MEMOIR

OF

GOUVERNEUR KEMBLE WARREN.

1830-1882.

BY

HENRY L. ABBOT.

READ BEFORE THE NATIONAL ACADEMY, APRIL 17, 1884.

BIOGRAPHICAL MEMOIR OF GOUVERNEUR KEMBLE WARREN.

MR. PRESIDENT AND GENTLEMEN OF THE ACADEMY:

The tendency of modern science is so much toward specialties that it is rare in our generation to find men eminent in widely different departments of knowledge. General WARREN was an exception to this rule, partly because his public duties at different periods of his life led him to devote attention to very distinct branches of his profession, partly because the character of his mind and his intense activity made him thoroughly investigate whatever happened to form the subject of his studies, and partly because it was his habit when mentally oppressed with overwork to seek relief by reading some favorite scientific or literary treatise to break the current of thought.

His mathematical education at West Point early turned his mind at leisure moments to the broader subject of logic, and his extensive reading in this direction exerted an influence which can be traced everywhere throughout his numerous writings. Close and convincing reasoning and good arrangement of ideas are characteristic of them all.

As a general he applied the same systematic analysis to the ill-defined impulses which control the actions of men in war, and this habit, with other high qualities of mind and heart, left him with few superiors among those who controlled the military operations in our great national crisis. It is the belief of those who knew him best that if circumstances had given him a more independent command the great reputation which he did achieve would have been greater still.

As a geographer he contributed much to the development of the western country, and especially to the great work of preparing the way for the construction of the Pacific railroads.

In geology, a science of which he was passionately fond and to

whose study he devoted close attention, he advanced original views and generalizations which have attracted favorable notice from men whose life-long labors place them at the head of the profession in this country.

In the science of hydraulics, whether applied to the improvement of our great inland rivers or to the amelioration of the harbors along the Atlantic coast, his investigations and writings class him among the most eminent of American engineers.

An expert in bridge construction, General Warren also devoted much study to the troublesome legal questions which have grown out of the conflicting interests of navigation and railroad transportation on our western rivers, and his exhaustive report upon bridging the Mississippi between St. Paul and St. Louis is a recognized authority consulted by lawyers as well as by engineers.

In several other departments of science which claim the attention of different members of the National Academy General Warren was a reader, and in the advancement of all he felt an interest. He always attended the meetings when other duties permitted; and although his modesty usually kept him from taking an active part in the discussions few listeners formed more just conclusions or were quicker to apply new ideas to practical use in their own specialties.

Such was the man whose seat among us is now vacant. In the maturity of his mental vigor he has ceased from his labors, leaving, I am sure, in the minds of many of his colleagues a sense of personal loss as well as of respectful remembrance.

General Warren was born at the village of Cold Spring, New York, on January 8, 1830. He entered the Military Academy in 1846, and was graduated in 1850 with the second rank in a class of forty-four members. He was at once assigned to the Corps of Topographical Engineers as brevet second lieutenant; promoted to be second lieutenant on September 1, 1854; first lieutenant on July 1, 1856, and captain on September 9, 1861. The two Corps of Engineers having been consolidated by act of Congress in 1863 he became major on June 25, 1864, and lieutenant colonel on March 4, 1879. He died on August 8, 1882.

The rapid settlement of the region west of the Mississippi during the past thirty-five years, and the consequent perfecting of the maps, have thrown into oblivion the great geographical problem presented when the subject of Pacific railroads first attracted earnest attention. Immense areas were then *terræ incognitæ* and others were only

known from the reports of exploring parties ill-supplied with means for accurately mapping their routes. Savage Indian tribes pursued their game and waged war upon each other and upon the few white pioneers throughout thousands of square miles where the iron horse was soon to find his way.

Congress made provision for the systematic exploration of five great routes between the Mississippi river and the Pacific Ocean, each following a different parallel of latitude, and the surveys were conducted by military expeditions commanded by officers of engineers of the army. The dangerous nature of the service may be inferred from the fact that two of these officers met a soldier's death in the line of this duty.

The general direction of the whole work, in 1854, was devolved by the Secretary of War upon General (then Captain) Humphreys, with Lieutenant Warren as principal assistant. The latter had already won a deserved reputation on various surveys upon the Mississippi river, and he now aided his chief in preparing a general report, which, appearing as their joint production, brought to both much professional distinction. He was also specially charged by Captain Humphreys with the compilation of a general map of the entire region from the preliminary reports of the parties and from all existing information. His monograph and map, which finally appeared in Vol. XI of the quarto edition of Pacific railroad reports, is a model of the manner in which such work should be done. Many of the latitudes were fairly determined in the field, but the problem of longitudes involved much difficulty. Warren solved it with extraordinary success, and filled in his map by a system of analyses and counter-checks, based on an intense study of a mass of more or less uncertain data, including reports from the earliest Spanish and French explorers to the latest accurate surveys. Many were in manuscript. Each authority was given weight according to his experience and the means of observation afforded by his instruments; and by this system topography was made available, which otherwise would have been worthless because incorrectly placed on the early maps. It was at this period that our life-long friendship began; and I well remember how the midnight hour often found him hard at work comparing and reconstructing his preliminary tracings or pouring over the old reports for missing data. To extract from a mass of erroneous and contradictory material results which have stood the test of subsequent good work in

the field is no mean test of scientific ability, and this Warren accomplished in a remarkable degree. At intervals while this labor was in progress he himself conducted three explorations in Dakota and Nebraska, traveling many hundreds of miles with small parties among hostile tribes, with his life in his hand. It was in this service that he acquired his strong taste for geological investigations, and where he devoloped that habit of self-reliance and that keen military instinct which subsequently were so conspicuous on the theatre of war in Virginia.

This is not the place to detail his career during the war. He entered the volunteer service as lieutenant colonel of the Fifth New York on May 14, 1861, and rapidly rose by his merits in the Virginia campaigns until on May 3, 1863, he attained the rank of major general, and, shortly after, the command of one of the corps of the Army of the Potomac. He served in that grade until the end of the war, resigning his volunteer commission and returning to duty in the Corps of Engineers when the fighting ceased in 1865. He was brevetted four times in the regular army for gallant services in action, having taken part in seventeen great battles and twenty skirmishes, and been wounded twice. A more glorious record falls to the lot of few soldiers.

It is difficult to convey an idea of General Warren's intense mental activity at this period. On one occasion, when we were lying before Petersburg and most officers were content to rest from the fatigues of the tremendous campaign just closed, although he was then in command of the Fifth Army Corps, he sent me an abstruse mathematical discussion of a problem of forces in pontoniering, written out for recreation. Later during that winter, when we were completely mud-bound, I found him one day at his headquarters at work with a microscope, just ordered from New York, examining some specimens of bacteria. At another time, having myself an artillery command, I was studying the development of Confederate rifled projectiles by collecting unexploded samples thrown into my batteries. Happening to mention this he at once turned over to me about 250 specimens which he had gathered himself with the same object in view. In a word, rest with him always meant activity in a new direction, and to this characteristic was due the surprising extent of his knowledge upon many subjects to which it would naturally be supposed his busy life had barred the door.

When peace returned after our great civil struggle many of the best officers of the Corps of Engineers were lying in bloody graves. The juniors, although experienced soldiers, had had little or no practice in the civil branches of their profession. The consolidation of the two corps and the immense impulse given to internal improvements by the new direction into which the energies of the nation were turned threw a weighty burden upon General Humphreys, then called to the command of the organization. Intimately acquainted with the professional ability and high attainments of General Warren, he naturally turned to him as one of his most trusted officers, and placed upon him responsibilities and labors which would have crushed a weaker man.

Between August, 1866, and May, 1870, General Warren was charged with surveys and examinations with a view to improve the navigation of the upper Mississippi, the Minnesota, the Zumbro river in Minnesota, the Cannon river in Minnesota, and the Fox and Wisconsin rivers; also with reporting upon the construction of railroad bridges across the upper Mississippi and Ohio rivers; also with a detailed survey of the battle-field at Gettysburg; also with the practical operations of improving the navigation of the upper Mississippi; also with the construction of a wagon road from Duluth to the Bois-Fort Indian reservation; also with the designing and partial construction of the bridge across the Mississippi at Rock Island. He likewise served as a member of a board to report upon the construction of a canal around the Des Moines rapids, and as a member of a special commission to examine into the condition of the Union Pacific railroad and branch lines east of the Rocky Mountains, and of another special commission for the same work upon the Union Pacific and the California Central Pacific railroads, and to point out their proper point of junction, and finally as a commissioner to report upon the five last completed sections of the Union Pacific railroad.

In May, 1870, his health having become impaired by exposure and over-exertion, General Warren found himself unable either to continue these labors or to accept the charge of the Lake Survey, which was offered him. He was finally ordered to the charge of a district on the seacoast comprising part of Massachusetts, Rhode Island, and Connecticut, with headquarters at Newport, R. I. This promised to afford him rest and leisure to complete his final reports upon several of the above-named works, which under the pressure

of his multifarious duties had been delayed; but Congress soon appropriated considerable sums for surveys and harbor improvements in his district, and he thus found himself burdened with new responsibilities and in a new field.

Moreover, besides these duties pertaining to the geographical district of which he had charge, others of a specially important character were brought upon him by his high reputation as an engineer. Thus, in 1870, he served on boards upon Ohio river bridges and upon the international bridge over the Niagara, and in 1871 upon alterations in a bridge at Cincinnati and upon the harbor at Chicago; in 1872 upon bridges over the Mississippi and Missouri; in 1873 upon bridges over navigable channels between Lakes Huron and Erie, upon the St. Louis bridge, and upon the Fort St. Philip canal project at the mouth of the Mississippi. In 1874 he was designated by the President as president of a special commission ordered by Congress to report upon the reclamation of the alluvial region of the lower Mississippi, subject to overflow. In 1876 he served on a board on bridges over the upper Mississippi, and in 1878 on the improvement of the Mississippi from the Falls of St. Anthony to Rock Island rapids. He also, in addition to the regular duties of his district, made a survey of the battle-field of Groveton, Va., and prepared certain maps to illustrate the campagn of 1862 in Virginia, for use in the Fitz-John Porter investigation.

This bald recapitulation of the more important duties which engaged the attention of General Warren between the end of the war and the time of his death is sufficient to indicate the character of his professional services. His reports, published in the annual reports of the Chief of Engineers or in Congressional documents, are very numerous. They all bear witness to his clear intellect, his close attention to duty, and his care to award due credit to his subordinates—a matter which with him was a religion.

The writings upon which his scientific reputation will rest, after his early Pacific railroad investigations, are perhaps his final reports upon the Minnesota river in 1874; upon the Fox and Wisconsin river improvements, 1876, and upon bridging the Mississippi between St. Paul and St. Louis, 1878. These rise above technicalities, and show the originality of his mind and the conscientious care he always brought to questions involving research. It is to be regretted that the pressure under which he labored did not allow leisure to elabo-

rate more papers in the same vein. Those who knew him will remember that his conversation about any of his works was full of suggestions which he rarely found time to develop on paper.

In illustration of his contributions to science I shall only advert to a generalization in physical geology which he first announced in a paper read before the American Association for the Advancement of Science at the Chicago meeting of 1868, and subsequently discussed in reports above mentioned.

The Minnesota river and the Red River of the North head in adjacent lakes so slightly separated that the waters of the former in heavy rains find their way in part to the Gulf of Mexico and in part to Lake Winnipeg and thence to Hudson Bay. From its source (Big Stone lake) the Minnesota, although a small stream, flows through a valley varying from one to two or more miles in width, sunk from 130 to 250 feet below the general level of the country. For over 100 miles its bed is partially granitic (probably Huronian) and the bluffs are drift. Its tributaries all discharge through narrow valleys eroded by the present streams, and the same is true of the Mississippi itself above its junction with the Minnesota, but below that point it winds through a continuation of the same broad valley. The detritus brought down into this great excavation by the tributaries is too much for the present volume of discharge to transport, and it is deposited near their mouths, forming dams which tend to transform the river into a series of long lakes connected by rapids and bar-obstructed channels. In a word the tributaries and the Mississippi itself, above the mouth of the Minnesota, are eroding rivers of the present epoch with volumes proportioned to their drainage areas, while the great valley above indicated now filling up with detritus is the bed of an ancient torrent to which the present stream is a rivulet. What has caused the disappearance of this mighty river?

General Warren was the first to comprehend this problem in all its bearings; and bringing to its solution his extensive knowledge of the country and of its geographical features he finally reached the following conclusions, which, supported by his facts and reasoning, are now, I believe, accepted by eminent geologists. I quote his own language substantially as he presented the subject before the American Association for the Advancement of Science in August, 1868:

"Northward from Lac Travers commences a vast lake basin, ex-

tending continuously to the north end of Lake Winnipeg, including this lake, Lake Winnipegoose, and Lake Manitoba. The greater part of this ancient lake bed is now dry, leaving a well-defined beach to mark its former extent. The Red River of the North flows along the lowest line of this bed. The waters of this basin once flowed southward through the Minnesota river into the Mississippi.

"The present level of Lake Winnipeg, according to Mr. Hines, is 650 feet above the ocean.

"To again cause the waters to flow southward with the present levels of the land existing would require the lake to be raised 330 feet.

"It is obvious that this could not be done while the Nelson river outlet existed. There is no good description of this outlet, it never being used for a line of communication; but it is known to abound in rapids and falls, which seem to show its recent origin. If we suppose the ice of the glacial period to have closed this outlet such barrier would have given the lake the whole extent of the basin and caused its discharge southward, but this will not account for all the phenomena observed.

"A more satisfactory explanation of a change of outlet from a southern to a northern one is to attribute it to a northern depression of the basin, for this accounts for the fact that Lake Michigan formerly had a southern outlet through the Illinois river and that Lake Winnebago also had a much greater extent and a southern outlet through the Wisconsin river. The shores of all the lakes show the water to be receding from their southern sides and encroaching upon their northern ones, as such change of level requires.

"This northern depression is known to be going on along the Atlantic coast from New Jersey to Greenland, so that it would seem to be continental in its extent; but further consideration has shown me that all the waters of Winnipeg basin, even if they had continued to flow southward, could not have excavated the passage way now occupied by the Minnesota and Mississippi rivers, and we must go further back in time to reach a sufficient cause.

"In doing this we will first consider the character of the rivers which existed in the periods preceding the glacial epoch.

"During the cretaceous period we know that an ocean extended from the present Gulf of Mexico to the Arctic Ocean, covering a large portion of the space between the Missouri river and Rocky

Mountains. At that time the country through which the upper Mississippi now flows was dry land, and its slopes must have sent its waters westward to that cretaceous ocean. As this continent rose this cretaceous ocean disappeared and the tertiary period began with great fresh-water lakes along the base of the Rocky Mountains. Into these lakes the waters of the upper Mississippi region continued to drain westward.

"The gradual southwestern elevation of the continent throughout the tertiary period is distinctly proved by the deposits of these tertiary lakes.

"The earliest deposits were of least area, and as they became more recent they expanded northeastward, and this action continued, apparently, to the time preceding the glacial epoch. This elevation at the southwest seems to have been in progress from the earliest geological epochs, every contemporaneous formation being found in the mountain regions of the southwest higher than to the northeast.

"Preceding the glacial period, then, all the water courses of the upper Mississippi region were westward and not southward, as now.

"Not only the slope of the land but the great folds of the silurian strata compelled the water to this course.

"Over a great deal of the region thus drained no rocks more recent than the silurian are found, so that it must have been dry land since the silurian period.

"In the immense ages succeeding the time of the silurian oceans these rocks were exposed to all the atmospheric influences; and we can conceive how they must have been cut up by ravines and valleys encroaching on each other in endless confusion, somewhat as we now see them in the bad lands of Nebraska, but on a grander scale.

"Even the hard azoic rocks forming the dry land of the silurian period must have exhibited the most stupendous atmospheric erosions. These preglacial erosions can still be distinguished from those made since.

"When, then, the glaciers came, it would seem that their work was easy, and they have planed down the whole region, removing silurian strata 500 feet in thickness over hundreds of miles.

"The whole upper Mississippi region was the scene of the drift action, and the valleys of pre-existing rivers were filled up and mostly buried out of sight. The existence of a distinct glacial

moraine (unmodified) at Warsaw, on the Mississippi, shows that the glaciers were at least that far south.

"I have determined the southwestern limit of the glacial drift action to be the Missouri river from about the 48th down to the 43d parallel of latitude.

"The modified drift forms the grand Coteau du Missouri lying on its east bank, and the material extends thence northeastward almost continuously.

"From the Missouri river to the Rocky Mountains, over a space varying from 300 to 500 miles in width, no drift is found except that due to local glaciers of the mountains, which in some cases extended for 50 miles east of their bases.

"The existence of this space between the Missouri river and the Rocky Mountains, free from drift, shows that the form of the continent and seas in the glacial time were such as to produce in the climate relations similar to those which now exist, namely: that the mountains to the west intercepted, as they now do, the moisture from that direction, and that the supply for the Mississippi valley came from the south as now, moved with the winds in a northerly direction as now, and left an arid region such as we now have along the plains east of the mountains.

"Since low temperature and moisture combined are required to produce a glacier, it follows that high temperature, or aridity, either of them, would resist their formation and determine their limit.

"If high temperature limited them southward, and aridity westward, the limiting line would have taken a northwest and southeast direction, somewhat as the summer isothermal line now does.

"The motion of the glacial mass must have been along the line of least resistance and towards this limiting line; and the glacial scratchings in the northwest show that the glacial motion was southwest.

"There, then, on that limit a river must have been formed to carry away the melting water from the glacier, and this limit was the Missouri river, and that was the river formed thereby.

"It cut along this glacial limit because all the streams west of it came from the mountains towards it, down the inclined plane, and there their old course was terminated.

"We see what lakes must have periodically formed here, what great barriers must have been formed and burst, one after another, and what deluges the lower valley must have experienced.

"As the glaciers began to retire to the northeast, so long as the general slope of the plain was towards the glacial mass, successive rivers were marked out by it along its western face, and all have a parallelism and are close to each other, and have short tributaries or parallel branches if any. There are, besides minor streams, the James, the Big Sioux, the Des Moines, the Iowa, and Cedar rivers, and finally the Minnesota and the Mississippi, the last of the parallel rivers.

"After the lowest line of the continental valley was passed the glacier would retire, so that the melting water would run directly from it, and so we see all the tributaries of the Mississippi on the east side.

"This direction corresponds with that of the preglacial rivers, and it is probable that many of them here washed out and regained their old beds, such as the St. Croix, Chippewa, and Wisconsin rivers, and so their appearance would indicate.

"The bend of the great valley along the Minnesota river, between Mankato and St. Paul, being at right angles to the main course of all the parallel glacial rivers, would seem to disprove the formation of this river having taken place along the glacial margin, and it probably is the bed of one of these pre-glacial rivers. It lies here in the proper fold of the silurian rocks to have been formed in an ancient valley, but from St. Paul southward the present course of the Mississippi is cut square across the fold in the rocks, and the glacial action is the only explanation of it.

"The manner in which the glacial action produced these excavations was not by abrading the strata with the grinding power of rocks imbedded in the ice, but after the manner in which a block of marble is sawed. The glacier supplied an immense power in the melting water, and into this water it was constantly dropping sharp rocks and sand. The action of falls also played an important part in this operation.

"The waters issuing from a lake have little abrading power, for they have comparatively little rubbing material to operate with. Lakes are only drained by abrading effects produced at waterfalls receding up stream.

"The waters issuing at the old southern outlet of Lake Winnepeg could make no impression on the granitic bed of the Minnesota. Had this material been soft like the silurian rocks lower down in its course, or like the tertiary and cretaceous rocks through

which the Missouri has cut its way, then this part of the valley might have been worn away as the others have been, and we should still have the drainage of all the Winnepeg basin to the southward.

"A cut of 400 feet at Big Stone Lake would have drained the whole Winnepeg basin, nor would the banks then have been as high as those of the Missouri at the Bijou Hills, which are 800 feet above the water of the river. The slope of the Missouri is more than double that of the Mississippi, and hence the water of the Missouri river is several hundred feet higher than that of the Mississippi at points in the same latitude in their upper courses.

"An examination of the bluffs along the Mississippi shows that the space between them is, on the whole, quite uniform in width, gradually increasing downward, being about a mile at Big Stone Lake, and reaching six to ten miles at Commerce, below which the space widens out to from forty to sixty miles.

"Sometimes the river, as at the 'Grand Tower' and 'Le montagne qui Trempe-à-leau,' and several other places, is found flowing between bluffs not even a mile apart, but the bluffs on one side or the other are always found to be a detached mass, and the main valley exists there too.

"Two remarkable exceptions to this occur at the rapids, one at Keokuk, the other at Rock Island. Without lengthening this paper, as it necessarily would to go fully into an explanation of these, I will state that, after being long puzzled by them, I discovered that the whole valley had been covered with an extension of the Gulf since the glacial period as high up as Savannah or Dubuque; that the silt brought in by the Des Moines river in the one case, and the Iowa and Rock rivers in the other, during this period, filled up entirely the valley cut out by the great glacial river, and that when the land rose again the Mississippi could not at these regain its old bed, so it had to cut a new one, and this is not yet completed.

"The space between the bluffs at these two places has the width the present river requires, and it is so nowhere else in its whole course."

This hypothesis of a continential southern elevation and northern subsidence, extending through a vast period of time and still probably in progress, admits of verification in districts not surveyed in detail by General Warren; and in his final report upon the Minnesota (1874) he ventured to predict that evidence would be found in the Maumee valley to prove that that river has wholly drained an

ancient lake to Lake Erie, as the Fox river now partially drains Lake Winnebago to Green Bay, the discharge of both lakes having been formerly southward. Such evidence would be "the existence of an ancient lake shore and a gorge somewhere along the Maumee if rock is encountered in its course." This prediction was verified by railroad surveys executed by Mr. Thomas P. Roberts, C. E., as reported by him in a letter to the *Toledo Blade* dated February 23, 1876.

General Warren was elected, before the war, a member of the St. Louis Academy of Sciences; in 1867 a member of the American Philosophical Society, Philadelphia; in 1876 a member of the National Academy of Sciences. In 1874 he was elected a member of the American Society of Civil Engineers, and for a time was a member of its Board of Direction. He joined the American Association for the Advancement of Science in 1858.

This imperfect sketch outlines the professional services and mental traits of an officer whose memory will long be cherished by his associates. Personally he was a firm friend and a generous enemy. His refinement of character is well illustrated by his love of flowers. To him they were living impersonations of beauty whose study was a never-ending source of pleasure. While attending our April sessions in Washington his favorite resort after adjournment was to the magnolia tree near the fountain in Franklin park, and he seemed to never tire of admiring its wonderful beauty at this season.

After the death of his father in 1859 General Warren tenderly discharged toward his mother and younger brothers and sisters every duty which devolved upon him as the head of the family. In 1863 he married Miss Emily F. Chase, of Baltimore. He leaves to her and to a beloved son and daughter a legacy of honor more precious than wealth.

When death has removed a cherished friend it is a trait of human nature to pass over what was heroic and great in his character and to cling to the memory of his kindly acts to the poor and unfortunate. The life of General Warren was full of such actions; and I cannot better close this tribute than by mentioning one out of many which came to my knowledge.

In the summer of 1855 he served as the Engineer officer of General Harney's staff in a successful Indian campaign in the Dakota country to avenge the massacre of Lieutenant Grattan's party, and was present at the resulting action near Blue Water

creek. During the attack he was with the advanced guard, but afterwards he devoted himself to the care of the wounded. He wrote to his brother: "After the fight I was on the ground taking care of the wounded until dark, and I hope relieved a great deal of innocent suffering—I mean the injured women and children, for all the men were killed. I was all blood at night from carrying the bleeding children in my arms. The soldiers left on the ground aided me, whenever I asked, in bringing them to water, bathing their wounds, and putting them under shelter. It was a sight to make one shed tears, but it could not be helped. The Indian men fired after ours had stopped, and killed two soldiers, and in destroying these men the women suffered."

Not all the bloody battles of the civil war could harden this kindly nature. During the bitter cold of the last winter, before Petersburg, it became necessary for his corps to execute certain movements upon the extreme left, which occasioned untold misery, especially to the wounded. Referring to this in a private letter he wrote: "I do not feel it much in my own person, but I sympathize so much with the suffering around me that it seems at times I can hardly endure it." While his soldiers admired his personal dash and trusted implicitly to his skill as a general, they were ready when the occasion offered to throw themselves between him and death, *because they loved the man.*