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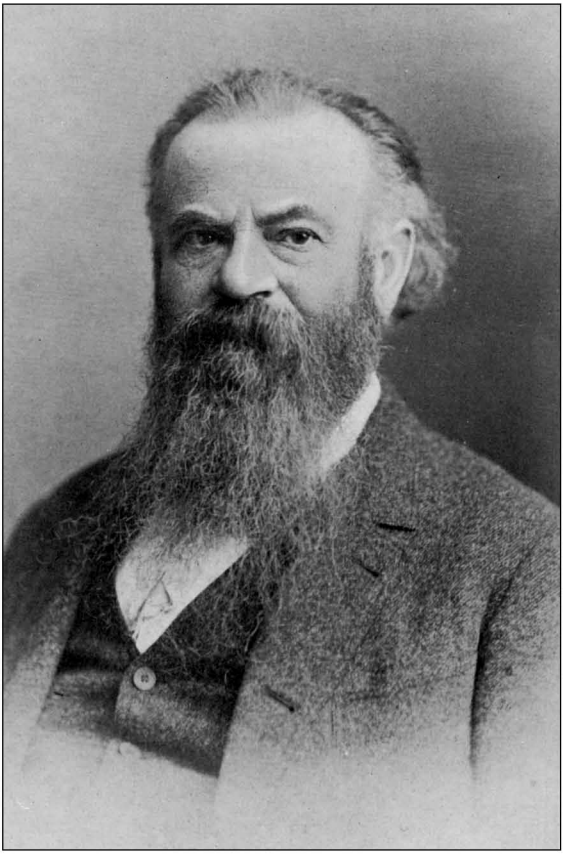

Yours Cordially
J. M. Power

JOHN WESLEY POWELL.

JOHN WESLEY POWELL was in more senses than one a scientific frontiersman. His life reveals the energetic working of a vigorous and independent personality, not trammeled by traditional methods and not so deeply versed in the history, the content, and the technique of the sciences as to be guided by them, but impelled to the rapid discovery of new principles by the inspiration of previously unexplored surroundings. His life shows us further how a man of exceptional power rises suddenly in an otherwise undistinguished lineage, and how he surmounts the limiting associations of early years, less through the opportunity provided by others than through opportunities

Much use has been made of the following articles, especially of the fifth, in which many details of Powell's life are recorded. In a number of cases extracts from these articles are incorporated in the present memoir, with single quotation marks or without marks:

John Wesley Powell, by W. H. Brewer. Amer. Journ. Sci., XIV, 1902, pp. 377-382.

In memory of John Wesley Powell. Minutes of a meeting held at the U. S. National Museum. Edited by S. P. Langley. Science, n. s., XVI, 1902, pp. 782-790.

John Wesley Powell, by G. K. Gilbert. Science, n. s., XVI, 1902, pp. 561-567, with portrait.

John Wesley Powell, by G. P. Merrill. Amer. Geol., XXXI, 1903, pp. 327-333, with portrait.

John Wesley Powell: A memorial to an American explorer and scholar. Articles by M. D. Lincoln, G. K. Gilbert, Marcus Baker, and Paul Carus. Edited by G. K. Gilbert and published in The Open Court. Chicago, 1902-1903.

John Wesley Powell: Proceedings of a meeting commemorative of his distinguished services. Proc. Washington Acad. Sci., V, 1903, pp. 99-130. This contains a portrait, articles by G. K. Gilbert, D. B. Henderson, S. P. Langley, W J McGee, C. R. Van Hise, and C. D. Walcott, and a complete bibliography by P. C. Warman.

John Wesley Powell, by C. D. Walcott. 24th Ann. Rept. U. S. Geol. Surv., 1903, pp. 271-287.

John Wesley Powell: A brief review of his career. Epilogue from the "The Romance of the Colorado River," by F. S. Dellenbaugh. New York, 1902, pp. 371-386.

opened by his own individual enterprise for the satisfaction of inborn interests.

EARLY LIFE.

Powell, the fourth of nine children, was born of English parents at Mount Morris, in the Genesee Valley of western New York, on March 24, 1834. His father, Joseph Powell, a Methodist preacher, and his mother, Mary Dean Powell, had come to the United States a short time before. The family moved from New York to Jackson, Ohio, in 1838-1839, to South Grove, Wisconsin, in 1846, and eventually to Illinois, settling first at Bonus Prairie in 1851, and later at Wheaton in 1854; thus in Illinois Powell lived from his seventeenth to his twenty-seventh year.

While he was still a boy in Ohio he had experience of anti-slavery agitation. His father was a staunch abolitionist, who did not conceal his opinions, and as a result the son was so unfairly treated by his mates in the village school that he was removed from it and for a time put under the care of a well-to-do elderly neighbor named Crookham, who taught gratuitously and irregularly in a log-house school and laboratory, as well as in the field. It was thus that young Powell made a beginning in scientific study and observation. When the move was made from Ohio, all the household goods were transported in a wagon and two carriages, one of the latter being driven by young John to Wisconsin. There the boy, when his father was away from home preaching, had the duty of conducting the farm, from which the family derived its principal support, and of hauling farm produce to markets, five or six days to a trip and twelve or more trips in a year; but his heart was in his studies, and in the winter of 1850 he went to Janesville, twenty miles from home, to attend school, working for his keep on a near-by farm.

In 1852 he began school teaching, with half his pupils older than himself; and for the following nine years he alternately taught, studied, and traveled. He had the good fortune at the outset of this laborious period to fall in with intelligent school officials, but much of his teaching was done under narrowing conditions of isolation and privation. His college studies were

varied; they were pursued at Illinois College, Jacksonville, 1855-1856; at Oberlin College, Ohio, 1858, where he studied chiefly botany, Latin, and Greek, and at Wheaton College in 1858. Powell was a naturalist at that time, fond of roaming, observing, and collecting. He had joined the State Society of Natural History in 1854, and in making an extensive collection of mollusca he crossed most of the prairie States. In 1856 he traveled, a young fellow of twenty-two, alone in his boat on the Mississippi; the next year he descended the Ohio, and the year after he followed the Illinois and Des Moines Rivers. His collections brought him into relation with various colleges; he became secretary of the Illinois Society of Natural History, and his friends of that time found him an entertaining narrator, full of enthusiasm, humor, and philosophy.

SERVICE IN THE CIVIL WAR.

Powell's studies and travels were interrupted by the outbreak of the Civil War. A visit to the South on a lecturing tour in 1860, where he closely studied the sentiment of the people regarding slavery, had persuaded him that nothing short of war could settle the matter. When war came he promptly enlisted as a private in the Twentieth Illinois Infantry on May 8, 1861, "with the avowed purpose of doing his part in the extinction of slavery in this country; and from the first day after the call was made for troops he felt thoroughly convinced that American slavery was doomed." He went to the front as sergeant-major, but was soon commissioned second lieutenant. His knowledge of engineering led him into such work as building roads and bridges and planning camps and entrenchments. In the winter of 1861-1862 he recruited a company of artillery, of which he was commissioned captain. A brief leave of absence in March, 1862, allowed him a hurried visit to Detroit, where with only two hours' delay he married his cousin, Miss Emma Dean, to whom he had been long engaged. She returned with him at once to the field, and cared for him not long afterward when he was wounded in the battle of Shiloh, on April 6, 1862. At the moment when he gave a signal to fire by raising his right arm a rifle ball struck his wrist and glanced toward the elbow. The hasty care at first

given to the wound was followed by an operation which left him with a mere stump below the elbow, from which he suffered pain for many years. He was incapacitated at the time for several months; but he later had nearly three more years of active service, during which he was frequently in close relations with General Grant and was commissioned as major of artillery. When finally detailed to act as chief of artillery he had sixteen batteries under his command. Among the busiest days of his life were the thirty or more prior to the fall of Vicksburg, in March, 1864, in part because in addition to his military duties he collected fossils from the trenches. He was honorably discharged January 14, 1865, and, refusing higher rank then offered, was known as "the Major" thereafter. The wound in his arm gave him much pain at various later periods and weakened an exceptionally strong constitution; not until a few years before his death was he fully relieved by a successful operation on the terminating nerves. Some years after the war he met a Confederate officer, Col. C. E. Hooker, who had lost his left arm at Shiloh; the two officers became friends, and when either one in later years bought a pair of gloves he sent the unused glove to his former enemy.

There can be little question that a school teacher of scientific bent, a lone rambler over prairies, a solitary voyager on long rivers, doing his own work as boatman and collector of natural-history specimens, learned much from the responsibilities placed upon him during four years of soldier's life in the way of reaching prompt decision, giving authoritative command, delegating work to others, and securing loyal obedience from his subordinates. It does not follow that the decisions reached were always the wisest possible, still they were the best available, and action had to be taken on them without hesitating deliberation. But Powell hated war, in spite of his willing service while war lasted; fighting was to him an uncivilized method of dealing with the problems of civilization. He must as an officer have developed many qualities that stood him in good stead as an organizer and administrator in later years; yet it may be well asked whether his faithful perseverance under adverse conditions during nine previous years of study and teaching in a time of peace were not equally decisive in

developing his capacity to carry through whatever he undertook.

VISIT TO THE ROCKY MOUNTAINS, 1867-1868.

The war over, Powell returned to his home in Illinois and was nominated clerk of Du Page County, Illinois, at a good salary; but at the same time he was offered an appointment more to his liking, though at a lower salary, as professor of geology in Illinois Wesleyan College, at Bloomington; this he accepted. A later appointment was that of lecturer and curator of the museum at the Illinois Normal University at Normal, near Bloomington. The young professor took his classes into the field, had an active part in public discussions in favor of introducing more science in college programs, and influenced the State legislature to advance science teaching in the Normal University.

In the summer of 1867 Powell, at the age of thirty-three, struck out on a new path that led to all his later work. Aided by the Illinois Society of Natural History, with which he was still connected, he conducted a party of sixteen "naturalists, students, and amateurs" across the plains to the Rocky Mountains of Colorado, then known more as a field for adventure than for research. His wife accompanied him. Through the aid of General Grant, it was arranged that the army posts should furnish his party with supplies at government rates; railroads gave him passes. A contemplated passage through the Bad Lands under military escort was given up on account of hostile Indians. The expedition visited South and Middle Parks, climbed Pikes Peak and other mountains, and gathered a great store of specimens that were shipped back to the colleges at Bloomington, Normal, and elsewhere. Powell was thus the first college professor to combine field teaching with western exploration, and this enterprise deservedly opened his larger scientific career. He remained in the mountains for a time after his students went home, and in the following winter published a preliminary report, a small affair of four pages, addressed to the Illinois State Board of Education and signed as curator of the Illinois Natural History Society; the only known copy is in the library of the United States Geological Survey.

He returned to Colorado with another party in the summer of 1868, this time with aid from certain colleges in Illinois, and from the Smithsonian Institution in Washington, and again with authority for getting provisions from military posts. He passed the summer in the region of Middle Park. The following winter, Mrs. Powell still being in the party, was spent in camp in the valley of White River, a branch of Green River, in western Colorado and eastern Utah. From this camp Powell made excursions to the Grand, Green, and Yampa Rivers, while thereabouts he made his first studies of Indian tribes and became an ethnologist. There is no indication that he had had earlier training in ethnology, and it may well be believed that it was as largely his warm sympathy as his keen inquiry that led him to eminent success in this field; but the more immediate result of this summer and winter, regarding which no report was published, was his plan for the exploration of the Green-Colorado River by following its course in boats. Perhaps his previous experience on the placid rivers of the prairies led to this adventurous project on a torrential river deeply inclosed in unknown canyons.

EXPLORATION OF THE COLORADO CANYON.

It was truly a daring project. Professor Brewer, of Yale, wrote of it some years later* in effect as follows: Being in Colorado while Powell was making his trip down the river, I was intensely anxious as to his fate, for I thought his project a mad scheme. . . . The river has an average fall of ten or fifteen feet per mile, and I had assumed that there must be great falls, and that the explorer must approach them from above. On telling Powell of this some years later, he answered in substance: "Have you never seen the river? It is the muddiest river you ever saw. Rapids I expected of course, but not falls. I was convinced that the canyon was old enough and the muddy water swift enough and gritty enough to have worn down all falls to mere rapids. I entered the canyon with confidence that I would have no high falls to stop us, although there might be bad rapids, and I believed that we might over-

* Amer. Journ. Science, XIV, 1902, p. 381.

come them in some way—and we did." The most significant words in this statement are "old enough," for they show that even before Powell had explored the Colorado he had somehow come to understand that a large muddy river must rapidly acquire a graded course, even though at the bottom of a deep canyon still inclosed by high walls.

Powell returned from the West by rail to Chicago in the spring of 1869 to get boats for the expedition. It was organized as a geographical and geological survey, supported by an appropriation from Congress and placed under the direction of the Smithsonian Institution, of which the then Secretary, Joseph Henry, advised that the collection of ethnological data should be made a leading feature of the journey. The party consisted of ten men. They embarked May 24, 1869, in four boats, where the Union Pacific Railroad crosses the Green River in southwestern Wyoming; followed Green River through deep gorges in the Uinta Mountains to its junction in open country with the Grand River, below which point the name Colorado is given; then continued down the Colorado through its profound canyons in the plateaus of southeastern Utah and northern Arizona to the open country near the Nevada line on August 29. Singularly enough, no sufficient account of this adventurous journey was published until several years afterward, although it attracted much notice at the time. A few brief summaries regarding the canyon and the adjacent region are buried in the congressional documents of the early '70s; but Powell did not at first intend to publish any full report of what he had done and seen. His famous volume, "Exploration of the Colorado River of the West," 1875, one of the best narratives of adventure anywhere to be found, was not written until four or five years after the event, and then only on the insistence of Representative (later President) Garfield, as Powell tells in 1895 in the preface to his popular book, "The Canyons of the Colorado." In addition to his report of 1875, several articles were contributed to Popular Science Monthly and to Scribners Magazine for that year. The country traversed was of exceptional interest and his articles awakened widespread attention. His official report treated the journey in a singularly free and unconventional manner; for

Powell reproduced his original diary, keeping the narrative in the present tense as when written in the canyon, with the result of giving a vivacity to his story unusual in government publications; yet one may read it without learning that the author had lost his right forearm!

The climax of the journey is reached when, after the party had made nearly all the dangerous distance in a little less than three months, three of the men insist that further progress is too perilous, and that the river must be abandoned: they seek a way out by climbing up to the plateau surface. The others persist in following the river, and that very afternoon come upon a group of the most dangerous falls in the whole journey. It is interesting to note that these falls do not constitute an exception to Powell's expectation that the river must have already graded its course in the uplifted rocks of the plateaus, for the obstruction which here caused the falls was formed in an exceptional manner by flows of lava that had, in altogether unpredictable fashion, cascaded down from the volcanoes of the Uinkaret plateau on the north, so recently that they have not yet been cleared away by the river.

As these falls are approached from upstream, there is no possibility of seeing their face and choosing the least dangerous point for descent. The walls are too steep for a portage along the bank; so one of the men, Bradley, approaches the brink of the fall in a boat, held by a tow-line from the cliffs. The current soon becomes so strong that the boat cannot be drawn back; Bradley promptly cuts the line and plunges over the falls, whirling in waves and foam, sinking out of sight, rising again, safe on board and waving his hat. Powell then tells his own manner of descent with two of his men: "We run to the other boat, jump aboard, push out, and away we go over the falls. A wave rolls over us, and our boat is unmanageable. Another great wave strikes us, the boat rolls over, and tumbles and tosses, I know not how. All I know is that Bradley is picking us up. We soon have all right again, and row to the cliff, and wait until Sumner and [W. H.] Powell can come [along the wall]. After a difficult climb they reach us. We run two or three miles farther, and turn again to the northwest, continuing until night, when we have run out of the granite once more." An early start is made the next morn-

ing. "The river still continues swift, but we have no serious difficulty, and at twelve o'clock emerge from the Grand Cañon of the Colorado." Thus simply is it told that on August 29, three months after the start from Green River, the party victoriously passes out of the deep canyon into the open country of the Great Basin. Some of the men go on down the river; Powell went northward through Mormon settlements to Salt Lake City, and thence home. He had been preceded by reports of disaster, and had the pleasure of reading a number of obituary notices of his life.

The good fortune of this daring journey was deservedly of great service to its chief. It developed his capacity for leadership in the field. It received much attention in the newspapers of the time, and thus gave its head a national reputation as a bold, adventurous, successful explorer; best of all, it secured the full confidence of men at Washington who could aid his further work. When in later years of exploration the men of his party gathered around the camp-fire, and the Major talked to them of his passage through the great canyon, "his influence over all his hearers was so profound that in the days that followed a word from him was sufficient to cause the men to go anywhere or to do anything, no matter what the personal danger might be;" and this is no wonder, for he was loyally devoted to his men. Of his companions through the canyon he wrote years afterward: "I was a maimed man; my right arm was gone, and these brave men, these good men, never forgot it."

GEOLOGICAL SURVEY OF THE TERRITORIES.

Powell returned to Utah and Arizona in 1870 and explored the plateaus north of the canyon. A good account of this trip is given in Chapter IX of the "Report on the Colorado River of the West." In 1871 he again made a boat trip on "the river." In 1874 and 1875 he worked chiefly in eastern Utah. Of these three campaigns there is unfortunately no narrative by Powell;* but many of the results are summarized in a re-

* F. S. Dellenbaugh, the youngest member of the latest canyon journey, brought out a belated narrative, "The Romance of the Colorado . . . River," in 1903; he also compiled an account of the earlier journey, "A Canyon Voyage," published in 1908.

markable "Report on the geology of the eastern part of the Uinta Mountains" (1876), published as the work of the second division of the "U. S. Geological and Geographical Survey of the Territories," of which he was then "geologist in charge." His later western journeys, as well as those of the summers of 1872 and 1873, were chiefly occupied with ethnological studies, of which brief accounts are given in Congressional and Smithsonian reports. Powell prepared no other important geological volumes; the great impression that he made on American geology must be credited—apart from his later work as an administrator—to the two reports on the Colorado River and the Uinta Mountains. The popular book on the "Canyons of the Colorado" (Meadville, Pa., 1895) was prepared more than twenty years after the event, and looks more like a publisher's than an author's venture. Several chapters on the native tribes were here included; but the whole appears to have been hastily put together, with too many pictures little related to the text.

REPORT ON THE COLORADO CANYON.

Of the two reports the earlier one on the Colorado is the more important; it is certainly one of the most famous books of exploration published in this country. It is unusually well illustrated, partly with wood cuts from photographs, partly with schematic drawings by Holmes, in some of which a foreground section showing geological structure and a perspective view showing surface form were admirably combined in the style of block diagrams. Powell himself seems to have had no graphic skill, and perhaps for that reason permitted the publication of certain exaggerated pictures, such as that of Horseshoe Canyon (opposite p. 162), drawn by Moran in a misleadingly realistic fashion; and of a seriously incorrect picture (opposite p. 212), probably drawn from verbal description, of the double unconformity at the bottom of the Grand Canyon, the interpretation of which has puzzled more than one reader, all the more because the excellence of the other illustrations gave reason for thinking that this one also must be trustworthy. The double unconformity is, however, correctly drawn in a geological section of the Uinta Mountains report (p. 43).

Along with the other exploring geologists of that time, Powell enjoyed the inspiring opportunity of working in a new and extraordinary field, where the problems were impressive in magnitude, yet relatively elementary in structure, and all plainly disclosed under the denuding influence of a dry climate. Facts which Nature elsewhere held as her secrets were there openly proclaimed in imposing grandeur. Great series of deposits followed in orderly attitude and almost unbroken sequence; deposition and denudation were measured in tens of thousands of feet; unconformities were superbly exhibited. Deformation had not gone so far as to produce almost unsolvable complications, but had sufficed to cause great faults and flexures of simple pattern, and also to displace huge crustal blocks, with only marginal disturbance, so that the structures of this kind in the Plateau province, first clearly set forth by Powell, became types for the world. The work demanded in detecting the geological history of the region was utterly unlike the detailed and technical investigation given year after year by European observers to the overthrusts of the highlands and the closed folds of the uplands of Scotland or to the overturns of the Alps. Minute studies were not called for in the Plateau country; conclusions were reached rapidly and large concepts were strongly impressed on the observer. It was therefore but natural that Powell's pathfinding geological work should be treated in a style and on a scale prompted by the simplicity and the magnitude of the great structural units with which he had to deal.

Powell used fossils only as guides to the dates of stratified formations, not as a means of making out past forms of life. His volcanic studies were free from complicated nomenclature, guiltless of petrographical technique, and without bearing on the classification of igneous rocks—a subject that was then taking modern shape. He briefly saw and named the Henry Mountains during his canyon trip in 1869, and described them as "composed of eruptive rocks in part" which had been "poured out through some fissures here, and spread over the country before it had been eroded to its present depth" (Colorado River, 177); but his curiosity must have been aroused as to what he did not see, for a few years later he had a special

study made there by Gilbert, whose famous report on the Henry Mountains was thus brought forth. Powell's inattention to the complex structures of crystalline rocks was shown by his usually giving the schists of the fundamental complex at the bottom of the Colorado Canyon the popular name of "granite." He attended relatively little to the conditions under which ancient stratified deposits were accumulated, and probably on this account did not free himself from prepossessions regarding the lacustrine origin of the freshwater Tertiaries, and did not offer any explanation of the extraordinary cross-bedding of the White Cliffs sandstone; but regarding larger structures, he developed broad and bold generalizations that followed immediately from field observation and geological common sense, illumined by a free and lively imagination. He evidently enjoyed the systematization of his results, and repeatedly reduced them to compact schematic form, from which irrelevant details and unknown local names were withheld, greatly to the advantage of his readers. His arguments were usually stated in a simple manner, free from technicalities, and his results were phrased in form for popular understanding. He was fully persuaded that his opinions were correct, and not infrequently stated them in the positive form of "inevitable conclusions," as most of them still seem to be. They carried conviction and are now accepted on nearly all points.

Powell's unconscious style was simple and direct, as in the extract given above describing the end of his passage through the Colorado Canyon, or again in the famous paragraphs cited below regarding the origin of the Green River canyon through the Uinta Mountains. On account of the loss of his right arm he had to employ an amanuensis, and therefore acquired the time-saving capacity of dictating. His reports are astonishingly free from the prolixity that too often accompanies this method of composition; but they occasionally bear marks of insufficient revision in the retention of impromptu inventions like "outthinnings" and in the use of certain words that might to advantage be replaced by others. It was perhaps not unnatural that his phraseology sometimes became exalted, as in the peroration of the Colorado River volume, where, as if recalling the excitement of the canyon journey, he wrote like an

exuberant impressionist: "Then again the restless sea retired, and the golden, purple and black hosts of heaven made missiles of their own misty bodies—balls of hail, flakes of snow, and drops of rain—and when the storm of war came the new rocks fled to the sea" (p. 214).

One of the most marked characteristics of Powell's reports is their freedom from citations of other authors. This was natural enough as far as the description of local features are concerned, for in the regions that he explored he had few geological predecessors, and to those he gives full credit. His citations from the reports of the lamented Marvine are most generous; but in the statement of general schemes of mountain and volcanic structures and of stream and valley classification the case is different. These subjects had been studied in Europe also, and the failure to give due credit to the work of foreign geologists in our Survey reports brought upon us a certain measure of discredit abroad. The reason for inattention to European studies evidently was that our geological frontiersmen found enough in the West to make up the whole of their science; and besides they did not read French and German, and they were so overwhelmed with work that they had no time to spend in looking up prior statements of their newly-perceived principles; so they overlooked foreign work in a continent-wide spirit of North American provincialism.

ANTECEDENT RIVERS.

A significant instance of this kind is found in Powell's famous discussion of the course of the Green River through the Uinta Mountains. He wrote: "The river had the right of way. In other words, it was running ere the mountains were formed; not before the rocks, of which the mountains are composed, were deposited, but before the formations were folded, so as to make a mountain range. . . . The emergence of the fold above the general surface of the country was little or no faster than the general progress of the corrasion of the channel. . . . The river was the saw which cut the mountains in two. . . . The summit of the fold slowly emerged, until the lower beds of sandstone were lifted to the altitude at first occupied by the upper beds, and if these upper

beds had not been carried away they would now be found more than twenty-four thousand feet above the river" (Colorado River, 152, 153). This is an admirable statement of a great idea. It bears not only upon the processes of river evolution, but upon the fundamental principles of geology. It was a welcome reinforcement of the arguments for uniformitarianism, which, though valiantly urged by Hutton, Playfair, and Lyell regarding processes of erosion and deposition, were even later than the middle of the nineteenth century not entirely successful in vanquishing the widespread traditional belief in violent processes of deformation and upheaval. Powell's demonstration, as he thought it, that the Uinta Mountains were not lifted up faster than the Green River could cut its canyon down through their broad anticline had great influence in convincing his contemporaries that uplift as well as erosion and deposition is a slow process, and thus aided, the gentle doctrine of geological peace on earth gained a vast backward extension into periods of the past that had long been conceived as ages of violence.

It was to rivers which, like the Green in the Uintas, had held their course through an area of adverse uplift that Powell gave the excellent name of antecedent. He appears to have made no search whatever to learn whether other observers had come upon the same idea; not that he was in the least disposed to claim priority by neglecting their labors, but that he was fully engrossed in his own. In a thorough review of this problem, Penck* points out that Medlicott in India and Hayden in the United States had both preceded Powell in recognizing the persistence of certain rivers in holding their courses through slowly uplifted mountain ranges. Medlicott† inferred the long persistence of certain rivers and the slow, imperceptible progress of deformation and uplift, because of "marked correspondence between the distribution of the accumulations of conglomerate [ancient piedmont river deposits] and the position of actual river gorges" through the outer ranges of the

* A. Penck. Die Bildung der Durchbruchstäler. Verein z. Verbr. naturwiss. Kenntnisse in Wien, 1888.

† H. B. Medlicott. The Alps and the Himalayas. A geological comparison. Quart. Journ. Geol. Soc., XXIV, 1868, pp. 34-52.

Himalayas. Some of the upturned conglomerates are "as thick and at as high angles as those on the Righi" in the Alps (46). The Sutlej in particular is instanced as having held its course from a time before the outer or subhimalayan ranges were raised. After issuing from deep valleys in lofty inner ranges it passes through low hills of soft rocks, and then trenches a ridge formed of "massive beds of coarse conglomerate of boulders, such as only occur in the main river channels. These beds are now raised to the vertical, and in both directions along the strike these conglomerates pass gradually within a few miles into the ordinary sandstones. The presumption from such a coincidence seems irrestible, that the Sutlej itself had deposited these banks of boulders at the spot where it still flows" (47).

Hayden's statement, based on studies in Montana, is as follows: "The fact that the streams seem to have cut their way directly through mountain ranges, instead of following synclinal depressions, indicates that they began the process of erosion at the time of the commencement of the elevation of the surface. This is shown all along the valley of the Yellowstone, and more conspicuously in the valleys of the Madison and Gallatin, which have carved immense canyons or gorges directly through two of the loftiest ranges of mountains in Montana. We believe that the course of these streams was marked out at or near the close of the Cretaceous period, and as the ranges of mountains were in process of elevation to their present height the erosion of the channels continued. The details of the observations which contribute to form this opinion would occupy a chapter or two." * Both of these authors, however, treated the problem of persistent rivers in an incidental manner, subordinating it to other larger topics; neither of them gave an elaborate or an emphatic a statement to his theory, and neither of them invented a handy and suggestive generic name for the kind of rivers that they explained. The taking term, antecedent, was a forcible supplement to the ex-

* Report of F. V. Hayden, Sixth Ann. Rept. U. S. Geol. Survey of the Territories for 1872. Washington, 1873, p. 85. The paragraph above quoted was foreshadowed in an earlier article. Amer. Journ. Sci., XXXIII, 1862, pp. 68-79.

planation of the profound idea involved in Powell's report; and this may be fairly taken to show that, notwithstanding the adverse opinion often inappropriately quoted to the contrary from the emotional pleading of a charming heroine, there is really matter of much import in a name.

But Powell's further argument in support of the antecedence of Green River through the Uinta Mountains includes, curiously enough, the case of certain streams which follow valleys excavated in belts of weak strata along the flanks of the range. Had the range been suddenly uplifted, these streams should, according to Powell, follow the dip of the strata; as they follow the strike instead of the dip, the uplift must have been gradual. "The direction of the streams is indubitable evidence that the elevation of the fold was so slow as not to divert the streams. . . . Had the fold been uplifted more rapidly, . . . all the smaller streams and waterways should have been cataclinal" (flowing down the dip). Hence "the drainage was established antecedent to the corrugation or displacement of the beds by faulting and folding" (Colorado River, 163). The same argument is used with respect to the drainage lines of the Arizona plateaus: "All the facts concerning the relation of the waterways of this region to the mountains, hills, cañons, and cliffs lead to the inevitable conclusion that the system of drainage was determined antecedent to the faulting and folding and erosion which are observed, and antecedent, also, to the formation of the eruptive beds and cones" (*Ibid.*, 198). Yet the longitudinal valleys, here referred to as so decisive in the discussion of antecedence, are apparently of the kind that had been explained ten years earlier (1862) by Jukes, from his studies of the Blackwater in southern Ireland, as having been slowly developed by headward or retrogressive erosion along the strike of weak beds; thus interpreted, they indicate slow adjustment of streams to structures and probably do not bear on the problems of antecedence at all.

This is not the place for further discussion of Green River, regarding which the theory of superposition suggested by Emmons merits consideration along with Powell's theory of antecedence. It indeed seems possible that Green River, which was described as the type of antecedent rivers when that term

was introduced, may be otherwise explained, so that its place as type will be taken by a better-proved example of antecedence, such as the Meuse in the Ardennes. This fate of a type is, however, not so very rare. The uplands of southern New England, described some twenty years ago as the type of an uplifted and dissected lowland of erosion, for which the name peneplain was then suggested, may, like Green River, have to yield their place to a better-proved example. The object in here pointing out the invalidity of Powell's argument is to show that even when a mind as original and powerful as his works in a field as inspiring as that of the Uinta Mountains, trenched by the canyon of the Green River, there is danger in overlooking, as Powell too often did, the work of earlier investigators on similar problems. It would be no more fitting to omit mention of this characteristic shortcoming of method from an account of Powell's work than to paint out a wrinkle in a true picture of his rugged and kindly face. But in any case, whether the Green River followed its present course antecedent to the uplift of the Uintas or not, and whether any other geologist preceded Powell in recognizing the occurrence elsewhere of rivers of this origin, it is distinctly to Powell that geology now owes the general acceptance of the idea of antecedence in river development.

GEOLOGICAL WORK.

Powell's contribution to geology—apart from the action of surface processes and the explanation of surface forms—related chiefly to large structural problems. He published many carefully studied columnar sections, giving indication of thickness, composition, and unconformities, and making provisional assignment of geological dates; but on the latter point he wisely held that "it would be manifestly absurd to introduce into a newly studied province the nomenclature which had been adopted in those provinces previously studied" (Uinta, 38). This principle guided him some years later, when he pointed out in his first report as Director of the United States Geological Survey that the introduction of local formation names has taken place "in opposition to received opinions, and in spite of the almost universal efforts of geologists to attain uni-

formity; *it therefore represents the logical and necessary growth of the science*. . . . It seems especially unwise for the exploring geologist to commit himself in early stages of investigation to refined and exact correlations, and in practice it is found that a great number of local names are used tentatively until further research demonstrates approximate identity or establishes diversity."

Powell was one of the pioneers in the demonstration of the almost undisturbed continuity of deposition in the West from Cambrian to Tertiary time, sometimes slightly interrupted by gentle unconformities, but without trace of the "revolution" that, from the structures known in Europe and eastern North America, had been previously supposed to mark a world-wide break between the depositional records of Paleozoic and Mesozoic times. He was the first to bring out the great structural features of the Plateau province, already referred to. He repeatedly emphasized the action of uplifting rather than of compressing forces, for he had chiefly to do with broad structures of nearly horizontal strata, limited by faults or, as he so justly remarks, their homologues, monoclinal flexures; and the latter style of deformation was in his time a geological novelty. Complicated deformation was mostly limited in the Plateau region to "zones of diverse displacement" between extended areas of little disturbance; the only sharp folds with which he had to do occurred in these narrow zones. He suggested that flexing of strata was probably a deep-seated process, while faulting was a more superficial one. As in his discussion of the problem of antecedence, stated above, so through all his writings, he strongly supported the then growing idea that "upheaval was not marked by a great convulsion, for the lifting of the rocks [in the Uintas] was so slow that the rains removed the sandstones almost as fast as they came up."

Following his systematic habit of mind, he grouped the mountainous reliefs of his region into two great classes; some were composed of sedimentary strata and others of extravasated materials. He then divided these classes into a number of types according to details of structure, and subdivided them still further according to the work of erosion upon them. The Appalachians were the only mountains here mentioned

outside of his own field. The names given to his types were usually taken from local examples, although in certain cases similar structures had long been well known in other fields. His reason for thus passing over the earlier work of others elsewhere was evidently that he wished simply to classify the phenomena that he had himself observed. It was perhaps by reason of the habit of reducing his facts to schematic arrangement that he gave an oversimplified account of the Basin ranges. He did not explicitly announce that the prefaulting mass in the Great Basin was of complicated structure and possibly of irregular surface; he indeed tacitly implied a horizontal structure and plain surface when he wrote: "When the blocks into which a district of country has been broken by faults are greatly tilted, so that the strata dip at high angles, the uplifted edges of such blocks often form long mountain ridges. . . . Many of the ridge-like mountains of the Basin province have this structure. Such a ridge is composed of monoclinal strata, the one side presenting a bold escarped front, the other a more gently sloped back conforming to a greater or less degree with the dip" (Uinta Mountains, 16). It is possible that the failure of later observers to find simple monoclinal structures and forms in the Basin ranges corresponding to this simple description is in part responsible for the misunderstandings that have arisen regarding the origin of the ranges. In another connection Powell's account of the Basin ranges is more satisfactory, as will appear below.

PHYSIOGRAPHIC WORK.

Powell's contribution to the discussion of erosional processes and their effect in the development of land forms was of fully as great value as his more strictly geological studies, and certainly exerted a marked influence on the work of later students of physiographic problems. It is not too much to say that in this division of his studies he, with his able collaborators, laid the foundations of what may be fairly called the American school of geomorphology, now eagerly embraced by modern physiographers everywhere, and that he thus contributed immensely to the awakening and the advance of the sluggish old science of geography. It is worth pointing out

that a physiographic turn was given to Powell's work, not so much from his own intentional preference or selection, but from the abundant and open opportunity for physiographic study in a semi-arid region, for, in common with nearly all the early geological explorers of the West, Powell was led by his environment to give much attention to surface forms; he could not fail to see their intimate relation to internal structure, so wonderfully displayed by reason of the scantiness or absence of vegetation. He therefore inevitably described the relief of his region by explaining it, and his explanation was presented in terms of structural masses, raised by internal diastrophic forces and worked upon by external destructive forces. He emphasized internal or "geological" structure as the prime basis for the classification of land forms, and adopted as the guide to their secondary grouping the erosion of what he called "concomitant," or, as would now be said, sequential, minor forms. He did not explicitly make the next step of systematically describing the stages in the progress of erosion during its work upon uplifted masses, but it must be a careless reader who does not repeatedly find this principle implied in a careful study of Powell's writings. At this time, as well as later, Powell had the great advantage of discussing his problems with a younger investigator of the Cordilleran region, whose sound views probably had a larger influence in shaping his senior's opinions than will ever be directly known.

As to the action of erosional processes, Powell's reports abound in quotable statements, of which the following are good examples: "Erosion is not greatly promoted by increased rainfall. . . . With greater rainfall we have greater power, but a lesser utilization of the power; with lesser rainfall we have lesser power, but greater utilization; and in these varying conditions, just where maximum degradation is found I am not able to state." "I have many times witnessed the action of a storm in an arid region where the disintegrated rocks were unprotected by forests, shrubbery, or turf, and as often have I been impressed with the wonderful power of the infrequent storm to gather up and carry away the land, as compared with the frequent storm in the prairie or forest of a land more richly clad" (Uinta, 188; see also Colorado River, 171).

Attention to stream action naturally led to an attempt to classify streams and valleys. Two classifications were proposed; the first was based on the relation of streams to the strata that they traversed; several types were admirably illustrated in ideal figures drawn by Holmes, and each type was given a name of Greek origin, as cataclinal, diaclinal, and so on; but these names have not come into general use, perhaps because they express only an empirical relation. The second classification of streams and valleys was in terms of their origin; the three kinds here recognized were given names of Latin derivation—antecedent, consequent, and superimposed—last two kinds having been recognized but not named by Marvine, from whom Powell quotes; and these names have come into general use among modern physiographers. River behavior was discussed with much originality, and reasonable meaning was given to features that had previously been stated empirically; for example: "In the Colorado river, with very few exceptions, all the falls and rapids which beset its course through the great cañons are caused by dams of boulders made by side streams having great declivity" (Uinta, 193). Regarding Platte River, on the plains, it is luminously stated: "The beds through which the river runs are incoherent, and although the river has as great a fall as the Colorado through the plateaus, and although the climatic conditions are essentially the same, yet the former runs in a broad sheet scarcely below the level of the plain, while the latter runs in a narrow groove at profound depths below the general surface" (Uinta, 194). The nature and amount of river load and the manner of its transportation are carefully considered. The load "does not float on the water, but behaves as an integral part of it, and with it obeys the laws of hydrodynamics" (Uinta, 184). The principles here announced were afterwards developed with greater fullness in an address before the National Academy of Sciences, under the title of "The laws of hydraulic degradation," with the object of mentioning "the principal efficient methods of controlling rivers in their floodplain reaches;" and here Powell's indifference to precedent is shown again, for although the problem and the technique of river control have been abundantly discussed and successfully practiced in

Europe, Powell's published paper (Science, XII, 1888, pp. 229-233) does not contain a single citation. As a correlative of the transportation of load by stream, its deposition was also considered, and a good beginning made toward recognizing the great importance of fluviatile deposits in the case of an extensive conglomerate (Uinta, 170). In connection with the transportation of large boulders from mountains by storm floods, a curious suggestion is made (Colorado River, 208) regarding a possible similar interpretation of parts of the "Drift" in the upper Mississippi Valley, which Powell had studied while he was a professor in Illinois.

BASELEVEL OF EROSION.

Among all Powell's many generalizations none has been more broadly applied than his conception of the base level (now better printed as a single word, baselevel) of erosion. He wrote: "We may consider the level of the sea to be a grand base level, below which the dry lands cannot be eroded; but we may also have, for local or temporary purposes, other base levels of erosion, which are the levels of the beds of the principal streams which carry away the products of erosion. . . . What I have called the base level would, in fact, be an imaginary surface, inclining slightly in all its parts toward the lower end of the principal stream draining the area through which the level is supposed to extend, or having the inclination of its parts varied in direction as determined by tributary streams." Where a "stream crosses a series of rocks in its course, some of which are hard and others soft, the harder rocks form a series of temporary dams; . . . and thus we may have a series of base levels of erosion" (Colorado River, 203).

It is to be noted that baselevel as thus defined seems to have two meanings. One meaning is very simple; it is simply the level of the sea, extending in imagination under the lands. The other is much more complicated; it is an imaginary, undulating, and inclined surface passing through a river and its tributaries, but passing beneath the intervening land surfaces. And as thus defined baselevel must be conceived with difficulty because of the vagueness as to the stage of river devel-

opment when it is first to be applied, because of the irregularity of its form, and because of its slow changes as the controlling stream lines are worn down to gentler slopes. Naturally enough, the more complicated meaning has been little used. The simpler meaning now prevails, under which baselevel may be concisely defined as the "level base" with respect to which river erosion is performed, determined either by sea-level in the most general case or by a rock-sill or lake surface or basin floor in various special cases. The idea thus presented is discoverable, provided the reader is already acquainted with it, as an implied factor of various explicit statements in the writings of certain earlier authors; but Powell makes it wholly explicit, and indeed sets it forth in a very striking and appealing manner. Moreover, he gave its leading element a handy name, as he did in the case of antecedent rivers, with the result of rapidly promoting a clear and general understanding of a principle of prime importance in the rational study of land forms. Simple as the principle here involved really is, the explicit announcement marks an era in rational physiography.

A second step of great importance followed from the first, as already intimated. The massive structures on which erosional processes operate having been conceived, the erosional processes themselves having been analyzed, and the baselevel with respect to which they work having been recognized, the successive steps in the progress of their work naturally became the subject of study. Powell clearly saw that mountain forms are not the result of disorderly and individual uplift, but of erosion. "The mountains were not thrust up as peaks, but a great block was slowly lifted, and from this the mountains were carved by the clouds—patient artists, who take what time may be necessary for their work. We speak of mountains forming clouds about their tops; the clouds have formed the mountains" (Colorado River, 154). This had been recognized by others, but Powell went further. "The first work of rains and rivers is to cut channels and divide the country into hills, and perhaps mountains, by many meandering grooves or watercourses, and when these have reached their local base levels, under the existing conditions, the hills are washed down, but not entirely carried away" (Colorado River, 204)—that is, a lowland of

small relief will in time be produced by the erosion of rain and rivers. Previous to Powell no one had ventured in the theory of land carving by rain and rivers to go beyond what would today be called a late-mature stage in the cycle of erosion—namely, the production of valleys between hills or mountains—unless one goes back to the brief generalization of the German philosopher, Kant, who a century earlier had recognized that the action of rain and streams must slowly wear down all highlands and rob the earth's surface of its inequalities; or to the broad principle of the Scotch geologist, Playfair, who a little later explained that the earth must tend gradually to become a spheroid of rotation by the external action of erosional forces, whatever its original form had been. But Powell is much more thoroughgoing and definite than any of his predecessors He states in his second report, after recognizing the rapid wearing down of highlands: "The degradation of the last few inches of a broad area of land above the level of the sea would require a longer time than all the thousands of feet which might have been above it, so far as this degradation depends on mechanical processes; . . . but here the disintegration by solution and the transportation of the material by the agency of fluidity come in to assist the slow processes of mechanical degradation, and finally perform the chief part of the task" (Uinta, 196). This passage is of special interest as being the most explicit statement made by Powell regarding the general possibility that normal erosional processes, working on a land-mass long undisturbed, will ultimately reduce the whole surface to a lowland but little above sealevel. His full understanding of the problem is shown when he thus points out the contrast between what would now be called the rapid changes of the youthful stage early in a cycle of erosion and the extreme deliberation of advanced old age at the end of the cycle.

PLANATION.

These general results were not left without practical application. The great plains of erosion revealed by the superb unconformities in the bottom of the Grand Canyon of the Colorado in northern Arizona were evidently regarded as the

result of persistent erosion by rain and rivers during prolonged still-stands of the region in ancient geological periods; but the phraseology adopted for the peroration, in which the history of these buried lands is set forth, must leave the uninformed reader in some doubt as to the precise nature of the facts and inferences there presented. A simpler statement is given for the plateau-like highlands of crystalline schists, flanked by upturned sedimentaries in the Colorado Front Range, which had made a "deep impression" on Powell when he crossed them in his first Western journey in 1867. He afterward recalls that he had then "dimly conjectured that tens of thousands of feet had been eroded from some of the ranges, and that the table or plateau like character of the ranges was due to some epoch of this later denudation of the ranges when they were planed down to a common level. . . . Such a planing down occurs when the channels of the eroding streams remain for a great length of time at a general base level" (Uinta, 27). It would thus appear that the first observer to recognize this fundamental process in the origin of the Front Range of the Rocky Mountains was not Marvine, to whom it has elsewhere been credited, but Powell. True, he does not explicitly state that the planed-down surface of the Front Range was afterward broadly uplifted to its present highland altitude in order to excite its streams to erode the gorges by which it is now dissected; but no one who reads his reports can doubt that he understood the uplift as clearly as the planing down. Following the principles so well and so early applied in Colorado, he afterward perceived that the ranges of the Great Basin, though composed of Eozoic and Paleozoic rocks, are mountains of very late upheaval, and that before upheaval their region was "a comparatively low plain, constituting a general base level of erosion to which that region had been denuded in Mezosoic and early Tertiary time when it was an area of dry land" (Uinta, 32). He was thus led to say: "Mountains cannot long remain as mountains; they are ephemeral topographic forms. Geologically all existing mountains are recent; the ancient mountains are gone" (Uinta, 196). I can well recall the exclamatory vigor that Powell gave to a statement at a scientific meeting in 1884, and the emphasis that he added with

rapid gestures of his empty sleeve: "If the Adirondacks had been uplifted in Cambrian time"—as was then generally supposed—"they would have been worn down *over and over* AGAIN!"

The discussion of cliffs of displacement and cliffs of erosion in the Colorado River report is an excellent example of Powell's deductive presentation, evidently based upon observed examples, but systematically extended beyond their reach and admirably illustrated by a series of block diagrams by Holmes. The ideal types thus presented are shown in far greater distinctness than could be reached in any direct view of actual examples. It is well said that "the cliffs of erosion are very irregular in direction, but somewhat constant in vertical outline; and the cliffs of displacement are somewhat regular in direction, but very inconstant in vertical outline" (Colorado River, 191). This sentence may indeed be taken as one of the best examples of Powell's power in condensed verbal exposition. The migration of divides and the associated beheading of consequent streams during the retreat of cliffs of erosion is recognized (*Ibid.*, 210), but the principle here involved was not developed to its more general application.

PHYSIOGRAPHIC ESSAYS.

It is in the pages on the land forms of the Plateau province that one finds some of Powell's best physiographic presentation, much better than in two later essays on "Physiographic Processes" and "Physiographic Features," which he contributed to the series of "National Geographic Monographs" in 1895. These monographs were intended for school teachers of physical geography, who were then, as they are still, in too large a proportion very imperfectly trained in their science, and who therefore needed, as they still need, only elementary essays presenting specific examples in simple language. Whatever Powell's earlier experience in teaching school may have contributed to his style of presentation, his later experience as leader of exploring expeditions and as organizer and director of large scientific bureaus did not adapt it to the needs of the readers here appealed to. The simple style in which cliffs and canyons are described in the Colorado River report is re-

placed in these two essays by an elaborate, sometimes an extravagant, manner of statement little suited to school teachers. They are literal readers, and must have been mystified by such sentences as: "The purple cloud is painted with dust, and the sapphire sky is adamant on wings;" or, "With the revolving moon the tides sweep back and forth across the surface of the sea, and alternately lash the shores with their crested waves;" and it was certainly disappointing to those who had labored to introduce the principles of uniformitarian geology into geography to find the authority of Powell back of a statement telling "how fire, earthquake, and flood have been involved in fashioning the land and sea." The small attention given to marine processes in Powell's official reports, written in the environment of a broad continental interior, was natural enough; but the scanty systematic treatment that these processes received in comparison with the attention given to rain and rivers in the essay on "Physiographic Processes" was as little appropriate as the insufficient discussion of river work and the exaggerated consideration of marine processes by certain earlier transatlantic writers of a more insular environment.

The third essay of this series, on the "Physiographic Regions of the United States," is better than the other two. The subdivisions of our country into provinces, as there presented, has been often used by later writers, and must in its larger features be permanently adopted, because it is based on underground structure as the prime element in physiographic classification, rather than on an empirical examination of surface features, independent of their origin, such as had been accepted in earlier years when geographers and geologists hardly had a speaking acquaintance with one another. The correlation of structure and form in the Plateau region had been admirably set forth in the Uinta report by means of a block diagram (facing p. 14), which marked an immense advance over the black-bodied profiles then in common use, and even today unhappily not extinct. The same report had clearly separated the Basin Ranges, the Plateaus, and the Rocky Mountains: "first, desert valleys between naked ridges; second, high plateaus severed by profound gorges, and, third, massive high mountains with shining snow-fields" (Uinta, 8). This is sup-

plemented in the "Physiographic Regions" by the statement that the Rocky Mountains terminate in northern New Mexico, where the Basin Ranges stretch far southeastward to meet the southwestern border of the Great Plains. Subordinate changes in Powell's boundaries and subdivisions may of course be made, as in the interpolation of the group of domed mountains in western North Carolina between the Piedmont plateau and the Appalachian ridges, or in the separation of the highlands of northern Minnesota and upper Michigan from the Lake plains farther southeast; but in the main the demarcation of the provinces here indicated in text and map constitutes a permanent advance in American physiography. How singular that a practiced observer, keen enough to see that the Rocky Mountains end southward in New Mexico, should not have, as a writer for teachers, moderated the hyperbolic peroration which in the last lines of this essay described the California coast ranges as a province "where the balm of the tropics bathes the winter with verdure, and boreal zones boon the summer with zephyrs!"

It was in connection with the explanatory or rational description of land forms in terms of their past history as dependent on underground rock-structure and external erosive processes, that Powell ingeniously applied his analytical method in a reversed direction, as if confident that a good rule must work both ways, for he frequently inferred the past history of a district from its present form. The reading of past history from depositional records had long been a standard method in geology; reading past history from erosional records was a novelty. This is well illustrated in his conclusion that while each Basin Range "is but a small residuary fragment of the great inclined block" from which it has been carved, yet when compared to the Kaibab or the Uinta "the erosion of the Basin Range ridges sinks into insignificance;" hence "we are forced to conclusion that the conditions for great erosion now found in the Basin Ranges have existed but for a short period" (Uinta, 33, 34). This principle has had wide application in later years.

LANDS OF THE ARID REGION.

Powell's large share in promoting a correct knowledge of the arid parts of the United States and their possible utilization will not be realized by readers today unless they recall the time when so much was said about taking the words "Great American Desert" off of the map. This name was, during a period of early exploration, recklessly extended over vast areas of the West which are by no means completely desert; but as the frontier was pushed westward half a century ago, the restriction of the name was hardly less reckless than its extension. The existence of a desert was actually denied, although there certainly is a large space in the West and Southwest truly not altogether devoid of vegetation, but permanently "desert" in the economic sense, whatever its name. It was, of course, open to occupation in a limited manner, as nearly all deserts are; settlers who advanced into the dry country soon recognized that certain small areas in nearly every part of it could be redeemed by irrigation, and that much larger areas were not so barren but that wandering herds of cattle could subsist on their scanty herbage, provided that water was not too distant. Thus the region began to have a better reputation than it deserved; and, curiously enough, about coincident with a wave of rapid immigration into the pasturage area of the Great Plains in the '70's and '80's, there was a period of increasing rainfall in that subhumid region which was taken by many—even by army officers, who ought to have known better—to result from plowing the soil, laying rails, or stretching telegraph wires, and therefore regarded as a permanent improvement of climate. Farming was for a time successful, and this was enormously advertised. Thousands of settlers, accustomed to farming on the moist prairies of the Mississippi Valley, attempted in good faith to establish themselves on the drier Plains, only to be driven away with bitter disappointment and heavy loss when a few years later a period of less rainfall caused the failure of their crops.

The irrigated areas naturally had better fortune, especially the larger undertaking of the Mormons in Utah and of the Greeley district in Colorado. These advantageously located

areas are permanent assets of immense value to the West, and much profit now comes from many similar but smaller areas; but even the greenest spots in the most barren wilderness were always called settlements, and never oases. In various parts of the arid region the latter name would have been quite as appropriate as it is in the Sahara, but its connotation of a surrounding desert was too manifest to make it acceptable.

Powell told the truth about the dry country, and advocated a comprehensive plan whereby its real values might be developed. It was at his suggestion that Congress appointed a commission to study the physical and economic conditions of the arid region, and he gave two years to this work. We have no narrative of his Western journeys in this connection, but the results were published in a most important "Report on the Lands of the Arid Regions of the United States" in 1879, to which Gilbert, Dutton, and Thompson contributed chapters. Few reports have had a greater value in pointing out the direction of safe and sound progress. The first edition of 1,800 copies was soon exhausted, and a second edition of 5,000 was issued. The area treated was about four-tenths of that of the United States, and the report was the first comprehensive study of the kind issued in this country; today it is recognized as a classic treatise on the subject.

Powell cautiously set the limit of successful agriculture without irrigation—the singular art of dry farming was then unknown—at the line of 20 inches of average annual rainfall, and showed the danger that farming must run from frequent droughts east of this line in that belt of the Great Plains trending north and south, which lies between the rainfall lines of 20 and 28 inches and which he first called "subarid;" but the name "subarid" was later, on suggestions received in Washington, changed to "subhumid" as a less unpleasant term. He recognized an increasing stream supply during a decade previous to the preparation of his report; but, instead of explaining it, as many have done, by an increase of rainfall, he ascribed it to an increased "run-off" due to artificial changes in the land surface. It may be noted, in passing, that the term "run-off," now in general use, was invented by Powell; his correlated term "fly-off," for rainfall that is lost by evapora-

tion, has not been adopted. He scouted the idea that any operations of man can have brought about increased precipitation, but added, "if it be true that increase of the water supply is due to increase in precipitation, as many have supposed, the fact is not cheering to the agriculturist of the arid region. . . . Usually such changes go in cycles, and the opposite or compensating change may reasonably be anticipated," for if the increase of streams results from an increase of rainfall, "we shall have to expect a speedy return to extreme aridity, in which case a large portion of the agricultural industries of the country now growing up would be destroyed" (91). Powell plainly stated that only a small fraction of the arid lands was available for agriculture, and pointed out that the redemption of the areas that could be irrigated would involve difficult engineering problems far too large for individual farmers, and possible only through co-operative labor controlled by carefully considered legislation; he saw, further, that when all this should be accomplished only a small portion of the arid region could be cultivated. These principles are well enough understood now, after a generation of experience; but they were novelties when published, and served as needed corrections of exaggerated stories then current.

The report on the arid region proposed a fivefold classification of the Western public lands, not based on the traditions of the East, but on the facts and conditions of the West. The five classes were named mineral, coal, irrigable, pasturage, and timber lands. With mineral lands the report had nothing to do. The abundance and importance of lignite coals was briefly stated; they were, indeed, regarded as "inexhaustible by any population which the country can support for any length of time that human prevision can contemplate;" it was recommended that their area should be determined by a thorough geological survey. The areas classified as timber lands were chiefly the higher plateaus and mountains, which have practically no value aside from their forests; but it was explicitly stated that these areas were by no means wholly occupied by standing timber, because of the terrible devastation by forest fires. Emphatic warning was given of this danger in the arid region. Most of the fires were ascribed to intentional burning

by Indians, who, displaced from lower lands by the advance of white settlers and impelled to hunt fur-bearing animals for trade, deliberately set fire to the forests for the purpose of driving the game; therefore the Indians should be removed from the forested areas. The burning of forests in the highlands of the arid region has been on a "scale so vast that the amount taken from the lands for industrial purposes sinks by comparison into insignificance" (15). Powell tells that he had "witnessed two fires in Colorado, each of which destroyed more timber than all that used by the citizens of that State from its settlement to the present day, and at least three in Utah, each of which has destroyed more timber than that taken by the people of the Territory since its occupation. . . . Everywhere throughout the Rocky Mountain region the explorer, away from the beaten paths of civilization, meets great areas of dead forests; . . . in seasons of great drought the mountaineer sees the heavens filled with clouds of smoke. . . . If the fires are prevented, the renewal by annual growth will more than replace that taken by man. . . . No limitation to the use of the forests need be made" (17). "Once protected from fires, the forests will increase in extent and value. This protection, though sure to come at last, will be tardy" (18). It is interesting to note in this connection Powell's unqualified statement that "fire is the immediate cause of the lack of timber on the prairies" (16), and the emphasis that he gave to the occurrence of large burned areas in the East at the time of the discovery of America. He wrote several years later: "When the lands [in the East] were plowed the fires were stopped, and vast regions that were prairies at that time are now forest-clad. Today [1895] the forests of the United States are somewhat more extensive than they were at the landing of Columbus" (Nat. Geogr. Monogr., 71).

In classifying all the lands between the highland timber areas and the lowland irrigable areas as pasturage lands, Powell did not overlook that certain districts are really deserts, too low for timber, out of reach of irrigation, and too dry for pasture. He wrote: "In very low altitudes and latitudes the grasses are so scant as to be of no value; here the true deserts are found. These conditions obtain in southern California,

southern Nevada, southern Arizona, and southern New Mexico, where broad stretches of land are naked of vegetation; but in ascending to the higher lands the grass steadily increases" (20). The threefold classification therefore seems to have been for the sake of simplicity; surely the confident assertion of value in the larger part of the arid region as a cattle-raising country has been abundantly verified. The sparse growth of herbage on the grazing lands demanded large farm units; Powell advised that the minimum be set at four square miles, or 2,560 acres. He further advocated a somewhat ideal plan of settlement, in which the ranchmen's homes should be grouped around irrigable tracts, so as to secure the benefits of social organization, and, as he thought that fences would not be used, he inferred that the herds must roam freely under local communal regulations. Practice has not always verified these anticipations; roaming heads have been common on open public lands; but large areas of private lands are now enclosed by long fences of barbed wire, hardly known in 1879.

Work for a generation was laid out in Powell's far-sighted treatment of the irrigable districts. He showed that their total area must be small in relation to the vast extent of the whole arid region; he studied the amount of water that an irrigated farm would need, and concluded that a continuous flow of one cubic foot of water per second would serve from 80 to 100 acres; he advised a better construction of canals to prevent the excessive waste that was then almost universal. Streams must be gauged to determine how much land they can serve; reservoir sites must be reserved against the time when they will be needed to save the winter run-off. But the most significant sentences in this part of his remarkable report concern the danger of monopoly in the ownership of water, and in this respect Powell showed himself a pioneer conservationist. He doubted the wisdom of too rapid enterprise, prompted by the intense desire for speedy development on the part of first-comers, who give little heed to "philosophic considerations of political economy or to the ultimate condition of affairs in which their present enterprises will result. . . . If, in the eagerness for present development, a land-and-water system shall grow up in which the practical control of agriculture

shall fall into the hands of water companies, evils will result therefrom that generations may not be able to correct, and the very men who are now lauded as benefactors to the country will, in the ungovernable reaction which is sure to come, be denounced as oppressors of the people. *The right to use water should inhere in the land to be irrigated, and water rights should go with land titles*" (41). "The ancient principles of common law applying to the use of natural streams, so wise and equitable in a humid region, would, if applied to the arid region, practically prohibit the growth of its most important industries," because the water there "has no value in its natural channel. . . . Water rights are being practically severed from the natural channels of the streams; and this must be done. . . . In the change it is to be feared that water rights will in many cases be separated from all land rights as the system is now forming. If this fear is not groundless to the extent that such a separation is secured, water will become a property independent of the land, and this property will be gradually absorbed by a few. Monopolies of water will be secured, and the whole agriculture of the [arid] country will be tributary thereto—a condition of affairs which an American citizen having in view the interests of the largest number of people cannot contemplate with favor. . . . The right to the water should inhere in the land where it is used, . . . not to the individual or company constructing the canals by which it is used" (42, 43). A natural result of this invaluable report was Powell's appointment as a member of the Public Land Commission by the Senate and House of Representatives in 1879.

The enormous import of Powell's conclusions may be understood when it is recognized how many of them have been given practical application on a large scale, in more or less modified form, by governmental bureaus. Land classification and stream measurement are now important functions of our national Geological Survey; the same survey for a time reported upon reservoir sites and upon the area and value of forests, but the latter duty has later been given to the Forestry Bureau, under which the greatest efforts are made to secure adequate protection from forest fires; the difficulty which

makes this protection "tardy," as Powell predicted it would be, not being found in mere problems of administration, but altogether in the failure of a negligent Congress to provide adequate funds for the relatively moderate expense involved. The survey of reservoir sites and the large engineering works, foreseen as necessary for the full developmnt of the possibilities of irrigation, are now conducted on an enormous scale by the Reclamation Service, an outgrowth of a branch of the Geological Survey and one of the best and most beneficent of our governmental undertakings. The introduction of electric-power plants, advantageously installed in connection with irrigation dams, and of immense economic value in using a natural supply of energy that would otherwise be wasted, have only increased the importance of everything that Powell said regarding the necessity of guarding our water supplies from monopolistic control and conserving them for the common good.

When all this is appreciated, Powell must come to be regarded as one of our great national benefactors. The opinions of two highly competent judges may here be quoted. Gilbert wrote, in effect, that Powell's Report on the Lands of the Arid Regions set forth with marvelous insight the conditions by which the problem of their best utilization is surrounded; his views were discredited at the time, because he announced that only a small percentage of the Far West can ever be reclaimed for agriculture. The Report raised a storm of indignation, because it characterized as semi-arid the middle belt of the Plains, toward which settlement was then tending, yet today it is recognized as a classic treatise.

Van Hise wrote in a similar vein, telling how Powell gave the benefit of his knowledge of the arid regions to the legislators of the nation. He saw that the arid lands were a possible great resource to the country, but an exceptional resource, which could not be wisely handled under the common law as it had been developed in humid regions. He saw that there was no danger of monopoly of land, but that the real danger was the monopoly of water—that he who controlled the water was the master of the land. Consequently he proposed broad and statesmanlike legislation for the division of the lands of the

West which are not mining lands into several classes, and advised that these lands should be controlled by special laws.

The suggestions which Powell made regarding the economic problems here treated have been in large measure incorporated into statutes. The effort for reform was complicated by conflicting interests, and at times it was a disheartening struggle: but it is a pleasure to record that during the Major's last sickness he was able to know of the passage of the Reclamation Act, the most important triumph of the arid-lands agitation.

THE GEOLOGICAL SURVEY.

In no case was Powell's capacity to turn the course of events more strikingly shown than in the organization of our present national Geological Survey. Through the '70's the existence of several official yet independent surveys of the Western country under different departments of the Government resulted in scandalous rivalries and animosities. Powell, at the head of one of these organizations, strove to reach an adjustment by mutual consent; failing in this, he boldly advocated complete reorganization. He had advised the consolidation of the several rival surveys in 1874, and it appears to have been at his suggestion that Congress, in June, 1878, called upon the National Academy of Sciences, of which he was then not a member, for advice. A committee of the Academy reported in November a plan which had been, in its main features, formulated and advocated by Powell, involving the abolition of the rival surveys and the creation of two separate bureaus—one, an enlargement of the Coast Survey under the title of Coast and Interior Survey, for geodetic and topographic mensuration; the other, a Geological Survey for studies of structure and resources, not of the United States, but of the "public domain;" all matters concerning the disposition and sale of public lands being left to the General Land Office. The present generation should be reminded that, during the discussion of the recommended organization, strong pressure was brought to bear upon Congress in favor of placing all topographic surveys in charge of the Engineer Corps of the Army, and European precedents for this plan were

abundantly cited. But it was urged, on the other hand, that our needs would be better served by civil rather than by military engineers, because the uses of our public domain would be much more largely in the way of peaceful settlement than of warlike campaigns. On this point, as on many others, Powell's opinion seems to have had weight. His view of the entire problem was presented in a letter as a supplement to the report of the Committee of the National Academy; and this letter the Hon. Abram S. Hewitt, then a leading member of the House of Representatives, urged all his colleagues to read, because the whole subject of reorganization of the surveys was there "so much better treated than any gentleman on the floor can hope to do."

The "Geological Survey" was established by an act of Congress on March 3, 1879. Although its work was, as noted above, limited to the "public domain," the name "United States Geological Survey" was at once assumed. A Bureau of Ethnology was created at about the same time, but the duties of the Coast Survey and the Land Office were not changed, and no special provision was made for a topographic survey. It is significant that the law establishing the Geological Survey mentioned the classification of the public lands before the examination of their geological structure. It is significant also that on account of Powell's active share in bringing the new Survey into existence he refused to be considered a candidate for its directorship. He was appointed instead to the directorship of the Bureau of Ethnology, and Clarence King, previously chief of the famous Fortieth Parallel Survey, was appointed Director of the new Geological Survey in March, 1879; he resigned two years later on the ground of preferring personal investigation to administration. Powell, believing his duty in the Bureau of Ethnology to be permanent and engrossing, had given up "all thought of continuing his work as a geologist;" but he was appointed Director of the Geological Survey after King's resignation, while still retaining his other directorship, and returned to geological work in March, 1881, with vigor and enthusiasm.

Many of the activities of the Geological Survey were then for over ten years so characteristic of Powell's method of work

that an account of them deserves an important place in a memoir of his life. The breadth of the organization reflected his native interest in comprehensive schemes and his unusual capacity in developing them. King had already secured the services of a number of geologists from the several surveys that had been disbanded and Powell brought in still others; thus a good volume of inherited work was quickly brought forward for publication. He had in Gilbert a wise adviser on scientific problems and in McChesney an able aid in all financial matters. The enlistment of many professors of geology in colleges all over the country, to contribute reports on subjects that they had previously studied independently, showed the broadly inclusive spirit in which the development of the Survey was conceived; thus the Director secured the personal interest of many widely distributed experts in the maintenance of the Survey, and at the same time brought together much accumulated knowledge in local or special fields. This was a wise step at the beginning, when the supply of well-trained young American geologists was small; but such a method of securing field geologists was outgrown half a generation later, when the students of the professors of the earlier time had in good number become expert members of the Survey, practiced in methods adapted to its special needs, and not distracted from its work by duties to other institutions. The standard of technical preparation expected of members in various branches of geology and topography was at the outset necessarily low, for there had been no demand to excite a well-trained supply, and the pressure of Congressmen to secure places for their relatives and friends did not tend to raise the standard; but it was raised as rapidly as possible, and the Survey thus reacted most helpfully on the development of the geological departments in our universities. In the meantime, if "Senators' nephews" sometimes gained positions as camp assistants or rodmen, they were seldom capable of geological work, and in any case Powell squarely accepted all responsibility as to the character of his appointees. He wrote in the Sixth Annual Report: "If, then, improper persons are employed, it is wholly the Director's fault."

A liberal policy was adopted regarding the exchange of the

Survey publications with productive geologists, whereby many an isolated worker was kept in touch with the progress of the great national undertaking. The early reports and monographs were, moreover, of exceptional interest and immediately commanded the admiration of the whole geological world. A sound method of business administration was developed. Powell's detailed account of it before a Joint Commission of Congress in 1885 made a most favorable impression on the majority of the Senators and Representatives who heard him. A full statement of this matter is given in systematic form in the Eighth Annual Report, and a briefer statement of the organization of the Survey was communicated to the National Academy in 1884 and printed in the American Journal of Science for February, 1885; but it is the original report of the Joint Commission, an exceptionally interesting public document, published in the form of questions and answers usual in such cases, that best shows Powell's close familiarity with all details of survey work and his remarkable competence in setting forth methods of administration. Those who were then members of the Survey will remember how nearly every one was for a time pressed into the work of summarizing the reports of foreign topographical and geological surveys, so that the Director should have precise and detailed information in his hands; his testimony illustrates how ably he used the varied material thus placed at his disposal.

Powell's third report—the Fourth Annual Report of the Survey—announces that the congressional act making appropriations for the Survey for 1882-1883 required the preparation of "a geologic map of the United States;" thus for the first time explicit authority was given for extending the operations of the Survey over the whole country, and therewith implicit authority for the preparation of a topographic map as the necessary basis of the geologic map. Who can say how far Powell himself suggested the use of these highly significant words! Reports on topographic work were thereafter placed at the head of the list of administrative statements in the annual reports issued by Powell. The failure of Congress to establish three years before an independent topographic bureau was thus repaired, and by a curious combination of cir-

cumstances Powell found himself in charge of both classes of work—topographic and geologic—that had been assigned to separate bureaus in the recommendation of the National Academy, and of the work in the Bureau of Ethnology as well. About six years later, 1888, the conduct of an Irrigation Survey was also placed under his charge; never before or since has so large and so varied a scientific responsibility been concentrated in the hands of a single governmental official at Washington.

TOPOGRAPHICAL MAP.

The sheets of the topographical map surveyed, drawn, and printed by the Survey have been immensely serviceable; indeed, no publications of the Survey have had up to the present date a greater general usefulness than this map, which, under Powell's strong initiative, was undertaken for the whole country. Scientists of the younger generation, who are now profiting from the large supply of good maps available for their uses, can hardly appreciate the rarity of cartographic material regarding nearly every part of our country—the coasts and the lake shores excepted—thirty years ago. The change from geographic barbarism of that earlier day to the relative civilization of the present time is due more to Powell than to any other one man, and in accomplishing this change Gannett was for many years his right hand.

The plan for the topographic survey of the United States is set forth in the Sixth and Seventh Annual Reports. "The map should be so simple that it can be used by all people of intelligence. . . . The uses for topographic maps . . . are very many; but there is no demand more exacting than that made by the geologist, and if properly made to meet his wants they will subserve the purposes of the civil engineer and the agriculturist, the military engineer and the naturalist." Map-making in Europe had been largely in the hands of military engineers, as has been intimated above, and maps had been there prepared chiefly for military or cadastral purposes. Our needs are neither military nor cadastral, but civil and general, and our methods must meet our needs. "No nation had yet undertaken to execute a work of this character over a region of such magnitude. It has therefore been deemed of

prime importance that the survey should be conducted with utmost regard to economy." Relief had usually been represented by shading or by hachures; shading is too vague, hachures are too expensive, contours are definite and not over costly; hence contour maps were determined upon. Co-operative work with States, first undertaken in 1884 with Massachusetts, has since then been greatly extended. Singularly enough, no provision was made at first for the sale of the topographic sheets to the public; but when this was allowed the price did not include any part of the cost of production apart from paper and printing; a wide distribution was thus secured. The same wise method was early applied in determining the price asked for Survey reports and later for geologic folios.

The plans as outlined at the beginning of this great topographic work were admirable; the difficulty of executing them was great. Liberal sums were available for topographic surveying, but for a time it was impossible to find trained topographers in the desired number; hence many insufficiently trained men had to be employed and their training came in the field. The pressure for the rapid production of maps at moderate cost over large areas led to hasty work insufficiently inspected; hence the published maps were not always correct to scale of publication. In some cases the dangerous practice was permitted of redrawing in new form the maps produced by previous surveys, and as a result certain sheets of deplorable inaccuracy were issued; some of these exhibit features that are hardly recognizable on the excellent maps of later date for the same districts. Nevertheless, progress toward greater accuracy was rapid afterward, when better methods were introduced and greater cost was allowed per square mile; and it may now be seriously questioned whether the large number of excellent maps annually issued at present could have been so soon reached in any way but by plunging in boldly and rapidly instead of slowly and accurately at the beginning. Certain it is that the revelation of geographical matters of fact regarding large areas of our country, as portrayed on the sheets issued during the last ten or fifteen years, is of immense service to us all today; and this service must be counted as a consequence of Powell's marvelous initiative.

REPORTS AND FOLIOS.

The many geological studies published in annual reports, monographs, bulletins, and folios exhibit admirably the work of individual members of the Survey; but they reflect credit also on the Director, who knew how to select good associates, and who wisely trusted them with great responsibilities and gave them great liberty of action. Powell, indeed, had so much native capacity that he never hesitated, as a weaker Director might have done, to employ men who knew more geology than he did himself. The "Correlation Papers," prepared according to a general plan by eleven specialists under Gilbert's supervision to summarize knowledge regarding successive geological periods, contributed greatly to a broad understanding of large problems; and these papers constitute a thoroughly characteristic product of Powell's administration. The annual volumes giving statistical summaries of mineral resources also deserve special mention as initiated under Powell's direction. They are probably as accurate as possible under the conditions of their preparation, but they are probably not so accurate as they appear to be. The geologic folios, containing sheets of the geological map of the United States which the Survey had been instructed to prepare, are based on a uniform and comprehensive plan, and exhibit, like the topographic maps, Powell's remarkable foresight and breadth of view. The plan for the publication of the folios was carefully discussed in several conferences of leading geologists; careful debate was given to the general explanatory text of the cover, to the scheme of coloring, so admirably carried into effect by the engraving department of the Survey, and to the liberal presentation of topography, geology, structure, and economic features on separate sheets, all this being told in the Tenth Annual Report (1888-1889). The first geologic folio was issued in 1892, thirteen years after the establishment of the Survey; later folios show marked improvement in various directions, the text in particular becoming more elaborate and pictorial illustrations were abundant; but the original plan is still followed, except for the inevitable departure from the intention that the text should be "so prepared as to be intelli-

gible to users who are not trained geologists." This feature of the plan has not been carried out, and cannot be carried out unless a great part of the laborious and expensive accumulation of scientific fact and inference is not published in direct connection with the geological map to which it so closely applies. Certain critics have questioned whether another form of publication than a large folio would not be more generally useful, and some folios have lately been prepared in the form of bulletins with folded maps for field use; but for purposes of study in every other place than on the ground the folio form introduced under Powell is the most convenient. If the whole series of folios, when completed, proves to be a heavy care for any library, this must be charged against the glorious misfortune of our large national area.

IRRIGATION SURVEY.

The Tenth Annual Report tells of the Irrigation Survey, instituted in 1888, as a department of the Geological Survey, for the determination of the extent to which arid districts can be redeemed by irrigation and for the selection of sites for reservoirs, but not the construction of irrigation works. This was a fitting though a delayed consequence of the report on the arid lands ten years earlier; but it added a heavy weight to the duties of the Director, and probably led to the appointment of Gilbert in 1889, and later of Walcott, as chief geologist. The establishment of the Irrigation Survey must be regarded as having been prompted by Powell himself, for he had continually urged upon Congress the necessity of making appropriations for such investigations, and had delivered addresses and written magazine articles on the same subject. Although the irrigation work was cut off in 1892, much progress in this direction was accomplished, as attested first by the growth for several years in the size of the special annual reports on irrigation problems and fourteen years later by the establishment of the Reclamation Service; and all this must be credited to Powell's initiative and to the enthusiasm that he aroused in the younger men whom he selected to carry on the work.

ADMINISTRATION.

The various aspects of the Geological Survey here summarized from successive volumes of Annual Reports reflect clearly enough the character impressed on this great organization by Powell as its Director; but they give a very imperfect picture of the labor demanded of him in maintaining the Survey. A governmental bureau depends on one side upon the annual appropriations of a changing Congress, and on the other side upon the loyal and expert work of its many members. The continuation of such a bureau and the fate of its members might be left by a philosophical outsider entirely to the wisdom of Congressmen, because in the abstract the bureau exists only to carry out the will of the people as expressed by their Representatives; but in the concrete case of any single bureau, especially of a bureau originally established for the performance of a great and long-enduring task, many other considerations enter into the problem, as Powell well knew, and weighty among these is a reasonable assurance of steady employment for those who have in good faith cast their lot in the work of the bureau, with a fair expectation of its long existence, and also an honorable ambition of the Director regarding the distant completion of the important task committed to his charge, already begun or planned for the immediate future. Not only general continuity of work, but steadiness in rate of work—or at least the avoidance of a decreasing rate—is essential for an employee's peace of mind and a Director's satisfaction; increase may be welcomed, but retrenchment is at once an embarrassment to the Director who is compelled to execute it, and a hardship to those upon whom it is executed. The approach of the critical season when Congressional appropriations are usually voted is, therefore, unavoidably a time of anxiety for the members of a bureau in which the work necessarily changes to some extent every year, for some members must lose their positions if the work is reduced; and it is a particularly anxious time to the Director, upon whom the responsibility for maintaining the bureau so largely depends; all the more so to a Director who, like "the

Major," felt a deep personal solicitude for the welfare of his fellow-workers, as if they were members of his family.

The internal organization of a scientific bureau is, as compared to this external responsibility, an enjoyable pastime to an able Director surrounded by loyal associates. One can, indeed, feel when looking over the annual administrative reports of the Geological Survey that Powell had a lively pleasure in the internal part of his work, and the same impression was given to visitors who, from time to time, heard him humming a tune as he made his way through the corridors of the Survey building to look at the work of some of his staff. If one may judge by the years of the rapidly ascending development of the Survey from 1881 to 1892, when Powell's staunch friends in Congress acted so heartily upon his suggestions and gave him practically every opportunity that he asked for, he had during that notable period as small a share of external anxiety as the head of a great bureau can expect; yet it must not be overlooked that during this famous decade of geological evolution no small amount of Powell's time was demanded in presenting his plans even to the more friendly members of Congressional committees, and no small measure of skill and patience was needed in winning the support of the less friendly members. But Powell was master here, as well as in a boat trip down the Colorado; he had enthusiasm for the work to be accomplished; he was deeply impressed with its great importance in the development of the country; he was honest in his presentation of its merits; moreover, he understood human nature pretty well, and knew how to deal with men of many kinds; and he had so full command of all pertinent facts that his opponents in Congressional committees were often left with nothing but their opposition to stand on. He doubtless deserved the reputation gained in the minds of persons long acquainted with Washington affairs, of being for the first ten years of his directorate eminently successful in accomplishing what he set out to accomplish, and in securing such Congressional enactments and appropriations as he wished to secure.

Naturally, therefore, the growth of the Geological Survey was phenomenal. It began with an appropriation of $100,000

and with 39 members on its pay-roll for the year ending June 30, 1880; for 1881-1882, the first full year of Powell's directorate, the figures were $156,000 and 50; in 1890-1891, the maximum appropriation of $719,000 was reached; the next year there was a moderate decrease to $631,000. This unrivalled development was accompanied by a swelling volume of publications of all kinds. It is not too much to say that the eyes of the geological world were turned in astonished admiration at so unprecedented an expansion, which had rapidly brought the United States Geological Survey under Powell's leadership to be not only the largest organization of its kind, but the largest scientific organization of any kind in the world. Instead of Philadelphia, as at first suggested, Washington became the inevitable place of meeting for the International Geological Congress of 1891; at the close of the Western excursion that followed the Congress, Powell led a party of visiting geologists across the Arizona plateau to the Colorado canyon, and seemed to enjoy giving the European members a sample of the rough conditions under which travel had then to be prosecuted in the Far West. The following winter the Cuvier prize was fittingly awarded "to the collective work of the Survey" by the Academy of Sciences of Paris.

RESIGNATION FROM THE SURVEY.

But even up to this time all had not been clear sailing in Washington. Already, in 1884, opposition to the rapid growth of the Survey, instigated, it is said, by some of those who were left out of the Government service in the reorganization of 1879, had arisen in Congress; the Joint Commission, above referred to, was its outcome. Powell's testimony disclosed, however, so perfect an organization, he showed himself so completely in control of it, and his "statement traversing certain averments" made by members of the opposing minority in Congress was so satisfying to his friends in the majority, that he came out victorious from the ordeal. The appropriation of nearly half a million for the Survey for the year ending June 30, 1885, was, in the face of the organized opposition, raised to a little over half a million for 1885-1886, and so con-

tinued for the next two years; it was raised to $605,000 for 1888-1889, reduced to $551,000 for 1889-1890, and reached the maximum of $719,000 for 1890-1891.

The decrease of nearly $90,000 for the following year marked the opening of a period of adversity which culminated in the summer of 1892. The establishment of the Irrigation Survey four years before had aroused the opposition of large land-owners and cattle kings in the West, a result that was not unexpectable when the scientific administration of a public bureau in the interests of the country as a whole clashed with the personal interests of men who were rapidly growing rich under the unrestricted use of public resources; and unhappily, at about the same time, Powell's wounded arm gave him much pain; the suffering thus caused made it difficult for him to labor with Congressional committees as successfully as he had before. The first successful stroke of the opposition was made in 1891, not only by the reduction of the appropriation for the year ending June 30, 1892, as above noted, but further by the assignment of definite sums for the salaries of designated members of the Survey and for special branches of work; work on irrigation was not mentioned and was therefore suspended.

The following year was nothing less than disastrous. The appropriation for the year ending June 30, 1893, voted at the late date of August 5, 1892, fell to $430,000; definite sums were assigned to work and salaries as before; but now fourteen stated salaries were discontinued, and at the same time the amount of money assigned to topographic surveys was so large a part of the total that the balance left for geology was scanty. Field work was in active progress by a number of divisions of the geological branch when this blow fell. It was stopped by telegraphic orders, and the workers were directed to prepare records already in hand for publication, or at least to put their material into systematic shape, so that it might be used later. Many salaries that were not cut off entirely were seriously reduced; some members of the Survey voluntarily worked through the following winter on small pay or no pay. It was a time of distress. The next year the appropriation was raised to nearly $500,000; but the volume in which this is announced opens with a page from Powell to his collaborators,

taking leave of them; his resignation, to take effect June 30, 1894, had been announced some months before. The burden of his work had grown, and its difficulties had been aggravated by antagonism; his poor health did not allow him to suffer the irritation of conflicts; his withdrawal from the Survey was made "necessary by painful disability," and he devoted himself thenceforward to the simpler duties of the Bureau of Ethnology, of which he continued to be the chief.

Powell's administration of the Survey was extraordinary in many respects. He was a strong, independent, and aggressive leader, as was to be expected in view of his freely expressed indifference to traditions and conventionalities. He was truly a director by nature, and so confident of his power that he never hesitated to appoint able men as his subordinates. His authority was maintained without resort to the formalities of rank; indeed, he replaced with a jovial comradeship the lofty inaccessibility not unknown in some official bureaus, American as well as European. He had a keen sense of justice. I well remember the outburst of indignation with which he replied at a scientific meeting to a speaker who had referred unfairly to the work of an absent colleague. He felt a warm personal interest in the work of his associates; more than one junior has felt the cheer of his sympathetic appreciation. He attached the members of the Survey to its service and secured their devoted and loyal support because he was helpful, trustful, and encouraging to them—when he was convinced that he had good grounds for being so. He felt a personal solicitude for the future of the workers in the Survey that outlasted his directorship. Withdrawal from office under a sense of disappointment was a sad ending to the vast work of creation and organization that Powell had guided almost from its beginning; but he had at least in the decade that followed the satisfaction of seeing the return of the Survey to a period of growth and prosperity under the direction of his successor, who had long been associated with him and to whom at the end of a difficult piece of work ten years earlier he had said—the older man putting his one arm around the younger—"My boy, you have done well; I hope you will stay with us."

RESIDENCE IN WASHINGTON.

We may here introduce between the accounts of Powell's work in Geology and in Ethnology a brief statement of his personal relations with his associates and of his large share in organizing and supporting scientific societies in the National Capital. His Washington home at 910 M street N. W. was for many years recognized as a scientific center not only for employees under his charge, but for the scientific men of Washington in general. It was in his parlor that the Cosmos Club was organized in 1878; he was then made its temporary president and became formally the president of the permanent organization on January 10, 1881. The club has now more than 600 resident and 350 non-resident members, and includes therein most of the representatives of science, literature, and art in the National Capital. Through the winter of 1883 an informal reception was held in Major Powell's parlor every Sunday evening for the members of the Geological Survey and Bureau of Ethnology, but these receptions soon grew too large to permit of their continuation.

Powell's large share in developing non-official scientific interests in Washington may be inferred from his relation to the following societies, most of which have their seat in the National Capital. He held at one time or another membership in the Anthropological Society of Washington, of which he was a founder, and also President in 1879-1882, 1883-1885, 1887, and 1895; in the American Anthropological Association, of which he was a founder; in the Washington Academy of Sciences, of which he was an incorporator and vice-president; in the National Geographic Society, of which he was an incorporator; in the American Association for the Advancement of Science, of which he was president in 1888; in the National Academy of Sciences; in the Philosophical, the Biological, the Chemical, and the Geological Societies of Washington; in the Geological Society of America, of which he was one of the first councillors, and in the American Folk-lore Society. He was known to be an associate member of the Société d'Anthropologie of Paris, and a corresponding member of the Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte;

but whether this completes the list of his foreign membership it as been impossible to determine.

ETHNOLOGICAL WORK.

Although Powell is probably known to a greater number of persons as a geologist than as an ethnologist, his publications on ethnology and anthropology and on the philosophical problems into which the study of these sciences led him are—apart from purely administrative reports—twice as numerous as those on geology; and it appears that his contributions to the content of the sciences of earth and of man stand in about the same proportion. His active interest in ethnology began when he came into contact with the Indian tribes of western Colorado and eastern Utah in the summer of 1868; it was probably reinforced by Secretary Henry's advice that special study of the Indians should be made during the canyon journey of the next year. But more important than its origin is the nature of the interest that Powell felt in ethnology; for it had the merit of being characterized by a willingness to recognize other standards than those of the civilized races of mankind, by a ready capacity to appreciate the position of the "other fellow," and by a sincere respect for humanity in all its stages of development. These are largely matters of temperament, not of learning; they are of prime importance to an ethnologist in the office as well as in the field. Gilbert gave emphasis to this point when he wrote that Powell "realized, as perhaps few had realized before him, that the point of view of the savage is essentially different from that of the civilized man; that just as his music cannot be recorded in the notation of civilized music, just as his words cannot be written with the English alphabet, so the structure of his language transcends the formulæ of Aryan grammars, and his philosophy and social organization follow lines unknown to the European."

The warm-hearted sympathy that was the basis of Powell's success in the field study of Indian tribes is nowhere better illustrated than in the comment he makes on the fate of the three men who left his party and climbed out of the Colorado canyon in August, 1869, as already briefly narrated. The story

was learned a year later by Jacob Hamblin, a Mormon missionary among the Indians, who spoke their language well and had great influence among them, and who was with Powell's party in the summer of 1870 on the plateau north of the canyon, not far from the point where the three men had ascended from the river the year before. "They came upon the Indian village almost starved and exhausted with fatigue. They were supplied with food and put on their way to the settlements. Shortly after they had left, an Indian from the east side of the Colorado arrived at the village and told them about a number of miners having killed a squaw in a drunken brawl, and no doubt these were the men. No person had ever come down the canyon; that was impossible; they were trying to hide their guilt. . . . In this way he worked them into a great rage. They followed, surrounded the men in ambush and filled them full of arrows." Powell's comment on this pitiful story contains not a thought of revenge or even of punishment; he realized that primitive and advanced men do not think alike and he respected the Indians' idea of justice. "That night I slept in peace, although these murderers of my men, and their friends, the *U-in-ka-rets,* were sleeping not five hundred yards away. While we were gone to the cañon, the pack-train and supplies, enough to make an Indian rich beyond his wildest dreams, were all left in their charge and were all safe; not even a lump of sugar was pilfered by the children" (Colorado River, 130, 131). Some years later Powell explicitly stated his creed in this matter: "When I stand before the sacred fire in an Indian village and listen to the red man's philosophy, no anger stirs my blood. I love him as one of my kind" (Philosophical Bearings of Darwinism, Washington, 1882, p. 12).

Powell's interest in Indian customs and languages was at first combined with some attention to problems in the practical administration of Indian affairs; he was appointed by Congress in 1872 (?) a commissioner to examine the condition of certain tribes in the Far West, and his report, made jointly with G. W. Ingalls, was his first ethnological publication (1874). It was at this time that he discussed the "causes and remedies for the inevitable conflict that arises from the spread of civilization over a region previously inhabited by savages;" but in

his later studies the Indians, unmodified by contact with the whites, were his subject.

Secretary Henry, of the Smithsonian Institution, who had early given Powell encouragement and assistance in the direction of ethnology, was greatly impressed with the exploration of the Colorado, regarding the report upon which he later wrote: "The whole work will do honor to the appreciation by the Government of scientific information of this kind, as well as of the ability and perseverance of Professor Powell and his assistants." It was evidently on the basis of this good opinion that, after Powell had turned from geology to ethnology in the early '70's, much material collected by the Smithsonian Institution was placed in his hands: this included 670 Indian vocabularies which had previously been submitted to Trumbull, and it was upon this extended basis that Powell prepared his first "Introduction to the study of Indian languages" (1877), an enlarged edition of which was published three years later.

BUREAU OF ETHNOLOGY.

A natural consequence of all this was that, when the Bureau of Ethnology was organized by act of Congress in 1879, Powell was made its Director, a post which he held with great distinction for twenty-three years. He entered upon these duties with the expectation of devoting the rest of his life to them, for at that time he had given up all thought of continuing his geological studies; yet only two years later he was at the head of the Geological Survey, as has already been told. It is astonishing that he could, for a period of twelve years, so ably direct both these important organizations; it is natural enough that, after having resigned his place as Director of the Geological Survey in 1894, he should continue until the end of his life in charge of his other and less onerous duties. If the Bureau of Ethnology did not reach the ideal development that he had contemplated and hoped, it nevertheless gained a highly respected scientific position. It was administered at no great cost; the appropriations ran from $20,000 at the outset to $50,000 in the last year of Powell's administration; the appropriation bill sometimes contained the thrifty item that "not

exceeding one thousand dollars may be used for rent of building." The object of the Bureau, as defined in its reports, was the prosecution of research by the direct employment of scholars and specialists in the Bureau itself, and by the promotion of research by collaborators elsewhere through the country. As far as the general progress of ethnology was concerned, Powell's great service here, as in geology, lay in organizing a corps of experts, in providing opportunity for their steady work under good conditions, in directing their work wisely, and in securing assurance of fitting publication for their results. In the opinion of an experienced Washington official, Powell worked little less than a revolution in educating Congress to bring the trained scientific expert into Government research. Twenty-three large volumes of Annual Reports of the Bureau, issued under Powell's direction, mark an epoch in American ethnology. But besides organizing this important Bureau, Powell took a leading part in its work. He gave much thought for many years, as well as all the time that he could spare, to problems connected with the life and customs of the American Indian; his favorite subjects for essays and addresses were chosen from topics of the same nature and from the philosophical problems to which they led.

INDIAN LANGUAGES AND MYTHOLOGY.

Powell's attention was early turned to the speech of Indian tribes, because he felt that a knowledge of languages was fundamental in gaining an understanding of other and more important characteristics—namely, thoughts and acts as embodied in customs, institutions, and religions. An elaborate Bibliography of North American Philology was undertaken by his associate, Pilling, and Powell himself gave much time to the study of Indian tongues in the field and office; the monograph on Indian linguistic families, to which these studies led, is further considered below.

In the First Annual Report of the Bureau of Ethnology for 1879-1880 (1881) Powell's strong bent toward the treatment of problems in generalized form is indicated by his discussing so large a subject as the "Evolution of language" in an essay

that had previously served him as presidential address before the Anthropological Society of Washington in 1880. It treats the specialization of the grammatic processes, the differentiation of the parts of speech, and the integration of the sentence, and affords profitable reading for persons of classical training, because it opens up surprising possibilities in the way of linguistic structure to which the languages of Europe are strangers. "Many conditions and qualifications appear in the verb [of the Indian languages] which in English and other civilized languages appear as adverbs and adverbial phrases and clauses." Again, Indian verbs often express a larger meaning than we are accustomed to compress into a single word; thus "the English verb *to go* may be represented [in an Indian language] by a word signifying to go home; another, go away from home; another, go to a place other than home; . . . one, to go up; another, to go down; . . . another, go up a valley; another, go up a river." But "it is in the genders of the article pronouns that the greatest difficulty may be found. The student must entirely free his mind of the idea that gender is simply a distinction of sex. . . . Often by these genders all objects are classified by characteristics found in their attributes or supposed constitution. Thus we may have the animate and inanimate, one or both, divided into the standing, the sitting, and the lying; or they may be divided into the watery, the mushy, the earthy, the stony, the woody, and the fleshy."

The extracts quoted below indicate some of the chief conclusions reached, and at the same time point out Powell's practical view of linguistic evolution—a view as natural in a man of his surroundings and training as it would be unnatural in a graduate of Eton and Oxford. "It is worthy of remark," he writes, "that all paradigmatic inflection in a civilized tongue is a relic of its barbarous condition. When the parts of speech are fully differentiated and the process of placement fully specialized, so that the order of words in sentences has its full significance, no useful purpose is subserved by inflection" (p. 15). He insisted that inflection is not economical, because "the speaker is compelled, in the choice of a word to express his idea, to think of a multiplicity of things which have no con-

nection with that which he wishes to express" (16). Thus judged, "English stands alone in the highest rank; but as a written language, in the way in which its alphabet is used, the English has but emerged from a barbaric condition" (16). He later returns to the same topic: "Men with linguistic superstitions mourn the degeneracy of English, German, and French without being aware of the great improvement which has been made in them as instruments for the expression of thought" (20th Ann. Rept., 1898-1899, 1903, p. CLII). After reading these extracts it is hardly necessary to add that Powell was an advocate of the introduction of simplified spelling, for the distinction between its advocates and its opponents is almost wholly a matter of temperament, not of learning.

The First Annual Report of the Bureau also contains one of Powell's earliest philosophical essays, entitled "Sketch of the mythology of the North American Indians," which he had read as a vice-presidential address before a section of the American Association for the Advancement of Science in 1879, under the title of "Mythologic Philosophy." Its headings are: "The genesis of philosopy," "Two grand stages of philosophy," "Mythologic philosophy has four stages," and so on. From the second heading the following characteristic aphorism may be quoted: "The unknown known is the philosophy of savagery; the known unknown is the philosophy of civilization." And then comes an exclamatory apostrophe, as if in scorn of our self-sufficiency: "Ye men of science, ye wise fools, ye have discovered the law of gravity, but ye cannot tell what gravity is. But savagery has has a cause and a method for all things; nothing is left unexplained" (pp. 21, 22, 29).

SAVAGERY, BARBARISM, AND CIVILIZATION.

Powell's capacity to frame concise summaries of elaborate studies is well illustrated in a "brief characterization of savagery, barbarism, and civilization," in which he summarizes the chief points of his addresses on "From Savagery to Barbarism" and "From Barbarism to Civilization," and out of which the following extracts are taken, with some rearrangement: "The age of savagery is the age of stone; the age of barbarism is the age of clay; the age of civilization is the age

of iron. The age of savagery is the age of kinship clan, when maternal kinship is held most sacred; the age of barbarism is the age of kinship tribes, when paternal kinship is held most sacred; the age of civilization is the age of nations, when territorial boundaries are held most sacred. The age of savagery is the age of sentence words; the age of barbarism is the age of phrase words; the age of civilization the age of idea words. In savagery, music is only rhythm; in barbarism, it is rhythm and melody; in civilization, it is rhythm, melody and harmony. In savagery, picture-writings are used; in barbarism, hieroglyphics; in civilization, alphabets. In savagery, beast polytheism prevails; in barbarism, nature polytheism; in civilization, monotheism. In savagery, a wolf is an oracular god; in barbarism, it is a howling beast; in civilization, it is a connecting link in systematic zoölogy. In savagery, the powers of nature are feared as evil demons; in barbarism, the powers of nature are worshiped as gods; in civilization, the powers of nature are apprenticed servants. In savagery, men can only count; in barbarism, they have arithmetic; in civilization, they understand geometry. In savagery, the beasts are gods; in barbarism, the gods are men; in civilization, men are *as gods*, knowing good from evil" (From Barbarism to Civilization, Amer. Anthrop., I, 1888, pp. 97-123).

SYNTHETIC ESSAYS.

It should be borne in mind that Powell's adoption of a generalized or synthetic style of presentation for the articles here cited and for many others was by no means because he had no command of other styles. He was capable of writing admirable narrative, as was early shown in his famous report on the voyage through the Colorado Canyon. He could present a difficult problem argumentatively and with rare common sense, as is evident from his memorable Report on the Lands of the Arid Regions. He published in much detail the long stories and myths that he gathered with painstaking care from his Indian friends; he set forth in a carefully analyzed form the system of tribal government of the Wyandotte, and he had the patience and perseverance necessary for elaborate induction, as will appear when we consider his monograph on Indian lin-

guistic families. Yet his usual method of writing, especially in his later years, consisted in the synthetic exposition of large problems, without the citation of sources or the mention of particular instances, but with abundant imagery and seemingly overabundant reiteration. It may be well believed that pressure of work was in large measure responsible for these peculiarities of composition. 'He was ever ready to draw off a generous flood from his great reservoir of knowledge, but he had no time to trace the flood back to its spring of supply.'

Powell's liking for generalization had been early shown in his classification of valleys and in his treatment of the broad principle of the baselevel of erosion; but in these two problems he was dealing with inorganic factors, which behave in the same way the world over. In ethnological problems, on the other hand, no one continent affords a sufficient base for all-embracing conclusions of the kind that one frequently meets in Powell's essays; and hence a reader who did not look farther than the printed page might infer that the conclusions there stated were sometimes broader than their foundation. Such a misjudgment would, however, only show that Powell's synthetic style of presentation did not reflect his habitual method of investigation. Most of his essays give no direct indication of the extended observation and the abundant reading on which their conclusions rest, for Powell was a profound believer in the scientific method of investigation, which regards the observation of visible facts as the essential first step in the approach to theoretical inferences as to invisible facts, and which finds in frequent return to observation the only means of verifying the correctness of the theoretical inferences. He had a great confidence in the results thus gained and accepted their guidance wherever they led.

A reader of the synthetic essays may sometimes feel not only that their author does not adduce a sufficient number of facts for the support of the generalizations to which he rapidly rises, but that he not infrequently passes over from induction of generalizations to deduction of consequences from them without giving sufficient notice of his passage. For this reason his essays do not necessarily carry conviction to one who is uninformed of the "patient research by the rigorous methods

of science" that lay behind them. Evidently in such case the failure to carry conviction should not be charged to insufficient investigation on Powell's part, but rather to the condensed form of presentation which he was forced to adopt, alike by his many original ideas which called for expression, and by his many administrative duties that called for execution. The absence of citations may, furthermore, contribute to a feeling that some of his essays are too speculative, for in these modern days of international acquaintance it has become the fashion for an author to give the source and authority of every statement that lies outside of his own responsibility. But Powell did not read French or German, and his method of work did not allow him to follow this fashion, even if he had cared to, and he probably did not care to. He had learned his lesson, and it was the lesson, not the text-book, that interested him. Foot-notes and references to sources are wanting in nearly all of his publications; if he had attempted to cite authorities with any completeness, he would never have had time to finish his work. Hence when one of his addresses presents an evident inference in the form of an observed fact—for example: "The primary and principal source of disagreement among primitive men at the inception of organized society grew out of their desires for the possession of women" (Presidential Address, Outlines of Sociology, Anthrop. Soc. Wash., I, 1882, p. 116)—and cites no evidence in support of it, we must understand that the object for which the address was prepared made bibliographic completeness unnecessary, and that the conditions under which it was prepared made such completeness impossible.

Sometimes the inferential nature of adopted conclusions is more explicitly set forth, as in the following extracts regarding the primitive condition of mankind, which form a summary for several paragraphs of more detailed statement: "It will thus be seen that from the five great co-ordinate departments of anthropology, *i. e.*, from somatology, . . . technology, . . . sociology, . . . philology, . . . and philosophy, we arrive at the common conclusion that man was widely scattered throughout the earth at some early period in his history in a very low state of culture; that in such state he

utilized the materials at hand—the loose stones of the earth, the shells stranded on the shores, the broken trunks and branches of trees. . . . And we further discover that he was organized into small tribes, doubtless scattered by every bay and inlet of the seas, along the shores of all the inland lakes, and every bend of the great rivers, and on every creek of the habitable earth. . . . Arts, institutions, languages, and philosophies have therefore a vast multiplicity of origins, and in tracing the outlines of their history we trace the change from multiplicity toward unity" (Human Evolution, Trans. Anthrop. Soc. Wash., II, 1883, pp. 181-182). Even in this instance the last sentence falls into the more habitual form of assertion, although with little danger of being misunderstood because of the context.

It must, however, be recognized that in certain other cases the presentation of an inference in the guise of a fact is carried dangerously far. It is very probably true that "attitudes of the body developed into gestures, and sound-making into oral speech, and the active organs of language were specialized, and, finally, oral speech to a large extent superseded gesture speech;" and yet even if true, it is none the less an inference. One may agree that "each minute structure within the body is in part the same as the antecedent structure and in part changed therefrom by the force of impressions from without," and that "it is in this manner that impressions are recorded, so that the structure itself is a product of all coexistent and antecedent agencies;" but it is a long step then to assert, without qualification: "Out of this arises memory" (Human Evolution, Pres. Address, Anthrop. Soc. Wash., II, 1883, pp. 184, 187).

MANNERISMS.

Powell's independence and originality are seen not only in his novel treatment of scientific problems, but also in certain peculiarities of his style in writing. He had a marked liking for unusual words, such as "acculturation" and "intellection." He seemed to regard the adjective termination, -al, as superfluous; it is retained in the five-syllable adjective of the "United States Geological Survey" because the title of the

Survey was fixed by congressional enactment; but it is dropped from the "Geologic Atlas of the United States" and from the "geologic" and "paleontologic" branches of the Survey, although retained in the "physical" and "chemical" branches. We have already seen that he liked to cast geographical phrases in striking forms; other examples are: "The lightnings that flash athwart the sky," "the coal mine is but a pot of pickled sunbeams," and "then . . . the egg of poetry is laid." He was particularly fond of reiterating a standard phrase-form, in which changes are rung on a variable element: "It is a wonder that the blows of the hammer are transmuted into heat. It is a wonder that the motions of the ether can be transmuted into the rainbow. It is a wonder that the egg can be transmuted into the eagle. It is a wonder that the babe can be transmuted into the sage. It is a wonder that an objective blow can be transmuted into a subjective pain. It is a wonder that the vibrations of the air may be transmuted into melody. It is a wonder that the printed page may be transmuted into visions of the beautiful" (Human Evolution, Trans. Anthrop. Soc. Wash., II, p. 208). Reiteration of this kind can hardly have been selected as a thought-saving device, such as makes for the evolution of language; nor would it appear to possess seductive value whereby a reader's attention is enthralled instead of fatigued; it must be regarded as one of those mannerisms by which originality sometimes overreaches itself, for it turns attention to the phrasing rather than to the content of the phrasing.

VIEWS ON EVOLUTION.

Powell was inevitably an evolutionist, fully convinced of the gradual development of the existing order of things from an earlier order. He maintained, however, that organic evolution, as ordinarily understood, should be limited to progress in bodily organs and functions, and that human evolution is progress in culture, in which such phrases as the "struggle for existence" and "the survival of the fittest" have no application. Yet to natural evolutionary processes he ascribed the development of all mental qualities, with their marvelous progress from the lower to the higher, among which "the wonder of

wonders is the transfiguration of selfishness into love" (Human Evolution, Trans. Anthrop. Soc. Wash., II, 1883, p. 208).

He repeatedly returned to the insufficience of the struggle for existence in human development. "In anthropic combinations the units are men, and men at this stage are no longer passive objects, but active subjects, and instead of man being passively adapted to the environment, he adapts the environment to himself through his activities. This is the essential characteristic of anthropic evolution. Adaptation becomes active instead of passive. . . . It has been shown that man does not compete with the lower animals for existence. In like manner, man does not compete with man for existence; for, by the development of activities, men are interdependent in such a manner that the welfare of one depends upon the welfare of others; and as men discover that welfare must necessarily be mutual, egoism is transmitted into altruism, and moral sentiments are developed which become the guiding principle of mankind. So morality repeals the law of the survival of the fittest in the struggle for existence, and man is thus immeasurably superior to the beast. In animal evolution many are sacrified for the benefit of the few. Among mankind the welfare of one depends upon the welfare of all, because interdependence has been established" (The three Methods of Evolution, Bull. Phil. Soc. Wash., VI, 1883, XLVIII, L). Again: "The struggle for existence between human individuals is murder, and the best are not selected thereby. The struggle for existence between bodies of men is warfare, and the best are not selected thereby. The law of natural selection, which Darwin and a host of others have so clearly pointed out as the means by which the progress of animals and plants has been secured, cannot be relied upon to secure the progress of mankind. . . . There are always too many plants born. . . . There are always too many animals born. . . . There are not too many human beings born into the world in lands of the highest civilization, because the earth is not now and never has been filled with men to the limit of its capacity; the great majority are not, therefore, killed off in the struggle for existence, and there is not a small remnant of the best preserved to continue human existence

and secure human progress" (Competition as a Factor in Human Evolution, Amer. Anthropol., I, 1888, pp. 303-304).

He continues to insist on this point: "When, during late years, the processes and methods of biotic evolution were clearly set forth by a host of biologists, and the theories successfully applied to all biologic sciences, it was discovered as inevitable that the same laws must apply to man as an animal. But their application was carried beyond the limits of truth. Man, as a being superior to the lower animals, was supposed to have made progress by the same laws—by the survival of the fittest. No error in philosophy could be more disastrous. And yet this statement is widely accepted. . . . In the anthropic kingdom . . . evolution of arts is by invention and the selection of the labor-saving. Evolution of institutions is by invention and the selection of the just. Evolution of language is by invention and the selection of the thought-saving. Evolution of opinions is by invention and selection of the true" (Human Evolution, Trans. Anthrop. Soc. Wash., II, 1883, p. 207). "The laws of biotic evolution do not apply to mankind. There are men in the world so overwhelmed with the grandeur and truth of biotic evolution that they actually believe that man is but a two-legged beast whose progress in the world is governed by the same laws as the progress of the serpent or the wolf; and so science is put to shame. . . . That which makes men more than beast is culture. Culture is human evolution—not the development of man as an animal, but the evolution of the human attributes of man. Culture is the product of human endeavor. . . . The old grows into the new, . . . not by natural selection, but by human selection" (Proc. Amer. Assoc. Adv. Sci., XXXVIII, 1889, pp. 4, 5).

EVOLUTION OF MUSIC.

In illustration of Powell's mature style, we might select either one of the two addresses before the Anthropological Society of Washington already referred to, one being entitled "From Savagery to Barbarism" (1885) and the other "From Barbarism to Civilization" (1886); but there is another address which exhibits even better his mannerism along with his manner; this is the address on "The Evolution of Music from

Dance to Symphony," which he prepared in 1889 at the mature age of fifty-five years for delivery on as important a public occasion as arrives in the life of an American scientist—namely, on his serving as president of the American Association for the Advancement of Science. In his constrained absence from the meeting of the Association at Toronto, the address was read by his loyal representative, G. K. Gilbert.

The theme of this address was the simple one that "Music . . . becomes by minute increments"—that is, it grows, it evolves. Such a subject might have been presented in the historic order of the discoveries on which the general conclusion is based, with abundant citation of specific examples. Indeed, this order of statement was adopted a few years later by Langley, when he, from the same chair, told in a most charming manner "The History of a Doctrine." Powell's method was altogether different. As usual, he gave no reference to authorities; he did not mention the name of any worker in his field; nor, for that matter, did he present the subject as his own. He marshalled facts and inferences in such order as pleased him for his own purpose, gathering them from the work of other students everywhere. Their variety so evidently exceeded the reach of one observer that it sufficed merely to refer them to "the labors of an army of patient, earnest, keen-visioned investigators." One of the mannerisms of the address was the introduction of long series of similar statements, after the fashion already indicated, apparently with the intention of re-enforcing the lesson that he wished to teach. Thus, in order to emphasize the varied conditions under which savages dance and chant, he wrote: "At the foot of the glaciers they have their homes, and walls of ice echo their chants; by mountain crags they have their homes, and the rocks echo their chants; in valleys they have their homes, and the savannas are filled with their chants; in tropical forests they have their homes, and 'the sounding aisles of the dim woods' ring with their chants." Some of his hearers may have been confused with his abundance of rhetoric; yet such was the richness of his subject that he could not make a short story of it. His beginning is very simple, as if to encourage his hearers; the opening sentence is: "A blue egg may become

a robin;" but in setting forth certain fundamental principles on the second page, he does not hesitate to write: "The third law in biotic evolution is denominated progress in heterogeneity," a statement which probably left some of his hearers behind.

After explaining that musical inventions, but not musicians, show a survival of the fittest, he turns to the adaptation of music to environment: "There is music for the dance and for the battle; music for the wedding and the funeral; music for the theater and the temple, and there is music about everything: the land, the sea, and the air, the valley and the mountain, the flower and the forest, the fountain and the river, the worm and the serpent, the zephyr and the tempest"—thus lavishing instances to the point of redundancy, as if overwhelmed with the wealth of his theme. He next points out that music is one of various arts, each of which was developed from a germ of another nature: "Fetich carving was the germ of sculpture. . . . Picture writing was the germ of painting. . . . Mythology was the germ of the drama. . . . The dance was the germ of music and poetry;" and then, as "sculpture represents material forms in solid matter," and "romance represents biography and history in fictitious tales," so "music represents ideas in sound, by rhythm, melody, harmony, and symphony;" and he thus prepares the way for the question: "How does music grow?" Some have thought it began as a "spontaneous outburst of the human soul in response to the music of the physical and animal world—the sighing of the winds, the murmur of the rills, the roaring of the cataracts, the dash of the waves on the shore, the singing of the forests, the melodies of the birds." Not so. "The objective study of music among the lower tribes of mankind, and among the various people of the world in different stages of culture, . . . leads to a different conclusion." Here the significant words, "objective study," must be dwelt upon; the motive that they suggest is altogether different from that at first suggested by their context, much of which is phrased in so exuberant a style and with such a surfeit of imagined illustrations in place of specific facts that many a hearer might have taken the whole for a flight of fancy unless these calmer words

"objective study," caught his attention, and led him to perceive that all the imagined illustrations are merely the generalized form of abundant observations.

Although the actual origin of music has nowhere been observed, the "objective study" of the kinds of music found today among primitive people leads inductively to a safe generalization, from which the origin of music in the unobserved past may be reasonably inferred. It began and long continued as a vocal chant, in which the rhythm of sound was adapted to the rhythm of motion in the dance. The chant was at first very simple, but in time the drama came to assist in the development of more varied form. The savage deifies the beast; the stories of animal-gods are dramatized, and the lives that they live are imitated. The eagle "plays among the clouds, rests on the mountain tops, and soars down to circle over the waves of the sea. The humming-bird poises over its blossom cup of nectar like a winged spirit of the rainbow. The deer bounds away through the forest and leaves the hunter lost in amazement. The squirrel climbs the tree and plays about among its branches, and springs from limb to limb and tree to tree, and laughs at the sport. The rattlesnake glides without feet over the rocks, and in his mouth the spirit of death is concealed. The trout lives in the water, and flies up the brook as the hawk flies up the mountain. Dolphins play on the waves as children play on the grass. The spider spins a gossamer web; the grub is transferred into a winged beauty; the bee lays away stores of honey; the butterfly sports in the sunshine like a flower unchained from its stem. The air, the earth, and the waters are peopled with marvelous beings."

At first the human voice chanted alone; then through long ages of savagery and barbarism the chant and the song that grew from it had, for instrumental accompaniment, only the unmusical noise of time markers or "thumpers" of many kinds: instruments of sweet sound are comparatively modern. They came recently, when increasing knowledge of many things led to a contemplation and an understanding of nature. "The human reason has acquired a knowledge of the universe and derived exalted emotions therefrom. The boundless sea now tells its story. From arctic and antarctic lands navies of

icebergs forever sail, to be defeated and overwhelmed by the hot winds of the tropics. The lands with happy valleys and majestic mountains rise from the sea, built by the waves and fashioned by fire and storm. Over all rests the ambient air, moving gently in breezes, rushing madly in winds, and hurling its storms against the hills and mountains of the sea and the hills and mountains of the land. . . . Looking above the earth, the worlds of the universe are presented to view, and their wonders fill the soul. So music has come to be the language of the emotions kindled by the glories of the universe." But this part of the address confessedly advances too rapidly. The higher phases of modern music are European, and Europe, with its civilized peoples, is a part of the world in which Powell was not at home, as he was in the Great West with its savages. It is doubtless true that "as the blue egg becomes a robin, . . . so 'ring-around-a-rosy' becomes a symphony," but the last stages of this evolutionary becoming need another author for their analysis.

INDUCTIVE STUDIES

In contrast to this rhapsodic address, with its imagined examples, its redundant and sometimes extravagant phrasing, and its synthetic treatment, it is desirable to make reference to Powell's inductive work, which is couched in much simpler style. An early example of this kind, already mentioned, is found in an article on "Wyandot government: a short study of tribal society" (First Ann. Rept. Bureau Ethnology, 1881, pp. 59-69); this is a purely objective study of the subdivision of a group of Indians into gentes and phratries, of their method of choosing councillor and chiefs, and of the functions of their civil and military government. It is practically free from inferences and theories of origin, except in a page or two of general remarks clearly separated from the pages of more inductive treatment. Much of Powell's fundamental work seems to have been of this safe kind, but its statement was usually elided in his synthetic addresses.

INDIAN LINGUISTIC FAMILIES.

Assuredly, one of the most important inductive contributions of the Bureau of Ethnology to science is the monograph on "Indian linguistic families," which, with the accompanying map of North America, exclusive of Mexico, was published in the Seventh Annual Report of the Bureau of Ethnology (1891). The idea of such a monograph, accompanied by a linguistic map, had been in Powell's mind for many years, but, owing to the pressure of his manifold duties, its final planning and execution was intrusted to his associate, Mr. H. W. Henshaw, then in charge of the Bureau under him. Gallatin had published a North American linguistic map in 1836; but the Bureau map was based on a much larger body of material, and followed Powell's own idea of lexic, not grammatic, classification—that is, linguistic relationship was determined for the Indian languages by similarities between single words, not by resemblances in the construction of genders and tenses. This treatment was adopted because word-roots were believed to be the most permanent elements of language, while grammatic structure is but a changing phase. Indian languages to the number of several hundred thus analyzed and compared were grouped in stocks or families, the members of each of which show fundamental lexic similarities believed to be inherited from a common ancestral speech, while the different stocks show no relationship whatever. During the long progress of this work some languages were set apart which had at first been placed together, and others were brought together after having been at first separated; but in the end no fewer than fifty-eight stocks were distinguished, all fundamentally different, not as French is from German, but as French and German are from Arabic and Hebrew; for each stock includes a group of languages, and the languages of some stocks are as diverse as the Indo-European tongues. The areas occupied by the stocks in their primitive distribution are represented by colors on the map, and the results thus graphically shown are very striking. First to be noted is the rarity of intermixed or fragmentary color areas; second is the extraordinary contrast between the great extent of the areas of the Algonquian and

Athabascan stocks and the small-scale patchwork of the stocks in the Coast ranges of California. While neither Powell nor his associates regarded the map as final, it was accepted as a sufficient base for several important inferences, among them that the aboriginal tribes had long been sedentary and not nomadic, as some ethnologists have supposed, for if nomadic the linguistic areas should show more overlapping and intermingling than is actually the case. It is only in view of this conclusion that the small areas of the California stocks can be understood, and even then it cannot be understood easily; for however sedentary the tribes of northern California have been, it is difficult indeed to believe that they represent complete linguistic independence in closely contiguous areas of moderate relief, without resemblances by inheritance or by short-distance intermixture. Recent studies indeed suggest that a way out of this quandary may be found by grouping together certain stocks which Powell regarded as wholly independent; but whatever changes may be made in the original map, it was a great contribution to the science of American linguistics.

PHILOSOPHICAL STUDIES.

Powell's interest in philosophical studies was early developed and long continued; as one of his friends said: "He drank deep at the perennial fount of classic philosophy . . . and had constant reference to the courses followed by the pioneers of definite thought about the east shore of the Mediterranean." It is therefore interesting to quote his three definitions of this elusive subject written in the early '80's. "Philosophy is the explanation of the phenomena of the universe" (Philosophical Bearings of Darwinism, Washington, 1882); "Philosophy is the science of opinion" (Three Methods of Evolution, Bull. Phil. Soc. Wash., VI, 1883, p. xxx); and "A philosophy is a system of opinions concerning the phenomena of the universe, which the people entertaining such opinions have observed" (Human Evolution, Trans. Anthrop. Soc. Wash., II, 1883, p. 181). How significant it is that the emphasis is shifted from the objective phenomena of the universe in the first definition to the subjective science of opinion in the second, and that the single science of opinion suggested in the

second definition should be replaced by an implied multitude of such sciences in the third!

Powell's epigrammatic rendering of the contrast between the philosophies of savagery and civilization have already been quoted. He naturally found little value in metaphysics, which he rightly viewed as the very opposite of science, and hence erroneous. "The error of the metaphysic philosophy," he said, "was the assumption that the great truths (or "major propositions") were already known by mankind, and that by the proper use of the logical machine all minor truths could be discovered and all errors eliminated from philosophy." On the contrary: "It is found that in the course of the evolution of mind minor propositions are discovered first, and major propositions are reached only by the combination of minor propositions; that always in the search for truth the minor proposition comes first, and that no major proposition can ever be accepted until the minor propositions included therein have been demonstrated. . . . As the metaphysic methods of reasoning were wrong, metaphysic philosophies were false; the body of metaphysic philosophy is a phantasmagoria" (The Philosophic Bearings of Darwinism, p. 6).

During the earlier years in which these passages were written, Powell's philosophical studies were subordinate to his work in ethnology. In later years philosophy came to have a more dominant interest, and at times so fully occupied his thoughts that in a lecture of apparent ethnological content, as indicated by its title, "Relation of primitive people to environment, illustrated by American examples" (Smithsonian Institution, Report 1895, pp. 625-637), he devoted a good share of his hour to an abstract consideration of the difference between "quality" and "property." It was in these later years that he sought, as others had done before him, to establish a fully logical foundation for mechanics, and reached the conclusion that motion, either molar or molecular, is constant in quantity, but may be deflected in direction; but his use of words in this connection was sometimes such that it was not easy to follow his meaning; he wrote, for example: "When motion becomes energy, then speed becomes inertia, and path becomes velocity;" and "When time becomes causation, then persistence becomes

state, and change becomes event" (Bureau of Ethnol., 19th Ann. Rep., 1900, pp. LVI, LVII). In another direction, he went so far as to conceive consciousness as one of the primary attributes of the particle: it would seem here as if, in the effort to know the unknown, he had reverted from the philosophy of civilization to that of savagery; it is indeed curious to find that one long practiced in observational sciences, and who had years before recognized the necessarily large subjective element in all philosophies, should at last persuade himself that, in a matter so recondite as the primary attributes of the particle, his mental concepts were really the true counterparts of external nature, from however much cogitation they had sprung.

PENTALOGIC SERIES.

During the eight years that elapsed between Powell's resignation from the directorship of the Geological Survey in 1894 and his death in 1902, a subject that attracted him greatly was the study of human activities—familiar matters for the most part, so that his explicit statement of them sometimes seemed like the unnecessary formulation of the common-place—but his object here must have been to bring even familiar matters to conscious attention, and to discover in them their essential and wonderful nature, especially wonderful when they are viewed as products of long-continued evolution. It was as if Powell wished to arouse us from our indifference to everyday affairs, and to place them objectively in the great procession of the world's march, with all the dignity belonging to their ancient origin. Such seem to be the motives underlying his study of the "pentalogic series of human activities," in which he classed everything connected with man's "pleasures, industries, institutions, languages, and opinions." He saw that the study of these activities gave rise to five sciences, "esthetology, technology, sociology, philology, and sophiology," each of which is again divided; for example, sophiology, or the science of instruction, contains five arts—"nurture, oratory, education, publication, and research." So fully was Powell convinced of the value of his pentalogic scheme, that for a time his administrative reports on the investigations conducted

in the Bureau of Ethnology were divided according to it, although this required the division of one man's work under different headings.

TRUTH AND ERROR.

Reflection upon these broad subjects seems to have developed the ambition to systematize all accumulated knowledge and philosophies, from those of the savage and lower barbarian to those of the modern scientific world, thus "framing a cosmic compendium at once broader and simpler than any previously conceived." He was in this way carried from the concrete study of human races to the more and more abstract study of human thought. The field that he sought to cover was more extensive than any that he had previously cultivated, and it is to be questioned whether so vast an ambition was not less a sign of continued strength than of approaching weakness. He planned to arrange the entire content of knowledge in a system of three parts, the first to deal with Nature, the second with Man, and the third with Mind; and with a view to giving his results a "general, and hence permanent, character, the work was given the form of a trilogy," and was "modeled after artistic rather than technical standards." The first part of this heavy undertaking was published under the title of "Truth and Error; or, the science of intellection" (1898); the second part appeared in a series of papers in the American Anthropologist, having for titles the names of the pentalogic series given above, and designed for reprinting with additions under the name of "Good and Evil." The third part was left unfinished.

A devotedly loyal disciple of Powell's says of this work: "The breadth and depth of its foundations were little realized by co-workers, still less by the critics of the preliminary essays; indeed, the modesty of the author seldom permitted him to see in its full magnitude the mighty task to which he was impelled by the same powerful instinct that inspired his military and exploratory efforts;" but the same disciple went so far in eulogizing his master that we must prefer the estimate of another of Powell's intimates, a man of more even

balance, who formed his judgment without overweight of admiration, and who wrote of his friend: "His philosophic writings belong to a field in which thought has ever found language inadequate, and are for the present, so far as may be judged from reviews of 'Truth and Error,' largely misunderstood. Admitting myself to be one of those who fail to understand much of his philosophy, I do not therefore condemn it as worthless, for in other fields of his thought events have proved that he was not visionary, but merely in advance of his time."

It is sad to close the record of an earnest life with an account of plans unfinished and unfinishable, rather than with a record of labors brought to a well-rounded close; it is sadder still to follow a leader to a point where his leading is not followed—where his latest thoughts, instead of remaining the inspiration and foundation of new studies, are passed over in silence by the generation that follows him. But for these reflections there are two consolations: one is the contemplation of the great and enduring work that the leader accomplished in years of fuller strength, and of that some record is here set forth; the other is the loving memory in which he is held by his many friends. Two of these may here speak, as they did at a meeting commemorative of Powell's services, held under the auspices of the Washington Academy of Sciences on February 16, 1903.

PERSONAL ESTIMATES.

Powell's long-time friend and trusted fellow-worker, G. K. Gilbert, from whose address the last preceding quotation is taken, said also: "The glow of his enthusiasm, the illumination of his broad philosophy, the warmth of his friendship, are still with us, and we should be either more or less than human to divest ourselves so soon of the influence of his inspiring personality. It was through this personality, too, that he accomplished much of his work for science. Gathering about him the ablest men he could secure, he was yet always the intellectual leader, and few of his colleagues could withstand the influence of his master mind. Phenomenally fertile in ideas, he was absolutely free in their communication, with the result

that many of his suggestions—a number which never can be known—were unconsciously appropriated by his associates and incorporated in their published results. . . . The scientific product which he directly and indirectly inspired may equal, or even exceed, that which stands in his own name."

The Secretary of the Smithsonian Institution, S. P. Langley, spoke of Powell in part as follows: "Wherever I have been with him, in whatever surroundings, I think I have been more impressed with the simplicity and self-comprised nature of his character than even with the complexity of his knowledge and achievement. He was to me not so much one of the common figures of daily life, as one of Plutarch's men. . . . Sincere he was, and truthful to the point of being unable to bring himself to hint the thing which is not, nor even to allow the shadow of deceit in his ways. Such sincerity existing in his own heart, begat a confidence in others which did not always meet its just return. . . . He was a generous man, kind to others and helpful; a combative and a brave, and always a self-contained man, who found in himself counsel sufficient for his need. . . . He was a truthful and steadfast man, and one who never deserted a friend."

Powell died at his summer home at Haven, Maine, on September 23, 1902, in his sixty-ninth year.