NATIONAL ACADEMY OF SCIENCES

CHARLES PETER BERKEY

1867—1955

A Biographical Memoir by

PAUL F. KERR

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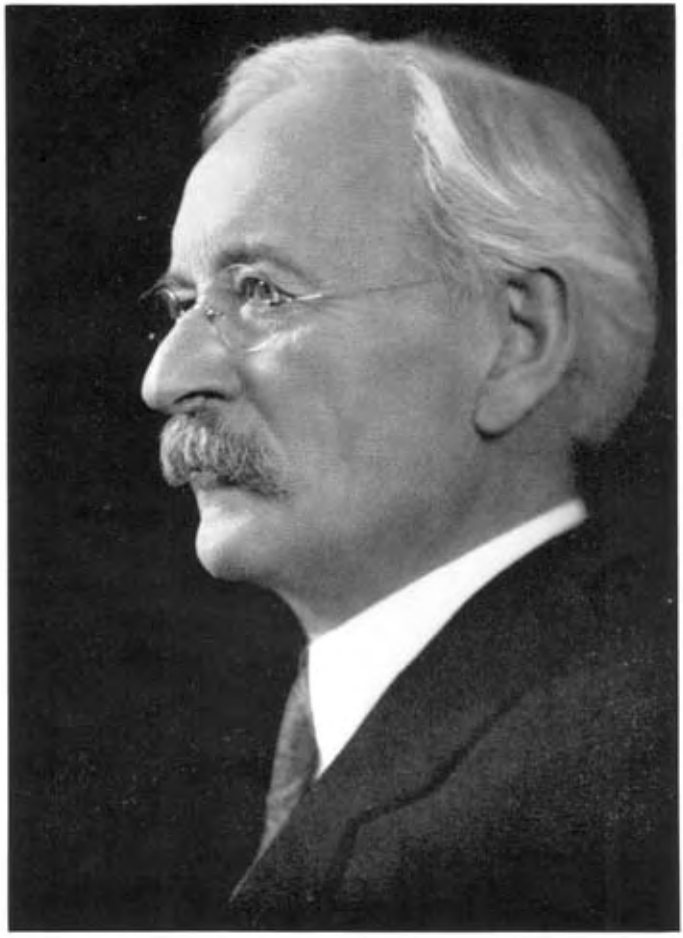

Charles C. Berkey

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AN ERA OF ENGINEERING GEOLOGY

IT IS UNUSUAL in the lives of scientists to find one man, who, to a considerable degree, has been a pioneer for an era. Yet, in all fairness, the credit for inaugurating such a period in engineering geology belongs more to Charles P. Berkey than to any other man.

In his younger days he never could have pictured even vaguely the role he would later play in the development of a new science. Nor was it indicated in his early program, which was devoted to obtaining a well-rounded geological education without specialization, nor apparent in his first scientific contributions, where he utilized with facility such widely separated fields as mineralogy and paleontology and combined the two in support of broad geological interpretation.

It is a significant coincidence that Charles P. Berkey's arrival in New York in 1903, to undertake an academic assignment at Columbia University as a junior staff member in geology, occurred at the time the Board of Water Supply of New York City was considering the project of bringing water from the Catskill watershed to the city. The Catskill Project, with an estimated cost of $176,000,000, was one of great magnitude for its day, and involved unusual features. Large tunnels were to pass through mountains; 92.5 miles of aqueduct were required; 34 access shafts were to have an aggregate depth of 14,723 feet; large dams were needed to create reservoirs; the entire water flow derived from the Catskills was to pass under

the Hudson River; and far down in the rock of the city 18 miles of distributing tunnel were to be driven. These undertakings frequently raised questions geological in nature, which in many cases could not be answered by the engineers responsible for construction. It was a situation made to order for an able young geologist.

During the early days of the project, Professor Berkey had the good fortune to be associated with Professor James F. Kemp of Columbia University, who, as an experienced geologist, was a consultant for the Board of Water Supply. Because of other responsibilities, Professor Kemp found his time to be limited and withdrew from the project in favor of his colleague; the mantle of responsibility then fell on Professor Berkey's shoulders.

Throughout the years during which the Catskill Project was undergoing design and construction, Professor Berkey was frequently called upon when on vacation or during weekends to visit some portion of the project where critical geological information was desired. When the original tunnel line passed through faulted and crushed rock zones, more substantial and less broken routes were frequently found. As advance borings were obtained, examination showed whether the tunnel conditions were normal or would require some special form of construction. Alternative dam sites were investigated and the adaptability of the bedrock conditions for various forms of engineering design was discussed.

In this work Professor Berkey acquired unusual experience in geological interpretation and prediction. At the same time he exhibited a remarkable facility in explaining geological features to engineers and other technical men who were not geologists. He firmly believed that, given an adequate opportunity to obtain geological facts, some simple form of easily understood geological explanation could be devised, which could form a basis for decisions by the men with whom he was constantly in contact.

While the work on the Catskill Aqueduct established Professor Berkey as an engineering geologist, the period of this activity was a prelude to an era of engineering geology, rather than a part of

the era itself. With the completion of the aqueduct, he became involved in the application of geology in several other fields; these will be mentioned later. However, as an engineering geologist with an unusually successful background, he was very often called upon for advice.

It may be said by some that engineering geology developed gradually as an inevitable process. This is partly true. It is generally agreed, nevertheless, that the great disaster in 1928 which resulted from the failure of the St. Francis Dam in southern California brought home to the public the importance of coordinating geological observation and interpretation with engineering construction. Before the failure of the St. Francis Dam, the application of geological interpretation to dams, tunnels, and other forms of major engineering construction was optional with the engineer in charge; after the failure, geological assistance became a requirement—by law or by the rules of accepted engineering practice.

Not all geologists were prepared either by training or temperament to accept the responsibility which this new situation imposed, and several years passed before experienced and competent geologists were trained to meet adequately the sudden demand for geological advice in engineering. However, engineers concerned with such problems soon learned that in New York City there was a geologist who was not only a competent and well-known scientist, but also possessed in full measure the desired type of experience.

In the era which followed the catastrophe of the St. Francis Dam, leadership in the field of engineering geology was assumed by Professor Berkey; this is largely described in the memorial volume on *Application of Geology to Engineering Practice* published by the Geological Society of America and known as the Berkey Volume. During this period many great dams were constructed, several large cities built aqueducts, important bridges were erected, and other forms of construction requiring geological advice were undertaken.

As a member of the Board appointed by President Coolidge to pass upon the plans and designs of the Hoover Dam, Professor

Berkey assured the engineers that the rock of the walls along the Colorado River at the site was safe for large outlet tunnels. He also advised upon the suitability of the rock floor to hold the highest dam in the world. The dam itself now stands as a silent witness to the value of his good judgment.

The enormous dam across the Columbia River at Grand Coulee and the large reservoir in Grand Coulee itself constituted another of the major projects on which he advised. Here again the rock floor was subjected to close scrutiny. The material itself, as well as every crack and fracture, was examined on a completely exposed surface to ascertain that the concrete when poured would form a dam inseparable from the rock beneath.

Over a period of 25 years few engineering structures of any magnitude requiring attachment to natural rock or the support of geological formations were built without having Professor Berkey at least examine the plans and visit the site. These projects included the Delaware Aqueduct of New York City, various aqueducts of Los Angeles and Boston, approaches to the Holland and Lincoln tunnels in New York, pier foundations for the George Washington, Whitestone, and Triboro bridges, and great dams such as Friant and Shasta in California, Bonneville in Oregon, Parker along the Colorado River, and the large structures built by the Tennessee Valley Authority.

The four highest[1] dams in the world were firmly bound to the rock floor on which they rest with the benefit of geological advice in which Professor Berkey participated. In recognition of his contribution to engineering science as well as geology he received a most signal tribute as a geologist—election as an honorary member of the American Society of Civil Engineers.

[1] Hoover, Colorado River, Arizona-Nevada, 726 feet; Shasta, Sacramento River, California, 602 feet; Hungry Horse, south fork of the Flathead River, Montana, 564 feet; Grand Coulee, Columbia River, Washington, 550 feet.

THE EARLY YEARS OF A GEOLOGIST

Professor Berkey was born in Goshen, Indiana, on March 25, 1867. His early life was spent on farms, first in Indiana, later in Texas, and finally in Minnesota. When he entered the University of Minnesota in 1889, he thought seriously of becoming a preacher. However, by the time he graduated in 1892 his interest had become firmly fixed in geology. He continued in graduate work, and in 1897 was awarded the first Ph.D in geology to be granted by the University of Minnesota.

His doctor's thesis was devoted to the geology of an area of some 60 square miles along the boundary between Minnesota and Wisconsin which included the locally well-known Dalles of the St. Croix River. It involved a comprehensive study of the geology of the area and included basic interpretations in paleontology, mineralogy, and petrology. It was a thesis publication that one could refer to with confidence more than a half century later.

After obtaining his degree, Dr. Berkey spent several years as an Instructor in Geology at the University of Minnesota. During this period he took advantage of every opportunity to broaden his experience in geological field observation. He visited the Uinta Mountains in Utah and carried on a geological reconnaissance which perhaps was the first step in a chain of events which ultimately led to his geological exploration in Central Asia. The publication describing his studies in the Uinta Mountains was his first contribution to the Geological Society of America—a society which he was to serve later as secretary and, ultimately, president.

In 1903 Professor Kemp was chairman of the Department of Geology at Columbia University. He was impressed with the early accomplishments of the young geologist from Minnesota and prevailed upon him to transfer to Morningside Heights. As previously indicated, it was also Professor Kemp who introduced Professor Berkey to the Board of Water Supply of the City of New York and encouraged him during the early studies of the Catskill Aqueduct.

Later, when contributions of friends of Professor Kemp made possible the creation of the Kemp Medal awarded for outstanding public service in geology, it was most appropriate that the first citation should be made to Professor Charles P. Berkey, who received the medal during the latter part of his distinguished career. As a fitting tribute, Professor Berkey was presented the Kemp Medal by Dwight D. Eisenhower, at that time President of Columbia University.

A GEOLOGIST IN A METROPOLITAN AREA

As soon as Professor Berkey came to Columbia he took steps to make himself part of the community in which he lived. He became active in the affairs of the New York Academy of Sciences. The field of exploration captured his interest, and he strongly supported the Natural History Survey of Puerto Rico and the Virgin Islands undertaken under the auspices of the Academy. He found occasion to visit Pureto Rico and published a geological reconnaissance of the island. For many years he ably served as chairman of the Puerto Rico Committee. As a result of his activity in the Academy, he became a member of the Council, was subsequently elected Chairman of the Division of Geology, and later served as President of the Academy.

An interest in local science, coupled with a desire to know as much as possible about the geology of the New York area, led to many field excursions. On holidays and weekends, in company with a group of enthusiastic students, he was apt to be seen at sites almost anywhere in the vicinity of New York where rocks could be observed. One of the few unpleasant episodes in an otherwise most harmonious career was his controversy with the Park Commissioner, Mr. Robert Moses. Certain rock outcrops in Mount Morris Park were looked upon by Professor Berkey as keys to the interpretation of the geologic structure on the eastern part of Manhattan Island. The Park Commissioner, however, felt that the rocks would look better if covered with concrete steps. Notwithstanding the vehement protests of Professor Berkey, the able and well-meaning but geo-

logically unsympathetic Park Commissioner covered the rocks with concrete—and covered they remain.

During the course of these local studies, Professor Berkey published a description of the geological features of southern Manhattan Island. This was followed by a paper on the geology of New York City and its relation to engineering problems. From these studies he turned northward, where he investigated the relations of the gneisses which form the rock floor of the Highlands.

With so much practical experience to draw upon and a keen ability for lucid explanation, Professor Berkey became an inspiring and popular teacher. A special course in which he took great pride was listed in the catalogue as "Applied Petrology." In many instances it was actually a geological clinic in which students had an opportunity to solve geological problems previously studied by Professor Berkey himself.

Together with his other duties, Professor Berkey was Executive Officer of the Department of Geology from 1914 to 1938. In 1929 he was elected Newberry Professor of Geology, and he became Professor Emeritus in 1938. His retirement was followed by at least 15 years of active professional work.

Another responsibility which Professor Berkey discharged for 18 years was the secretaryship of the Geological Society of America. It was largely because of his efficient administration as Secretary that Dr. R. A. F. Penrose decided to leave a bequest amounting to $5,000,000 to the Society.

A GEOLOGIST IN THE GOBI

Those interested in the role that Professor Berkey played in exploration of the Gobi Desert in Mongolia will find many of their questions answered by reading *On the Trail of Ancient Man* by Roy Chapman Andrews. Henry Fairfield Osborn and his associates of the American Museum of Natural History in New York had long been interested in the possibility that Central Asia was the birthplace from which mammals migrated westward to Europe and

eastward across the Bering Strait to North America. Dr. Andrews with characteristic vigor and imagination set out to organize and conduct an expedition to visit this important region where, with the benefit of the best scientific advice obtainable, verification of ideas then prevalent might be found. Ultimately, a staff composed of 21 members was chosen, and full-scale journeys were made by the Central Asiatic Expedition in 1922, 1923, and 1925. Professor Berkey was the Chief Geologist and Petrographer for the Expedition.

Late one summer day an early expedition was returning from the desert before snows made the trails impassable with mud. Several features of unusual geologic interest had been called to the attention of the group by Professor Berkey and his associate, Professor Frederick Morris. The photographer for the Expedition, not being otherwise occupied, wandered over to some low hills near by which aroused his curiosity. By accident he came upon what later proved to be a fossil bonanza. A colorful locality, it was called the Flaming Hills, and it was here that the now famous dinosaur eggs were first found.

Early training in reconnaissance geology was particularly helpful to Professor Berkey in the Gobi. Conditions under which geologic work was conducted were far from ideal. Long trips by car over terrain without roads were tiring. In an expedition forced to keep a schedule to reach water holes and meet supply trains on time, frequent stops to make ground observations were not feasible. Great ingenuity was required to piece together a coherent geological picture. It is a high compliment to his ability as a field geologist that Professor Berkey was able to integrate the general outlines of the geology of an unmapped and little known region; the area is now inaccessible to the free world. It is our good fortune that the volume entitled *The Geology of Mongolia* by Berkey and Morris stands as a model in the field of geological exploration.

Professor Berkey was duly elected a member of the National Academy of Sciences in 1927 in recognition of his fine Asiatic work.

CHRONOLOGY

1867 Born (March 25) Goshen, Indiana.
1892 B.S., University of Minnesota.
1893 M.S., University of Minnesota, Instructor in Mineralogy.
1894 Married Minnie May Best.
1897 Ph.D., University of Minnesota.
1903 Tutor in Geology, Columbia University.
1904 Special Geologist, New York Board of Water Supply.
1907 Assistant Professor, Columbia University.
1913 Vice-President, New York Academy of Sciences.
1914 Associate Professor, Columbia University.
1916 Professor, Columbia University; Executive Officer, Department of Geology.
1922 Secretary, Geological Society of America; Chief Geologist, Central Asiatic Expedition, American Museum of Natural History.
1927 Elected to the National Academy of Sciences.
1928 President, New York Academy of Sciences.
Appointed to the United States Colorado River Board by President Coolidge.
1929 Sc.D., Columbia University (honorary); Newberry Professor of Geology.
1937 Vice-President, Geological Society of America.
1938 Newberry Professor Emeritus, Columbia University.
1941 Honorary Member, American Society of Civil Engineers.
President, Geological Society of America.
1948 Received the Kemp Medal for distinguished public service in geology.
1955 Died (August 22), 1076 Cumbermede Road, Palisade, New Jersey.

KEY TO ABBREVIATIONS

AIME Bull. = American Institute of Mining and Metallurgical Engineers Bulletin
AIME Tech. Pub. = American Institute of Mining and Metallurgical Engineers Technical Publication
Am. Geol. = American Geologist
Am. Jour. Sci. = American Journal of Science
Am. Mus. Jour. = American Museum Journal
Am. Mus. Nat. Hist. Bull. = American Museum of Natural History Bulletin
Am. Mus. Nov. = American Museum Novitates
Am. Philos. Soc. Year Book = American Philosophical Society Year Book
An. N. Y. Ac. Sci. = Annals of the New York Academy of Sciences
Cal. Div. Wat. Res. = California Division of Water Resources
Civ. Eng. = Civil Engineering
Col. Alum. News = Columbia Alumni News
Ec. Geol. = Economic Geology
Eng. Contract. = Engineering and Contracting
Geol. Nat. Hist. Surv. Minn. = Geological and Natural History Survey of Minnesota
Geol. Soc. Am. Bull. = Geological Society of America Bulletin
Jour. Eng. Min. = Journal of Engineering and Mining
Jour. Geol. = Journal of Geology
Min. Met. Soc. Am. Bull. = Mining and Metallurgical Society of America Bulletin
Nat. Hist. = Natural History
N. Y. Ac. Sci. = New York Academy of Sciences
N. Y. St. Mus. Bull. = New York State Museum Bulletin
Pan-Am. Geol. = Pan-American Geologist
Proc. Am. Philos. Soc. = Proceedings of the American Philosophical Society
Proc. Am. Soc. Civ. Eng. = Proceedings of the American Society of Civil Engineers
Proc. Geol. Soc. Am. = Proceedings of the Geological Society of America
Proc. L. Sup. Min. Inst. = Proceedings of the Lake Superior Mining Institute
Q. Jour. Geol. Soc. London = Quarterly Journal of the Geological Society of London
Sch. Mines Q. = School of Mines Quarterly
Science, n. s. = Science, new series
Sci. Mo. = Scientific Monthly
Trans. = Transactions, American Institute of Mining and Metallurgical Engineers
U. S. Bur. Recl. Petrog. Lab. Rpt. = United States Bureau of Reclamation and Petrography Laboratory Report

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