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BOOK REVIEWS

ORIGIN OF GRANITE BATHOLITHS, GEOCHEMICAL EVIDENCE. Edited by M. P. Atherton and J. Tarney. Shiva Publishing Limited, Orpington, Kent. 148 pages. $9.00.

This well edited and nicely published collection of 11 essays brings together papers delivered at a one-day meeting of the Geochemistry Group of the Mineralogical Society, held in Liverpool on May 2, 1979. All 17 of the authors are British; the Universities of Liverpool and Birmingham provide 7, including both editors, 4 are from the Open University at Milton Keynes, 4 from the Institute of Geological Sciences, and one each from St. Andrews and the Scottish Universities Reactor Center. The geographical range of the discussion is appropriately broad, however, including papers on the granites of Scotland, Southeast Asia, Western South America, and Antarctica. The volume lacks an index but, in a welcome departure from current practice in symposium volumes, the editors have drawn all references into a single bibliography. More than 80% of the 330 titles it contains were published during the last decade, and nearly two-thirds appeared after 1975. Evidently discussion of the venerable granite problem is undergoing one of its intermittent revivals.

Except for reports of two meetings of IGCP Project 30 (Circum-pacific Plutonism), which have not yet achieved wide circulation, this seems to be the first English language symposium volume on the subject since the Geological Society of America's Memoir of 1948 and the immediately subsequent shift of interest to volcanic rocks. And beneath the remarkable proliferation of new code words, of which more later, it's apparently pretty much the same old ball game.

If one concedes that (some) granites are magmatic and that the ultimate ancestor of a magma is a solid, it becomes necessary to generate magma by melting. The reasonable man must then seek ways to decide how much of what is to be melted. In this respect the major distinction between 1948 and 1979 seems to be that in 1948 the whole notion of a magmatic phase in the development of granite was under frontal attack. The strict magmatists, perhaps overimpressed by the brilliance with which the then available experimental data had been brought to bear on the subject, insisted not only that all granites formed from magma but that all granite magma was generated by the fractional crystallization of basaltic magma. But the 'actualists,' whose Scandinavian and North American representatives then argued mostly from field studies of the Pre-Cambrian, maintained quite as stoutly that there was neither evidence nor need for granite magma; wherever they looked they saw only granites formed by one or other variety of ultrametamorphism. Even among less devoutly committed—one hesitates to say less unreasonable—petrologists there simply was no possibility of a meeting of the minds, so we abandoned the granites and took our trade elsewhere.

Thirty years later it seems that nearly all of us can have our cake and eat it too. At several points in this volume it is either argued or assumed that there are 'S'-granites and 'I'-granites, *each* a product of magmatic activity, and that 'S'-granites, not accompanied by 'consanguineous' (a hold-over code word!) gabbros or other basic igneous rocks, are formed from magmas generated from salic lithospheric material. The 'I'-granites, on the other hand, are part of an assemblage of igneous rocks dominantly 'tonalitic' (a term fortunately now so well understood as to require no definition), often including gabbroic members, and thought not to be derived from crustal material. If they are not of crustal origin they must be subcrustal; most contributors to this volume explicitly accept, and none deny, the origin of 'I'-type granites by fractionation of basalt-like magma, itself a product of the melting of eclogite or peridotite in the upper mantle. Although there is as little evidence today for the wholesale formation of granite by fractional crystallization of basalt as there ever was, most contributors who take firm positions on the matter seem to feel that granites of the 'I' persuasion are dominant. It is notable, however, that the question can now be discussed temperately and without undue heat.

Two major developments seem primarily responsible for this suspiciously comfortable resolution of old and sometimes bitter doctrinal differences:

(1) In the course of the last 30 years the lithosphere has become so thick as to overcome most of the thermal objection to anatexis as a source of magma. (One of the essays in this book uses "models" in which it may be as much as 200 km thick.)

(2) The Sr isotope ratio has been rather widely accepted as an indicator of the provenance of granite source material.

Thus it now seems possible to recognize and it no longer seems impossible to generate a magma of either type. But a petrologist attempting to unravel the history of *some particular granite* is still not much better off than a camel trying to pass through the eye of a needle. And for much the same reason, to wit, too much baggage. In this respect, other participants seem to this reviewer to make out about as do Atherton *et al.*, who remark, with regard to the coastal batholith of Peru, that "At the moment, models of batholithic genesis . . . are numerous and involve fractional crystallization, partial melting, vapor and/or liquid transport, magma mixing, *etc.*, in a multi stage process. Rarely can a semiquantitative model be put forward, even with good knowledge of partition coefficients, liquid–solid equilibria, fraction solidified, *etc.* . . . We believe that future models must be constrained by better field and petrographic evidence". Amen. And what else is new along these lines?

If there has been slight improvement in the ability to apply or choose between competing hypotheses of granite formation in specific instances, the essays in this little book make it clear that there has nevertheless been a sea change in the language in which these concepts are couched, as well as a major reorientation in the ways in which objects called granite are described. The change in language is perhaps primarily a consequence of the shotgun marriage

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of chemical petrology with its distant but fashionable cousin, plate tectonics. Most of the authors seem to feel uneasy until they have offered the now conventional obeisance to such reigning totems as 'intraplate environment', 'zones of lithospheric plate subduction', 'destructive plate margins', 'back arc environment', or 'subductive underplating', to name only a few. But not all the terminological ornamentation is generated by enthusiasm for the new tectonics. In addition to the tectonically, or, at any rate, plate-tectonically, neutral 'super-units', 'segments', 'magma sequences', and 'isotopic domains', there are 'metamorphically harmonious' plutons, 'metamorphically disharmonious' plutons and 'gregarious' batholiths, as well as 'forceful' and 'permitted' granites. Jargon often facilitates communication among specialists, but an overdose tends to inhibit rather than promote it, creating an impression of profundity and wisdom when in fact neither may be in particularly good supply.

It is to be hoped the current fascination with jargon will soon wane, for, as these essays admirably illustrate, there is indeed a wealth of new information about isotopes and trace elements to be conveyed. It is here that one notices the biggest difference between the new attack and earlier mass assaults on the granite problem. The ability to collect data of this sort, previously almost nonexistent, has now far outrun current facility for reducing, portraying and evaluating the resulting large and complex data arrays. When sampling, data reduction, and data evaluation techniques pull abreast of data collection capability, fundamental advances in knowledge of the natural history of batholiths and the origins of granite may materialize.

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ATLAS OF THE TEXTURAL PATTERNS OF BASIC AND ULTRABASIC ROCKS AND THEIR GENETIC SIGNIFICANCE. By S. S. Augustithis. Walter de Gruyter, Berlin, 1979. x + 393 pages. DM 255, approx. $145.00.

This new textural atlas follows two previous works by the author on the textures of granitic and basic rocks. Much like the first two books, it is organized into about 100 pages of text and about 250 pages of photomicrographs with short captions. The photography and printing of the photomicrographs are quite good. The text however is poorly written, in grammar, organization, and scientific style. The scientific content is highly biased, neglects important details which do not fit the author's metamorphic-metasomatic theories, and lacks a basic understanding of important aspects of crystal–melt processes.

We are warned in the preface that the book will not take a classical approach to the study of ultrabasic rock textures because the author considers most of these rocks have been previously misinterpreted as igneous. Ultramafic rocks join granitic and basic rocks, interpreted in the author's previous two books, as products of metamorphism–metasomatism. In addition to granitization, and indeed complementary to it, we read that gabbroitization, anorthositization, and Mg-metasomatism may be processes responsible for most rocks previously considered as plutonic igneous.

The first seven chapters, about 25 pages, discuss olivine- and diopside-bearing rocks that most petrologists would agree are metamorphic and, perhaps, metasomatic. These would include calc-silicate skarns, meta-carbonates, many eclogites, amphibolites, and granulites. The next eleven chapters, about 40 pages, attempt to demonstrate how many plutonic igneous rocks and complexes can be reinterpreted as metamorphic–metasomatic because of their textural similarities to the rocks discussed in the first seven chapters. Among rocks thus reinterpreted are gabbros, norites, troctolites, dunites, peridotites, and anorthosites. The author suggests that the Bushveld, Stillwater, and Skaergaard complexes represent metasomatized, layered sedimentary sequences. Indeed, are any of the igneous rocks we learned about in Geology One above suspicion? A short chapter on komatiites comes down on the side of volcanic igneous origin but ophiolites do not fare as well. They are generally interpreted as mantle diapirs and are thus "ultrametamorphic" in origin, although in a footnote there is a brief discussion of their possible origin as obducted oceanic crust–upper mantle. The last eleven chapters discuss the relationship of ore minerals and alteration and weathering to basic and ultrabasic rocks.

Although the author does not summarize them, a number of textural features of basic and ultrabasic rocks are used in the book to interpret these rocks as metamorphic–metasomatic.

(1) Poikilitic (-blastic) crystals of olivine, pyroxene, or amphibole require metasomatism.
(2) "Invasions" that result in graphic intergrowths such as those found between cpx–pl, sp–ol, and qtz–pl are due to metasomatic processes.
(3) "Invasions" that produce interlaminated phases, like cpx–opx, ab–an, ab–or, are evidence of metasomatism.
(4) "Invasions" that produce symplectites, like mt–opx, qtz–opx, qtz–pl, qtz–amp, and pl–sp, indicate metasomatism.
(5) Reaction coronas, such as ol–opx, ol–pl, or opx–pl result from disequilibrium associated with metasomatism.
(6) Granular textures in general are not igneous. They represent meta-sediments like norites, or tectonites like dunites.
(7) "Autocathartic tendencies" in minerals such as ol, pl, and px indicate recrystallization and remobilization.

Most petrologists would take exception with one or more of the above criteria, which range from the almost certain misinterpretation of exsolution features ("invasions") in pyroxenes and feldspars to the problematic nature of symplectic intergrowths. I consider none of these textural criteria to be certain indicators of metamorphism–metasomatism.

Other general features of ultramafic rocks and complexes which the author suggests require metasomatism are:

(8) Association with granites or granophyres—because these were shown in his 1973 book to be of metasomatic origin.
(9) The presence of quartz, since it has no eutectic relationship with plagioclase.
(10) The absence of basic, intermediate, and acidic rocks required as the complements to crystal fractionation.
(11) Layered complexes indicating preexisting sedimentary strata.
(12) Absence of thermal contacts.
(13) Deformation (shearing, twinning, *etc.*).

Again these criteria should be considered as ranging from unacceptable to problematic.

In summary, this third book by Augustithis is much like his first two in style. Both the organization and scientific content are marginal in quality. Considering the cost of this book and its relative scientific value I cannot recommend it as an addition to either personal or institutional libraries.

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CRYSTAL STRUCTURE DATA OF INORGANIC COMPOUNDS, KEY ELEMENTS O, S, Se, Te (substance numbers b1818–b2804). By W. Pies and A. Weiss. Group III, Vol. 7b2 of *Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology*, edited by K.-H. Hellwege and A. M. Hellwege. Springer-Verlag, Berlin, 1980. xxv + 210 pages, 15 figures. DM 265, approx. $148.40.

KEY ELEMENTS N, P, As, Sb, Bi, C (substance numbers c3339–c4734). By W. Pies and A. Weiss. Group III, Vol. 7c3. Springer-Verlag, Berlin, 1979. xxvii + 291 pages, 16 figures. DM 360, approx. $201.60.

See reviews of earlier parts of Group III, Vol. 7 (*Am. Mineral., 59,* 1142; *61,* 334, 817; *63,* 800; *65,* 214). Part b2 extends the coverage to oxycompounds of the halogens with metal ions and includes the minerals zavaritskite, ralstonite, eglestonite, bismoclite, perite, botallackite, atacamite, paratacamite, koenenite, laurionite, paralaurionite, fiedlerite, penfieldite, percylite, diaboleite, bideauxite, boleite, kempite, calumetite, anthonyite, pseudoboleite, cumengite, iowaite, blixite, daubreeite, akaganeite, hematophanite, lautarite, bellingerite, schwartzembergite, seeligerite, and salesite. Part c3 comprises graphite intercalation compounds, carbides, carbonyls, carbonates, cyanides, and cyanates; the section on carbonates includes a considerable number of minerals.

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INDUSTRIAL CRYSTALLIZATION 78: Proceedings of the Seventh Symposium on Industrial Crystallization, Warsaw, Poland, 25–27 September 1978. Edited by E. J. DeJong and S. J. Jančić. North-Holland Publishing Company, Amsterdam, 1979. xiv + 588 pages. $73.25.

The series of 85 papers from this European symposium deals primarily with the practice and theory of the industrial-scale preparation of relatively small crystals from water solution. Well covered are the roles of nucleation, kinetics, hydrodynamics, impurities, as well as the operating parameters of various types of commercial crystallizers used for salt, sugar, and a wide variety of mostly inorganic substances.

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PHYSICS OF MINERALS AND INORGANIC MATERIALS. By A. S. Marfunin. Springer-Verlag, New York, 1979. xii + 340 pages. $49.80. (Translated from the original 1974 Russian edition by N. G. Egorova and A. G. Mishchenko.)

The interface between mineralogy and chemical bonding theories has been strengthened and refined in the past decade, largely through increased discriminatory research on minerals and related synthetic phases using a variety of spectroscopic techniques, and as a result of the growing awareness by mineralogists of quantum mechanics and group theory. The publication of interdisciplinary journals has also helped to bridge the gap. One of the leaders in this field is A. S. Marfunin, whose two recent books[1] providing a general introduction to the spectroscopy and bonding of solids and surveying the theory and applications of several spectroscopic techniques to minerals have been translated from earlier Russian editions.

In the preface of the first of these books, *Physics of Minerals and Inorganic Materials*, Marfunin states that "this book is primarily intended to provide a general introduction to all sections of the physics of minerals." In fact, the coverage is restricted to theories of chemical bonding and electronic properties of minerals. The author claims that "this book (1) provides a full account of the topics selected for mineralogists; (2) it treats (the theories of solids) as part of mineralogy, in fact the most essential part of concepts and methods of mineralogy; and (3) it is adapted to the geological style of thinking, training and manner of formulating questions." ". . . mineralogists need results that make use of final data for minerals." Unfortunately, the author falls short of these goals.

In the first four chapters (Chapter 1: Quantum Theory and the Structure of Atoms, 55 pages; Chapter 2: Crystal Field Theory, 38 pages; Chapter 3: Molecular Orbital Theory, 61 pages; and Chapter 4: Energy Band Theory and Reflectance Spectra of Minerals, 22 pages), familiar concepts scattered among textbooks of inorganic chemistry, quantum mechanics, group theory, and solid state physics are integrated in an abbreviated, generally coherent manner. However, the section on group theory and its applicability to character tables and crystal field states is too brief. Unfortunately, the author chooses to use I instead of J as the symbol for total resultant angular momentum, leading to confusion with nuclear spin quantum number and with notation for certain spectroscopic terms (*e.g.*, the ground term for Er^{3+}, $^4I_{15/2}$ also has I = 15/2; J = 15/2 would have been less ambiguous). Also I is used instead of more familiar E for the identity operation in group notation.

Only a few very simple mineralogical examples are used to illustrate principles discussed in these chapters; the reflectance spectra in chapter 4 relate to band energy schemes for structure types of binary compounds such as NaCl, MgO, and PbS. However, chapter 1 concludes with an interesting description of how atomic and X-ray spectra relate to spectrochemical analyses of minerals and solar system objects. Chapter 5 (Spectroscopy and the Chemical Bond, 12 pages) provides a summary of various solid-state spectroscopic techniques from which chemical bonding parameters are derived for minerals.

The last three chapters are potentially the most interesting to mineralogists. Chapter 6 (Optical Absorption Spectra and Nature of Colors of Minerals, 49 pages) describes the theory and results of visible-region spectra of minerals. It focusses on crystal field spectra of first-series transition elements, with but passing reference to intervalence metal→metal and ligand→metal charge transfer bands. General features of the spectra of individual transition metal ions are described in terms of different $3d^n$ configurations and not by specific mineral structure. Although attempts are made to relate spectral features to mineralogical examples, the choice of minerals is disappointing and numerous inaccurate assignments exist. For example, terrestrial titanaugite is chosen as an example of Ti^{3+} crystal field spectra, despite the fact that work published in 1976 clearly demonstrated that titanaugite spectra in the visible region are dominated by $Fe^{2+}\rightarrow Fe^{3+}$ and $Fe^{2+}\rightarrow Ti^{4+}$ intervalence transitions and spin-forbidden transitions in octahedrally- and tetrahedrally-coordinated Fe^{3+} ions. Spectra of pyroxenes from moon rocks and the Allende meteorite published in 1973 would have provided unambiguous examples of Ti^{3+} crystal field spectra! Mineralogical examples of Mn^{3+} spectra have been published for manganoan epidotes (thulite, piemontite), andalusite (viridine), and micas, but were ignored in favor of synthetic

[1] The other book is *Spectroscopy, Luminescence and Radiation Centers in Minerals* by A. S. Marfunin. Springer-Verlag, 1979, 352 p. [translated from the original 1975 edition by V. V. Schiffer].

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cesium manganese alum. A vast array of published spectra and crystal chemical correlations exists for Fe^{2+} in common ferromagnesian silicates, but the author does not choose to use relevant spectral data for well-studied olivines, pyroxenes, and garnets. The concluding section on the nature of colors of minerals is too brief, generally lacks specific examples, and is out-of-date. Chapter 7 (Structure and the Chemical Bond, 35 pages) contains sections describing developments in lattice energy calculations of ionic crystals, derivations of crystal field and spectroscopic parameters, and evaluations of methods to obtain atomic and ionic radii. The text rambles somewhat but does contain a useful derivation of the Dq parameter. Chapter 8 (Chemical Bond in Some Classes and Groups of Minerals, 43 pages) reviews information on bonding in silicates, sulfides and other classes of minerals.

The book concludes with an impressive listing of 484 references grouped according to chapter headings. Although some 1976 and 1977 papers are cited, the majority of the references cover the period prior to the 1974 Russian publication of the book. The literature of solid state physics and chemistry and of Russian publications are well covered. However, there is a conspicuous neglect of standard American, British, and Canadian mineralogical journals, particularly for the period 1973–1976 during which several key papers on mineral spectroscopy and chemical bonding in minerals were published. This omission contributes to the poor choice of mineralogical examples throughout the book. The writing style is stilted and there are the inevitable grammatical errors inherent in a book translation. Russian alphabet characters remain on some figures. Unfortunately, the book abounds with printing errors and there are a large number of inaccuracies, particularly in chapter 6. For example, C_3 is used instead of C_{3v} for the symmetry of the AlO_6 octahedron in corundum. Figure 78 is incorrectly labelled, Figure 92 is unintelligible because too much information is crowded onto the poorly-labelled diagram, and *d*-orbital energy levels are incorrectly correlated with crystal field states on Figure 113. The implication that Cr^{3+} ions entering smaller Al octahedra produces pink, red, and violet colors is invalidated by emerald. Confusion exists over cubic (8-fold) coordination and cubic fields (includes octahedral coordination) when relative energies of t_{2g} and e_g orbitals are discussed.

Although the publication of this book is timely, it cannot be recommended as a textbook in mineralogy course; there are too many errors to make it authoritative. The book may be useful to better informed mineral spectroscopists as a reference source of Russian research on minerals.

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TWO HUNDRED YEARS OF GEOLOGY IN AMERICA, Proceedings of the New Hampshire Bicentennial Conference on the History of Geology. Edited by Cecil J. Schneer. University Press of New England, Hanover, New Hampshire, 1979. xvi + 385 pages, 24 figures. $20.00.

In the fall of 1976, a conference convened in the pine woods of the University of New Hampshire campus with the object of reviewing the history of American geology in a suitably bicentennial spirit. In the words of the organizer, the conference was "to bring together scholars with a common interest in the evolution of geology but with backgrounds and training as diverse as possible, so that the subject seen in manifold perspective would take on depth and illumination and reach the maturity of a considered discipline." That may have been the intent, but the result, alas, was not a symphony but babel.

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In the conglomerate of the Proceedings, mineralogists may find interesting André Cailleux's article about the 1752 "Carte Minéralogique" of Jean-Étienne Guettard. Covering North America east of the Rockies, it represents the earliest attempt to show the location of American mines, mineral localities, and geologic features on a map. Guettard also published the first geologic maps of France, but he never saw America and relied entirely on second-hand evidence for his American map. Another mineralogical article is by Arthur Mirsky, who summarizes the "Geologic Resources of the Original Thirteen United States" on 2½ pages (including a map). Robert and Margaret Hazen give just a hint of their quantitative studies on early American geologic literature, and William Jordan illuminates the connection between the canal movement and the development of geology in Pennsylvania and New York. There is also a number of biographical studies, mostly extracted from unpublished manuscripts and dissertations (Thomas Pickett on James C. Booth, Nancy Alexander on Dumble, Stephen Pyne on Gilbert again, Lintner and Stapleton on Latrobe, Nelson and Fryxell on Meek and Hayden, Patsy Gerstner on the stratigraphic nomenclature of the Rogers brothers, Thomas Manning on George Otis Smith, and Hubert Skinner on Thomassy). In the same vein, Michele Aldrich reviews early State surveys and Harold Burstyn covers physical oceanography in America. R. H. Dott gives a valuable analysis of the growth of the geosynclinal concept, the first major geological idea "made in America", and Joseph T. Gregory writes a brief but carefully-balanced history of American vertebrate paleontology. Stephen Gould reports finding some extensive and important annotations in Louis Agassiz's hand in a book by Haeckel, which cast new light on Agassiz's "sadness and growing despair" with the way things were going in the literature on evolution a few years before he died. Several papers focus on art history, literature, and philosophy, but I would not presume to review them, except for the last one.

By design or otherwise, the first and the last papers of the symposium cover the same subject: the ultimate geological acceptance of the continental drift hypothesis. The first is by William Menard, who did not know when he wrote it that he would soon be the Director of the U. S. Geological Survey, and the last is by Henry Frankel, professor of philosophy at the University of Missouri in Kansas City. Menard recalls his experiences in marine geology in the 1950's and 1960's and candidly relates how he marched up those intellectual blind alleys along with everyone else, only to recognize they were not the way. He spoke and writes with humor and the quiet insight of one who was there. Frankel, as if trying to illustrate the mutual incomprehension of scientists and humanists, writes in many words unfamiliar to me and with the air of a student brimming with newly-acquired knowledge. He presents his conclusions with earnest sincerity, but only the very youngest geologists could find them novel.

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SYNTHETIC GEMS PRODUCTION TECHNIQUES. Edited by L. H. Yaverbaum. Noyes Data Corporation, Park Ridge, New Jersey 07656, 1980. 353 pages, numerous diagrams. $39.00.

This volume is an updating of the 1973 publication on *Synthetic Gem and Allied Crystal Manufacture*. Most of the production methods for the major synthetic gem materials are discussed in episodic fashion. The book is not indexed by subject matter, but a detailed table of contents serves the purpose for the professional reader. The major subject headings are corundum, asteriated gems, rutile, titanates, garnets, and miscellaneous crystals and processes. More than half of the volume is devoted to the synthesis of diamond, and the treatment is quite comprehensive, dealing with catalysts, shock treatment techniques, seeding procedures, low- and high-pressure apparatus, and color modification.

This volume is quite fascinating. Indeed, no one who lectures on gem material synthesis should be without it. However, it has extremely limited application for the mineralogist or petrologist. Although one might acquire insights for the construction of special-synthesis apparatus, the book has severe limitations. One of these is the lack of references; the work is intended for the commercial crystal grower and relevant references are given, but only to patents. The written literature is ignored completely. A company index, an inventor index, and a U. S. patent number index are given. The company index is simply a listing of the companies that hold patents in this field.

In spite of these limitations to the work, I found it very interesting. It describes the procedures of gem synthesis well and in sufficient detail with a good number of line drawings of apparatus. The drawings are of high quality (having been taken from the original patents), and they are well labeled. The numbers used for the labelling of different parts of apparatus are referred to clearly in text. This book will be essential to the crystal grower and gem expert, but of limited use to the mineralogist.

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THE IRON ORE DEPOSITS OF EUROPE AND ADJACENT AREAS, volumes I (418 p.) and II (286 p.). Edited by A. Zitzman, published in 1977 and 1978, respectively. Produced under the auspices of the International Geological Congress; Commission for the Geological Map of the World; Subcommission for the Metallogenic Map of the World. Distributed by E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Johannesstrasse 3A, D-7000 Stuttgart, West Germany. Price for both volumes together DM 138.-.

These two volumes represent the "Explanatory Notes to the International Map of the Iron Ore Deposits of Europe, 1:2,500,000". This international map, consisting of 16 sheets, became available in 1974. Each sheet costs DM 18.-, the complete set totaling DM 288.- (available from GeoCenter, International Landkartenhaus, POB 800830, D-7000 Stuttgart 80, West Germany). Volume I consists of 40 articles describing the occurrence and geologic setting of iron ore deposits in 40 of 42 countries covered by the Map of Iron Ore Deposits of Europe. The articles range from half a page in length ("The Iron Ores of Iceland" which describes two insignificant limonitic clay occurrences) to a major compendium of 66 pages on the wide range of iron ore deposits of the USSR. Of the 40 papers, twenty have been written or co-authored by the editor, A. Zitzman. The remaining contributions are by representatives of the various countries covered in the project. Seven of the papers are in French with the remaining 33 in English. Wherever applicable, the iron ore deposits within each country have been subdivided by a genetic scheme which includes the following categories: (1) liquid magmatic iron ore deposits; (2) Kiruna type ores; (3) contact metasomatic ores; (4) hydrothermal deposits; (5) volcano-sedimentary iron deposits; (6) marine-sedimentary iron ore deposits; (7) continental-sedimentary iron ore deposits; (8) iron deposits formed by weathering; and (9) metamorphic banded iron ore deposits. Although the above classification scheme is used whenever possible for the descriptions, several contributions use somewhat different schemes. For example, "The Iron Ore Deposits of Sweden" by R. Frietsch treats the various deposits by age groups such as the Mesozoic Ores and the Precambrian Ores. This contribution, by the way, is the only one which gives photographs (two) of the textures of the ores. It also has some of the most detailed and lucid geological maps of various iron districts in Sweden.

Volume I has five introductory and review articles with Zitzman as the single author or as co-author. These are entitled: (1) Introduction to the International Map of the Iron Ore Deposits of Europe; (2) Arrangement of the International Map of the Iron Ore Deposits of Europe; (3) The genetic types of iron ore deposits; (4) The distribution of iron ore deposits; and (5) The iron ore economic situation in Europe.

Volume II contains brief descriptions in the form of lists for specific iron ore deposits. These lists include information about their location, size, geology, mineralogy, contents, and mining. Such listings are given only for those deposits for which not all the pertinent information was presented in volume I. Sixty percent of the known deposits in Europe and adjacent countries are treated in this fashion (528 deposits in 34 countries). Volume II also contains tables which give information on genesis, age, mineralization, chemical composition, production and reserves for the 887 known iron ore deposits in all European and neighboring countries.

These two volumes in conjunction with the International Map of the Iron Ore Deposits of Europe provide a very comprehensive and exhaustive reference to economically important and geologically highly diverse iron ore deposits. The listings of references after each contribution reflect the highly varied sources from which the authors have drawn their information. Many such original sources are not available in most geological or mining libraries. As such these compendia represent a publication milestone in the history of European iron ore mining and production. The two volumes are well laid out, well illustrated, with a neat and very readable print, and few misspellings and misprints. The editor, Arnold Zitzman, is to be commended for his able and careful completion of this very large task.

The books are not inexpensive, nor is the set of 16 sheets of the map; thus only those who are professionally closely involved with iron-formations and iron ores will probably acquire these volumes for their private libraries. However, all institutional geologic and mining libraries should have copies in their reference collections.

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