BOOK REVIEWS

GEOCHEMISTRY AND MINERALOGY OF RARE ELEMENTS AND GENETIC TYPES OF THEIR DEPOSITS: VOLUME 1, GEOCHEMISTRY OF RARE ELEMENTS, 688 pages, 54 figures, 372 tables; VOLUME 2, MINERALOGY OF RARE ELEMENTS, 945 pages, 340 figures, 483 tables. Israel Program for Scientific Translations, Jerusalem, 1966 [Russian edition, Moscow, 1964]; U. S. Agents, Daniel Davy and Co., New York, N. Y. Edited by K. A. Vlasov and prepared by a group of some 80 research workers associated with the Institute of Mineralogy, Geochemistry and Crystal Chemistry of the Rare Elements (IMGRE) of the Academy of Science of the U.S.S.R. The books are photo-offset reproductions of unjustified typescript (vol. 1, $24.00; vol. 2, $34.00). The authors of the 20 separate sections of volume 1 are not individually identified. The authorship of the mineral descriptions in volume 2, however, is given in an appended table. It lists 50 names, including many well-known specialists on the mineralogy and geochemistry of particular elements.

The two volumes contain a comprehensive and well-documented survey of the geochemistry and mineralogy of Li, Rb, Cs, Be, Sr, Sc, Y, the lanthanides, Zr, Hf, Nb, Ta, Cd, Ga, In, Tl, Ge, Se, Te and Re. The selection of these elements is based on their very low lithospheric abundances and on their non-occurrence in substantial ore concentrations. A third volume, on the genetic types of deposits of these elements, has appeared in Russian but is not yet translated. The set of volumes is a monument to the Russian work in this field, and constitutes an invaluable work of reference for geochemists and mineralogists generally.

Text references are arranged by element (vol. 1) or by mineral name (vol. 2); they are admirably complete and accurate. The latest year cited is 1962. A few inadvertences appear: among them, the references to *Bull. Geol. Surv. America* and *Geol. Surv. Profess. Paper* both refer to publications of the United States Geological Survey, and *Notulae naturae* is a sub-title of several different publications. In volume 1 a total of about 1300 references are cited, including 730 Russian and 570 non-Russian; volume 2 contains a tolat of about 1860 references, 710 Russian and 1150 non-Russian.

In volume 1, the elements are treated in the sequence of their group position in the periodic table. The volume opens with a discussion of the abundance and general distribution of the rare elements and of historical aspects of the field, where quite appropriate acknowledgement is made of the pioneer contributions by V. I. Vernadskii, A. E. Fersmann and K. A. Nenadkevich among other earlier Russian workers. The treatment of the individual elements begins with a summary of their chemical, physical and crystallochemical properties, including brief reference to technological applications. The clarke, mode of occurrence in nature, and the mineralogical expression of the element both as an essential and as a vicarious consitituent is then discussed, with extensive tabulations of analytical data. This is followed by a treatment of the distribution of the element in rocks and minerals, and its behavior during magmatic, pegmatitic, pneumatolytic-hydrothermal, hydrothermal and supergene processes. Here again there are extensive and very useful supporting tabulations of analytical data on rocks and minerals. The section closes with a brief survey of the genetic types of deposits in which the element is found, with a tabular classification referring to paragenesis, association with other elements, and particular localities. Few of the latter are more precisely located than Central Asia, Urals, Western Siberia, Caucasus, etc. The more familiar aspects of the subject are not documented in detail, although the names of leading contributors may be mentioned in passing, and the great bulk of the cited references relate to work done in the past few decades. There is also a good deal of in-passing reference, mostly of the nature of illustrative detail, to undocumented and evidently

unpublished Russian studies. The tabulations of analytical data in both volumes are almost completely documented as to source, and here in particular the great volume of the Russian work in this field becomes apparent.

Volume 2 describes about 415 mineral species and varieties. The list includes not only minerals in which the rare element in question is an essential constituent, but also varieties of other minerals in which the element is a vicarious but consequential trace or minor constituent. Thus, the niobian and tantalian varieties of rutile called struverite and ilmenorutile are included but not rutile itself. The descriptions themselves are neither definitive nor critical, but may be found adequate for the geochemical context in which they are written. Documentation is generally lacking for the physical and bulk chemical properties, and the crystallography is dealt with summarily. Structural data are given, often with diagrams, and both X-ray powder and DTA data are cited. The line drawings are adequate and the photographs poor. The mineral descriptions are arranged by element, with an introductory section giving pertinent crystallochemical and geochemical observations together with tabulations of the minerals containing the element in question.

The systematic manner of treatment and the numerous tabulations make both volumes easy and convenient to use. Well over 100 misspellings of the names of minerals and of persons were noted. A few are misprints, such as a section headed Berrylium, but most are the result of single or double transliteration. A footnote questioning the existence of the name perseite [peareceite] is of this origin, and the conversion of dzjezkazganite to jeskasganite is well-intentioned but confusing.

The rare elements have become of rapidly increasing importance in recent decades in a wide range of technological applications, providing impetus for the study of their geochemical characters to aid in creating an adequate raw material base. The Russian effort in this direction is large scale and first rate.

CLIFFORD FRONDEL
Harvard University

LANDBOLT BORNSTEIN, NUMERICAL DATA AND FUNCTIONAL RELATIONSHIPS IN SCIENCE AND TECHNOLOGY. NEW SERIES, GROUP 3: CRYSTAL AND SOLID STATE PHYSICS. Vol. 1. R. Bechmann, R.F.S. Hearmon. 1966. 160 pages.

A bilingual handbook for elastic, piezoelectric, piezooptic and electrooptic constants of crystals, this text outlines basic theory and terminology in English and German, and provides numerous tables and graphs. The first chapter on the elastic properties of non-piezoelectric crystals is by Hearmon, and the second chapter on piezoelectric crystals is by Bechmann. In the final chapter, Bechmann treats the piezooptic and electrooptic effects in crystals. Hearmon's tables and figure captions are in English, Bechmann's in German, with keys or explanations for all tables bilingual.

Both authors employ the usual matrix shorthand for tensor components. Bechmann must also introduce vectors, and thus indicates tensor components by Greek suffixes and vector components by Latin suffixes. In contrast, Hearmon's tensor components have Latin suffixes, which may confuse the reader.

All tables contain physical constants published before the end of 1964. Pressure and temperature coefficients for the elastic constants of numerous crystals are included, some of which are rock-forming minerals. Graphs illustrating the variation of elastic constants with temperature are added to the usual tables. Both authors clearly relate symmetry of physical anisotropy to crystal symmetry. Bechmann emphasises the relationships between elastic and electric constants of piezoelectric crystals, as well as those between piezooptic and electrooptic constants. Both authors specify orientation of physical reference axes with

respect to crystal lattice. This offers a distinct advantage over similar handbooks, where the relationship is generally obscure.

The book assumes a certain knowledge of crystal physics and linear algebra. It should be useful for mineralogists, experimental and structural petrologists, and crystal physicists.

W. M. SCHWERDTNER
University of Toronto

DIRECTORY OF METEORITE COLLECTIONS AND METEORITE RESEARCH. 50 p., UNESCO, Paris, 1968. Collected under the auspices of the Working Group on Meteorites and the Committee for the Museums of Natural History of the International Council of Museums, this directory lists for 50 states the names and addresses of collections, catalogues of meteorites, a bibliography, and the names, specialties, and institutions of principal researchers.

PHYSICAL-CHEMICAL MECHANICS OF SOILS, CLAYS, AND BUILDING MATERIALS.—A SYMPOSIUM. P. A. REBINDER, K. S. AKHMEDOV, eds., Tashkent, FAN, 1966, Uzbek Akad. Nauk, 476 pages. Price 2 Rb. 54 kop. [in Russian].

Regretfully the important advances in the theory of rheology of disperse systems by P. A. Rebinder and his school have not yet found general application in mineralogy and sedimentary petrology. The reason may be that little was available in English; one article on the "Formation of Structures in Disperse Systems", appeared recently in *Pure Appl. Chem.* **10**, 337–357 (1965). In the special field of setting phenomena of hydraulic binders, however, many contributions in Russian periodicals reflect Rebinder's fundamental ideas and the experimental results of his school. In 1966 there appeared, with about the same title as listed above, an excellent symposium, under the aupices of the Academy of Sciences USSR, Moscow (400 pages), in which Rebinder contributed a very valuable introduction into the entire field of colloid physics. The present volume of the Tashkent Academy is introduced by Rebinder and contains three impressive series of articles from his school.

Emphasizing here what is important for mineralogy and geology, we recommend a first series of 7 papers on soils (pp. 85–146), mostly from the group around Akhmedov, treating problems of civil engineering, under extremely difficult soil conditions in saline sediments. Particularly fascinating are modern methods using cation-surface active agents for hydrophobization of sands and caly minerals. Rheology in clay sediments of widely varying types are covered in 20 following papers (pp. 147–318), including behaviour of clay suspensions in oil wells, in "muds" for drilling shafts, and the highly complex problems of stability of the walls of such shafts. These papers indicate the importance to the petroleum engineer of the physical-chemical and rheological properties of sediments.

The last series of 18 papers (pp. 319–473) is dedicated to a modern interpretation of setting reactions, especially of hydraulic binders. Although the first Symposium of the Moscow Academy contains much material in this field, the present report gives supplementary information on: (1) the reactions in hydrating Portland cement clinkers to calcium silicate hydrates, chiefly of the tobermorite polydisperse group. (2) the reaction of calcium aluminates with gypsum to form ettringite in the cement "glue", and (3) the analogous phenomena (brucite crystallization) in magnesia cement suspensions. Steam treatment of cement "glues" is analogous with low-temperature hydrothermal crystallization of the fibrous or tabular habits of calcium silicate hydrates like afwillite, gyrolite, and even xonotlite, as distinct phases approaching thermodynamic equilibria with time. Micrographs demonstrate impressively such crystallization, though unfortunately they are printed on paper of very low quality.

These few remarks may be sufficient to show the value of the present symposium volume in an important special field of physical-chemistry, applied mineralogy and petrology.

W. EITEL
University of Toledo

FIBROUS SILICATES—NATURAL AND SYNTHETIC ASBESTOS. A. D. FEDOSEEV, L. F. GRIGOR'EVA, AND T. A. MAKAROVA. Akad. Nauk SSSR, Inst. Khimii Silikatov in I. V. Grebenshchikova, Izdat. "Nauka", Moscow and Leningrad, 1966, 184 pp., Price 84 kop. [in Russian].

This monograph discusses natural asbestos as a raw material for a great variety of industrial manufactures, and its replacement by synthetic products. Academician N. A. Toropov, Director of the Grebenshchikov Institute points out that the latter problem is underestimated in its industrial and economic significance, and that a practical solution is urgent.

The first chapter reviews the mineralogy of fibrous silicates in general, including both amphibole and serpentine groups. Unit cell dimensions are the basis for considering isomorphic substitution of both cations and hydroxyl-fluorine in the structures of amphiboles and serpentine minerals. Cation replacement on particular sites of the structure is useful in substitution syntheses. Optical data are important for identification of the numerous possible amphibole and serpentine phases, since X-ray powder diffraction patterns are insufficient. Data and diagrams are given for absorption, differential-thermal, and thermo-gravimetric analysis.

Chapters II and III treat phase equilibria important for systematic synthesis of amphibole and serpentine minerals: the systems MgO-SiO_2; MgO-MgF_2; MgO-MgF_2-SiO_2 for fusion-crystallization, and MgO-H_2O; SiO_2-H_2O; MgO-SiO_2-H_2O for hydrothermal syntheses. Equipment and methods of the Geophysical Laboratory, the Bureau of Mines, and some detailed improvements for the fusion process from the Grebenshchikov Institute are described. The interesting pneumatolytic synthesis method used by W. Lüdke and K. H. Scheumann (1933) which, as a matter of fact is to date the only one applied on an industrial scale for the synthesis of amphibole asbestos, may merit future consideration.

Chapter IV describes synthetic fibrous amphiboles and serpentines and their properties including abundant data from numerous Russian authors, the Bureau of Mines, and more recently by Noda and Sudo in Japan. They include crystallization from pure melts, low-melting salt solvent mixtures, and solid pressed compacts. The authors review the excellent monograph by E. Schiebold (1958), and work done in the USSR by I. A. Ostrovskiĭ (1956) and in the USA at the Geophysical Laboratory, for the synthesis of hydroxyl amphiboles. Serpentine minerals were synthesized by F. V. Syromyatnikov (1935), and by students of P. Niggli (1951), with the aim of converting minerals and rocks containing olivine by hydrothermal treatment (HF mineralizer) olivine-containing minerals and rocks to chrysotile and also to richterite amphiboles using Li_2SiO_3. The present monograph adds unpublished material on work done in the Grebenshchikov Institute.

The fifth chapter criticizes the obsolete existing official and industrial standards (including those valid in USSR) for asbestos, which are abundant in hair-splitting details of classification from elementary test data alone. On the other hand, the authors give an impressive list of applications in which not only asbestos minerals can be of fundamental usefulness, but also synthetic products.

The literature references (at the ends of chapters) are instructive, valuable, and accurate, including foreign periodicals, especially from those in the United States. Usefulness of the whole monograph would have been considerably increased by an index of authors, subjects, and minerals.

W. EITEL
University of Toledo