

## BOOK REVIEWS

THE SUDBURY ORES: THEIR MINERALOGY AND ORIGIN. J. E. HAWLEY.  
Mineralogical Association of Canada, University of Toronto Press, Toronto, 1962.  
207 pp., \$5.00.

This book, based on thirty years of research by the author and graduate students under his direction, is a major contribution to the literature on one of the world's greatest and most interesting mineralized districts. The main subject matter of the book is indicated by the title, but mineralogy and origin have been examined against the background of the geology of the Sudbury district, so far as this is understood at the present time.

The book has three parts. The first gives an extended summary of the geologic features of the Sudbury intrusive and its geological setting, with emphasis on findings of recent years that have clarified a considerable number of the puzzling aspects of the district. The second section is a factual description, first of the ore deposits of the Sudbury district, then, in great detail, of the minerals of the ores. Substantial chemical information is given for the various minerals. Textural relations are described and illustrated by 96 excellent photomicrographs. The section closes with a detailed discussion of the distribution of metals and minerals in the ores.

The final section of the book is devoted to the history and origin of the ores as interpreted by the author. Gravity separation of immiscible sulfide-rich liquid from the norite magma is accepted as the prime mechanism of concentration of the ore constituents. Concentration of some ore bodies is ascribed to *in situ* crystallization of settled liquid, of others to injection of the segregated sulfide-rich liquid along fractures, breccia zones, and other structural features associated with the margin of the main norite body or with the offsets. The evidence for origin of the two classes of ore deposits is reviewed and new evidence is brought forward. The diversity of occurrence and variations in the mineralogy of the deposits are ascribed largely to differences in mode of emplacement or degree of differentiation of the sulfide-rich liquid. The remarkable "upside-down" zoning of minerals and metals in the Froid-Stobie deposit is attributed to crystallization downward from the heat source, the overlying portion of the intrusive.

Features of certain ore deposits of the Sudbury district are not attributable to the processes summarized above. They are not all understood at present, but (leaving out supergene alterations) the author points out that some, at least, can be ascribed to local remobilization by post-ore granite or Keweenaw dikes, or to a much later hydrothermal mineralization. Supergene alteration is in general a minor feature of the district.

The book is of interest for many reasons, some obvious from the above. The complexity of the deposits as a function of the long geologic history of the district is clearly brought out. With the advantage of hindsight, it is easy to see why the origin of the Sudbury ores has been controversial for so many decades. Almost any hypothesis of origin can be supported by selected features of the district. The true picture of origin of so complex a group of deposits emerges only as their overall characteristics become known, and it becomes possible to sort out the major features from the details and aberrations from the norm. As the author himself points out, there are numerous features that are still incompletely understood and will provide food for debate in the future. In the meanwhile, the author has given a synthesis of the present state of knowledge and of his own experience and interpretation that will be of interest to every mineralogist and economic geologist.

EUGENE N. CAMERON

PETROLOGY. WALTER T. HUANG. McGraw-Hill Book Company, Inc., New York, 1962.  
480+xi pp. \$9.75.

The author has recognized the dire need for a completely new textbook in elementary petrology (nonmicroscopic). This book, however, so hastily prepared, so full of informa-

tional errors, and so bad an example of the "scientific method," is definitely not the answer. Much of the writing is characterized by incoherence or loose thinking. Portions appear to be a hodgepodge of facts and ideas.

The author's intent was to present the fundamentals of modern petrology to students who have had little more than elementary geology. The book is very complete, with a wide assortment of relatively up-to-date material. There is a good balance between the three parts, which treat of igneous, sedimentary and metamorphic rocks. The general scope and organization are quite satisfactory, and the text material is supplemented with an array of clear, well-executed figures and tables.

The author attempts to present in a single elementary work the principal content of several advanced textbooks and many individual studies in petrology. His sources and choice of material are excellent, but the integration is poor and the coverage much too great. Extractions are commonly too incomplete and loaded with technical jargon, or the main point is subdued or lost in a mass of seemingly irrelevant detail.

Time and again, due to an aberrant style of writing, the reader is likely to lose the trend of thought as, it appears to this reviewer, even the author has done on occasion. Some sections of the book are so rudimentary they are dangerous; others will have little meaning for the beginner.

The lack of discrimination between the genetic and descriptive material is a very bad feature of this book. It is likely to reduce the utility and versatility of the text and unlikely to encourage the student first, to observe, and then, to interpret.

In part I, *The Igneous Rocks*, the author proposes to use the terms texture and structure synonymously (p. 51) on the grounds that "there is no general agreement" in petrography as to what is texture and what is structure. This reviewer can accept neither his reason nor its validity. The two concepts—texture and structure—still remain; and although the author does not recognize the distinction, he rarely fails to conform with the dyadic scheme. Such consistency is unlikely coincidental and may have been unconsciously acquired.

The treatment of phase diagrams is conventionally skimpy and gives the student little insight into the meaning and application of the diagrams.

The igneous rock table (p. 88) is poorly arranged, incorrectly constructed, and inconsistent in itself and relative to the text. The porphyries, pegmatites, aplites, lamprophyres, and diabase are the sole representatives of the plutonic group. All members of the monzonite clan are improperly placed.

The igneous rock descriptions appear highly inconsistent in regard to detail, organization and treatment. Hand specimen descriptions, an essential in such a text, are rather brief and disappointing. Commonly in his enthusiasm, the author loses himself; and the description degenerates to a detailed treatment of mineralogical varieties and petrographic (microscopic) variants which the student will little appreciate, comprehensibly or otherwise. One distinct imbalance is illustrated by the 30-page description of the granite, granodiorite and tonalite families as compared with the 4-page treatment of the aphanitic equivalents.

The combined descriptive-genetic treatment fails to stress rock association in petrogenesis. To consider rock genesis on a family basis is petrologically unsound. Familial treatment requires oversimplification and is dangerously misleading.

The scope, coverage, and organization of the chapter on petrogenesis of igneous rocks is generally good, but this chapter, like most of the book, is characterized by contradiction, lack of accuracy and clarity, awkwardness and looseness of expression, and other rhetorical weaknesses.

Part II, *The Sedimentary Rocks*, covers fairly well the descriptive and genetic aspects.

For the most part, the material is up-to-date and well illustrated. However, the figure (p. 221) showing variations in detrital and chemical fractions of sedimentary rocks puzzles this reviewer. It appears not only incorrect, but also redundant, and its representation is obvious.

Interestingly enough, sedimentary textures and structures are distinguished. In the metamorphic rock section, however, such features are grouped as fabrics. The terms stratum and lamina are clearly defined; but precisely what the author means by the term bedding, and how current-bedding and cross-bedding are to be distinguished are not made clear. Such primary structures as mud cracks and rill marks are not mentioned.

The figure (p. 230) illustrating simple cross-stratification needs further explanation. To the beginner, it may seem inverted because otherwise it appears to violate the very relation (geometrical truncation) he is told to watch for.

Part III, The Metamorphic Rocks, is particularly deficient in visual representation of field features. Such common structures as lenses, veins, boudins, pegmatites and knots are neither illustrated nor described. In the metamorphic rock table (p. 384-385) a number of major mineralogical constituents are incorrectly indicated. Gneisses are not necessarily higher grade rocks than schists, and migmatites are not derived only from "felsic igneous rocks mixed with sediments."

The author badly confuses, and nowhere clearly defines, the terms schistosity and foliation. Gneisses are not all coarse grained and banded and all schists are not strongly schistose. The treatment of metamorphic facies is not only inconsistent but misleading and in part incorrect, and the author tends to tie lithologic types too closely to specific facies. Many of the criteria for distinguishing paragneisses from orthogneisses (p. 416-417) are weak. Others are so cryptic they will be of little use. In the incomplete treatment of contact metamorphism of argillaceous rocks, the student is unlikely to understand certain major steps in the reasoning.

Many scores of statements, definitions and explanations lack precision, lucidity and completeness. Such terms as composite dike, granulose fabric and lepidoblastic are vaguely and poorly defined. The student will not grasp the fundamental distinction between such terms as gneiss, granulite and schist, or between assimilation, incorporation and contamination. The following quotations exemplify a careless misleading style. "Small crystals disappear and large ones grow larger; thus shale becomes slate and slate becomes schist . . ." (p. 445). "This tendency is reversed by metamorphism, for metamorphism tends toward uniformity of distribution of the elements" (p. 454). "Stylolites are exceedingly irregular, interlocking columns of various length that project in opposite directions and meet among a very uneven surface" (p. 233). ". . . magmatic crystallization is primarily a function of its ionic size and ionic substitution" (p. 453).

A most disappointing feature of the book is the great number of misprints, omissions and grammatical errors; there are probably hundreds of such defects. The norm calculation (p. 78-79) carries at least 21 errors. The inclusion of molecular weight values for diopside and hypersthene in the normative mineral table (p. 77) suggests a lack of understanding of the phenomenon of solid solution.

Much material is presented without clear reference as to source, and the beginner will undoubtedly credit the author with these contributions. A more complete index and the inclusion of all and complete references should have been given at the end of the text.

It is the strong feeling of this reviewer that a book with such fundamental deficiencies should not be used as a text, because it runs counter to the very objectives we strive for in pedagogy in science.

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FUSED CAST REFRACTORIES, by A. A. LITVAKOVSKII. Translated by I. Morgenstern and published by the Israel Program for Scientific Translations, 1961; PST Cat. No. 36, \$2.75, 273 pp., 102 illust. The original book, Plavlenye Litye Ogneupory, Gosudarstvennoe izdatel'stvo literatury po stroitel'stvu, arkhitekture i stroitel'nym materialam, was published in Moscow in 1959.

This book is essentially a review of Russian papers about the petrography, physical chemistry, development, testing and commercial use of fused cast refractories. A rather complete Russian bibliography with a few references to American, British and French papers follows each chapter, but the book does not have an index. In the first chapter, the reader is introduced to the petrography of different refractories corroded by molten glass. The following two chapters review Mendeleev's table to relate the high-melting metals and oxides to their atomic arrangements, and present the oxide and silicate phase diagrams and a theory about the chemical and electrochemical corrosion of glass-tank refractories. The author discusses the phase diagrams for the system  $ZrO_2-Al_2O_3-SiO_2$ , shows the steps for the fusion of three compositions near the eutectic for baddeleyite ( $ZrO_2$ ), corundum, and mullite, and describes laboratory tests and commercial experience with these compositions. He suggests that crystal size and shape in the cast block can be controlled by additives and heat treatment after casting of the fused material. The impurities in the raw materials are discussed because  $TiO_2$ ,  $Na_2O$ ,  $K_2O$ ,  $Fe_2O_3$ ,  $CaO$ , or  $MgO$  cause excess glass to form and affect the service of the fused product. The fusion and casting operations are thoroughly discussed. Most of this subject matter is covered in American papers and text books. The collection of 70 photomicrographs would have made this an outstanding work, but the quality lost in reproduction limits the usefulness of this book as an edition for petrographers and as reference material for the corrosion of glass-tank refractories.

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SCIENCE OF CERAMICS: VOL. I, edited by G. H. STEWART, British Ceramic Society, Academic Press Inc., Ltd., Berkeley Square House, Berkeley Square, London, W.1; 111 Fifth Avenue, New York 3, New York, 334 p., 1962, \$11.50.

This volume constitutes the proceedings of a conference held at Oxford, 26-30 June, 1961, under the auspices of the British Ceramic Society and the Nederlandse Keramische Vereniging. It consists of 23 papers by contributors from eight countries. Except for 3 papers in German, all are printed in English, and each is preceded by abstracts in English, German and French. The subject matter ranges from the mineralogy of raw materials through the mineralogy and various properties of fired ceramics, including sintering, pore-size distribution, fracture mechanisms, dielectric constant, crystal-glass phases and applications to electronics and atomic energy areas. Most of the papers are basic, analytical, and develop considerable theory, *i.e.*, not empirical in approach, as once characterized ceramics.

Emphasizing a viewpoint of mineralogy that is oriented (or biased) toward geology, as well as toward ceramics, readers will find the following topics of particular interest. The first paper in the book on "Basic Phenomena in Sintering," by James White, President of the British Ceramic Society, treats by alternate models agglomeration of fine particles by heat in terms of a decrease in surface free energy of the system. Students of welded tuffs may find application of this thinking to some of their problems. Another investigation on sintering presents evidence of anisotropic grain growth due to a liquid phase at grain boundaries. In still another paper, fritted zircon is shown to melt and dissociate into  $SiO_2$  and

ZrO<sub>2</sub>. Metastable tetragonal zirconia may convert to monoclinic zirconia in the opacifying phases of glaze.

A copper-containing lead glaze yields a good light-red color by reduction with relatively pure CO. Color plates illustrate the effects of CO, H<sub>2</sub>, "town gas," methanol, ethanol, and mixtures on the color. Reactions are proposed and their standard free energies presented.

Two new aluminas are reported: a new type  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>, and one designated Kl-Al<sub>2</sub>O<sub>3</sub>. Very fine-grained active  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> was obtained which, under steam pressure, transforms at temperatures below 400° C. into boehmite and diaspore. The curves for the systems, Al<sub>2</sub>O<sub>3</sub>-H<sub>2</sub>O, as published by Ervin and Osborn, are modified. Thermodynamics of the conversions are calculated.

Ceramic raw materials are discussed, in terms of availability ranging in quantity from tons of gross material to impurities in defect structures, and their sources, both synthetic and natural. Quantitative determination of minerals in ceramic raw materials by use of electron microscopy, thermobalance, and dark-ground illumination (shown in color plates) is discussed (in German). Electron microscopy as a tool, and its techniques applied to ceramics, using replicas and peels, are described and illustrated. The thesis is presented, in one paper, that the clay mineral in kaolinitic and illitic clays is represented by a continuous modification of the kaolinite clay lattice to illite. Hydroxyl groups are presumably reduced in number by replacing them by divalent cations in octahedral positions. Evidence offered for this mechanism of transition may be unconvincing to many clay mineralogists.

An interesting differential dissolution of octahedral and tetrahedral layers of clay minerals, using dilute hydrochloric acid saturated with silica was used on montmorillonite, glauconite, kaolinite and biotite. Dissolution was checked by *x*-ray and infrared measurements.

Plasticity of mono-ionic clays was studied.

Texture of porous ceramic bodies was studied, and new methods of measurements described (in German). Another article describes the measurement of coarse pores in fired ceramic bodies. These methods would be applicable to porosity studies of rocks.

Fracture induced in MgO by thermal shock showed satisfactory agreement between theoretical and experimental values of strain.

The effect of solid solutions between barium titanate and strontium titanate, barium stannate, or barium zirconate, on the dielectric constant of corresponding ceramic capacitors was determined qualitatively, but quantitative relations are still lacking. Another paper showed that by using an excess of 4-8% titanium oxide in ceramic barium titanate, the ferroelectric permittivity can be increased to 3,000.

Cordierite and andalusite were developed, as shown by *x*-ray diffraction, in soft porcelains by a suitable raw-material mix in which the vitreous phase was high. Cordierite-containing ceramic bodies were developed by solid-state reaction in a mixture of sepiolite, kaolinite and MgCO<sub>3</sub>.

Mullite is formed by heating sericite in the range 1000° to 1400° C. The crystals become more nearly perfect with increasing temperature. Addition of kaolinite and  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> to sericite yields mullite additively at high temperature.

During the thermal decomposition of CaCO<sub>3</sub> and MgCO<sub>3</sub> the size of oxide crystals increases as the CO<sub>2</sub> pressure increases. The reaction shows a marked induction period in which two processes overlap: the formation of nuclei and the growth of crystals. This paper is in German.

Near the eutectic of CaF<sub>2</sub>-MgF<sub>2</sub> a ceramic material may be prepared by melting and casting. A UF<sub>4</sub> coating may be applied to graphite by this method.

The effects of physical interaction between crystal-glass phases were investigated in

ceramic bodies in relation to strength, elasticity, thermal expansion, fracture paths and systems, and other physical properties. Application of these findings to rocks having analogous textures is obvious.

The paper, typography and physical characteristics of the book are excellent.

W. D. KELLER

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**BERYLLIUM. EVALUATION OF DEPOSITS DURING PROSPECTING AND EXPLORATORY WORK**, by A. A. BEUS. Ed. by Lincoln R. Page, transl. by F. Lachman, prelim. ed. by R. K. Harrison. Publ. arr. by the Geochemical Society. 16+x pp., 40 figs., 24 tables. W. H. Freeman and Co., 660 Market St., San Francisco 4, Calif. \$5.00, 1962.

In some ways the long-awaited English version of this book comes as a disappointment, doubtless largely because the translation was considerably delayed. The original in Russian appeared in 1956, and in the interval there have been many new developments in the study of beryllium deposits and several new major publications on the geology of beryllium (e.g. Warner *et al.*, *U. S. Geol. Surv., Prof. Paper 318*; Mulligan, *Geol. Surv. Canada, Paper 60-21*). In fact, Beus, himself, has a second book on beryllium published in 1960, which also is to be translated under the auspices of the Geochemical Society.

As the result of this hiatus and the developments during it, the book is markedly out-of-date. One looks in vain, for example, for information on the beryllometer and its use in prospecting or the use of the Be content of muscovites for evaluating pegmatites for beryl in those cases when all exposures have been robbed of the mineral. Nor, owing to the delay, are there included descriptions of major new non-pegmatitic Be discoveries, e.g. Agua Chile, Mexico (fluorite-bertrandite replacement), Utah (fluorite-bertrandite in tuff), Georgetown, Colorado (beryl skarn), Mt. Antero (beryl-bearing granite), and Seal Lake, Labrador (barylite and eudymite in fenite). Such absences are, of course, no fault of the book, but they do point to the fact that many major developments in the field have come in the last five years and that, thus, the appearance *now*, of the first Beus book, is anticlimatic.

Apart from this aspect of the translation, the book itself is top heavy in its treatment of pegmatites as Be sources, their geology, prospecting and evaluation. About 100 pages in all of the 161 are devoted to pegmatites, and much of this material is elementary or empirical. As is typical of Russian publications no localities are listed for illustrative examples from the USSR (see Figs. 3, 4, 15, 17, 18, 25, 26, 33, 34). A series of figures (5-12) showing general shapes of pegmatites is an inclusion of dubious value, and Fig. 37, Conventional patterns for use on pegmatite maps and sections, is in the same category. An awkward translation might be noted here (p. 44, 82)—“pegmatites of the crossing-line.” Presumably what is meant is “pegmatites transitional to hydrothermal deposits.”

There is no real discussion of chrysoberyl pegmatites, or of the paragenetic relations of chrysoberyl and beryl. Gadolinite pegmatites are likewise cursorily treated. Actually in some districts, the restriction of most of the pegmatitic Be to gadolinite may indicate the presence of genetically associated hydrothermal deposits of beryl.

The list of Be minerals (p. 24) omits karpinskyite—a Russian discovery, but retains “gelbertrandite” and “spherobertrandite.” In the description of bertrandite no mention is made of the difficulty of distinguishing the fine-grained mineral (which it commonly is) from sericite.

In the discussion of hydrothermal deposits the author states (p. 38) “It should be noted that the paragenesis and composition of beryllium minerals in the hydrothermal-pneumatolytic deposits is determined in most cases by the character of the country rocks subjected to pneumatolytic action.” Most vein deposits containing Be minerals show little wall

rock influence, being formed in fractures independent of wall rock structures; containing few, if any, wall rock inclusions; showing minimal reaction zones against their walls; and showing *no general correlation* between the nature of their Be minerals and the wall rock composition (no more than the types of Be minerals in pegmatites are functions of the wall rock composition). A sweeping statement such as this implies that the pressure-temperature-concentration environment of a vein solution depends totally on the wall rock composition and that most such solutions become "contaminated" by reactions at places other than those at which deposition occurs. Table 15, which expands the above statement, ignores, for example, the helvite-bearing manganiferous veins and the Muzo, Colombia emerald veins.

Despite these complaints the book contains a great deal of value, particularly in Part I (Occurrence, minerals, geochemistry, deposits). Part II (Prospecting and evaluation) is of lesser significance. The translator and the editors have done an excellent job of preparing the author's material into suitable English form. The translation of Beus' second book should prove even more interesting.

*ewh*

SCANDIUM, ITS GEOCHEMISTRY AND MINERALOGY, by L. F. BORISENKO.

Transl. from the Russian. Russian text publ. by Acad. Sci. USSR, Inst. Mineral. Geochem., Crystallochem. Rare Elements, Moscow, 1961. Consultants Bureau Enterprises, Inc., 227 West 17th St., New York 11, New York. Paper cover, 78 pp.,  $8\frac{1}{2} \times 11$ , \$17.50, 1963.

This is an excellent and complete summary of what has been reported in the literature on the geochemistry, mineralogy and geology of scandium. The author's summation of the published information, both from Russian and non-Russian sources is concise and unusually complete.

Despite the wealth of data on the distribution and abundances of Sc in rocks and minerals, there remain some unexplained anomalies in what is known of the geochemistry of this element. Particularly peculiar is its two-fold concentration: 1) In mafic and ultramafic rocks as a dispersed element, presumably proxying for  $Mg^{2+}$  and  $Fe^{2+}$  in silicates such as olivines and pyroxenes (Question—how is the electrical neutrality of olivine maintained if  $Sc^{3+}$  replaces  $Mg^{2+}$ ?); 2a) As a dispersed element in minerals of certain pegmatites (*e.g.* garnet, pyrochlore, allanite, euxenite, fergusonite, biotite, etc.) and of high-temperature Sn-W veins (*e.g.* wolframite, cassiterite, beryl, etc.); 2b) As excessively rare occurrences of the heretofore only known Sc mineral—thortveitite.

Goldschmidt reconciled these two concentrations, separated by a considerable petrogenetic hiatus (*i.e.*, mafic rocks→granitic pegmatites), by suggesting that pegmatites obtained their Sc contents from the assimilation of Sc-bearing amphibolites. Actually no correlation between Sc in pegmatites and their wall rocks is known.

The discovery by Mrose and Weppner (*Bull. Geol. Soc. Am.* **70**, 1648-1649, 1959) that sterrettite is a Sc rather than an Al phosphate, opens a further broad group of mineral deposits as potentially favorable sources of Sc. It also points to the pressing need for a careful restudy of the geology and origin of the Fairfield, Utah phosphate deposits.

In the search for Sc deposits the relationship of  $Sc^{3+}$  to  $Mg^{2+}$  has been overemphasized. In beryl  $Sc^{3+}$  probably proxies for  $Al^{3+}$ . Furthermore it is peculiar that in co-existing pyroxenes Sc is preferentially contained in augite (with Al) rather than in hypersthene.

Borisenko's summary is a most valuable contribution to the literature on Sc, particularly the section dealing with the geology and geochemistry of the Sc-bearing Sn-W veins, much of the work on which has appeared in Russian. Unaccountably he fails to include, in Table 22, Classification of genetic types of Sc-bearing deposits, the Utah deposits, which may well represent a major concentration of this element.

*ewh*

THE TECTONICS OF THE CANADIAN SHIELD. Edited by JOHN S. STEVENSON.

This is the third volume in a series on the Canadian Shield, published by the Royal Society of Canada, and is called Special Publication No 4. The first volume is on the GRENVILLE PROBLEM; the second on the PROTEROZOIC OF CANADA; and the third on the SOILS OF CANADA.

Tectonics of the Canadian Shield is a symposium of 14 papers. The first describes the new tectonic map of the Canadian Shield which is in progress of preparation. This includes a brief description of the structural provinces and the nomenclature and time classification used. A major break is made with the traditional, namely; isotope age determinations and the thus established "orogenic periods" are the base for the classification of the rocks. The isotope ages indicate three main orogenies, and these, when considered in relation to the main unconformities, permit the rocks to be mapped according to their age of folding, metamorphism and intrusion. Areas involved in more than one deformation are differentiated where possible, and areas of flat-lying or unfolded strata are distinguished from those affected by the orogenies.

The traditional Laurentian-Algonian orogeny or orogenies of about 2500 m.y. will be called the *Kenoran* on the new map, and the Penokean at about 1700 m.y., the *Hudsonian*. The third is the conventional *Grenville* at about 950 m.y. All rock sequences as far as possible are bracketed between these three orogenies and correlated across the shield accordingly.

The major structural provinces recognized are the Bear, Slave, Churchill, Superior and Grenville, and a small subprovince just north of Lake Huron, the Penokean. The second paper relates the metal occurrences to these provinces.

A third paper describes the structural and isotope age relations in southeastern District of Mackenzie. A fourth paper does the same for northeastern Alberta.

The fifth paper describes the major faults in Saskatchewan, particularly, and in the entire western part of the Shield. A sixth paper concerns the tectonics of northern Manitoba.

Another paper describes the extent of the Huronian system between Lake Timagami and Blind River, Ontario. Still another depicts a major reconnaissance mapping project covering 350,000 square miles extending from Lake Winnipeg to Lake Mississinini.

Some tectonic features of the Grenville province are treated in the ninth paper. A tenth paper covers the tectonics of the regions bordering the Ungava stable area.

The Phanerozoic (post-Proterozoic) events in the Shield are treated in still another paper, and the oil and gas occurrences in sedimentary basins adjoining the shield on which the Precambrian tectonics have a bearing, are depicted in another. The last is a brief statement of the evolution of the Canadian Shield in light of new orogenic theories.

The book is a most valuable publication and will be of great interest to all Precambrian geologists.

A. J. EARDLEY

DETRITAL HEAVY MINERALS IN NATURAL ACCUMULATES WITH SPECIAL REFERENCE TO AUSTRALIAN OCCURRENCES by GEORGE BAKER, ed. by J. T. Woodcock. Monograph Series No. 1. The Australasian Institute of Mining and Metallurgy, 399 Little Collins St., Melbourne, Australia. 146 pp., 17 tables, 4 figs. (in color), 1 appendix, 3 indexes (author, locality, subject). 1962. £2 2.0+4/5d postage.

This volume incorporates the results of the author's research, over the past 30 years, on the heavy mineral assemblages "in a wide variety of igneous, metamorphic, consolidated sedimentary and uncompact sedimentary rocks from Australia and New Guinea. To these are added the results of investigations, over the last 14 years, of various crude sands,



experimental concentrates, and run-of-mill products . . . over three-quarters of a million mineral grains have been determined and statistical counts made to determine the proportions of different minerals present in over 600 heavy mineral assemblages. . . .”

This short monograph is a generalized compilation of the general features, physical and optical properties, composition, identification features, parageneses, assemblages and provenances of the heavy accessory minerals.

After a brief introductory chapter and one on “heavy mineral assemblages” (general genetic characteristics, definition, and a listing of methods of study and separation), there follows Chapter 3, The stability of heavy detrital minerals. Actually most of this chapter consists of a description of 66 heavy detrital species (Table 3 and ff.), alphabetically arranged. Much of this is valueless for identification purposes: *e.g.* one index of refraction regardless of optical group; no information on optical orientation, dispersion or cleavage orientation; no optical data at all on the opaque species. What real value for identification of detrital grains stems from listing Mohs hardness values? Or from a table attempting to relate specific gravity to Mohs hardness values?

Compositional data are similarly heterogeneously presented. Chemical formulae are given in two different ways; in some cases only a very general statement of the compositions is presented; no real ideas are given of major variations in composition, yet Table 7 lists abundances (in oxide ppm) of trace and minor elements reported for each species. Even this is not complete, *e.g.* Zr and Be in aegirine, Na and Fe in beryl, Si in apatite, Th in sphene, and P in zircon to cite but a few omissions.

Other sections or chapters describe inclusions, alterations, intergrowths, composite particles, coatings, fluorescence, radioactivity, grain size, and magnetic and electrical properties. Chapter 9 describes source rocks for the heavy detritals; again, major omissions are numerous: andalusite in pegmatites, cassiterite in rhyolite vesicles, diopside in basalt, dumortierite in aluminous metasomatic replacement deposits, spessarite in pegmatites, etc.

Chapter 10 describes types of heavy mineral assemblages—all Australian or New Guinean examples. In the final chapter there are briefly described Australian economic products derived from heavy mineral assemblages.

The book is most uneven; as a “hand book” for the study and identification of heavy detrital minerals it is incomplete and inadequate.

*ewh*

ATLAS OF PLACER MINERALS by N. N. TRUSHKOVA AND A. A. KUKHARENKO. (Russian, English, German, French). 436 pp., 102 plates, Collet's, Holdings Limited, 44-45 Museum St., London, W.C. 1 (published by the State Publishing House of Scientific and Technical Literature on Geology and Conservation of Mineral Resources, U.S.S.R.), 1961. 60 shillings.

This is certainly one of the most handsomely illustrated books that has ever appeared in the field of petrology. In truth, a review could end with that declaration. The work is a series of plates, most of them in color, and most of them made up of four or more figures, of detrital minerals, both heavy and light. Nearly 200 species are illustrated (including obsidian, meteorite and amber). For each figure is given (in the 4 languages): Name of the species (for most, a brief habit or form statement); magnification; locality (not in all cases); and (in some cases) the geological age of the deposit. The photographs are of minerals from the basic collection made by the Central Expedition of the U.S.S.R. Geological Research Institute, “during a study of Soviet Placers, mainly diamond deposits, over a period of several years, and during work in concentrate mapping of different regions of the Soviet Union.” The arrangement is according to the fractions in which they occur: non-magnetic, electromagnetic, magnetic, light.

The Atlas, by itself, is of little diagnostic value, but reference is made in the Preface to a work "Mineralogy of Placers" (presumably in Russian) in which is given "a more complete description . . . including their most important properties, diagnostic indications and morpho-genetic features . . ." In this second book, references are made to each of the Atlas figures. An English translation of the "Mineralogy" plus the Atlas, would doubtless prove important in the identification of detrital species.

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