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CLARENCE EDWARD DUTTON

1841—1912

A Biographical Memoir by

CHESTER R. LONGWELL

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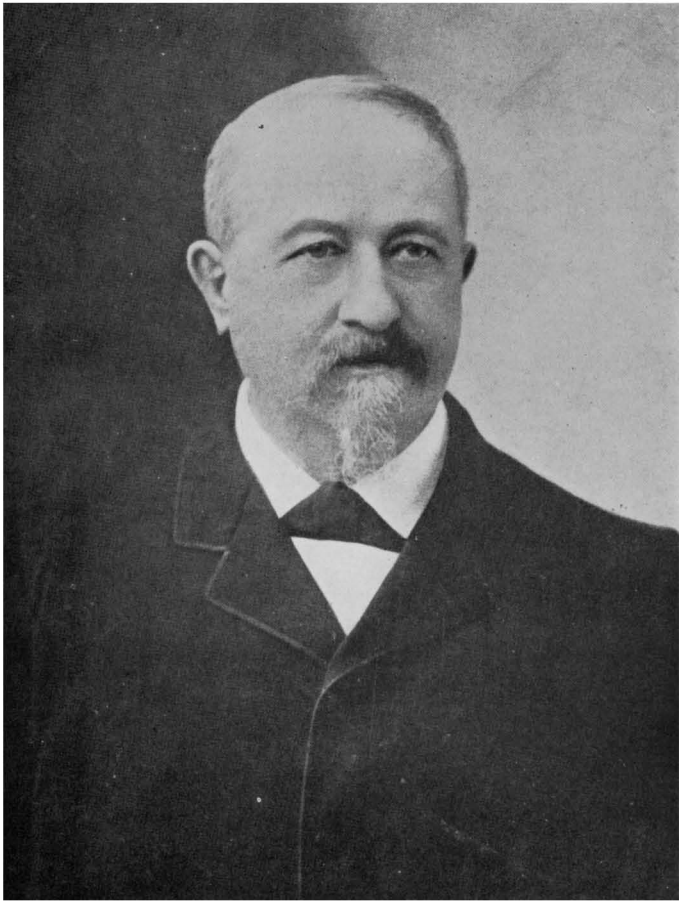

C. E. Dutton

CLARENCE EDWARD DUTTON

May 15, 1841—January 4, 1912

BY CHESTER R. LONGWELL

SCIENTIFIC EXPLORATION "west of the hundredth meridian," interrupted in its early stages by the Civil War, was resumed promptly with the return of peace. Ferdinand Hayden and Clarence King led off with ambitious programs, and a significant recruit, John Wesley Powell, began his constructive public service in 1869 with the first exploratory trip down the Colorado River of the West. The grim experiences of the war years matured and hardened Powell and some of his potential assistants for the rigorous labors involved in field study of a rugged, sparsely settled country. One destined to become a top-flight assistant and colleague was Clarence Edward Dutton, now identified in standard biographies as "soldier and geologist."

Dutton was born May 15, 1841, at Wallingford, Connecticut, where his father was a shoemaker and also served for many years as postmaster. Clarence had much of his early schooling at Ellington, Connecticut, and advanced so rapidly that he could have gone to college at the age of fourteen. He was held back for a year, then entered Yale College and was graduated with the class of 1860, shortly after his nineteenth birthday. His early intention, encouraged by his family, was to fit himself for the ministry, but continued study and maturing judgment brought conviction that his real interests were in other fields. Literature attracted him strongly, as evidenced by his winning the "Yale Lit" medal in his junior year. Macaulay's essays fascinated him, and Thackeray was his favorite novelist. Doubtless

his early absorption in good literature bore fruit in the style of his own later writings.

Dutton's enthusiasm for learning did not make him an unbalanced, ascetic individual. He had a fine physique, and as an undergraduate he became an outstanding athlete, particularly in gymnastics and in rowing. In later years he liked to recall that he rowed No. 7 in the first crew race between Yale and Harvard. A sturdy constitution was later an essential asset when he engaged in long seasons of geologic work, traveling on horseback and afoot in the western plateaus and canyons.

Dutton continued at Yale in graduate study for two years after receiving the B. A. degree. Whether James Dwight Dana may have planted the seed that later grew into his flair for geology is not known. Certainly mathematics and chemistry came to share a place with literature in his broad range of interests. Clarence King, his junior by a year and later one of his chief associates, was graduated from the Sheffield Scientific School in 1862, but perhaps the two did not meet as students—"Sheff" and "Ac" were close neighbors physically, but at that date they were essentially separate institutions.

The war became a pressing reality, and in September, 1862, Dutton enlisted in the Twenty-first Connecticut Infantry and was appointed adjutant, with rank of first lieutenant. His unit saw early action, and he was wounded at the battle of Fredericksburg, but stayed with his regiment, recovering to take part in the battle of Suffolk and in many minor skirmishes. In March, 1863, he was promoted to the rank of captain. Later the same year he passed an examination given by the Ordnance Corps of the regular army—an exceptional accomplishment for one without West Point training—and in January of 1864 he accepted appointment as second lieutenant of ordnance. In the last year of the war he commanded the ordnance depot of the Army of the Potomac.

When the war ended he kept his army assignment, and early in 1867 he was promoted to be first lieutenant. Apparently he liked the ordnance work, his position gave him and his growing family

security and—probably an important determinant—it afforded some leisure and facilities for further study in scientific fields. For several years he devoted time to study of geology and to certain aspects of chemistry. A revolution in the manufacture of steel was under way, and in 1869, while Dutton was stationed at the Watervliet Arsenal, West Troy, New York, he read before the American Association for the Advancement of Science his first scientific paper, "On the Chemistry of the Bessemer Process." [1] His transfer the following year to the Frankford Arsenal, Philadelphia, placed him within the congenial orbit of the Franklin Institute, the American Philosophical Society, and the Academy of Sciences. At a meeting of the Philosophical Society he presented a paper, "The Causes of Regional Elevations and Subsidences," which reveals that he had already given some thought to profound geologic problems, though he was barely thirty years old and his military duties had first call on his time and energy.

The stay in Philadelphia was brief. In 1871 he was transferred to the arsenal at Washington, D. C., just in time to witness the struggle among rival groups of geologists that finally was resolved by the establishment of the U. S. Geological Survey in 1879. He joined the Philosophical Society of Washington, where he met distinguished men in various fields of learning; his love for literature remained strong; and he maintained a broad interest in science. During his long residence in Washington, he associated freely with leaders in the sciences and arts, professionally through the learned societies, socially through the Cosmos Club, in the founding of which he played a part. When Dutton moved to Washington, J. W. Powell was away, directing the second trip down the Colorado River and planning an ambitious program of mapping in the plateau country. Probably he and Dutton met in 1872, and their acquaintance soon became firm and intimate. The two were long known among their acquaintances as "the Major" and "the Captain," Powell carrying the

[1] Only the title of this paper was printed in the *Proceedings* of the Association for 1870.

former title from his Civil War service and Dutton acquiring the rank Captain of Ordnance by promotion in 1873. Dutton usually referred to Powell as "Professor," a title derived from Powell's teaching experience in Illinois.

In maturing plans for further geologic studies in Utah Territory, Powell became convinced that Dutton was the man best equipped to have charge of the field work. For some time Dutton demurred, but the prospect was attractive to him, and in 1875 the Ordnance Corps agreed to detach him temporarily for detail to the Survey of the Rocky Mountain Region under the Interior Department. This assignment began for him a fifteen-year period of phenomenal activity and achievement.

When Dutton was detailed by the Ordnance Corps for geologic work, he felt he was in some respects a novice among the more experienced field workers, and he cultivated their acquaintance and counsel. A favorite colleague was G. K. Gilbert, who had begun his far-western work with the Wheeler party in 1871. Gilbert started his historic study of the Henry Mountains in 1875, and so shared with Dutton the beginning of systematic mapping in the plateau country near the Grand Canyon. A brief report by Dutton on some of the igneous rocks collected in the Henry Mountains is included in Gilbert's monograph, *Geology of the Henry Mountains,* published in 1877. J. W. Powell shared with Gilbert a high place in Dutton's esteem, and during the winter months in Washington the three were often together for comparison of notes and discussion of problems relating to the plateaus. Dutton testified that these friendly consultations had benefited him immeasurably, and in a published acknowledgment to Powell and Gilbert he stated, "If I paid them their intellectual dues I would be bankrupt."

Powell, Gilbert, and Dutton together laid a firm foundation on which rests much of our present understanding of geologic history as it is revealed in the unexcelled exposures of the wide Colorado Plateau. In considerable part their published records and conclusions have been superseded by results of later, more detailed work. Inevi-

tably the first reconnaissance of an area so immense and rugged, by a few trained men who lacked equipment now considered indispensable, gave results that by modern standards are somewhat crude and in part erroneous. But some basic conclusions set down by these early workers mark them as men of exceptional initiative and vision. Powell, in his introduction to Dutton's report on the High Plateaus, reveals that at that early stage in study of the sedimentary rocks the evidence of earlier highlands to the west had been detected. Gilbert's report on igneous bodies of the Henry Mountains remains a classic with international recognition. Dutton's attention was focused particularly on the evidence for differential uplift of crustal blocks, and on the major role of erosion in fashioning the Grand Canyon and other surface features of the plateau country. He recognized evidence for two major episodes of erosional history: the first he called "the great denudation," the second "the canyon cycle." With Gilbert and Powell he did much to stimulate ideas on the systematic development of land forms.

Geologists who have some present-day acquaintance with the high-plateau country of southcentral Utah can have only the highest admiration for the results accomplished there by Dutton and his party in three summers of field work. Much of the country is extremely rugged, and in the 1870s practically all of it was difficult of access. Settlements were restricted to widely spaced valleys, the only railroad was far to the north, and the means of travel for men and supplies was restricted to team and wagon, pack train, and saddle horse. Formidable relief increased the physical difficulties; several of the large plateaus have altitudes well above 11,000 feet, and from their cliffy margins steep slopes extend into nearby valleys several thousands of feet lower. And Dutton was faced not only with unknown geology—the geography of this region also was in a nebulous state. Base maps were a first essential.

Because of high altitudes, the winters in the high plateaus are long and seasons for productive field work are short. Yet from 1875 to 1877 Dutton's party mapped an area measuring about 150 miles long

from north to south, 50 miles wide at the north and 110 miles wide at the south—fully 12,000 square miles—on a scale of 4 miles to the inch. A. H. Thompson, who had been with Powell on both trips down the Colorado, established the triangulation net for control, and two skilled topographers equipped with plane tables sketched the chief physical features on sheets with contours spaced at intervals of 250 feet. On this base Dutton represented the geology: the sedimentary rocks by systems, Carboniferous to Quaternary, and the igneous rocks classified in four categories. The result is of course a first approximation, and Dutton himself was acutely conscious of the deficiencies. But the aim was to present a broad picture of the geography and geology of that little-known region as quickly as possible. Time was cut to a minimum not only in the field study, but also in arrangements for publication. Less than three years after the third field season was complete, the Government Printing Office was distributing a quarto volume of 307 pages filled with Dutton's clear descriptions and explanations, accompanied by an atlas, measuring 22 x 32 inches, made up of well-executed maps and structure sections. This work was received with enthusiasm both in this country and abroad; more than one competent critic gave it emphatic approval.

Dutton became more and more fascinated by the Grand Canyon country, directly south of his high plateaus. He made brief excursions along the lower belt near the canyon late in the season, after the high region grew too cool for comfort, and on completion of the high-plateau project he devoted three seasons to a comprehensive study of the Grand Canyon geology. While this work was in progress, the U. S. Geological Survey was organized, with Clarence King as its first Director. Dutton's Grand Canyon work was one of the first projects to be completed and published by the new organization. Again both Dutton and the publishers were prompt; field work ended in 1880, and two years later two large reports were in print. One of these, comprising about 120 pages with plates and figures, appeared in the second *Annual Report* of the Geological Survey; the

other, consisting of a quarto volume with 264 pages, accompanied by a large atlas, is Monograph 2 of the Survey, but actually the first of the monographs to be published.

The latter work remains an outstanding classic of geology. Inspired descriptions of the Canyon landscape are reinforced with fine panoramic drawings by W. H. Holmes. Dutton found the Canyon country "a great innovation in modern ideas of scenery, and in our conceptions of the grandeur, beauty, and power of nature." Living for weeks with the grand panorama spread before him, seeing the subtle variations in color, outline, and composition as light values changed with the height of the sun, he came to feel that the scientific and esthetic qualities of the canyon landscapes were inseparable and that "the severe ascetic style" of ordinary description could not do the subject justice. Accordingly, a part of his report is a sort of guided tour in which choice parts of the Canyon scenery are exhibited to the reader through Dutton's experienced eyes. Readers who may feel that parts of the description are overdrawn should spend a few hours at one of Dutton's viewpoints, such as Point Sublime, to appreciate the judgment of the British geologist, Archibald Geikie, who said after reading Dutton's monograph: "Any man who could sit down and dissect these cañons in cold blood, and with as little emotion as he would show in cutting up a joint of beef, would be a creature not to be envied."

Abundant volcanic rocks in the plateaus drew Dutton's attention to volcanism as a major geologic problem, and in 1882 he spent six months in a field study of Hawaiian volcanoes. True to his habit, he put his findings and resultant ideas into print, this time in several short papers, besides a lengthy report published by the Survey. Meanwhile, he resumed field study in the plateaus, spending two seasons in the extinct volcanic field around Mount Taylor, New Mexico, and the adjacent Zuñi uplift. With volcanism still uppermost in his interest, he began a survey of the Cascade Range in Oregon and northern California, but before the end of his second season there his attention was diverted by the earthquake of 1886 at Charleston, South Caro-

lina. Intensive study of that event and its effects resulted in a major publication, as well as shorter papers on earthquakes in general.

Dutton was elected to the National Academy of Sciences in 1884.

Dutton's publications up to this point assured him wide recognition in geology, but probably his name is best known because of a short paper, published in 1889, entitled, "On Some of the Greater Problems of Physical Geology." An early essay, published before his transfer to Washington, revealed his concern about the basic reasons for large-scale uplift and subsidence of the earth's surface. During his studies in the plateau region, he had been impressed with eloquent examples of such movements: wide plateau blocks, floored with sedimentary rock formed in the sea, now thousands of feet above sea level; the Front Range of Colorado and other Rocky Mountain units, all once below the sea and now thousands of feet higher than adjacent plains and plateaus. Long reflection on these facts led him to favor the concept of a general balance within the earth's crust, with lighter weight blocks coming to stand higher than adjacent blocks with higher density. For this concept, first expressed by Pratt and Airy in the 1850s, Dutton now proposed the term *isostasy,* "equal-standing," a term that has met world-wide acceptance.

In 1890, when the many and diverse projects he had undertaken for the Geological Survey were completed, Dutton was returned to military duty upon his own request. The next year he was advanced to the rank of Major and placed in command of the San Antonio (Texas) Arsenal, where he remained for eight years. Early in 1901 his application for retirement was granted, but his interest in geology and related subjects continued unabated. He had kept abreast of rapid developments in seismic study, and in 1904 he published a book on which he had worked for years, *Earthquakes in the Light of the New Seismology.* The discovery of radioactivity, announced while he was on duty in Texas, fired his imagination. Could radioactive heat be the basic cause of volcanic activity? This concept was embodied in a paper, "Volcanoes and Radioactivity," published in 1906.

His last years were spent in the home of his son at Englewood, New Jersey. Failing health took away much of his energy, but not his interest in scientific developments and writings. Arteriosclerosis made rapid inroads, and he accepted calmly the certainty that the end was near. One of his last comments was, "Farewell to my old friends on the Geological Survey." He died peacefully on January 4, 1912, in his seventy-first year.

Dutton's immediate family was small. He married, April 18, 1864, Emeline C. Babcock, of New Haven, Connecticut. They had a son, Clarence Edward, Jr. Their only daughter had passed away nine years earlier. No member of the family is now living.

Surely this man's career was exceptional, and a considerable part of his published results has lasting value. Few professional geologists have within a span of fifteen years done as much constructive scientific work; yet his contribution was made outside his official position in the regular army. His publications are an enduring testimony to his scientific and literary abilities, and fortunately some intimate associates have set down impressions of his personality and character.

Dutton was an attractive person, with erect carriage and powerful physique. Beards were popular in his day, and published photographs show him with large moustache and small chin whisker. Ordinarily he was reserved and unassuming, but always friendly, interested in all kinds of people, and an excellent conversationalist. He read rapidly and widely, had an exceptionally retentive memory, and was well informed on current as well as historical matters and on good literature. Intricate problems fascinated him, and in their solution he showed remarkable powers of concentration. From an early age he liked chess, and sometimes he played as many as seven simultaneous blindfold games. Occasionally he would spend an entire night wrestling with a chess problem, finally laying it aside to join the family at breakfast. This kind of diversion went logically with his love of mathematics and science. During these absorbing games, as well as in period of serious study, he smoked prodigiously.

But when he was about fifty years old he gave up chess as an interference with his work, and a few years later he stopped smoking, convinced that it was injuring his health.

The son, Clarence E. Dutton, Jr. has set down some information that helps explain the large volume of his father's contribution within a few years. An important part of the explanation lies in the elder Dutton's early mastery of literary analysis and composition. "The literary side was first cultivated and its expression fixed before he turned to science." In preparing a report, "the subject at hand was always mentally laid out in practically final form before he began writing. Most of it he wrote out, and there were few changes made. For several years I was his amanuensis and typed his papers as he dictated; little had to be rewritten. . . . In one (very long) working day he dictated to me over 11,000 words. There were two minor corrections only. . . . I was so familiar with his expression that I could usually catch up with him, if he spoke fast, at the end of a sentence. If I failed, he would repeat the entire sentence without hesitation, no matter how long."

Preparation of an adequate biographical sketch nearly half a century after Dutton's death has not been an easy task. For much of the required basic information I am indebted to the Alumni Records of Yale University, and to the generous help of two people whose researches have been concerned with J. W. Powell and his professional associates: Professor Wallace Stegner of Stanford University, and Professor Thomas G. Manning of Texas Technologic College.

KEY TO ABBREVIATIONS

Am. Jour. Sci.=American Journal of Science
Ann. Rpt.=Annual Report
Bull. Phil. Soc. Wash.=Bulletin of the Philosophical Society of Washington
Congrès Internat.=Congrès International
Geol. Mag.=Geological Magazine
Internat. Cong. Geol., Am. Comm. Rpts.=International Geological Congress, Reports of the American Committee
Jour. Geol.=Journal of Geology
Mon.=Monograph
Penn. Monthly=Pennsylvania Monthly
Pop. Sci. Monthly=Popular Science Monthly
Proc. Am. Assoc. Adv. Sci.=Proceedings of the American Association for the Advancement of Science
Proc. Am. Phil. Soc.=Proceedings of the American Philosophical Society
Senate Misc. Doc., 52nd Cong.=Senate Miscellaneous Documents, Fifty-second Congress
U. S. Geog. and Geol. Survey=U. S. Geographical and Geological Survey
U. S. Geog. and Geol. Survey Terr.=U. S. Geographical and Geological Territorial Survey
U. S. Geol. Survey=United States Geological Survey

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