upon keeping them up and do our best to make possible the proper preparation of the students.

With teachers prepared to teach zoology as probably we all feel it should be taught in our schools, and consequently with our students quite ready for a deeper look into animal life, and with a more widely distributed interest in zoological work, we shall find the more or less vague feeling for something that is wanting vanished and shall have a larger and more capable class of applicants for more special and advanced courses. Until this condition is realized we must as best we can provide for both classes of our students as well as for the preparation of the men and women who are to bring the rich blessing of a general interest in natural history to the commonwealth.

In the progress toward the realization of this worthy end Section F, in my humble judgment, can be made a most efficient factor by serving as the one sure and safe link between the general public and the zoologists as investigators and teachers.

The preparation being well done below the plane of the investigator, or, if you prefer, outside the circle of investigators, Section F will continue as a vigorous branch of a fruitful vine, and, being trained to meet the conditions of its general environment will yield to the people at large attractive, choice and satisfying fruit.

H. F. NACHTRIEB

THE UNITED STATES GEOLOGICAL SURVEY[1]

THE record of the work of the Geological Survey during the fiscal year 1912 may fitly be preceded by a statement of the conditions under which that work has been done, not as an apology for either the quantity or quality of the results of the investigations made, but rather as an exhibit of the limitations forced upon this bureau —limitations on economy and efficiency which seriously hamper all efforts for better administration in the expenditure of public money.

The offices of the Geological Survey have become wholly inadequate and unadapted to its needs. Since 1884, when the Survey was first quartered in the Hooe Building, at 1330 F Street, the effort has been frequently made to provide for the growth of the organization by adding wings and extensions to the building, but every increase in floor space has been made at the expense of proper lighting of the older portions of the building, so that its fitness for the Survey's use has been steadily impaired, and the resultant conditions constitute an actual detriment to health and a menace to life and property, as well as an obstacle to efficiency. The conditions under which the Survey employees work in the Washington office are to be condemned for both humanitarian and business reasons. . . .

The present housing of this federal bureau is unworthy of the nation. Both the work and the workers of the United States Geological Survey have an international reputation, and visiting foreign scientists do not conceal their astonishment at the miserable environment in which these investigations are being carried on. Our neighbors on this continent, in Canada and Mexico, have erected buildings especially adapted to the work of their geological surveys, which are properly housed, as is nearly every other geological survey in the world, and yet the geological survey of no other nation compares in size of organization or scope of work with that of the United States. In fact, the surveys of several of the larger European countries are organizations whose personnel is com-

[1] Extracts from the Thirty-third Annual Report of the Director.

parable in number only with that of single divisions of the American Survey.

The practical side of this feature is the increased inducement that suitable quarters would afford in retaining in the government service men of the highest professional talent. At best, most of these investigators are carrying on their government work at a financial sacrifice, and the temptation to go into professional or corporation work at largely increased salaries is strengthened by the contrast between the well-lighted and sanitary offices generally provided in the business world and the noisy, dirty, dark and crowded quarters offered by the Survey. To retain in the government service the best men is by far the largest administrative problem of the director of the United States Geological Survey.

Notwithstanding the growth of the Survey work along practical economic lines, scientific work has not been neglected. In fact, in the Geological Survey the scientific investigations are inseparable from the economic work, though the one or the other may predominate in purpose according to the needs of the particular research in hand. In any field economic work of the highest rank is impossible without full knowledge of the scientific laws and principles pertaining to the subject of the work; but as there is no application of geology which does not involve unsolved problems, some of them of the highest importance, the best knowledge available is nevertheless relative. It thus follows that the broad and searching observations which should accompany every piece of good economic work comprehend data that are eventually combined in the construction of new scientific hypotheses, some of which, as more observations accumulate, grow into established laws or principles that are in turn of the greatest practical consequence. Thus the detailed studies of the metalliferous deposits in one region or another bring to light evidence from which to determine the genesis of the ores and the modes or conditions of their occurrence, and the economic inquiry becomes more intelligent and successful when once this new principle regarding the mode of an ore occurrence is understood.

On account of the plain duty of this federal service to minister to the immediate needs of the various mining districts, it is not generally possible to concentrate and direct the observations to a series of regions systematically chosen as suited soonest to furnish the requisite data bearing especially on some particular scientific problem, however important and advantageous its solution may be; but nevertheless the data are gradually accumulated for the interpretation of many of these problems without sacrifice of the Survey's obligations to the public. An interesting illustration of the deduction of a principle from data so accumulated is found in the paper by W. H. Emmons on the enrichment of sulphide ores, the manuscript of which has been completed during this year. Another illustration of scientific results based on a long period of field studies, pertaining mainly to economic areas, is found in the pre-Paleozoic history of central North America, as described in the monograph by Van Hise and Leith on the geology of the Lake Superior region, which appeared during the year.

Among other long-term studies more distinctly scientific in character may be mentioned particularly the investigations, made under Mr. Vaughan's direction, of the formations of the southern Coastal Plain and Gulf embayment, which, though having an economic object, are yielding important contributions to our knowledge of the stratigraphy, physiography and

geologic history of this province; the work under the direction of Mr. Cross in the San Juan region of southwestern Colorado, which, in connection with the thorough geologic studies made during the preparation of folios, is affording new scientific results of a higher order concerning especially the volcanism and physiography of the region; and the studies begun last year by Messrs. Campbell and Alden in the Glacier National Park, which promise important results concerning the origin of the structure and physiography of this part of the Rocky Mountains and of the glacial topography, which, as it is still "in the making," offers exceptional opportunities for scientific study as well as observation by the traveler interested in the natural wonders of his own country. Important regional studies of high scientific rank which should also be mentioned are those prosecuted by Mr. Keith and his associates, on the difficult stratigraphy and intricate geologic structure of the older Paleozoic regions of western New England and the Appalachian region, the results of which are partly published in folio texts, and those carried on by Professor Emerson in southern New England. A report by Professor Emerson on the geology of Massachusetts and Rhode Island has been submitted during the year.

The paleontologic work of the Survey continues to be of the highest rank. Many of its publications, written by the most distinguished representatives of the various branches of paleontology in the country and embodying experience and observations gathered during years of patient research, have contributed much to the scientific reputation of the organization. The descriptive paleontologic papers are often treated as "pure science," yet instructive, striking or tedious, as may be these delineations of the groups of animal or plant life which lived on the globe in some particular epoch, there is not one of these papers describing the fauna or flora of a formation that does not prove sooner or later to possess practical value and to be essential to geology in its constantly increasing refinement of study and results. Without paleontology the geologic classification of formations, their correlation, and the determination of their mutual relations would be impossible. In fact, real and symmetrical progress in geology is impossible without corresponding interrelated development and refinement of its handmaid paleontology. The economic geology of any region of complicated structure is blind and inconsequent unless the time relations of the strata concerned are known. The monograph now being issued from the press on the Cambrian Brachiopoda, prepared by ex-Director Walcott and representing many years of painstaking study and distinguished attainment, embraces our best and most complete presentation of the criteria for the discrimination of the Cambrian formations in America and will for many years be a manual for the use of workers in Cambrian geology and paleontology. This monograph brings deserved credit to American science and to the Geological Survey, under whose auspices most of the work was accomplished. Other paleontologic publications specially deserving mention by reason of their scientific merit are J. P. Smith's philosophic treatment of the Middle Triassic faunas, and the monograph on the Mesozoic and Cenozoic Echinodermata of the United States by W. B. Clark and M. W. Twitchell, the manuscripts for both of which are now in hand. Work like that of Kindle on the Onondaga fauna, lately printed, and that by Berry on the Upper Cretaceous and Eocene floras of South Carolina and Georgia and by Stephenson on the Cretaceous deposits of the eastern Gulf region,

both now in manuscript, is indispensable to geology. In these papers the stratigraphic value and the practical application of the results of the paleontologic investigations are given much prominence. The two papers last named are based on materials gathered in the course of the study of the Coastal Plain already mentioned, the economic motive for which was the investigation of the underground water resources. They are therefore representative of a series of scientific reports resulting from studies whose immediate object is economic.

The folios describing and mapping in detail the geology of quadrangles in different parts of the country are regarded as mainly scientific, though always giving attention to the economic resources of the region. The areal studies now in progress in the valley region of central Alabama, a part of which has been described by Mr. Butts in the Bessemer-Vandiver and Montevallo-Columbiana folios, now in hand, promise important additions to the geologic history of the southern Appalachian region. On the other hand, the Claysville (Pennsylvania) folio, which has been issued during the year, affords a striking example of the first-hand aid in oil and gas development to be derived from the careful delineation of geologic structure and its economic explanation. Not inferior in scientific value to the papers just cited, though primarily economic, are such reports as those by Messrs. Brooks and Prindle on the Mount McKinley region, Alaska, and by Messrs. Calkins and Emmons on the geology and ore deposits of the Philipsburg quadrangle, in Montana.

An important and interesting effect upon the scientific work of the Survey has resulted from the work in land classification. The constantly increasing demand for both completeness and exactness of information regarding the mineral resources of the public lands under classification have developed methods and scope of view in this economic work that have exerted a marked influence on the folio work in other areas.

Thus, the training and methods developed in the course of the classification of the coal lands have brought about higher standards of refinement in stratigraphy, as well as in economic work, in other regions of the country. Another very notable illustration of scientific results springing from the study of economic problems is found in the administration of the Weeks Act. The intensive hydrometric experimental studies carried on in order actually to show, in accordance with the terms of the law, the degree of protection afforded by forests to soil and water in certain areas proposed for purchase as national forests have resulted in empirical determinations and demonstrations of high scientific value as well as of tangible economic importance.

The principles governing the origin and mode of occurrence of petroleum and natural gas are as yet but fragmentarily grasped. Every oil field examined in detail contributes its data for use in the eventual interpretation of the problems, and each pool is studied with keen alertness for the discovery of some key which may aid in the coordination of the data, which sometimes, according to the region and conditions, seem, on account of our lack of knowledge, even to be in conflict. The observations made by the survey geologists in the oil and gas fields of California and Kentucky promise to further the solution of some of the problems, and by pointing out the relations of oil and gas occurrence to the geologic structure of the regions examined they have rendered important scientific as well as economic aid in oil and gas development; but the basic

principles controlling the widely varied modes of occurrence and accounting for the differences in kinds of the oils in widely separated regions are possibly still far from view.

On account of the more conservative and dignified character of the official publications of the Survey and the care taken to confine their substance to matters of demonstrated fact, they do not offer to the geologist the forum for free discussion of scientific theories and problems that are afforded by those periodicals and serial publications of scientific societies which are especially devoted to matters of strictly professional interest and which are more widely distributed among scientists. For this reason many of the scientific results of the Survey's operations are first published in these journals. Examples of papers of high rank contributed in this way are numerous. Without implying relative merit among these, mention as typical may be made of the paper by Mr. Campbell, "Historical Review of Theories Advanced by American Geologists to Account for the Origin and Accumulation of Soil," published in *Economic Geology,* Vol. 6, No. 4, and that by Mr. Ulrich, entitled "Revision of the Paleozoic Systems," printed in the *Bulletin of the Geological Society of America,* Vol. 22, No. 3. Besides contributing to the programs of other scientific societies in Washington, the members of the Survey maintain for the discussion of purely geologic topics three professional societies, including the Geological Society of Washington, before which Mr. Campbell's paper, just cited, was presented as a presidential address. Meetings of some one of these societies or of their sections average two a week for the winter and by far the greater number of the papers read are offered by members of the Survey.

EDUCATIONAL WORK OF THE SURVEY

Closely connected with the scientific work of the Survey is its educational function, which has not, on the whole, received the attention that so importantly useful a work deserves. The Survey has, however, in cooperation with several state surveys, participated in the preparation of a number of educational bulletins that have, in accordance with the agreements, been submitted to the respective states for publication. As distinctly educational in their scope, though far from elementary, should be named the valuable paper by Mr. Willis, entitled "Index to the Stratigraphy of North America," published as a professional paper in explanation of the new geologic map of the continent, and the paper by Messrs. Tarr and Martin, describing the earthquake phenomena in the region of Yakutat Bay, Alaska.

A notable contribution to the study of physiography was the Survey's Professional Paper 60, "The Interpretation of Topographic Maps," by R. D. Salisbury and W. W. Atwood, consisting chiefly of reprints of parts of the Survey's maps and of brief suggestions as to the origin and history of the features shown on them. For many years the topographic maps made by the Survey have been regularly used in the courses of instruction in geography and physiography in most of the universities and colleges and to some extent in the secondary schools. It is very gratifying to note that the maps prepared in accordance with the present high standard, and more fully adapted to such use, are coming to the attention of teachers in the graded and country schools. Teachers of schools located in the quadrangles surveyed in recent years find the corresponding topographic sheets a most practical and invaluable aid to their efficiency and success in teaching elementary geography.