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BOOK REVIEWS

ANLEITUNG ZUR ALLGEMEINEN UND POLARISATIONS-MIKROSKOPIE DER FESTKOERPER IM DURCHLICHT. By Rinne-Berek. Third edition by Hilmar Schumann, with assistance from Franz Kornder. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 1973. xii + 323 pages, 212 figures, one colored plate. DM49.

The first edition of this work appeared in 1933 just after the death of F. Rinne who had prepared the X-ray part. The second edition came in 1953; it was mainly the work of M. Berek (who died in 1949). There was no section covering X-rays, but xiii + 366 pages dealt with optical crystallography, including both transmitted and reflected light. In this third edition the material has been extensively rearranged by Professor Schumann; the portions dealing with reflected light (pp. 294–346, 2nd ed.) have been omitted, and these will appear in a later volume.

This third edition rates as a first class textbook in optical crystallography (by transmitted light). Section A of 95 pages covers basic crystallography (17 pp.; could well be omitted), wave theory, the compound microscope and geometrical optics, the refractometer and other auxilliary equipment, as well as sample preparation. Section B (33 pp.) deals with observations in non-polarized light. Here on page 117 appears Berek's fine diagram to explain central illumination phenomena, but unfortunately his drawing elucidating the Becke fringe (2nd ed., p. 172) is missing. Section C, work with polarized light, is in two parts: orthoscopic (84 pp.) and conoscopic (85 pp.). U-stage work has 37 pages in the former, 10 pages in the latter. Berek would be no happier than I am to see that this new edition no longer uses his simplified "international" method of designating U-stage axes; instead the Reinhard scheme has been resurrected. The spindle stage is not mentioned.

A 15-page appendix covering projections, *etc*, is followed by a 7-page bibliography (which omits Hartshorne and Stuart's excellent work; see *Am. Mineral.*, **59**, 216). The 3-page index is unsatisfactory; it is far less complete than that of the 2nd edition (11 pp.). The fold-out colored Michel-Lévy chart of interference phenomena is a desirable innovation. The book has no determinative tables. It should be emphasized that solving the equations of optical crystallography using an electronic slide rule type of portable or desk calculator is generally quicker and of course far more accurate than the use of nomograms. References to other parts of the book are common; they are indicated by section designations involving as many as five characters; at least eight of them are erroneous; they should be replaced with page numbers. SI units are not used, and indices are represented by n with a subscript α, β, or γ. This valuable textbook will be welcome to those dealing with this subject who can handle German; the excellent coverage of interference figures is to be noted.

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CRYSTAL STRUCTURE DATA OF INORGANIC COMPOUNDS. By Wolfgang Pies and Alarich Weiss. Part a: *Key Elements F, Cl, Br, I* (VII. Main Group) *Halides and Complex Halides.* Part g: *References for III/7.* Edited by K.-H. Hellwege and A. M. Hellwege. Volume 7, Group III: Crystal and Solid State Physics, of Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology, New Series, edited by K.-H. Hellwege. Springer-Verlag, Berlin, 1973. Part a: xxxii + 647 pages, $178.50; Part g: 457 pages, $90.20.

Group III, Volume 7, of the Landolt-Börnstein Tables summarizes the crystal structure data of inorganic compounds as determined by X-ray, neutron, or electron diffraction studies wherein the lattice constants, at least, have been measured. Substances are also included whose isostructuralism with well known crystal structures has been confirmed. For each substance listed, there is given: the formula, the space group and unit cell parameters, the density when known, the structure type, and an abbreviated reference to the source literature. The Preface, Table of Contents, and Introduction are written in German and in English. The tabulated data constituting the bulk of the volume is in German, but most of the words used have English cognates so that, except for the footnotes, English-speaking readers will have no difficulty in reading the tabulated material.

Part *a* summarizes data for compounds which contain at least one of the following elements—F, Cl, Br, I, O, N, and P—but are not considered organic because they lack such groups as C–H, C–C, C–NH_2, C=NH, or C–*X* (where *X* signifies F, Cl, Br, or I).

Volume III/7g contains the keys to the abbreviated literature citations given in the remaining parts (a) to (f) of Volume III/7.

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GEOLOGICAL LABORATORY TECHNIQUES. By Michael Allman and David F. Lawrence. Arco Publishing Company, Inc., New York, 1972. 335 pages. $25.00 cloth.

As anyone knows who has ever attempted in a text, pamphlet, or quarter or semester course, to compile and present an overview of laboratory techniques, the task of such synthesis is formidable. The authors of *Geological Laboratory Techniques* are to be complimented upon their attempt to give justice to this task.

Although the dust cover claims it to be "the first comprehensive handbook [of] practical information" and that "it covers advanced and sophisticated procedures," an examination of individual chapters reveals that this claim does not hold for each chapter or topic.

The topics described include specimen cutting and grinding, the preparation of thin sections of rock for microscopic

study, the petrological microscope, microfossil separation from various matrices, isolation of minerals from mixed powders, molding and casting methods to reproduce fossils, and modern embedding techniques for specimen display.

The chapter on cutting and grinding contains sections on abrasives, diamond tools, coolants, and machines. It gives specific information on such things as diamond bond type and rim speed to cutting efficiency for various rock types. It describes a number of machines, some of which are far more sophisticated than needed in the average college laboratory. The chapter on thin section preparation gives step by step instructions for making sections using the simplest equipment. Four pages of color photographs show progressive color changes in thin sections as they are ground from 90 to 30 microns. The authors also describe what they consider to be the ideal thin section laboratory. This turns out to include considerable machinery that apparently was custom designed and built for their own laboratory. They fail to mention a number of "thin section machines" marketed in this country such as the Ingrahm-Ward, Hillquist, and others. It is also unfortunate for the American reader that nearly all of the suppliers they list are British. These shortcomings are more than compensated by the excellent section on impregnation and treatment of difficult rock types.

In their excellent discussion of staining, the authors have perhaps for the first time systematized with flow charts, recipes, and outlines, the procedures of the multitude of carbonate, feldspar, and clay staining techniques and elusive recipes.

With their chapter on separation, the authors make an important impact with a discussion of methods of preparing samples for heavy liquid separation, including centrifugation and their necessary time-rate charts. The worker will find very helpful the listing of main mineral types, their specific gravity range, and separation liquids together on one chart. Also included are recipes for preparing disaggregation solutions, peptizers, and dispersives as well as heavy-liquid handling and dilution.

The above—followed by an absolutely "top-notch" effort in moulding and casting and a chapter on peel techniques—leave no doubt that the authors have absolutely "done their homework" and have made strong contributions replete with dozens of excellent cross-sections, diagrams, photographs, and figures. These chapters certainly make the handbook worthwhile.

On the idea of not necessarily covering "advanced and sophisticated procedures," cases in point could be made for the sections on "elements of optical microscopy" where it is really all that is entitled; however, it overemphasizes parts of microscopes and their function to the *n*th degree. However, the "how-to," or techniques, leave much to be desired. The information on the universal stage could be better obtained from just two or three pages from Bloss's or Phillips's optical texts than can be gained from this entire chapter, partly because the chapter is more instrument description than methodology or technique.

The chapter on X-ray and spectrographic methods is an excellent example of overemphasis on instrument description. It appears to be explanatory gloss of some X-ray methods and instruments, whereas the technician would be more interested in Table 34 of that chapter—"suggested equipment setting for major element analysis," or in a graphical plot of the effect of mounting pressure on count rates (Fig. 145). Finally, the portion devoted to IR and AA is, at best, cursory and offers little or no technique.

Laboratory work in geology serves a wide variety of purposes. Some is for sample preparation, some is for data gathering on prepared rock or fossil samples, some is for rock or mineral synthesis, and some is for manuscript preparation. The authors of *Geological Laboratory Techniques* have, for the most part, concentrated on methods of sample preparation. To this end they have produced seven excellent chapters on cutting and grinding, thin section preparation, staining techniques, crushing and sieving, separation methods, molding and casting techniques, and peels and embedding. These reviewers know of no other source where so much information on these very useful techniques is so readily and completely available to the geologist. Two other chapters on elements of optical microscopy, and X-ray and spectrographic methods, however, are inadequate substitutes for many excellent texts and equipment manuals on these subjects. The authors purposefully omitted discussion of "wet chemical analysis, photography, cartography and curating as they are . . . well covered in existing literature." They also have omitted techniques used in experimental synthesis of rocks and minerals. What results is seven excellent chapters on sample preparation.

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GEOLOGY OF THE LEECH LAKE MOUNTAIN-BALL MOUNTAIN REGION, CALIFORNIA. *A Cross Section of the Northeastern Franciscan Belt and Its Tectonic Implications.* By John Suppe. University of California, Publications in Geological Sciences, 1973. 82 pages, maps.

This report documents the geology of about 450 square miles (1,170 sq km) of rugged terrain underlain by rocks of the Franciscan assemblage in the northern Coast Ranges of California. It gives the results of Ph.D. thesis and postdoctoral work extending over about 6 years and including field mapping, petrographic studies, K/Ar dating, and a few electron probe examinations. The accompanying map covers parts of three 15-minute quadrangles, Anthony Peak, Covello, and Paskenta.

The Franciscan rocks are divided into the intertonguing Hellhole Graywacke Facies and Williams Chaos Facies, the Taliaferro Metamorphic Complex, South Fork Mountain Schist with Chinquapin Metabasalt Member, and an inconsequential serpentinite unit not considered further in this review. These units are distinguished by different bedding, metamorphic textures, and metamorphic mineral assemblages. The author believes that each occupies separate thrust plates lying beneath the Coast Range thrust and its overlying rocks of the Great Valley Sequence. On the basis of fossil and K/Ar dates, and postulated *P-T* conditions responsible for the metamorphic mineral assemblages, he suggests that the plates are shuffled so that neither their stratigraphic order nor metamorphic grade shows a continuous sequence.

The study of the metamorphic mineral assemblages will be of greatest interest to mineralogists and petrologists. All of

the units are high *P*-low *T* blueschist in that they contain the key index mineral, lawsonite. Details of mineral assemblages for metagraywackes and metabasalts for each unit obtained from study of hundreds of specimens are presented in tabular form and also on convenient maps showing plots of distribution of a mineral or of related minerals. Jadeite plus quartz is confined to the Taliaferro Metamorphic Complex. Aragonite and lawsonite occur in all units. Pumpellyite is common in the lowest unit; closely related celadonite also occurs in the lower part of the pile but tends not to occur in samples having pumpellyite. Stilpnomelane is found in most metagraywacke in plates below the highest, which contains South Fork Mountain Schist. Blue amphibole, generally crossite, is common in the highest plate and in the Taliaferro Metamorphic Complex but rare in other units. Epidote is restricted to the metabasalts of the South Fork Mountain Schist and the Taliaferro Metamorphic Complex. On the basis of the mineral assemblages, the plates are assigned to *P-T* fields between 5.5–9 kbar and 200–300°C. Although there is considerable overlap in the *P-T* fields assigned each plate, in general the lowest pressure and temperature assemblage is at the base of the pile. The Taliaferro Metamorphic Complex, which is assigned the highest pressure field, however, occupies an intermediate position within the pile.

The shuffled plates are interpreted in terms of a subduction zone model, operative through the entire period of deposition and metamorphism from 150 to 70 m.y. ago. Suppe suggests that after subduction and metamorphism, the "deep-seated metamorphic blocks were emplaced . . . as huge sheets, slabs, and smaller tectonic blocks upward along younger thrusts . . . (pumpkin-seed kinematics). A mechanical explanation for the process remains to be discovered." The closing paragraph giving the author's belief that the Taliaferro Metamorphic Complex and perhaps the South Fork Mountain Schist were deposited east of the "oceanic" Great Valley Sequence does not seem to fit with the rest of the tectonic model presented.

The report unfortunately suffers from lack of good editing and proofreading, which make it confusing in places and erroneous in others. For example, there is no list of illustrations, and the folded maps and sections in the pocket have no figure numbers, so it is difficult to know which map is being referred to by figure number in the text. The most important, large, "Preliminary Geologic Map" is printed at an irrational scale (1 inch to a little less than 1 mile), which perhaps caused the author to write (p. 1) that he mapped an area measuring 80 × 40 km, although the map covers an area only 43.8 × 23.7 km. Apparently, the map explanation and text distinguish Williams Chaos Facies from other units by the absence of bedding, but on the map there are dozens of "attitude of bedding" symbols within areas shown as Williams Chaos Facies. In addition, on the map the pattern for South Fork Mountain Schist shown in the explanation is omitted entirely. Typographical errors are few, though we find "ultramaphic" on page 30 and on page 72, ". . . dimensions of the place" instead of ". . . of the plate," which could lead to misinterpretation. The new unit names Hellhole Graywacke Facies, Williams Chaos Facies, and Taliaferro Metamorphic Complex would have been better without "Facies" and "Metamorphic" as part of the formal names and are in fact used in the text without these extra words.

Although many would disagree with the author's modest statement that "The FIRST major Mesozoic structures to have been discovered within the Franciscan Terrain . . . are documented," this is a useful contribution to California Coast Range tectonics and to better understanding the puzzling problem of "inverted metamorphic zones" so commonly reported for blueschist terrains. All those dealing with Pacific Margin plate tectonics or details of internal structure in subduction zones will find it a useful reference.

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GENESIS OF PRECAMBRIAN IRON AND MANGANESE DEPOSITS. PROCEEDINGS OF THE KIEV SYMPOSIUM, 20–25 August 1970. UNESCO, 1973. Unipub, Inc., Box 433, New York, N.Y. 10016. 382 pages. $41.50.

Geologists have been interested for many years in the origin, occurrence, and history of Precambrian iron-formations as an indicator of the early history of the earth as well as important sources of iron ore. The publication of the Kiev Symposium on the "Genesis of Precambrian Iron and Manganese Deposits" held in 1970 brings to the geologic public important information concerning iron-formation, manganese and iron ore deposits. Thirty-nine papers presented at Kiev are published in this volume. The reports concern iron-formation and iron ores of Australia, Brazil, Canada, Gabon, India, Liberia, Mauritania, Morocco, Sweden, Union of Soviet Socialistic Republics, and the United States of America and manganese deposits of Brazil, Gabon, the Guianas, India, Morocco, and the U.S.S.R. This volume is especially noteworthy in that it includes 15 papers dealing with the geology of iron and manganese deposits in the U.S.S.R. The papers are published in English with summaries in French.

Papers are arranged into 4 topic areas with a rather peculiar grouping of papers that at times seems illogical. This does not detract from the papers, but requires the reader to check all papers for general subject matter. The following discussion is by topic groupings but does not attempt to indicate papers in order within each group.

(1) *"Genesis and types of iron-silicate and ferruginous cherty formations, their position in geosynclinal sedimentary or volcanic sequences, and the relation between these and analogous manganese-bearing formations."* This section includes 15 papers of which 5 are concerned with U.S.S.R. deposits. The introductory paper by G. A. Gross deals with the depositional environment of principal types of Precambrian iron-formations. Gross groups iron formations into the "Algoma Type" associated with eugeosynclinal volcanic-sedimentary rocks and the "Lake Superior Type" associated with miogeosynclinal rocks. The paper presents a fairly detailed account of the Snake River iron-formation of the Yukon-MacKenzie District. It concludes with a suggestion that Precambrian iron-formations may be related to "major deep-seated fault and tectonic systems of global dimensions." The other papers in this section are concerned with the time-distribution and type-distribution of iron-formations and the jaspilitic iron ores of Australia; Archean iron deposits of Canada associated with volcanogenic rocks; iron

and manganese deposits of Brazil, iron ores of India; the Precambrian iron and manganese deposits of the Anti-Alas region, Morocco; the sedimentary iron ores of Sweden; and the iron deposits of Krivoyrog, Kursk, and the Baltic Shield areas of the U.S.S.R.

(2) *"Absolute Age dating of iron-silicate and ferruginous formations and their position in the Precambrian stratigraphic sequence and analogous formations from the Phanerozoic."* This section is largely concerned with deposits in the U.S.S.R. with absolute age dating a very minor consideration in the papers. This section includes a paper by N. P. Semeneko that summarizes information on the iron-chert formations of the Ukrainian Shield; a paper on the high-grade iron ores of the Krivoyog type; iron deposits north and west of Lake Balkhash in Kazakhstan; the Maly Khingan iron deposits near the Amur River in Siberia; and the Uda area near the Sea of Okhofsk in far eastern U.S.S.R. The section also includes an interesting paper on the Altai iron deposits of Devonian age found in Western Siberia and Eastern Kazakhstan. These deposits consist of compact, interlaminated hematite and tuffite that locally contains plant fossils. These iron deposits are associated with ignimbrites, tuffs, volcanogenetic sediments, sandstones, shales, and local lenses of dolomitic limestone. The hematitic beds are high in alkalis. This section includes one non-Russian paper by B. Chaubert which summarizes the geology of manganese deposits in the Guianian Shield area of Brazil, French Guiana, Guyana, and Surinam. These deposits are associated with metavolcano-sedimentary rocks that give a metamorphic age of from 2050 to 1,700 m.y. The paper presents the broad regional geologic setting of the manganese-bearing rocks of northeastern South America.

(3) *"Differing degrees of metamorphism, the mineral facies and petrographic nomenclature of ferruginous rocks such as ferruginous quartzites, taconites, jaspilites, and itabirites."* This section includes a summary paper on the Mesabi, Gunflint, and Cuyuna ranges in Minnesota; a brief review of iron-formations of the Aldan Shield of eastern Siberia; and iron and manganiferrous-iron deposits of Precambrian to Middle Paleozoic age north and west of Lake Balkhash in Kazakhstan. The section also includes a discussion by Y. P. Melnik and R. I. Siroshtan of the metamorphism of cherty-iron rocks. Their paper makes separate calculations for silicate iron-formation, carbonate iron-formation, silicate-carbonate iron-formation and oxide iron-formation. Included in the section is an interesting paper by W. Scarpelli on the Serra do Navio manganese deposits, Amapa, Brazil, that describes the stratigraphy, structure, metamorphism, and secondary enrichment of the manganese-bearing metasediments to manganese ore and a paper by S. Roy that presents a comprehensive summary of the origin and metamorphism of Precambrian manganese deposits of India. He shows the possible changes in manganese mineralogy with increasing temperature and uses microphotographs to illustrate manganese mineral relationships.

(4) *"Genesis of high-grade secondary iron and manganese ores from iron-silicate and ferruginous formations and ores, metasomatic processes and processes of oxidation in them."* This section includes a particularly interesting series of papers. A. F. Trendall discusses the possible origin of Hammersley Group cherty iron-formations as varved evaporites; W. N. MacLeod describes the iron ores of the Hammersley area, Australia; G. E. Tolbert *et al* describe the vast high grade iron ores of Serra Dos Carajás of Pará, Brazil; and F. G. Percival describes the iron ores of Kedia d'Idjil, Mauritania, discusses possible time of ore enrichment, and suggests that leaching may have started in the Precambrian and continued for a long period of time. S. J. Sims summarizes the origin and occurrence of the Belinga iron ore deposit in the Mekambo District, Gabon. H. Gruss presents an interesting comparison of the geology of itabirite iron ores of Liberia and Sierra Leone and Venezuela and indicates that the iron deposits occur in similar geological environments and are of similar age, 2,500 and 3000 m.y. The author includes brief summaries of the El Pao, Cerro Bolivar, and San Isidro deposits in Venezuela, the Bomi Hills, Bong Range, Mona River, and Nimba deposits in Liberia, and the Marampa deposit in Sierra Leone. G. V. Tokhtnev describes the variety of structural situations related to folds and faults that control high grade iron ores at Krivoyrog, U.S.S.R. J. E. Gair presents a summary review of the iron deposits of Michigan, U.S.A., that brings together information on the geology and occurrence of iron deposits of the Gogebic, Iron River-Crystal Falls, Menominee, and Marquette Districts. F. Weber gives an informative paper concerning the extensive Moanda manganese deposits of Gabon which occur in unmetamorphosed, Precambrian sediments with some associated volcano-sedimentary rocks that are dated at 1740 m.y. Weber suggests a source of manganese in volcanic rocks with subsequent sedimentary enrichment in manganiferrous carbonate shales and dolomite and a final enrichment to ore by weathering to high grade manganese ore. A paper by E. C. Perry, Jr., and F. C. Tan on carbon isotope variations in carbonates of the Biwabik iron-formation, Minnesota, seems out of place in this section as it is concerned with variations in carbon isotopes and the possible relationship of carbon isotopes to the transportation and deposition of iron.

The Symposium papers are followed by a brief discussion of "Problems of nomenclature for banded ferruginous-cherty sedimentary rocks and their metamorphic equivalents." This addition to the volume presents the problem of different usage in various parts of the world with different terms used for the same rock and the same terms for different rocks. There is an evident need to standardize the nomenclature used to describe banded, ferruginous-cherty sedimentary rocks. As a result of the Kiev symposium an Ad Hoc Committee was established. The results of this committee's work are published in *Economic Geology,* Volume **67,** pages 682–684, 1972. The problem of usage was not solved by the committee and exists to some degree in the papers of the Kiev Symposium.

As mentioned previously, the order of papers in this volume is confusing and requires that the reader peruse many of the papers to determine whether the paper contains the type of information he is seeking. Many of the papers are reviews of extensive work or very brief summaries of complex geological situations. Readers will find the geology and occurrences described in some papers, dealing with unknown deposits and districts, difficult to understand. Several of the papers, particularly a number of papers describing the U.S.S.R. deposits, do not contain maps to show the general

geographic location and do not show a scale for maps or sections. Often maps do not locate geographic sites referred to in the text. The reviewer had difficulty in locating some deposits, except very generally, on readily available maps of the U.S.S.R.

This volume contains much very useful information concerning iron and manganese deposits of the world. Even though there is an uneven quality of papers, this publication is an important addition to the geological literature of iron and manganese.

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INTERNAL WORLD OF GEMSTONES. DOCUMENTS FROM SPACE AND TIME. By E. Gübelin. ABC Edition, Zurich, 1973. 234 pages, 360 color illustrations. Swiss fr. 168. = ~$53.00.

This is the long-awaited successor to the author's previous work on inclusions in gemstones published by the Gemological Institute of America in 1953 under the title *Inclusions as a Means of Gemstone Identification*. Whereas the latter was illustrated largely in black and white, the present book is entirely in color, utilizing superbly precise photographs which often are very beautiful in the artistic sense, quite aside from their illustrative value to the serious student of gemology. Indeed one need not even be a gemologist or mineralogist to obtain pleasure from viewing some of the fantastic arrays of inclusions in striking color which appear upon these pages.

This work is aimed primarily at the gemologist who wishes to examine microscopic inclusions in transparent gemstones from the diagnostic viewpoint. Hence the text is written in simple language principally to acquaint the reader with the genetic factors which are responsible for inclusions, with detailed descriptions of the inclusions themselves following, and all of it nailed down by provision of numerous examples illustrated in the photographs.

The introduction discusses the history of prior investigations into crystal inclusions and the means by which they may be investigated now, including the use of the electron microprobe for chemical analysis of naturally exposed inclusions or of those that are exposed by lapidary techniques to provide sufficiently large areas for microprobe work. While the technical portions are too brief to be of practical value, the methods have been adequately described in other publications and need not be repeated here, although specific references to where such techniques are described would have been helpful.

The next major text section concerns itself with the genetic classification of inclusions; the author divides them into protogenetic, syngenetic, and epigenetic types and discusses the formation and significance of each type of inclusion. Specific mineral examples are provided. Inclusions are categorized as solid, liquid, gas, negative crystals, twinning, banding, asterias, cracks, cleavages, *etc*, again with examples which prominently appear in well known gemstones.

The third section takes up principal gemstones in which inclusions commonly form distinctive features, namely diamond, corundum, beryl, feldspar, garnet, peridot, quartz, spinel, topaz, tourmaline, and zircon. Inclusions characteristic of synthetics are described in the final section, *i.e.*, inclusions in corundum, emerald, spinel, rutile, strontium titanate, yttrium aluminate, and glass. A five-page glossary and a bibliography of about 85 entries complete the work. Unfortunately, there is no index.

Aside from its obvious value to gemologists, Gübelin's book should prove helpful to mineralogists who seek clues to the identity of inclusions in mineral crystals under investigation. Admittedly the species discussed are restricted to those of greatest interest as gemstones, but the inclusions themselves may well appear within other associates in the parageneses in which the described gemstones are typical members. In any event, everyone is sure to enjoy this high quality, beautifully illustrated, and authoritative work, regardless of his degree of interest in gemology as such.

JOHN SINKANKAS
Earth Sciences Literature

MINERALOGY OF SOIL CLAYS AND CLAY MINERALS. Edited by S. K. Mukherjee and T. D. Biswas. Indian Society of Soil Science, New Delhi, Bulletin No. 9, 1974. vi + 262 pages and "Soil Clay Minerals Map of India."

This volume is dedicated to Dr. J. N. Mukherjee on occasion of his 82nd birthday. It consists of 14 chapters by 24 Indian authors and co-authors writing on their specialities, plus the introduction and a final chapter in glorious tribute to the eminent Dr. Mukherjee. Topics covered include genesis, structure, mineralogy, ion exchange, electro and colloid chemistry, and distribution of clay minerals, especially in soils. Four chapters are devoted to applications of clay minerals in industry.

The introduction correctly states that in the volume, "The contributions of Indian soil scientists . . . refer mainly to investigations on Indian soils in the background of the available world literature on the various topics." "The Bulletin covers two broad and somewhat overlapping themes, namely mineralogy of soil clays, and properties and technological utilization of clay minerals."

Accordingly the papers are structured mainly as introductions and reviews of the world literature within the subject area, plus special applications to Indian occurrences. The papers thus are not primarily reports of individual investigations but are excellent reviews independently prepared. There is some overlap, as the Introduction states. The reviews are broad in approach informing the reader, for example, of such fundamentals as the basal spacing of kaolinite being about 7 Å as well as the latest publications on clay synthesis, plant nutrition via clay minerals, and the use of carboxymethylcellulose to reduce filtration loss of drilling mud. Likewise, one reads that "the adsorption of basic dyestuffs, like methylene blue and malachite green, on clay minerals provides a comparatively easy method of clay mineral identification" (p. 231) but also finds a discussion on the use of electron diffraction for identification and analysis (p. 123) of clay minerals.

Readers in India will naturally find the volume more useful to them locally than will those of us overseas. We will be most favorably impressed by the thorough familiarity of clay scientists in India with world literature on clays and

clay minerals. A foreign visitor likewise will need this volume to inform himself of the most active Indian publishers and their fields of study. It is fitting, by this volume, for his colleagues to highly honor world-wide the exemplary achievements of Dr. J. M. Mukherjee during his pioneering and long, illustrious career in clay service.

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NATURE OF EARTH MATERIALS. By Anthony C. Tennissen. Prentice-Hall, New Jersey, 1974. vii + 439 pages. $11.95.

The major purpose of this book, to serve as a text for a college course on earth materials, has been attained. Up to the time of this review, the reviewer had come in contact with no other book having such a wealth of information concerning earth materials, including even petroleum and water. Although there are many fine features, unfortunately there are also a few that detract from the quality of this book.

This text has been divided into four sections. The first, comprising 42 pages, deals with atoms, ions, and crystals. The second, 167 pages, concerns properties and descriptions of 114 minerals. The third includes 136 pages about origins, characteristics, and descriptions of igneous, sedimentary, and metamorphic rocks. The last part, 67 pages, covers uses of earth materials, origins of ore deposits, classification of ore deposits, exploration and discovery of economic earth materials, mining, quarrying, processing, beneficiation, and refining of earth materials. There is a three-page bibliography and a very brief appendix containing 1970 data concerning U.S. metals, nonmetals, industrial rock, and fuels production. In addition, there is a 21-page index.

The most disturbing feature of this book is the series of photographs of each of the 114 minerals described. If the photographs had been in color, and taken by a mineralogist skilled in photography, their value would be inestimable for the student using this book. However, they were taken in black and white by the director of photographic services at the college where Tennissen teaches, and for the most part they are useless. For example, what good is a black and white picture of very poorly crystallized sulfur associated with unnamed minerals? Or of a rounded octahedral diamond crystal measuring about 2″ × 2″ on the photograph with no scale given? Undoubtedly the photograph has been enlarged, but how will the student know this when no information is given in the legend accompanying the photograph? Many of the captions are inadequate. One states that fluorite has both cubic and octahedral cleavage. (If this is so, almost every mineralogy textbook now in print should be revised.)

In places there is too much detail and in other places treatment is inadequate. For example, is it necessary in a book on earth materials to list the crystal forms for each crystal system, including such unusual ones as the tristetrahedron, and omitting the disphenoid of chalcopyrite? In the discussion of the crystal systems the hexagonal system is described, but nothing is said about the rhombohedral division. The author does not state that the *c* axis is perpendicular to the plane containing the three horizontal axes. In addition, he erroneously states, "crystals in this system are six-sided, or at least display a hexagonal (six-sided) outline when viewed parallel with the vertical axis." Yet in describing tourmaline he states that it has a triangular cross-section. He says nothing about hemimorphism or enantiomorphism.

The selection of minerals for discussion is very good and that of rocks is fairly complete. However, there are numerous minor errors, indicating poor editing and perhaps hurried writing without enough attention to correctness and latest information. He has included nothing about the synthesis and commercial production of quartz crystals. The use of quartz in timepieces is not mentioned. Graphite has not been mined in New York State for at least 25 years, yet this state is listed as producing graphite. Nothing but a caption on a photograph reveals the location of garnet in New York state, which has the largest working garnet mine in the world and some of the largest, if not the largest, garnet crystals in the world. The photograph shows "fine deep red garnet from Warren County, New York," but one would have to have an excellent imagination to see the garnet in the picture. The correct locality of the large garnet crystals is Gore Mountain, New York. The author's treatment of abrasives comprises a mention of emery, one sentence under the mineral description of garnet, and one word under the section on sandstone.

A feature which the reviewer found a nuisance was the separation of uses from descriptions of the minerals. Perhaps the author could have included at the bottom of each mineral description the page number where its use would be given, and then, where the uses were discussed, have given the page numbers of the descriptions. Instead, each time further information was desired, this reviewer had to go to the index, a time consuming process.

There are a number of inconsistencies or inaccuracies. For example, (1) on page 389 appears the statement "diamonds can be broken with a hard blow because they lack toughness in certain directions," yet on page 100 diamond is said to have octahedral cleavage; on page 389 he states, "diamonds have a high melting point" yet gives nothing about diamond burning at 1000 degrees. (2) Turquoise is mentioned as having geometric perfection. How can this be so when the largest turquoise crystals (triclinic) are not even one centimeter long and are very rare? (3) A variety of corundum, sapphire, is said to be blue. Sapphire can also be yellow, green—almost any color except red—but the reader is given the impression that the only color of sapphire is blue.

The diagrams are of good quality and well labelled. However, a rear face has its Miller indices as (111) when they should be $(\bar{1}11)$. This will cause confusion as a front face is correctly labelled on the same diagram. An attempt should have been made to show the angles involved on the diagrams and photographs of the rhombohedral cleavage of calcite. As it appears in the text, the cleavage too closely resembles cubic and by the uninitiated will probably be so interpreted.

On page 79, a formula is given for calculating the specific gravity from data obtained with the Jolly balance. The formula is S.G. $= n_1 - (n/n_1) - n_2$; $n =$ reading with the spring carrying both pans, $n_1 =$ reading when small mineral fragment is placed on upper pan in air, $n_2 =$ reading when same mineral fragment is on lower pan. In each case, the lower pan is submerged in water. The principles involved in

the operation of the Jolly balance are omitted. The formula does not work, as the reviewer tried it on data obtained with the Jolly balance. A search of the literature for this formula was fruitless. A formula based on the Archimedes principle, which does work, is the following: S.G. $= (n_1 - n)/(n_1 - n_2)$.

The section on rocks appears to have fewer errors than that on minerals. One noted by this reviewer is that exfoliation is attributed to diurnal change in temperature, and nothing is mentioned about the role of hydration in exfoliation. As a matter of fact, temperature change alone in the laboratory has not produced exfoliation, and as yet no exfoliation has been found on the moon, whereas, and if large temperature changes were responsible for exfoliation, the moon would certainly have examples.

In the description of loess, nothing is stated about the angularity of the grains and the role that this shape plays in making the loess in many localities so stable that it will have an angle of repose in road cuts of 90 degrees.

In the bibliography there is an error in the title of Azaroff's and Buerger's book. The correct title is *The Powder Method in X-ray Crystallography*. The fourth edition of *Dana's Textbook of Mineralogy* revised by William E. Ford published by Wiley was copyrighted in 1932, not 1948. It is strange that with the excellent books on gems, not one book devoted solely to gems appears in the bibliography. Also omitted are the set of five volumes on *Rock-forming Minerals* by Deer, Howie, and Zussman, and reference works on petroleum, coal, and water.

In his preface the author writes that the book should have general appeal to geologists and rockhounds as well. The reviewer does not agree. There are numerous excellent mineralogy books and some fine petrology texts which would serve geologists and rockhounds in a far better manner. However, the reviewer does agree that, despite the deficiencies and minor errors, this is the single book which would most suit those students enrolled in a course dealing with earth materials, provided that they were not geology majors.

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RÖNTGEN-, ELEKTRONEN- UND NEUTRONENBEUGUNG AN GLÄSERN. Edited by H. Wondratschek. Fachausschussbericht Nr. 68 der Deutschen Glastechnischen Gesellschaft E.V., Frankfurt (Main), 1973. vii + 104 pages. DM 40.00.

Röntgen-, Elektronen-, und Neutronenbeugung an Gläsern is one of a series of committee reports of the *Deutsche Glastechnische Gesellschaft*. The volume (format 8 × 12 inches) contains three review articles and a useful introduction by the editor in which the merits of diffraction studies of glasses are evaluated and put into perspective.

The first and longest article (68 pages, 402 references) is by H. Krömer. It deals with X-ray diffraction of glasses and consists of 4 main chapters: X-ray diffraction on amorphous substances (10 pages), experimental (3 pages), evaluation of measurements and interpretation of results (10 pages), results of X-ray studies of glasses (28 pages). This review covers studies dealing with the X-ray determination of the atomic dimensions of glasses, namely by analysis of the radial density distribution. Sources of experimental error and limitations of the method are discussed. In some cases the results are compared with results of NMR and small angle scattering studies. A short review of the closely related structural investigation of liquids, liquid crystals, and organic polymers is also given.

The reviews on electron diffraction (by E. Deeg and H. Bach, 15 pages, 54 references) and neutron diffraction of glasses (H. Böhm and W. Hoffmann, 19 pages, 34 references) are similarly arranged but much shorter than the X-ray article, because less has been published in these fields and because the general diffraction theory has been covered in the first review.

The volume is useful as a critical and fairly complete introduction to the literature on the subject (references up to 1972 are included). However, it cannot be called authoritative because none of the authors of the reviews is a leading practitioner in the field being reviewed. Unfortunately, no index has been provided.

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STABLE ISOTOPE GEOCHEMISTRY. By Jochen Hoefs. Vol. 9, *Minerals, Rocks, and Inorganic Materials*. Springer-Verlag, New York, Heidelberg, Berlin, 1973. ix + 140 pages. $14.50.

Professor Rankama's *Isotope Geology* and *Progress in Isotope Geology* played a very important role in the development of isotopic studies in earth sciences. Isotopic techniques for the study of earth sciences have been used even more widely in the 1960's and early 70's than when Professor Rankama was writing, and it is becoming increasingly difficult for active researchers to keep up with the new information being published.

This new publication by Dr. Hoefs gives recent developments in isotopic studies in earth sciences, and will play the same role as did Professor Rankama's books. Readers will especially appreciate the bibliography of about 500 papers.

The text is divided into three parts. Section A briefly discusses isotope effects and the basic principles of mass spectrometry. Section B describes sample preparation for isotope analysis, isotope reference samples, and isotope fractionation mechanisms of light elements in nature. As Hoefs acknowledges, the discussions are too short to give more than a general idea to readers who are not familiar with these subjects. Section C (60 percent of the volume) gives a detailed description of the isotopic variations in extraterrestrial materials, lithosphere, atmosphere, hydrosphere, and biosphere. This section is valuable for a reader who is looking for up-to-date knowledge of these topics, as the author has succeeded in reviewing thoroughly the present status of research.

As one title in the monograph series of "Minerals, Rocks, and Inorganic Materials," the book has to cover too many important subjects to give the detailed information on isotope geology and geochemistry that this reviewer expected. Because of the importance of knowledge of both equilibrium and kinetic isotope effects and mass spectrometry, this reviewer hopes that a book on theoretical and

experimental isotope geochemistry will be published later in this series. For a clear understanding of these latter subjects, a beginner in this field is advised to consult the original papers which are referenced in this book.

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WORLD DIRECTORY OF MINERAL COLLECTIONS, prepared by the Commission on Museums of the International Mineralogical Association, Pieter C. Zwaan, Chairman, Ole V. Petersen, Secretary, Marjorie Hooker, I.M.A. Secretary.

A listing of mineral collections within the member countries of the International Mineralogical Association, namely Austria, Belgium, Brazil, Bulgaria, Canada, Czechoslovakia, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Spain, Sweden, Switzerland, United Kingdom, United States of America. For each museum listed there is given its name and address, its year of founding, the person in charge, the total number of specimens, the uses that the museum serves, its specialties, whether it will loan material to qualified investigators, whether it has material for exchange, whether a catalogue of its holdings is available, and its hours of admission. The preface notes that

"We are well aware that this first edition is incomplete. We hope, however, that publication will encourage those who have not cooperated up to this time to submit completed questionnaires so that they will appear in a future edition. Questionnaires can be obtained from Dr. O. V. Petersen, Mineralogical Museum, Øster Voldgade 5–7, DK-1350 Copenhagen, Denmark."

At present only 3 museums are listed for the United Kingdom and only 9 for the United States. This directory deserves to grow. Those going abroad will find it a great convenience if they wish to visit mineral collections.

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List of Books Received

FUNDAMENTALS OF COSMIC PHYSICS. Volume 1, Numbers 1/2, 1974. Edited by A. G. W. Cameron. Published by Gordon and Breach Science Publishers, New York. $17.50/year, U.S.A.

GEOSCIENCE CANADA. Volume 1, Number 1, March 1974. Edited by G. V. Middleton. Published by Geological Association of Canada Publications, Business and Economic Service Limited, 111 Peter Street, Toronto 1, Ontario. $10.00 per year (nonmembers); $3.00 per copy.

INDIAN JOURNAL OF EARTH SCIENCES. Volume 1, No. 1, 1974. Edited by A. K. Saha. Published by Department of Geology, Presidency College, Calcutta 700012, India. $10.00/year, U.S.A.

THE NOMENCLATURE OF PETROLOGY. By Arthur Holmes. Facsimile of the 1920 edition. Hafner Publishing Company, New York, 1971. 284 pages. $9.95.

THE SCIENTIFIC PAPERS OF DR. TOKITI NODA AND HIS COLLABORATORS. 1973. Published in Japanese, with some abstracts in English. Available from Dr. T. Noda, 15-3 Shikannonmichi Nishi, Tashiro-cho, Chikusa-ku, Nagoya 464, Japan.

SOLID STATE MATERIALS: PREPARATION AND PROPERTIES. VOLUME 1, ASPECTS OF CRYSTAL GROWTH. Edited by R. A. Lefever. Marcel Dekker, New York, 1971. 284 pages. $18.50.

SOUTHERN CALIFORNIA INDUSTRIAL MINERALS. Published by MINOBRAS, P. O. Box 4870, Irvine, California 92664. 1973. 112 pages. A Directory of mines, deposits, and occurrences for the 13 counties of Southern California.

SYMMETRY OF CRYSTALS. By E. S. Fedorov. Translated by David and Katherine Harker. American Crystallographic Association, 1971. 315 pages.