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BOOK REVIEWS

Glossary of Mineral Synonyms 1994 by Jeffrey de Fourestier, Sanssouci Verlag, Fabreville-Laval, Québec, Canada, 61 pages, Paper, 8.5 × 11″, spiral bound, $18 (Cdn).

I gave a talk at the Tucson Show in 1994 in which I had to admit that I did not know what "sklopsite" was. It had turned up in the text of an old song from 1893. I finally got the answer, "haüyne", weeks later. Within a month of that, however, along came this slim volume by Jeffrey de Fourestier, which solved all my mineral synonym questions at once.

De Fourestier, a linguist by profession, began as an eleven-year-old junior member of the Montreal Gem and Mineral Club in the early nineteen seventies. He has since matured into a collector of note, and a researcher who pays extreme attention to detail. This slim volume, the result of years of searching in libraries on two continents, lists over 4,500 mineral synonyms and equivalent names. While some may be fairly obvious to collectors, akanthite = acanthite, for example, how many know offhand that aedelforsite is impure wollastonite, or that volnyne = barite?

To check the accuracy of the equivalency in names would require repeating the years of research. Suffice it to say that the repetition of names with only slight differences (*vide* akanthite, above) is a measure of the attention to detail which characterizes de Fourestier's work. Every variation found has gone into this volume. Still, there are minor omissions. The term *Bleispath*, for example, is translated simply as "cerussite", although Wulfen used it in 1785 in his *Abhandlung vom kèrnthnerischen Bleispate* to describe the yellow crystals from Carinthia, which eventually became wulfenite. Also, the word "sklopsite" that I was having trouble with originally, is spelled here "scolopsite." Nonetheless, the meaning remains clear. The author is currently working on a second edition, which should fill even small gaps such as this.

The attention to detail follows in the organization of the text. Synonyms, variety names, and discredited or other names are listed in regular type in alphabetical order. Names approved by the IMA appear in bold type after each synonym. Parenthetical additions may indicate the mineralogist or location of origin, or the more common variety name. Multiple possible names are given in alphabetical order. If some possibilities are more likely than others, they are separated in order of decreasing likelihood. An appendix lists many identified "UK" (unknown) minerals according to their assigned sequential number by locality, and gives the accepted names. For example, UK50 (of Mont Saint-Hilaire) = hochelagaite.

While there are other books which provide much of the same information, some, such as Egleston's *A Catalogue of Minerals and Synonyms* (1892) are simply too far out of date, while others, such as the new Hey's *Mineral Index*, are a great deal more expensive. The usefulness of this book to the collector is beyond question, and its price, $18 (Cdn) is reasonable. Order from Sanssouci Verlag, 1044 12ème Avenue, Fabreville-Laval, Québec, Canada H7R 4N4.

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Essentials of Statistical Methods, in 41 Pages. By T.P. Hutchinson. Rumsby Scientific Publishing, P.O. Box Q355, Queen Victoria Building, Sydney, N.S.W. 2000, Australia, 1993, 42 p. $9 (CDN), with a price reduction of 35% on orders for 8 more copies, stapled pages (ISBN 0-646-12621-0).

This short work, a tract of sorts, is not a textbook, but a cookbook, and a rather handy one at that. In the words of its author: "This is not a book suitable for teaching yourself with." He recommends its use in parallel with the taking of a conventional course in statistics; it will serve as "a very useful memory-jogger."

The author is a professor in the School of Mathematics and Statistics at the University of Sydney, N.S.W. (Australia). He is neither a mineralogist nor a geologist, and some of the tools he treats are rarely if ever used by earth scientists. Nevertheless, those that we are used to are there and explained clearly, though in the briefest of fashions. He has divided the work into 187 numbered paragraphs, spread nearly uniformly among three parts: Data description, Probability, and Inference. Examples are brief, and none are mineralogical.

Today, few of us toilers calculate our statistics by hand; we use any of a number of commercially available software packages, enter our data, and press "run." We are less critical, perhaps, than we used to be, and I venture that a smaller percentage of us understands the logic and math behind our statistics than was the case back in the days of the Friden and slide rule. In my view, a principal use of the concise and inexpensive work here under review is for professionals: to surmount shortcomings in background statistical knowledge.

On the 42nd page (yes, there are 42 pages), the author lists some 45 relevant quotations in small type. Among them are: "He uses statistics as a drunk uses lampposts – for support rather than illumination" (Andrew Lang), and "With seasonally adjusted temperatures, you could eliminate winter in Canada" (Robert L. Stanfield). Not included are my two favourites: "There are lies, damned lies, and statistics" (Oscar Wilde), and "The future ain't what it used to be" (Yogi Berra).

My recommendation? Buy the 41 pages are get one extra for free. The coins in your change purse are nearly enough.

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Geologic, Hydrothermal, and Biologic Studies at Escanaba Trough, Gorda Ridge, Offshore Northern California. Edited by Janet L. Morton, Robert A. Zierenberg and Carol A. Reiss. U.S. Geological Survey, Map Distribution, Box 25286, MS 306, Federal Center, Denver, Colorado 80225, U.S.A., tel. (303)236-7477, 1994, 359 pages, US$27, ISBN: not applicable, softbound.

This volume is a summary of recent, multi-faceted research conducted by the U.S. Geological Survey (USGS) on the Escanaba Trough (ET), the site of past and present seafloor hydrothermal venting and related mineralization at a sediment-covered spreading ridge about 300 kilometers off the west coast of North America. The spreading axis is blanketed by about 500 meters of intercalated turbiditic and hemipelagic sediments. Volcanic bodies have pierced the sediment fill at about 15 km intervals. Most of the work concentrated on two of the volcanic hills (NESCA and SESCA), where hydrothermal fluids are being focussed along faults and rise to form several large massive sulfide deposits up to several tens of meters high and a few hundred meters across.

Eighteen papers describe studies conducted during numerous surface and submersible cruises, mostly between 1985 and 1989. The purpose of these cruises was to study the form and composition of hydrothermal deposits, the geological setting and structural control of the deposits, nature of active venting, and type of associated biological communities.

The introduction gives a cursory history of seafloor hydrothermal vent studies, the history of the USGS study of hydrothermal vents and the program at ET. It then introduces the site and highlights significant findings. Finally, it provides directions for future work. The following chapters are logically organized and grouped according to three themes: 1) Geologic processes; 2) Hydrothermal and Geochemical Studies; and 3) Biologic Studies.

The Geologic Processes section contains eight topical papers comprising the structural and geological setting, thermal regime, numerical modeling, crustal magnetization and basement structure, sediment fill, sedimentation and neotectonics, volcanic geomorphology, and igneous petrology and mineral chemistry, as well as a synthesis chapter that presents the current understanding of the geological processes at the sites of sulfide accumulation. Chapter 2 (Structural setting and interaction of volcanism and sedimentation at Escanaba Trough: geophysical results, by J.L. Morton and C.G. Fox) describes Sea Beam mapping, which indicates that ET consists of two segments with a small right-lateral offset. A shallower portion of the seafloor blocks tuirbidity flows. Based on high-amplitude returns, the authors speculate that significant subsurface mineralization occurs in the sand-rich beds. Numerous color seabeam maps, as well as geophysical profiles, are included. Chapter 3 (Thermal and tectonic structure of Escanaba Trough: new heat-flow measurements and seismic-reflection profiles, by E.E. Davis and K. Becker), along with the previous chapter, uses bathymetric and seismic-reflection data to delineate six major volcanic centers along the sedimented spreading axis. Heat-flow measurements show that away from areas of venting, heat flow is relatively low, suggesting that heat sources are localized or that insufficient time has passed to allow high basement temperatures to equilibrate in the thick sedimentary section. Mass- and thermal-balance modeling consistent with geophysical observations demonstrates that sufficient heat and volumes of rock are available to produce the large hydrothermal deposits; however, the model is necessarily crude, as relatively little is known about the extent and composition of mineralization at depth. Continuing on the theme of modeling, Chapter 4 (A thermal and mechanical model for sediment hills and associated sulfide deposits along Escanaba Trough, by R.P. Denlinger and M.L. Holmes) suggests that the hills formed by inflation of basaltic dikes in the near-subsurface, and normal fault zones were developed during uplift, which allowed focussed hydrothermal fluid upflow. Chapter 5 (Crustal magnetization and basement structure of Escanaba Trough, by R.E. Karlin and J.L. Morton) presents magnetic data to show that the sedimented axis of ET lacks a central magnetic high that might be indicative of alteration of the basaltic basement induced by closed-system hydrothermal activity. Chapter 6

(Sediment fill of Escanaba Trough, by W.R. Normark, C.E. Gutmacher, R.A. Zierenberg, F.L. Wong, and R.J. Rosenbauer) concludes that the majority of the sediment fill covering the right axis probably originated from the Columbia and Klamath river drainages and likely accumulated during the last two or three low stands of sea level during the Pleistocene. Chapter 7 (Sedimentation and neotectonism in the SESCA area, Escanaba Trough, southern Gorda Ridge, by R.E. Karlin and R.A. Zierenberg) shows through the study of magnetic susceptibility profiles that the magnetic susceptibility of the surface sediments in the SES CA area record changes in sedimentation that can be correlated with the change from glacial to interglacial conditions at the Pleistocene–Holocene transition. Chapter 8 (Volcanic geomorphology of the SESCA and NESCA sites, Escanaba Trough, by S.L. Ross and R.A. Zierenberg) examines the distribution and morphology of exposed volcanic rocks and concludes there was a central source region in the NESCA area. Chapter 9 (Petrology and mineral chemistry of basalt from Escanaba Trough, by A.S. Davis, D.A. Clague, and W.B. Friesen) shows that recovered basalt pillow and sheet-flow fragments are low-K MORB. Lead isotope compositions indicate that these rocks have locally assimilated small amounts of sediment prior to eruption. Chapter 10 (Geologic setting of massive sulfide mineralization in Escanaba Trough, by R.A. Zierenberg, J.L. Morton, R.A. Koski, and S.L. Ross) outlines the setting of the massive sulfide deposits in relation to the hills at SESCA and NESCA. This paper describes in detail the relationship between the hydrothermal deposits and geological features.

The Hydrothermal and Geochemical Studies section contains six papers on: hydrothermal vent fluid chemistry, stable isotope systematics, fluid flow, sediment alteration, formation of hydrothermal hydrocarbons, and composition and growth history of the hydrothermal deposits. Chapter 11 (Chemistry of hydrothermal fluids from Escanaba Trough, Gorda Ridge, by A.C. Campbell, C.R. German, M.R. Palmer, T. Gamo, and J.M. Edmond) characterizes hydrothermal fluids that are from 15° to 217°C, slightly alkaline, and have chlorinities up to 19% greater than seawater. Transition-metal contents are low, and alkali and alkaline earth elements and ammonia are higher than fluids at sediment-free rifts. Chemical and isotopic considerations indicate the fluids have reacted extensively with subsurface sediment and are the result of waning hydrothermal activity. Chapter 12 (Stable isotope study of hydrothermal vents at Escanaba Trough: observed and calculated effects of sediment–seawater interaction, by J.K. Bohlke and W.C. Shanks, III) reports hydrogen and oxygen isotope compositions of vent fluids that are close to seawater. Sulfur isotopes values of H_2S in the fluid and precipitated sulfide minerals that are higher than for sediment-free ridge crests owing to incorporation of reduced seawater sulfate by high-temperature interaction with organic matter in the sediment. Geochemical reaction-path modeling is consistent with reaction of seawater with sediment at temperatures between 220° and 300°C at water:rock ratios of 2 to 6 in a closed system. Chapter 13 (Evidence for hydrothermal fluid flow through surficial sediments, Escanaba Trough, by A.J. Magenheim and J.M. Gieskes) uses vertical changes in bulk geochemistry of sediment and pore-fluid chemistry to characterize flow of low-temperature hydrothermal fluid through (and reaction with) surficial sediments. Chapter 14 (Sediment alteration associated with massive sulfide formation in Escanada Trough, Gorda Ridge: the importance of seawater mixing and magnesium metasomatism, by R.A. Zierenberg and W.C. Shanks, III) discusses the mineralogical, geochemical, isotopic, and mass-balance effects of hydrothermal activity on near-surface sediment. Three styles of hydrothermal alteration (smectite-, chlorite-, and talc-alteration) related to the deposits are recognized. The replacement of hemipelagic sediment by Mg-rich chlorite occurred during intense Mg-metasomatism by the interaction of hydrothermal fluid with seawater at greater than 200°C. Mass-balance calculation show increases in Mg and concomitant decreases in Na, K, Rb, and Ca. Chapter 15 (Hydrocarbons in sediment from Escanaba Trough, by K.A. Kvenvolden, J.B. Rapp, and F.D. Hostettler) shows that organic matter in the near-surface sediments is derived predominantly from terrigenous sources. Furthermore, organic matter in the Holocene sediment is more mature than that in underlying Pleistocene sediment, and this may reflect resedimentation by turbidite flows. Chapter 16 (Composition and growth history of hydrothermal deposits in Escanaba Trough, southern Gorda Ridge, by R.A. Koski, L.M. Benninger, R.A. Zierenberg, and I.R. Jonasson) demonstrates that the deposits are pyrrhotite-rich and have significant copper in the form of isocubanite. Many samples are also enriched in gold. Relative to deposits at sediment-free ridge crests, ET samples are enriched in arsenic, antimony, bismuth, lead and tin derived from altered sediment in the high-temperature reaction zone at depth. This is a substantial chapter, with many color plates of the sulfide deposits, recovered samples of hydrothermal precipitates, and photomicrographs. Bulk compositions and mineralogy are discussed and considered in a model for the geochemical evolution of the hydrothermal system and related precipitates.

Finally, the Biological Studies section contains two papers on the hydrothermal vent communities and Quaternary forams: Chapter 17 (Soft-sediment hydrothermal vent communities of Escanaba Trough, by J.F. Grassle and R. Petrecca) and Chapter 18 (Quaternary foraminifers from Escanaba Trough, northeast Pacific Ocean, by P. J. Quinterno).

This volume substantially increases our knowlege of

ET. Here, in one handy volume, is an excellent synopsis of research done on this important sediment-covered spreading center and its related hydrothermal system and deposits. Of particular value is the inclusion of supporting data. The book is well produced on high-quality paper, with few typographical errors. The writing style and format are similar to those in scientific journals. The figures are uniformly excellent and uncluttered. The volume is profusely illustrated, with many maps, plates, core logs (a sizeable portion of these are produced in color). For this reader, the volume stops short of providing direct comparisons with analogues in the ancient geological record. Such a chapter may have been outside the scope of this volume, but it would be invaluable to students of economic geology and mineral deposits geologists and explorationists in particular. Given the reasonable price, this volume would be a worthwhile addition to the personal library of anyone studying modern (and ancient) seafloor hydrothermal mineralization processes at sedimented ridges. Certain chapters would be excellent reading for a graduate course in this field; it is a bit too detailed and specific for undergraduate teaching.

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Hydrothermal Vents and Processes. Edited by L.M. Parson, C.L. Walker and D.R. Dixon. Geological Society Special Publication, The Geological Society Publishing House, Unit 7, Brassmill Enterprise Centre, Brasmill Lane, Bath BA1 3JN, U.K., 1995, 411 pages. US $108 (ISBN 1-897799-25-X).

It has been said that our understanding of the modern seafloor is less than that of the moon's surface, and this is no less true with respect to hydrothermal vents. Although modern seafloor vents have been known since 1977, new sites are continually being discovered in different tectonic and geological settings. Hydrothermal vents are important from so many viewpoints. For example, hydrothermal fluids represent a major flux of many elements to the oceans, they establish chemosynthetic ecosystems that shed light onto biological processes, and they provide natural laboratories for the study of processes controlling the formation of base metal ore deposits.

Twenty-nine papers, an introduction by the editors and an index are presented in this volume. About one-half of the papers focus on the Mid-Atlantic Ridge. The volume includes a summary paper on the regional setting of hydrothermal vents (German, Baker and Klinkhammer), a comparison of vents at fast- and slow-spreading ridges (Krasnov, Poroshina and Cherkashev), and studies of vent sites within the Mid-Atlantic Ridge (papers by Murton, Van Dover and Southward; Krasnov, Cherkashev, Stepanova, Batuyev and others; Edmond, Campbell, Palmer, Klinkhammer and others; Klinkhammer, Chin, Wilson and German; James, Elderfield, Rudnicki, German and others; Duckworth, Knott, Fallick, Rickard and others; Cherhaskev; Van Dover; Sudarikov and Galkin; Rudnicki), the Reykjanes Ridge (paper by Palmer, Ludford, German and Lilley), the East Pacific Rise (papers by Stuart, Harrop, Knott, Fallick and others; Rieley, Van Dover, Hedrick, White and others), the Galapagos Rift (paper by Knott, Fallick, Rickard and Bäcker), the Woodlark, Manus and Lau basins in the western Pacific (papers by Scott and Binns; Hodkinson and Cronan), and the Aegean Sea (paper by Dando, Hughes and Thiermann). The book also contains more general papers on hydrothermal plumes (paper by Sudarikov, Davydov, Bazelyan and Tarasov), biology and organic geochemistry (papers by Dixon, Jollivet, Dixon, Nott and others; Cowan), the modeling of fluid flow (papers by Dickson, Schultz and Woods; Pascoe and Cann; Speer and Helfrich), and a comparison of hydrothermal and anthropogenic metal fluxes to the oceans (paper by German and Angel). The book can be divided thematically into sections on the geological settings of vent fields, the chemical composition of hydrothermal fluids, the mineralogy, geochemistry and genesis of depositional products, the biology and organic geochemistry of vent communities, the modeling of fluid flow during hydrothermal discharge, and the contribution of hydrothermal fluxes to oceans.

The volume, as stated by the editors, "represents the most recent reviews and reports of the latest advances in understanding of an area of marine science which we are just beginning to recognize the scope and significance of". However, as is typical for conference volumes, the papers are highly variable in length, scope, originality and attention to detail. A number of papers provide valuable documentation of the geological setting, mineralogy, chemical composition and biology of vent sites. With respect to these papers, those by Krasnov *et al.* on detailed studies of hydrothermal products at the TAG and MARK fields, Duckworth *et al.* on massive sulfide deposits at Broken Spur, and Scott and Binns on hydrothermal processes and associated mineralization in the Woodlark and Manus basins are especially noteworthy. From the viewpoint of addressing fundamental questions on hydrothermal processes, there are a number of papers that particularly stand out. The paper by Baker on the characteristics of hydrothermal discharge following magma intrusion provides convincing chemical and isotopic evidence that vent-fluid compositions are affected by magmatic events that cause a sudden and short-term increase in the flux of heat and the release of magmatic volatiles. Sudden magmatic input can initiate phase separation producing both fluids highly enriched in the vapor phase and saline brines, and cause an increase in the flux of magmatic volatiles. This paper sheds light on the origin of saline brines trapped in fluid inclusions at ancient seafloor hydrothermal deposits, which is of great interest to geologists studying volcanogenic massive sulfide deposits.

Hodkinson and Cronan use the geochemistry of cores from Sites 834 and 835 to decipher the history of crustal evolution in the Lau backarc basin. The peak in rates of metal accumulation in sediment sections at 3.2 Ma reflects maximum plume fallout related to the southward propagation of Eastern Lau Spreading Center into attenuated pre-spreading crust. For those interested in the biology of hydrothermal vents, Van Dover's paper provides an up-to-date and thorough synthesis of the current knowledge of the ecology of Mid-Atlantic vent sites, in areas of biogeography, tropic ecology and sensory physiology. Of particular interest is the conclusion that the Mid-Atlantic Ridge and East Pacific Rise hydrothermal systems operate under very different biogeographical constraints. For example, several invertebrate types characteristic of the Pacific hydrothermal systems (*e.g.*, vestimentiferan tubeworms, vesicomyid clams, and alvinellid polychaetes) are absent at Atlantic vents sites, whereas decapod crustaceans and bathymodiolid appear especially important at Atlantic vent sites. Of particular interest are shrimp that populate the Mid-Atlantic Ridge sites and are blind, but have specially developed sensor devices for detecting thermal radiation from vents.

German and Angel take a novel approach to comparing hydrothermal with anthropogenic fluxes of metals to the oceans. According to their calculations, hydrothermal venting appears significant only for dissolved Mn in the modern ocean. Net fluxes of hydrothermal Pb, Cu, Cd, Zn and Co are negligible when compared to anthropogenic discharge. It is important to note, however, that the calculated new production of waste metals is taken as the anthropogenic contribution, despite the fact that most of this metal is recycled and never ends up in the oceans.

The book is generally well produced, with few typographical or grammatical errors. The figures (including those in color) are very legible and carefully annotated. Running headings of the title of each article alternating with authorship are presented at the top of each page. Although the style of writing reflects the style of individual authors, the material is generally up-to-date, logically organized and clearly presented. One criticism is that the papers are not always in logical order. For example, papers on the modeling of hydrothermal fluids occur near the middle of the book (*i.e.*, papers of Dickson, Schultz and Woods; Pascoe and Cann) and at the end (paper by Speer and Helfrich). Likewise, papers on hydrothermal plumes can be found throughout the book. The book is appropriate as a related volume in the library of mineral deposit geologists, geochemists and biologists studying processes and products of hydrothermal fluid venting at modern and ancient oceanic spreading centers. The price is comparable to other books in the field.

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Mineralisation in the British Isles. Edited by R.A.D. Pattrick & D.A. Polya. Chapman & Hall, London, U.K., 1993, 499 pages. US$99.50 (ISBN 0-412-31200-X).

This volume covers, for the first time, a detailed genetic treatment of the major developments of mineralization within the British Isles. Much of the content deals with mineralization that does not reach ore-deposit status, but that is nonetheless important in understanding regional controls on the genesis of potential deposits. All chapters are written by acknowledged experts. The volume starts with an introductory chapter on mineralization in the context of the geological evolution of the British Isles. This is a very good, well-illustrated summary, which would make good reading for anyone interested in an outline of British geology. The remaining eight chapters cover stratiform mineralization in the Scottish Dalradian, mineralization associated with Caledonian intrusive activity, the Dolgellau gold belt of North Wales, mineralization in the Irish Midlands, mineralization associated with the Cornubian granite batholith, lead – zinc – fluorite – barite deposits of the Pennines, North Wales and the Mendips, the Cumbrian hematite deposits, and sedimentary iron ores.

The work is well produced, well laid out and well illustrated. There are extensive maps at national, regional and deposit scale, schematic cross-sections and model diagrams, the great majority of which were redrawn from their original sources, and very clearly done, not cluttered by over-labeling. There are also just a few good-quality photomicrographs. However, given that this volume is regionally focussed, rather than a textbook on mineralization, the balance of figures is fine.

One of the admirable achievements of the volume is the extensive use of tables to summarize occurrences, characteristics, mineralogical and compositional data in each chapter, some with references. These tables are substantial bodies of information, which will prove invaluable to workers wishing to develop research in these areas, or to use them as analogues elsewhere. It is pleasing to report just how much information is presented in the tables and other figures, in support of the models described in the text.

The bibliographies, which are given at the end of each chapter, are very thorough, and include unpublished theses and meeting abstracts. Production of the book since writing seems to have taken a very long time. For example, in the chapter on Irish deposits, the opening page, which is marked "Published in 1993" reads "Recent mineral exploration...... suggests the likelihood that Ireland will become a significant producer (of gold) in the early 1990s", and the bibliography lists no publications since 1989. Given the rapid advances in some fields, and in exploration in Ireland in particular, this is indeed unfortunate, but clearly not the fault of the authors.

The volume will be an important reference work for anyone concerned with the geological evolution of the British Isles, especially from the point of view of mineralization. It will be purchased by workers at graduate level and above, and will be a useful source of material for teaching. Most chapters contain information on potentially analogous mineralization elsewhere in the world; hence the volume will be valuable to an international readership.

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Geology. An Introduction of Physical Geology. By Stanley Chernicoff. Worth Publishers, 33 Irving Place, New York, N.Y. 10003, U.S.A., 1995, 636 p., $46.95, softbound (ISBN 1-57259-017-3).

Not in many years has a new general geology text received as much hype as has this one. It was even the feature of two booths at last year's Annual Meeting of the GSA at New Orleans. Faced with such commercial pressure, this reviewer becomes suspicious, even defensive. In picking up this book, at the outset, I was apprehensive: a new book in a rather crowded field by a pair of men from relatively hidden corners of our profession. And all that hype! Many hours later, having read *Geology* attentively from colorful cover to colorful cover, my uneasiness had dissolved. This is a fine book that if I were (again) to teach General Geology, I would probably choose as the course's text.

A beginning text has special requirements. For example, only a few students will go on in the field; most will end their formal exposure to geology with the final exam. Thus, the text must be not only accurate, but it must convey the importance of geology in a modern context: the science's role in planning our survival on Earth. Or, in the words of Chernicoff: "Pay close attention – what you learn will affect you in one way or another every day of the rest of your life" (p. 31). At the same time, the beginning text must be attractive enough to hold the interest of a student who perhaps has little inclination to science. All these requirements are met admirably by Chernicoff's *Geology.*

The book is divided into three sections: 1) Forming the Earth (235 pages); 2) Shaping the Earth's crust (122 pages), and 3) Sculpting the Earth's surface (221 pages). Broadly speaking, the three sections treat, respectively, rocks, minerals and geologic time, structural geology and geophysics, and surficial processes, with a tacked-on chapter (probably the weakest in the book) on the human use of the Earth's resources. In all, the organization of topics is logical, and students should find the text easy to follow. Each of the 20 chapters concludes with a summary in which new terms are given in bold-face type (I found this feature particularly useful), a list of key terms with page citations, a list of questions for review, and some points "for further thought." Nearly all chapters feature a "highlight", a special topic to capture the students' attention by use of a particularly relevant subject (example: "How to choose a stable homesite"). The main text is followed by a series of seven appendices (conversion factors, statistics about the Earth, topographic and geological maps, mineral charts, common rocks, sources of geoinformation, and careers in the geosciences), and an 18-page glossary with some 500 entries.

The text is clear and written concisely; at times, one feels the presence of the author. Certainly, an outstanding feature of the book is the plethora of useful and attractive full-color drawings. These are the work of Ramesh Venkatakrishnan, himself a consultant with a Ph.D. in geology. The drawings are supplemented by well-chosen photo illustrations from other sources. Illustration credits don't clutter the text. They are assembled on three pages at the end of the book.

Proofreading is virtually impeccable; I found but one typo: metamorphosis instead of metamorphism (p. 200). However, this is a new book, and minor errors are present that one hopes will be eliminated in future editions. I have listed a few: At the very outset, opposite the title page, the long dimension of the original illustration should be 367.6 cm. The temperature of the dull red incandescent basalt (p. 4) is not 2000°C. The numbers on Figure 1–12 (spreading rates) are not defined. Then, orthoclase is more central to the definition of granite than is plagioclase (p. 36). The seemingly endless confusion between weight and density doesn't abate: it is the denser particles of gold that sink to the bottom of the pan (p. 50). Stishovite has not been found at Manicouagan (p. 60). Without scales, the close-up photos on p. 67 and Figure 3–12 are meaningless. Along the same line, Venkatakrishnan's fine drawings of small features, thin sections, mineral grains, and so on, would be enhanced greatly by adding scales. To continue, silica content does not decrease from left to right uniformly across Figure 3–4; it increases from syenite (at the left end) to a maximum at granite (roughly at "Rock X"), then it decreases. Norman L. Bowen might have been pleased at last to be recognized as a Canadian (p. 75), but he would be dismayed at the treatment afforded his reaction series (p. 76). To wit: most amphiboles are poorer in SiO_2 than are their pyroxene relatives (*i.e.*, average hornblende has ~45% SiO_2 *versus* ~50% SiO_2 in typical augite). Worse, calcium does not account for 90 to 100% of positive ions in anorthite. Then, the "sill" in Figure 3–17 is in fact a horizontal dyke and only serves to entrench a common misconception. On page 137, smectite is not a mineral species, but rather a group of clay minerals. The origin of the work "arkose" lies in the Greek, not French (p. 161). Metamorphism does not require "more than 1 kilobar of pressure" (p. 183). Also, the emphasis given to directed pressure in metamorphism is outdated (p. 184). Staurolite is more typical of schists than of gneisses (Table 7–1), and the grain-size transition between phyllite and schist is not 1 cm (p. 187). The scaling chosen for Figure 8–27 gives (at first glance) the false impression that the Cenozoic is longer than was the Precambrian. The omission of the role of fluids in rock deformation (p. 242) is unfortunate, as is the omission of the common term "hypocenter" (p. 268). Two distinct values are given for the dextral displacement on the San Andreas fault produced by the 1906 quake: 7 m (p. 250), and 6.4 m (p. 277). Spinel does not have the same composition as olivine (Fig. 11–7), and ilmenite is not $MgSiO_3$ (p. 310). The caption "grains of iron, copper, and other sulfide minerals" (Fig. 12–14) is confusing. Sinking plates become more dense not only due to partial melting and the loss of felsic components (p. 354), but also due to the basalt-to-eclogite transformation. Then, a scale would clarify Figure 14–32, Chimborazo and Cotopaxi are reversed (Fig. 17–3), and it is Duxbury (not Duxburg, Fig. 19–18). Was global sea level at the glacial maximum ~140 m (p. 488), or ~130 m (p. 557) lower than today? The formulas for sphalerite and galena are wrong (p. 582), and the white substance in Figure 20–19 certainly is not platinum. Finally, the vast asbestos reserves of Quebec are not in "high-grade metamorphic rocks" (p. 589). Here, I might add, I would have liked to have seen a highlight on the hysteria that asbestos has provided south of the border and a rational analysis of the situation using mineralogy. A missed opportunity!

My little pointed criticisms are meant to help the author through the second edition that I'm sure this book will see. It is a fine, useful and attractive text, and if you, my reader, are faced with the teaching of the proverbial Geology I, look this book over carefully. I think that you may choose it as the text for your course.

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Mineralogy of Arizona. by John W. Anthony, Sidney A. Williams, Richard A. Bideaux and Raymond W. Grant. The University of Arizona Press, 1230 N. Park Avenue, Suite 102, Tucson, Arizona 85719-4140, U.S.A., 1995, 508 p. US$35 paperback, $75 hardbound (ISBN 0-8165-1555-7 and 0-8165-1579-4).

Arizona is a treasure-house of minerals. Some 809 mineral species have been described from the State, of which no less than 76 were first identified at Arizona localities. Most of these are rare, but included are coesite and stishovite (from Meteor Crater), two minerals of great petrological significance.

Mineralogy of Arizona is a big book, carefully produced and filled with information largely restricted to the subject defined by its own title. It is the third edition of a book that originally appeared nearly 20 years ago. The first edition superseded F.W. Galbraith's and D.J. Brennan's *Minerals of Arizona*, a modest 116-page bulletin last published in 1959.

A 34-page, chronologically ordered introductory chapter on the history of Arizona mining and mineralogy opens *Mineralogy of Arizona*. This is followed by short and elementary chapters on porphyry copper deposits, porphyry-copper-related and other hydrothermal deposits (with focus on the Bisbee district, Tombstone, and the Mammoth mine), uranium and vanadium deposits, granitic pegmatites, "mine-fire" minerals at the United Verde mine, and Arizona meteorites. The more than 800 Arizona minerals are then treated alphabetically (acanthite to zunyite) in the 333 pages that make up the core of the book. Varieties (as, for example, crocidolite), related substances (flint), members of mineral groups (illite), popular names (pitchblende), doubtful species (arizonite), and the 190 species identified in Arizona following the publication of the second edition in 1982, are all clearly flagged. Here, I have my only significant criticism: this list is really for the initiated alone. It includes literally hundreds of rare and unusual minerals, many of which may have only an Arizona locality, and one or two elsewhere in the world. Yet the reader is offered little information about the identification of these singular minerals, commonly not even their most basic physical properties. The reader not familiar with artroeite, for example, must look elsewhere to find what this mineral, found only at the Grand Reef mine, looks like.

Maps at various scales of the 16 or so Arizona mineral districts follow. As no index map is offered, and the individual maps are without latitudes and longitudes, they will not easily be related to the geography of the large (295,000 km^2) state of Arizona by casual readers. An unusually complete bibliography with nearly 1200 references takes up the closing 45 pages of the book.

An insert of 60 color photographs of mineral specimens printed on glossy paper, two to a page, merits special attention. The subjects are mostly exceptional examples, and the quality of the photographs and of their reproduction is outstanding.

In summary, *Mineralogy of Arizona* is probably of limited use to the professional mineralogist, although it is an indispensable resource for the serious amateur and for the curator faced with documenting samples from the youngest of the 48 contiguous United States. Any mineralogist or geologist, amateur or professional, planning a visit to the southwestern U.S. might be well advised to consult and probably to bring along a copy of *Mineralogy of Arizona*. It will be well thumbed by the end of the trip.

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Formulas of Minerals. Thermodynamic Analyses in Mineralogy and Geochemistry. By A.G. Bulakh, V.V. Krivovichev and A.A. Zolotarev. St. Petersburg University Publishing Co., University Emb. 7/9, St. Petersburg 199034, Russia, 1995, 260 pages, soft cover (ISBN 5-288-01456-6). In Russian.

In this new book, Bulakh, Krivovichev and Zolotarev set out to provide students of mineralogy and geochemistry with a solid foundation with which to tackle the quantitative aspects of their science. The book consists of thirteen chapters, each of which contains a set of exercises. The authors have tried to cover the material in such a way that everyone can learn from their reference manual, from the beginning undergraduate to the seasoned veteran. The organization of the material seems very systematic and logical.

Rather than provide a review in the real sense, I provide here a detailed outline of the contents of the book. Chapter 1 introduces the definition of a mineral species, the concept of end members and solid solutions, and the determination of molar proportions of the end members in a solid solution. In Chapter 2, on Methods of Calculation of Mineral Formulae, the authors discuss procedures of recalculation on the basis of ionic charges, and of the contents of the unit cell, with words of wisdom on corrections of mineral composition and density in cases of contamination by impurities. In Chapter 3, on Uncertainty in the Calculated Formulae, they discuss sources of error and estimates of statistical significance of the formulae. Chapter 4 tackles the calculation of proportions of end members in the rock-forming minerals, with specific discussions of olivine, pyroxene-group minerals, hornblende, alkali amphiboles, ferromagnesian micas, feldspars and nepheline.

Chapter 5, on Chemical Reactions and Changes in Concentration of Components, deals with the formulation of chemical reactions and an evaluation of metasomatic changes. Chapter 6, on Calculation of Changes in Enthalpy and Entropy in Chemical Reactions, and Chapter 7, on Gibbs Energy as a Function of State, cover basic thermodynamic relationships.

Chapter 8, on Phase Relations among End-Member Solids, includes a discussion on polymorphism. Chapter 9, on the Equilibrium Constants of Mineral-Forming Reactions, introduces the reader to the thermodynamic analysis of systems involving dissolved species and gases. Chapter 10 deals with the phase rule, chemical potential diagrams, the Schreinemakers approach, and simplifying assumptions needed in dealing with real systems. Changes in Gibbs free energy in electrochemical reactions and Nernst's equation are introduced in Chapter 11.

The authors then introduce Distribution Coefficients (Chapter 12). They explore the dependence of these on temperature and pressure, and consider applications to model the fractional crystallization of a magma. They conclude with applications to Geothermometry and Geobarometry (Chapter 13), in which they consider equilibrium constants of exchange reactions, their dependence on temperature and pressure, the relationship between activity and composition in solid-solution series, and the properties of reliable geothermometers and geobarometers. Roughly 80 pages of appendices include information on atomic and molecular weights and conversion factors, thermodynamic properties of minerals and gases, fugacity coefficients of H_2O, CO_2, CO, CH_4, O_2 and H_2, standard electrode potentials, coefficients to calculate enthalpy, entropy and free energy at various temperatures, and, finally, the solution to all the problems and exercises.

For the benefit of users whose knowledge of Russian is rudimentary, the authors have provided all figure captions and a detailed table of contents in English. In my opinion, an English translation of the book would sell well as a textbook at the senior undergraduate to graduate level in our universities.

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