly in assembling this Review. The modest cost of *Sulfate Minerals* and its wealth of information make this a cost-effective advanced introduction to the subject. I recommend it without reservation.

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Type Mineralogy of Brazil. Daniel Atencio. Instituto de Geociências, Universidade de São Paulo, Rua do Lago 562, 05508-900, São Paulo-SP, Brazil. 114 pages, US\$10.00 + \$2 post (softcover). (No ISBN number).

Type Mineralogy of Brazil is a descriptive historical compilation of the minerals originally described from Brazil. The 39 valid mineral species are tabulated: a) historically, starting with chrysoberyl in 1789, b) chemically, with the native element palladium, and c) geographically.

The 39 valid mineral species, and 370 possible mineral species, discredited mineral names, and unnamed minerals are described in eleven chapters based upon a chemical classification. The references are listed on seventeen pages, and an alphabetical index of 409 mineral names is five pages long. Among the many interesting facts, the reader is informed that the yttrium silicate of Damour is xenotime-(Y), an yttrium phosphate. Also, brazilianite (Mawe) is gibbsite, and not as reported by Chester (1896) and in many subsequent publications. The error was caused by relating the mineral to hydroargillite of Dewey (1820) rather than to the hydroargillite of Cleveland (1822).

Different languages use different endings for mineral names. These are -ite (English, French, Italian), -ita (Portuguese, Spanish), -iet (Dutch, Afrikaner), and -it (German, Swedish) or -(l)ith (German). Rather than use two or three of these endings, it would have been better to use only that given in the original publication. This suggestion would reduce the number of discredited mineral names by about one hundred.

The book is well written and easy to read. The type is large and clear on A4 format paper. There are exceedingly few typographical errors. The cost is low, so that the book represents good value for money. Any mineralogist interested in descriptive mineralogy will find this book useful.

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