River *Ceratopsia* to those of the Cow Island beds is marked. Lambe's *Centrosaurus apertus* is much like Cope's *Monoclonius crassus*. The skull of the great spiked dinosaur *Styracosaurus albertensis* Lambe, the most unique of the horned dinosaurs, appears to be related to Cope's *Monoclonius sphenocerus*. The Edmonton *Trachodon* secured from Macheche Creek six miles above Drumheller, on the Red Deer River, Alberta, is closely related to *Trachodon annectens* from the Lance formation.

CHARLES H. STERNBERG
GEOLOGICAL SURVEY OF CANADA

"HYDRAULICS" IN THE ENCYCLOPEDIA BRITANNICA

TO THE EDITOR OF SCIENCE: While examining the article "Hydraulics" in the eleventh edition of the Encyclopædia Britannica, Vol. 14, p. 35, I discovered three errors, one of which, at least, is worthy of note in SCIENCE, as it may cause some one to lose valuable time if the published figures are taken too seriously.

The first and most serious of these errors is the value of the coefficient of viscosity for water at 77° F. which is stated to be 0.00000191 in lbs. per sq. ft. per unit velocity gradient in feet per second.[1]

The correct equation for this value in C.G.S. units is

$$\text{Coefficient of viscosity} = \frac{0.0178}{1 + .0337t + .000221t^2}$$

t being in centigrade degrees.[2]

If the numerator be multiplied by the number of square centimeters in one foot and divided by the number of dynes in one pound while the value of t is replaced by $(t - 32) \times 5 \div 9$, the expression for the coefficient of viscosity will become

$$\text{Coefficient of viscosity for water} = \frac{0.0000372}{.4700 + .0144t + .000068t^2}$$

the units being the foot, pound and Fahrenheit degree.

If 77 be now substituted for t the result will be the value of the coefficient for water at 77° F., or, 0.0000188, which is nearly ten times the value given by the Encyclopædia Britannica.

[1] See p. 35, upper right-hand part.

[2] See p. 536, Lamb's "Hydrodynamics," 1906.

Another error occurs in the same article, p. 77, near the top, equation (4). The last sign in the right-hand member should be a minus sign instead of a plus sign. The correct equation is

$$H_1 = \sqrt{(2u_0^2 H_0 \div g + \tfrac{1}{4}H_0^2)} - \tfrac{1}{2}H_0. \quad (4)$$

In Fig. 168, p. 90, the curve marked "Exper. III." should be marked "Exper. I." and the curve marked "Exper. I." should be marked "Exper. III.," the numerals evidently being transposed.

The error in the coefficient of viscosity was carried forward from the ninth edition of the Encyclopædia Britannica and was noted by me in 1909 in a paper on backwater published in *The Minnesota Engineer*, University of Minnesota.

B. F. GROAT

SCIENTIFIC BOOKS

Principles of Stratigraphy. By AMADEUS W. GRABAU, S.M., S.D., Professor of Paleontology in Columbia University. New York, A. G. Seiler and Co. 1913. Pp. xxxii + 1185 + index, with numerous illustrations.

This is a monumental work, one which presents fully and systematically the newer viewpoints in the interpretation of the rocks as the record of geologic history. For this reason it will be of great value, especially to the younger generation of American geologists, in broadening their mental horizon and outlining the problems which rise for solution in the twentieth century study of the rocks. It differs from other manuals in the English language to such a degree that it supplements but does not supplant them. It contains a notably large incorporation of material from German sources and makes full use of recent critical literature of both foreign and American authors. Nearly all of the older geologic manuals, although valuable encyclopedias of geologic science, have stored up the proven knowledge of the past, but have not pointed out the fields for investigation. They have further emphasized facts and principles as explaining facts, rather than as criteria of interpretation. This work contains a wealth of facts, though differing quite largely from that assemblage which has been carried down

in English manuals; but it is in the presentation of the facts as a basis for the interpretation of the past that it shows a different point of view.

The author has made large use of physiographic data. In fact, many chapters could be used without change in a work on physiography. This the reviewer regards as an element of great strength in the book. Physiography, a younger member of the family of geological sciences, rests upon a stratigraphic and structural foundation. The present can not be understood without a knowledge of the past. On the other hand, the past can not be interpreted without an understanding of the present, but stratigraphers and students of historical geology have not learned as yet to make full use of physiographic principles. It is the purpose of an investigation which should determine the classification of the field of science rather than the facts which are used. Defined by this standard, physiography is that division of geology whose purpose is to explain the present; the purpose of stratigraphy and historical geology is to explain the past. But as both involve an understanding of past and present, no man can work to advantage in either field without a knowledge of both. For these reasons Grabau rightly regards the work of W. M. Davis as of great importance for the principles of stratigraphy.

The aim and scope of a volume are best shown by a statement of the conditions which developed its need and led to its production. Quotations from the author's preface will best give this view.

> This book is written for the student and for the professional geologist. It aims to bring together those facts and principles which lie at the foundation of all our attempts to interpret the history of the earth from the records left in the rocks. Many of these facts have been the common heritage of the rising generation of geologists, but many more have been buried in the literature of the science, especially the works of foreign investigators, and so have generally escaped the attention of the student, though familiar to the specialist. Heretofore there has been no satisfactory comprehensive treatise on lithogenesis in the English language, and we have had to rely upon books in the foreign tongue for such summaries. It is the hope of the author that the present work may, in a measure, supply this need.
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> The book was begun more than fifteen years ago, and the material here incorporated has been collected and sifted during this interval. . . .
>
> The "Einleitung in die Geologie als historische Wissenschaft" had appeared only a few years before, and its influence in shaping geologic thought, especially among the younger men, was just beginning to be felt. The "Lithogenesis der Gegenwart" presented such a wealth of facts concerning the origin of sedimentary rocks, that attention began to be diverted from the problems of the igneous rocks which had heretofore almost exclusively occupied petrographers, and "Sediment-Petrographie," or the petrography of the sedimentary rocks, attracted more and more of the younger geologists, especially in Germany and France. . . .
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> It was at this period, too, that the attention of geologists and especially stratigraphers was first seriously directed toward the desert regions of the world and the phenomena of extensive subaërial deposition. Here, again, Walther led the way in that classic, "Die Denudation in der Wüste," followed in 1900 by his epoch-making book, "Das Gesetz der Wüstenbildung," which, in its revised edition, appeared in 1912. It is, of course, true that important studies of the desert regions were made earlier, notably those of von Zittel on the Libyan desert (1883), but the significance of the desert deposits in terms of stratigraphy was first fully appreciated within the last decade. That the importance of the desert as a geological factor has become widely recognized is shown by the numerous recent studies, especially those on the Kalahari by Passarge, and those on the Asiatic deserts, by Sven Hedin, Pumpelly, Huntington and others.
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> It is during this decade that the sciences of glyptogenesis and geomorphology have come into being, notably through the labors of Davis in America, and of Suess and Penck in Europe. Suess's "Antlitz der Erde" began to appear, it is true, in 1883, but it is only in recent years that this work has been readily accessible to most American students, through the medium of the English translation by Sollas and Sollas (1904–1909). Penck's "Morphologie der Erdoberfläche" appeared in 1894, but did not become well known in this country until much later. It was, however, Davis's publications in this country, chiefly during the early nineties of the last century, which gave

the great impetus to the study of land forms, and especially of the influence of erosion on their production. The concept of the peneplain, of the cycle of erosion, of the sequential development of rivers and erosion forms on the coastal plain and on folded strata, and others chiefly due to him, have become of incalculable value to the stratigrapher. The more recent development of the idea of desert planation by Passarge and Davis has opened further promising fields to the stratigrapher, who seeks to interpret the record in the strata by the aid of modern results achieved by universal processes.

In the field of correlative stratigraphy the past decade has likewise seen striking advances. The publication of the "Lethæa" falls into this period, and so does Marr's comprehensive little volume, "The Principles of Stratigraphical Geology," not to mention the elaborate recent texts of Haug, Kayser and others, or the numerous publications of government surveys, and of individual contributors. That questions of correlation have reached an acute stage in American geology is manifested by such recent publications as the "Outlines of Geological History" and Ulrich's "Revision of the Paleozoic Systems," and the numerous papers accompanying or called forth by these. Finally, paleogeography, as a science, is of very recent development, most of the works of importance having appeared in the last five years. In America Schuchert and Bailey Willis are the acknowledged leaders, while in Europe many able minds have attacked the problems of paleogeography from all angles.

It is thus seen that this book was conceived during the period of initial reconstruction of our attitude toward the problems of geology, and that its birth and growth to maturity fell into that tumultous epoch when new ideas crowded in so fast that the task of mastering them became one of increasing magnitude and, finally, of almost hopeless complexity. To summarize and bring together the ideas of the past decade, and focus them upon the point of view here essayed, is probably beyond the power of one individual. Nevertheless, the attempt to present the essentials of the new geology for the benefit of those who, grown up with it, have perhaps treated it with the lack of consideration usually bestowed on a contemporary, as well as for those who will carry on the work during the next decade or two, can not but serve a useful purpose. May this attempt be adjudged not unworthy of its predecessors, nor unfit to stand by the side of its contemporaries.

Having given the author's point of view, there may be noted briefly the especial features of some of the chapters.

In Chapter II., on the atmosphere, in addition to a review of meteorological principles, there is an extensive treatment of wind erosion and transportation. Space is given also to the indications and nature of rhythmic climatic changes.

The hydrosphere is treated in the next three chapters. Under Morphology and Subdivisions of the Hydrosphere are considered the forms of oceans, lakes and rivers. The most pertinent assemblage of material of this section is, however, in that chapter dealing with the movements of the hydrosphere and their geological effects, especially in the transportation and shaping of material.

There follows in Chapter VI. a classification of the rocks of the earth's crust.

The heart of the volume is found, however, in ten chapters, IX. to XVIII., inclusive, which deal with the original structures and lithogenesis of the sedimentary rocks, and it is for this section of 417 pages, if the reviewer mistakes not, that the work will be regarded as most distinctively a contribution to geologic science. There is throughout an application from present sedimentation to ancient sediments, more especially to those of the Paleozoic. If this section be compared with those dealing with the nature of sedimentary rocks in the standard manuals of geology in the English language, it will be seen that not only is it many times more comprehensive and extensive, but that traditional, over simple, and conventional interpretations are retested by the appeal to nature. This section leads to the conclusion that a much larger part than has been the custom should be ascribed in earlier ages to eolian and fluviatile sedimentation and their climatic implications.

Chapters XIX. to XXIII., inclusive, give 164 pages to metamorphism, earth sculpture, igneous activity and diastrophism. Parts of these chapters are better and more fully treated in other works and are not clearly within the province of the book, but other

parts, such, for example, as that on subaquatic gliding of sediments, are novel, are well treated, and valuable for their bearings on the origin of certain structures and relations of stratified rocks.

The next section of 187 pages deals with the biosphere. There is given a classification of the organic kingdom and the relations of each group to its environment. The principles which control the geographic distribution of animals are also set forth.

A final section deals with the principles of classification and correlation of geologic formations.

One of the most valuable features of the volume consists of the bibliographies which are given at the end of each chapter and the frequent references to the more important papers on each subject. The work thus is a guide to the student for his independent navigation and exploration upon that ever-broadening and rising ocean of literature which threatens to drown research.

From this statement of contents it is seen that the work is a notable contribution. Every geologist dealing with stratigraphic or historical geology should give it a place in that elect reference shelf, the revolving book case within reach of his office chair.

To prove that this eulogistic review is the result of a judicial study of the volume it is necessary, however, to supplement the previous statements by finding something for adverse comment, even if only of minor importance.

A good deal of space has been given to the discussion of secondary structures—faults, folds, metamorphism, igneous intrusion, etc. This has added to the bulkiness and cost of the volume without adding proportionately to an increase in its value. This greater cost will tend to keep it on the reference shelves of libraries instead of installing it in the private library of every student. The book is consequently likely to have less influence than if the detailed discussion of secondary structures had been ruled out or published as a separate volume. The subject matter does not appear sufficiently essential for the principles of stratigraphy to require incorporation, and a comprehensive study of these fields requires furthermore the study of other treatises, such as those of J. Geikie, Van Hise and Leith.

Classification is necessary in order to deal with the subject-matter of science, and classification must grow with the growth of knowledge. One of the noteworthy features of the work is the development of systematic classification to cover the field of sedimentation and stratigraphy. It aids in a logical and precise treatment, but the reviewer thinks that the author may have partially hindered his purpose by an over-classification and the extensive coinage of unfamiliar Greek names. Such words as caustobioliths and sapropelcalcilyths are examples. The renaming of contact metamorphism as æthoballism and dynamic metamorphism as symphrattism seems unnecessary and is hardly likely to succeed. To discuss earthquakes under the division of the centrosphere seems also quite inappropriate. "The littoral" in its original meaning and as used by a number of geologists has been restricted to the zone of shore between high and low tide. The stratigraphic characters are unique in that they receive the impress of alternate exposure to the air and sea. This dual relation must be recognized in order to avoid the inherited confusion between continental and marine deposits. The reviewer regards it as unfortunate, therefore, to extend it as a general term as is here done to cover all that region from the high-tide line to the edge of the continental shelf. This in some regions is more than 100 miles from the shore and in ancient times was often vastly farther. On the other hand, however, it should be noted that the refinement of classification adds greatly to the analysis of the original structure and lithogenesis of the continental sediments, divided under the heads of atmoclastic, anemoclastic and hydroclastic rocks, assisting in a better presentation of these groups than has heretofore appeared.

An enumeration and discussion of the multiple hypotheses which may participate in complex processes is of great value to the advanced student, opening his mind to various possibilities and stimulating his imagination to

new research. Through most of the book this is very well done, but the causes of climatic change through geologic time do not find adequate treatment. There is, for instance, a rather extensive presentation and commendation of the several hypotheses of a wandering pole, but almost no discussion of the influence of changing atmospheric composition and none of such factors as a possible reversal of the oceanic circulation or possible changes in solar radiation. The absence of a dynamic proof of polar wandering adequate to account for climatic change makes it seem to the reviewer the least supported of all the climatic hypotheses.

To sum up this volume in a sentence—it is in the broad and admirable treatment of the present processes of sedimentation and in the interpretations which they give to the older sedimentary rocks that the book will be found to have its unique value.

JOSEPH BARRELL

Some Fundamental Problems in Chemistry. By E. A. LETTS. New York, D. Van Nostrand Co. 1914. 15 × 22 cm. Pp. v + 235. Price $2.50.

In the preface the author says that one of his "chief ideas was to contrast certain ancient views, such as those of atoms and a primordial element or primordial elements in the shape of air, earth, fire, and water, together with the possibility of transformations of these latter into each other, with the modern conception of electrons and the discovery of changes, such as those which the radioactive elements experience, which amount in fact to a change of one so-called chemical element into others. . . ." It is perhaps a question whether many readers will agree with the author that these two modern discoveries prove that even in science history may repeat itself; but fortunately one may like the book without accepting the author's thesis.

The book consists of four chapters on the older chemistry and seven on the newer chemistry. Under older chemistry the subheads are: ancient theories regarding the nature of matter and more recent theories as to the nature of energy; the atomic theory and atomic weights; the periodic law. There is nothing especially interesting or novel about this portion of the book and it might well have been omitted, thus giving the author an opportunity to amplify the portion on the newer chemistry, which is very interesting.

The newer chemistry, as understood by the author, deals with the effects of electrical discharges on gases in high vacua, radioactivity, Lockyer's theory of inorganic evolution, and Arrhenius's views on the birth and death of worlds. This part is admirable though distinctly not critical. The author apparently accepts, without much reservation, all the transmutations which Ramsay has described.

With Plücker tubes as a starting-point the author discusses the production of cathode rays when the degree of exhaustion is increased, and the properties of these rays. From cathode rays he passes to canal rays and thence to Röntgen rays. After that come Becquerel rays and then the discovery of radium by the Curies. The properties of the α, β, and γ rays are discussed and then the decomposition products of radium. The facts in regard to the production of helium are followed by an account of Ramsay's experiments on the alleged formation of lithium, carbon and neon. The author does not point out, as he well might have done, that it would be in the interest of science for Ramsay either to accept Mme. Curie's work on lithium or to repeat it and show wherein the discrepancy occurs. The present state of things is distinctly not creditable, and Ramsay's unwillingness to meet the situation raised by Mme. Curie's work on the alleged production of lithium has caused Ramsay's work on the alleged production of carbon and neon to be received with much suspicion. The last chapter on radioactivity deals with J. J. Thomson's discussion of the periodic law on the basis of the electron theory.

The chapter on inorganic evolution may be summed up as follows: In the very hottest stars we find hydrogen, helium, asterium and doubtless other gases still unknown. At the next (lower) temperatures, we find these gases