BIOGRAPHICAL MEMOIR

OF

CLARENCE KING.

1842-1901.

BY

SAMUEL FRANKLIN EMMONS.

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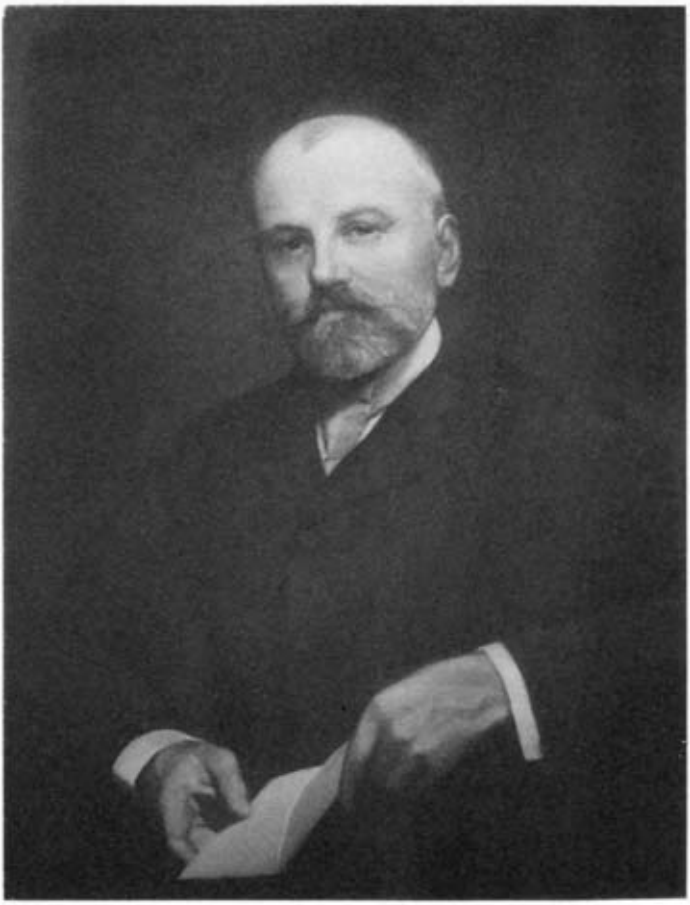

Clarence King

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The greatest advance in geological science in the past half century has been due less to the brilliant generalizations of individual investigators, of which, however, there has been no want, than to the systematic organization of geological work which has given a sounder basis for theoretical deduction and rendered the work of the individual more permanent and effective.

It was not until the truth that geological studies could not be profitably confined within State lines or other artificial boundaries had been proved by practical demonstration that the aid of the general government was freely and permanently enlisted and thereby geological science in America raised to its present high position.

To the accomplishment of this result the late CLARENCE KING was the foremost and one of the most active contributors. His influence on the development of geological science in this country was exercised at a critical point in its history, when the personality of the man, aside from his purely scientific ability, played a much greater part than it would at the present day, when the labors of men of his type have already borne abundant fruit in impressing upon the people at large the practical importance of a scientific guidance in the development of their material resources. It seems, therefore, appropriate in speaking of the man, even to a strictly scientific audience like the present, that the more personal element should receive attention.

For believers in atavism a consideration of King's ancestry will possess a peculiar interest. On both sides he came of good English stock planted on New England soil, where conditions seemed propitious for the gradual development of the varied characteristics that showed themselves so remarkably combined in this brilliant man.

Daniel King, the first of the name in this country, came to Lynn, Massachusetts, in 1637—a younger son of Ralphe Kinge of Watford, in Hertfordshire, England.

Fifty years later we find his son, Capt. Daniel King, a resident merchant of St. Kitts, in the West Indies. On the floor of St. George's chapel at Basseterre, on that island, is a stone bearing the arms of the King family and recording the death of Benjamin King, presumably Daniel's son.

Benjamin King, a grandson of the first Daniel, moved from Salem to Newport in the first half of the eighteenth century, dying there in 1786. In him already was Commerce giving way in a measure to Science, for he displayed strong tastes in the latter pursuit, which the means acquired in the former permitted him to indulge, and he made a point of importing from Europe the latest philosophical instruments. It is a family tradition that the great Benjamin Franklin, on one of his voyages between Philadelphia and Boston, visited him to view the latest electric novelty—a Leyden jar.

Next Art came to pay her tribute, for Samuel, son of Benjamin the scientist, was a portrait painter of no mean repute, and numbered among his pupils the famous Washington Allston and Malbone, the miniaturist.

The maternal side contributed literary culture and statesmanship.

The Honorable Ashur Robbins, one of King's great-grandfathers, was born at Weathersfield, Connecticut, in 1761, and died at Newport, in 1845. He graduated at Yale in 1782, married Mary Ellery in 1791, was United States district attorney at Newport in 1812, received the honorary degree of LL.D. from Brown in 1835, and from 1825 to 1839 served his country with distinction in the United States Senate. He was distinguished as an orator and classical scholar and was a friend and associate of Daniel Webster.

William Little, another great-grandfather, was a graduate of Yale in the class of 1777 and received an honorary degree from Harvard in 1786. His son, William Little, Jr., was already distinguished as a linguist and classical scholar, when he died at the early age of 40. His wife, Mrs. Sophia Little, Clarence's grandmother, from whom he evidently inherited many characteristic traits, was a poetess and philanthropist, a woman of remarkable public spirit, energy, and decision of character. She retained her mental and physical vigor in the most remarkable degree up

to the time of her death, at the age of 95, in 1893. Her son, Robbins Little, was for many years librarian of the Astor Library, New York.

The immediate ancestors of the name were pioneer merchants of the East India and China trade in the first half of the last century. His grandfather, Samuel Vernon King, moved from Newport to New York, and in 1803 was senior partner in the commercial house of King & Talbot. His four sons, Charles, James, Frederick, and David, successively replaced him in the firm, which became known as Talbot, Olyphant & Company, and later as King & Company. Three of these four brothers died in the far East; the fourth fell in the first year of the Civil War.

James, the father of Clarence, though induced by family influence to follow the calling of a merchant, had a natural leaning toward scientific studies. He married Florence Little at the age of 21, but was obliged to leave his young wife before the birth of their first child in order to take the place of his elder brother in the house in China. He died suddenly at Amoy, China, in 1848, leaving as a legacy to his wife and only child his interest in the business of the China firm.

The young mother, left a widow at 22, devoted herself to the education of her son, learning with an inherited facility both classical and modern languages that she might teach them in turn to him, and cultivating the taste for natural science, an inherited quality, which early showed itself in the child. While living at Pomfret, Connecticut, whither she had gone that he might have the benefit of Dr. Park's excellent school for boys, the young Clarence, then only seven years old, came to his mother one day in January, when the ground was covered with frozen snow, and asked if she could go a little way with him to see something. The little way proved to be about a mile and the something a remarkably distinct fossil fern in a stone wall, and the boy wished his mother to explain to him how it came there. Books on geology were consulted, and from that time on, she writes, "my rooms became a veritable museum, where all kinds of specimens were studied with enthusiasm." In his later school-boy days, which were principally spent in the endowed high school at Hartford, Connecticut, while in the summer vacation trips in the Green Mountains were devoted to camping out among

the rocks and plants he loved to study, his mother was his companion and guide. As the boy developed into the man and as the relative disparity of age lessened, there grew up between them a close intellectual companionship that never weakened during his lifetime. She was a woman of remarkable intellectual caliber, who might readily have made a name in literature had she had that ambition; but she was contented to live in the reflected glory of her son's reputation. On his side, his tender affection and solicitude for her welfare was one of the most marked traits of his character, and through all the many vicissitudes of his checkered life his first thought and duty was to provide for her comfort and happiness.

In the crisis of 1857 the house of King & Company became bankrupt through the loss of a steamer which, in charge of a confidential clerk, was carrying a large amount of specie to meet their liabilities at another port, and the property which had been left by James King for the support of his widow and only son was thereby lost.

Not long afterward King entered as a clerk in a business house with the idea of following a commercial career, but although he succeeded in satisfying his employer, his natural taste lay so strongly in the direction of science and literature that he could not satisfy himself, and after a few months' trial abandoned the attempt.

In 1859 he became a student at the Scientific School at Yale, then a much less prosperous and generously endowed institution than at the present day, but rich in the possession of such inspiring teachers as James D. Dana and George J. Brush. Already, according to the testimony of his fellow-students, King showed many of the qualities which distinguished him above his fellows in later life. He studied enthusiastically both in books and in nature. His observations of natural objects, plants, animals, or rocks were so vivid that they seemed to photograph themselves upon his memory, so that he could recall the picture at will. He wrote readily and with delicate literary judgment and skill, thanks to the influence of his mother's teaching. His love of outdoor life had so developed a naturally robust physique that he readily excelled in all athletic sports, especially rowing.

In whatever he was engaged, whether study or recreation, he was naturally accepted as a leader by his fellows.

In 1862 he was graduated from Yale College with the degree of B. S., his class being the first to which this degree was accorded by the University. During his college life his strong natural taste for scientific and artistic study of the greater features of natural scenery had been stimulated by reading the then popular works of Tyndall and Ruskin on the Alps of Europe, and Winthrop's stirring pictures of Northwestern America; and an even more direct impulse was given by the incidental hearing, in a letter to Professor Brush, of an account of the ascent by the members of the Geological Survey of California of Mt. Shasta, then supposed to be the highest peak in North America.

Immediately upon graduation he planned a boat trip from Lake Champlain down the St. Lawrence River to Quebec, which was carried out in company with his friends, James T. Gardiner, Samuel Parsons, Jr., and Daniel Dewey, in the autumn of 1862. They rowed themselves in a four-oared boat from Whitehall, on Lake Champlain, to Quebec, camping out *en route* and supporting themselves largely by the fruit of their rods and guns.

During the winter of 1862-'3 King was for a time a student of glacial geology under the elder Agassiz, and an enthusiastic member of an art club which, under the guidance of Russell Sturgis, devoted itself to the study of Ruskin and the pre-Raphaelite school of art.

The final impulse to the step which had the most influence upon his life was characteristically given by his solicitude for the welfare of another; his life-long friend Gardiner, having broken down in health through overstudy and an open-air life having been recommended to him, King planned a trip across the continent to the sunny skies of California. In May, 1863, the two young men proceeded to St. Joseph, Missouri, then the westernmost terminus of railroads and the starting point for emigrant travel across the plains. On the train between Hannibal and St. Joe King's kindly attention to the young children of a well-to-do emigrant family led to the adoption of Gardiner and himself as members of their party. The route followed by the party led up the valley of the North Platte River into

Wyoming, and thence by the South Pass and the Sweetwater Mountains across Green River Valley and around the northern end of Salt Lake to the Humboldt River, in Nevada, corresponding thus in a general way to that followed in later years by the transcontinental railroads and included in the belt which the party under King's charge was destined to survey.

The progress of the wagons was necessarily slow and about three months were occupied in the journey, which gave the young travelers, who were mounted upon their own horses, abundant opportunity for making detours along the route, of which they fully availed themselves. In more than one instance, while exploring the neighboring mountains, they ran the risk of capture by hostile Indians, but the experience thus gained was undoubtedly of great service in King's explorations of later years.

After crossing the deserts of Nevada they left the party and made a detour to the south to examine the already famous Comstock Lode at Virginia City. The very night of their arrival their lodging-house took fire and burned so rapidly that they barely escaped with their lives, losing everything they had with them, even to their letters and clothing. This was a serious blow, as they were entirely unknown in the place; but they were equal to the occasion, and having been fitted out by hospitable miners with rough clothing, they found employment in one of the quartz mills, where they worked until they had saved money enough to continue their journey. Starting anew, they crossed the Sierra Nevada on foot and reached Sacramento with just enough money to pay their passage on the river steamer to San Francisco.

On this trip they met by chance Prof. William M. Brewer, then first assistant of Prof. J. D. Whitney, of the Geological Survey of California, who was making a reconnaissance along the upper portions of the Sierra Nevada and had temporarily left his party in order to get further aid before going into the northern country, where the Indians were reported to be troublesome. The immediate result of this incident, his appointment as volunteer assistant geologist of the recently organized Geological Survey of California, was one that had a far-reaching effect on King's future career.

Although a few enterprising geologists had succeeded in pene-

trating the great mountain regions of the far west and had brought back vivid accounts of the phenomena observed at various points, the great region beyond the Mississippi River was still geologically a *terra incognita,* when in 1861 the legislature of California had appropriated a generous sum for a geological survey of that State and made Prof. J. D. Whitney its director.

No more attractive field for geological exploration and study could be found than that of the great Sierra Nevada, from which had already come a stream of gold whose volume had disturbed the monetary systems of the world. The problems presented in its structure were in many respects new in the experience of the American geologist, especially in the field of vulcanism, whose manifestations in the eastern part of the continent, where students of geology had hitherto been mainly occupied, are comparatively insignificant. To King, full as he was of youthful energy and enthusiasm, the prospect of exploring the summits of this great range and repeating in the Alps of America the experiences of Tyndall and Ruskin in those of Europe was indeed a powerful inducement for joining the Survey, and how abundantly and fruitfully he embraced the opportunities is well shown in his delightful book on "Mountaineering in the Sierra Nevada."

His first experience was as an assistant to Professor Brewer, when, in September, 1863, they explored the regions in northern California, where the granite crest of the Sierra Nevada suddenly breaks down and is succeeded by broken hills and lava-capped plains out of which rise the imposing volcanic cones of Lassens Peak and Mt. Shasta. Here he had his first opportunity for a field study of volcanic rocks—a study in which, aided by the teaching of his great friend, the German geologist Von Richthofen, he afterward became so proficient that for many years he was recognized as the highest American authority upon the subject.

A large portion of the summer of 1864 was spent in exploring the southern part of the Sierra Nevada around the Yosemite Valley and the high peaks to the eastward at the headwaters of the King and Kern rivers. In climbing one of the highest peaks of this group, which they had called Mt. Tyndall, two still higher ones were discovered, to the loftier of which, evidently the cul-

minating point of the whole Sierra, they gave the name of "Mt. Whitney" in honor of their respected chief. This King attempted to climb later in the same season, but when near the summit he found his further progress stopped by a sheer wall of granite which rendered its ascent from that side impossible. To show the great unwillingness of the man to abandon any important enterprise that he had undertaken, it may be stated that long after he had severed his connection with the California Survey he twice repeated the attempt from the other side of the range. In 1871 he supposed he had attained the highest point, but a storm coming up just as he had reached it, the clouds in which he was enveloped hid the true summit, which was a little higher than the one which he was on. Two years later the news came to him in New York that observations by a member of the California Survey had proved his error, and without a moment's delay he crossed the continent and climbed it again, this time reaching the actual summit, the highest peak within the United States.

In the summer of 1868, with William Ashburner, the distinguished mining engineer, he was for a time engaged in an economic survey of the Mariposa land grant under F. L. Olmsted, and it was during the progress of this work that he made the discovery of the fossil that finally settled the question of the age of the auriferous slates of the Sierra Nevada. In the following winter, the Survey funds being exhausted through lack of appropriations, he with his friend Gardiner returned to the east by the Nicaragua route, spending two weeks on the Isthmus while waiting for a steamer to New York. On his arrival he was detained for a long time at the house of his stepfather, George S. Howland, at Irvington-on-the-Hudson, by an attack of malaria, after which he took a post-graduate course in field and practical astronomy at Yale.

Returning again to California in the autumn of 1865, the two young men were soon after their arrival engaged as geological and topographical engineers for an exploratory expedition through Arizona, made by General McDowell with a company of cavalry. This expedition occupied the winter of 1865-'6 and, carried on as it was in a desert country infested by hostile Apaches, involved no little hardship and danger. At one time,

while carrying on their scientific work out of sight of their escort, they were ambushed by a party of Indians and only escaped death through the coolness of King, who first prevented his companion from making what he perceived to be a futile resistance, and later delayed the preparation of their torture by fire by exciting the curiosity of the Indians by his barometer, which he explained was a new kind of long-distance gun, and thus gained time enough to allow the cavalry to come in sight and effect their rescue.

In the spring of 1866, further work in Arizona having been rendered impracticable by the substitution of raw infantry from the east for the California cavalry, which had hitherto been an efficient guard against the Apaches, the young men returned to San Francisco, making the difficult and then somewhat dangerous journey across the great deserts of southern California alone, being obliged to travel at night and lie by during the daytime that they might not be seen by the Indians and also to avoid the great heat of midday sun. After working up the results of their field work they resumed their connection with the California Survey and spent the following summer in surveying the high Sierras to the east of the Yosemite Valley. It was during this work, according to Mr. Gardiner, that they planned the system of rapid surveying by triangulation checked by astronomical locations and barometrical measurements which was later so successfully carried into practice in the Exploration of the 40th Parallel.

In the early autumn, while still engaged in this work, King received news of the sudden death of his stepfather, Mr. Howland, and at once started home to be near his mother, who, with three young children left dependent upon her, for the second time found herself reduced from affluence to comparative poverty.

At this crisis he found himself in a position whose difficulties would have daunted a less courageous and sanguine nature. Without other means than his active brain and the experience gathered during his four years' apprenticeship on the California Survey, he had not only to make a career for himself, but to provide for the comfort of those who naturally looked to him for protection and support. That experience, however, was one that was invaluable to him at this time. He had familiarized himself

with the best method of overcoming the natural difficulties to be met with in carrying on scientific exploration in the west, and thus so strengthened the inborn self-reliance of his nature that, as in the case of reaching the summit of Mt. Whitney, failure seemed only to spur him on to further effort.

Not long after his return to the east, therefore, he determined upon attempting to carry out the project that had been gradually shaping itself in his mind ever since he first crossed the continent, that, namely, of inducing Congress to authorize the making of a geological and topographical survey across the entire Cordilleran system at its widest point, and thus connecting the geology of the east with that of the west. Before leaving California he had submitted his plan to Professor Whitney, but the latter, while thoroughly appreciating its great scientific importance, had refused him any written indorsement for the reason that he believed the natural obstacles in its way to be insurmountable.

King, however, confident of the feasibility of his plan, felt that then, if ever, was the time to favorably influence the minds of our statesmen, when their best endeavors were directed to strengthening the liens that bound the various parts of our great country together. There had been considerable apprehension during the dark days of the Civil War lest California, physically isolated as she was at that time, should separate from the other States and set up an independent government. The subsidizing of the transcontinental railroad was the first step toward overcoming this isolation and binding her more closely to the east; but still another step was necessary; the resources of the intermediate region should be ascertained and a foundation laid for the development of the mineral wealth locked up in its mountains and desert plains, the importance of which few beside himself were able at that time to appreciate. In no other way could this be more thoroughly accomplished than by such a scientific exploration as he proposed. Subsequent events have abundantly proved the correctness of this view, for nowhere in the history of the world has there been recorded such an amazingly rapid and permanent development of a comparatively unknown region as has been effected in the thirty years that have elapsed since the opening of the transcontinental railroad.

It was with the object of impressing this view upon Congress and influencing their favorable action that in the winter of 1866-'7 King, then barely 25 years old and looking still more youthful, presented himself at Washington armed only with a few letters of introduction from his college professors and from friends whom he had made in California. It was to his earnestness and the magnetic influence of his personality rather than to these letters, however, that was due the favorable impression he soon made upon the leading men to whom he first addressed himself. Chief among these were John Conness, of California, and Abram S. Hewitt, of New York, who became his legislative advisers and champions upon the floors of the Senate and the House respectively; General A. A. Humphreys, Chief of Engineers, eminent not only as a military commander, but also as a scientist, under whose administrative control the survey was carried on, and Spencer F. Baird, Secretary of the Smithsonian Institution, his scientific adviser, all of whom soon became and always remained his warm and sympathetic friends.

On the second of March, 1867, Congress approved a bill whose last clause authorized the Secretary of War "to direct a geological and topographical exploration of the territory between the Rocky Mountains and the Sierra Nevada Mountains, including the route or routes of the Pacific Railroad." No definite sum was appropriated at that time, as the bill provided that the expense should be met out of existing appropriations, but it had been arranged beforehand that certain unexpended balances of appropriations for surveys for a military wagon road across the continent should be used for this purpose.

Five days later King received his formal appointment as Geologist in Charge of the Geological Exploration of the 40th Parallel, and at once proceeded to organize his corps. As all the resources of the country were to be studied, animal and vegetable as well as mineral, this included, besides geologists and topographers, also a zoölogist and a botanist; a feature novel at that time was the addition of a photographer, to which position a man was selected who had had wide field experience with the Army of the Potomac during the Civil War. An escort of cavalry was also provided as a guard against possible danger from hostile

Indians, which proved a by no means useless though sometimes troublesome adjunct.

In the following May the party proceeded to California by way of the Isthmus of Panama, but it was near the end of July before all the necessary preparations had been made and they took up their march from Sacramento across the Sierra Nevada to their field of work.

In these days, when the West is covered by a network of railways, it is difficult to conceive of the obstacles that had to be overcome in carrying out so ambitious a work as that which King had planned. Of the transcontinental railroads but a few miles at either end had yet been constructed. The territories of Utah and Nevada were represented on most maps of the day as one broad desert, and it was considered doubtful whether sufficient water and grass could be found there to support a camping party.

Through such a country it was designed to carry, not a simple meander survey along a previously chosen route, as had hitherto been the custom in military explorations, but the detailed mapping, both topographical and geological, of an area about 100 miles in width, which finally extended nearly 1,000 miles in length.

As far as was possible to human foresight, King had provided means to overcome the difficulties liable to be encountered. Guided by his previous experience in such work, he had personally supervised the preparation of every article of the party's equipment, from the scientific instruments, many of which were specially constructed for the purpose on his own special designs, down to the minor details of construction of wagons and pack saddles. Nevertheless there were many times, especially in the first two seasons' campaigning in the deserts of Nevada, when, through weakness resulting from malarial fever contracted in the Sacramento Valley bottoms, the impossibility of obtaining potable water, a shortness of food supplies, or delays from storms or other causes, discouragement took possession of different members of the party. But King's abundant courage and energy never failed and his fertility in expedients was equal to every emergency; so that he gradually impressed upon every member of his corps such confidence in his ability as a leader

that their personal devotion to him and their faith in the complete success of the undertaking knew no bounds.

In 1869, when the two ends of the transcontinental railroad had met in the Salt Lake Valley, the work of the Survey had been carried eastward to the boundary of Wyoming, which was the eastern limit of the area it was primarily intended to survey. In recognition of the public demand for a direct application of the results of government geological work, King had caused special study to be made of the then developed mining districts of the West, more particularly of the Comstock Lode, at that time recognized as one of the three or four greatest silver deposits in the world. This work was pushed rapidly to completion and was issued in 1870 in an elaborately illustrated quarto volume, written conjointly by himself and James D. Hague, under the title of "Mining Industry." It was described by one of its most capable critics as by "itself a scientific manual of American precious metal mining and metallurgy." It was considered a classic among works in its line, and has served as a model for similar monographs since published under government auspices, which have been important factors in raising the mining industry of America to its present high position.

In July, 1870, while the members of his corps at New Haven were engaged in writing up the reports of what was supposed to be their completed field work, King received telegraphic instructions from General Humphreys to immediately take the field, since Congress, of its own impulse and without solicitation, now appreciating the importance of the work, had voted money for its further continuation. It being then too late in the season to carry on field work to advantage in the higher regions of the Rocky Mountains, King planned an exploration of the great extinct volcanoes of the Pacific coast in order to complete the record of the volcanic phenomena so abundantly exhibited within the area already surveyed in the Great Basin, and during the late summer and autumn special studies were made of the then practically unexplored peaks of Shasta, Rainier, and Hood.

The field work of the seasons of 1871-'2 carried the work of the Survey across the Uinta and Rocky Mountains well out onto the Great Plains. It was at the close of field work in the latter season that occurred the exposure of the great diamond fraud of

1872, an incident that brought into strong relief King's decision of character and readiness in an emergency and made him more widely and favorably known to the general public than any single act of his varied career.

News of an apparently well authenticated discovery of diamonds in sufficient quantity to affect the markets of the world had been circulated throughout the public prints during the entire summer. Its location had been kept carefully concealed, though it was generally assumed to be somewhere in Arizona. A company with ten millions of capital had been formed to work the diamond fields, whose stock had been freely subscribed to by some of the most prominent men in the East as well as the West, while a host of other companies were already organized ready to float their stock as soon as the position and character of the diamond-bearing rocks should become known.

Late in the autumn the writer and several other members of the 40th Parallel Survey, while on their way to San Francisco at the close of field work, became possessed of a number of clues, which though separately of the most indefinite character, when combined together enabled them, from their intimate knowledge of the country, to fix the location of the supposed discovery at a certain point within the area surveyed by him during the previous year. Whether by chance or intention, the location selected by the supposed discoverers had been singularly well chosen from a geological standpoint, for when asked where within that area diamonds would most probably be discovered, King at once fixed on that very region as the most probable one for their occurrence. It was because of its scientific importance that he decided upon an immediate investigation in spite of the lateness and inclemency of the season. It required over a week's travel for himself and assistants to reach the spot, and when, after several days' careful geological investigation, it was found that the diamonds could not have been placed there by Nature, King realized that a most cleverly planned fraud had been foisted on the public, which, if not promptly and conclusively exposed, would result not only in pecuniary loss to innocent investors, but in great suffering and even loss of life to the many that would probably rush to the bleak exposed region where the locations had been made. By journeying night and day across the

bad-land country he reached the railroad, and proceeding to San Francisco laid his facts before the managers of the company, offering to take to the spot with his own outfit any experts they might be willing to send to test the truth of his statements. Their journey was rendered doubly difficult by the great blizzard of that year that overtook them while in camp, but the company's engineers fully confirmed the conclusions arrived at by him and his party, and upon their return they were promptly made public by the officers of the company, thus averting what bid fair to be the most widespread and gigantic financial calamity that the world had seen since the Missouri Bubble of Law.

After the completion of field work of the Survey in 1873 there was necessarily a long delay before the abundant collections in the various scientific branches could be worked up by the respective specialists, the lithologic collections alone numbering about 5,000 specimens, for, under the high standards fixed for his work, it was only to the highest authorities in their respective branches that King was willing to entrust the final study of these collections.

Thus, under his instructions, the writer spent the summer of 1874 in Europe conferring with the heads of the leading European geological surveys as to their methods of work, and buying, at King's expense, the best and latest geological literature, with which at that time American libraries were but scantily provided. Furthermore, by personal persuasion he succeeded in inducing Professor F. Zirkel, the founder of the science of microscopical petrography, to visit America and study in the presence of the collectors their numerous collections of eruptive rock specimens, for at that time there was no geologist in America who had any practical knowledge of this new branch of geology.

King reserved for himself the final summarizing of the work of his assistants, and the drawing of general conclusions and theoretical deductions therefrom. This he did in the winter of 1877-'8 after the five government quartos and two great atlases embodying the details worked out by his various assistants had been printed. This summary was published in a volume, entitled "Systematic Geology," of over 800 pages, profusely illustrated by reproductions of photographic views illustrating typical geologic phenomena and analytical charts representing the im-

portant stages in the geological history of the Cordilleran system. It was probably the most masterly summary of a great piece of geological work that has ever been written, and was well characterized by its most competent critic in the following words:

"The most satisfactory part of Mr. King's work, next to its scientific thoroughness, is the breadth of view which embraces in one field the correlation of such extended forces and the vigor of grasp with which the author handles so large a subject without allowing himself to be crushed by details. Hitherto every geological report has been a geological itinerary without generalization or arrangement. This volume is much more; it is indeed almost a systematic geology in itself, and might be printed in cheaper form and used as a text-book in the technological schools."

Aside from the direct contributions to science embodied in the seven quarto volumes that contained the published results of this great survey, King exerted a most important influence upon geological work in this country by the high standards he set for it and his practical demonstration of the possibility of living up to them. Thus a topographic survey which should afford an accurate delineation of the relief of a country had not hitherto been considered a necessary base for geological mapping either in State or government surveys. A system of rapid surveying by triangulation and the use of contours to express relief was first employed by him in making maps of large areas, and inaugurated an improvement in our systems of cartography that has made the maps issued by our government superior to any in the world. He demonstrated the importance of the general use of photography as an adjunct to geology, which previously had not been considered practicable because of the labor and expense involved in transporting the necessary apparatus for the developing of wet plates in the field. Of even greater moment was the practical introduction of the methods of microscopical petrography, supplemented by chemical analysis, in the examination of rocks—an innovation which marked the opening of a new era in geological study in the United States.

His mind was possessed in a high degree of the quality, known as scientific imagination, that enabled it to grasp almost at a glance the ultimate bearing of observed phenomena on the

broader problems of geology, and thus he was often able to suggest to others profitable lines of investigation which he himself did not have time to follow out. Thus, during his study of the glaciers of Mt. Shasta, he made the observations that are credited with first suggesting the true origin of the kettle-holes and kames of New England, and his later discovery in the summer of 1874, that the line of islands extending along the southern coast of New England from the heel of Cape Cod to Staten Island contains remnants of the terminal moraine of the great glacier that once covered the northeastern States, had much influence in inducing the later systematic studies of the Continental glacier which have brought about the most important advance in the science of glaciology since the days of the elder Agassiz.

It had been the hope and ambition of King and his associates on the 40th Parallel that the quality and demonstrated usefulness of their work would be such that it would ultimately lead to the establishment of a general geological survey of the United States, whose permanence would be assured by being made a bureau of one of the executive departments of the government. This result came about much earlier than either of them had anticipated, and its accomplishment, singularly enough, was hastened by the zeal of rival leaders of different government surveys which it entirely superseded.

After two seasons of field work with the 40th Parallel Survey had demonstrated the practicability of geological map-making in the West, a second survey was inaugurated under the Engineer Department by Lieut. George M. Wheeler, which was designated "United States Geographical Surveys West of the 100th Meridian." In 1894 the already existing "Hayden Survey" adopted King's system of making topographic maps as a basis for its geology, employing for this purpose the topographers on the 40th Parallel after their work in the latter survey had been completed, and its title was changed to the "United States Geological and Geographical Surveys of the Territories." The fields of work of these organizations were not limited by any definite bounds, as had been that of the 40th Parallel, and with increasing popularity each became desirous of surveying the regions which contained the most remarkable and striking phenomena.

Thus their work often overlapped and was duplicated, and their rivalry finally became so intense that the influence of one party with Congress was used to curtail the appropriation allotted to the other. As a final result of this rivalry there was serious danger of a reaction in the feeling of Congress toward such surveys that would result in cutting off all government aid to geological work.

In this crisis King was appealed to as a disinterested party, and it was mainly through his influence with the leading scientific men of the country and his tactful management of affairs in Congress that the danger was averted. Congress was induced to call upon the National Academy of Sciences for its advice as to the best methods of carrying on the various scientific surveys which were then being conducted under different departments. Although a member of the Academy since 1876, King was not appointed on the committee to whom this question was referred, but was freely consulted by its members in making up their report.

By the law of March 3, 1879, the present United States Geological Survey was established as a bureau of the Interior Department, the exact language of the Academy's report being adopted so far as it related to geological surveys, and the previous organizations were thereby discontinued.

President Hayes, after consultation with the best scientists of the country, appointed Clarence King as the first director of the new Bureau. King accepted the appointment with the distinct understanding that he should remain at its head only long enough to appoint its staff, organize its work, and guide its forces into full activity. At the close of Hayes' term he offered his resignation, but at the President's request he held over until after the inauguration of Garfield. The latter accepted it on March 12, 1881, in an autograph letter expressing in the warmest terms his appreciation of the efficiency of King's service and his regret that he did not find it possible to remain longer in charge of the Geological Bureau.

Brief as was the duration of his administration, his influence being exercised at the critical period of the Survey's existence, left a lasting impress upon it. He outlined the broad, general principles upon which its work should be conducted, and its

subsequent success has been in a great measure dependent upon the faithfulness with which these principles have been followed by his successors. His belief was that a geological survey of a great industrial country, while not neglecting the more purely scientific side of its work, should occupy itself primarily with the direct application of geological results to the development of the mineral resources of the country.

Under his direction were carried on the examinations of the Comstock, Eureka, Leadville, and other mining districts, whose importance is to be measured not solely by the accurate information which they afforded of these particular regions, but in far greater degree by their influence upon the whole body of mining engineers, in teaching them the practical importance of a study of the geological relations of ore deposits.

He also planned and supervised the collection of statistics of the precious metals for the Tenth Census, a work which has never been equaled in detail or scientific accuracy, and whose logical result was the annual collection of statistics of all the mineral resources of the United States, which has been carried on by the Geological Survey ever since the completion of the work of the Tenth Census.

King set the very highest standard for the work of the Survey and showed remarkable judgment and knowledge of character in his selection of the men who in their respective branches were best fitted to keep it up, as nearly as possible, to this standard. In his establishment of a physical laboratory for the determination of the physical constants of rocks, he took a step in the direction of the application of methods of exact science to geological problems so far in advance of the average standards of the day that its importance was not generally realized until long after.

In all his after life he maintained a lively interest in the work of the Survey and kept closely in touch with his successors in office, who frequently consulted him on important questions of policy.

In giving up his official connection with government geological work, King was doubtless influenced by several motives: His many years of strenuous work and unusual responsibility had been a severe strain upon his health, and he felt the need of rest

and change. Moreover, he was confident that he could render a greater service to geological science by pursuing the theoretical researches into its deeper problems, for which the physical laboratory he had established would in time furnish the necessary data, than by devoting his time and strength to administrative duties. Financial considerations doubtless had some weight also, for under the new law his official position shut him out from any professional remuneration beyond his salary, and that was not sufficient to enable him to meet the obligations he felt it incumbent upon him to assume for others.

During the remaining twenty years of his life much of his time was necessarily given to private professional work, either in personally managing and developing mining properties or acting as adviser for others. In this work his ambition was to accumulate sufficient capital to enable him to pursue unrestrainedly the necessarily expensive experiments needful for the carrying out of his chosen line of investigation, and to insure the comfort of those depending upon him. Freed from the confinement and responsibilities of the administration of a great survey, he was, moreover, now able to devote more of his time to the cultivation and indulgence of his pronounced literary and artistic tastes; but his scientific investigations, though of necessity frequently interrupted, were ever present in his mind, and never, as some have erroneously assumed, abandoned.

In 1882, being called to London on business connected with some large Mexican mining companies, of which he was president, he came into familiar converse with the leaders of the scientific and literary circles of that great intellectual center, to whom his work was already well and favorably known and his charming personality soon endeared him.

The greater part of the next two years was spent there and in traveling extensively on the continent. While he naturally came into contact with most of the prominent scientific men in Europe and recalled with special pleasure his intercourse with Sir William Thomson (now Lord Kelvin), whose investigations into terrestrial physics had early attracted his attention and excited his admiration, he was perhaps even more widely known and admired in Europe for his literary and social qualities and as a connoisseur of art.

In 1890 Brown University conferred upon him the honorary degree of LL.D. That he received no public recognition of his later scientific work may perhaps be ascribed to its peculiarly unobtrusive character, which gave rise to the erroneous impression that he had abandoned science altogether.

In 1892 he wrote the only scientific publication of his later years on the "Age of the Earth," which appeared in the *American Journal of Science* in 1893. It is the latest and perhaps one of the most profound discussions from the point of view of terrestrial physics of that important subject, and was most favorably received by such great physicists as Kelvin and Helmholtz.

By the great financial disaster of 1893 King, in common with many others, suffered severe financial losses, and by the failure of a national bank which he had founded the greater part of his accumulations of previous years were swept away. In the following winter, during convalescence from a serious attack of nervous prostration, he spent several months in Cuba at the country house of his friend, Henry Adams, the historian, during which he became deeply interested in the political condition of the island and visited the camps of the revolutionists, thus becoming personally acquainted with their chiefs. The sympathy with their cause which resulted from his investigations led him to actively espouse it during the discussions in this country which led up to the Spanish war, both in personal interviews with the leaders of the administration and in published articles in the "Forum."

He also investigated the geology and economic resources of the island, which so interested him that it became one of his cherished plans of future work to organize a geological survey in Cuba, if political conditions should become sufficiently settled to justify it.

During his later years the great stimulation of mining industry of this country led to an ever-increasing demand for his services, both as expert in important mining investigations and in passing on the value of properties offered as investments to capitalists, demands which he did not feel justified in refusing. Such work often involved the most severe and even dangerous strain, and in this, as in everything else in which he was engaged, King never spared himself.

In January, 1901, he undertook the examination of a mining property in Missouri which had been sold to English capitalists subject to his approval. An attack of whooping cough and pneumonia in the previous month had left him with a slight tubercular affection of one lung. The weather was inclement and the examination proved unusually long and laborious, so that at its close it was found that tuberculosis had taken so firm a hold upon his system that he was obliged to abandon all business and give himself up entirely to the attempt to recover his health.

After a fruitless visit to the tropics, which had hitherto proved a balm for all of his ailments, he attended the annual meeting of the Academy in April, 1901, and then went West, where he spent the balance of the year in southern California and Arizona in a brave though hopeless fight against the inroads of the dread disease.

In this, with a thorough understanding of the probable outcome of his illness, he displayed the same cheerful courage and spirit of self-renunciation that had characterized his whole life. He would not yield to the desire of his devoted mother to hasten to his bedside, fearing the effect of the long journey in her then precarious condition of health, and he courteously declined the many offers of his friends to visit him and cheer his loneliness. On Christmas eve of 1901, at Phœnix, Arizona, he finally passed away, quietly and without suffering, in the prime of intellectual life, with his greatest scientific work not yet fully completed and leaving a void in the hearts of friends that can never be filled.

It is difficult to fairly judge King's scientific publications in the light of the present day, for they were written just before the opening of an era of great change in the methods of geological investigation—a change which has thus far proved destructive rather than constructive in its results. Many of the fundamental theories of geology which prevailed at that time have been disproved or abandoned, while as yet there is no general acceptance of those which have been put forward to replace them.

In June, 1877, he delivered the address at the 31st anniversary of the Sheffield Scientific School on "Catastrophism and the

Evolution of Environment." It was a protest against the extreme uniformitarianism of that day, based largely on the geological history of the Cordilleran System as developed during the work of the 40th Parallel Survey. This uniformitarianism he characteristically described as "the harmless undestructive rate (of geological change) of today, prolonged backward into the deep past." He contended that while the old belief in catastrophic changes had properly disappeared, yet geological history, as he read it, showed that the rate of change had not been so uniform as was claimed by the later school. While a given amount of energy must evidently be expended, he reasoned, to produce a given effect, yet the expenditure of this energy might be extended over a very long time or crowded into a comparatively short one; and his observations showed him that at certain periods in geological history the rate of change was accelerated to such a degree that the effect upon life produced was somewhat catastrophic in its nature.

Of his great work upon Systematic Geology, the larger part—that which outlines the geological history of the Cordilleran system—stands as firmly today as it did when written, as a correct and authoritative exposition. In view of the circumstances under which the field work was originally done, its essential correctness, even in matters of minor detail, is considered surprising by those who have since had occasion to make detailed studies of portions of the area covered.

In the more theoretical sections, while he necessarily did not take into account the great number of new facts which have been established by more recent work, especially in the domain of microscopic petrography, he showed such grasp of his subjects and such originality and power of thought that his views constituted not only an important advance over those of the day, but they were suggestive of the lines of investigation that have been most fruitful in the modern advance of geological science.

For instance, in his discussion of the reason for the changes from acid to basic eruptives within the individual groups, which he proposed as a variation from the natural order in age of volcanic rocks, as laid down by Richthofen, he advanced views very suggestive of the modern conception of differentiation in eruptive magmas.

Again, in endeavoring to account for the formation of those types of granite that pass into gneiss and crystalline schists of essentially the same chemical composition, but which show no evidence of having been subjected to such excessive heat as would produce actual liquefaction, he called in the agency of the immense pressure to which such rocks would necessarily have been subjected. While the long years of combined field work and microscopic study of modern petrographers, made since King's theory was enunciated, have proved that the structure of crystalline schists *is* due to pressure, they do not go so far as he did in assuming that the end product of such mechanical pressure might be granite.

Perhaps his most enduring theoretical discussion of that time was that on hypogeal fusion, in which, accepting the validity of the physical arguments against the fluid interior of the earth, he discusses and rejects Hopkins' theory of residual lakes and Mallett's conception of local lakes produced by mechanical crushing. He then advances an hypothesis of his own which may be called that of a critical shell, or *couche,* between the permanently solid interior and the outer crust of the earth, which is above the temperature of fusion but restrained from fusion by pressure. In this, therefore, the opposing forces of pressure and temperature hold themselves reciprocally in equilibrium, but when this equilibrium is disturbed, as, for instance, by a sudden change of the relative position of isobars and isotherms—say by local erosion and rapid transfer of load within limited areas—local lakes of fusion would be created. Iddings, in his "Origin of Igneous Rocks," says of King's treatment of this subject: "By the breadth of his treatment and by better and fuller data he advanced the problem of the origin of the various kinds of volcanic rocks far beyond the point reached by any of his predecessors."

In his chapter on Orography, King says, in speaking of the causes of crust motion: "I can plainly see that were the critical shell established its reactions might thread the tangled maze of phenomena successfully, but I prefer to build no farther until the underlying physics are worked out." He was at that time already very strongly impressed with the imperfection of the then existing knowledge of terrestrial thermo-dynamics and the

indispensability of more exact data in this branch of science for a rational discussion of the fundamental problems of geology.

This idea found a practical outcome a few years later in the establishment of a physical laboratory, immediately after his assumption of the Directorship of the United States Geological Survey. His earnestness and energy is shown by the fact that instead of waiting for the slow action of Congress, he defrayed the cost of the delicate apparatus necessary for this work out of his own pocket. The credit of the brilliant physical investigations carried on in that laboratory is naturally due to Professors Barus and Hallock, who conducted them, but it was King's acumen and good judgment that was responsible for their selection, and his action that made it possible for them to carry on their work. To himself, as he says ten years later in his paper on the Age of the Earth (Am. Jour. Sci., vol. xlv, January, 1893), he reserved the privilege of "making geological applications of the laboratory results." The experiments on the physical constants of rocks contemplated were to be directed to the determination (*a*) of the phenomena of fusion, (*b*) of those of elasticity and viscosity, and (*c*) of those of heat conductivity, each considered with special reference to their dependence on temperature and pressure.

The paper on the Age of the Earth, mentioned above, is his only published result, and was but an earnest of what he had planned to do. This was an attempt to advance to new precision Kelvin's estimate of the earth's age deduced from terrestrial refrigeration. It consists mainly of a mathematical discussion of the earth's thermal age as determined from various postulates presented by Laplace, George H. Darwin, and Lord Kelvin, and based on Barus' determinations of the latent heat of fusion, specific heat, melted and solid, and volume of expansion between the solid and melted state, of the rock diabase. This is followed by a critical examination of other methods of determining the earth's age—by tidal retardation, by sun-age, and by variations of eccentricity. After a careful scrutiny of all the data on the effect of pressure on the temperature of consolidation, King concluded that, without further experimental data, "we have no warrant for extending the earth's age beyond 24 millions of years," an estimate which, as the result of a somewhat more ex-

tended discussion, was afterwards confirmed by Lord Kelvin himself. (Smithsonian Report, 1897, p. 345.)

His further investigations along the same general lines on the fundamental principles of upheaval and subsidence were in an advanced stage of completion when they were cut off by his untimely death.

It is practically impossible to adequately characterize King's literary work, for the greater part of what he did was never published, and very likely never even written. It was his habit to work out in his head any subject which interested him, even down to its minutest details, before putting a pen to paper; once this was accomplished to his satisfaction, he wrote with such ease and rapidity that the words actually flowed from his pen. Probably one reason that he did not write more was that his own literary taste was so refined and exacting that he was never thoroughly satisfied with his own conceptions. In his scientific writing, there was generally some imperious necessity that made it urgent upon him to give his results to the public in spite of the imperfections he might still see in them, but in literature such necessity rarely appeared. What he did publish he himself held in comparatively light esteem, but in the opinion of the best literary writers of the day, with most of whom he was on terms of friendly and intimate intercourse, his writings, and even more his affluent and delightful talks, disclosed a literary quality that might have given him a foremost place among American men of letters.

His one literary book, "Mountaineering in the Sierra Nevada," went through more editions in England than in this country, and was very generally regarded there as far the best book of its kind that had ever been written. Of it Edward Cary, one of our most discriminating literary critics, has said:

"There is in these pages a vital harmony between the subject-matter and the form. It cannot be analyzed; much less can it be described or accounted for; least of all can it be resisted. It stimulates and energizes, while it charms the mind. It gives, in its own way and in its field, an intelligent reaction akin to that given by certain passages of Shakespeare in which he explores the depths of human consciousness, and every inflection,

every cadence thrills with the solemnity and the vastness of the subject."

Of his occasional articles in current periodicals, two appeared in the *Century* in 1886, two in the *North American Review,* and three in *Forum.* Of the latter, two on Cuba, published in the years immediately preceding the Spanish War, were written under the impulse of strong feelings of sympathy with the cause of the insurgents, with whom he had come into intimate personal contact during the winter he spent on the island.

Of his *Century* articles, one was a delicate tribute to his closest friend, John Hay, as one of the biographers of Lincoln; the other, a short sketch of his search for the "Helmet of Mambrino" for a fellow-Cervantista, was that which more than anything he ever published disclosed the exquisite delicacy of his literary touch, which rivaled that of Howells or James and showed an even rarer and more refined quality of wit than Bret Harte's.

The best idea of the estimation in which he was held by his many friends and associates in the literary and artistic world may be obtained from the following quotation from the necrology of the Century Association of New York, of which he had been a prominent member for the last quarter of a century:

"He was himself a blend of varied qualities and gifts that were not always ready to keep the peace one with another, but the collective manifestation of which was to his fellows a constant joy. The talk he made or evoked may be equaled by those who are to come after; it can never be matched. Its range was literally incalculable. It was impossible to foresee at what point his tangential fancy would change its course. From the true rhythm of Creole gumbo to the verse of Theocritus, from the origin of the latest *mot* to the age of the globe, from the soar or slump of the day's market to the method of Lippo Lippi, from the lightest play on words to the subtlest philosophy, he passed with buoyant step and head erect, sometimes with audacity that invited disaster, often with profound penetration and with the informing flash of genius. It is but a suggestion of his rare equipment to say that in his talk, as in his work, his imagination was his dominant, at moments his dominating quality. Intense, restless, wide-reaching, nourished by much reading, trained in

the exercise of an exact and exacting profession, stimulated by commerce with many lands and races, it played incessantly on the topic of the moment and on the remotest and most complex problems of the earth and the dwellers thereon. And within a nature brilliant and efficient beyond all common limits glowed the modest and steady light of a kindness the most unfailing and delicate. The good one hand did he let not the other know; both were always busy, laying in many lives the foundations of tender and lasting remembrance."

The following list comprises the principal published works of Clarence King:

Mountaineering in the Sierra Nevada. Boston, 1870.

Mining Industry (by James D. Hague, with geological contributions by Clarence King), vol. III of the Fortieth Parallel Reports. Government Printing Office, Washington, 1870.

Active Glaciers within the United States. *Atlantic Monthly*, March, 1871.

On the Discovery of Actual Glaciers on the Mountains of the Pacific Slope. *Am. Jour. Sci.*, 3d ser., vol. I, p. 157. 1871.

Three Lakes. Poem in hexameters. Privately printed in folio, 1875.

Notes on Observed Glacial Phenomena and the Terminal Moraine of the N. E. Glacier. *Proc. Boston Soc. Nat. Hist.*, vol. XIX, p. 60. 1876.

Paleozoic Subdivisions of the Fortieth Parallel. *Am. Jour. Sci.*, 3d ser., vol. XI, p. 475. 1876.

Notes on the Uinta and Wahsatch Ranges. *Ibid.*, p. 494.

Catastrophism and Evolution. *Am. Nat.*, vol. II, p. 449. 1877.

Systematic Geology. Vol. I of the Fortieth Parallel Reports. Government Printing Office, Washington, 1878.

First Annual Report of the U. S. Geological Survey. Government Printing Office, Washington, 1880.

Production of the Precious Metals in the U. S. U. S. Geol. Survey, 2d Ann. Report, pp. 333-400. Government Printing Office, Washington, 1882.

On the Physical Constants of Rocks. U. S. Geol. Survey, 3d Ann. Report, p. 3. Government Printing Office, Washington, 1883.

Style and the Monument. *North Am. Review*, November, 1885. (An article on the proposed Grant monument—anonymous, but known by friends of Mr. King to have been written by him.)

Artium Magister. *North Am. Review*, October, 1888.

The Age of the Earth. *Amer. Jour. Sci.*, vol. XLV, January, 1893.

The Helmet of Mambrino. *Century*, p. 154, May, 1886.

The Biographers of Lincoln. *Century*, p. 861, October, 1886.

The Education of the Future. *Forum*, p. 20, March, 1892.

Shall Cuba be Free? *Forum*, p. 50, September, 1895.

Fire and Sword in Cuba. *Forum*, p. 31, September, 1896.