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BOOKS REVIEWS

Atlas of Crystal Structure Types for Intermetallic Phases. By Jo L.C. Daams, Pierre Villars & Jan H.N. van Vucht. ASM International, Materials Park, Ohio 44073-0002, USA, 1991, 7026 pages in four volumes. US $1,309.00 (ISBN 0-87170-421-8).

The *Atlas of Crystal Structure Types* is a companion set to the *Pearson's Handbook of Crystallographic Data for Intermetallic Phases, Second Edition* by Pierre Villars and Larry D. Calvert reviewed in *The Canadian Mineralogist* (**30**, 236-237, 1992) and *Handbook of Ternary Alloy Phases Diagrams* by Pierre Villars, A. Prince and H. Okamoto to be published in 1993. The structure types, which are given in the *Handbook of Crystallographic Data*, have been checked for geometric correctness and are reported in the *Atlas*.

The first structure-type index (30 pages) is sorted alphabetically on structure type (AgAsHg - YZn), and the second structure-type index (30 pages) is sorted on Pearson symbol (aP4-cF448). The contents of the structure-type indices are structure type, Pearson symbol, space group, and exclusion number (reason). The term "number" is a poor substitute for "reason". The definition of number is difficult to find, but is located in the preface on page V and refers to the position in an unnumbered list of reasons. Reason 3 refers to structure types with more than 20 point-sets; this includes many sulfosalts.

The structure-type atlas (6960 pages) is sorted by Pearson symbol (aP4 - cF448). The first page of each structure type contains detailed crystallographic data, including a reference, together with a three-dimensional drawing. The second page of each structure type contains the coordinates of every atom in the unit cell, together with two two-dimensional projections of the crystal structure. The third page (and up to the seventh page) of each structure type contains for each point-set (maximum 20), a) a list of all coordinating atoms with their coordinates, distances to the central atom, and its coordination number, b) a three-dimensional drawing of the polyhedron (atomic environment), and c) a next-neighbor histogram.

The numerical data occupy the left-hand column, whereas the diagrams and drawings occupy the right-hand column in a double-column sideways format. The format results in an easy-to-find layout; however, this also produces white space at the end of the tabulated data and on the last page of each structure type. The tabulated data are complete except for a list of interatomic angles.

The set represents an up-to-date treatment and covers all structure types at the same level. The three-dimensional diagrams of members of the pyrite group are different, because the origin is shifted (0.0,0.25,0.0) in cobaltite (*oP*12) compared to isotropic pyrite (*cP*12) and ullmannite (*cP*12). The number of atoms in these three-dimensional diagrams of the pyrite group vary from 12 in ullmannite to 22 in anisotropic pyrite. The clarity of the diagrams is excellent; however, one minor problem is that occasionally the number of an atom lies on the unit-cell scale in the two-dimensional projections.

The printing is clear on high-quality paper, and the binding is strong. The volumes do not have a table of contents, and the indices are not marked on the side of the pages; however, this creates little problem.

The volumes represent good value for money. Although the price will eliminate most mineralogists from having a personal set, every scientific library with an interest in native elements, sulfides, and sulfosalts should have this reference set available for their readers.

Peter Bayliss
University of Calgary

Introduction to Optical Mineralogy (2nd edition). By William D. Nesse. Oxford University Press, 70 Wynford Drive, Don Mills, Ontario M3C 1J9, 1991, 335 pages. CAN $59.95 hardbound.

This book is intended for use by the beginning student in optical mineralogy. It combines, in one volume, both the optical theory necessary for mineral identification with the petrographic microscope, and mineral descriptions of the common rock-forming minerals.

The second edition is 10 pages longer than the first. It has been updated and contains revisions of text that explain some concepts more clearly. Errors in the first edition (that were generally minor) have been corrected. Some reorganization has taken place in Chapter 1, which allows figures and text to remain together. A new and useful table of birefringence *versus* index of refraction is printed on the back of the color chart.

The theory and methods of optical crystallography are thoroughly outlined in chapters 1

through 7 and are explained using the optical indicatrix. (A discussion of ray-velocity surfaces is included in the Appendix). Many students, especially those with problems in three-dimensional visualization, find optical theory difficult to understand. Nesse realizes this and presents the material in a clear, logical and very readable style and makes frequent use of excellent diagrams. Particularly good are the figures employed to illustrate the formation and appearance of interference figures.

Chapter 7 includes a chart for the determination of 2V by Kamb's method, which includes curves for a numerical aperture of 0.65 as well as the more commonly encountered curves for a numerical aperture of 0.85. However, its scale is a little small for my liking. In fact, if I have one criticism of this second edition, it is that the scale of some of the determinative charts was not increased just a little.

Chapter 8 is a short but useful chapter that is greatly appreciated by the beginning student. In it, a systematic approach to the often-intimidating task of identifying an unknown mineral is presented. Included is a helpful summary of frequent associations of mineral in a variety of common rock-types.

The latter part of the text presents detailed descriptions of the common rock-forming minerals. The material is well organized, clearly presented, and amply illustrated with crystallographic diagrams and black-and-white photomicrographs (some of which are new and all of which now have scale indicated). Numerous useful charts showing the variation of optical properties with composition for minerals with variable chemistry are given. Again, however, the scale of the charts could have been a little larger. The appendix contains useful identification tables, based on a variety of optical properties. The book has a large and extremely high-quality chart of interference colors that is now located in a pocket inside the back cover rather than bound into the book.

Nesse includes little in the way of crystal chemistry, no chemical compositions of actual minerals, no experimental phase- diagrams, and very little on reflected-light studies. This may be a disadvantage in some introductory courses and does limit the usefulness of this text in more advanced courses. The changes in this edition are improvements on what continues to be the best "combined" text available. It is an ideal book for most introductory courses in optical mineralogy.

Jon Jones
University of Calgary

Contact Metamorphism. Edited by Derrill M. Kerrick. Reviews in Mineralogy, volume 26. Mineralogical Society of America, 1130 Seventeenth Street NW, Washington, D.C. 20036, U.S.A., 1991, 847 pages, US $26 (ISBN 0-93950-31-6).

This is the 26th volume of the "Reviews in Mineralogy" series and, as Paul Ribbe, the series editor, comments, is the largest ever published in the 18-year history of the series. At 847 pages of single-spaced text, it is indeed a formidable tome.

The work adopts a multidisciplinary approach, whereby processes relating to contact metamorphism are reviewed in the light of igneous and metamorphic petrology, geochemistry, thermal modeling and structural geology. The work is certainly up-to-date in the field of study. It should definitely be in all libraries and should be read by those teaching metamorphic petrology at both the undergraduate and graduate levels. After having read the work, I for one shall be modifying the "contact metamorphism" components of my third year and especially my fourth year metamorphic petrology courses. In addition, most hard-rock graduate students would benefit from reading it. Like other volumes in this series, it is not really suitable as a course book at the undergraduate level because it is generally too detailed and advanced, although it remains a valuable source for formulation and modification of undergraduate courses.

My one major criticism is that there is no index at the end of the text (as, I believe, is the case for all the volumes in this series). It would have been a great help to have been able to access information on, for example, certain minerals or specific plutons and their aureoles as they are discussed throughout the text, rather than having to rely on the relatively terse chapter outlines at the beginning of the book. Understandably, constructing an index would have been an additional task for the editor to manage, but would have been feasible and extremely helpful to the reader.

There are fourteen chapters in all, and one is struck by the enthusiasm displayed by the authors for their subjects and lucidity with which they present their information. Chapter 1 (Overview of Contact Metamorphism by D.M. Kerrick) gives a succinct introductory review of the subject. The important questions of distinguishing low-pressure (contact) metamorphism (LPM) when affecting large areas from regional metamorphism (especially in andalusite–cordierite sequences) is also broached (and further developed in Chapters 4 and 10). Chapter 2 (Physical and Chemical Characterization of Plutons by G.W. Bergantz) provides a valuable account of magmatic processes relevant to contact metamorphism. Coupled with Chapter 10 (Modeling Thermal Regimes by K.P. Furlong, R.B. Hanson and J.R. Bowers), here are the necessary

basics required to appraise the igneous "heat engine" that drives contact metamorphism.

Five chapters are primarily concerned with the important but elusive fluid phase. Chapter 3 (Chemical and Physical Properties of Fluids by T.C. Labotka) summarizes the chemical and physical properties of contact-metamorphic fluids in the form of tables, graphs and coefficients for PT conditions of 150–600 MPa and 350–800°C. Chapter 6 (Development and Maintenance of Metamorphic Permeability: Implications for Fluid Transport by J. Brenan) assesses the mechanisms of fluid flow in terms of hydrofracturing, porous flow and distribution of an intergranular fluid. Chapter 7 (Metasomatism by M.D. Barton, R.P. Ilchik and M.A. Marikos) reviews the effects of infiltration metasomatism and the less significant process of diffusion metasomatism. Chapter 8 (Dehydration and Decarbonation Reactions as a Record of Fluid Infiltration by J.M. Ferry) reviews the mineralogical record of contact-metamorphic fluid flow, whereas Chapter 9 (Stable Isotope Monitors by P.I. Nabelek) discusses the use of oxygen, carbon and hydrogen isotopes as "the best tracers" for studying the thermal and hydrodynamic responses of wallrocks of igneous intrusions.

Two fundamental chapters deal with equilibria and thermobarometry of, firstly, the all-important metapelites (Chapter 4 by D.R.M. Pattison and R.J. Tracy) and, secondly, calcareous, ultramafic and mafic rocks and iron formations (Chapter 5 by R.J. Tracy and B.R. Frost). These provide much of what is perceived as the more traditional aspects (*e.g.*, information on facies, textures, isograds, bathograds, *etc.*) of contact metamorphism and, as such, should be of particular interest to those field-based metamorphic and structural geologists who are trying to understand their mineral assemblages.

Two chapters deal specifically with aspects of kinematics (Chapter 11: Kinematics of Coarsening and Diffusion-Controlled Mineral Growth by R.L. Joesten, and Chapter 12: Kinematics of Heterogeneous Reactions by D.M. Kerrick, A.C. Lasaga and S.P. Raeburn). Both highlight the gradual shift in metamorphic petrology that is taking place from the "static", equilibrium approach to the "dynamic" mode, where the nonequilibrium aspects and kinetics of metamorphic processes are being given increasing emphasis.

The concept of "static" metamorphism is further dispelled in Chapter 13 (Aureole Tectonics by S.R. Paterson, R.H. Vernon and T.K. Fowler), where mechanisms of emplacement and related structural effects are reviewed. Last, but not least, Chapter 14 (Aureole Systematics by M.D. Barton, J.-M. Staude, E.A. Snow and D.A. Johnson) represents an excellent synthesis of the diversity and systematics of igneous-related metamorphism.

Unfortunately, there is no chapter dedicated to economic deposits associated with contact metamorphism and, in general, economic aspects receive little coverage in this text. Also, if they were to have been dealt with at all, the enigmatic dynamothermal aureoles related to alpine-type peridotites (both lherzolitic and ophiolitic subtypes) could have been appraised in more detail. However, no book is ever complete, and this one is massive enough already.

The quality of diagrams and print is good though not stylish, the sacrifices made in the visual quality of the text and the frequency of minor typographic errors (note the "errata" page inclusion for Chapter 5) being far outweighed by price which, at $26 US, is fantastic value by anyone's standards. When many geological texts of significantly smaller size typically cost $50–100 and more, the Mineralogical Society of America, under the series editorship of Paul Ribbe, is to be commended for producing these no-nonsense, information-packed texts. Long may it continue.

John G. Spray
University of New Brunswick

Rocks and Minerals. By Joel Arem, Geoscience Press, Inc. Phoenix, Arizona, 1991, 159 pages. US $8.95 (ISBN 0-945005-06-7).

Rocks and Minerals is a small-format pocket guide (as the author suggests) intended for amateur afficionados and beginning students of mineralogy. It follows the usual format, with chapters on definitions, crystals, mineral properties, a long section of mineral descriptions, a short one on gems, and then ending with rocks and a few appendices. The text, for the most part, is clear and concise, the difficult task of presenting mineralogical concepts to the nonspecialist well accomplished. However, there are the inevitable simplifications that may rankle purists, most being in the peripheral chapters ("Rocks make up large structures called formations" (p. 11); dolomite instead of dolostone (p. 132) *etc.*). There are even statements that can be considered incorrect, such as "Amygdules are almond-shaped gas pockets in basalt" (p. 127). The main chapter of mineral descriptions is better; clearly this is the author's specialty. The mineral descriptions, however, follow no set pattern, and the reader is required to check the appendices for formulae (which do not always match standard references such as the *Glossary of Mineral Species*) and crystal systems. Unfortunately, only a specialist can determine when accuracy has been sacrificed for simplicity. The descriptions do include interesting tidbits of

historical data and examples of industrial applications. There are numerous excellent color photographs by the author, and several good colored line-drawings.

The biggest drawback to the this book is its age. This is not really a 1991 publication, but a sixth printing of the original 1973 version. The plates are still in very good condition, although a couple are out of alignment. But a few are obviously dated, the electron microprobe (*circa* 1967 and printed backward) in Chapter Two looks like the prototype. The text is clearly old; whereas the author could not be expected to have removed the USSR from the locality lists (hardly useful information anyway!), readers might be hard-pressed to find South-West Africa, Ceylon, Rhodesia and British Guiana on maps printed during the last decade.

To summarize, the photos are good, the text is acceptable, but there are newer books which, although not as inexpensive, are probably better.

Jon Greggs
University of Calgary

Encyclopedia of Earth System Science. Edited by William A. Nierenberg. Academic Press Inc., 1250 Sixth Avenue, San Diego, CA 92101, USA, 1992, US $950 per set. Volume 1 A – Co, 663 pages (ISBN 0-12-226722-2); Volume 2 Cr – L, 687 pages (ISBN 0-12-226723-0); Volume 3 M – Re, 760 pages (ISBN 0-12-226724-9); Volume 4 Ri – Z, index 715 pages (ISBN 0-12-226725-7).

Entries in mineralogy include bauxite and laterite soil ores by G.H Brimhall and C.J. Lewis, marine mineral resources by M.J. Cruickshank, optical mineralogy by M.E. Gunter, and silicates by J.D. Dunning, J.G. Brophy, D.L. Goldsby and B.J. Douglas. Entries in mineral physics include infrared and raman spectroscopy in the geosciences by P.F. McMillan, NMR spectroscopy in the earth sciences by I. Farnan, oceanic gabbros, magnetic properties by J.E. Pariso, powder-diffraction techniques by D.K. Smith, and synchrotron radiation in earth sciences by W.A. Bassett and G.E. Brown.

Entries in ore deposits include crustal fluids by B.E. Nesbitt and B.J. Tilley, magmatic sulfide deposits by A.J. Naldrett, and ore formation by D.A. Polya. Entries in petrology include analytical petrology by P.C. Ragland, igneous petrogenesis by T.H. Pearce and J.K. Russell, metamorphic petrology by J.C. Palmquist, and volcanos by D.J. Geist. Entries in geochemistry include beryllium isotopes in the earth's environment by D.L. Bouriès, brines in sedimentary environments by P.K. Egeberg, and water geochemistry by Y. Kitano.

The set contains about 220 articles with an average length of 12 pages by about 250 contributors. Each article begins with a list of major headings in the article and ends with a bibliography and a glossary of terms. The high quality of the editing is shown by the consistency between articles, although an occasional spelling error and grammatical error was noted. Some addresses of the authors are exceeding short such as USDA-ARS. The set ends with a list of contributors in alphabetical order, a relational index between the articles (13 pages), and a detailed subject index (171 pages).

Since there are so many articles in this set, it is not practical to comment in detail and what follows are some general observations. Each of the areas in earth science appears to be given equal treatment. There are about nineteen articles out of about 220 in the general area of mineralogy, and they cover most of the present research areas and problems. The level of treatment appears to be uniform in each of the well-written mineralogical articles. The treatment of the mineralogical articles is far too brief for a mineralogist or graduate student; however, the non-mineralogical articles will appeal to a mineralogist. The alphabetical order by article name means that the reader must use the index; however, a more logical order would have been to group articles in a similar area together in each volume with a suitable subtitle.

The quality of the paper is high, and the binding is strong. The printing is easily readable, with high-quality diagrams and half-tones in a double-column format. Running headings of the article are printed at the top of each page of every article. The price of this set compared to other scientific books is reasonable in today's market. Every scientific library should purchase this set.

Peter Bayliss
University of Calgary

Cambridge World Gazeteer, a Geographical Dictionary. Edited by David Munro. Cambridge University Press, 1990, 845 pages, CAN $47 hardbound. (ISBN 0-521-39438-4).

The book is a reissue of the 1988 *Chambers World Gazeteer* under a new name. The publisher promotes it as a standard international directory of places. Although it is not as comprehensive as some gazeteers, it is conveniently sized and serves as a useful reference for students and researchers. For the mineral curator or collector, it is useful in providing the accepted names of countries (and their internal divisions) with cross references for countries having had name changes (up to 1988); it is of limited use in verifying locality names since mineral occurrences are generally in obscure

locations rather than in urban centers such as those listed in this book.

The book is comprised of two parts: a gazeteer section and an atlas supplement. The 114-page full-color atlas contains 73 maps with 24 insets presented in clear, easy-to-read type. The gazeteer section contains some 20,000 alphabetically arranged entries spread over 733 two-column pages. The entries include countries and their divisions, cities and towns (the distinction between them is blurred: Edmonton, Calgary and Halifax are towns, Dawson (Yukon) is a city), major waterways and landforms, and man-made features such as dams and canals.

There is more to this book than a simple listing of names and locations. There are statistics on area and on population (as recent as 1985, but as far back as 1968), and pertinent details of economic, historical, political, cultural and touristic significance. The text is supported by 150 line maps of countries with their respective divisions, and 263 tables listing population and area for each division. The line maps vary in size. Only Thailand is represented on a full page. Canada, Venezuela, Yugoslavia, the U.S., and the U.S.S.R (pre-1992) each occupy about half that space, and the Canary Islands take up the smallest space, about 1/8 of a page. The tables range from two lines for the Isle of Wight to 3 1/2 columns for Texas. The primary divisions (states, provinces, regions, *etc.*) are tabulated for each country, but secondary divisions (counties, districts, boroughs) are listed only for some countries: Australia, France, Great Britain and the U.S.

Along with geographic detail, the *Gazeteer* supplies interesting and tantalizing touristic and geological information. The reader is told that Kamloops (British Columbia) has a Gold Rush Museum (it has a museum, but not by that name), that Dawson (Yukon) was the scene of the 1896 gold rush, but it is Edmonton that hosts the Klondike Days Festival each July, that the Kingston (Ontario) Pump House Steam Museum has the largest collection of steam engines that work, and that Lethbridge (Alberta) has the largest authentic Japanese garden on the continent. The reader will also learn that there is in Tucson (Arizona) a festival in April, but will not be told that the greatest mineral and gem show on earth is held there each February.

More on a geological or mineralogical note are the following tidbits: the largest potash fields in the world are in Saskatchewan; the Great Canadian Oil Sands are estimated to contain enough oil to supply all of North America for 60 years; copper ore was discovered in 1883 in Sudbury, and gold in 1896 on Bonanza Creek; Dinosaur Provincial Park (Alberta) is a "graveyard full of partially excavated dinosaur skeletons, exhibitions of fossils and relics and weird rock formations"; Bryce Canyon National Park (Utah) "features curiously eroded rock formations". Kimberley, South Africa is listed as a major diamond mining center, but a similar producer, Kimberley, Australia, fails to make the list. Referring back to Kimberley, S.A., and "the biggest hole ever created by man", readers may wonder why in the world such a hole was created.

Ann P. Sabina
Geological Survey of Canada

Volcanoes of the Central Andes. By S.L. de Silva and P.W. Francis. Springer-Verlag, Berlin and New York, 1991, 216 + viii pages. US $89 (ISBN 0-387-53706-6).

This is a richly illustrated and informative book. It is, basically, a catalogue of volcanoes and volcanic features of the Central Volcanic Zone (CVZ) of the Andes. Although fundamentally a scientific reference, the beautiful splendor of its illustrations bring *Volcanoes of the Central Andes* close to the realm of "coffee table" books.

The CVZ lies between 14° and 28°S Lat. It is restricted to Peru, Bolivia, and the northern parts of Chile and Argentina. The CVZ is larger and more impressive than the adjacent northern (Colombia and Ecuador) and southern (austral Chile and Argentina) volcanic zones. The magnificence of the CVZ is due in large part to an exceptionally dry climate, even at high elevations. The aridity of the CVZ has kept vegetation in check and allowed a remarkable preservation of volcanic landforms. This, plus the prevailing nearly cloudless skies, cause the CVZ, unlike its northern and southern neighbors, to be an ideal subject for analysis and interpretation by satellite imagery - the pivotal feature of de Silva's and Francis's book.

Volcanoes of the Central Andes is partitioned into six chapters. The first is introductory and spells out the basic philosophy of the book. Following an outline of the techniques of satellite imagery, the authors specify morphological criteria that can be read from Thematic Mapper (TM) images to establish the recency of activity, with particular attention given to the relative ages of glacial and volcanic features.

The second chapter bears the title of the book and is its heart. It contains details, from north to south, about the 44 volcanoes considered "potentially active" by the authors. (Note: of the 44, only 15 are recognized by the standard *Catalogue of the Active Volcanoes of the World Including Solfatara Fields*). They admit to having visited only half of these volcanoes on the ground, and point out that the published information on most of them is thin

at best. They state: "Many ... are so poorly known that we present their first published description in this volume, which, regrettably, is often meagre". A standard format is followed. The name of the volcano (and any synonyms), location, type (simple, composite, *etc.*), elevation, edifice height, and category (active, fumarolic, *etc.*) are given in tabular form. These are followed by brief comments on structure and evolution, current activity, hazard (if appropriate), geochemistry, and references (generally no more than three or four). Spectacular annotated TM color images, mostly at a scale near 1:150,000, are the crown jewels of each description. These are supplemented by snippets of topographic maps, and conventional aerial and ground photos.

Chapter 3 deals with 18 "minor centers", distributed between "explosive silicic events", "domes", "others", and "lava fields". Like the incongruous grouping chosen, this chapter is a bit of a mish-mash, though this is fully pardonable, if one takes into account the diversity and complexity of these features. Again, the presentation is enhanced by spectacular TM color images.

The fourth chapter treats eleven large silicic systems (essentially examples of caldera-forming volcanism) that have formed ignimbrite sheets and associated rocks. Interestingly, only the advent of satellite imagery has allowed an appreciation and regional evaluation of these vast features that, in the Andes, individually cover from 1,000 to 50,000 km^2. The chapter is illustrated by stunning examples, including three full-page TM color images at a scale of 1:600,000.

Chapter 5, only 8 pages long, is entitled "broader issues" and is a bit of a pot-pourri. It deals with such topics as segmentation and deflection of the Andean magmatic arc (little agreement is found here), petrogenesis and the influence of the greatly thickened continental crust, glacial histories, and the interaction of volcanic activity and climate.

Chapter 6 is composed of two appendices: information on the TM images (it would have been desirable here to give their scales), and a list of all identifiable volcanic landforms in the CVZ. These total 1113 features and include those discussed in chapters 2–4.

Certainly this book is the last word on Andean volcanism between 14° and 28°S lat. It reflects the rich field experience of the authors in the region over the past two decades. The book was printed in Germany to the most exacting standards. Errors are few and insignificant. Omissions are more numerous: missing annotations on some TM images, and a lack of scale on the topo map insets. The book is mostly well written, although the large number of sentences that begin with "there is" or "there are" is tiresome.

This is a fine book that will interest Andinophiles. Any geologist travelling to Peru, Bolivia, or Chile, be it for tourism or for study, would be well advised to pack a copy of *Volcanoes of the Central Andes* in his baggage.

Tomas Feininger
Centre géoscientifique du Québec