BOOK REVIEWS

COLLOQUE INTERNATIONAL SUR LES PHOSPHATES MINERAUX SOLIDES VOLUME 1 STRUCTURE ET PROPRIETES DES PHOSPHATES. Centre National de la Recherche Scientifique, Paris, 1967, 201 p., 70 fr.

This colloquium was held at Toulouse, 16–20 May, 1967, under the auspices of the Societe de Chimique de France. These proceedings comprise 44 pagers, in French or English, under the following headings: *preparation and properties of phosphates, phosphate structures, influence of oligo-elements on properties of phosphates, luminescent phosphates, phosphates as catalysts, and ion, exchange phosphates.*

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PROGRESSIVE CONTACT METAMORPHISM OF THE BIWABIK IRON FORMATION, MESABI RANGE, MINNESOTA. BY BEVAN M. FRENCH. Minn. Geol. Surv. Bull. 45; Univ. Minn. Press, 1968, 103 p., $4.50

Because of their economic importance, chemical simplicity, and enigmatic geologic origin, the iron formations of the Lake Superior region have long attracted petrologists. In recent years, added impetus has been given to the study of these formations because they promise to shed light on the thermodynamic status of the "volatile" components, particularly oxygen, in metamorphism. The present volume by Bevan French is a welcome addition to the literature.

After a brief but adequate summary of the geologic setting of the Biwabik Formation, the textures and mineral assemblages of the progressively metamorphosed rocks are described; there are numerous potentially excellent photographs showing the textural relations and modifications upon metamorphism but unfortunately several of the half-tone reproductions frustrate rather than illuminate. The author next goes on to discuss the progressive mineralogic changes upon approach to the Duluth Gabbro Complex, based on the premise, with which not all agree, that each stratum was originally laterally uniform in mineralogy and composition. The book concludes with a discussion of possible physicochemical environment of metamorphism, including a discussion of the roles of various volatile components. There is a good subject index, but no author index.

The work demonstrates that the rocks had already been mildly recrystallized, probably through an episode of regional metamorphism, before the intrusion of the Duluth Gabbro Complex superimposed its contact-metamorphic effects. The existence of this earlier event may obscure the nature of the original sedimentary assemblages; for instance, one wonders about the reality of "primary" stilpnomelane: could it be a product of low-grade metamorphism of glauconite? On the other hand, different grades of earlier regional annealing might affect the mineralogic nature of later contact effects, and French's work should be a good starting point of an inquiry into this possibility. Incidentally, French argues ably for the case that the progressive contact metamorphism was essentially isochemical except for the volatile components, and refutes the idea of Gunderson and Schwartz that the contact effects involve liberal metasomatic changes.

One commendable feature of this study is the attention given to the effect of progressive metamorphism upon the carbonaceous material in the rocks. Too often petrologists ignore this aspect of mineralogic change; there has not been enough cross reference between results of metamorphism of coals and of more ordinary rocks. French shows a progressive change in the X-ray pattern of the carbonaceous material, leading to graphite. It remains to be seen to what extent the variations could be due to grain size alone. Many petrographers suspect that abundant hyperfine carbonaceous matter may inhibit the growth and enlarge-

ment of silicate minerals in metamorphic rocks; the present work should stimulate a systematic study of this problem.

French shows that the reduction of iron upon increase of metamorphic grade varies according to the individual stratigraphic units and therefore, on such a scale, oxygen behaved as an inert component (in the sense of D. S. Korzhinskiy). This conclusion accords with those of H. L. James, who studied the regional metamorphism of the Lake Superior iron formations. The conclusion is also supported by an enumeration of components and phases, but is more positive than is possible via the phase rule approach alone, which has been used by several recent studies of the role of oxygen in metamorphism.

Special attention was given to the compositional changes of the carbonates and of the cummingtonite-grunerite series of amphiboles with progressive metamorphism. The carbonates are a "continuous monitor" of metamorphic grade, whereas the appearance of an amphibole marks a discontinuous facies change. The compositions of these minerals were determined by optical and X-ray measurements. It is a measure of the rapid progress in instrumentation that today the same information, perhaps even superior in accuracy and in greater detail, could be obtained more readily by means of the electron microprobe. Recent electron probe studies on metamorphic amphiboles have shown that many of these are multiphase intergrowths; one wonders what such a study of the amphiboles of the Biwabik Formation will reveal. Determination of the atomic distribution in complex minerals such as the amphiboles, and of detailed crystal structures of minerals as related to the chemical compositions and to the environment of formation, represent an exciting new union of crystallography, experimental mineralogy, thermochemistry, petrography, and field geology. French's study should provide a good basis for more detailed and elaborate studies of this sort; one hopes that this promising field will not long lie fallow.

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MINERALSPEKTREN, AUFGENOMMEN MIT DEM JENAER SPEKTRALPHOTOMETER UR 10, BY HORST MOENKE, Jena. Akademie-Verlag, Berlin, 1966. 22 pp., with 2 Tables and 150 Charts for mineral determination.

A review of Part I of this collection of infrared absorption curves was published previously in *Amer. Mineral.* **48,** 1425–1427 (1963). The present Supplement is also for mineral identification using commerical spectrometers for the medium infrared range, on the basis of characteristic bands. For all of the silicate minerals for which data were available in 1963, those spectral absorption ranges are selected which are important for analytical identification. Prevailingly minerals with anisodesmic and mesodesmic structures are taken into consideration, among the non-silicates those which occur in deposits of economic significance.

Among the 150 charts of the collection in this Supplement, 145 have not been studied before by infrared absorption methods. The KBr pressed-pellet technique is preferred, using mineral samples of 0.2 to 0.4 weight percent. New classification principles, based on infrared absorption characteristics (cf. W. KLEBER and H. MOENKE, *Monatsber. Deut. Akad. Wiss. Berlin,* **6,** 384 (1964): H. MOENKE, *ibid.* p. 628) follow the crystallochemical divisions postulated by R. C. EVANS, "*Introduction in Crystallochemistry*" (German Translation, by E. THILO, Leipzig, 1964) namely anisodesmic, and mesodesmic structures, with simple, and complex resonance groups, and nine classes of minerals according to their chemical composition.

A detailed discussion is presented of that range of infrared spectra for given minerals in which the strongest infrared-active bands are observed, together with a well-selected bibliography of recent publications in this field (p. 9 to 18), concerning carbonates-borates,

sulfates-chromates-tungstates phosphates-arsenates-vanadates, and specifically silicates. The text of introductory information on silicates contains many details, *e.g.* on coordination polyhedra in neso-subsilicate structures (among these mullite, thaumasite), complex groups in sorosilicates, and difficulties arising in the interpretation of inosilicates.

The charts are of the same type and quality as those in Part I of the Collection. They are reproductions from the original spectra, with indication of the wave numbers (cm^{-1}) for the characteristic absorption bands. In special cases spectra of structurally analogous minerals, or even macroscopically similar crystal types are suggested. The charts are in this way a most valuable documentary help for mineral identification, independent of other methods.

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EINFÜHRUNG IN DIE LASER-EMISSIONS-SPEKTRALANALYSE. BY HORST MOENKE AND LIESELOTTE MOENKE-BALNKENBURG, 2nd ed. Verlag Akademische Verlagsgesellschaft, Geest & Portig, K.-G., Leipzig, 1968, 250 pages, 21 tables, 83 figures, DM 26.

The present book gives an impressive review of the surprisingly rapid evolution of a particularly efficient new method of applied spectroscopy, namely the use of lasers as sources of production of vapor plasma emission, with highly locallized and concentrated high-energy impact on a sample. In 1960, T. H. Maiman developed the first crystal laser; already in 1962, F. Brech and R. L. Schuch (Jarrell Ash Co., Newtonville) demonstrated the first laboratory instrument furnished with a controlled laser source, as an "optical microprobe," in combination with a grating spectrograph. Zeiss-Jena (1964) improved this remarkable new tool for micro-spectroscopic investigations to a commercially available unit (LMA) and since then a wealth of investigations over a wide field of microchemical analysis has appeared.

For geologists, mineralogists, and metallurgists this handy book is specifically useful because of a clearly written and instructive description of the fundamental physics of laser techniques, and because of many examples from a rich experience in problems of the mineralogy and technology of ores, silicate minerals and rocks, ceramics, metallurgy, and even archaeology. In addition, there is one fascinating chapter in which a comparison is made of the specific advantages offered by the laser methods on one hand, and the classical chemical, microchemical, and microscopic methods on the other hand, including a detailed discussion of the merits of electron microscopy and microprobe techniques. Particular advantages of laser spectral analysis are very simple sample preparation; accuracy; absence of the troublesome cyanogen bands in the spectra; and the possibility to operate in the open atmosphere (without the restrictions of the high vacuum systems used in electron micro-probes).

The book is supplemented by a very useful bibliography, which includes many publications of Russian authors who have contributed to the rapid progress of the laser spectroscopic methods and instrumentation. One may particularly applaud one interesting chapter in which possibilities for future developments of laser techniques are discussed. This well-written monograph will be appreciated in the mineralogical laboratory, certainly, but also in the centers of industrial prospecting, ore refining, and metallurgical and ceramic processing.

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