BOOK REVIEWS

ZUR ENTSTEHUNG DER MARIN-SEDIMENTÄREN EISENERZE, by HORST BRAUN. Heft 2, Clausthaler Hefte zur Lagerstättenkunde und Geochemie der mineralischen Rohstoffe (in German, English summary). Gebrüder Borntraeger, Berlin. vi+133 pages, 24 figures, 36 photomicrographs (6 in color) 25 tables, 1964. (Price not given.)

This volume is the second in a projected series on mineral deposits (the first, by Josef Dybek, is on uranium, *Am. Mineral* **49**, 216, 1964), based on work done at the Institut für Mineralogie und Lagerstättenkunde at Clausthal, West Germany, under the general direction of H. Borchert. It deals with oolitic ironstones of the minette type, which are so abundantly represented in northern Europe and from which most of the specific samples are drawn.

The subject matter can be divided into four main parts: (1) a brief but fairly comprehensive review, in part in tabular form, of the stratigraphic position of post-Precambrian ironstone units of the world, with a summary of the paleogeography of European occurrences; (2) discussion of the mineralogy, texture and paragenesis of 14 principal facies types that are based on various combinations of iron oxides, "Brauneisen-Silicat" (limonitic iron oxide with a substantial Al and Si content), chamosite, siderite, glauconite, pyrite and calcite, most of which may be found as either ooliths or matrix. This discussion is supported by 28 pages of detailed description of thin sections and by 15 chemical analyses with calculated norms and measured modes; (3) an appraisal of the physical and chemical aspects of marine environments in relation to the behavior of iron, silica and alumina and (4) conclusions as to origin. According to Braun, ironstone originates by mobilization of iron from normal marine sediments in CO_2-rich bottom environments, followed by selective precipitation as oxide, siderite, chamosite and pyrite, depending on specific bottom conditions that range from O_2-rich, H_2S-poor to O_2-poor, H_2S-rich. Mineral formation is preceded by a colloidal stage, during which ooliths are formed and variously mixed by current action.

Although the general concepts presented differ but little from those of H. Borchert (for a paper in English, see H. Borchert, 1960, Genesis of marine sedimentary iron ores. *Inst. Mining and Met.*, **69**, 261–279), this report is exceedingly valuable for its content of related chemical and mineralogical data on ironstones of the minette type. The excellent photomicrographs (captions in both English and German) are highly informative, and the bibliography (about 270 references) will prove useful to many researchers in this field.

HAROLD L. JAMES

KRISTALLCHEMIE, by W. KLEBER, Humboldt-Universität, Berlin. (Mathematisch-Naturwissenschaftliche Bibliothek, No. 36, 1963. Teubner Verlags-Gesellschaft, Leipzig), 128 pp. 61 text-figures. Price (paperbound) DM 9.30.

Although the series of Monographs in the Mathematisch-Naturwissenschaftliche Bibliothek of the well-known Teubner Publishing Company in Leipzig is prevailingly dedicated to generally and easily understandable introductions into selected fields of scientific investigation, the present volume is written with admirable mastership by one of the leading crystal chemists in Europe, equally for the use of students, and for specialists in crystallographic-chemical research. The material discussed is deliberately restricted to inorganic compounds and their structures, generally discussed from stereochemical viewpoints. Very fascinating is the strictly logical start from the theory and properties of densest, and not completely dense, spherical packings following P. Niggli (1941), from which the coordination polyhedra are derived. The multiple possibilities of combination of such polyhedra to higher structural units (Bauverbände) is based on the beautiful systematics of those prin-

ciples as developed by F. Laves in his classical papers, *Zeit. Kristal.* **73,** 1930, 202–265 and 275–324, for the full appreciation of which, Kleber's book is a most welcome introduction and supplement. The coordination polyhedra appear in this aspect as a special application of Laves' principles for combinations of structural units. They present a firm and beautifully logical fundament for the crystallochemical problems of correlations between crystal structures and exterior morphology. Perhaps many a reader may be surprised to see that many allegedly "new" structural discussion methods in the literature of the last thirty years were implicitly and explicitly disclosed in Laves' previous deductions, which have often been disregarded, in spite of their classical clearness and conclusiveness. In this particular respect, the merits of Kleber's monograph are of great importance. Although this author uses in all his deductions an apparently elementary language, the reader will be surprised to find most modern and even highly complex problems of crystallochemistry here included, e.g. modern theories of bonding, or lattice energy, with many instructive examples. The American student will have particular profit in studying Kleber's careful introduction into the ideas of Russian authors in these fields, including the older theories of Fersman and Kapustinskiĭ, and the recent systematics of silicate structures as developed by N. V. Belov. The literature index of the monograph offers an excellent information in this field, in which also Kleber's book *Angewandte Gitterphysik* (third edition, Berlin 1960) and his *Einführung in die Kristallographie* (6th edition, Berlin, 1963) may be emphasized for advanced studies.

W. Eitel

EVALUATION OF INFRARED SPECTROMETRY FOR COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SOILS, by R. J. P. Lyon, prepared for the National Aeronautics and Space Administration, Washington 25, D. C., under Contract No. NASr-49(04), by Stanford Res. Inst., April 1963, xvii and 118 pp. OTS price $2.75 (*cf.* NASA Techn. Note D-1871).

The feasibility of infrared spectral emission analysis of rock material of compact, or porous-powdery surface consistency, in comparison with spectral reflection from highly polished flat surfaces of the same rocks, is one of the most attractive problems for preparing accurate and reliable knowledge of what may be expected when in the more or less near future unmanned or manned space crafts will be able to land on the Moon and/or on planets of the solar system. Lyon has, in his well-known mastership of handling infrared spectralphotometric techniques, contributed in the present fascinating monograph a collection of 58 chosen absorption spectra reproductions from 370 rock-forming minerals, prevailingly silicates, which are fundamental as mineral ingredients of 80 types of rocks which may build up the surface crust of the Moon or of planets. Different degrees of crystallinity, the problems of the constitution of volcanic lavas and glasses, and of meteorites are included in these studies. It is interesting to note among the samples selected for reflection studies minerals like coesite and stishovite, Katmai ash, australite tektites, and chondritic meteorites, further explosion-shock-waved minerals (under pressures of 350/660 kilobars). A comparison is made for the infrared emittance of quartz and a black body as a function of wavelengths and temperature, further curves for granite, obsidian, dunite, and a stony chondritic meteorite, as a function of wavelengths at const. 350° K. The range studied in the absorption curves covers wavelengths from 2.5 to 25 μ (4000 to 400 cm^{-1}). Also the problem of the presence or absence of water either as loosely bonded molecules, or as firmly bonded hydroxyl groups is accessible to infrared methods as here presented. In an appendix, which refers to the theoretical background for thermal emissivity data to be expected from lunar surface rock material, the result is important that there is a strong contradiction to the premises concluded from the theories of Pettit and Nicholson on lunar black body radiation

and temperature (*cf. Astrophys. Jour.* **71,** 1930, 102–137) and the classical data of Coblentz (1906, 1910), and Bell *et al.* on infrared radiation from white sands (*Jour. Opt. Soc. Am.* **46,** 1956, 303–4). It is impossible to deny or to confirm either theory for emissivity of the Moon while the measuring equipment is situated on the Earth because of the spectral interference of the 9.2 μ absorption in the atmosphere by ozone. Calculations of the temperature based on location of the wavelength of maximum energy can be in error by as much as 65° K., the error for temperature differences using radiometric techniques may be $\pm 10°$ K. The estimated lunar surface temperature varies between 115° and 374° K. Having solved in this very valuable monograph the first task challenged by the Stanford Research Institute, namely to evaluate infrared absorption spectra of minerals and of assemblages of minerals under laboratory conditions, the future tasks are evident, namely, (1) to evaluate possibilities of using infrared spectrophotometers as a tool in a mapping system in a moving surface vehicle, or an orbiting space craft, using reflected or emitted infrared radiation from the Moon's or a planet's surface, (2) to evaluate possibilities of instrumenting an infrared system compatible with operational specifications, for a soft-landing space craft, in the environment of the Moon or a planet.

W. EITEL

MINERALS IN THE INFRARED. A CRITICAL BIBLIOGRAPHY, by R. J. P. LYON. Stanford Research Institute, Menlo Park, California, 1962, xii and 76 pp. Price $1.

In the first paragraph of his review of the Tablework of Horst Moenke, "Mineralspektren, aufgenommen mit dem Jena-Spektralphotometer UR 10" (*Am. Mineral.* **48,** 1425, 1963), the undersigned reviewer mentioned the present bibliography by Lyon as an important analogue and supplement to the collection of infrared absorption spectra of selected minerals, offered in the special publication of the German Academy of Sciences, Berlin. The opportunity is most welcome to emphasize the particular usefulness of this carefully chosen bibliography of 440 publications of the international literature, with valuable indication of where to find rapid information in the *Chem. Abstracts*, with extensive alphabetic indexes of the minerals investigated in their infrared absorption characteristics, and of the authors. Both collections of data and literature of the German and American authors mentioned here form a highly appreciated unit of information in this important modern field of mineral physics.

W. EITEL

ELEMENTS OF STRUCTURAL GEOLOGY, by E. SHERBON HILLS, John Wiley & Sons, Inc., New York, 1963, pp. xi+483, 422 figures, $8.50.

This long awaited book—an expansion of Hills' *Outlines of Structural Geology*—will receive widespread adoption as the textbook for undergraduate structural geology courses. It contains a reasonably thorough coverage of the fundamentals of structural geology with adequate attention to definitions and basic descriptive material. The many illustrations and the extensive references are especially helpful.

The book is divided into 14 chapters as follows: chapters I–III cover the scope of the subject, sedimentary structures, and non-diastrophic structures; chapters IV and V deal with the theory of deformation and include an appendix on Mohr's concept of failure; chapters VI–XII treat individual structural features such as joints, faults, folds, cleavage, and structures in igneous rocks; chapter XIII discusses structural petrology (written by E. Den Tex); and chapter XIV covers structural geomorphology and morphotectonics. This subdivision of the subject material is a very logical approach and will prove effective for student and teacher alike. The reader will find the discussions on theories of failure particularly helpful, especially those of stress-strain relations to rupture. Two other sections de-

serve special mention. They are the discussion (Chapter XIV) on the influence of structure to geomorphology which has been slighted in several previous basic structure texts and the coverage (Chapter XI) of major structures and tectonics which presents an interesting broad-brush picture of structures on a regional scale. Treatment of subject matter is greatly enhanced by use of examples of structural features from all over the world. This aspect will be particularly appealing to those teachers whose knowledge tends to be provincial or touches only on 'classic' areas outside their own country.

Unfortunately, there is a full 4-year time lag between the latest literature cited and the book's date of publication. This gap is particularly significant because of rapid developments in several fundamental areas of structural geology; perhaps the most serious omission resulting is any up-to-date discussion of the role of fluid pressure in thrust faulting. Some other pertinent subjects which were not included are the mechanics of folding based on the physical state of the rock, meteoritic impact structures and shatter cones, the nature of pluton injection using quantitative trend surface analyses, and vertical tectonics.

Several other features detract from the overall effectiveness of the book. The footnote reference system used has inherent disadvantages which are compounded by listing only the author(s) for all references of figures. For example in Chapter VI, figures 9 and 12 are 'after Spencer-Jones' but no additional information is available, as Spencer-Jones is not mentioned in the text. Referencing by author and date with a compiled bibliography as an index would have avoided this unfortunate condition. Also, although the book is well illustrated, many of the photographs lack contrast which would enhance their value.

The problem of integration of theory and descriptive material is only partly solved by Hills. Too often the reader encounters reference to material covered in more detail in another chapter of the book, a situation which the student finds particularly disconcerting. More careful organization and clearer phrasing would have made the book more readable.

Despite these objections, *Elements of Structural Geology* is the most up-to-date text available for the introductory structural geology course. It is indeed an important contribution and will be an asset to the library of all geologists as well as deservedly becoming a popular text in its field.

ROBERT E. BOYER
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ROCK-FORMING MINERALS, VOL. 3, SHEET SILICATES, W. A. DEER, R. A. HOWIE and J. ZUSSMAN, 1962, New York, John Wiley and Sons Inc., p. x+270, Price $15.50.

Volume 3 is a comprehensive presentation of the data on the sheet silicates and an interpretation of these data from the standpoint of these minerals as rock formers. The authors have accomplished this in a treatise of only 270 pages by a succinct, well-organized treatment of a selected body of data and pertinent theory.

The sheet silicates—the phyllosilicates—are logically introduced by the mica group. The basis of the presentation of the mineralogy of a group or species is the crystal structure; and every attempt, within the limitation of the treatise, is made to explain the relation of the structure to the properties. In reading this book, I would have appreciated a wider use of either photographs or drawings of structural models, such as Bragg used so successfully in his books.

The selection of chemical analyses of the micas is generous in number, of good quality, and widely representative of genetic types. There are 15 analyses of muscovite, 3 of paragonite, 6 of glauconite, 12 of phlogopite, 16 of biotites from igneous rocks, 16 biotites from metamorphic rocks, 7 lepidolites, and 4 zinnwaldites. All analyses are expressed in weight percent and their formulas have been calculated on a structural basis.

After the micas, the brittle micas (margarite, clintonite, xanthophyllite) are considered. Then a resume of stilpnomelane is admirably given. About 1937–38, Professors Gruner and Hutton reawakened an interest in this previously neglected mineral group. The prototypes of the montmorillonite group, pyrophyllite and talc, are discussed in terms of their structure and characterized chemically by seven analyses for pyrophyllite and nine for talc. The chemistry of the chlorite group is especially well treated. With the use of 39 analyses, an excellent interpretation of the chlorites occurring in metamorphic and igneous rocks is presented. The 7 Å chlorites, here called septechlorites, include amesite, chamosite, greenalite, and cronstedtite in addition to the synthetic substances. A crisp treatment of the serpentine-group minerals is given in a carefully integrated chapter of only 21 pages. The clay minerals, including vermiculite, are covered in a three-page introduction and in four chapters—about one-quarter of the text. The aim here has not been identification, but rather a balanced approach to clay minerals as the phases produced in the late stage magmatic processes and weathering. With the intense research on the clay minerals, it is very likely that this section will be the most greatly changed in the next edition of this work. This applies also to the nomenclature of these minerals. The use of so many commercial analyses, with unknown analysts is unfortunate, especially when so many good, signed analyses of the clay minerals are available. For example, such an analysis, #16 for hectorite fails to show fluorine, probably present to the extent of 6% (plus or minus). Two minerals of particular importance in the study of some amygdaloidal basalts—apophyllite and prehnite—are treated in this volume.

The relationships between physical chemistry, chiefly phase equilibria, and mineral paragenesis are clearly presented. The application of the research of the Geophysical Laboratory of the Carnegie Institution of Washington is obviously appreciated and extensively used in the discussion of the stability of minerals under magmatic conditions and in metamorphic processes. The minerals of the metamorphic facies assemblages are fully discussed and it is evident that the authors made every effort to seek out appropriate analyses.

This book is a necessity for practicing geologists, mineralogists, petrologists, and geochemists, and an important source of information for other scientists. Unfortunately its price is excessive.

GEORGE T. FAUST

ARIDITY AND MAN—The Challenge of the Arid Lands in the United States. CARLE HODGE, Editor; PETER C. DUISBERG, Associate Editor. Publ. No. 74, American Association for the Advancement of Science Washington, D. C., 1963.

This book is an interdisciplinary volume, the product of some seventy-four different scientists, compiled by the Committee on Desert and Arid Zones Research of the American Association for the Advancement of Science. The purpose of the book is to summarize the experience of the United States in the arid lands.

The book was written in the spirit of self-analysis and constructive criticism. Among other things it reports on research which has shown "that agriculture, traditionally one of the highest-priority users of water in the West, actually returns less to the total economy for the water it utilizes than do industry, cities, recreationists, and other users." The diversion of water to non-farm uses is thus likely to receive increasingly serious consideration. The overall problem faced in the West is a social one—while scientific research can help greatly with some of the problems faced, only public understanding of both the problems and the solutions and the public's willingness to change from the traditional, prejudiced ways of doing things will lead to a solution.

The chapter on mineral and energy sources in the West briefly summarizes the distribution and reserves of the several economic materials. It points out the well-known fact that

the West produces much more of many materials than it uses—it is the world's major producer of copper and helium, is a major producer of petroleum, and possesses about ninety per cent of the nation's potash and much of its other, more rare, evaporites. Aridity has led to little vegetative and soil cover and has hence aided in the development of open-pit mines. On the other hand, the aridity of the region has necessitated the development of several types of dry processing of ores, most of which are not greatly unlike conventional wet methods except that air replaces water as the transporting fluid. However, much more research needs to be done on dry ore processing.

The main thrust of the book is to point out, time and again, the need for men of the machine age to relearn what all arid region natives know—the need to use with care the limited water supply.

DONALD F. ESCHMAN

RELATION BETWEEN DUAL ACIDITY AND STRUCTURE OF H-MONTMORILLONITE. Geological Survey Professional Paper 386-C. ALFRED M. POMMER. United States Government Printing Office, Washington, 1963, 23 pp.

This Professional Paper describes in detail the application of the techniques of discontinuous titration to the construction of a neutralization curve for a pre-prepared H-montmorillonite. The curve is then discussed as evidence for two kinds of proton environments in the structural model of montmorillonite, without reference to its correspondence with a superposition of the Al^{3+} preciptimetry titration onto a normal weak acid-strong base titration curve. The thoroughness with which data were collected actually extends to citation that Al^{3+} from self-deterioration of the acid clay was in fact being precipitated through the range attributed to the stronger of the "dual" acid titres.

W. F. BRADLEY