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JOHN WESLEY POWELL: FRONTIERSMAN OF SCIENCE

Paul Meadows
University of Nebraska - Lincoln

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PAUL MEADOWS

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July 1952

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JOHN WESLEY POWELL: FRONTIERSMAN OF SCIENCE

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PAUL MEADOWS

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THE UNIVERSITY OF NEBRASKA

TO

MICHAEL AND PETER

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PREFACE

I should explain that this book is more or less an accident. It started with a suggestion by my friend and former colleague, the late Joseph Kinsey Howard, that the Major was worth knowing. A Montana newspaperman and writer, Howard had been impressed by the amazing far-sightedness of Powell's report, published in 1878, on the arid lands of the West. At the time I was preparing a report of my own for a Rockefeller Foundation research project in the humanities. Upon reading the Major's study of the arid lands, it occurred to me that it would be profitable to review all his materials from the point of view of American regionalism.

I quickly found that the Major was no mere regionalist, that he had been in a relatively short space of time an explorer, geologist, anthropologist, administrator, and philosopher. At the time of his death in 1902 there were already a number of enduring monuments to his memory: a half-dozen outstanding scholarly studies, a host of scientific and philosophic articles, the establishment and directorship for twenty-three years of the Bureau of American Ethnology, and a masterful record as Director for thirteen formative years of the U. S. Geological Survey. Besides all this, there was his conquest of the Grand Canyon of the Colorado. This one-armed Civil War veteran was, I discovered, an important though almost forgotten figure. The Major grew on me, just as he must have grown on his colleagues in those eventful years in American science and public policy.

John Wesley Powell belonged to the westward expansion of America. He helped explore and survey it. He assisted in the shaping of public policy for the western lands. He was a pioneer in the promotion and use of scientific research by government. He was, physically and intellectually, a frontiersman of the American scene. His mind was wide-ranging and generalizing, relating many fields of human knowledge: a mind such as we find in the writings of Herbert Spencer (whom he disliked and distrusted) or Lester F. Ward (whom he admired). The Major does not deserve the obscurity which the half-century since his death has brought him. For a quarter of a century Powell was vigorously at work on many fronts, discovering, advising, administering, encouraging, protesting. Like many others of his day,

he was a self-made man whose scholarly achievements were recognized and honored by national and international professional associations and great institutions. No history of the public lands, of American geology, of American ethnology, of American adventure can be complete without him.

This book is primarily a study of the intellectual life of the man. Wherever and as often as possible in these pages Powell speaks for himself, or is seen through the eyes of his contemporaries. This ambition will, I hope, explain and excuse what is otherwise an inexcusable fault, the extensive quotations appearing in the text.

I regret that the present study of Powell was completed before the publication of William Culp Darrah's full-length and invaluable biography, *Powell of the Colorado* (Princeton University Press, 1951). In what will quite probably be the definitive biography of the man, Darrah relates with abundant documentation ("nearly 6,000 items of Powelliana") "the story of a man who enjoyed everything he did with boundless energy and insatiable curiosity." I have been content with the lesser goal of recounting Powell's work as a scientific trapper, as a restless and gifted frontiersman of American science.

I should like to acknowledge with gratitude the assistance in the form of travel grants and research time made available for purposes of this study by the Research Council of the University of Nebraska. These grants made possible visits to Powell's old home town, Bloomington, an examination of the Powell Collection at Illinois State Normal University, and a review of the manuscript and other materials at the Library of Congress and the Smithsonian Institution.

PAUL MEADOWS

Lincoln, Nebraska
April 5, 1951

Chapter I

THE MAJOR IS A MANY-SIDED MAN

1.

Frontier Odyssey

"On the 25th of May," wrote Lester F. Ward, "I had a long interview with the Major." It was 1881, and Major John Wesley Powell had recently been appointed Director of the new U. S. Geological Survey, succeeding Clarence King. Writing his impressions of the interview, Ward observed that the Major's life belonged to "the pattern of the American self-made man." [1]

Born in New York in 1834 and reared in Ohio, Wisconsin and Illinois, this son of an itinerant Methodist farmer-preacher received only fragmentary schooling: a few months at Oberlin, Illinois, and Wheaton colleges. Degreeless, he climbed to the top in a field whose outstanding men could boast of the best training. Indeed, most of his colleagues and subordinates in later years had been superbly trained: King at Yale, Emmons at *École des Mines,* the Hague brothers at Göttingen and Heidelberg, Hilgard at *Bergakademie* in Freiburg. The answer seems to lie, in part, in the personality of the Major: a driving, restless energy, a genius for systematization, a lively curiosity, a remarkable skill for encouraging and cultivating people, and a courage not always wise but never unprofitable. The answer seems to lie, in part, in the times: a great war and its inevitable aftermath of reconstruction, a nation pouring westward, a paucity of trained men, and a government fortunately though grudgingly investing in the talent and eagerness of its small corps of scientists.

A part of the Major's remarkable story is a river, the dangerous and then unkown Colorado. More than anything else it was a river which made the Major famous and which even to this day most frequently recalls his name. Powell's voyages through the Grand Canyon of the Colorado caught the public's attention, compelled many an unwilling Congressman in later years, and commanded the devotion of many a colleague in science. *Ka'-pu-rats*—"old arm off" as the Utes and Shoshones called him—rolled and bounced down a river to fame.

Over a quarter of a century after he emerged from the Canyon, a

group of American scientists, members of the Washington Academy of Sciences, met in a memorial session, six months after Powell's death. Said Charles D. Walcott, Director of the Geological Survey and president of the Academy: "We have come together tonight to honor the memory of John Wesley Powell, soldier, teacher, explorer, geologist, anthropologist, organizer and administrator of institutions, and a broad-minded, kindly natured man. He became distinguished both as a direct, personal contributor to science and administrator of organizations which have made and will continue to make large contributions to knowledge." [2] In similar vein, folklorist Alexander Chamberlain wrote of Powell: "Investigator, teacher, soldier, geologist, anthropologist, philosopher, the genius of the man dwelt within no limited bounds." [3] It was a long haul from Washington to the Illinois prairies where a self-taught farm boy spent his spare time botanizing in the fields and paid for his meager training from equally meager earnings as a teacher in one-room schools. But he was able to create among American scientists and statesmen a vast indebtedness to a maimed and sick veteran of "bloody Shiloh."

"John Wesley Powell," wrote W. M. Davis, in a memoir for the National Academy of Sciences, "was in more senses than one a scientific frontiersman." [4] To begin with, he belonged to the geographical frontier, the rapidly filling and mobile West.

2.

APPROACH THROUGH NATURAL HISTORY

Joseph and Mary Dean Powell were born in England. The family was Welsh and English. "My grandfather," wrote John Wesley, in response to an inquiry from a Powell family in Pennsylvania, "was George Powell who I think was born in the parish of Reabon, county of Denbigh, North Wales. I have many distant relatives in Wales by the name of Powell and some also in England." [5] Joseph, who had been a licensed exhorter in the Wesleyan Church in England, continued his activities upon arrival in the United States. Finding himself in opposition to slavery, he quickly joined the newly organized Wesleyan Methodist church and became an ordained minister. John Wesley was born March 24, 1834 in Mount Morris, New York, where the family lived until 1839. His father's itinerant ministry took the family first to Jackson, Ohio and thence in 1846 to South Grove, Wis-

consin. Another move brought them to northern Illinois, to Bonus Prairie, Boone County.

In his father's frequent absences John Wesley became increasingly responsible for the management of the farm. Very early he developed an interest in shell and rock collection, along with the parentally required study of the Bible. His father's anti-slavery sympathies had brought the family in contact with a number of outstanding figures in Ohio: among them, Salmon P. Chase, Joshua R. Giddings, and faculty members of Oberlin College. However, perhaps the most formative influence on Powell's life in this early period was a man named Crookham, whom he met while the family lived in Wisconsin.

Crookham, described as "a man of some means," lived on a farm near the Powells. He had retired from business, was then an old man, was reputed to be a great scholar.[6] On his farm he built two large log-houses, one a library, museum and laboratory, the other a schoolhouse. As the son of an abolitionist, John Wesley, so his parents thought, could not safely attend school. So Crookham proposed to the boy's father: "Great Britain, I will take the boy and make a scholar of him." "Mr. Crookham," reports an early biographer of Powell, "took great pains to direct his reading." Historical works loomed large, alternating with nature study walks and talks and examination of items collected for the museum.

Powell's reading continued after the family moved to Illinois. Some twelve to fifteen trips a year into town had to be made, carrying produce; the round trip required almost a week. "On these trips," according to Mrs. Lincoln, "he reread Hume's *History of England,* Gibbon's *Rome,* a history of the United States, Dick's *Philosophy* and some works in Mental Philosophy."[7] There was, of course, the inevitable Bunyan.

In 1852 Powell decided to go to college. He spent six weeks poring over grammar, arithmetic and geography. He was hired to teach a country school some thirty miles away, at Jefferson Prairie. On his own time he lectured one night a week to his most advanced students, studied elementary algebra and went through three or four grammars. In 1853 he enrolled at the new Wesleyan Methodist College at Wheaton. The following year he taught school in Macon County. After a business venture in the spring of 1855 with his brother-in-law, he enrolled at Illinois College, studying Latin and Greek, reviewing trigonometry, and attending lectures in chemistry. He decided to return to

Wheaton the next fall, but an idle winter term made it necessary for him to study alone.

In 1857, in order that he might "enjoy a theological atmosphere," his father sent him to Oberlin. But it was botany that caught his fancy. He organized a group of botany students, and they constructed an almost complete herbarium of the county. Mr. Carlos A. Kenaston, of the class of '61, remembered Powell from those days. "It was our practice to meet almost daily, at eleven o'clock, after morning recitations, in his room for the purpose of reading Bailey's *Festus,* then being first published." [8]

After the year in Oberlin, Powell followed his nature study impulses by spending all his money on an Ohio River trip that took him from Pittsburgh to Cairo. He worked his way up through the Iron Mountain country near St. Louis. Returning home, he set out again on a boat trip that carried him down the Illinois River to its mouth and then up the Des Moines. Coming back broke, he secured a teaching job in Hennepin, Illinois in the fall of 1859, working on the side in an investigation of the geology of Hennepin County. Hearing about the newly organized Illinois Natural History Society, he promptly joined and just as promptly became its secretary. The Society was conducting a natural history survey of the state. Powell was assigned the department of conchology.

Whether he knew it at the time or not, Powell had hit upon the pattern of his life. Rivers and rocks and plants were to claim a good deal of his time from then on. He had on his own made the leap from history to natural history, and though the latter was by that time a spent force in the East,[9] the men in the West did not know it. The second half of his life was to be devoted to the pursuit of some phase of natural history, or some derivative of it.

3.

RECOURSE TO ARMS

The abolitionist activities of his father had made the younger Powell very much aware of the approaching conflict. A lecture tour into some of the southern states late in 1860 convinced him that war was impending. Returning to his Hennepin job, he spent the rest of the winter in a study of military science and engineering. When the 20th Illinois Infantry Volunteers was organized in May, 1861, Powell rode over and joined. He was made a sergeant-major of the regiment

and was soon promoted to Second Lieutenant. He made a hurried trip to Chicago and came back with a box of books on military science. December 11th he was commissioned captain of Battery F of the Second Illinois Light Artillery Volunteers and in March was ordered to Tennessee. A month later, Powell, by then a major, was fighting at Shiloh, where he lost his right arm. A hasty amputation made a second operation necessary: he was left with a mere stump below the elbow joint, a bit of field surgery that caused him pain for the next thirty years. He finally found some relief through an operation at Johns Hopkins.

His services after Shiloh were varied. Years later General David B. Henderson summarized them at the memorial meeting in Washington. "From June 19 to July 4, 1863, Powell took a conspicuous part in the siege of Vicksburg, from February 3 to March 6, 1864, he was with an expedition to Meridian, Mississippi; and from September 19 to November 31, 1864, he took part in the campaign in northern Georgia and northern Alabama." [10] An interesting experience which the General omitted was Powell's assignment for six months to organize a regiment of Negroes. He left this duty to return to his beloved artillery, for he was commanding officer of the artillery brigade of the Seventeenth Army Corps.

After the fall of Atlanta he was sent back to join General Thomas' staff in the battle of Nashville. At Christmas 1864 he was directed to return to Springfield to attend to the re-organization of his regiment. Less than two weeks later he handed in a request to be mustered out.

It is difficult to assess the meaning of the Civil War to Powell. In a letter to a friend, written much later, he said: "It was a great thing to destroy slavery, but the integrity of the Union was of no less importance: and on and beyond it all, was to be counted the result of the war as an influence which should extend far into the future. . . . " [11] Powell had been offered a commission as a colonel in the regular army, but he declined in favor of his old interests. Indeed, even during the war he afforded much amusement to his men by the manner in which he would conduct forays of his own into the countryside, collecting plants and rocks, studying the geology of the terrain.

The war experience itself stamped a great many qualities on the Major. Years later the command role would be useful in organizing river expeditions, in running a couple of government research agencies, in pushing for funds for research. His friendship with Grant and Sherman he was able to put to good use. Yet others were not so

charitable or influenced. The Major could easily become the old war horse, driving and urging and barking in situations where the military mode was unfamiliar and distasteful. The sore arm was a constant irritation, making him ill-tempered and restless. However, one slight gesture which suggests a great deal about his feelings and personality was the Major's habit in later years of sending, as an act of good-will, a right-hand glove to Colonel C. E. Hooker. That Confederate officer had lost his left arm at Shiloh. An exchange of gloves took place between the two men for years. In the files of the Bureau of Ethnology in Washington there is a letter written by the Major to J. J. Snodgrass, Quartermaster, dated May 2, 1891. It is a request that his name be dropped from the rolls of the John A. Logan's Command No. 2, Union Veterans' Union. "It is unwise to continue the organization of different societies among the Union soldiers who are survivors of the Civil War, and thus perpetuate distinctions among men, all of whom were impelled to serve their country through patriotism."

4.

POWELL AT NORMAL AND POINTS WEST

"All persons," reads an announcement in the Bloomington (Ill.) *Daily Pantagraph* for November 16, 1865, "favorable to the formation of a Natural History Society, will meet in Dr. C. R. Parke's office this Thursday evening, at 7 o'clock. The object is for forming a Local Society in the city of Bloomington, to meet as often as is convenient for the members, and act in concert with the State Natural History Society." [12] The notice is signed by R. Holder, J. W. Powell, and C. R. Parke. Powell was not only back from the war, he was back in his pre-war pattern of botanizing, collecting, and teaching.

During the war, shortly before Shiloh, Powell had managed to secure a leave, had gone to Detroit, and had brought back with him his cousin, Miss Emma Dean, as his bride. They had left for Wheaton after his discharge, had turned down a promising business opportunity, and had come to Bloomington, where the Major had accepted a post as professor of geology at Illinois Wesleyan University. A year later he moved to neighboring Normal, where in addition to teaching at the State Normal University he was museum curator. The Major was now in his element.

The work of collecting continued apace. A story in the January 25, 1868 edition of the *Daily Pantagraph,* evidently emanating from the

local Natural History Society, announced: "Additions made the last year exceed in number and volume all the previous collections. Too much credit cannot be given Prof. Powell. He works 16 hours a day, and pays his assistants out of his own meager salary." His salary as professor of natural science and museum curator was $1,000. The courses which he was expected to teach included, according to the college catalogue, botany, cellular histology, comparative anatomy, physiology, systematic zoology, natural philosophy, the logic of natural science, geology, and mineralogy. It was a heavy schedule, to which were added the duties of the Museum.

Research was fast becoming a prime passion with Powell. Very early he acquired the habit of turning to government as the subsidizer of research work. Thus, he appeared before a committee of the Twenty-fifth Session of the Illinois General Assembly with a statement of the goals of the Illinois Natural History Society. Its aims, he said, included:

> "1. Original research in the various departments of Natural Science. 2. A survey of the natural history of the State of Illinois, to determine the rocks and mineral species, the plants, and the animals indigenous to the State. 3. To supply all Universities, Colleges, and High Schools as shall co-operate in the work, with Museums for the illustration of the several departments of Natural History. 4. To build up a Central Museum in the halls of the Society at the State Normal University, from which the collections made by its members may be distributed to the several museums of the State." [13]

This statement was followed by a request for $2,500 for the Museum, $1,500 for a curator and $1,000 for books and supplies.

That year, 1867, Powell forged another link in the chain of events which was to lead him in a very short time to the ranks of the country's topmost scientists. He decided that teaching geology and the other natural sciences must be done in the field as well as in the classroom and laboratory. He would take a party of students on a summer field trip to observe and collect. This decision was a marked innovation in American educational practice. A custom today, it was unheard of then.

That summer, he and his party set out for the Colorado Front Range, having been advised that their first choice, the Dakota Bad Lands, was dangerous. Most of the students came home early, but Powell continued on into Wyoming. There he met Jack Sumner, the man who convinced him that a trip through the mysterious Colorado

Canyon was "the real thing." Powell hurried back to Illinois, fired with a new ambition. A second field trip the following summer made him all the more impatient.

Back at Normal the next winter, he was able to wangle funds from the Illinois Natural History Society and the Chicago Academy of Sciences, promising to donate whatever collections he made in the field. In Chicago, he had boats built according to a design which he and the trapper Sumner had agreed upon, arranged for supplies from the Army and passage on the Union Pacific, and set out with Mrs. Powell and his youngest brother, Walter, for Green River Station in Wyoming. There he met Sumner and his men, selected because of their knowledge of the West and its rivers and their enthusiasm for adventure. Mrs. Powell went on to Salt Lake City to wait for the Major. The eight men embarked May 24, 1869 and left the river September 1st, thus completing the first trip down the Colorado River system and the Grand Canyon—as the Major himself called it—ever made by white men.

The nation had heard of the trip and awaited anxiously the news of its fate. A false report of disaster had been circulated by a renegade frontiersman and had been vigorously denied, on the basis of circumstantial evidence, by Mrs. Powell. Obituary notices appeared in many of the nation's papers, which the Major was to read with relish. The story had actually built up tremendous national interest in the exploit. When the Major checked in at Salt Lake City, he was hailed as a popular hero.

The adventure received front page attention. Powell was asked to lecture about the expedition at various places throughout the nation. This opportunity he turned to good advantage, for his public appearance was excellent, his delivery captivating. Though there was another expedition—in 1870-1872—this was the one which both the public and Powell remembered.

Years later C. R. Van Hise, remarking on this phase of Powell's career, pointed out: "The primary purpose of his explorations was not to get into unknown territory for its own sake, was not even to become a pathfinder (the purpose of many explorations) but was to study the region through which he went, in all of its aspects." [14]

Powell had indeed become a research man in a great unexplored region of the country. Normal, Illinois, was now only headquarters; the West had become his place of work. In 1870 he was attached to the U. S. Geographical and Geological Survey of the West, operating under

F. V. Hayden, and was given the rank of Geologist in Charge. A part of the time he spent in and near the Colorado River basin, making the second trip through the canyons during this period.

> "In 1874 I started with a pack from Green River Station, went up Little Bitter Creek, across Quien Hornet Mountain, through Red Creek Canyon into Brown's Park; thence southeastward to the junction of the Snake River with the Yampa, where it was crossed; thence across the Yampa Plateau to the foot of Split Mountain Canyon, and thence to the Uinta Valley. Returning from the Uinta Valley I visited the region drained by Ashley's Fork and Brush Creek, crossed the Uinta Mountains to the head of Sheep Creek, and returned to the Green River Station.... In 1875, I again started with a pack train from Green River Station, went east to Rock Springs and Salt Wells, thence south to the mouth of the Vermillion, thence to the eastern foot of the Dry Mountains, thence west through Brown's Park, past Flaming Gorge to the head of Sheep Creek, and thence through the Cameo Mountains to Green River Station. On this trip also the train moved slowly, and my studies were extended many miles in either direction from the general route." [15]

The energetic and observant Powell, working as a "scientific trapper," had combed enough country and talked to enough people to head east and write accounts of these experiences. The first of his reports was made to Joseph Henry and James G. Blaine: *Report of the Survey of the Colorado of the West* (1873). This geological document was followed by his *Exploration of the Colorado River of the West* (1875). Then came his *Report on the Geology of the Eastern Portion of the Uinta Mountains* (1876). The same year there appeared the first of three volumes of collected ethnological studies, *Contributions to North American Ethnology,* published by the Smithsonian Institution. In 1878 he published his classic *Report on the Lands of the Arid Region of the United States.* The next year he was named head of the newly established Bureau of Ethnology at the Smithsonian. Except for occasional quick trips, the Major's mountain-climbing days were over. By no means glued to a chair in Washington, he found his time and interests rather well occupied with the demands of government research. His administrative responsibilities were more than doubled when he was asked in 1881 to succeed Clarence King as Director of the U. S. Geological Survey. Two research trips through the Southwest and a rather profitless expedition to Cuba with W. H. Holmes in 1900 seem to be the extent of his field work after 1876. Yet he never lost his love of the western country. Near the end of his life

he received an invitation from a mountain-climbing group in Portland to join them in an expedition. He declined in a very touching note of regret that he should never again see the West.

But he had covered the Rockies from the lower end of the Colorado River in Arizona to the Basin Range in the Northwest. And in so doing, he had pioneered in two great frontier fields of science, geology and anthropology, and had made an important contribution to pedagogy.

5.

ORGANIZER OF RESEARCH

Much of Powell's success lay in his ability to see an opportunity and to follow it through. After his first Canyon trip, he interviewed Joseph Henry, then Secretary of the Smithsonian, about the wisdom of an additional exploration of the Colorado. It had been a hurried trip, many records had been lost, photographs ought to be taken, and the surrounding region ought to be investigated. It was Henry who recommended that Powell be attached to the Rocky Mountain Survey then being conducted by the Department of Interior under Hayden's direction. It was Henry's assistance that made possible the 1870 uplands and the 1871-1872 lower basin exploration. Stephen F. Baird, Henry's successor, was also impressed by Powell's ability to organize ethnological research and by his pronounced interest in it; he named him Director of the newly organized Bureau of Ethnology of the Smithsonian.

This appointment, based in part upon the able series of *Contributions to American Ethnology,* seems to be most surprising, for Powell had been working in the West as a geologist. Its background may be explained in Powell's own words.

> "It has been my habit to have two or three intelligent Indians ride with me wherever I have gone. This has afforded a rare opportunity for talking with them on the journey and in camp, and I have made it available in the study of their language, having collected more than 2,000 words, and obtained some knowledge of the grammar of their language, such as the declension of the pronoun and noun, conjugation of the verb, modification of the adjectives, their use of numerals, and many idiomatic expressions. I have also discovered among them a very elaborate system of mythology, which is their explanation for the origin of things, their authority for habits and customs, and their common or un-

written law. I have also collected a number, perhaps three or four score, of their simple songs. Their marriage and burial customs have been noted, and many other interesting facts observed." [16]

Even more surprising at the time was the fact that Powell himself was not made director of the new U. S. Geological Survey, for the Major had been largely responsible in the first place for its establishment.[17] Apparently he had, as a condition of his promotion of the new agency, requested that he not be considered as a candidate for the position. He was in fact delighted to see his friend, the popular and urbane mining engineer and geologist, Clarence King, named to the post.

The directorship of the Bureau of Ethnology gave him the free rein of time and contacts which his personality needed. Able to enlist good men in spite of inadequate salaries, he was also alert to research interests being pursued by college and university people, and he encouraged their activities wherever and as he could. When he assumed direction of the Geological Survey three years later, he continued this policy of recruitment and encouragement; to further the work he effectively petitioned Congress for more and more funds. His budgets for research became larger with the years. Within ten years the Geological Survey, for example, was not only the largest scientific agency in the nation, it out-ranked any other such agency in the world.

Research fields were plotted out on a logical rather than geographical basis, and those men whose specializations fitted the program were sought out and hired. Voluminous correspondence with interested persons both in the United States and elsewhere was carried on. Impressive quarto volumes of annual reports were prepared, a bulletin series was inaugurated, a series of folio atlases was introduced, an international exchange of scientific publications was set up, a bureau of engraving staffed by men especially trained for the work was started, and a fast-growing library was established for both the Survey and the Bureau. When the Major resigned the Survey in 1894, he could look back over thirteen years of prideful achievements. His ill health, which made supervision of both research agencies increasingly difficult, continued to dog his trail as director of the Bureau. He continued with the latter, however, until the year of his death, though much of the day-to-day work was done by his colleagues McGee and Holmes.

Powell's own contributions to research during the years of his directorship are scanty, if counted in terms of publications over his

own name. Much of the Report of the Public Lands Commission in 1880 was Powell's work. Brief articles in the annual reports were signed by him and of course he wrote the introduction to each of them. A large number of semi-popular and technical articles were published in the the journals.[18] His most ambitious and still standard study was the *Indian Linguistic Families of America North of Mexico* (1885-1886). His testimony before the Joint Committee on the Scientific Research Services of the Federal Government (1885) deserves special mention as a courageous and far-seeing document, the equal in this respect of his more famous Arid Lands report. His detailed and knowledgeable report to the House Select Committee on Irrigation (1890) is a spirited and brave continuation of this Arid Lands study.

During his last decade he was preoccupied with problems of philosophic synthesis. His publications in this area impressed his colleagues very little and posterity not at all. Planned as a trilogy, only one volume was actually published: *Truth and Error, or the Science of Intellection* (1898). The outlines of the second volume may be traced in the various articles appearing mainly in the *American Anthropologist* during the years 1899-1901. It is difficult to say what the third volume would have contained, though he himself intimated in several places that it would deal with the emotions, a study in psychology. He wrote poetry, apparently a good deal of it, but he permitted only one poem, "The Soul," to appear; perhaps it is just as well that the others did not reach the editor's desk. Above all, any appraisal of Powell's writing must be made in terms of the annual reports of the Survey and the Bureau. His summaries of the field reports of his colleagues and his over-view of the complex problems of geology and anthropology are masterly in their conciseness, generous in their praise, and far-seeing in their prospect.

Powell was pre-eminently an organizer of research. This capacity was affirmed by his co-workers, who were quick and openhanded in their acclaim. "Major Powell's mind," wrote W. H. Holmes in the Twenty-fourth Annual Report of the Bureau, "was so broadened and strengthened by the varied experiences of his early career that when he was called upon to enter the services of the nation as explorer, geologist, geographer, and ethnologist, he naturally assumed the role of organizer. At all times he was the master spirit, compassing with clear vision the widest horizon and easily pointing the way to even the ablest." [19] Similarly Paul Carus, friend of the great scientists and philosophers of his day, remarked: "Major Powell was not only a

scientist but also a chief; he was an organizer, and it is his spirit even today after he has passed away that pervades the institutions which with him and partly through him were called into existence. Yet while he was a born leader, he was never domineering but always amiable and considerate. He appeared to the younger generation that grew up under the influence of his powerful personality, not as their teacher or master, but their serious friend. . . ." [20]

In 1891 the Academy of Sciences of the Institute of France honored Powell and the Survey with the award of the Cuvier Prize. The committee declared: "Under the powerful impulse which the Federal Government has given to it, the geological service of the United States has produced in twenty-five years results very considerable and very skillfully attained. It must be said that in no other region of the globe has been made such discoveries in so short a space of time." [21] Writing in the *Forum* in 1899, anthropologist W. J. McGee commented: "Since 1879 he has had charge of the Bureau of American Ethnology, the leading official ethnologic bureau in the world." [22]

When Powell died, observers noted the similarities between his contributions to the organization of research and those of Spencer Baird, notable leader of the Smithsonian for many years and one of the first to recognize Powell's abilities. Anthropologist W. H. Dall recalled at the memorial meeting in honor of his late chief that Powell's own statement on the occasion of Professor Baird's funeral was equally appropriate to the Major. At that time Powell had said: "A continuous line of research, prosecuted by a corps of men so that the boundaries of knowledge are carried forward, can result only from a continuous line of inventions in the apparatus of research, and it was here that Baird exhibited his skill." [23] Unquestionably Powell was thus expressing his own philosophy of research administration. How well he himself succeeded is suggested in Walcott's review of the Geological Survey under Powell's leadership. "Provision for other branches of scientific work was made by the establishment of a division of chemistry and physics, a division of paleontology, and, eventually, a division of hydrography; and much attention was given also to the organization of divisions with operative functions auxiliary to scientific work, such as the library, the division of engraving, and the division of accounts." [24]

The Major's concern about the organizational pattern of research by no means overshadowed his desire to bring to the tasks of science the ablest men that he could recruit and to publish widely and with

ample credit to their findings. How well he attained that goal is indicated in the following appreciation by folklorist Chamberlain. "To have made possible the publication of the results of the labors of Yarrow, Holden, Royce, Mallery, Dorsey, Gotschet, Cushing, Smith, Henshaw, Matthews, Holmes, Thomas, Dall, MacCauley, Boas, Hoffman, Mooney, Mindeleff, Murdock, Bourke, Turner, Fowke, Pilling, Fewkes, Hewitt, McGee was an achievement of which one might be proud." [25]

His labors as a frontiersman of American science did not go unnoticed and unrewarded by the professional associations and academic institutions of his time. He was either a co-founder or member of the following: Anthropological Society of Washington, American Anthropological Association, Washington Academy of Sciences, American Association for the Advancement of Science (of which he was president in 1888), National Academy of Sciences, the Philosophical, the Biological, the Chemical, and the Geological Societies of Washington, the Geological Society of America, American Folk-lore Society, American Historical Association, International Geological Congress. He was an associate member of the *Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte.*

This self-trained Illinois farm boy and western explorer was likewise honored by a number of higher institutions. In 1886 the doctorate *honoris causa* was bestowed upon him by the University of Heidelberg, with the statement:

> "We, the Senior Dean and other professors of the Faculty of Philosophy in the Karl Rupert University, duly certify by this diploma bearing our seal that we have conferred the rights and privileges of a doctor of philosophy, *honoris causa,* upon that most learned and distinguished man, John W. Powell, of Illinois, heretofore chief of the public institution of ethnography, now of geology, in the United States of America, who, laboriously and wisely studying and measuring the vast and spacious regions of his own country with others, has scientifically observed and expounded the structure, form, and origin of the earth; and who has so associated with himself and brought together into one institution a great number of the most distinguished geologists of his country that they have materially advanced or solved, not less wonderfully than speedily, very difficult and profound questions in mineralogy, petrology, geology, and paleontology; they have studied under his auspices as chief, thereby causing these things not only to be most skillfully brought together in various works, but also to be communicated with the greatest liberality to all students of these subjects in Europe." [26]

Institutions in the United States also honored Powell: Columbian (now known as George Washington University), LL.D., 1882; Oberlin, M.A., 1882; Harvard, LL.D., 1886; Illinois Wesleyan, Ph.D., 1887; Illinois College, LL.D., 1889.

6.

PERSONALITY PROFILE

What kind of man was the Major? The men who knew him best were generous in their praise. Lester Ward's interview led him to exclaim: "Personally, he is of most agreeable manners, frank, genial, and cordial under all circumstances, and possessed a great individual magnetism." [27] This latter trait appears over and over again in the contemporary appraisals of the man. Thus, Dellenbaugh, a companion on the 1871-1872 Canyon expedition, wrote: "He had a rare faculty of inducing enthusiasm in others, and by reposing complete confidence in the individual, impelled him to do his very best. Thus he became the main-spring for much that was never credited to him, and which was really his in the germ or original idea." [28]

E. A. Spitzka collected opinions from some forty of Powell's friends and associates.[29] Typical are the following comments. "He did not mention or publish observations by themselves, but only in classified form, or as illustrative of theoretic ideas." "It was his habit to refer all minor problems to the broadest possible categories." "His clear view of the relations of concrete things made him a really good administrator and organizer of institutions." "I should think that unflinching courage was Powell's leading characteristic." "I know of no one who has so successfully, so wisely and so permanently organized the forces of national scholarship in a specific field as Major Powell." Spitzka's own summary of the Major's personality is interesting. "Keenness of observation, therefore, with a superior ability of forming concrete concepts, profound insight into the interrelations of what he saw or heard, great capacity for associating and generalizing his thoughts and giving them expression in words; all these, with the musical and practical faculties characterized Major Powell's mind." [30]

His honesty and self-containedness seem to have impressed his contemporaries. Thus, S. P. Langley, Secretary of the Smithsonian, wrote of him: "Wherever I have been with him, in whatever surorundings, 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. 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." [31]

Yet firey tempered as he was and inclined to the martinet role at times, he occassionally aroused strong emotions of another sort. His fight for the expansion of the Geological Survey and for a scientific approach to land utilization and water control in the West created many enemies, in and out of Congress. There is no doubt that his resignation from the Survey in 1894 was occasioned in great part by his awareness that his own personality stood in the way of further Congressional support of the Survey, even endangered the Survey. His failure to give credit to the three men who left his first Canyon expedition is open to severe censure.[32] Another neglect is mentioned, with great restraint, by his friend Dellenbaugh.[33] "One inexplicable action in his career, to my mind, was his complete ignoring in his report of the men and their work, of his second river expedition, particularly of his colleague, Professor Thompson, whose skill and energy were so largely responsible for the scientific and practical success of the second expedition. The report embodied all the results achieved by this expedition and gave no credit to the men who with unflagging zeal, under stress and difficulties innumerable accumulated the data. This has ever appeared to me unjust, but his reasons for it were doubtless satisfactory to himself." In justice to the Major it should be pointed out that this failure seems to belong to his early career, for later colleagues never once mentioned it in their evaluations of his supervision of the Survey and the Bureau. Powell himself later on was sensitive about his neglect to give due credit, and when he learned that Dellenbaugh was preparing to write the story of the second Canyon trip, he expressly asked that proper credit be given to the men.

Lester Ward noted in his sketch of Powell: "Though social by nature, he has a strong preference for persons of culture, and especially of independence of thought, as his friends, and seems to possess the tact of securing such without giving offense to others." [34] His Washington home at 910 M Street, N. W. was, as Davis says, "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." [35] This club included at the time such famous persons as Henry Adams, Daniel Coit Gilman, John Jay Knox, and Lester F. Ward.

Powell died on September 23, 1902 at the age of sixty-eight and was buried in the National Cemetery in Arlington, survived by his wife and daughter. On the second anniversary of his death, a meeting of the International Geological Congress at Grand Canyon, Arizona recommended a memorial monument be erected to his memory. It was dedicated May 20, 1918. Secretary of the Interior Franklin Lane said on this occasion: "Major Powell, throughout his life, was the incarnation of the inquisitive and courageous spirit of the American. He wanted to know and he was willing to risk his life that he might know. This was the spirit that he showed in making the hazard of his life in exploring the Colorado River Canyons." [36] It was altogether fitting that a memorial be constructed on the rim of the Canyon which brought him fame and made him a son of science. It was not his only monument, however. There were two in the East: the U. S. Geological Survey and the Bureau of American Ethnology. And in the West there are the Powell National Forest in Utah; Powell Plateau and Powell Saddle, within Grand Canyon National Park; Powell Lake, near Needles, California; and the town of Powell in Mohave County, Arizona.

That colorful editor of *Irrigation Age,* William Smythe, editorially noting Powell's resignation from the Geological Survey in 1894, wrote that in estimating the man "we must remember that the Major is a many-sided man." [37] The succeeding chapters will seek to explore some of the ramifications of this fact.

REFERENCES

1. Lester F. Ward, *Glimpses of the Cosmos* (New York: G. P. Putnam's 1913), Vol. II: "Sketch of John Wesley Powell," pp. 426 ff.
2. Charles D. Walcott, "Powell's Administrative Work," *Washington Academy of Sciences,* V (1903), pp. 99 ff.
3. Alexander Chamberlain, "In Memoriam: John Wesley Powell," *Journal of American Folk-lore,* XV (1902), pp. 202 ff.
4. W. H. Davis, "John Wesley Powell, 1834-1902," *Biographical Memoirs, National Academy of Sciences,* Vol. III, pp. 11 ff.
5. Bureau of American Ethnology Letterpress, 1879-1902.
6. Mrs. M. D. Lincoln, "John Wesley Powell," *Open Court,* XVII-XVIII (1902-1903), pp. 705 ff.; pp. 14 ff.; pp. 86 ff.; pp. 162 ff.; pp. 228 ff.; pp. 281 ff.
7. Lincoln, *ibid.*
8. Quoted in a letter from Mr. Donald M. Love to Miss L. G. Morris, Librarian, Illinois State Normal University, Feb 20, 1947; Powell Collection.
9. W. M. Smallwood, *Natural History and the American Mind* (New York: Columbia University Press, 1941).
10. General David B. Henderson, "Powell as a Soldier," *Washington Academy of Sciences,* V (1903), pp. 100 ff.
11. Lincoln, *op. cit.,* pp. 14-15.
12. Powell Collection, Illinois State Normal University.
13. Twenty-fifth Session, Illinois General Assembly, *Reports,* Vol. II (1867), p. 1; Powell Collection, Illinois State Normal University.
14. C. R. Van Hise, "Remarks on Powell as Explorer," *Washington Academy of Sciences,* V (1903), pp. 105 ff.
15. J. W. Powell, *Report on the Geology of the Eastern Portion of the Uinta Mountains and a Region of Country Adjacent Thereto* (Washington, D. C.: Government Printing Office, 1876), p. v.
16. J. W. Powell, *Report of the Survey of the Colorado River of the West,* 42nd Congress, 3rd Session, *House Miscellaneous Document,* No. 76 (1873), pp. 7-8.
17. H. M. Smith, "Clarence King, John Wesley Powell, and the Establishment of the U. S. Geological Survey," *Mississippi Valley Historical Review,* XXXIV (1947), pp. 38 ff.
18. See the bibliography of Powell publications.
19. W. H. Holmes, *Twenty-Fourth Annual Report,* Bureau of American Ethnology (Washington, D. C.: 1902-1903), pp. xxxv ff.
20. Paul Carus, "Major Powell, the Chief," *Open Court,* VI (1902), pp. 716 ff.

21. *Thirteenth Annual Report,* U. S. Geological Survey (Washington, D. C.: Government Printing Office, 1891-1892), Part I, pp. 62 ff.
22. W. J. McGee, "The Foundations of Science," *Forum,* XXVII (1899), p. 173.
23. *Smithsonian Miscellaneous Collections,* XXXVII (1888), p. 75.
24. Walcott, *Twenty-Fourth Annual Report,* U. S. Geological Survey, p. 278.
25. Chamberlain, *op. cit.,* p. 202.
26. Carus, *op. cit.,* p. 716.
27. Ward, *ibid.*
28. F. D. Dellenbaugh, *The Romance of the Colorado River* (New York: G. P. Putnam's, 1902), p. 383. Quoted by permission.
29. E. A. Spitzka, "A Study of the Brain of the Late Major J. W. Powell," *American Anthropologist,* V (1903), pp. 639 ff.
30. Spitzka, *op. cit.,* p. 642. The reference to musical ability is intriguing, to say the least. Powell's niece, Maud Powell, was a famous concert artist in the *fin de siècle* days, popular both in the United States and in Europe.
31. Davis, *op. cit.,* p. 83.
32. See the review of this problem by J. M. Chalfant, ed., *Colorado River Controversies* by Robert M. Stanton (New York: Dodd, Mead, 1932).
33. Dellenbaugh, *op. cit.,* p. 386. Quoted by permission.
34. Ward, *ibid.*
35. Davis, *op. cit.,* p. 59.
36. H. C. Bryant, "John Wesley Powell," *Cosmos Club Bulletin,* I (June, 1948), pp. 2-5.
37. *Irrigation Age,* VI (1893-1894), pp. 54 ff.

Chapter II

KA'-PU-RATS CONQUERS THE CANYON

1.

A TAMED RIVER

Raymond Rossiter tells how on one occasion Clarence King, attended by his valet, made his way to the Grand Canyon. Standing on its brink, King turned to his man.

"Well, Joe, how does it strike you?"

"It is no place for a gentleman, sir."

Indeed it is not, then or now. In spite of the giant Boulder Dam and trips by gentlemen in motor boats (fueled by helicopters), the Colorado River is no drawing-room.

Yet it has been tamed. Across it the smooth, white curve of a great dam has been thrown. The fifteen-million-year-old river, unstopped in its downward rush by even the granite mountains, no longer splits its way to the sea unchecked. "In five little years the minute hand of man has reached into that open gash and stopped it. . . ." [1]

To this task the engineers brought the knowledge of three generations of explorations and many more of physical science. But when it was first conquered, it was by a one-armed soldier-geologist and his party. It was Powell who first learned the secret of the Colorado. "Everything that has followed, whether exploration or commerce, has been based on the courageous work of the one-armed soldier and his men."[2] The floods and droughts which menaced the Imperial Valley and the Southwest have ceased. Lake Mead and Boulder Dam supply the region with the water and the power it needs. The millions of tons of silt no longer sweep into the delta. A new subscience of geology, geomorphology, owes a tremendous debt to this red-brown muddy river and its canyons, and so does American ethnology.

2.

A ROMANTIC RIVER

The basin of the Colorado extends over 240,000 square miles, draining the waters of seven southwest American states. The parent river

flows for over 2,300 miles through arid country, the only one of its kind in the United States. Its sand-charged waters have cut away at its granite walls and beds, gashing for over a hundred and fifty thousand centuries a tortuous, mile-deep canyon in a high, uplifted plateau. Rising in the Wind River Mountains of Wyoming, where the Columbia and the Missouri also have their start, it whirls its way down, in boiling tumult, ten thousand feet in some two thousand miles, to the Red Sea, once the Sea of Cortes, now the Gulf of California. Cliff-bound most of the way, fed by tributaries whose canyons rival those of the Colorado itself, it has dug away a magnificent system of gorges awe-inspiring even to the sophisticated modern traveller.

Surrounded by a breath-taking chaos of mountains, mesas and valleys, this mad, unruly river had been whispered about by untold generations of men. Long known to the Amerinds of the West, its story first reached the white man in the sixteenth century when, in 1539, Francisco de Ulloa, a captain of Cortes, sailed into the Gulf of California. Ulloa did not see the river, he only guessed its presence from the tremendous delta and surging waters at the head of the Gulf. He left its discovery to a bolder man, who followed him soon.

In 1540, Coronado's man, Alarçon, found himself at the head of the Gulf where Ulloa had watched and battled the turbulent rush of waters, "a very mighty river," as he reported, "which ran with so great a fury of a stream, that we could hardly sail against it." He later estimated that he had gone "above thirty leagues" into the country before he finally turned back, having never seen the canyons.

Meanwhile, pushing across country was Coronado himself, searching for the fabled cities of Cibola. From Cibola (Zuni) itself, he dispatched one of his men, Don Lopez de Cardenas, to the country northwest, in the direction of the great river they had recently heard about from the natives. Guided by the Tusayans, who knew the highway down the Gila to the Colorado, Cardenas moved along the southerly edge of the Colorado Plateau, through the Coconimo Forest until he came to the rim of the Grand Canyon itself, in the autumn of 1540.

Cardenas was the first white man ever to see it; the real discoverer will never be known. He was followed by the padres, by the migratory trappers, and finally by the explorers. The *entradas* of the padres—the most famous was that of Escalante—came to a close in the 1780's. The beaver-hunting trappers opened the next phase of Colorado history in the 1820's, led by the restless Pattie and the venturesome

Carson. By 1840 the West had been traversed by many Americans and was rather well known, all of it except the canyons of the Colorado, which were as unknown, at least those below the mouth of the Grand, as they were before the fur traders began to roam the West. Prospects of converts and profits had spurred the earlier expeditions. But the scientific explorer entered the country, wanting knowledge. The advance guard of the many expeditions to the Colorado country was that of Fremont, who came along the flank of the Wind River Mountains to the headwaters of the Colorado. "We had reached a very elevated point," he reported, "and in the valley below and among the hills were a number of lakes at different levels; some two or three hundred feet above others, with which they communicated by foaming torrents. Even to our great height the roar of the cataracts came up, and we could see them leaping down in lines of snowy foam." [3] Lieutenant Ives, Captain Johnson, Captain Macomb, Captain Rodgers added their perilously won information to the slowly swelling store of knowledge about the canyons.

The Civil War brought an end to Colorado explorations. The canyons had still not been conquered, the river had still not been run through its entire course. It was still the Great Mystery of the West. When Powell entered the Colorado Front Range in 1867 and again in 1868 he heard the many wonderful stories about the river. "Stories were related," he wrote, "of parties entering the gorge in boats, and being carried down with fearful velocity into whirl-pools, where all were overwhelmed in the abyss of waters; others, of underground passages for the great river, into which boats had passed never to be seen again. It was currently believed that the river was lost under the rocks for several hundred miles. There were other accounts of great falls, whose roaring music could be heard on the distant mountain-summits. There were many stories current of parties wandering on the brink of the canyon, vainly endeavoring to reach the waters below, and perishing with thirst at last in sight of the river which was roaring its mockery into dying ears." [4]

3.

AN INVERTED MOUNTAIN RANGE

"The Grand Canyon," writes Dellenbaugh, who voyaged with Powell on the second trip, "may be likened to an inverted mountain range. Imagine a great mountain chain cast upside down in plaster.

Then all the former ridges and spurs of the range become tributary canyons and gulches running back twenty or thirty miles into the surrounding country, growing shallower and shallower as the distance increases from the central core, just as the great spurs and ridges of a mountain range, descending, melt finally into the plain. Often there are parts where the central gorge is narrow and precipitous, just as a mountain range frequently possesses mighty precipices." [5]

The canyons are the creation of a drainage system. The headwaters are in the high mountains, and the streams race through hundreds of miles of desert lands and sedimentary formations. The erosive and corrasive powers of the waters are the sculptors, carving away the cliffs, sawing away at the bottoms of the gorges. The canyons farthest away from the high mountain ranges are the deepest. The Grand Canyon, the greatest gorge of the entire basin system, is the one farthest from the headwaters, and lies at the end of the high arid plateau which made it possible. The streams drain back and away from the gorges themselves, cutting side canyons, by circuitous channels usually. This backward extension of the drainage leaves the rims of the gorges standing higher than the region surrounding them.

It is a region of great plateaus and mountain masses. The latter, fountainheads of the canyon-carving waters, are snow-covered through the year, and there are many of them: Uinta, Zuni, San Francisco, Henry, Pine Valley, Uinkaret, Beaver Dam, Virgen, Navajo, La Sal, and others. The Colorado basin is very largely a plateau region. The "High Plateaus," reaching an altitude of eleven thousand feet above the sea and forming an area called by Powell "The Plateau Province," merge eastward into the "parks." Lying between the High Plateaus and the parks are the "Mesa Plateaus," characteristically outlined by vertical cliffs. In the region around the Grand Canyon itself Mesa Plateaus predominate: the Shevwits, Uinkaret, Kanab, Kaibab, the Paria, and the Kaiparowits. "The edges of these Mesa Plateaus, precipitous cliffs, stretch for many miles across the arid land like mountain ranges split asunder." [6]

The country drained by the Colorado basin is about eight hundred miles long, from three hundred to five hundred miles wide—an area larger than all the New England and Middle States, and Maryland and Virginia added. It has two distinct portions. The lower third, a little above sea level, is bounded by a line of cliffs, hundreds to thousands of feet below the plateaus. The upper two-thirds of the basin, rising from four to eight thousand feet above the sea, is ringed

by ranges of mountains, some of which vary from eight to fourteen thousand feet. Under the summer sun, their snows melt and come tumbling down the mountain-sides in millions of cascades. "Ten million cascade brooks," writes Powell, "unite to form ten thousand torrent creeks; ten thousand creeks unite to form a hundred rivers beset with cataracts; a hundred roaring rivers unite to form the Colorado, which rolls, a mad, turbid stream, into the Gulf of California." [7] Every river cuts narrow, winding gorges or deep canyons. "Every river entering these has cut another canyon; every lateral creek has cut a canyon; every brook runs in a canyon; every rill born of a shower, and born again of a shower, and living only during these showers, has cut for itself a canyon; so that the whole upper portion of the basin of the Colorado is traversed by a labyrinth of these deep gorges." [8]

4.

THE FIRST VOYAGE THROUGH

The Colorado, formed by the junction of the Green and the Grand (now known as the Colorado) in Utah, is a Jekyll-Hyde river, flowing quietly over sand-bars in some places, rushing in a reddish muddy tumult in others, hurling millions of tons of pulverized debris at granite walls and sandstone cliffs. It has been run, or attempted, by geologists, soldiers, artists, criminals, photographers, trappers, botanists, a mad man, thrill-seekers, and a hardware merchant. The first man to run its whole course was Powell.

Davis' brief account makes it sound like child's play. Powell and his men, he wrote "embarked May 24, 1869, in four boats, where the Union Pacific Railroad crosses the Green River in southwestern Wyoming; followed the Green River through deep gorges in the Uinta Mountains to its junction in open country with the Grand River, below the point the name Colorado is given; then continued down the Colorado through its profound canyons in the plateaus of southeastern Eutah [*sic*] and northern Arizona to the open country near the Nevada line on August 29th." [9]

Powell's own contemporaries knew, as Davis of course did, that it was not child's play. Powell was afraid of it, but then he was not foolhardy about it either. W. H. Brewer recalled a very revealing conversation with the Major many years after the trip. "Smoking the after-dinner cigar with some of his friends, he gave his reasons for

his faith in undertaking it. Said he: 'Have you never seen the river? It is the muddiest river you ever saw. I was confident that I would find no considerable falls. Rapids I expected, of course, but not falls.' " [10] It was his belief that the falls had been worn down to mere rapids.

Powell's account of his canyon voyages first appeared in a government document, *Exploration of the Colorado River of the West and Its Tributaries.* It was published in 1875 by the Government Printing Office, under the auspices of Joseph Henry of the Smithsonian. It was a good seller. In 1898 Powell wrote the Honorable Jesse Overstreet that there had been four editions. A briefer version of this report was published in 1895, at the insistence, according to Powell, of Representative James A. Garfield. The following excerpts are taken from this briefer account, which Powell edited for the adventure series published by Horace Kephart of the Outing Publishing Company. The narrative is in the form of diary entries, most of them Powell's, some of them adapted from the diary of Jack Sumner and from that of his brother-in-law, A. H. Thompson, who accompanied him on the second trip. Powell's story merges materials from both expeditions.

"The good people of Green River City," Powell wrote in his diary May 24, 1869, "turn out to see us start. We raise our little flag, push the boats from shore, and the swift current carries us down.

> "Our boats are four in number. Three are built of oak; stanch and firm; double-ribbed, with double stem and stern posts, and further strengthened by bulkheads, dividing each into three compartments.
>
> "Two of these, the fore and aft, are decked, forming watertight cabins. It is expected these will buoy the boats should the waves roll over them in rough water. The little vessels are twenty-one feet long, and, taking out the cargoes, can be carried by four men.
>
> "The fourth boat is made of pine, very light, but sixteen feet in length, with a sharp cut-water, and every way built for fast rowing, and divided into compartments as the others.
>
> "We take with us rations deemed sufficient to last ten months; for we expect, when winter comes on and the river is filled with ice, to lie over at some point until spring arrives; so we take with us abundant supplies of clothing. We have also a large quantity of ammunition and two or three dozen traps. For the purpose of building cabins, repairing boats, and meeting other exigencies, we are supplied with axes, saws, hammers, augers, and other tools, and a quantity of nails and screws. For scientific work, we have two sextants, four chronometers, a number of barometers, compasses, and other instruments.

"The flour is divided into three equal parts; the meat and all other articles of our rations in the same way. Each of the larger boats has an ax, hammer, saw, auger, and other tools, so that all are loaded alike. We distribute the cargoes in this way, that we may not be entirely destitute of some important article should any one of the boats be lost. In the small boat, we pack a part of the scientific instruments, three guns, and three small bundles of clothing only. In this, I proceed in advance, to explore the channel. J. C. Sumner and William H. Dunn are my boatmen in the *Emma Dean;* then follows *Kitty Clyde's Sister,* manned by W. H. Powell and G. Y. Bradley; next, the *No Name,* with O. G. Howland, Seneca Howland, and Frank Goodman; and last comes the *Maid of the Canyon,* with W. R. Hawkins and Andrew Hall." [11]

Below the town a mile or two, the party hit a sand-bar; two men jumped out to lighten the load; the boats were swept into an eddy; two men were thrown overboard. Powell wrote in his diary: "The men seem quite discomfited, much to the amusement of the other members of the party." It was a bad beginning, but the first of many duckings.

Striking their first camp along the strangely carved rocks of the Green River badlands, the men had an opportunity to look at the terrain. It was one which would become familiar before they left the river: sandstones and slates, multicolored, lying in strata; fantastic architecture, weird statuary; barren desolation. "Standing on a high point, I can look off in every direction over a vast landscape, with salient rocks and cliffs glittering in the evening sun. Dark shadows are settling in the valleys and gulches, and the heights are made higher and depths deeper by the glamour and witchery of light and shade." [12]

Sixty-two miles from Green River City, they entered their first large canyon.[13] "The river is running to the south; the mountains have an easterly and westerly trend directly athwart its course, yet it glides on in a quiet way as if it thought a mountain range no formidable obstruction to its course. It enters the range by a flaring, brilliant, red gorge, that may be seen from the north a score of miles away. The great mass of the mountain-ridge through which the gorge is cut is composed of bright vermillion rocks; but they are surmounted by broad bands of mottled buff and gray, and these bands come down with a gentle curve to the water's edge on the nearer slope of the mountain.

"This," continues the diary, "is the head of the first canyon we are about to explore—an introductory one to a series made by the river

through this range. We name it Flaming Gorge."

Leaving Flaming Gorge, they quickly entered another.[14]

> "On either side the walls rapidly increase in altitude. On the left are overhanging ledges and cliffs five hundred—a thousand—fifteen hundred feet high. On the right, the rocks are broken and ragged, and the water fills the channel from cliff to cliff. Now the river turns abruptly around a point to the right, and the waters plunge swiftly down among great rocks; and here we have our first experience with canyon rapids. I stand up on the deck of my boat to seek a way among the wave beaten rocks. All untried as we are with such waters, the moments are filled with intense anxiety. Soon our boats reach the swift current; a stroke or two, now on this side, now on that, and we thread the narrow passage with exhilirating velocity, mounting the high waves, whose foaming crests dash over us, and plunging into the troughs, until we reach the quiet water below; and then comes a feeling of great relief. Our first rapid is run."

Canyons followed canyons in swift pace: after Horseshoe came Kingfisher, Red, Swallow. On the way they had to make portage over their first falls.

> "On a high rock by which the trail passes we find the inscription: 'Ashley 18-5.' The third figure is obscure—some of the party reading it 1835, some 1855. James Baker, an old time mountaineer, once told me about a party of men starting down the river, and Ashley was named as one. The story runs that the boat was swamped, and some of the party drowned in one of the canyons below. The word 'Ashley' is a warning to us, and we resolve on great caution. Ashley Falls is the name we give to the cataract." [15]

June 7th the Major looked back and looked forward on his venture.

> "This evening, as I write, the sun is going down, and the shadows are settling in the canyon. The vermillion gleams and roseate hues, blending with the green and gray tints, are slowly changing to somber brown above, and black shadows are creeping over them below; and now it is a dark portal to a region of gloom—the gateway through which we are to enter on our voyage of exploration tomorrow. What shall we find?" [16]

The next day they lost their first boat while making portage. It was the *No Name,* which Captain Howland, his brother, and Goodman had been manning. The three men were washed onto an island in the river, where they were rescued. "We are as glad to shake hands with them as though they had been on a voyage around the world, and wrecked on a distant coast." [17]

A week later they camped at the mouth of a little creek, surrounded by cedars, box-elders and dead willows. Powell climbed up an alcove cut by the creek.

> "While away a whirlwind comes, scattering the fire among the dead willows and cedar-spray, and soon there is a conflagration. The men rush for the boats, leaving all they cannot readily seize at the moment, and even then they have their clothing burned and hair singed, and Bradley has his ears scorched. The cook fills his arms with the mess-kit, and, jumping into a boat, stumbles and falls, and away go our cooking utensils into the river. Our plates are gone; our spoons are gone; our knives and forks are gone. 'Water catch 'em; h-e-a-p catch 'em.' " [18]

During the two weeks that followed they reached the mouth of the Uinta River. They had rolled and portaged their way through Whirlpool Canyon, Island Park, Split Mountain Canyon to Antelope Valley at the Uinta. It was here that Frank Goodman left the party, saying that he had seen danger enough. Powell wrote: "As our boats are rather heavily loaded, I am content that he should leave, although he has been a faithful man." [19]

The next two weeks they rode the Uinta to the junction of the Grand and the Green. Quiet waters alternated with rapids, tortuous canyons with sweeping valleys and extensive sand plains. Most of the way they hardly had time to gaze upon the terraced and sloping escarpments or to follow with appreciative eyes the quiet curves of vast amphitheaters until they were in the midst of another rapids.

> "Standing on deck, I think it can be run, and on we go. Coming nearer, I see that at the foot it has a short turn to the left, where the waters pile up against the cliff. Here we try to land, but quickly discover that, being in swift water, above the fall, we cannot reach shore, crippled, as we are, by the loss of two oars; so the bow of the boat is turned down stream. We shoot by a big rock; a reflex wave rolls over our little boat and fills her. I see the place is dangerous, and quickly signal to the other boats to land where they can. This is scarcely completed when another wave rolls our boat over, and I am thrown some distance into the water. I soon find that swimming is very easy, and I cannot sink. It is only necessary to ply strokes sufficient to keep my head out of the water, though now and then, when a breaker rolls over me, I close my mouth, and am carried through it. The boat is drifting ahead of me twenty or thirty feet, I overtake it, and find Sumner and Dunn clinging to her. As soon as we reach quiet water, we all swim to one side and turn her over. In doing this, Dunn loses his hold

and goes under; when he comes up, he is caught by Sumner and pulled to the boat.

"In the meantime we have drifted down stream some distance and see another rapid below. How bad it may be we cannot tell, so we swim toward shore, pulling our boat with us, with all the vigor possible, but are carried down much faster than distance toward shore is gained. At last we reach a huge pile of drift wood. Our rolls of blankets, two guns, and a barometer were in the open compartment of the boat, and, when it went over, these were thrown out. The guns and barometer are lost, but I succeeded in catching one of the rolls of the blankets, as it drifted by, when we were swimming to shore; the other two are lost, and sometimes hereafter we may sleep cold.

"A huge fire is built on the bank, our clothing is spread to dry, and then from the drift log we select one from which we think oars can be made, and the remainder of the day is spent in sawing them out." [20]

There were compensations for drenchings and duckings, such as those offered in Bow-Knot Canyon.

"There is charm in our ride today down this beautiful canyon. It gradually grows deeper with every mile of travel; the walls are symmetrically curved, and grandly arched; of a beautiful color, and reflected in the quiet waters in many places, so as to almost deceive the eye, and suggest the thought, to the beholder, that he is looking into profound depths. We are all in fine spirits, feel very gay, and the badinage of the men is echoed from wall to wall. Now and then we whistle, or shout, or discharge a pistol, to listen to the reverberations among the cliffs." [21]

At times they tossed and turned through a rock country.

"The landscape everywhere, away from the river, is of rock—cliffs of rock; tables of rock; plateaus of rock; terraces of rock; crags of rock—ten thousand strangely carved forms. Rocks everywhere, and no vegetation; no soil; no sand. In long, gentle curves, the river winds about these rocks." [22]

It took the men over three weeks to traverse the river from the junction of the Grand and Green to the Grand Canyon itself. July 21st the Major wrote in his diary: "We start this morning on the Colorado. The river is rough, and bad rapids, in close succession, are found." [23] Two days later, wearied with shooting the interminable rapids, the men made an early camp, spent the afternoon and evening "discussing the probabilities of successfully navigating the river below. The barometric records are examined, to see what descent we have made since we left the mouth of the Grand, and what descent

since we left the Pacific Railroad, and what fall there yet must be to the river, ere we reach the end of the great canyons. The conclusion to which the men arrive seems to be about this: that there are great descents yet to be made, but, if they are distributed in rapids and short falls, as they have been heretofore, we will be able to overcome them." [24]

Canyon after canyon was run. Many side canyons flashed in view. And then the rains came.

> "It rains again this afternoon. Scarcely do the first drops fall, when little rills run down the walls. As the storm comes on, the little rills increase in size, until great streams are formed. Although the walls of the canyons are chiefly limestone, the adjacent country is of red sandstone; and now the waters, loaded with these sands, come down in rivers of bright red mud, leaping over the walls in innumerable cascades. It is plain now how these walls are polished in many places." [25]

August 13th they were ready for the great canyon, the Great Unknown, the Grand Canyon, as Powell named it.

> "Our boats, tied to a common stake, are chafing each other, as they are tossed by the fretful river. They ride high and buoyant, for their loads are lighter than we could desire. We have but a month's rations remaining. The flour has been resifted through the mosquito net sieve; the spoiled bacon has been dried, and the worst of it boiled; the few pounds of dried apples have been spread in the sun, and reshrunken to their normal bulk; the sugar has all melted, and gone on its way down the river; but we have a large sack of coffee. . . . We are three-quarters of a mile in the depths of the earth, and the great river shrinks into insignificance, as it dashes its angry waves against the walls and cliffs, that rise to the world above; they are but puny ripples, and we but pigmies, running up and down the sands, or lost among the boulders. We have an unknown distance yet to run; an unknown river yet to explore. What falls there are, we know not; what rocks beset the channel, we know not; what walls rise over the river, we know not. Ah, well! we may conjecture many things. The men talk as cheerfully as ever; jests are bandied about freely this morning; but to me the cheer is somber and the jests are ghastly. With some eagerness, and some anxiety, and some misgiving, we enter the canyon below, and are carried along by the swift water through the walls which rise from its very edge." [26]

As they proceeded, they noted that the granite was rising higher, until a thousand feet of the lower part of the walls were composed of

this rock. About eleven o'clock—it is August 14th—they heard a great roar ahead, and they approached cautiously.

> "The sound grows louder and louder as we run, and at last we find ourselves above a long, broken fall, with ledges and pinnacles of rock obstructing the river. There is a descent of, perhaps, seventy-five or eighty feet in a third of a mile, and the rushing waters break into great waves on the rocks, and lash themselves into a mad, white foam. We can land just above, but there is no foot-hold on either side by which we can make a portage. It is nearly a thousand feet to the top of the granite, so that it will be impossible to carry our boats around, though we can climb to the summit up a side gulch, and, passing along a mile or two, can descend to the river. This we find on examination; but such a portage would be impracticable for us, and we must run the rapid, or abandon the river. There is no hesitation. We step into our boats, push off and away we go, first on smooth but swift water, then we strike a glassy wave, and ride to its top, down again into a trough, up again on a higher wave, and down and up on waves higher and still higher, until we strike one just as it curls back, and a breaker rolls over our little boat.
>
> "Still, on we speed, shooting past projecting rocks, till the little boat is caught in a whirlpool, and spun around several times. At last we pull out again into the stream, and now the other boats have passed up. The open compartment of the *Emma Dean* is filled with water, and every breaker rolls over us. Hurled back from a rock, now on this side, now on that, we are carried into an eddy, in which we struggle for a few minutes, and are then out again, the breakers still rolling over us. Our boat is unmanageable, but she cannot sink, and we drift down another hundred yards, through breakers; how, we scarcely know. We find the other boats have turned into an eddy at the foot of the fall, and are waiting to catch us as we come, for the men have seen that our boat is swamped. They push out as we come near, and pull us in against the wall. We bail out our boat, and on we go." [27]

Supplies were running low, through loss and spoiling; the river was running high from the continuous rains; the canyon walls towered higher; the granite—always a sure sign of rapids—seemed to appear and reappear endlessly. "This morning the river takes a more southerly direction. The dip of the rocks is to the north, and we are rapidly running into lower formations. Unless our course changes, we shall very soon run again into the granite. This gives us some anxiety. Now and then the river turns to the west, and excites hopes that are soon destroyed by another turn to the south. About nine o'clock we come to the dreaded rock." Two hours later they headed into a spot which

seemed much worse than any they met during the trip. "A little creek comes down from the left. We land first on the right, and clamber up over the granite pinnacles for a mile or two, but can see no way by which we can let down and to run it would be sure destruction. After dinner we cross to examine it on the left." [28]

Inspecting the river first on one side and then the other, Powell decided it was possible to let down over the first of the two falls they should see, then run near the right cliff to a point just above the second fall, where they could pull out into a little chute. He announced to the men that they would run it the next morning.

That evening an unexpected turn of events took place, one which has been a matter of some controversy ever since.[29] Powell told the story this way.

> "After supper Captain Howland asks to have a talk with me. We walk up the little creek a short distance, and I soon find that his object is to remonstrate against my determination to proceed. He thinks that we had better abandon the river here. Talking with him, I learn that his brother, William Dunn, and himself have determined to go no farther in the boats. So we return to camp. Nothing is said to the other men."

That night Powell plots out their course, decides that in a direct line they are about forty-five miles from the mouth of the Rio Virgen, which is their destination. He wakes Howland, spreads his plot on the ground, and talks it over again.

> "All night long, I pace up and down a little path, on a few yards of sand beach, along by the river. Is it wise to go on? . . . I feel satisfied that we can get over the danger immediately before us; what there may be below I know not. . . . To leave the exploration unfinished, to say that there is part of the canyon which I cannot explore, having already almost accomplished it, is more than I am willing to acknowledge, and I determine to go on."

Breakfast was like a funeral. The three men insisted on leaving. Guns and ammunition were given them, and food if they wanted it. Duplicates of the records were given them; a letter to Powell's wife was entrusted in their care; and Jack Sumner's watch, intended for his sister. They shook hands. The three men climbed a crag to see the others off. Powell and his men stepped aboard the *Maid of the Canyon,* the *Emma Dean* being left behind. They ran the falls as planned and were able to swing clear of the dangerous rocks below. They had shot many more dangerous places than this. "We land at the

first navigable point below and fire our guns, as a signal to the men above that we have come over in safety. Here we remain a couple of hours, hoping that they will take the smaller boat and follow us." They finally pushed on. The other three men set out across country and a few days later were killed by Indians in an ambush.

Two days later Powell and his men saw the Grand Wash, and in short time they pulled up at the mouth of the Rio Virgen. This ended the first trip down the Colorado basin and through the Grand Canyon. Some of the men headed farther down river and thence overland to Los Angeles. Powell and his brother struck out for Salt Lake City. *Ka'-pu-rats* had conquered the canyon!

REFERENCES

1. D. C. Woodbury, *The Colorado Conquest* (New York: Dodd, Mead, 1941), p. 3. Quoted by permission.
2. *Ibid.*, p. 24. Quoted by permission.
3. Quoted by F. S. Dellenbaugh, *The Romance of the Colorado River* (New York: G. P. Putnam's, 1902), p. 135. Quoted by permission.
4. J. W. Powell, *First Through the Grand Canyon* (New York: Outing Publishing Company, 1895),p. 24.
5. Dellenbaugh, *op. cit.*, p. 40. Quoted by permission.
6. *Ibid.*, p. 52 f. Quoted by permission.
7. *First Through the Grand Canyon,* p. 18.
8. *Ibid.*, p. 19.
9. W. H. Davis, "John Wesley Powell, 1834-1902," *Biographical Memoirs, National Academy of Sciences,* VIII, p. 17.
10. W. H. Brewer, "John Wesley Powell, " *American Journal of Science,* XIV (1902), p. 381.
11. *First Through the Grand Canyon,* pp. 29-30.
12. *Ibid.*, p. 31.
13. *Ibid.*, p. 34.
14. *Ibid.*, pp. 41-42.
15. *Ibid.*, pp. 49-50.
16. *Ibid.*, p. 58.
17. *Ibid.*, pp. 67-68.
18. *Ibid.*, p. 79.
19. *Ibid.*, p. 111.
20. *Ibid.*, pp. 122-123.
21. *Ibid.*, pp. 134-135.
22. *Ibid.*, p. 137.
23. *Ibid.*, p. 151.
24. *Ibid.*, p. 155.
25. *Ibid.*, p. 191.
26. *Ibid.*, pp. 200-201.
27. *Ibid.*, pp. 203-204.
28. *Ibid.*, pp. 236-237.

29. *Ibid.,* pp. 240 ff. This whole episode has been reviewed by Chalfant and Stanton. They agree that Powell's account does discredit to the men who left his party, that they did not do so through cowardice on their part, that it seems to have been a case of nerves and of intense dislike for Powell's own martinet behavior. Cf. J. M. Chalfant, ed., *Colorado River Controversies* (New York: Dodd, Mead, 1932). Both Chalfant-Stanton and Dellenbaugh give full credit to the Major for having been the first to go through, and they both expressly deny the wild yarn by the Kenosha, Wisconsin prospector, James White, that he had come through on a raft in 1867. The Dunn-Howlands episode is a blemish on the Major's record. So is his neglect to give ample credit to the men of the second party. But these failures do not obscure the triumph which Powell and his men achieved, the conquest of the turbulent and treacherous Colorado and the solution of the last geographical problem of the United States.

Chapter III

MOUNTAINS ARE MINUTIAE

1.

PLACE IN AMERICAN GEOLOGY

"In Powell's day," according to a recent history of geology, "few geologists on this side of the Atlantic realized that land changes were worth serious study or that land forms themselves were records of the past as significant as series of strata." [1] Major Powell was the first American geologist to realize the tremendous implications of this view of the earth and systematically to set forth the evidence for it.

His contemporary, geologist G. K. Gilbert, a half-century ago appreciated the importance of Powell's contribution to this phase of geological science and summarized it thus: "He developed a new classification of mountains, by structure and genesis; a structural classification of dislocations; a classification of valleys; and a genetic classification of drainage systems." He expressed two broad notions: "that the physical history of the earth might be read from a study of its drainage system in relation to its rock structure" and "that since the degradation of the land is limited downward by the level of the standing water which receives its drainage, the types of land sculpture throughout a drainage area are conditioned by this limit." This latter is the concept of the "baselevel of erosion." These two items, remarked Gilbert, "are the fundamental principles of a new subscience of geology and sometimes called geomorphology, or physiographic geology." [2]

It is a sizable contribution for one man to have made. His work is even more impressive when one recalls that it was accomplished by a self-taught student whose field work occupied not more than seven or eight years. This fact suggests a mind which not only could quickly capitalize on immediate observations but which could absorb the reports of others and together reorganize them into the beginnings of a systematic science. Here we see one phase of Powell's genius, which is displayed over and over again: an unexcelled capacity to bring together great quantities of facts, many of them apparently unrelated, in a new and profitable perspective.

European geologists had been preoccupied for some time before Powell with the morphology and dynamics of the earth's surface. But their work was relatively unknown to Americans and not at all to Powell. Moreover, the classifications and names for geological structures were European in origin and reference. American geologists during the last quater of the nineteenth century not only succeeded in adapting European classificatory systems to geological phenomena in this country but proceeded to do some trail-blazing of their own, filling in great lacunae in geological science.

They were greatly aided in this task by the amazing land formations of the North American continent, by the hundreds of thousands of dollars spent for this purpose (in part!) by the federal government, and by the glowing enthusiasm of a small but alert corps of young scientists. They not only explored the American West in one generation but also "geologized" it. It was a period of monumental industry and achievement. And foremost among the leaders in this period was Powell himself. "Every geologist," the Fentons report, "looks upon him as a sort of American Murchison, who encouraged young men when they needed help, built up an adequate federal survey, and helped to make the nation's political capitol a great capitol of science."[3]

2.

THE CANYON VISTA

Powell's first glimpse of dynamic geology apparently came from the great Kaibab and Coconimo plateaus which rise six to nine thousand feet above the sea. Here he saw an immense gorge cut by the Colorado River: a broad, intricately sculptured chasm with a host of imposing peaks and buttes, gulches and ravines, canyons within canyons.[4] Its complex earth carving, its anatomy of the earth's past, its ramifying valleys and streams offered a gigantic laboratory for observing and testing. This same opportunity Powell came across when he wandered through the Uinta Mountains. The geology of the Colorado basin system and its mountain watersheds formed the subject-matter of his best-known geological publications.[5]

Pondering over the meaning of these dramatic scenes, he captured both their history and their power in a stirring paragraph. He wrote:

> "The river had the right of way. In other words, it was running ere the mountains were formed; not before their rocks, of which the mountains are composed, were deposited, but before the forma-

tions 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 24,000 feet above the river." [6]

Powell was not the first to sense the historic role of the drainage system in the patterning of land surfaces. Hayden had come to the same conclusion in his discussion of the gorges and canyons of the rivers of Montana.[7] But Powell was the first to systematize and publish the evidence for the thesis.

His was a breath-taking reconstruction of the geological past, equal to the breath-taking beauty of the country itself.

"Three times has this great region been left high and dry by the ever shifting sea; three times have the rocks been fractured and faulted; three times have floods of lava been pourd up through the cervices, and three times have the clouds gathered over the rocks, and carved out valleys in their storms. The first time was after the deposition of the schists; the second was after the deposition of the red sandstones; the third time is the present. The plateaus and the mountains of the first and second periods have been destroyed or buried; their eventful history is lost; the rivers that ran into the sea are dead, and their waters are now rolling as tides, or coursing into other channels. Were there canyons then? I think not. The conditions necessary to the formation of canyons are exceptional in the world's history." [8]

The poet in the man spoke to the geologist as the immense time pattern of this geological drama began to dawn upon him.

"We have looked back unnumbered centuries into the past, and seen the time when the schists in the depths of the Grand Canyon were first formed as sedimentary beds beneath the sea; we have seen this long period followed by another of dry land— so long that even hundreds, or perhaps thousands, of feet were washed away by the rains; and, in turn, followed by another period of ocean triumph, so long, that at least ten thousand feet of sandstones were accumulated as sediments, when the sea yielded dominion to the powers of the air, and the region was again dry land. But aerial forces carried away the ten thousand feet of rocks, by a process slow yet unrelenting, until the sea again rolled over the land, and more than ten thousand feet of rocky beds were built over the bottom of the sea; and 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. Now we have canyon gorges and deeply eroded valleys, and still the hills are disappearing, the mountains themselves are wasting away, the plateaus are dissolving, and the geologist, in the light of the past history of the earth, makes prophecy of a time when this desolate land of Titanic rocks shall become a valley of many valleys, and yet again the sea will invade the land, and the coral animals build their reefs in the infinitesimal laboratories of life, and lowly beings shall weave nacre-lined shrouds of themselves, and the shrouds shall remain entombed in the bottom of the sea, when the people shall be changed, by the chemistry of life, into forms; monsters of the deep shall live and die, and their bones be buried in the coral sands. The other mountains and other hills shall be washed away into the Colorado Sea, and coral reefs, and shales, and bones, and disintegrated mountains, shall be made into beds of rock, for a new land, where new rivers shall flow." [9]

The mountains, asserts Powell, are temporary and transient. They are minutiae. The great land formations are the creations of giant but slow-working forces operating on the surface of the land. Erosion is the *deus ex machina* of this ancient darma.

"All the mountain forms of this region are due to erosion; all the canyons, channels of living rivers and intermittent streams, were carved by the running waters and they represent an amount of corrasion and erosion difficult to comprehend. But the carving of the canyons and the mountains is insignificant, when compared with the denudation of the whole area, as evidenced in the towering cliffs of erosion. Beds hundreds of feet in thickness and hundreds of thousands of square miles in extent, beds of granite and beds of schist, beds of marble and beds of sandstone, crumbling shale and admantine lavas have slowly yielded to the silent and unseen powers of the air, and crumbled into dust and been washed away by the rains and carried into the sea by the rivers. The story we have told is a history of the war of the elements to beat back the march of the lands from the ocean depths." [10]

But erosion, Powell points out, is only part of the story. There are other agencies: those that disturb the level of the geological formations, causing folds and faults, and those which erupt, pouring sheets of lava over the surface, throwing up mountain masses and forming cones.

"These three agencies have produced three distinct classes of topographical features. Erosion . . . has produced that labyrinth of deep gorges or canyons, that has made the country so nearly inaccessible that, before the present expedition, the region has been

left entirely unexplored; the faulting and folding of the rocks have, together with erosion, produced long lines of cliffs of a magnitude that is believed to be elsewhere unknown. . . . The third class of agencies, in conjunction with erosion has produced a number of black mesas, composed of sheets of cooled lava. On these mesas, and directly over the fissures through which the lava was ejected, naked, black cinder-cones, usually with well-defined craters, have been thrown up." [11]

It is, Powell is suggesting, like a great orchestral score whose mighty crescendoes are followed by dimuendoes of stark and startling beauty.

"The eruptive formations connected with these disturbances are of three general classes: First, the earlier eruptions, modified by subsequent erosion, have produced a number of mountain-ranges; second, later flows have produced sheets of basalt, that form the summits of low mesas and table-lands, or have partially filled and modified the valleys; third, the expiring energies of these agencies have left, standing in lines along the fissures, great numbers of cinder cones." [12]

Could all this have happened elsewhere? Powell did not think so.

"The aridity of the climate is such that this may be considered a region of lesser, rather than greater erosion. We may suppose that, had this country been favored with an amount of rainfall similar to that of the Appalachian country, and many other districts on the surface of the earth, that the baselevel of erosion of the entire area would have been the level of the sea; and, under such circumstances, though the erosion would have been much greater than we now find, the evidences of erosion would have been more or less obliterated." [13]

Moreover, "a greater precipitation of moisture would have resulted in a very different class of topographic features. Instead of canyons, we should have had water-gaps and ravines; instead of valleys with cliff-like walls, we should have had valleys bounded by hills and slopes; and if the conclusions to which we have arrived are true, the arid conditions now existing must have extended back for a period of time of sufficient length to produce the present canyons and cliffs. But there are facts which seem to warrant the conclusion that this condition has existed for a much longer period than that necessary for the production of the present features; that is, the characteristics of the present topography have existed for a long time."

Powell's demonstration that the mountains were not lifted up faster than the river could cut its canyons down their broad anticline convinced his contemporaries that uplift as well as erosion and

deposition is a very slow process. The doctrine of geological peace on earth, as Davis observed, thus "gained a vast backward extension in periods of the past that had long been conceived as ages of violence."..[14]

When Powell's field reports on the Colorado and Uinta Mountains surveys came in, Joseph Henry, Secretary of the Smithsonian, wrote James G. Blaine: "In view of the results obtained at a comparatively moderate expense, I would respectfully commend the application of Professor Powell for a renewed appropriation for continuing his explorations and surveys." It was a mild, though to Powell a crucial, recognition.

3.

GEOMORPHOLOGY

Davis has written an excellent summary of Powell's efforts to construct a geomorphology of the West.[15] "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." [16]

The American West offered a pioneering geologist all he could want. Indeed, he could hardly fail to see the intimate relation between surface forms and internal structure in an area whose ground cover is so scanty. Powell, 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 the 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." [17]

In support of his theory, Powell wrote: "had the fold been uplifted more rapidly . . . all the smaller streams and waterways should have been cataclinal" (that is, flowing down the dip). Hence, "the drainage was established antecedent to the corrugation or displacement of the beds by faulting and folding." [18] This sequence holds true both for the drainage basin of the Green and of the drainage lines of the Arizona plateau. "All the facts," recorded Powell, "concerning the relation of the waterways of the region to the mountains, hills, canyons,

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." [19] This conceptualization led Davis to conclude that "it is distinctly to Powell that geology now owes the general acceptance of the idea of antecedence in river development."

Original observations in an unexplored country call for emancipation from inflexible taxonomy. In his first report as Director of the U. S. Geological Survey, Powell stated that in the process of reduction local formation names had been used "in opposition to received opinions, and in spite of the almost universal efforts of geologists to attain uniformity; it therefore represents the logical and necessary growth of 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. . . ." Powell was thus formulating a rule which he himself had been following for a number of years. In his classification of streams and valleys he freely invented names for what he saw. He experimented with a two-fold classification. One was based on the relation of stresses to the strata they traversed; each type was given a name of Greek origin,—"cataclinal," "diaclinal," and so on; this classification did not achieve wide currency. The second classification of the waterways and valleys was formulated in terms of their origins, using Latin derivatives: thus "antecedent," "consequent," and "superimposed"; these have come into general use.

One enduring contribution which Powell made to geological science was the concept, baselevel of erosion.

> "We may consider the level of the sea to be a grand baselevel, below which the dry lands cannot be eroded; but we may also have, for local or temporary purposes, other baselevels 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 baselevel 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 baselevels of erosion." [20]

The concept is simple, but its announcement marks an era in rational physiography.[21]

Mountain formation was far more fascinating to Powell than the mountain forms themselves, and he theorized quite successfully on the nature of the processes of formation. He held 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 above their tops; the clouds have formed the mountains." [22] The eroding agencies work fast at first, but with exaggerated deliberation at the end of the cycle.[23]

Powell perceived the role of planation in the processes of mountain formation on his first trip West with his party of students. Speculating on the plateau-like highlands of crystalline schists flanked by upturned sedimentaries in the Colorado Front Range, he then "dimly conjectured," as he later said, "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 planing down occurs when the channels of the eroding streams remain for a great length of time at a general baselevel." [24]

Viewing mountain formation over the long ranges of geological history, Powell came to a startling conclusion. "Mountains cannot long remain as mountains; they are ephemeral topographic forms. Geologically, all existing mountains are recent; the ancient mountains are gone." [25] Davis writes: "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!' " [26]

4.

THE EARTH AS A STRUCTURAL SHELL

Powell was adept in writing for lay audiences. An instructive example is his exposition of his theory of earthquakes.[27] This article, along with paragraphs in his Uinta Mountains report and an essay in one of the scholarly journals, sets forth a systematic theory of dynamic geology.

He asked his readers to think of the land surfaces of the earth as consisting of a series of formations imposed on it. "Formations are piled on formations." [28] "The whole system of formations," he continued, "may be thought of as constituting a kind of structural shell." The shell may be fractured, suggested Powell, and the edge of one side of the fracture turned up to the light of day; and upheavals and subsidence may fold it. Below the shell there is a great primordial and universal formation of consolidated rocks. Displacements of the shell, known as faults, come from upheavals and subsidence. Land surfaces are the products, in part, of these displacements. If above the sea level, the formations are acted upon by rain and rivers the process of degradation takes place. If the elevation from upheaval is greater than the rate of degradation, the mountainous terrains are formed. "The evidence is abundant that the structural shell of the earth is still in progress of deformation by defaults, flexures and folds." [29]

With this orientation, Powell adduced from his study of the Uintas a number of basic principles by which changes in the structural shell occur. Here, he says, three great categories of facts are represented on a grand scale: facts relating to displacement, facts relating to degradation, and facts relating to sedimentation. "The displacements are of great magnitude, and because the beds involved are sedimentary strata but rarely altered, the characteristics of these displacements are plainly revealed. . . ." [30] Moreover, both displacement and degradation have been very great, yet the country has not been planed down to a general baselevel.

In this giant laboratory nature has been at work with two powerful reagents, the processes of erosion and of degradation. Since erosion (and its corollary, corrasion) was discussed earlier in another connection, we will review Powell's data on degradation to illustrate the way in which, as he saw it, the structural shell of the earth is changed by the force of factors external to it.

"Degradation," he pointed out, "consists of disintegration and transportation, and they are mutually dependent parts of the general process." [31] Disintegration is the work of gravity, heat, crystallization, and mineral reaction, working within the matrix of climate and declivity and petrology. The rate depends on declivity too. But the process is interactional, interdependent with climate and rock structure. The higher the momentum of transportation, the more rapid the disintegration of the land form. High mountains cannot last much longer than

low ones. Indeed, mountains cannot remain (geologically speaking, of course!) as mountains for long. They are ephemeral topographic forms. Present mountain ranges are recent; the old ones have disappeared.[32]

5.

BENEATH THE STRUCTURAL SHELL

Powell sought to relate his information about the dynamics of land surfaces to the momentous changes in the deep-lying regions of the earth.[33]

It is plausible, on the basis of the evidence, to assume that the interior of the earth is in a fluid condition. The solid shell which covers it is comparatively thin but variable in depth, perhaps twenty-five miles at the maximum. The earth's crust is "in a state of floating equilibrium." Hence, Powell continued in his article in *Science,* "if some portion of rocky material is taken from any district, it rises, and the district on which it is deposited subsides."

To understand the consequences of such earth-shaking transportation, it is necessary to remember that the earth's crust consists of great geological formations, broken into great blocks by great fault and plexure planes. Each block or segment of a faulted formation is divided further into small fragments by stratum planes, joints, schists, planes, and slaty cleavages. "The general rigidity of the crust," Powell observed in his paper in *Science,* "is dependent on mechanical structure. . . . The fragments of which the crust of the earth is composed are exceedingly minute when compared with geologic formations, and they appear relatively as but grains of sand when compared with the whole crust of the earth."

Now suppose that on this crust a critical stress is applied. "The strain," according to Powell, "is propagated laterally by the condition of rigidity, but not indefinitely, as the rigidity speedily vanishes in the presence of the enormous forces involved in the weight of the crust itself, and in the great bodies of matter that are unloaded and loaded at the surface."[34] The distance is also lessened by the fact that the crust is not a continuous solid.

Whence come these critical stresses and strains? They arise partly from the conditions induced by the cooling process affecting the earth itself. This process brings contractions and expansions within the earth. But other factors are operative. Different earth materials have

different specific gravity. Water action which is constantly occurring causes a continuous lateral transference of materials across the shell of the earth. There is a constant vertical transference of material by displacement and a transference of material from beneath to the surface by a process which Powell called "extravasation." In addition, there is the ever-changing density of the earth, due in part to chemical action in the form of hydration, in part to the solidification of rocks and minerals from the melted state and liquefaction from the solid state, and in part to pressure and relief from pressure which the solidification-liquefaction processes produce.

These factors and processes induce variable results in the structural shell. Powell tabulated them as follows: "general secular contraction; transference of material horizontally at the surface by aqueous agencies and vetrically by subsidence and upheaval, and from within to the surface by extravasation; changes in the chemical and lithical constitution of rocks, as seen in various forms of metamorphism; local lateral compression of formations, exhibited in plication and implication, and local stretching, exhibited in certain parts of flexures." [35]

Powell speculated on the long-time trends of these global movements. In general, he felt that they are, from a secular point of view, diminishing. However, certain secondary agencies and activities—such as local loading and unloading, chemical reactions arising from changes of temperature, pressure, and hydration, expansion of water into steam—increase in efficiency "by reason of increased heterogeneity in the structure of the crust." [36] Moreover, he continued, internal heterogeneity of the earth "renders the crust more sensitive to external agencies of change. . . ." The problem of the measurement of the rate of change or its direction must await more detailed physical and mathematical information. However, it is reasonable to believe, he thought, that "the earthquakes of human history sink into insignificance in comparison with the earthquakes of geologic history." [37] The time-scale of human history is too short for a measure of the earth. Geologically, even mountains are, after all, only minutiae.

REFERENCES

1. C. L. and M. A. Fenton, *The Story of the Great Geologists* (New York: Doubleday, Doran, 1945), p. 244. Quoted by permission.
2. G. K. Gilbert, "Remarks on J. W. Powell," *Annual Report Smithsonian Institution,* 1902, p. 638.
3. Fenton, *op. cit.,* p. 258. Quoted by permission.
4. G. W. Wood, "The Grand Canyon," *Encyclopedia Britannica,* X (1946), pp. 630 ff.
5. J. W. Powell, *Report on the Geology of the Eastern Portion of the Uinta Mountains and a Region of Country Adjacent Thereto* (Washington, D. C.: Government Printing Office, 1876); *Exploration of the Colorado River of the West and Its Tributaries Explored in 1869, 1871 and 1872* (Washington, D. C.: Government Printing Office, 1875).
6. *Exploration of the Colorado River . . . , op. cit.,* p. 213.
7. Cf. G. P. Merrill, *The First Hundred Years of American Geology* (New Haven: Yale University Press, 1924), pp. 479 ff.; also F. V. Hayden, *Sixth Annual Report,* U. S. Geological and Geographical Survey of the Territories for 1872, p. 85.
8. *Exploration of the Colorado River . . . , op cit.,* p. 213.
9. *Ibid.,* p. 214.
10. *Ibid.,* p. 208.
11. *Ibid.,* p. 9.
12. *Ibid.*
13. *Ibid.,* p. 209.
14. W. H. Davis, "John Wesley Powell, 1834-1902," *Biographical Memoirs, National Academy of Sciences,* VIII: p. 25.
15. Davis, *op. cit.,* pp. 29 ff.
16. *Ibid.*
17. *Ibid.*
18. *Exploration of the Colorado . . . , op. cit.,* p. 163.
19. *Ibid.,* p. 198.
20. *Ibid.,* p. 203.
21. Davis, *op. cit.,* p. 33.
22. *Exploration of the Colorado . . . , op. cit.,* p. 154.
23. *Report on the Geology of the . . . Unita Mountains . . . , op. cit.,* p. 196.
24. *Ibid.,* p. 27.
25. *Ibid.,* p. 196.
26. Davis, *op. cit.,* p. 35 f.
27. "The Cause of Earthquakes," *Forum,* II (1886), pp. 370 ff.
28. *Ibid.,* p. 373.

29. *Ibid.*, p. 378.
30. *Report on the Geology of the . . . Uinta Mountains . . . , op. cit.*, p. iii.
31. *Ibid.*, p. 182.
32. *Ibid.*, p. 196.
33. "On the Fundamental Theory of Dynamic Geology," *Science,* II (1884), pp. 511 ff.
34. *Ibid.*
35. *Ibid.*, p. 512.
36. *Ibid.*
37. "The Cause of Earthquakes," *op. cit.*, p. 383.

Chapter IV

THE LOGIC OF LAND USE

1.

"THE GREAT AMERICAN DESERT"?

"For the first half of the ninteenth century," observes Walter Prescott Webb, "and in some quarters until after the Civil War, there existed in the public mind a Great American Desert situated to the east of the Rocky Mountains."[1] Even the maps during this period showed such a place, so named. No one did so much as Powell to expel this notion and to replace it with the idea that here was a region capable of great human development, though not extensive settlement. Nor did any one in the nineteenth century understand so well as he that there were limitations and hazards in this tremendous "district of country," as he was fond of calling it. And in this day when soil conservation districts, grazing associations, irrigation and water conservancy districts have become a commonplace phenomenon on the Plains, it is surprising to learn that as early as the 'Seventies Powell was advocating, without success and with much opposition, just such institutions. Yet he predicted that they would come in time, for he knew as few men of his day did that survival on the Plains would absolutely require them.

It is an immense stretch of country whose boundaries are generally indicated by rainfall lines on the east and mountains on the west. Extending from Texas to Manitoba, it is bounded on the west by the Rockies and on the east by the so-called 20-inch rainfall line, approximately at the 98th meridian. It is a dry country. But there is no uniformity in its precipitation pattern. Some parts of it have as little as 8 inches, others as much as 20. Taking the 21-year period to 1938, one finds that 17 years had less than average rainfall. If a span of 150 years is taken, tree ring data, supplied by E. A. Bell, formerly Superintendent of the Northern Montana Experiment Station at Havre, show that eight periods, lasting four to nine consecutive years, were very likely below average.[2] It is an unpredictable country, a fact which has led to disastrous results for the economy. Variations in climate have parallels in the variations in weather; blizzards are followed by

light snow, dew by heat, cloudbursts by dry, hot winds. Droughts sometimes bring rust in their wake, and late rain and snow in the spring may contrast with summers of blowing dust.

An elevation profile of the northern part of the Great Plains shows a progressive drop from the 4,500 feet of the eastern edges of the Rockies through the 2-4,000 feet of most of Montana and the western half of the Dakotas and Nebraska, to the 1-2,000 feet of the eastern half of these last-named states. Scattered throughout the Plains are mountain-like formations—e. g., the Sweet Grass Hills and the Bear Paw Mountains of Montana, the Black Hills of South Dakota; there are moraine deposits, plateaus, river valleys, and lake beds. There is variability in the topography. But the over-all picture is one of vast, relatively uninterrupted, wind-swept, sun-baked landspaces.

Walter Prescott Webb has tried to formulate a pervading principle of the Plains country. It is, he thinks, a geographical unity whose influences have been so powerful as to put a characteristic mark upon everything that survives within its borders.[3] Its unity is a compound of level surface, treelessness, and sub-humid climate. Its soils in general lack minerals, its streams are non-navigable, its rivers have quicksand. Its winds have intense heat and extreme dryness; they average ten to twelve miles an hour in most sections and are constant; and there are the storied "chinooks," "northers," and "blizzards." It is a short-grass country, its grasses suited to withstand conditions of excess dryness, excess drought, and fires; nonetheless, the Plains is a grasslands country.

Its soils reflect the variability of its topography, but certain uniformities can be observed. The eastern third of the Plains consists of "blackearth" or "dark-colored chernozem" soils, which are unusually fertile and suited to grain farming on an extensive scale. The western two-thirds of the Plains has chestnut-colored soils, with some brown and gray, fertile but dry. As a rule, in the Plains the diversity of the soil pattern is so great and so complex that most farms have several types. This diversity is associated with the range and variation in the average crop yields.

The utilization of these soils in an area so dry and unpredictable represents a complex of novel, intricate adjustment problems. These problems have some relationship, of course, with the soils themselves. Generally speaking, the Plains soils are, as the Great Plains Committee has pointed out, "suitable in texture, inherently fertile, and without need for lime or commercial fertilizers."[4] But much of the Plains

land is sandy and light-textured, subject to wind erosion and with poor absorptive capacity. These features, in combination with a climate which hovers around the point critical for vegetation, create conditions for a peculiar way of life.[5]

Paucity of water is the most striking characteristic of the Great Plains. The most important drainage system is the Missouri, into which flow the Yellowstone, the Platte, and the Kansas systems. This great river basin is perennial in character, unlike many of the Plains streams which flash in the spring and disappear in the summer. Indeed, most of the streams of the Plains are "not dependable sources of water for highly developed irrigation practice unless large amounts of storage are provided."[6] For this reason, irrigation is dependent upon the large, perennial streams, and these have been levied upon in places to the point where it is now necessary to import water from the great watersheds by storage and planned release. Ground supplies over great areas of the northern half of the Plains are at such depths as to make their utilization prohibitive, as Powell pointed out in his day. A further aspect of the water supply is its unreliability: the sequence, repeated again and again, is for springs, wells, waterholes to dry up, making it necessary to haul water, transport stock, and all too frequently to abandon farms.

Plant and animal life represent the kind of adaptation one might very well expect in an environment such as obtains in the Plains. The grasses are those which can survive the fluctuations and severity of this environment: grama, buffalo, galleta, wire, Muhlenbergia, western wheat, and needle grasses. Animal life likewise shows an adaptation. As Kraenzel has written: "The native animal life on the Great Plains is characterized by ability to move great distances rapidly and without water for long periods of time."[7] Chief among the native animal population are the antelope, buffalo, jack rabbit, prairie dog, gopher, wolf, coyote: all able to roam great distances, adapted to stand the fluctuations in temperature and rainfall on the Plains, physically hardy and fleet.

The variable controlling survival in the Plains region is climate, or more precisely the ebb and flow of cycles of climate.[8] Climatic cycles are common in most regions, but here their effects are most severe. Continuous climatic pulsations of varying degrees of magnitude and duration, then, hold the key to the planning and the patterning of land use in this great region.

2.

A UNIQUE DISTRICT OF COUNTRY

Such, then, in a very general way is the information which we now have about the Plains after two or three generations of occupance and scientific study. But in the 'Seventies and 'Eighties only Powell, probably, was able to say these things with certainty and understanding. "Up and down the temperature of agriculture," he warned the North Dakota Constitutional Convention, "will rise and fall with the seasons. . . . The only practical thing to do is to look the thing squarely in the face and remember that in middle Dakota, agriculture will always be liable to meet with failure unless you provide against it. . . . Years will come of abundance, and years will come of disaster. . . . You hug to yourselves the delusion that the climate is changing . . . you may as well not hope for any improvement in this direction. You are going to need, each year, a little more water than you are going to get." [9] It is a dangerous, unpredictable country, not as easily subdued as the Indians, and it is deceptive. "Luxuriant vegetation has often tempted the settlers to select lands at too great an altitude, and many towns have been moved downstream." [10] Before a House Committee in 1884, he estimated that every town in Utah—a part of Powell's "arid lands" but outside the Great Plains—moved on an average twice before final settlement.

Even its monotonous sameness is deceptive. In the Public Lands Commission report (1880), which Powell had a large share in writing, Congress was advised: "Its most conspicuous characteristic from an economic point of view is its heterogeneity. One region is valuable exclusively for mining, another solely for timber, a third for nothing but pasturage, and a fourth serves no useful purpose whatever. The very small proportion which is capable of agriculture must, in the greater part of the West, be irrigated, in order to yield a crop." [11]

However, one common denominator, according to Powell, is the climate. "Extending from the 100th meridian line eastward to about the isohyetal line of 28″, the district of country thus embraced will be subject more or less to disastrous droughts, the frequency of which will diminish from west to east. For convenience sake let this be called the Sub-humid Region." [12] It is a land of fertile soil, but inadequate rainfall. "Far too much attention," he warned, "has heretofore been paid to the chemical constitution of soils and too little to those physical conditions by which moisture and air are supplied to

the roots of growing plants." [13] The rainfall is the strategic thing. "Experience teaches us that it is not wise to depend upon rainfall where the environment is less than twenty inches annually, if this amount is somewhat evenly distributed throughout the year, but if the rainfall is unevenly distributed, so that 'rainy seasons' are produced, the question whether agriculture is possible without irrigation depends upon the time of the 'rainy season' and the amount of its rainfall." [14] "At twenty inches agriculture will not be uniformly successful from season to season." [15] Dry-land farming is a bad risk.

But so is unplanned development through irrigation. The first impulse of settlers will be, he warned, to use the smaller streams "without regard to the subsequent use of the larger streams to which the smaller ones are tributary." [16] Over and over again during the 'Eighties and 'Nineties Powell returned to this theme: irrigation through the utilization of the larger streams. Storage of waters in great reservoirs in the highlands, he insisted, is the only answer to an adequate and a fair system of irrigation works in the West.

What, then, are the problems of government action in the lands of the arid West? Powell pointed to eight of them.

First, some 100,000,000 acres must be redeemed at an expense of at least a billion dollars. Second, laws must be passed distributing the land among the people. Third, there must be an equitable division of the waters among the States. Fourth, the waters must be distributed among the people "so that each man may have the amount necessary to fertilize his farm." Fifth, forests must be protected and preserved from fire "in order to protect the sources of water." Sixth, the grasslands lying between the irrigated areas and the forests must be protected and utilized. Seventh, the minerals must be kept "ready to the hand of industry and the brain of enterprise." Finally, the power of the factories (water power) must be created and utilized.[17]

In line with this logic he drew up two bills which sought to establish a new land system for the West. One provided for irrigation districts, the other for grazing districts. Land units in the one were to be limited to 80 acres, in the other to 2560 acres. The title to water was to inhere in and to pass with the land. The land must be surveyed in such a manner that each person would have access to water: a topographic basin system must replace the older rectangular system.

Unhappily, these proposals, as Webb says, "broke too much with the past to be acceptable to the lawyers and politicians. . . .The mental

and legal inertia was too great to be overcome." [18] Many years later a beginning was made with the Newlands Reclamation Act, still later there was the Taylor Grazing Act, and in our own time the Soil Conservation Act. Slowly and expensively, after much physical waste and human loss, institutions for the arid lands were perfected! But not in Powell's time.

3.

PHILOSOPHY OF REGIONAL PLANNING

It was characteristic of the Major that he should plan a general offensive against the complex problems which he had noted in this new and undeveloped country. "It was my purpose," he explained in the preface to his Arid Lands report, "not only to consider the character of the lands themselves, but also the enginering problems involved in their redemption, and further to make suggestions for the legislative action necessary to inaugurate the enterprises by which these lands may eventually be rescued from their present worthless state." [19]

Such a program was above all timely. For the West was quickly filling up: frontier farmers, government troops, prospectors and miners, cattlemen, and railroad builders were moving restlessly across it. At the time he wrote his famous report one billion acres of public land remained: about one half of the whole United States. During the Civil War and the decade following, Congress had passed four major land laws: the Homestead, Timber Culture, Desert Land and Mineral Acts, along with numerous railroad and educational grants. In 1887, the year the Major was writing his report, the General Land Office disposed of nearly five million acres. In the decade of the 'Eighties it sold on an average of twenty million acres annually. Yet the government land policy was, to put the matter mildly, so inadequate, its procedures so antiquated, many of its officials so confused or corrupt, that the United States could scarcely be said to have a land *system* at all. The editor of the widely read *Copp's Land Owner,* in a November, 1885 issue, congratulated a retiring law officer of the Land Office. "He has," wrote the editor, "furnished valuable precedents on all sides of nearly every question of importance during the past fifteen years." [20] Congressional attention to its public domain was a patchwork of apathy, neglect, and strong western pressures.[21]

Largely as a result of the Major's Arid Lands report, a Public Lands Commission was appointed and brought in its report in 1880 after extensive hearings in Washington and throughout the West. Powell was a member, along with Clarence King, J. A. Williamson (chief of the General Land Office), Thomas Donaldson and A. T. Britton. In this report, in his earlier Arid Lands study, in his untiring fight for an irrigation survey of the western lands, and in numerous articles in the national magazines, Powell outlined his philosophy for the regional planning and development of the West.

In 1888 he wrote the Secretary of the Interior, W. F. Vilas: "The establishment of a general system of irrigation on a comprehensive plan is of immediate importance, because the agriculture of the arid region, now in its infancy, is rapidly developing and its development without suitable regulation constantly involves the use of temporary plans which interfere with and obstruct the adoption of those necessary to the fullest utilization of resources." [22]

This insistence on an immediate but comprehensive approach—to him scientifically necessary, though, as he knew, politically unrealistic—displays the Major at his best. A Westerner, he was used to wide margins, like Walt Whitman; a scientist and philosopher, he saw matters in their wholeness. Thus, when he was finally assigned the task of making the irrigation survey which he had so urgently requested, he went about it with customary thoroughness. He outlined his objectives thus: (1) maximum area and most advantageous selection of farming land; (2) best selection of sites for reservoirs and their proper sizes; (3) best system of headworks and canals. To secure these goals he insisted that it was necessary (1) to prepare topographic maps of the western lands; (2) to determine total annual discharge of waters from catchment basins; (3) to make soil surveys.[23] For Powell there must be no half-measures.

Moreover, regional planning must be detailed as well as extensive. Thus: "Account must be taken of the total volume of water susceptible of storage, of the loss through evaporation and seepage in the reservoirs and canals, of the local duty of water, of the value of the redeemed land for the growth of the crops adapted to the climate and soil, of the expense for construction of irrigation works and the interest on the same, of the expense of their maintenance, of the deterioration of reservoirs by clogging with debris, and of vested rights if any exist; and all these must be considered in connection with the topographic

configuration." [24] To Powell's mind, regional planning and development must be total, whatever else it may be.

4.

INSTITUTIONS FOR THE ARID LANDS

In April, 1878, Powell wrote J. A. Williamson about his Arid Lands report. "After setting forth the general facts relating to the conditions under which these lands must be utilized, I have taken the liberty to suggest a system for their disposal which I believe would be adapted to the wants of the country." [25]

His proposals were based entirely on his conviction about the uniqueness of the western country. "The march of settlement in its progress westward has reached a region of country where the physical conditions and limitations of agriculture differ from those prevailing in the regions first settled, and problems are presented now to us and unknown to our ancestors, who came from northern Europe, but very old to the people of southern Europe and of other regions of the earth." [26] A sub-humid region must develop its own institutions; to transplant those of humid areas would wreak havoc on the land and on the society.

Specifically, Powell proposed different institutions for different types of land. For the dryland areas he had in mind that "the farm unit should not be less than 2,560 acres; the pasturage farms need small bodies of irrigable lands; the division of these lands should be controlled by topographic features in order to give water fronts; residences of the pasturage lands should be grouped; the pasturage farms cannot be fenced—they must be occupied in common." [27] The colony system is indigenous in this country; the large-scale spread is imperative; access to water is vital. These considerations form the background for his proposal that the pasturage lands be organized into districts, "in which the residents should have the right to make their own regulations for the division of the lands, the use of the water for irrigation and for watering the stock, and for the pasturage of the lands in common or in severalty." [28]

His argument in support of this proposal is persuasive.

> "The lands, as lands, are of but slight value, as they cannot be used for ordinary agricultural purposes, i.e., the cultivation of crops; but their value consists in the scant grasses which they spontaneously produce, and these values can be made available only

> by the use of the waters necessary for the subsistence of stock, and that necessary for the smallest unit of irrigable lands which should be attached to the several pasturage farms. Thus, practically, all values inhere in the water, and an equitable division of the waters can be made only by a wise system of parcelling the lands; and the people in organized bodies can be trusted with this right while individuals could not thus be trusted." [29]

It is interesting that for all its uniqueness the arid West, so Powell thought, could best be developed by the traditions of democracy: "the people in organized bodies can be trusted," he wrote in his *Lands of the Arid Regions.*

Similarily, for the irrigable areas Powell found the answer to the problems of land and water utilization in co-operative oragnization. "This, then, is the proposition I make: that the entire arid region be organized into natural hydrographic districts, each one to be a commonwealth within itself, for the purpose of controlling and using the great values which have been pointed out. . . . Each such community should possess its own irrigation works; it would have to erect diverting dams, dig canals, and construct reservoirs; and such works would have to be maintained from year to year. The plan is to establish local self-government by hydrographic basins." [30] Here is not only vigorous regionalism but militant democracy!

His argument in support of his proposed irrigation districts is partly historical, partly logical. The establishment of such a system would actually mean extending a practice which was already growing up in the West. California, for example, in its Wright bill had organized such a district. Powell reviewed the history of irrigation systems elsewhere in the world.

> "There are two methods of controlling irrigation and dealing with these questions. Throughout all lands, where agriculture depends upon irrigation anywhere, there are two diverse systems of administration. The Spanish and Italian people provided one system of administration; the French and English provide another. . . . Either the people are put in possession of the rights by municipalities and work out their own systems of administration for themselves, as in the Spanish colonies and in Spain itself; or the British system prevails, where the Government owns the works, and takes possession of the waters and supplies the water to the farmers and charges them for it. This is the British system in India." [31]

Powell makes it clear that his own sympathies lie with the Latin system.

However, its equivalent in the United States at that time, the Wright program in California, appeared to him to have serious weaknesses.

> "The difficulty with the Wright bill is this, that it does not provide for the organization of irrigation districts as natural hydrographic basins. Any tract of land or region of country may be organized into an irrigation district, and the people may issue bonds to raise the money for the construction of irrigation works. But these districts will soon be in conflict with one another, as there are no means yet provided for the division of the waters among them. . . . As it is, it will ultimately lead to the multiplication of controversies, and put neighborhood at war with neighborhood. In most of the States—if I remember rightly in all the other States which have been organized—the State constitutions declare that the waters are the property of the people, but at the same time rights are granted to companies and individuals to control the water as distinct from the land so that the tendency . . . is to put the lands and the waters in the hands of capitalists or corporations; and that is going on at a very rapid rate." [32]

But finances and monopoly are only part of the difficulty. The trends Powell saw pointed to a gross violation of what he regarded as an indispensable regionalism. "The present State lines and present county lines are not laid out with the end of securing a homogeneous body of people, a people having one common interest in one county or one State government. If this country had been divided into counties and States by river basins, that difficulty would have been avoided. If it had happened that States had been divided by river districts, all these problems could have been solved by the States themselves; but as the facts actually exist the problems cannot be solved by State governments. . . ." [33]

Powell's vision of the West and its future was daring and original.

> "I think it is possible to divide all the arid region where irrigation is dependent on living streams into natural districts. I am not speaking of irrigation by the storage of storm waters, artesian waters, etc. I am speaking of irrigation from the sources where these great water rights are involved—that it is possible to divide into two or three hundred districts the whole of that vast empire, so that all the water, all the land, all the timber, and all the pasturage will be divided among these districts in such a manner that the people of one district will have control of the group of common values in these districts, and do as they please with them. My theory is to organize in the United States another unit of government for specific purposes, for agriculture by irrigation, for

the protection of the forests which are being destroyed by fire, and for the utilization of the pasturage which can only be utilized in large bodies; that is, to create a great body of commonwealths. In the main these commonwealths would be like county communities in the States. In many cases the districts would compose portions of two States. If it were possible to solve it so that every district would be within one State, and let the whole thing be turned over to the States, it would be to the best advantage, but to turn over the subject to the States under the facts which actually exist is to turn over to the States an endless conflict. Let the General Government designate the boundaries of these districts and let the Government make the surveys and say that the waters of each stream shall be used on specific lands." [34]

Powell said it was possible to do these things, and two generations later events would bear him out, in part at least; but he did not say it was probable that they would be done. The day-by-day administration of two Washington bureaus had taught him differently.

Indeed, no one was more aware of the magnitude and the unconventionality of his proposals and of their lack of political realism. "With a degree of misgiving the Director begs permission to suggest as his own opinion that the best solution of the problem under the present circumstances is to withdraw all the lands of the arid region from 'sale, entry, settlement, or occupation,' except those selected as irrigable lands, and to allow titles to irrigable lands to be acquired only through the operation of the homestead laws and the desert land laws." [35]

The spirit which motivated such planning was science. In this great "district of country," science must, according to the Major, become the instrument of public policy; through it he anticipated an orderly conquest of the land. Testifying before a Congressional Committee, he described the pattern of a scientific occupation of the country. He illustrated his Utopia by sketching the possible development of the Rio Grande Valley.

"This, then, is needed in the Rio Grande Valley, that its agriculture may develop normally, and that all rights established may be maintained: First, it should be divided into irrigation districts. . . . In each district the catchment area and the irrigable lands should be determined and defined. To define the irrigable lands, it is necessary to measure the waters, in order to determine how much land can be used. Then the irrigable lands should be declared such, and the law should prevent any other lands being irrigated. Then the catchment areas should be defined, and settlement on the catchment areas for agricultural purposes should be

> prohibited, and the people farming on the irrigable lands should have a right to control the catchment areas and to protect and use the forests and grasses. Then, in each district the storage basins should be segregated and reserved from sale and occupation, so that they may not fall into the hands of speculators whose rights would have to be purchased before the waters were stored; but the people who live in the district as a body politic and corporate should have a right to control these storage basins for the common use. The dam sites and the canal sites ought in like manner to be designated and preserved from sale to individuals and held for the common use of the people." [36]

What were the alternatives to the Major's scientific Utopia for the West? "Monopolies of water will be secured, and the whole agriculture of the country will be tributary thereto in a condition of affairs which an American citizen having in view the interests of the largest number of people cannot anticipate with favor." [37]

5.

A CONSERVATIONIST OUT OF TIME

This general philosophy of the western lands and their development was formulated by Powell as early as the middle 'Seventies. And for a quarter of a century, in and out of season, he preached it. What he had to say fell on deaf ears, though time was to bear witness to minds closed to science. Within ten years after his death a vigorous conservation movement was under way. New land and water laws had been written. The nation had come alive to the deep inroads of monopoly and waste into their natural resources. But before the Pinchots and the Roosevelts he had seen the intricate mutuality of nature and had come to understand how an imbalance of one part of the physical environment brings in wide-swinging arcs losses in other parts.

A case in point is his theory about floods. Powell put little faith in levees and channel clearance *per se*. The problem of flood control called for more and greater plans than these. "My judgment," he told a Congressional Committee, "is that the only practical way of relieving the valley of the Mississippi, from Cairo to its mouth, of its floods is to take out the waters of the upper streams and use them in irrigation. The sources must be reached." His mind always seized on the apparently unrelated. "The greatest engineering problems in America are the protection of the flood plain of the Lower Mississippi

from overflow and the redemption of the great plains from their desert condition, and the two problems are practically one." [38] He saw the devastating floods of the river valleys as the last act in a drama that begins in the highland benches of the mountain ranges.[39] The remedies he prescribed are typical in their comprehensiveness.[40] The surplus waters must be stored in great artificial lakes. River channels must be cleared and shortened, new outlets to the sea opened. The flood plains must be protected by embankments. A signal system must be devised to warn the people of impending floods. Above all investigation is needed. "The first need is for accurate topographic maps; the second need is for geological surveys by which flood-plains are outlined; the third need is for hydraulic surveys by which the rivers are gauged and the powers to be controlled are discovered." [41] He was always coming back to how little is really known.

Powell's sense of the interrelatedness of things appreciated their causal relatedness. Take his view of timber protection. "I have seen one fire in Colorado," he told a House Committee, "destroy more timber than has been used by man from the migration to Pike's Peak to the present time; and I have seen several such fires in Colorado." [42] What is the route to fire control? It is to be found in the facts of humidity. "Where the rainfall is great and extreme droughts are infrequent, forests grow without much interruption from fires." [43] Herein lies the clue to fire control. "It will come in part by pasturing the lands. The pasturing of the lands will destroy the young growth and consume the grass, and stock will make trails and roads by which the fires will be cut off and not spread widely. Then, by annual burning, at times properly selected, when not too dry the trees can be protected." [44] The present-day art of timber protection goes far beyond this perception, but Powell's theory of humidity still forms its basis.

There is indeed a logic of land use, Powell thought. To illustrate his thinking, there is the case of the grazing lands of the Great Plains. The pattern of settlement of the Plains must use a large scale, a scale of thousands of acres. The small, intensive farm unit of the East will not work in the West, save in the irrigable lands. The western ranges are unique. "To be utilized they must be carefully protected, and grazed only in proper season and within prescribed limits. They cannot be enclosed by fences in small fields." [45] Large tracts are needed to support even a small herd. The western farmer needs wide margins. He must not be fenced in on small spreads.

Here again, then, the Major does battle for his conviction about the West. It must develop, it must be free to develop, but it must be assisted and advised in developing its own institutions. It was a conviction that grew, not out of sentimental sectionalism, but from a scientific understanding of the country itself. "Powell gave to a deaf nation," as Joseph Kinsey Howard pointed out, "one of its earliest and finest examples of economic planning." [46]

REFERENCES

1. Walter Prescott Webb, *The Great Plains* (Boston: Ginn and Company, 1931), p. 152. Quoted by permission.
2. Joseph Kinsey Howard, *Montana: High, Wide and Handsome* (New Haven: Yale University Press, 1943), p. 285. Quoted by permission.
3. Webb, *op. cit.*, Chapters I-II.
4. Great Plains Committee, *The Future of the Great Plains* (Washington, D. C.: Government Printing Office, 1936), p. 34.
5. *Ibid.*, p. 36.
6. *Ibid.*, p. 33.
7. Carl Kraenzel, "New Frontiers on the Great Plains," *Journal of Farm Economics,* XXIV (1942), pp. 50 ff.
8. F. E. Clements and R. W. Chaney, *Environment and Life in the Great Plains* (Washington, D. C.: Carnegie Institution, 1936; Supplementary Publication No. 24), p. 37.
9. Quoted by G. K. Rule, *Soil Conservation Districts in Action on the Land,* United States Department of Agriculture, *Miscellaneous Bulletin* No. 448, 1941, p. 3.
10. J. W. Powell, *Report on the Lands of the Arid Region of the United States with a More Detailed Account of the Lands of Utah, with Maps,* 1st Edition (Washington, D. C.: Government Printing Office, 1878), p. 89.
11. *Public Lands Commission Report,* 4th Congress, 2nd Session, *House Executive Document* No. 46, p. ix.
12. *Arid Lands, op. cit.*, p. 3.
13. *Ibid.*, p. 10.
14. *Ibid.*, p. 2.
15. *Ibid.*, p. 3.
16. *Ibid.*, p. 12.
17. J. W. Powell, "Institutions for the Arid Lands," *Century,* XVIII (1890), pp. 114 ff.
18. Webb, *op. cit.*, p. 422. Quoted by permission.
19. *Lands of the Arid Region . . . , op. cit.*, p. viii.
20. Quoted by T. G. Manning, *Science in a Democracy: The Origins and Early History of the U. S. Geological Survey* (Ph.D. Dissertation, Yale University, 1941), p. 199.
21. Cf. H. H. Dunham, *Government Handout, A Study in the Administration of the Public Lands* (Ann Arbor: Edward Brothers, 1941); Dunham, "Some Crucial Years of the General Land Office, 1875-1890," *Agricultural History,* XI (1937), pp. 117 ff.

22. J. W. Powell, "Organization of the Irrigation Survey," *Tenth Annual Report,* U. S. Geological Survey, 1889, p. 14.
23. *Ibid.,* pp. 10-11.
24. *Ibid.,* p. 12.
25. Quoted by Manning, *op. cit.*
26. J. W. Powell, "Preliminary Report on the Organization and Prosecution of the Survey of the Arid Lands for Purposes of Irrigation," Testimony, 50th Congress, 2nd Session, *Senate Executive Document* No. 43, 1888, p. 12.
27. *Lands of the Arid Region, op. cit.,* p. 28.
28. *Ibid.,* p. 28.
29. *Ibid.,* p. 38.
30. "Institutions for the Arid Lands," *op. cit.,* p. 114.
31. J. W. Powell, "Testimony before Select Committee of House on on Irrigation, Feb. 27, 1890," *Eleventh Annual Report,* U. S. Geological Survey, 1889-1890, p. 237.
32. *Ibid.,* p. 236.
33. *Ibid.,* p. 254.
34. *Ibid.,* p. 255.
35. "Organization and Prosecution of Survey . . ." *op. cit.,* p. 12.
36. *Eleventh Annual Report,* U. S. Geological Survey, *op. cit.,* p. 226.
37. *Lands of the Arid Region, op. cit.,* p. 41.
38. J. W. Powell, "Testimony before Joint Committee on the Scientific Research Services," 49th Congress, 1st Session, *Senate Miscellaneous Document* No. 82, 1885, p. 697.
39. J. W. Powell, "Our Recent Floods," *North American Review,* CLV (1892), p. 156.
40. *Ibid.,* p. 158.
41. *Ibid.,* p. 159.
42. *Eleventh Annual Report* (USGS) , *op. cit.,* p. 207.
43. *Lands of the Arid Region, op. cit.,* p. 15.
44. *Eleventh Annual Report, op. cit.,* p. 208.
45. *Ibid.,* p. 209.
46. Howard, *op. cit.,* p. 32. Quoted by permission.

Chapter V

THE SCIENTIST IN A DEMOCRACY

1.

FIGHTING FOR INTEGRATED RESEARCH ADMINISTRATION

One frontier in which Major Powell pioneered was research by government. A contemporary of his, the philosopher-educator W. T. Harris, speaking at a memorial meeting in the National Museum, declared: "It was Major Powell who worked little less than a revolution in the matter of educating our national legislature through its committees into the habit of seeking for and obtaining the scientific expert in all places where he is needed. It was he who influenced the government to expend very large sums for the production, in worthy style, of publications giving the results of scientific research and publication." [1] This service to American science began with his fight for an integrated research administration.

For ten years following the Civil War four great survey teams were at work in the West. One group, under Clarence King, was conducting the famous Fortieth Parallel Survey. Another group, serving under Lieutenant Wheeler, worked through the Great Lakes region and west of the Mississippi. Dr. F. W. Hayden and his men, employed by the Interior Department, had surveyed great parts of the trans-Mississippi country. Powell, during the 'Seventies, had covered much of the Rocky Mountain region. There was, in addition, the important work carried on by the Coastal and Geodetic survey of the Treasury Department, already at work in the lake country. Altogether during these years the Federal Government had spent almost two million dollars for research. Wheeler and Hayden had received the lion's share of the appropriations.

The results were far from encouraging. T. G. Manning has ably summarized the situation of the scientific surveys.[2] The picture as of 1878, as Manning says, passes incredulity. Wheeler had carried on a reconnaissance until 1873 before adopting under pressure a trigonometric method. During the years 1871-1872 Hayden had surveyed the Yellowstone region, the basis of his sole geographic contributions up to that time. King's approach to the problems of survey

methodology was followed only in the case of Gardiner, appointed in 1873. Powell and King themselves had differed on the use of measured base lines and triangulation. King had, for purposes of triangulation, used natural points, low peaks and mountains. Powell felt that these were not sufficiently accurate. The Fortieth Parallel work had been recorded in sketch books and descriptive notes.

In the matter of cartography differences were even more pronounced. Since both the Interior and War Departments were responsible for surveys, both had plans for an atlas of the remaining territory of the United States. The Interior Department maps used a scale of four miles to the inch, those of the War Department eight miles. The map makers of the War Department preferred polyconic projection; the civilian map makers were fond of secant-conic projection. Wheeler indicated relief by means of hatchings and contours, King employed shading in his topographic maps and contours in his geologic maps, Powell followed Wheeler's procedures, and Hayden's maps were solely contour.

Other complications, differences, and duplications among the survey parties may be noted. Thus, during the years 1872 and 1873 Wheeler covered a small part of Powell's territory, and in 1873-1875 he worked across areas in Colorado previously or simultaneously being surveyed by Hayden. Meantime, confusion promised to be compounded by the entry of the Coast and Geodetic and the Great Lakes Survey into the interior.

By 1875 there were, then, five different surveys of the public lands of the United States, three systems of topography, three systems of geodesy, and the cadastral survey of the Land Office. The situation was one of diverse and discordant objects and method, questionable results and limited usefulness, and wastefulness through duplication.[3]

Even more important than the overlapping, confusion, and inadequacy of the existing surveys was their rivalry. Each group sought priority in Congressional considerations and appropriations, even using pressure devices so familiar to businessmen. Walcott, who succeeded Powell as Director of the Geological Survey, did not exaggerate when he wrote that "the resulting rivalry threatened the Congressional appropriations." [4]

The sequence of events which led to the establishment of the unified Geological Survey is suggestive of the politics which had begun to badger the scientific work of the Government. Hayden, in January, 1877, persuaded his friend, Representative Holman, to oppose all sur-

veys but his own. Powell and J. S. Newberry immediately prevailed upon the influential New York Congressman, Abram S. Hewitt, to intervene. The result was that Powell's Rocky Mountain Survey managed to squeeze through. The following year, Hayden, through Congressman Atkins, was able to secure committee discussion of a resolution calling for Congressional inquiry into all the various surveys, with the obvious intention of smearing the others. This time Wheeler and his votaries rushed into action, stopping the proposed investigation. Unquestionably action of some sort was impending. Commissioner J. A. Williamson of the General Land Office, disgusted and handicapped by the existing contract system of surveying in the western states, had thrown his influence in the direction of congressional inquiry; he had, in fact, recommended the appointment of a Chief Surveyor with a full-time staff, in an effort to eliminate the confusion.

In May, 1878, an unexpected turn of events gave a novel twist to the campaign. The following account is based upon the detailed report by Henry Nash Smith, who has studied this particular episode more intensively than any other American scholar.[5]

It started with the death of Joseph Henry, president of the National Academy of Sciences. He was succeeded by Othniel C. Marsh of Yale University. Marsh's relationships with the surveys were a little involved. His rival in the field of vertebrate paleontology was Edward D. Cope, an associate with Hayden in the Geological and Geographical Survey of the Territories. In addition, there had been some difficulties between Hayden and Marsh. It was Marsh's conviction that Hayden had tried in 1874 to blackmail him into an endorsement of Hayden's survey in return for Marsh's election to the Academy. There was also the significant fact that Marsh and King had been students at Yale. In 1876, moreover, Thomas Huxley had praised Marsh's work to King. This had led to a renewal of friendship between the two men. In 1880 King arranged for the publication of Marsh's monograph on the fossil-toothed birds as Volume VII of *Report of the Geological Exploration of the Fortieth Parallel.*

Clearly, the accession of Marsh to the presidency of the National Academy had possibilities. One of the Hewitt group developed the proposal to align the Academy with the demand for a reform of the geological surveys and the land system. Hewitt was able to secure passage of a resolution by the Congress referring the problem of the

surveys to the Academy for study and recommendation. The committee appointed by Marsh consisted of James D. Dana, William B. Rogers, John S. Newberry, William P. Trowbridge, Simon Newcomb, and Alexander Aggassiz. The committee accepted Powell's program. The chief recommendations of the committee included:

1. Transfer of the Coast and Geodetic Survey from the Treasury Department to the Interior Department, and extension of its function to include all land-parceling surveys of the public domain.
2. Abolition of the offices of surveyors general and of the existing system of land-parceling surveys by private contractors.
3. Consolidation of the Wheeler, Hayden, and Powell surveys into a single United States geological survey in the Department of the Interior.
4. Appointment of a public lands commission to codify the land laws.

This report by the committee was accepted by the Academy in November, 1878. It was submitted to the Congress that same month. The legislative battle, extending through the rest of the winter, precipitated open rivalry betwen the surveys, created alliances between the different groups of scientists and Congressional factions. Prior to this struggle neither Powell nor King had been involved in the quarrel between Hayden and Wheeler. Indeed, Powell's own opposition to military control of the surveys had, as Smith points out, rather identified him with Hayden's group. Meantime, Hayden had canvassed the leading scientists on the faculties of Yale and Harvard—Dana, Aggassiz, and Rogers, among them—and had secured letters from them urging civilian control of scientific exploration in the West. Hewitt himself had, prior to the report by the Academy committee, favored consolidation of the surveys under the War Department. This view probably reflects his friendship with Clarence King.

The legislative battle brought a realignment of forces. By February, 1879 Hewitt was championing the Academy recommendations, which he attributed to Powell. The Hewitt group in Congress by this time included the Democratic Atkins and the Republican James A. Garfield. Support for the Academy program was crossing party lines. A new source of strength came with the endorsement of the Powell program by Wheeler. Hayden had firmly entrenched himself with the western bloc of Congressmen.

An intensive private campaign for the Academy program had been initiated by Powell early in November. Thus he had contacted

Newberry of Columbia University, asking him to represent the Academy's position to a certain scientist who had made known his preference for a military survey system. At the same time Powell asked King to discuss the Academy proposals with Carlisle P. Patterson of the Coast and Geodetic Survey.

In December Powell was invited by Representative Peter D. Wigginton of California, a member of the Committee on Public Lands, to make "a full and thorough report" for the use of the Committee.

As things turned out, the recommendations of the Academy were not introduced by the Public Lands Committee, for it had in the past suppressed similar measures. But the recognition of Powell's abilities is a significant measure of his increasing acceptance in official Washington.

In the House debates on the Academy proposals speakers over and over emphasized the ideas and data developed in Powell's *Report on the Lands of the Arid Region.* The opponents of the Powell program reiterated the arguments that there was of course an abundance of good agricultural land left in the public domain. They castigated the proposals as the work of "new-fledged collegiates" and of "scientific lobbyists," who were attempting to curtail the development of the West. These men had committed the unforgivable sin of skepticism about the roseate and infinite developmental possibilities of the western lands. Powell himself was bitterly denounced. Patterson of Colorado alluded to Powell as "this revolutionist," "this charlatan in science and intermeddler in affairs of which he has no proper conception."

Floor debate continued through much of February. A compromise proposal by Congressman Page was finally passed by the House 98 to 79. This agreement would retain consolidation of the scientific surveys and the appointment of a public lands commission, but it omitted any change in the land system or the land-parceling surveys. The Senate, however, dropped even this emasculated program, without debate and without a division. The appropriation bill was sent along to a conference committee.

It was here that a parliamentary maneuver by Hewitt saved the day. For he was able to insert provisions into the bill for the consolidation of the scientific surveys and for the appointment of a public lands commission. This dubious parliamentary procedure occurred in the well known last-minute rush at the end of the congressional session. The Sundry Civil Expenses Bill was the vehicle by which the Academy

proposals were saved. The conference report was accepted. The campaign for consolidation moved to final success.

The battle for an integrated survey administration having been won, Powell turned to ethnological studies, which he had threatened to do as early as 1877, for he was tired of the continuous tensions aggravated by Hayden.[6] He had freed himself from any imputation of personal ambitions in the fight for the establishment of the consolidated Survey.[7] And when his friend King was nominated and appointed, he wired him warm congratulations and expressed willingness to serve on the new Public Lands Commission. In reply, King wrote:[8]

> My Dear Powell:
>
> Your welcome telegram came to me Saturday. I am more delighted than I can express. Hamlet with Hamlet left out is not to my taste.
>
> I am sure you will never regret your decision and for my part it will be one of my greatest pleasures to forward your scientific work and to advance your personal interest.
>
> In the whole matter of the survey I feel like a condemned culprit ascending the gallows but I suppose you are right in predicting that when my blood gets up I shall enjoy being hung.
>
> Please drop me a line saying where our resolution is and what is the prospect of getting two more men on the Land Com.
>
> With kind regards to Mrs. Powell believe me ever devotedly yrs.
>
> C. K.

For Powell the struggle had not been for mere administrative change. Better than any other public figure of the time, he saw beyond the quarrel to a central issue in American politics. It was the question whether the trans-Mississippi domain should be developed in the public interest or turned over to private exploitation.

When the restless King, who apparently accepted the directorship of the new Survey with the understanding that it would be only a temporary assignment, resigned, there was little opposition to Powell's appointment. Recommended by the powerful Ohio representative, James A. Garfield, and the Smithsonian Secretary, S. F. Baird, he succeeded King in March, 1881. He brought to the administration of the new research agency the same broad grasp of the over-all problem of the West which had inspired his Arid Lands report and which had prompted him to help engineer the consolidation of the surveys. It was this desire to rationalize the administration and disposition of the public lands which in great part enabled him to enlist the services of

the country's top-flight geologists and technicians. It was this same ambition which, thirteen years later, was to drive him in punishment from the directorship of the Survey.

2.

PHILOSOPHY OF RESEARCH ADMINISTRATION

Charles D. Walcott, who was Powell's colleague and later successor as Director of the Survey, thoughtfully pointed out after his friend's death: "There are administrators who achieve a fair amount of success through securing from the organization economical and efficient work along prescribed lines. These are, properly speaking, executives. There are administrators of another kind, who possess insight and creative ability, who have scientific imagination and the power of initiative. . . . Among this class Major Powell was eminent." [9] Writing several years later an official memoir of Powell for the National Academy of Sciences, William H. Davis observed that Powell "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." [10] Powell wanted the best he could secure within the limited budget for salaries at his disposal. It is a credit to the man's own personality as much as anything else that as head of both the Bureau and the Survey he was remarkably successful in this ambition.

Effective personnel was, however, only part of his conception of the task of research administration. It was necessary that it be clearly and comprehensively conceived and systematically though flexibly organized. Testifying before a joint committee of Congress on the scientific services of the Federal Government, he outlined his philosophy of administration of scientific agencies. He underscored several considerations.[11]

First, he told the committee, "the investigations prosecuted by all of these scientific institutions are in their nature inter-related and interdependent." For this reason they should be "co-ordinated, that they may work together and aid each other," without duplication and without invidious competition. To this end, they should be centrally managed. However, he said:

> "Scientific investigation must be controlled by the facts discovered from year to year, and from month to month, and from day to day. The operations of investigation, therefore, can only be con-

> trolled by the men who are actually performing the work. The plans of the work prosecuted by the organization for scientific work must originate with the experts and the specialists who are themselves engaged in the investigation, and the most important function which the director of such an institution has to perform lies in the selection of the proper men,—the specialists who have a genius for research."

He was firm in his opposition to a directive commission or to a board composed of military and civil officers. He laid down a fundamental principle: "the several bureaus engaged in research should be left free to prosecute such research in all its details, without dictation from superior authority in respect to the methods of research to be used."

Administratively speaking, he sought to co-ordinate research on a functional basis. The Geological Survey was organized into divisions of topography, general geology, economic geology, with co-ordinate divisions of paleontology, physics, chemistry, library, and accounts. Congressional committees experienced again and again his close familiarity with all the details of each division and his outstanding ability in describing their methods and findings.

Though he conceived of the Bureau and the Survey as tools for Federal policy-making and administration, he would not surrender their function as fact-finding, fact-organizing, and fact-presenting agencies. His friend, geologist G. K. Gilbert, has commented on this phase of his leadership. "As he always drew about him the best ability he could command, his assistants were not mere elaborators, but made also important original contributions, and the ideas which he gave the world through others are thus so merged and mingled with theirs that they can never be separated." [12]

In one of the annual reports of the Geological Survey, Powell outlined his philosophy of the relation of research to science. It is an impressively prescient statement. "Science," he wrote, "advances by distinct yet correlative alternate steps, of which the first is aggregation in a magma on a given plane, and the second aggregation from the magma and elevation to a higher plane; the first is quantitative extension, and the second is qualitative enhancement." [13] The first stage is observational or experimental, one "in which facts are gathered, not solely for immediate use, but as a foundation for a superstructure of science which it may not be possible even to foreshadow." Eventually there is "a constructive or creative period, in which the magma is crystallized and reared into a final superstructure. . . ." [14]

These stages in observation and theory are paralleled by stages in classification.

> "The classification employed in the primitive stage of extension is commonly designed to facilitate recording of findings, and is frequently based on external or artificial or adventive features or characters; moreover the process of adventive classification is usually one of successive division, in which the facts classified are successively separated by real or fancied differences. The classification employed in the stage of segregation and elevation of knowledge, on the contrary, is commonly designed to express natural relations, and is usually based on essential and inherent characters; and moreover, throughout the entire domain of natural science the classific process is one of successive regrouping by resemblance—the antithesis of the primitive process of dividing by difference." [15]

Another phase of his interest in the relationship between research and science was his anxiety to make research findings as widely available as possible. "Science is cosmopolitan, and in order that the best progress shall be made and that each country shall enjoy the benefits resulting from scientific investigations in other countries, it is necessary that there shall be international circulation of documents in which the results of research are recorded." [16] Powell would in all probability have been grieved by the curtains of secrecy which surround atomic energy research. For him classification did not include "classified" information!

A scientist in research and administration, he was nonetheless a human being and did not forget that his co-workers were human beings. Davis' comment is especially revealing in this connection. "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." [17]

3.

SCIENCE AND PUBLIC POLICY

Research, according to Powell, must, in addition to its extension of the domain of knowledge, be an instrument of public policy. This conviction had been the core of his enthusiasm in the fight for the unification of the surveys. It was the heart of his interest in the prob-

lem of the public lands. The scientist must be free to collect and organize facts; but even more—he must be free to state the facts.

In 1894 he was asked to address the International Irrigation Congress in Los Angeles. Editor Smythe of the western promotional journal, *Irrigation Age,* tells the story this way.[18] "The speech of Major John Wesley Powell, on the water supplies of the arid region . . . was the one element of discord in that remarkable gathering." The cause of the trouble was the following sentence in the Major's speech. "There is not water enough and can never be; a quantity of water can never be conserved sufficient to irrigate more than one-third of the land already owned by private individuals." This statement had been made after a platform declaration by the Congress that homes for millions can be made on the arid public domain. Later on, continues the editor, he talked with the Major in the smoker of a Pullman. "The writer pointed out the offensive features of Major Powell's assertions, and received from him the explanation that his speech, taken as a whole, would not bear the construction placed upon the sentences quoted; and furthermore, that when he had been assailed by stump speeches he replied in kind, rather than with the scientific statements which the convention was then in no mood to receive."

Behind this strongly worded declaration of personal philosophy lay some twenty years of thoughtful and laborious study of the western lands. The sole point of the matter was that the Major was painfully anxious to make an effective scientific rather than an opportunistic political disposition of the public domain. "The American people," he wrote in the annual report of the Geological Survey for 1885-1886, "have now passed that pioneer stage in the settlement and utilization of the national domain in which man can avail himself of the fruits of the land without thought for tomorrow." [19] This task, so far as he was concerned, required a scientific approach.

He had stated such an approach as early as 1878 in testimony before a House committee; indeed it is the central theme of his Arid Lands report, and he never deviated from his line of attack for the next twenty-five years. At that time he told the committee: "The surveys of the public lands made for the purpose of parceling the same have been of such a character that a heritage of litigation relating to boundary-lines has been bequeathed to posterity, ever increasing with the enhancing value of lands."[20] "A proper scientific survey," he continued, "embracing the geography of the public domain with the par-

celing of the lands, and the geology with all the physical characteristics connected therewith, is necessary for the following reasons:

"First, to secure an accurate parceling of the public lands and enduring boundary lines.

"Second, for the proper administration of the laws relating to the public lands.

"Third, for a correct and full knowledge of the agricultural and mineral resources of the lands;

"And fourth, for all purposes of abstract science."

The pursuit of this philosophy became tumultuous when the Survey began to move from the preparation of folio atlases to the selection of irrigation sites and the designation of irrigable lands. It was at this point that the mutterings and slumbering hostilities of the western interests, long angered by interferences with their "Big Barbecue," broke into an aroused opposition. The active fight lasted six years, 1888-1894, and it ended with Powell's departure from the Survey. It had begun with merciless and gruelling committee inquiry, for which Powell was superbly prepared. Failing in their ordeal by Congressional immunity, the leaders turned to a hoary strategy, which, as usual, worked to their complete satisfaction. The story illustrates one of the oppressive problems of science in a democracy.

The scalping party of western landowners and cattle kings and Congressional mouthpieces manuevered Powell into a tight financial corner: they killed him off by budgetary inanition. Lopping off salaries, slashing annual appropriations over the period of hostilities by almost $300,000, ear-marking funds for special purposes which did not include irrigation surveys, they forced Powell to resign in order to save the Survey itself.

Ultimately time was to prove that Powell was right. Three months before his death Congress passed the Newlands Reclamation Act authorizing surveys of irrigable areas and reservoir sites and the preparation of plans for dams and irrigation systems—a quarter of a century late! One wonders whether—in a democracy especially—a modern industrial society can afford to wait so long for public policy to come to terms with science.

REFERENCES

1. W. T. Harris, "Remarks on Powell," Minutes of a Meeting Held at the U. S. National Museum, Preceding the Funeral of Major J. W. Powell, Sept. 26, 1902, *Smithsonian Annual Report,* 1902, p. 787.
2. T. G. Manning, *Science in a Democracy: The Origins and Early History of the United States Geological Survey,* (Ph.D. Dissertation, Yale University, 1941).
3. Manning, *op. cit.,* pp. 114-116.
4. *Twenty-Fourth Annual Report,* U. S. Geological Survey, p. 277.
5. H. N. Smith, "Clarence King, John Wesley Powell, and the Establishment of the U. S. Geological Survey," *Mississippi Valley Historical Review,* XXXIV (1947), pp. 42-52.
6. "Geological and Geographical Surveys. Letter from the Secretary of the Interior, Transmitting a Report of Professor Powell in Regard to Surveys," *House Executive Document* No. 80, 4th Congress, 2nd Session, pp. 8-12.
7. Cf. "Remarks by G. K. Gilbert," *Smithsonian Annual Report,* 1902, p. 636.
8. Quoted by Smith, *op. cit.,* p. 56.
9. Charles D. Walcott, "Administrative Work," *Washington Academy of Sciences,* V (1903), p. 100.
10. W. H. Davis, "John Wesley Powell, 1834-1902," *Biographical Memoirs, National Academy of Sciences,* VIII, p. 52.
11. J. W. Powell, "The Administration of the Scientific Work of the General Government," *Science,* V (1885), pp. 52 ff.
12. Gilbert, *op. cit.,* p. 636.
13. J. W. Powell, "General Work in Taxonomy," *Fourteenth Annual Report,* U. S. Geological Survey, Part I, 1892-1893, p. 65.
14. *Ibid.,* p. 66.
15. *Ibid.*
16. J. W. Powell, *Eighth Annual Report,* U. S. Geological Survey, 1886-1888, p. 48.
17. Davis, *op. cit.,* p. 55.
18. William Smythe, "The Progress of Western America," *Irrigation Age,* VI (1894), p. 5.
19. J. W. Powell, *Seventh Annual Report,* U. S. Geological Survey, 1885-1886, p. 40.
20. J. W. Powell, "Report on the Methods of Surveying the Public Domain," 45th Congress, 3rd Session, *House Miscellaneous Document* No. 5, 1878, p. 16.

Chapter VI

THE DEMONOMIC ANALYSIS

1.

SCHEMATIZING THE SOCIAL SCIENCES

Powell was unable, indeed saw no reason, to limit himself to mountains and rivers. Very early in his professional career he found himself drawn to the study of human relations. "In the winter of 1868," reported his friend Dellenbaugh, "while on White River, he studied language, tribal organization, customs, and mythology of the Utes and from 1870 to 1873 he carried on studies among the Pai-Utes, the Moki, etc., being adopted into one of the Moik clans. On his journeys during these periods he often took with him several of the natives for the purpose of investigating their myths and language."[1]

This bent of his natural curiosity led him within ten years to the directorship of the Smithsonian's Bureau of Ethnology, where he was able to make and become acquainted with a host of empirical and theoretical studies of human societies. A systematizer and taxonomist, he sought in the 'Nineties to organize the data of the field of human relations with which he had become familiar. He intended to use these materials as the subject-matter of a book, which was never published as such. However, his various articles in the *American Anthropologist* during these years provide a fair picture of his thinking.

It is altogether characteristic of the man that he did not document his sources. A number of well known works must have been available to him. Yet the only writers whom he specifically acknowledges were his friends Lewis H. Morgan and Lester F. Ward. Herbert Spencer, who was enjoying a great vogue in those years, he detested, but at least we know he was acquainted with Spencer's works.

In a sense this period was a birthing time for the social sciences. Several writers had, in fact, cast aside the swaddling clothes of that moralizing and reformistic movement, the American Social Science Association, which had been a powerful influence since its inception in 1865. R. J. Wright's *Principia, or Basis of Social Science,* had appeared in 1875. In 1883 three important volumes were published: George F. Holmes' *Science of Society;* William Graham Sumner's

What the Social Classes Owe to Each Other; and Ward's *Dynamic Sociology.* A self-conscious professionalism, separating itself from the older social science movement, had led to the establishment during the 'Eighties of three national societies: the American Historical Association, 1884, the American Economics Association, 1885, and the American Academy of Political and Social Science, 1889. The over-all trend in the study of human society was toward objectivity and specialization.

Luther Lee Bernard, leading American historian of the social sciences, has summarized the changes taking place in the intellectual climate of the United States during the 'Eighties and 'Nineties:

> "In this development we have seen the movement evolve from wishful thinking into critical theory; from a theory based largely on metaphysical disputation regarding the foundation principles of human association, resting mainly on Natural Law, into a practical movement emphasizing social investigation, planning, and legislation; and, finally, again into a renewed effort to establish competent intensive theoretical disciplines capable of dealing effectively with rapidly increasing bodies of social data." [2]

Powell was part of this current of affairs in the academic world, though probably not an influential part: Bernard nowhere mentions Powell's work.

Powell's favorite word for human society is "demotic," by which he referred to the organized, customary, conventional activities of the people. Fond, as he was, of the search for principles or laws governing phenomena, he preferred the word "demonomy" in describing and interpreting social facts.[3] His demonomic analysis, therefore, necessarily committed him to a generalizing approach to human society, and it embraced what is now customarily thought of as the specialized fields of economics, sociology, ethnology, education, and humanities. This coverage suggests that, despite his desire to systematize the field of the social sciences, he was still in a transitional stage. Aside from the staff members of the Bureau of Ethnology at the time, few American social scientists have ever employed either his new terms or his organization of the field. The only term which seems to have survived Powell, "acculturation," was one which he himself did not particularly emphasize in his writings.

Seeking to classify the data of the social sciences, as was his habit, he made a thoroughly typical approach by selecting the idea of human activities or functions as his starting point. What are the fundamental

social activities of human beings? He found five of them: industries, institutions, expressions, instructions, and esthetics.[4] This handful of social activities of man are the subject-matter of the five major social sciences: technology, sociology, philology, sophiology, and the humanities. Naturally neglecting existing precedents, Powell proceeded to outline the scope of each of these provinces of social investigation.

Industry he defined as "an activity whose immediate nature is the production of welfare for self and others." [5] The term welfare he used in a purely biological sense: welfare of life. Hence, by definition an industry is any activity exercised to promote life. "Technology is the science of industries,"—a considerably more humane definition than is current today. Classifying the various industries, he noted, inevitably, that there were five of them: substantiation, construction, mechanics, commerce, and medicine.[6] Production and consumption are correlative terms, denoting relationships to each of these industrial activities. Technology, then, is the study—for Powell, a descriptive, historical, and institutional study—of these five life-promoting activities. The technologist is any man skilled in any one or combination of these activities. In a manner which was later to be associated with Veblen, Hobson, Commons, he sought to give to technology a comprehensive biological value: the technologist is any man who can contribute to a life-conditioned environment.

Sociology Powell regarded as a generalizing and all-inclusive social science.[7] Its subject-matter is institutions. "An institution is a rule of conduct which men make by agreement or which is made for them by some authority which they recognize as such." [8] Sociology he formally defines as "the science of the control of human activities, not by mechanical devices as in mechanics, but institutional devices." [9] Its specialized fields include statistics, economics, civics, historics, and ethics.

Statistics consists of "the enumeration of human beings and the material things which they produce." More broadly, it is "the science of the verification of sociologic inferences." [10] Functionally, it is comprised of classification, mensuration, enumeration, and verification. Economics is "the science of the relation of production and consumption through the mediation of corporations." [11] The latter he defined as "groups of men organized for a purpose,"—for pleasure, welfare, justice, expression, or knowledge. It is clear that Powell's conception of the corporation went far beyond its conventional commercial forms. Its function is "to control the conduct of the members of the incorporation in relation to the purpose for which the society is organized." [12]

Civics is "the science of government." The function of government is justice, and justice consists in five elements, "no one of which can be neglected if any other is secured and at the same time justice maintained": peace, equity, equality, liberty, and charity. "Historics is the science which records events of social life and shows the relation existing between social causes and social effects." [13] Finally, ethics Powell defined as "the science of conduct controlled by conscience," and the latter he regarded as "the instinctive impulse toward conduct." [14] "An instinct," he goes on to explain, "is inherited not as a developed habit, but as a tendency or facility to do or act in a definite manner." [15] Ethics as the science of behavior so controlled studies the dualities of pleasure and pain, welfare and want, justice and injustice, truth and falsehood, wisdom and folloy.

The third major field of social investigation, according to Powell, is philology, "the science of activities designed for expression." [16] Specifically, it is the study of language. "Natural methods of activity are themselves indicative of thought which others may interpret, but when activities are conventionally produced for the purpose of expression and interpreted as such by others, language is produced," [17] Language is defined as "the artificial expression of concepts in judgments by words in propositions." He distinguished five (!) types of language: emotional, gestural, oral, written, and logistic. [18] His use of the term "logistic language" is especially interesting. It is "the language of reasoning," and its "essential characteristic" is that its "sematology is universal." [19] It is a language of the future, for "it has indeed scarcely been developed." However, "when logic is wholly emancipated from metaphysics, logicians will devise a grammar of logistic language." [20]

Sophiology, the fourth major social science, according to Powell, is the peculiar word which he introduced to describe "the science of activities designed to give instruction." [21] More precisely, it is the study of how opinions originate and change and may be changed. It is a most difficult science, for it is constantly beset by ingrained and institutionalized opinions in the form of mythologies. The sophiologist —that is, the educator, as we would say today—must constantly fight for verification with the proponents of the rituals of repetition. "Errors associate in communities . . . a fraternity for mutual protection." [22] Moreover, "when the trendrils of mythology are intertwined in the branches of institutions, the attempt to substitute science for myth appears to be an attack upon the institutions in which it is entwined,

and thus the reformer and the defender come to blows." [23] The history of sophiology is the story of man against myth. The institutions of a society and the arts of instruction are seldom at peace.

The science of esthetic activities, another division in Powell's taxonomy, is, broadly speaking, "the humanities." [24] All human activities, he pointed out, are arts: the arts of learning are directed to knowledge; the institutional arts, to justice; the arts of speech, to expression; the arts of industry, to welfare; and the arts of pleasure, to happiness. The humanities are primarily concerned with the arts of human happiness. Man is not simply a biotic entity: he is a culture-creator. The field of the humanities, thus, embraces the activities of human beings as creators of and participators in human culture. It includes far more than plastics and painting: every human activity, skillfully done and bringing pleasure to one's self and others, is an art, and the medium of such pleasure-production and pleasure-participation is culture. The humanities, then, deal with the creative and appreciative life of man in all of its phases. When and as the great pentalogy of human society—industries, pleasures, languages, institutions, opinions—are viewed from the standpoint of the arts of culture creation and enjoyment, "the humanities" have their birth and being.

2.

EVOLUTION AND HUMAN SOCIETY

Powell was not content with a mere taxonomy of scientific investigations of society. He was also interested in its history. A geologist and natural historian, he would logically view human institutions in the broad light of the evolutionary hypothesis; and this he did.

Unqestionably Powell's conception of social evolution was colored by his knowledge of Lewis H. Morgan's *Ancient Society* (1877), one of the most influential anthropological documents of the late ninetenth and early twentieth centuries. Powell, moreover, knew Morgan, arranged for the publication of one of his last studies, and wrote a fine appreciation of the man in one of the journals.[25] Like Morgan, he divided social evolution into "three grand stages"—Savagery, Barbarism, and Civilization.[26] The prime force in this evolution, a telic force, has been the human endeavor "to create a new environment—better conditions for human happiness." [27]

However, for his explanation of this grand strategy of human evolution Powell turned to Darwin, but to a considerably modified Dar-

winism. "In human evolution overpopulation is not a factor, as it is in biotic evolution." [28] Human—unlike animal—evolution comes through the development of the arts: not by natural selection but human selection! [29] Sentiency replaces competition as a factor in adaptation. The law of selection becomes less operative as species become higher and higher.[30] Looking at evolution at long range, Powell noted four major stages.

> "The evolution of life is accomplished in four stages. In the first mode of life, which is vitality, progress is made by survival of the fittest in the struggle for existence. In the second mode of life, which is sentiency, progress is made by the development of organs in the struggle for happiness. In the third mode of life, which is percipiency, progress is made by the discovery of truth in the struggle for knowledge. In the fourth mode of life, which is volitiency, progress is made by the establishment of justice in the struggle for peace." [31]

The social pattern which this evolutionary process produces is characterized by "a steady development in social organization."[32] By organization Powell meant an arrangement of interdependent parts constituting a whole. The trend in social organization, which actually begins at sub-human levels, brings increased differentiation and division of labor, regulative organization, larger and larger territorial units of social interaction. Function precedes structure; form is the structuralization of function. For example, consider the emergence of international organization. "Activital organization must precede governmental organization by the steady development of the industries of the world. Men must become thoroughly related and interdependent through the arts of peace. When all mankind are woven into a firm fabric by their material interests in such a manner that each shares in the prosperity of all . . . when all mankind are bound into one body by industrial organization . . . and the unification of the languages of the peoples of the earth is the unification of their habits of thought," then international organization can make its appearance.[33]

Like Lewis Morgan, Powell observed stages in all cultural evolution.[34] Thus, music progressed from rhythm, through melody and harmony, to symphony. Graphics began with outlining, proceeded to relief and perspective, and finally to chiaroscuro. Drama started with dancing, became sacrifice, developed as ceremony, and finally took the forms of historic art. The evolutionary pattern of poetry consisted

of personification, similitude, allegory, and trope. The "grammatic process" likewise underwent an evolution: through combination, vocalic mutation, intonation, and placement.[35]

The processes of social evolution are not orderly or without waste. Vestiges from earlier stages constantly clutter life in later ones. Thus, superstitions "are domiciled in many parlors, they are paraded on many platforms, they are worshipped in many temples, and they lurk even in scientific haunts and appear in scientific publications and are taught by scientific men." [36] Powell did not regard the processes of social evolution as inevitable or without the need for social control. Such a point of view, known as Social Darwinism, was fashionable in his day, but he vigorously opposed it.

The secretary of the Anthropological Society of Washington recorded the following illuminating minutes of a meeting for March 15, 1881. "He (Powell) said that the doctrines taught by Herbert Spencer and that school, would, at a rough estimate, if practiced, neutralize nine-tenths of the legislation of the world."[37] The rest of the minutes of the meeting is even more enlightening.

> "He showed that the natural evolution of industry was legitimate and harmless so long as it was confined, as it must necessarily be at first, to simple differentiation, but when the differentiated parts commenced to become integrated, there arose social evils. He was not hostile to corporations, but held that they were the instruments through which nearly all the operations of society will eventually be performed. But they require regulation. He believed that the social unit will eventually be a business corporation, and that there will be a hierarchy of corporations, the highest of which will embrace all the rest and constitute the government. The basis of society will then cease to be property, and will become industry."

Such was his forecast of the new society.

3.

ON THE NATURE OF CULTURE

It was probably Powell's contacts with the Indian tribes in the West that made him aware of the nature and significance of human culture. Like most people, he came to understand his own culture by acquaintance with another. These contacts led him to an important discovery about human beings, the conclusion "that the human race

is one."[38] True to his natural habit of observing similarities, he enlarged upon this theme in many ways.

Homologies in human behavior derive from the fact that "we find men everywhere to a large extent performing the same functions."[39] They may perform them differently—the phenomenon of culture variability—but the fundamental fact is the presence of functional similarities. The latter may be classified into two types, autogenous (or independently originated) or syngenous (or commonly originated). The former may be due to "concausation" or to "advention"; the latter may be the result of "cognation" or "acculturation." For example, stone arrow-heads are very likely autogenous in different regions among different peoples; they may indeed have developed from several "centers." But this would not exclude the hypothesis that many tribes learned such arts by imitation, i.e., by acculturation.[40]

Uniformities in human cultures may be explained in a number of ways.[41] Powell formulated nine such "principles of interpretation." First, "the arts of life have their origin in the endeavor to supply physical wants. They result everywhere in primitive life from the utilization of the materials at hand. Many wants are universal, felt by all men in all lands. . . .With regard, then, to the arts of life, the presumption is in favor of independent origin by concausation." Second, "in so far as arts are expressed in material forms they constitute simple object-lessons, easily learned, and observations would spread them far and wide. Whenever, therefore, the origin of such an art cannot be explained by the principle of concausation, the presumption would be in favor of its origin by acculturation." Third, "institutions, languages, and opinions are not expressed in material forms, and do not so easily pass from place to place and from people to people. The presumption, therefore, is that similarities discovered in these three classes of activities are not derived by acculturation." Fourth, "when many similarities among two or more peoples are discovered in institutions, languages and mythic opinions, the presumption is that they all have a common origin in some ancient stock from whom the savage tribes have been derived."

Again, "when similarities in institutions are discovered between peoples not related in language, the presumption is that such similarities are autogenous by concausation." Sixth, "when many verbal similarities are discovered among distinct peoples, the presumption is that they have a syngenous origin by inheritance; when few verbal similarities between different peoples are discovered, it becomes necessary to

inquire into the history of the people to discover whether they have their origin in acculturation or advention." Seventh, "when similarities in opinion are discovered among peoples, if such peoples belong to different linquistic stocks, the presumption is such that they have their origin in consausation." Eighth, "when similarities in opinions are discovered in peoples of the same linguistc stock, it becomes necessary to inquire into the history of the peoples and to determine the period of their separation, and if such opinions are probably so primitive that it is reasonable to be supposed that they were entertained in the stage of culture in which the primitive stock existed, the presumption is in favor of the theory that the similarities are such by cognation." Finally, "when similarities of opinion are discovered between peoples speaking languages of the same stock, if such opinions belong to a stage of culture subsequent to the separation of a primitive stock, it is probable that such opinions had their origin in concausation."

Powell was very much interested in the phenomena which develop from culture contacts. His short-hand expression for such phenomena is the word he coined, "acculturation," referring to the borrowing and imitation of culture traits. The culture changes which are thereby induced are, typically, unpremeditated, gradual, and undirected. He sorted out several types of changes which may occur in a society under conditions of acculturation.[42] First, there is cultural degradation: individuals "who are imbecile, depraved, or ignorant, and who thus utterly fail to exhibit the current culture." Second, there is cultural relapse: "a new art may be invented a little too early to be generally adopted and the struggle to the advanced position may be followed by relapse." Third, there is cultural replacement: "when a new art is developed some old art may be gradually replaced thereby." Fourth, there is cultural loss: the borrowed activity "may not at first be carried on with the same skill by the borrower as by those from whom it was taken." Fifth, there is cultural bastardization: initial cultural contacts between lower and higher cultures produce "a jargon of corrupted words derived from both languages." Sixth, there is cultural passing: borrowing by lower cultures is not always recognized as such, so ably has the borrowed material been absorbed by the society.

The phase of culture which Powell himself studied most extensively was language. His approach was basically acculturative. Identifying and classifying American Indian languages, he grouped them into 58 families. This investigation, pursued over a period of twenty years, led

him to posit a number of theses about language as an index of culture and culture change. In the first place, his study of language made him certain that "the mind of man is everywhere practically the same , . . . the innumerable differences of its products are indices merely of different stages of growth or are the results of different conditions of environment." Again, he asserted that "borrowed materials exist in all the languages and that some of these borrowed materials can be traced to original sources, while the larger part . . . cannot be thus relegated. In fact, it is believed that the existing languages, great in number though they are, give evidence of a more primitive condition, when a far greater number were spoken." Moreover, "the longer the study has proceeded the more clear it has been made to appear that the grand process of linguistic development among the tribes of North America has been toward unification rather than toward multiplication, that is, that the multiplied languages of the same stock owe their origin very largely to absorbed languages that are lost." Finally, he found no evidence for the belief that "the lower languages change with great rapidity"; "savage tongues are singularly persistent." [43]

Powell's knowledge of the dynamics of acculturation prompted him to make definite recommendations for public policy dealing with the Indians. Indeed, his very first major ethnological effort (in 1874) was made in connection with his appointment to a commission reporting on the conditions among certain tribes in the Utah country. His thinking about Indian policy was dominated by his appreciation of the importance of the acculturation process. He regarded any action that would deliberately thwart native institutions as a shocking forfeiture of the debt of civilization owed by the Whites to the Indians. "When the institutions of savagery are rudely and violently destroyed the savages themselves become a horde of brutal men impelled by an ungovernable rage to seek revenge on civilized men." [44] He put his faith in an intensified interaction between Whites and Indians by means of which the opportunities and incentives for imitation would encourage the absorption of the institutional arts of White men.

There are three main barriers to peace through acculturation, he thought: the Indian clan system, their communal property system, and their language. Yet he warned against undertaking the elimination of these obstructions at once or altogether. His confidence in the power of acculturation was a patient faith. He would have government policy-makers remember how much has already been accomplished. Referring to changes occurring in American Indian cultures, he wrote

in his first annual report as head of the Bureau of Ethnology (1879): "The great body of the Indians of North America have passed through stages of culture in the last 100 years achieved by our Anglo-Saxon ancestors only by the slow course of events through 1,000 years." [45]

4.

HUMAN SOCIAL ORGANIZATION

In 1896 Powell was asked to address the American Bar Association, meeting at Saratoga Springs, on the general subject of primitive law. His discussion there, along with further amplification in three or four articles in the journals, provides an excellent background for his theory of the way human societies are organized as going concerns.

The clue to human social organization is the role of regimentation and justice in human affairs. "Regimentation in sociology is the analogue of organism in biology. The accomplishment of justice in institutions is the analogue of function in the biotic realm." [46] Regimentation is the grouping of peoples by institutional bonds; justice is the social function which such a grouping perfoms. There have been two major types of regimentation: tribal, which has its basis in the bonds of kinship, and national, which has its basis in the bonds of territory. Feudalism he thought of as a transitional form.

Among the so-called simpler societies kinship patterns the social organization in three ways: the clan (or the gens, depending on whether the group is patrilineal or matrilineal), the tribe, and the confederacy.[47] "A clan is a union of persons who reckon consanguineal kinship in the female line, a tribe is compounded of clans whose members reckon kinship by consanguinity and affinity; while a confederacy, which is more or less ephemeral, is a union of tribes reckoning kinship as a legal fiction." The primary function of regimentation among primitive peoples is the establishment of peace. For there are two fundamental principles at the basis of primitive law: "first, controversy should be prevented; second, controversy should be terminated. A third is derivative from them: namely, infraction of law should be punished."

When the transition to territorial society is made, the pacific function of regimentation becomes secondary to the function of justice. For Powell justice is more than a matter of courts. In a series of declaratory statements, he asserted: "Justice is the establishment of peace. Justice is the establishment of equality. Justice is the establishment of

liberty. Justice is the establishment of equity, and justice is the establishment of truth." [48] For this diversified set of functions territorial societies develp a differentiated set of institutions, which are present in tribal societies only in diffused and unspecialized forms.[49]

In a paper, titled "Outlines of Sociology," read before the Anthropological Society of Washington in February, 1882, Powell analyzed the institutional pattern of a territorial society (or, as he then called it, "property society") as distinct from a kinship culture.[50] The paper is in fact a brief political sociology. Among a people who have moved from kinship to territory (or property) as the basis of their social organization, the State replaces the tribe as the central vehicle of regimentation. The State is "an organized body of the highest order, embracing all its subsidiary organizations." [51] The dynamic of the State, he continued, lies in its social classes and ranks, which "affect in varying degree the form of the government, and the relations arising therefrom." There are two "grand classes" in most States. The first, which is directly related to government, includes the civil, military and priestly organizations, "based upon heredity, possession of land, wealth, and other circumstances." The second, which is indirectly related to government, are the institutional associations organized to serve a variety of purposes—educational, industrial, charitable, religious, and so forth. Powell calls these groups "corporations," using the more literal and medieval meaning of the word.

The State, thus, is "a plexus of organizations" which form a descending series, so that the State has a compound structure.[52] Government is "the sociologic organ differentiated from the State for the regulation of conduct." Government is evolved in a society in order to establish and maintain justice among the differentiated classes and corporations of the society. The motive-power for this process of evolution is the multiplication and specialization of social units within the State. Regimentation and justice become increasingly complex, for conflicts between the social units arise, and each social unit develops its own regimentation and concept of justice for itself. Unhappily, the failure of property as a cement binding the people in peaceful and just relations contrasts vividly with the success of kinship. Indeed, one feels, reading Powell's observations, that he doubted if a "property society" can ever mature the kind of social bond—and, therefore, justice—among its peoples that is commonplace among kinship cultures.

REFERENCES

1. F. D. Dellenbaugh, *The Romance of the Colorado River* (New York: G. P. Putnam's, 1902).
2. L. L. Bernard, *Origins of American Sociology: The Social Science Movement in the United States* (New York: T. W. Crowell, 1943), p. 835. Quoted by permission.
3. J. W. Powell, "Sociology, or the Science of Institutions," *American Anthropologist,* n. s., I (1899), pp. 475 ff.; pp. 695 ff.
4. J. W. Powell, "Technology, or the Science of Industries," *American Anthropologist,* n. s., I (1899), pp. 319 ff.
5. *Ibid.*
6. By "substantiation" Powell meant those activities which produce substances, a very literal usage.
7. J. W. Powell, "Sociology . . . ," *op. cit.,* p. 475.
8. *Ibid.*
9. *Ibid.,* p. 477.
10. *Ibid.,* p. 479.
11. *Ibid.,* p. 495.
12. *Ibid.,* p. 483.
13. *Ibid.,* p. 695.
14. *Ibid.,* p. 742.
15. *Ibid.,* p. 743.
16. J. W. Powell, "Philology, or the Science of Activities Designed for Expression," *American Anthropologist,* n. s., II (1900), pp. 601 ff.
17. *Ibid.,* p. 604.
18. Oral language has five different phases, according to Powell: phonics, lexicology, grammar, etymology, and sematology. The latter is roughly the present-day field of semantics. *Ibid.,* p. 622.
19. *Ibid.,* p. 636.
20. *Ibid.,* p. 637.
21. J. W. Powell, "Sophiology, or the Science Designed to Give Instruction," *American Anthropologist,* n. s., III (1901), pp. 51 ff.
22. *Ibid.,* p. 58.
23. *Ibid.,* p. 63.
24. J. W. Powell, "The Humanities," *Science,* n. s., I (1895), pp. 15 ff.
25. J. W. Powell, "Sketch of Lewis H. Morgan," *Popular Science Monthly,* XVIII (1880), pp. 114 ff.
26. By culture stage Powell had in mind "the aggregate of human activities, the humanities, extant among the people and during the time to which such characterization belongs." Cf. Powell, "From Barbarism to Civilization," *American Anthropologist,* I (1888), pp. 97 ff.

27. *Ibid.*, p. 99.
28. J. W. Powell, "Competition as a Factor in Human Evolution," *American Anthropologist,* I (1888), p. 302.
29. *Ibid.*, p. 312.
30. J. W. Powell, "The Growth of Sentiency," *Forum,* XI (1891), pp. 157 ff.
31. *Ibid.*, p. 167.
32. J. W. Powell, unpublished manuscript, Bureau of American Ethnology Letterpress.
33. *Ibid.*
34. "Sociology . . .," *op. cit.*, p. 695.
35. J. W. Powell, "On the Evolution of Language," *Smithsonian Miscellaneous Collection,* XXV (1883), pp. 35 ff.
36. J. W. Powell, "The Lessons of Folklore," *American Anthropologist,* n. s., II (1900), pp. 1 ff.
37. *Smithsonian Miscellaneous Collection,* XXV (1883), pp. 42 ff.
38. J. W. Powell, "Problems of American Archaeology," *Forum,* VII (1890), p. 638.
39. J. W. Powell, "On Activital Similarities," *Second Annual Report,* Bureau of American Ethnology, 1881-1882, p. lxv.
40. *Ibid.*, p. lxvii.
41. *Ibid.*, pp. lxxii ff.
42. "From Barbarism to Civilization," *op. cit.*, pp. 99 ff.
43. J. W. Powell, "Indian Linguistic Families of America North of Mexico," *Seventh Annual Report,* Bureau of American Ethnology, 1891, pp. 7-8 ff.; 30-36, 39-41.
44. J. W. Powell, unpublished manuscript, Bureau of American Ethnology Letterpress.
45. J. W. Powell, *First Annual Report,* Bureau of American Ethnology, 1879, p. xxviii.
46. J. W. Powell, "On Primitive Institutions," *19th Annual Meeting,* American Bar Association, XIX (1896), p. 574.
47. *Ibid.*, p. 577.
48. *Ibid.*, p. 582.
49. "Tribal Society," *Smithsonian Miscellaneous Collection,* XXV (1883), pp. 76 ff.
50. J. W. Powell, "Outlines of Sociology," *Smithsonian Miscellaneous Collection,* XXV (1883), pp. 106 ff.
51. *Ibid.*, p. 107.
52. *Ibid.*, p. 110.

Chapter VII

THE UNIVERSE IS A QUINCUNX

1.

"THE FIRST OF A SERIES OF SCIENTIFIC PHILOSOPHY"

In December, 1898, Powell wrote Prince Kropotkin: "I send you, today, a little book,—the first of a series of scientific philosophy." He went on to explain that he had long contemplated the subject, and added: "I may not live to complete the plan but the first volume is out." [1] The volume which Kropotkin received was *Truth and Error.* The others were never sent; apparently they were never completed.[2]

The year before, Powell outlined to his friend, Paul Carus, the scope of the series. "I am gradually reducing the material on which I have been at work for the past thirty years to form for publication. The first volume is now undergoing final revision; the second volume is nearly ready in first draft, while the third volume is in the form of a scheme and notes. The third volume will be rather small." [3]

Truth and Error, which was published by Carus' Open Court Publishing Company in Chicago, was dedicated to "Lester F. Ward, Philosopher and Friend." The closing sentence of the book, written almost as an after-thought, admirably sets forth the ambition of the author. "The philosophy here presented is neither Idealism nor Materialism; I would fain call it the Philosophy of Science." [4] The subject has become a popular one in recent years. Powell's pioneer effort, however, has received little if any attention.

The book is far different from his earlier studies, which had been even in their most theoretical phases largely concerned with empirical data. Powell had during the years insisted on being the practicing scientists. Whatever it was that turned his synthesizing mind in the direction of philosophy—it is impossible even to conjecture on his motives—he found himself during the last decade of his life almost completely absorbed with problems of scientific method and with the phenomenal world of the scientist. He apparently realized that simply to reject metaphysics—as was fashionable then (and even now) among scientists—is no answer to the questions raised by metaphysics. What is reality? How do we know it? It was not enough to spurn the answers which metaphysicians have made. If the problems are im-

portant—as Powell seemed to think—then they ought to be solved in the manner and spirit of science. This he proceeded to do, casting aside, as was his habit, the clues and solutions of other men, though his own answers belong in the tradition of Machian positivism.

2.

VENERABLE GHOSTS OF SCIENCE

To formulate a philosophy of the phenomenal world of the scientist, one which would describe its structure and would portray the processes by which it is known, is not easy. For even the scientist falls into the fallacies of the savage. "The savage philosopher," Powell told a meeting of the American Association for the Advancement of Science, "classifies by obvious resemblances—analogic characters. The civilized philosopher (the scientist?) classifies by essential affinities—homologic characteristics. . . ." [5] In the first mode, the universe is explained by analogies derived from human experience; in the latter, phenomena are explained as orderly succession events. The scientist must let reality tell its own story, divesting himself of his own personal refractions.

Powell recognized that it has taken man a very long time to arrive at an objective description of his world. At different stages man has been a hecastotheist, holding that everything is a god; a zoötheist, that animals are gods; a physitheist, personifying natural phenomena; and a psychotheist, personifying mental and social characteristics.[6] In philosophy the heir of this projective tendency is metaphysics.

"Metaphysics," as Powell defined it, "is a system of explaining how the essentials of bodies are generated from one another." [7] Its devices are "force," "idea," "form," "extension," and so on. It is "the doctrine that one of the essentials of a particle or body is primordial, or the one from which the others are derived. They may be derived from parental genesis, as in ancient metaphysics; by evolution, as in modern materialism; or by creation, as in idealism." [8]

The psychology of such metaphysics is contained in the phenomenon of reification. "Ideas are expressed in words which are symbols, and the word may be divested of all meaning in terms of number, space, motion, time and judgment and still remain, and it may be claimed that it still means something unknown and unknowable; this is the origin of reification." [9] The habit is reënforced by the cul-

ture. "The social organization of mythology is always found to be essentially identical with the social organization of the people who entertain the philosophy." [10] Consider, for example, the conception that reality is characterized by a universal substrate. This notion, says Powell, is a mythological one; it had its background in Greek society, in "the survival of the tribal habit or mental tendency to claim superiority for the ancient or the first." Here is the cultural background of the idea of the Absolute. But when imperialism has led to monotheism, a new substrate was discovered—the deity as something eminent in the world of attributes. Later on, other substrates replaced deity: thus, Kant's thing-in-itself as noumenon, leading to the belief in the world only as phenomenon.[11]

Venerable ghosts clutter up the philosophic workshop of the scientist. Powell inventoried the most influential of the apparitions which haunt modern scientific philosophy and found seven of them,—"seven reified words, seven voids, seven nothings." [12] They are: substrate, essence, space, time, force, mind, and cause—"perhaps the most fundamental and far-reaching of the vast multitude of illusions which appear in the history of error." [13] As concepts, they are, if properly defined and used, necessary to the scientist; as substances, as "thingified" words, they vitiate any scientific enterprise. Whatever else a philosophy of science does, it must banish these ancient shadows. For science deals with realities. And realities must be defined as existents, as "bodies with their properties. All the facts embraced in this vast field of research are expressed in terms of number, space, motion, time and judgment; no other terms are needed and no other terms are coined. . . ." [14]

Unreified, these ghostly words are useful. Thus: "Substrate is matter; matter is the substrate of all bodies. Essence is any collocation of units into a unit of a higher order, which makes it a kind or class. Space is any extension or any collocation of extensions; force is any collocation of motions that are related by collisions; time is any duration or collocation of durations; mind or spirit or ghost is any judgment or collocation of judgments; cause is any antecedent or collocation of antecedents of a change." [15]

In constructing his philosophy of reality and knowledge of reality, then, the scientist needs only operations or processes. He starts with something given, to be sure: matter, with its five factors—number, extension, motion, duration, and judgment (the latter in the case of some matter at least). "If science deals with realities and not chimeras,

it is proper to ask what are these realities. [They] are bodies in relations to one another and the properties which they present in their relations." [16] All of the facts embraced in this vast field of research are expressed in terms of the number, extension, motion, duration and judgment of bodies in their relations.

3.

"THE UNIVERSE IS A HIERARCHY"

Reality is a relational field, according to Powell. "The universe is a concourse of related bodies composed of related particles. Every relation must be between two or more particles or bodies, and every particle or body is related to every other particle or body directly or indirectly. The universe is a hierarchy of bodies, and thus there is a hierarchy of relations." [17] Powell was fascinated by this notion of the relatedness of reality.

> "Relations, therefore, are so great in number and so many in kind that the subject of relations is apt to overwhelm the mental powers, for man discovers that in his reasoning he is forever dealing with relations far more directly than with the bodies themselves. In this manner he discovers that the world is a congress of molar bodies that are related to one another through their properties; when they are analyzed into related particles or synthesized into related bodies, relations seem to swallow all else, so that philosophers often assume and sometimes affirm that all that is known of the universe is only a system of relations and the substantiality of the universe is denied. The universe thus becomes a universe of relations without terms." [18]

In a relational field something—some things—must be related. These substances are the realities of science, and they may be fundamentally classified into six groups: "(1) the particles of the ether, the science of which I call etheronomy; (2) the bodies and particles of the stars, the science of which is astronomy; (3) the bodies and particles of the earth, the science of which I call geonomy; (4) the bodies and particles of plants, the science of which I call phytonomy; (5) the bodies and particles of animals, the science of which I call zoönomy; (6) the bodies which are invented by man, the science of which I call demonomy." [19] A review of these provinces of science reveals the presence of homologies, which extend from atom to organism.[20] Indeed, "there is a hierarchy of homologies throughout the universe which constitute a continuum, and logically no plane of demarca-

tion can be discovered which constitutes an absolute gap." [21] The discernment of homology is important for a scientific philosophy, for among other things it yields generalizations about the nature of reality. "Whatever is true of one object is true of its homologue in so far as they are identical. . . ." [22]

The establishment of a continuum of homologues leads to a seriation of the universe in a hierarchy of relations: a flow-chart of reality. Classification, a preliminary step in science, is "the discovery of kinds in series." [23] Unlike metaphysical classification which affirms the venerable essences and essential attributes and which breeds dichotomies *ad nauseam,* scientific classification searches for kinds in series and co-ordinates "series of kinds in systems, and systems again in series." [24] The test for such classification is three-fold. "First, within the class all of the individuals must constitute an unbroken series, with a beginning and an ending, each class demarcated by a gap or discrete degree. Second, the classes themselves must be seriated with the least possible gaps. Third, the series thus produced must be traced to convergence." [25]

The convergence of phenomena into one another—an inevitable aspect of the notion that the universe is a relational field—impressed Powell tremendously.

> "I have tried to demonstrate that an ultimate particle, and hence every body, has five essentials or concomitants, these terms being practically synonymous. It has been shown that there is something absolute and something relative in every one. The essentials of the particle are unity, extension, speed, persistence and consciousness, which are absolute. The relations which arise from them, in order, are multeity, position, path, change, and choice, which give rise to number, extension, motion, time and judgment, as properties that can be measured. It has been pointed out that particles are incorporated in bodies through affinity as choice, and by this incorporation the quantitative properties become classific properties which, in order, are class, form, force, causation, and conception. In the development of number into class, unity becomes kind and plurality becomes series. In the development of space into form, extension becomes figure and position becomes structure. In the development of motion into force, speed becomes velocity and path becomes inertia. In the development of time into causation, persistence becomes state and change becomes event. In the development of judgment into conception, consciousness becomes recollection and choice becomes inference." [26]

This flowing hierarchical pattern of the universe, so markedly in contrast to the fixity of Aristotelian categories, is a pentalogical pat-

tern: the universe is a quincunx. Matter is the substrate (operationally?) of a design whose concomitants include five factors—number, extension, motion, duration, and judgment. Particles are related to each other through plurality, position, path, change, and incorporation. The relations are internal, as the following paragraph shows. "Class is the reciprocal of number. It is class in the body as kind and series, and it is number in the particle as unity and plurality. Form is the reciprocal of space, which is form in the body as figure and structure, and it is space in the position of the extensions of the particle. Force is the reciprocal of motion; it is force in the body as action and passion; it is motion in the particle as speed and path. Causation is the reciprocal of time; it is causation in the body as cause and effect; it is time in the body as persistence and change." [27]

5.

REALITY AS PENTALOGIC PROCESS

Reality, then, has the pattern of a hierarchical series. "Nature expresses ultimate simplicity in organizing the bodies of the universe, molecular bodies being organized on the basis of unity, stellar bodies on a basis of extension, geonomic bodies on a basis of speed, plants on a basis of persistence, and animals on a basis of consciousness." [28] At each successive level of reality Powell pointed to the manner in which classes develop into series.

Thus, in geonomy (geology), changes in kind bring changes in form: metamorphosis. Sedimentary formations are seriated in layers or strata, and sedimentary strata are seriated.[29] Succession of changes in force occurs: metaphysis.[30] Causality is a process (metagenesis) in which relations of time to time (cause and effect) change, being affected in process by force, form, and kind (as Powell defines these terms).[31]

Similarly, in phytonomy (botany), development in series takes place. "During growth, which is an increase of form and structure by a succession of changes, it also exhibits a new mode of motion, which is vitality or life, and the cessation of this activity is death, when the plant returns to the geonomic world by decay. But assimilation, growth and life are continued from one generation to another, and imply time from period to period. This time is occupied by making changes, and causation is metagenesis. Now a new element of time appears, for by producing germs and thus multiplying individuals like

itself the same stages of metabolism, growth and life observed in the parents are repeated in the offspring. This new element is heredity. . . ." [32] Concludes Powell: "Generations are generations of processes. The processes are assimilation, construction and destruction, growth of form and structure, vitality exhibited in endosmosis and exosmosis, and finally processes are repeated by heredity represented by parents and children." [33] The pentalogic pattern of reality is displayed in the plant world even more vividly than in the realm of rocks and minerals. "We find in plants the same essentials: unity, extension, speed, and persistence as they are compounded into the properties of number, space, motion, and time, and as they are further developed as time, form, force, and causation; we also find the fifth property of affinity, which now seems to be choice even more plainly than we have found it in other bodies." [34]

The pentalogic pattern of processes is much more pronounced in the animal world (zoönomy). The evolution of animal life is the development of organs of metabolism, reconstruction, motility, reproduction, and conception.[35] Each series gives rise to the other in the evolutionary development. Evolution is "the totality of changes occurring in the universe. These changes can all be resolved into changes in the position of the ultimate particle of matter. Directed changes in position lead to incorporation, then incorporation is succeeded by re-incorporation, and the totality of these changes is the totality of evolution." [36]

In animal life evolution occurs through the convergence of affinity, adaptation, heterogeneity, survival and effort. Affinity is choice of association; it is observable in atoms and molecules; it becomes "choice" in animals. It is the basis of animal evolution, so that changes wrought in the animal are progressive in geometrical ratio by the compounding of all the factors." [37]

At the human level, in civilization, "the law of effort is transmuted into the law of culture, the method of invention; that is, the effort is designed effort for the purpose of improving human conditions." [38] Human evolution, therefore, becomes mental evolution, the product of culture by invention. "The law of culture transforms and then absorbs the law of adaptation, the law of heterogeneity, the law of survival, and finally the law of effort." [39] Adaptation to environment becomes adaptation of the environment to man: culture itself becomes an environment.[40] Historically, the successive modes of evolution may

be noted: by direct adaptation to the environment, by indirect adaptation, and by environment adaptation to man.[41]

6.

THE FALLACY OF THE MASTER HYPOTHESIS

Pentalogy became an *idée fixe* with Powell, one which he defended with great vigor, as is customary in persons with such obsessions. "It was more than a chance that produced the decimal system, for the universe is pentalogic, as all of the fundamental series discovered in nature are pentalogic by reason of the five concomitant properties. The origin of the decimal system was the recognition by primitive man of the reciprocal pentalogic systems involved in the two hands of the human body, and the pentalogic properties are always in pairs. While the properties are five, they are manifested in reciprocal pairs. The universe is not an endless series of infinitesimal variables, but it is a universe of divergent series as branches spring from a trunk." [42] It is as though the Major, pacing back and forth in his office and dictating to his secretary, was ever mindful of his empty sleeve. As early as 1883 one finds evidence of his involvement with the idea of quinary systems. By the time he sent the manuscript of *Truth and Error* to the editor the concept had been elaborated with architectonic symmetry.

Lester F. Ward, to whom the book was dedicated, gave it harsh treatment in a review.[43] He found that the Major had evolved at least a dozen and a half pentalogies. In addition to those sketched in these pages there are quincuncial patterns of the human psyche: e.g., that of the faculties—sensation, perception, apprehension, reflection, and ideation. Ward constructed a table of general correlations arranged into a tabular flow:

1. As number develops into class, unit becomes kinds and plurality.
2. As space develops into form, extension becomes figure and position.
3. As motion develops into force, speed becomes velocity and path.
4. As time develops into causation, persistence becomes state and change.
5. As judgment develops into conception, consciousness becomes recollection and choice.

Concludes Ward: "By thus constructing the material universe out of five immaterial elements, Major Powell seems to think he has made his

peace with the idealists and now might turn on the materialists. It cannot be denied that he has evolved a system as thoroughly ideal as that of Berkeley, and about the only difference between it and the Berkeleyan idealism is that it consists of five nothings instead of one." Ward asks the inescapable question: "Why pentalogic? Is the universe really a quincunx?"

In tracing the pattern of the universe through the internal relations which, as he thought, its bodies and particles have with one another, Powell formulated a conception of reality as process, a conception of enormous value to be sure. But what was unquestionably a profitable working hypothesis became a master hypothesis. It nullified his own intriguing adage: "Fools collect facts, the wise man selects them." [44] In fact, it exemplified the very fallacy which he had engaged in battle. "This postulation," he had said, "of all properties from one, if neglected, leads to what has here been called reification." [45] Powell not only reified his concepts, he systematically reified them.,

Moreover, he broke his own basic rule of true science: that classes must be discovered, not invented. His pentalogy became, unhappily, a metalogic.

Steering a course between Idealism and Materialism by means of his quinary chart, he was swallowed up in a wave of pentalogical inventions, was shipwrecked somewhere—it does not matter really just where—between these two evil geniuses of scientific philosophy.

Yet this much should be said. Powell's expedition into the philosophy of science was a courageous adventure, matching in spirit and flair—if not in significance—his famous voyage down the Colorado River thirty years earlier. As in the Canyon, so here other men had been wrecked. He was not the first man to take the world of knowledge as his province; nor the last. Unfortunately, this company of brave men, if not already extinct, at least seems to be disappearing.

REFERENCES

1. Bureau of American Ethnology Letterpress.
2. The status of the other two volumes in the series is obscure. May 5, 1898 Powell wrote Dr. Titus M. Coan, New York: "I wish to consult you concerning the publication of a book. It will make a volume of about 500 pages. It is an attempt to develop the fundaments of a scientific psychology." June 1, 1898 there is a note to Coan: "I send you the manuscript of my book." Apparently it was never published, and a search at the Bureau of Ethnology revealed no such manuscript. January 2, 1902, Powell wrote G. Stanley Hall that he hoped to send him soon "a manuscript . . . 'On the Organization of Mind,' " which he said would be "the first chapter in a system of psychology." (Bureau of American Ethnology Letterpress). The author was unable to determine the whereabouts of these manuscripts, or of the one on "Good and Evil," which is mentioned in the published volume, *Truth and Error.* The last five years of his life were handicapped by ill health; Powell could not maintain the rugged pace of the previous quarter of a century.
3. Bureau of American Ethnology Letterpress.
4. *Truth and Error, op. cit.,* p. 423.
5. J. W. Powell, "Mythologic Philosophy," *Popular Science Monthly,* XV (1879), p. 797.
6. *Ibid.,* p. 804.
7. J. W. Powell, "Sophiology, or the Science Designed to Give Instruction," *American Anthropologist,* n. s., III (1901), p. 65.
8. *Ibid.* p, 67.
9. *Truth and Error,* p. 3.
10. "Mythologic Philosophy," *op. cit.,* p. 58.
11. *Truth and Error,* p. 423.
12. J. W. Powell, "Seven Venerable Ghosts," *American Anthropologist,* IX (1896), p. 82.
13. *Truth and Error,* p. 69.
14. *Ibid.,* pp. 5-6.
15. "Seven Venerable Ghosts," p. 69.
16. *Ibid.,* p. 78.
17. *Truth and Error,* p. 20.
18. *Ibid.,* p. 22.
19. *Ibid.,* p. 42.
20. *Ibid.,* p. 145.
21. *Ibid.,* p. 146.
22. *Ibid.,* p. 147.

23. *Ibid.*, p. 117.
24. *Ibid.*, p. 118.
25. *Ibid.*, p. 117 f.
26. *Ibid.*, p. 413.
27. *Ibid.*, p. 41.
28. J. W. Powell, "Classification of the Sciences," *American Anthropologist,* n. s., III (1900), p. 603.
29. *Truth and Error,* p. 50.
30. *Ibid.*, p. 59.
31. *Ibid.*, p. 63.
32. *Ibid.*, p. 65.
33. *Ibid.*
34. *Ibid.*, p. 73.
35. *Ibid.*, p. 78.
36. *Ibid.*, p. 187.
37. *Ibid.*, p. 200.
38. *Ibid.*, p. 200.
39. *Ibid.*, p. 39.
40. *Ibid.*, p. 204. An interesting anticipation of the work of Childs, Sherrington, Bernard, and others is Powell's formulation of the concept of cortex dominance, along the lines of hierarchical series. "The human body is a hierarchy of conscious bodies. In this hierarchy the lower members are controlled by the higher members. The lowest members are ultimate particles and the highest member is the cortical body. Now the cortical body controls all the others in the hierarchy and it ought to receive intelligence from all the others, for the consciousness of the particle is transmitted to the cortex, and the will of the cortex is transmitted to the cortical body, but only those which require regulation by it." (p. 87).
41. J. W. Powell, "The Three Modes of Evaluation," *Smithsonian Miscellaneous Collection,* XXXIII (1888), pp. xxvii ff.
42. *Truth and Error,* p. 112.
43. "Review of J. W. Powell's *Truth and Error,*" *Science,* n. s., IX (1898), pp. 126 ff.
44. J. W. Powell, "Darwin's Contributions to Philosophy." *Smithsonian Miscellaneous Collection,* XXV (1883), p. 68.
45. *Truth and Error,* p. 416.

POWELL BIBLIOGRAPHY

1867

"Report to the 25th Session of the Illinois General Assembly, January 7,"
Reports, Vol. II (Powell Collection: Illinois State Normal University).

1873

"Some Remarks on the Geological Structure of a District of Country Lying to the North of the Grand Canyon of the Colorado,"
American Journal of Science, V, 456 ff.

1875

"Physical Features of the Colorado Valley,"
Popular Science Monthly, VII, 385 ff., 531 ff.
"Ancient Province of Tusayan,"
Scribner's Magazine, XI, 150 ff.
Exploration of the Colorado River of the West and Its Tributaries Explored in 1869, 1870, 1871 and 1872
(Washington, D. C.: Government Printing Office).

1876

Report on the Geology of the Eastern Portion of the Uinta Mountains and a Region of Country Adjacent Thereto
(Washington, D. C.: Government Printing Office).
"Types of Orographic Structure,"
American Journal of Science, XII, 414 ff.

1877

Outline of the Philosophy of North American Indians
(New York: Douglas Taylor).

1878

"Report on the Methods of Surveying the Public Domain,"
45th Congress, 3rd Sess., *House Miscellaneous Document,* No. 5.
Report on the Lands of the Arid Region of the United States with a More Detailed Account of the Lands of Utah, with Maps, 1st ed.
(Washington, D. C.: Government Printing Office).

1879

"Mythologic Philosophy,"
Popular Science Monthly, XV, 795 ff.; XVI, 56 ff.

1880

"Sketch of Lewis H. Morgan,"
Popular Science Monthly, XVIII, 114 ff.

"Report of the Public Lands Commission,"
46th Congress, 2nd Sess., *House Executive Document,* No. 46.

1881

"On Activital Similarities,"
Second Annual Report, Bureau of American Ethnology (1881-1882), lxv ff.
(Washington, D. C.: Government Printing Office).

1882

"Tribal Marriage Law,"
"On Kinship and the Clan,"
"On Kinship and the Tribe,"
Third Annual Report, Bureau of American Ethnology, xxxviii ff.; lvi ff.
(Washington, D. C.: Government Printing Office).

1883

"Review of Ward's *Dynamic Sociology,*"
Science, I, 45 ff., 105 ff., 171 ff., 222 ff.
"On the Evolution of Language,"
Smithsonian Miscellaneous Collections, XXV, 35 ff.
"On Limitations to the Use of Some Anthropologic Data,"
Smithsonian Miscellaneous Collections, XXV, 113 ff.
"Wyandotte Government—A Study of Tribal Society,"
Smithsonian Miscellaneous Collections, XXV, 76 ff.
"Outlines of Sociology,"
Smithsonian Miscellaneous Collections, XXV, 106 ff.
"Darwin's Contributions to Philosophy,"
Smithsonian Miscellaneous Collections, XXV, 68A.

1884

"Certain Principles of Primitive Law,"
Science, IV, 436 ff.
"On the Fundamental Theory of Dynamic Geology,"
Science, IV, 511 ff.

1885

"The Administration of the Scientific Work of the General Government,"
Science, V, 51 ff.
"Introduction,"
Seventh Annual Report, Bureau of American Ethnology
(Washington, D.C.: Government Printing Office).
"Indian Linguistic Families of America North of Mexico,"
Seventh Annual Report, ibid.
"The Larger Import of Scientific Education,"
Popular Science Monthly, XXVI, 452 ff.
"Testimony before Joint Committee on the Scientific Research Services,"
49th Congress, 1st Sess., *Senate Miscellaneous Document,* No. 82.

"Introduction,"
Seventh Annual Report, U. S. Geological Survey
(Washington, D. C.: Government Printing Office).

1886

"The Cause of Earthquakes,"
Forum, II, 370 ff.
"Introduction,"
Eighth Annual Report, U. S. Geological Survey
(Washington, D. C.: Government Printing Office).

1887

"Museums of Ethnology and Their Classification,"
Science, IX, 612 ff.

1888

"Competition as a Factor in Human Evolution,"
American Anthropologist, I, 297 ff.
"From Barbarism to Civilization,"
American Anthropologist, I, 97 ff.
"The Three Modes of Evolution,"
Smithsonian Miscellaneous Collections, XXXIII, xxvii ff.
"The Personal Characteristics of Professor Baird,"
Smithsonian Miscellaneous Collections, XXXIII, 71 ff.
"Reservoirs for the Storage of Water in the Arid Regions of the United States,"
50th Congress, 1st Sess., *Senate Executive Document,* No. 163.
"Preliminary Report on the Organization and Prosecution of the Survey of the Arid Lands for the Purposes of Irrigation,"
50th Congress, 2nd Sess., *Senate Executive Document,* No. 43.
"The Laws of Hydraulic Degradation,"
Science, XII, 229 ff.

1889

"The Lesson of the Conemaugh,"
Popular Science Monthly, CXLIX, 150 ff.
"Effect upon Certain Rivers in Colorado of the Diversion of Water for Irrigation,"
50th Congress, 2nd Sess., *Senate Executive Document,* No. 120.

1890

"Prehistoric Man in America,"
Forum, VII, 489 ff.
"Problems of American Archaeology,"
Forum, VII, 638 ff.
"Institutions for the Arid Lands,"
Century, XVIII, 114 ff.
"The Irrigable Lands of the Arid Regions,"
Century, XIX, 766 ff.
"The Non-irrigable Lands of the Arid Regions,"
Century, XIX, 915 ff.

1891

"The Growth of Sentiency,"
Forum, X, 157 ff.
"The New Lake in the Desert,"
Scribner's Magazine, VII, 463 ff.
"The Study of Indian Languages,"
Science, XVII, 71 ff.
"The Four Modes of Life,"
Forum, X, 157 ff.
"Irrigation," Testimony before Select Committee of House on Irrigation,
Eleventh Annual Report, U. S. Geological Survey
(Washington, D. C.: Government Printing Office).

1892

"Our Recent Floods,"
North American Review, CLV, 149 ff.
"Award of the Cuvier Prize by the Academy of Sciences of the Institute of France,"
Thirteenth Annual Report, U. S. Geological Survey
(Washington, D. C.: Government Printing Office).

1893

"Are Our Indians Becoming Extinct?"
Forum, XV, 343 ff.
"General Work in Taxonomy,"
Fourteenth Annual Report, U. S. Geological Survey
(Washington, D. C.: Government Printing Office).
"Are There Evidences of Man in the Glacial Gravels?"
Popular Science Monthly, XLIII, 316 ff.

1894

"The Water Supplies in the Arid Region,"
Irrigation Age, VI, 54 ff.; 143 ff.
"On the Nature of Motion,"
The Monist, V, 55 ff.
"Marriage Law in Savagery,"
Science, XVIII, 471 ff.

1895

Physiographic Processes
(New York: American Book Company).
"The Five Books of History,"
Science, n. s., I, 157 ff.
"Proper Training and Future of the Indians,"
Forum, XVIII, 622 ff.
"The Humanities,"
Science, n. s., I, 15 ff.

1896

"On Primitive Institutions,"
Nineteenth Annual Meeting, American Bar Association, XXIX, 573 ff.

"Seven Venerable Ghosts,"
American Anthropologist, IX, 67 ff.
"Certitudes and Illusions, an Illusion Concerning Rest,"
Science, n. s., II, 426 ff.

1898

"Whence Came the American Indians?"
Forum, XXIV, 676 ff.
Truth and Error, or the Science of Intellection
(Chicago: Open Court Publishing Company).
"How a Savage Tribe Is Governed,"
Forum, XXIV, 712 ff.

1899

"Technology, or the Science of Industries,"
American Anthropologist, n. s., I, 319 ff.
"Sociology, or the Science of Institutions,"
American Anthropologist, n. s., I, 475 ff., 695 ff.
"The Soul,"
The Monist, V, 43 ff.
"Reply to Critics,"
Science, n. s., IX, 259 ff.

1900

Archaeology
Limestone College Studies
(Gaffney, S. C.: Limestone College).
"Philology, or the Science of Activities Designed for Expression,"
American Anthropologist, n. s., II, 1 ff.
"Classification of the Sciences,"
American Anthropologist, n. s., III, 601 ff.
"Sophiology, or the Science Designed to Give Instruction,"
American Anthropologist, n. s., III, 51 ff.
"The Categories,"
American Anthropologist, n. s., III, 404 ff.

1902

"The American View of Totemism,"
Man, II, 101 ff.
Letterpress, 1879-1902, Bureau of American Ethnology,
Smithsonian Institution, Washington, D. C.