BOOK REVIEWS

Mineralogy of Uranium Deposits, Goldfields, Saskatchewan. By S. C. Robinson. *Geol. Surv., Canada, Bull.* **31**, 1955. 128 pages.

The district around Goldfields, Saskatchewan, is now know as the Beaverlodge Region and ranks second in uranium production in Canada. This bulletin presents concise descriptions of 40 uranium deposits in this region as a basis for discussion of their mineralogy, geochemistry, age and genesis.

Three distinct types of uranium deposits are recognized; (1) epigenetic deposits in which the uranium and associated minerals were deposited in veins, shear zones, breccia zones and replacement bodies, (2) syngenetic deposits, including migmatites, monazite-biotite segregations, a pegmatite and a uraniferous granite, and (3) supergene deposits. Epigenetic deposits are predominant and comprise all the orebodies of this region. It is noted that epigenetic deposits occur in rocks of both the Tazin and Athabasca series, whereas syngenetic deposits are all in the Archaean Tazin rocks.

The distribution, texture, environment and paragenesis of over 80 minerals are described and illustrated by 48 excellent photomicrographs. Pitchblende is the only major ore mineral of uranium and this thorough study of its varying habits, textures and associations contributes data useful to an understanding of its genesis. Thucholite, originally described from pegmatites in Ontario, is found in some hydrothermal deposits of this region. The rare association of a suite of selenides, including clausthalite, berzelianite, klockmannite, tiemannite, umangite and a new copper-cobalt-nickel selenide, with native copper and pitchblende is noted. Nolanite, a new iron vanadate, intimately associated with pitchblende is known only from this region and has been recognized in some abundance from four deposits. Gold is found in rounded grains in pitchblende and in arborescent forms in carbonate from several properties, and in one, is associated with platinum and palladium. Masses of hisingerite containing inclusions of pitchblende are recorded from one deposit. Arsenides and sulpharsenides of cobalt, nickel and iron, including arsenopyrite, cobaltite, dyscrasite, niccolite, pararammelsbergite, rammelsbergite, siegenite and ullmannite, are restricted to four small properties in the southeast part of the area. The principal minerals associated with pitchblende throughout the region are hematite, chalcopyrite, pyrite and galena in gangue composed of calcite, chlorite and quartz. Radioactive minerals found in migmatites and the pegmatite

include: uraninite, fergusonite, allanite, monazite, pyrochlore, thorite, uranothorite and xenotime.

Thorium always accompanies uranium in the syngenetic deposits and rare-earth elements are also commonly present. Uranium is also found in multiple oxides or niobium and tantalum in the one pegmatite. In contrast, thorium, rare-earths, niobium and tantalum are absent from hydrothermal deposits. Titanium and iron are present in both types. The association of selenium and vanadium with uranium in the clearly epigenetic hydrothermal deposits of the Beaverlodge region is similar to the association found in the deposits of the Colorado plateau although different minerals are involved. The association of silver, nickel, cobalt, and arsenic with uranium, so prominent at Great Bear Lake, is only locally represented and in minor amount at Beaverlodge. The presence of oxides, sulphides and native metals in the same deposit is indicative of a complex origin. Four generations of pitchblende and calcite, and three of hematite and chlorite are recognized in the paragenesis.

A chapter is devoted to consideration of the age determinations of minerals in the deposits. Previously published age data are summarized and 30 new ages together with 8 isotopic analyses of leads from galenas and clausthalites are presented. Radioactive minerals in the pegmatite and migmatites are approximately 1,800-1,900 million years old. The oldest pitchblende ages are 1,500–1,700 million years and other generations are dated at 850–930 million years and 235–365 million years with some intermediate ages. Lead from galena and clausthalite in pitchblende veins is partly radiogenic in origin. These data corroborate the complex paragenesis and lead to the conclusion that original hydrothermal deposits were re-opened, part of their pitchblende dissolved and later redeposited with separation of the accumulated radiogenic lead as clausthalite or galena. The latest period of reopening of the veins appears to have been in Palaeozoic time. For pitchblendes, the systematic divergence in ages based on the isotopic ratios ($Pb^{206}/U^{238} < Pb^{207}/U^{235} < Pb^{207}/Pb^{206}$) is recorded and possible reasons for it are discussed.

In the final chapter, evidence concerning the following problems is presented and assessed: (a) relation of epigenetic to syngenetic deposits, (b) duration of mineralization, (c) process of mineralization of epigenetic deposits, (d) nature of mineralizing solutions, (e) temperature of deposition of hydrothermal deposits based on mineral assemblages, exsolution textures, decrepitation temperatures, and oxygen isotope ratios, (f) vertical extent of deposits, (g) classification of epigenetic deposits, and (h) genetic association of uranium deposits.

This bulletin differs from earlier works on areal mineralogy in which mineral descriptions are predominant in that the wider fields of environ-

mental mineralogy, textural relations, geochemistry, isotope analyses, age determinations, palaeotemperature, and allied subjects are investigated in an attempt to elucidate the processes of mineralization, its source and vertical extent.

R. J. TRAILL

A TRANSLATION OF *GEOCHEMISTRY*

The Geochemical Society has undertaken the publication of an English translation of the Russian journal *Geokhimiya* (editor A. P. Vinogradov), which is published by the U.S.S.R. Academy of Sciences. The title is *A Translation of GEOCHEMISTRY* and is edited by Earl Ingerson and E. Wm. Heinrich. There are eight issues per year and the subscription rate is $10 p.a. to members of the Geochemical Society and to educational institutions, and $20 p.a. to others. The journal began in Russia in 1956 and translation has started with the first issue of 1958.

The first issue contains 130 pages and is made up of 10 papers and a brief review of an International Conference on Interplanetary Substance which took place in Jena in 1957. Titles of the papers follow:

(1) The ionium method of determination of age of marine sediments.
(2) The formation of free hydrogen in the earth's crust, as determined by the reducing action of the products of radioactive transformations of isotopes.
(3) *X*-ray investigations of natural oxides of uranium.
(4) Parageneses in boron-bearing magnesium skarns of Taezhnoe deposit in the Archean of the Aldan plate.
(5) Evolution of rocks during progressive metamorphism, as exemplified by the Middle Suite of Krivoi Rog Series.
(6) Distribution of cobalt, nickel, and copper in hydrothermally altered rocks of the Pyshma-Klyuchevskoe deposit.
(7) Experimental studies in oxidation of cobalt and nickel arsenides in solutions containing oxygen and carbonic acid.
(8) Rhenium in molybdenites of the Tyrny-Auz deposit.
(9) Zr/Hf ratio in zircons in some igneous rocks of northern Kirgizia.
(10) A contribution to geochemistry of titanium in intrusive process of granitic series.

From these titles it may be seen that (as Ingerson points out) the journal covers a very similar range of topics to *Geochimica et Cosmochimica Acta*. There are no papers of outstanding importance in the first

issue but most are of good quality. One or two are primarily factual and of local interest only. In several, however, the style and manner of presentation makes difficult reading. This is always a problem in papers presenting great quantities of observational data, but in articles of this kind the author should pay particular attention to logical and literary presentation if he has some ideas to communicate.

The translation of the first issue was made by V. P. Sokoloff, who is to be commended for his care, as shown by the numerous footnotes indicating problems of terminology and translation. The Geochemical Society and especially Earl Ingerson (with financial asistance from the National Science Foundation) are performing a valuable and arduous task in translating this useful journal, which will probably be for some time the main organ through which western scientists can follow modern Russian geochemistry.

D. M. SHAW

Moravské Nerosty a Jejich Literatura (*Moravian Minerals and their Bibliography*). BY EDUARD BURKHART. Nakladatelství Československé Adademie Věd, Prague, 1004 pages, 1953. Price 98 Kcs (about $13.00).

This encyclopaedic volume on the mineral occurrences of Moravia, Czechoslovakia is written in German, and is intended primarily as a handbook for the mining industry. It contains over 400 mineral names and lists 1530 occurrences.

The book is written in 4 parts: (1) a bibliography containing over 1200 references; (2) a well-documented description of each of the 1530 mineral occurrences; (3) an alphabetical list of the minerals listing all the occurrences for each mineral, and giving both German and Czech equivalents for the place-names; and (4) indexes.

Dr. Burkhart's exhaustive compilation must undoubtedly be of great interest to anyone connected with the Czech mining industry, or interested in collecting Moravian minerals.

E. H. NICKEL

Mineralogy: Concepts, Descriptions, Determinations. BY L. G. BERRY AND BRIAN MASON. Drawings by Roger Hayward. W. H. Freeman and Company, San Francisco, California, 1959. xiii + 612 pages, many figures.

This book has the usual arrangement of subject matter found in elementary mineralogy textbooks to-day, but mainly because of its emphasis

on crystal structure and crystal chemistry, it is more modern in its approach than other such textbooks. It is hardly necessary to list the contents of this book, and this review will consist of some of the strengths and weaknesses of this work as they appear to this reviewer.

In the section on Crystallography (Chapter 2) the appealing features are the development of the fourteen space lattices in the manner of W. L. Bond, and an indication of their structural meaning; the detailed descriptions of both the stereographic and gnomonic projections and their use in deriving axial ratios; and M. J. Buerger's treatment of the cause of twinning in terms of crystal structure. This reviewer would, however, like to see symmetry treated as a separate topic very early in the chapter rather than as an almost incidental part of the description of the rows, nets and lattices; and he would like to see emphasis laid on the fact that it is the repeat nature of the lattice that so drastically restricts the symmetry of crystals.

Chapter 3 on the Chemistry of Minerals is well done, with crystal structure again being emphasized throughout; and Chapter 4, the Physics of Minerals, covers the usual physical properties with the appropriate addition of radioactivity. Chapter 5 on the Genesis of Minerals has, as one might expect in this work, a strong geochemical flavour, and it would provide in a very satisfactory way the essentials of mineral, rock and ore formation for students taking no further mineralogy as the authors intend in part. Chapter 6 on Determinative Mineralogy describes briefly the usual methods of identifying minerals. In view of the emphasis placed on crystal structures in this book many readers will find the very brief treatment on x-ray diffraction (on p. 270) disappointing. Chapter 7 describes the classification of the minerals whose descriptions are given in Chapter 8, the classification being essentially that in the Seventh Edition of Dana's *System of Mineralogy*.

This reviewer feels that the descriptions of the 200 or so minerals are the best yet given in such a textbook. Crystallographically the descriptions are a happy combination of the classical and the modern, the former finding expression in the many elegant drawings of common crystal habits, the listing of common interfacial angles and the axial ratios, and the latter in the structures frequently drawn and described, and the lattice type and cell dimensions always given. One small valuable addition to the former would be a set of common interfacial angles in the cubic system. With these features, the very adequate physical descriptions, and the strong crystal-chemical and geochemical emphasis throughout, this textbook is likely to find wide appeal among teachers of mineralogy.

R. B. FERGUSON