ELISHA HANSON

THE NATIONAL GEOGRAPHIC MAGAZINE

VOLUME II, 1890

WASHINGTON

PUBLISHED BY THE NATIONAL GEOGRAPHIC SOCIETY

1891

OFFICERS OF THE NATIONAL GEOGRAPHIC SOCIETY

1890

PRINTERS

TUTTLE, MOREHOUSE & TAYLOR,

NEW HAVEN, CONN.

CONTENTS.

VOL. I. NO. 1.

VOL. I. NO. 2.

April 1889.

VOL. I. NO. 3.

July 1889.

VOL. I. NO. 4

October 1889.

(*Volume I comprises pp. i-ii, 3-181, 183-335, with sixteen plates.*)

VOL. II. NO. 1.

April 1890.

VOL. II. NO. 2.

May 1890.

VOL. II. NO. 3.

VOL. II. NO. 4.

Vol. II. No. 5.

(*Volume II comprises pp. i-viii. 1-169, 171-229, 231-285, 287-339, with ten plates, and pp. i-ii for Volume I.*)

ILLUSTRATIONS.

VOLUME I.

PLATES.

FIGURES.

VOLUME II.

PLATES.

FIGURES.

Vol. II. No. 1.

THE NATIONAL GEOGRAPHIC MAGAZINE.

NATIONAL GEOGRAPHIC SOCIETY
INCORPORATED
A.D. 1888.

PUBLISHED BY THE

NATIONAL GEOGRAPHIC SOCIETY.

WASHINGTON, D. C.

Price 50 cents.

CONTENTS.

Published April, 1890.

PRESS OF TUTTLE, MOREHOUSE & TAYLOR, NEW HAVEN, CONN.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

Vol. II. 1890. No. 1.

ON THE TELEGRAPHIC DETERMINATIONS OF LONGITUDE BY THE BUREAU OF NAVIGATION.

By Lieut. J. A. Norris, U. S. N.

The following definitions are given by Chauvenet in his Spherical and Practical Astronomy.

"The longitude of a point on the earth's surface is the angle at the Pole included between the meridian of that point and some assumed first meridian. The difference of longitude between any two points is the angle included between their meridians." To describe the practical methods of obtaining this difference or angle, by means of the electric telegraph both overland and submarine, and especially those employed by the expeditions sent out by the Navy department, is the object of this paper.

Before the invention of the telegraph various methods more or less accurate in their results were employed, and are still in use where the telegraph is not available. The one most used and giving the best results was that in which a number of chronometers were transported back and forth between two places the difference of whose longitudes was required. "For," as the author quoted above says, "the determination of an absolute longitude from the first meridian or of a difference of longitude in general, resolves itself into the determination of the difference of the time reckoned at the two meridians at the same absolute instant." If a chronometer be regulated to the time at any place *A*, and then transported to a second place *B*, and the local time at *B*, be determined at any instant, and at that instant the time at *A*, as shown by the chronometer is noted, the difference of the times is at once known, and that is the difference of longitude required. The principal objection to this plan is that the best chronometers vary. If the variations were constant and regular, and the chronometer always gained or lost a fixed amount for the same interval of time, this objection would disappear. But the variation is not constant, the rate of gain or loss, even in the best instruments, changes from time to time from various causes. Some of these causes may be discovered and allowed for in a measure, others are accidental and unknown. Of the former class are variations due to changes of temperature. At the Naval Observatory, chronometers are rated at different temperatures, and the changes due thereto are noted, and serve to a great extent as a guide in their use. But the transportation of a chronometer, even when done with great care is liable to cause sudden changes in its indications, and of course in carrying it long distances, numerous shocks of greater or less violence are unavoidable. Still, chronometric measurements, when well carried out with a number of chronometers and skilled observers have been very successful. Among notable expeditions of this sort was that undertaken in 1843, by Struve between Pulkova and Altona, in which eighty-one chronometers were employed and nine voyages made from Pulkova to Altona and eight the other way. The results from thirteen of the chronometers were rejected as being discordant, and the deduced longitude was made to depend on the remaining 68. The result thus obtained differs from the latest determination by $0^s.2$.

The U. S. Coast Survey instituted chronometric expeditions between Cambridge, Mass., and Liverpool, England, in the years 1849, '50, '51 and '55. The probable error of the results of six voyages, three in each direction, in 1855 was $0^s.19$, fifty chronometers being carried.

Among other methods of determining differences of time may be mentioned the observation of certain celestial phenomena, which are visible at the same absolute instant by observers in various parts of the globe, such as the instant of the beginning or end of an eclipse of the moon, the eclipses of Jupiter's satellites by the shadow of the planet, the bursting of a meteor, and the appearance or disappearance of a shooting star. The difficulty of identifying these last mentioned objects and the impossibility of foretelling their occurrence prevents the extended use of this method.

Terrestrial signals may be used and among these can be included those sent by the electric telegraph. But when two stations are near together a signal may be made at either or at an intermediate station, which can be observed at both, the time may be noted at each of the stations and the difference found directly. These signals may be made by flashes of gunpowder, or the appearance and disappearance of a strong light, or a preconcerted movement of any object easily seen. The heliotrope reflecting the image of the sun from one station to the other with an arrangement for suddenly eclipsing it, is a useful and efficient apparatus.

Various truly astronomical methods have been employed with good results, of these may be mentioned moon-culminations, azimuths of the moon, lunar distances, etc.

Coming now to the use of the electric telegraph for this purpose the following is a rough outline of the methods employed. Suppose two stations A and B connected by wire, and provided with clocks, chronographs and transit instruments. A list of suitable fixed stars is compiled and each observer furnished with a copy. The observer at A the eastern station, selects a star from his list and sets his transit instrument upon it. He is furnished with a key by which he can send telegraphic signals over the line and also mark the time on his own chronograph. The instant he observes the star crossing the spider line which represents the meridian, he taps his key, thus registering the time on his own chronograph and on that at station B and this operation he repeats with as many stars as necessary. B has his instrument set for the first star, and when it crosses his meridian, he taps his key marking the time on his own chronograph and also on A's. Then, disregarding instrumental and personal errors and the rate of the clock, A has a record of the times at which the star passed both meridians. The difference of these times is the difference of longitude sought, except for an error due to the time occupied in the transmission of the signal over the wire between the stations. B also has a record of the same difference of time with the same error affecting it in the opposite way. A mean of these two differences, will be the true difference with the error of transmission eliminated. This method has the advantage of not depending upon the computed position of the star. The instrumental errors may be allowed for, as well as the rate of the clocks, and the personal error may be eliminated by the exchange of stations.

There are disadvantages inseparable from this method, however, especially when the meridian distance is great. A star observed at the first station, may be obscured by clouds at the time of its meridian passage at the second. And the weather generally, at the two stations may be cloudy, so that while stars can be observed at intervals, yet it may be impossible to note the meridian passage of the same star at both places on the same night. Then the telegraph lines are usually the property of some commercial company and while their use for a short time might be freely granted, yet a protracted occupation of them as necessary when the meridians are distant from each other, would prove a serious hindrance to their regular business.

The method at this time most generally employed, is to observe at each station a number of stars entirely independently of the other. From these stars are deduced the clock errors and rates upon the respective local times. Then at some prearranged period, communication is opened between the stations, and a comparison of the clocks made which shows their exact difference at a given instant. By applying the error to the time as shown by the clock at this instant, the exact local time at each station is the result, and applying the difference between the clocks as shown by the comparison, the required difference of longitude is readily obtained.

These methods originated, as did the electric telegraph, in the United States, and soon after Morse's invention came into practical use, they were extensively employed by the Coast Survey, in accurately determining points in every part of the country that could be reached, no pains being spared to make the determinations as accurate as possible. Upon the completion of the first successful Atlantic cable in 1866, an expedition was organized and placed in charge of Dr. B. A. Gould, for the purpose of measuring the meridian distance between Greenwich and the Naval Observatory at Washington. This was successfully carried out in spite of numerous difficulties, and the result proved that the determinations already made upon which the most reliance was placed were decidedly in error. The result from the chronometric expedition in 1855 previously referred to differing over a second of time.

In constructing charts for use at sea, the accurate determination of latitude and longitude is of the utmost importance. The navigator starting on a voyage must know the exact position of his destination as well as the location of dangers to be avoided. He must know the error and rate of his chronometer when he sets out, but as the rate is not constant he should have some means of re-rating it at any place where he may stop. If the longitude of this place is well determined, the operation of obtaining the error and rate is an easy one, and may save his vessel from loss.

Surveys, of coasts or countries must have well established starting points, and while the latitude of a place is comparatively easy to determine, the longitude, except when the telegraphic method is used, is attended with more or less uncertainty.

In 1873, Commodore R. H. Wyman, U. S. N. Hydrographer to the Bureau of Navigation, organized by permission of the Navy Department, an expedition for the telegraphic determination of longitude in the West Indies and Central America. The submarine cables of the West India and Panama Telegraph Co. had just been completed, extending from Key West through Havana and Santiago de Cuba, south to Jamaica and Aspinwall, and east through the Virgin and Windward Islands to the northeast coast of South America, thus affording admirable facilities for the accurate determination of many points. It had long been known that the longitudes of various points in the West Indies and in Central and South America, did not harmonize, there having been no systematic attempt to determine them with relation to each other or to a common base. Longitudes in the western part of the Caribbean Sea depended upon the position of the Morro lighthouse at Havana, which had been determined by occultations. Further to the eastward, positions depended upon that of Fort Christian at St. Thomas. This in its turn depended upon the observatory of Major Lang in the Island of Santa Cruz about forty miles distant. This position depended upon numerous observations of moon culminations and occultations. Martinique and Guadeloupe in the Windward Islands had been surveyed by French officers who based their positions upon longitudes derived from moon culminations. The absolute determination of these starting points would of course fix all points derived from them.

The U. S. Steamer Fortune was designated by the Navy Department for the conveyance of the expedition, and Lieut. Commander (now Commander), F. M. Green, U. S. N. was placed in charge. This officer had given great attention to the subject, was a practiced observer, and exceptionally well qualified for the position. The services of Mr. Miles Rock, a skillful astronomer and computer who is now chief of the boundary survey of Guatemala, were obtained as principal astronomical assistant. The breaking out in the autumn of 1873, of the trouble with Spain and Cuba, over the Virginius affair, delayed the expedition until the next year, but in November 1874, a start was made from Washington, and after a short stay in Kingston, Jamacia, Aspinwall was reached early in December. Mr. Rock with one set of instruments proceeded immediately to Panama, while Lieut. Commander Green remained in Aspinwall with the other. The outfit for each party consisted of:—first, a portable observatory. This was made of wood in sections, framework of ash, covered with tongued and grooved pine boards. The sections were connected when set up by iron knees and bolts. When packed it was not difficult to transport, and it could be put up, or taken down in an hour. When set up it was about eight feet square, with doors in all sides, and a shed roof. The roof was made in three sections, the middle one being hinged so that it could be raised for observing. These observatories proved to be very strong and serviceable. They remained in use for a number of years with occasional slight repairs, were transported many thousand miles and set up in a great number of places in Europe, Asia, North and South America. They were designed by Mr. J. A. Rogers, and constructed at the Washington Navy Yard. Upon arriving at a point where observations were to be made, after obtaining the necessary permits from the local authorities, a suitable location for the observatory was the first consideration. The essential requirements were, a clear view of the heavens in the meridian, firm ground, a spot secluded enough not to attract attention from inquisitive idlers, and proximity to the telegraph office, or end of the telegraph line. Such a spot being found and permission being obtained from the owner for its use, an approximate meridian line was laid out by compass, and the house set up with reference to it. Experience soon showed the advisability of making certain additions to the observatory not contemplated by the designer, but which added much to convenience and comfort.

A foundation was made, of timbers about six inches square, mortised together at the ends which could be placed in position and leveled before the observatory was set up, rendering this operation much easier and giving greater stability. A floor was laid upon joists supported by this foundation. Shelves were put up at various points, affording resting places for tools and small instruments, while a table in one corner, supported the chronometer, and offered a convenient place for an assistant to record observations, etc.

The principal instrument used was the transit. Those furnished for the use of the expedition were designed by Mr. J. A. Rogers, and constructed under his supervision in the repair shop of the Hydrographic office. The object glasses, made by the Clarks at Cambridge, were of 2½ inches clear aperture with a focal length of thirty inches. The instruments were of the prismatic or "broken" form in which the eye piece is at one end of the axis, and the light is reflected from the object glass to the eye by a prism placed at the junction of the telescope tube with the axis. The observer does not have to change the position of his eye, no matter what the zenith distance of the star may be. This renders observation much less fatiguing and conduces to accuracy. The eye-piece was furnished with the usual spider line reticle and also with a filar micrometer for the measurement of zenith distances for latitude. A vertical finding circle was on the eye-piece end of the axis, and the instrument was provided also with a horizontal circle, fourteen inches in diameter, graduated to ten seconds. Other necessary parts were the striding and zenith telescope levels, and the illuminating lamps. The ends of the axis were supported by Ys at the ends of a transverse arm which in its centre was screwed to the top of a vertical axis supported in a socket surmounting the tripod. This vertical axis was slightly conical in shape and accurately fitted into its socket. A screw was so placed underneath, that the axis, and with it the instrument, could be raised slightly, when it was easily revolved horizontally into any desired position, a reverse movement of the screw then lowered the axis into its seat, when the instrument was held firmly by the friction. For supporting the instrument there was used at first, a portable pier made in the shape of the frustrum of a cone, of strong oak staves, firmly bound with iron hoops, and when set up, filled with sand or earth. Subsequently a brick pier was found to be more stable and the wooden ones were discarded.

Of equal importance with the transit was the Chronometer. The expedition was supplied with four of these made by Negus of New York. They were regulated to sidereal time, and provided with a break circuit arrangement. This consists of a toothed wheel acting on a jewel pallet attached to a light steel spring. In this spring is a platinum point, which touches another platinum point, except when the spring is acted upon by the toothed wheel. These points are connected respectively with terminals on the outside of the chronometer, and are insulated from each other except at their point of contact. The electric circuit is complete through the chronometer except when the teeth of the wheel acting on the jewel pallet separate the points. The circuit is opened for about one-fortieth of a second and closed during the rest of the time. One tooth in the wheel is omitted and the circuit remains unbroken at that point which is the beginning of each minute. Each chronometer is provided with a condenser to take up the extra current, and avoid burning the contact points. These chronometers were most excellent instruments, the rate was generally small and very regular, and did not seem to be influenced in any way by the passage of the current. They are still in use, and are as efficient as ever.

The expedition was at first provided with a substitute for the chronograph in the shape of the old fashioned Morse telegraph register. In this a steel point or stylet was pressed by the action of an electro-magnet against a long fillet of paper, unwound by clock-work at a rate more or less regular. This magnet was in circuit with the chronometer and with a break circuit key in the observer's hand. As long as the electric circuit was closed the stylet made a continuous indented straight line on the paper; but as soon as it was broken, either by the chronometer or the observer's key, the stylet flew back and left the paper unmarked until the circuit was again closed. The effect of the action of the chronometer was to graduate the fillet of paper into a series of straight indentations, from one to two inches in length, separated by unmarked spaces from $\frac{1}{16}$ to $\frac{1}{8}$ inch in length. When the key was pressed an independent clear space was left on the paper, and by the relation in distance between the beginning of this space and the beginning of the second spaces immediately preceding and following, the time of pressing the key was determined. The omission of the break at the sixtieth second, made the mark of double length, and hence the beginning of the minute was easily recognized. These instruments served their purpose very well, but had several disadvantages. The rate of movement of the paper was not regular; when the clock-work was first wound up the motion was rapid and the second spaces long, and as the spring ran down the marks became shorter and shorter. Another drawback was the great length of the fillet; with spaces only an inch in length, it required five feet of paper to record a minute in time, and after a night's observation, there would be several hundred feet to examine, measure and record, occupying the greater part of the following day. By stopping the instrument between the observations something was gained in this respect, but this tended somewhat to confusion and error in keeping the record. They were only used for one season's work, and in their stead were procured two cylinder chronographs, made by Bond of Boston. These were fine instruments, but somewhat too delicate to stand the necessary transportation. In these instruments as in most other chronographs, a cylinder about six inches in diameter is made to revolve by clock-work once in a minute. An electro-magnet mounted on a carriage actuated by the same clock-work moves alongside the cylinder, in a direction parallel with its axis, at the rate of about an eighth of an inch in a minute. The armature of the magnet carries attached to it a pen, the point of which rests upon a sheet of the paper wrapped around the cylinder. While the circuit through the coils of the magnet is complete, the pen makes a continuous spiral line upon the paper, but when the circuit is broken by the chronometer, or key, it flies to one side making an offset, and immediately returns to its position, as soon as the circuit is again closed. The result is to graduate the whole surface of the paper into second spaces, from which the observations can be read off with the greatest ease.

For supplying the electric current, there was used at first, a modification of the Smee battery, but this proving very uncertain in strength, a gravity battery was substituted, and afterwards a number of LeClanché cells were procured.

Upon the first expedition, no telegraph instruments were carried, but the use of such as were needed was easily obtained from the telegraph companies. The line between Aspinwall and Panama was in good condition and no trouble was experienced in exchanging the time signals by which was effected the comparison of the chronometers. Wires were stretched from the observatories in each place to the respective telegraph offices, and for the exchange of signals were connected directly to the ends of the line.

Everything being ready, the routine of the work was as follows :—The transit being carefully leveled was placed in the meridian by observation of zenith and circumpolar stars. From six to ten time stars, and two or three circumpolars were then observed, the instrument was reversed in the Ys and nearly the same number of stars observed in the new position. At some time agreed upon, generally when the regular work of the telegraph line was over for the day, the wires were connected up and one of the operators came to the observatory to assist in holding communication. By a simple arrangement of relays, in the line and chronograph circuits the chronometer at one station was made to register its second beats on the chronograph at the other, which was all the time being graduated into second spaces by its own chronometer. This was done for about five minutes and the times of beginning and ending noted. Then the connections were reversed and both chronometers allowed to beat for five minutes on the chronograph at the first station.

This method of exchanging signals was only practicable on land lines or very short cables. The ordinary relay used on a land line requires a strong current to work it, and would not be affected in the least by the delicate impulse sent over a long cable, consequently when the expedition came to compare chronometers over the 600 miles of cable between Aspinwall and Kingston, it was necessary to use another method. At that time the instrument in general use on submarine cable lines was what is known as Thompson's mirror galvanometer. It consists of a coil of very fine insulated wire wound with great care on a spool or bobbin of vulcanite, about three inches in diameter and 1½ inches thick. In a hole in the centre of the spool is made to slide a small tube, so that the end of the tube will be in the centre of the coil. In the end of the tube is mounted a small mirror, swung in a vertical position on a single upright fibre of silk. Horizontally across the back of this mirror is secured a small permanent magnet, in length about the diameter of the mirror or about one-eighth to one-quarter of an inch. The mirror and magnet together weigh only one or two grains. When an electric current is sent through this coil it deflects the magnet and with it the mirror to the right or left. The apparatus is exceedingly sensitive so that it is influenced by very feeble currents. Communication has been maintained with an instrument of this kind over the Atlantic cables, by the current proceeding from a battery composed of a single copper percussion cap with a small scrap of zinc and a drop of acidulated water. The use of the mirror is to make visible the movements of the magnet. The coil is mounted upon a standard so as to be about eight inches above the table. At the distance of eighteen inches or two feet is placed a lamp. This is surrounded by a screen which cuts off all the light, except that which passes through a tube directed towards the mirror. Lenses in the tube focus the light on the mirror and thence it is reflected to a vertical white surface, a sheet of paper for instance, at a suitable distance and appears as a small and brilliant spot. A movement of the magnet causes a horizontal deflection of this spot to the right or left depending upon the direction of the current passing through the coil. As these movements can be produced at will by means of the key at the sending station, it is only necessary to apply to them the dots and dashes of the Morse alphabet, to have a very ready and perfect means of communication. To the uninitiated spectator the facility with which the practiced operator translates these apparently meaningless movements is remarkable. If the cable is long and not in good condition the signals are sometimes almost imperceptible, while any slight jar of the table or apparatus will produce a large and irregular effect. Earth currents also will cause vibrations hard to distinguish from the signals, and if, as sometimes happens, the battery is connected in the wrong way, the signals will be reversed. In spite of these drawbacks the skillful operator reads off the message and rarely makes an error. This instrument is still in use on some of the cable lines, but on most of them it has been replaced by a recording instrument, also the invention of Sir Wm. Thompson, which is almost as sensitive, and of which I will speak later on. The key used in connection with these instruments, both the mirror and recorder, is arranged with two levers, so connected that pressing one of them causes a current to be sent over the line in one direction, while the other sends it in the opposite.

The method adopted for comparing chronometers by means of these instruments was as follows :—Everything being ready for the exchange of signals, the observer at one station seated himself, where he could see the face of the chronometer, with his hand on the cable key. At ten seconds before the beginning of a minute as shown by the second hand, he pressed his key several times in quick succession, thus sending a series of impulses through the line, which appeared at the other end as a rapid movement of the light to and fro. This was a warning signal, and the observer at the second station with his eye on the light, tapped his chronograph key in the same way making a series of marks, which indicated the beginning of the comparison. The first observer exactly at the sixtieth second by his chronometer pressed his key quickly and firmly and repeated this operation at every fifth second for one minute. The second observer tapped his key promptly as soon as he saw the light move, thus registering the time on his chronograph. The minute at which the first signal was sent, was then telegraphed, and repeated back, to insure against error, and the operation was repeated until sixty-five signals had been sent from one station and received at the other. Then the second observer sent the same number of signals to the first in precisely the same manner, thus giving sixty-five comparisons of the chronometers in each direction. The results derived from this method are affected by errors from two causes. One is the personal error of the observers in sending and receiving signals and the other the time consumed by the electric impulse in traveling over the line and through the instruments. If the same strength of battery is used at each station, and the resistance of the instruments is the same, the errors arising from this latter source will be eliminated by the double exchange. The observer sending the signals kept his eye on the chronometer and counted the second beats by both eye and ear, moving the hand which he had on the key slightly in unison with the beats, and could thus be sure of pressing the key at the proper time within a very small fraction of a second. At the other end of the line, considerable time is lost after the actual movement of the light before the observer can press his chronograph key, and the principal error affecting the result is the difference of this time in the two observers, which was found to be very small.

As I have said, the cable was first used in the measurement between Kingston and Aspinwall, Lieut. Commander Green occupying the former station, and Mr. Rock the latter. After the successful completion of this link, measurements were made from Santiago de Cuba to Kingston, and to Havana. It was the intention to measure from this last point to Key West, but about this time yellow fever broke out there and the expedition was ordered by the Secretary of the Navy to return. The Fortune arrived at Washington in April, 1875, and the time until November was spent in working up the winter's observations. Speaking in a general way this work is as follows :—From observations extending over many years, the exact positions in the heavens of a large number of fixed stars have been found, so that their times of passing any meridian can be computed with great accuracy. The transit instrument is furnished with an eye-piece containing a number of parallel lines usually made of spider silk. These are placed in the focus of the instrument, and it is set in position, so that the middle line of the group is in the plane of the meridian. The observer provides himself with a list of desirable stars, and setting his instrument on those he may choose, records the time at which they pass each of the spider lines, by tapping his chronograph key. If there were no instrumental errors to be discovered and allowed for, if the star's place were known absolutely, and the observer had no personal equation, then it would be only necessary in order to find the error of the clock, to observe one star upon the middle line of the reticle. The difference of the clock time of transit and the real time as already known, would be the clock error and no further trouble would be required. But as none of these conditions are fulfilled, it is necessary to multiply observations in order to eliminate accidental errors, and to obtain instrumental corrections which may be applied so as to get the most probable result. Accidental errors of eyesight and perception are nearly eliminated by taking the star's transit over several lines instead of one and using the mean. Some of the instrumental errors are from the following causes. If the pivots which support the telescope are unequal in size the axis of the tube will be thrown to one side or the other of the meridian, and the star will be observed either before or after it crosses. The weight of all transit instruments causes a flexure of the horizontal axis and this effect is at its maximum in those of the prismatic pattern. The spider lines must be adjusted so that the middle one is exactly in the axis of the tube, or as this can seldom be done the resulting error, called the collimation, must be found. The horizontal axis of the instrument must be as nearly level as possible, and the error in this respect must be found by frequent applications of a delicate spirit level. Finally the instrument must be directed as nearly as possible to the north and south points of the horizon, and a correction must be made for any error in this respect. The result of each of these errors is to cause the star's transit to be recorded too early or too late, and to get the true result they must all be found and applied with their proper signs. The inequality of pivots and the flexure correction are found by delicate measurement and observations, when the instrument is first used, and are recorded as constants to be applied in all subsequent work. The level tubes are graduated and the value of their divisions obtained in angular measure. The collimation error is found by observing stars near the zenith in one position of the instrument and then reversing and observing others, or by taking the transit of a slow moving star over a portion of the spider lines then reversing and observing the same intervals in the opposite order. The error of azimuth, or deviation from the north and south line, is found by comparing the observations of stars whose zenith distances differ considerably. These corrections all being found and applied to the observation of each star, the result is the correct time of transit as shown by the chronometer, and the difference between that time and the true time, is the error of the chronometer. A mean of the observations of several stars on the same night, gives a very accurate value for this clock error, and by comparing the results of several nights' work, the rate is found. By applying the rate to the clock error it is reduced to any required epoch, as for instance, the mean time of the exchange of time signals, and the difference of longitude is easily found. As may be imagined the computation and application of all these errors, exercising the greatest care to insure accuracy is a long and tedious process. The operations described give a very close result, but in order to arrive at the greatest accuracy obtainable the computations are made again by the method of least squares.

In the Autumn of 1875, the expedition again took the field, this time in the side wheel steamer Gettysburg, which was much better adapted to the work than the Fortune. The first link measured was between Key West and Havana. Key West had already been telegraphically determined by the Coast Survey, and now afforded a base for the system of measurements completed and for those to follow. The next measurement was between Kingston and St. Thomas. Then from the latter place to Antigua and to Port Spain, Trinidad. From Port Spain, measurements were made to Barbadoes and Martinique. The position at St. Thomas was then re-occupied, and measurements made thence to San Juan, Porto Rico, and to Santa Cruz. This ended the work in the West Indies, differences of longitude having been measured between nearly all the important points connected by telegraph. The Latitude of all the stations, was also determined by the zenith telescope method, and the position of the stations was referred either to the observation spot previously used, when that could be identified, or to some prominent landmark.

Between St. Thomas and Santa Cruz, the measurement was made twice, the observers exchanging stations at the completion of the first series of observations. This was to eliminate the effect of their personal errors, and to obtain a value of these, which might be applied to the other measurements. It has long been known that different people perceive the same phenomenon at different times, varying with different individuals, but reasonably constant with the same individual. In the particular case of observing the transit of a star, most people will record it on a chronograph from one to three tenths of a second after it happens. In the method of observing by eye and ear the error is generally much greater. The whole question of personal equation, however, is a mixed one and I will not attempt to discuss it, but will only give some of the results obtained in this particular work. In longitude measurements the error from this cause is half the difference of the personal equation of the two observers. If this difference remained constant, then it would be easy to find it once for all, and apply it to all measurements made by the same observers. In the West India work, it was assumed that it did remain constant, and half the difference between the two measurements made from St. Thomas to Santa Cruz, was applied to all the other links. The correction was quite small, being only $0^s.025$. In subsequent work by the same and other observers it was deemed wiser not to apply any corrections at all, rather than one that was probably not exact, and might be much in error. To show the fluctuations to which this elusive quantity is subject, I will cite the results of some observations made to determine it, by observers engaged in this same work at a subsequent period. In April and May, 1883, at Galveston, Texas, two observers D. and N. having just completed a telegraphic measurement between that place and Vera Cruz, Mexico, made some observations for the determination of their relative personal equation, by observing transits of alternate stars under the same conditions as near as possible. Both used the same instruments, transit, chronometer and chronograph. On April 30, two sets of observations were made, showing the difference of the equations to be $0^s.26$. On May 1, one set gave $0^s.32$, and another $0^s.29$. On May 2, only one set was made giving $0^s.36$, a variation of $0^s.07$ in two days. In June 1884, one year later, another series of observations of the same character was made at the Naval Observatory in Washington, and on the same nights the personal equation machine invented by Prof. Eastman, was used as a comparison. This is an instrument in which an artificial star is made to record its own transit over the wires of a reticle, while the observer records the same with a chronograph key. The difference is manifestly the personal error of the observer. This gives the absolute equation of the observers, and their difference is the relative equation, and should accord with that found by the method of alternate stars. Some of the results were as follows :—On June 4, the difference by machine of their personal errors was $0^s.16$ and by star observations $0^s.24$, on the 15th of June the machine gave $0^s.10$ and the stars $0^s.24$, on the 16th, machine $0^s.14$, stars, $0^s.13$, a very close agreement, on the 17th, machine gave $0^s.07$ and stars $0^s.18$. The observer N. combined with another, C., who had not had as much experience in observing, gave still more discordant results. On June 20, the machine gave as their relative equation, $0^s.08$, while star observations gave $0^s.27$, on June 23, machine $0^s.13$, stars $0^s.51$, and on June 28, machine, $0^s.20$, stars $0^s.35$. In the case of the first two observers a mean of the determinations amounting to about $0^s.20$ might have been applied to the measurements made by them, but as these were made under all conditions of climate, in latitudes varying from 30° N. to 36° S. and in different states of health and bodily comfort, it was concluded not to introduce any correction at all rather than one that might be considerably in error. In all of the work it has been the custom as far as possible to place the observers alternately east and west of each other, so that the result of personal error in one measurement is neutralized to a greater or less extent in the next. Of course the method of exchanging stations and making two measurements of each meridian distance would afford the best solution of this problem, but except in certain favorable conditions, this is precluded by considerations of time and expense. In the measurement between Galveston and Vera Cruz mentioned above, it had been the intention to exchange stations, but by the time the first measurement was finished the season was rather far advanced, there was danger of yellow fever in Vera Cruz and an observer going there at that time, if he escaped disease would have had the certainty of being quarantined from entering the United States for three weeks or a month after leaving Mexico.

Upon the completion of the West Indian work, and the publication in 1877, of the results, it was determined by the Bureau of Navigation to send an Expedition for the same purpose to the east coast of South America. Cables were in use extending from Para in northern Brazil to Buenos Ayres in the Argentine Republic. A cable had at one time connected this system with the West Indies, through British Guiana and Trinidad, but one of the links was broken and there was no prospect of its repair, otherwise the Station established at Trinidad in 1874 might have been taken as the starting point. There was direct communication however between England and Brazil, by the way of Portugal, and the Madeira and Cape de Verde Islands. Lisbon seemed to afford the most convenient place to start from, but its longitude had never been determined by telegraph and it was decided to request the French Bureau of Longitudes to coöperate by making this measurement from Paris. This request was readily granted, but for some reason the agreement was not kept. For the use of the Expedition the old fashioned sailing ship *Guard* was furnished and Lieut. Com. Green was given command. Mr. Rock being otherwise employed his place was taken by Lieut. Com. (now Commander) C. H. Davis, U. S. N. The instruments having been placed in good order, and new supplies furnished where necessary, the expedition sailed from New York for Lisbon in the latter part of October, 1877. The Guard was a slow sailer, the weather was rough and the wind generally ahead, consequently a month was consumed in making the passage. It was the intention to make the first measurement between Lisbon and Funchal, Madeira. Lieut. Com. Davis with party and instruments occupied the latter station, proceeding by mail steamer at the first opportunity. The cable from England does not land directly at Lisbon, but at a small town called Carcavellos on the coast about twelve miles from the city. As it was not practicable to connect the land line from Lisbon direct to the cable, it was necessary in making the exchange of signals to adopt another method, or rather combination of methods. An officer of the ship was sent to Carcavellos, furnished with a chronometer and chronograph. When the time came for exchanging signals, he first compared his chronometer with that at Lisbon, by the automatic method, in use on land lines, then with the Funchal chronometer over the cable using the mirror galvanometer. Finally a second automatic comparison was made with Lisbon. From the data furnished by these comparisons it was an easy matter to compute the difference between the chronometers at Lisbon and Funchal. The Lisbon party had been received with great courtesy by the director of the Royal Observatory, Capt. Oom of the Portuguese Navy, and had been given the use of a small detached observatory near the main building. The party at Funchal selected a site on the ramparts of an old fort, which afforded a clear view and was near the landing place of the cable. Here occurred an accident to the transit instrument, which fortunately was easily remedied. Near the beginning of the observations on the first night the wind, which was blowing almost a gale, lifted a part of the roof off the observatory, and dropped one section of it inside. The transit was knocked off the pier, and was at first thought to be much injured. Fortunately the precaution had been taken to bring along a couple of spare instruments, borrowed from the Transit of Venus Commission for use in case of such an accident. The Funchal party was provided with one of these, which was set up for use by the next night, and the injured one was sent to Lisbon for repairs. The injury proved to be less than supposed and the repairing was an easy matter. Upon the completion of this measurement the Lisbon party proceeded to St. Vincent one of the Cape de Verde Islands. This is a barren and desolate spot of volcanic formation, but being on the route of steamers from Europe to Africa and South America is of much importance as a coaling station. Measurements were made from this point to Funchal and to Pernambuco in Brazil, and the Guard then sailed for Rio Janeiro. Upon arriving at that point after a long passage, it was found that the cable between Rio and Pernambuco was broken, and there being no immediate prospect of its being repaired, the Pernambuco party was ordered by mail steamer to Rio, and thence to Montevideo. A measurement was made between Rio and Montevideo and then between the latter place and Buenos Ayres, Lieut. Com. Green occupying the Montevideo station for that purpose. The position of the observatory at Buenos Ayres was referred to that occupied by Dr. B. A. Gould, Director of the Argentine National Observatory, in a similar measurement a short time before between that place and Cordova.

Both parties now returned to Rio, only to find that the cable was still broken. In order to be ready for work as soon as it should be repaired, Lieut. Com. Green proceeded to Bahia with the ship and established a station there, Lieut. Com. Davis with his party remaining in Rio. After waiting a month, and there still seeming to be no prospect of the repair of the cable, the expedition finally sailed for home, arriving at Norfolk, Va., after a pleasant and uneventful voyage of forty-five days. Repairs to the cable were not completed until several months afterward. In May of the next year, the party was again sent out, to complete the measurement on the Brazilian Coast, and also to measure from Greenwich to Lisbon, the French Bureau of Longitudes having failed to carry out its promise to measure from Paris. There being no ship available for the purpose the traveling was done by mail steamer. Upon arrival in England, an interview was had with the Astronomer Royal, who readily agreed to assist in the work. Lieut. Com. Green accordingly established his observatory at the landing place of the cable at Porthcurnow in Cornwall, and Lieut. Com. Davis proceeded to Lisbon and occupied the station used there the year before. Owing to the foggy and rainy weather prevalent in England at that season, it was found impossible to make any astronomical observations at the Porthcurnow observatory. The work was therefore done in this way:—Observations were made at Greenwich and at Lisbon, and Porthcurnow and Carcavellos were used as transmitting stations. The chronometer at Porthcurnow was compared automatically with the clock at Greenwich, and by cable with the chronometer at Carcavellos. The latter was compared automatically with that at Lisbon, before and after the cable exchange. At this time there were made at Carcavellos, some experiments with a view to making the receipt of the time signals over the cable automatic, thus doing away with the personal equation of the receiver. The instrument in use for the regular business of the cable was what is known as the siphon recorder, also the invention of Sir Wm. Thompson. In this a small coil of fine wire is suspended by a fibre of silk, between the poles of a powerful permanent magnet. The currents from the cable pass through this coil and the action is to deflect it to the right or left, just as the mirror is deflected in the instrument already described. Attached to this coil is a siphon made of a capillary glass tube. One end of the siphon dips into a reservoir of aniline ink, and the other hangs immediately over the centre of a fillet of paper, which is unwound by clock-work. If the siphon touched the paper, the feeble currents sent through the cable would be powerless to move it, on account of the friction, and in order to produce a mark some means must be found of forcing the ink through the capillary tube. This is accomplished by electrifying the ink positively and the paper negatively, by means of a small inductive machine, driven by an electric motor. The effort of the two electricities to unite, forces the ink through the tube and it appears on the paper as a succession of small dots. When the paper is in motion and the coil at rest, a straight line is formed along the middle of the fillet by these dots, but as soon as a current is sent through the coil the siphon moves to the right or left making an offset to this line. These offsets on one side or the other are used as the dots and dashes of the Morse alphabet. A time signal sent over the cable while this instrument was in circuit, appeared as a single offset on the paper, and it was only necessary to graduate the paper into seconds spaces by the local chronometer, in order to have the automatic record required. The ordinary chronometer circuit could not be put through the coil directly, as it would then charge the cable and interfere with the signals, and besides, the current, unless by the introduction of a high resistance it was reduced in strength, would infallibly give such a violent motion to the coil as to break the siphon, if it did no other damage. The result was obtained in this way ; an ordinary telegraph relay was put in the chronometer circuit and the armature of course moved with the beats. To this armature was fastened one end of a fine thread. The other end was attached to a slender piece of elastic brass which was fixed at one end to the framework supporting the paper, in such a way that the other end touched the metallic vessel holding the ink, except when the thread was drawn tight enough to pull it away. This the armature of the relay did while the circuit through the chronometer was complete, but as soon as it was broken at the beginning of a second, the tension of the thread was relaxed and the brass sprung back against the ink well, allowing the positive and negative electricities to unite independently of the siphon. The ink then ceased to flow, until the spring was drawn away, thus leaving a small blank space in the line of dots and forming a very good chronographic record. This was liable to a small error due to the length of time that elapsed between the release of the spring by the armature and its impact on the ink well. Had there been time for more extensive experiment this difficulty might have been overcome. Or if the same method had been adopted at both stations, the result would have been affected by only the difference between the times of movement of the brass spring which would have been minute. Lack of time for experiment, and the fact that the observers were averse to introducing untested methods into a chain of measurements most of the links of which were already completed, prevented any use being made of this achievement. The measurement between Greenwich and Lisbon being satisfactorily completed. Lieut. Com. Green by order of the Navy Department returned to the United States, and the links between Rio and Pernambuco and between the latter place and Para, were measured by Lieut. Com. Davis and the writer, completing the work of the expedition, after which the party returned to Washington.

The computation of this work, showed the somewhat surprising fact that the heretofore accepted position in longitude of Lisbon, differed from the true one by about two miles. The longitude of Rio Janeiro had always been more or less in doubt, various determinations had differed by as much as nine miles, but the position finally decided upon by the best authorities agreed very closely with that obtained by telegraph.

The next expedition was sent out by the Bureau of Navigation to China, Japan and the East Indies, Lieut. Com. Green being still in charge. The officers composing the party sailed from San Francisco by mail steamer in April, 1881, for Yokohama, where they joined the U. S. Steamer Palos. From Hong Kong north to Vladivostok in Eastern Siberia the cables were owned by a Danish company. From Hong Kong to the south and west they were the property of English companies. Beginning at Vladivostok observations were made at all stations on the Asiatic coast except Penang, as far as Madras, India. It was intended to try and make some use of the automatic method of receiving time signals, on this work, but on arriving in Japan it was found that the recording instrument used by the Danish company was entirely different from that used by the English lines. It consisted of a series of electro-magnets acting on a single armature, which carried a siphon madé of silver. The signals consisted of long and short movements, to one side of the middle line, instead of equal deflections on both sides as in the Thompson recorder.

An attempt was made to convert this instrument into a relay, by causing the siphon to make and break a circuit, but it was not successful. The movements of the siphon were not regular enough, and the contact was not firm. Consequently the mirror method of exchanging signals was still adhered to.

The longitude of the position occupied in Vladivostok, had been determined telegraphically from Pulkova, by the Russians, using the land lines across Siberia. The English had also determined the position at Madras, using the cables through the Mediterranean and Red Seas. The work of the United States Expedition joined these two positions, completing a chain of measurements extending over many thousand miles, made by observers of different nationalities in various climates. It was to be expected that considerable discrepancy would be found in the final result, but taking the longitude of Vladivostok as brought from Madras, and comparing it with that determined by the Russians, the difference was only $0^s.39$. Taking everything into consideration, this result was gratifyingly close. Upon the conclusion of this series of determinations, the connection of Lieut. Commander Green with the work was severed, he receiving his promotion to the rank of Commander.

The next work was under the charge of Lieut. Com. Davis, and consisted in the determination in 1883-84, of positions in Mexico, Central America and the west coast of South America. Cables had just been completed, extending from Galveston, Texas, to Vera Cruz, thence across Mexico to the Pacific and down that coast to Lima, Peru, where connection was made with another system extending to Valparaiso. Galveston was a point determined by the Coast Survey, and the measurement thence to Vera Cruz was the first one made. It was completed in May '83, and in the Autumn of the same year the party proceeded to the South American coast, and stations were established and observations made at various points from Valparaiso to Panama, and at one point, La Libertad, in Central America. It was at first the intention to extend the series across the Isthmus of Tehuantepec and connect with Vera Cruz, but lack of time prevented this, and as the station at Panama determined nearly ten years before, afforded a convenient starting point, the idea was abandoned. From Valparaiso, a measurement was made with the coöperation of Dr. Gould to his observatory at Cordova, using the line across the Andes, and exchanging signals automatically. These measurements constituted the final links in a long chain, extending from the prime meridian Greenwich across the Atlantic to the United States, thence via the West Indies to Panama, down the west coast of South America to Valparaiso, across the Andes to Cordova and Buenos Ayres, up the east coast to Pernambuco, across the Atlantic to Lisbon, and thence to Greenwich, altogether a distance of eighteen to twenty thousand miles. The two longitudes of Cordova, as brought from Greenwich by the two routes, differed from each other by only $0^s.048$, a result which speaks well for the accuracy of the methods employed. When preparations were being made for this expedition, it was determined to accomplish if possible something in the way of getting rid of the personal equation in exchanging signals. An idea which had been suggested by work done by Major Campbell, R. E. in the measurement between Bombay and Aden, seemed to promise well. It was to be used with the siphon or other form of recorder. The ordinary double current cable key with two levers, was arranged with an additional lever in such a manner that while in ordinary use in the telegraph office, it could also be put in circuit with the chronometer and chronograph in the observatory, and a signal sent through the cable would have its time of sending registered on the chronograph. Ordinarily in speaking over a cable line, connection is made in such a way that the current sent does not pass through the recorder at the sending station, as a violent movement of the siphon would result. By means of a shunt, however, it is possible to control this movement somewhat. Suppose now, that the connections at each station are made in such a way, by means of this key and the shunt, that a signal sent from one, is registered on both recorders and on the sender's chronograph. The observers leaving their assistants to take care of the chronographs, go to the respective telegraph offices, and all being ready, the observer A taps his key. This sends an impulse through the cable, which appears on A's recorder, as a violent jump or kick of the siphon. On B's recorder it is registered as a deflection like the ordinary dot or dash, at the same instant is recorded on A's chronograph the time of sending. As soon as B sees the signal on his recorder, he taps his key also registering the signals on both recorders and on his chronograph. A, seeing B's signal again taps his key, and so on, as long as desired. The result is that each observer has a record on his siphon fillet of all signals sent and received, while the times of those he sent are recorded on his chronograph. By the use of the diagonal scale and the Rule of Three, he can without difficulty find the times of the signals received. The siphon recorders are well made, and the paper moves with great regularity. This system was used in the measurement between Galveston and Vera Cruz with great success. It was intended to employ the same method throughout the measurement on the west coast of America, but on arriving at Lima, it was found that the company owning the lines south of that point still used the mirror galvanometer, and it was of course necessary to return to the old method. The improved key was used however, which eliminated the error in sending signals.

After this work was completed and the results published in 1885, nothing was done in this line by the Bureau of Navigation for some years. Upon the return of the writer in the spring of 1888, from a cruise in the South Pacific, he found that the subject of sending an expedition to complete the measurements in Mexico and Central America was under consideration in the Bureau of Navigation and the Hydrographic office. It was finally decided that the work should be done, and the writer was placed in charge. The instruments were brought out of their retirement, and by the aid of the Hydrographic Office a very complete outfit was furnished, and in November of last year a start was made from New York, the expedition proceeding by mail steamer to Vera Cruz. Here the spot occupied by Lieut. Com. Davis in '83 was found, his transit pier, which was still standing was repaired, and instruments mounted. Lieut. Charles Laird, U. S. N., who had been identified with the longitude work since the China expedition in 1881, was left in charge of the observatory at Vera Cruz, and the writer proceeded with his party to the small town of Coatzacoalcos, at the mouth of the river of the same name. This point is about one hundred and twenty miles southeast of Vera Cruz, and is the landing place of the cable. A land line extends from this point to Salina Cruz on the Pacific coast, a distance of about two hundred miles. In exchanging time signals between Vera Cruz and Coatzacoalcos, the automatic method was employed, the cable being short. The old wooden observatories were used at these points, but as they were too heavy for transportation across the Isthmus, tents made especially for astronomical purposes were substituted for them in the observations made on the Pacific coast. The journey across the Isthmus was slow, about two weeks being employed in traveling two hundred miles, though as the route was devious, the actual distance was nearer three hundred. Some of the instruments were heavy, and after being taken in canoes a hundred miles up the Coatzacoalcos river, against a rapid current, they were loaded on a train of pack mules, and carried the rest of the way by land. While the first party was crossing the Isthmus, the other was on its way from Vera Cruz, and being ready at about the same time, a successful measurement was made between Coatzacoalcos and Salina Cruz, exchanging signals automatically. The Coatzacoalcos party then crossed to Salina Cruz, while the other proceeded to La Libertad in Salvador, where the station established in the Spring of '84, was again occupied. The measurement between these places being completed, the Libertad party went on to San Juan del Sur, in Nicaragua, near the terminus of the proposed interoceanic canal. In the measurement between this point and Salina Cruz, as well as in the one preceding, the exchange was effected by mirror signals. This completed the season's work, and the two parties made the best of their way home via. Panama, arriving in Washington in April and May respectively. The computation of the observations is not yet complete though well advanced ; it was the intention to publish preliminary results this Fall, but owing to lack of time that can not be done.

Another piece of work is laid out for the same party for the coming winter, which is the measurement from Santiago de Cuba, through Hayti and San Domingo to La Guayra in Venezuela, over the cables of a French company, which have just been completed. This work will consume about six months, and the expedition which is to start almost immediately will probably return in April or May next. The determination of the longitude of La Guayra will give a point from which many other measurements may be made along the north coast of South America, furnishing material for extensive corrections of the charts of that region.

Having presented an outline of the work done so far, as well as that proposed for the near future, I will now mention some of the trials and tribulations, as well as the pleasures experienced in carrying out the object desired in an expedition of this kind. The greatest politeness and kindness have always been experienced from the officials and employees of the various telegraph companies over whose lines work has been carried on. The government officials of the foreign countries visited, have also invariably shown the utmost politeness, but sometimes this politeness has been visibly tinged with suspicion. The measurements in Peru and Chili were made amid the closing scenes of the war between the countries. Upon the arrival of the expedition in Lima, an interview was had with the Chilian Commander-in-Chief who had possession of the city, and permission was requested and readily granted to occupy a station in Arica. Upon arriving at the latter place some days after, the Chilian governor in charge was found to have instructions to facilitate the work, and readily granted permission to establish the observatory in a convenient locality, but flatly refused to allow a wire to be extended to the telegraph office, and also refused to forward to his immediate superior, a request that it might be allowed. He evidently supposed the party were emissaries of the United States, sent to treat secretly with conquered Peru, but how he expected this was to be done remains a secret. By a vigorous use of the telegraph in communicating with the U. S. Ministers to both Chili and Peru, his objections were silenced, and the wire was put up. The observatory at Arica was erected on the side of a hill to the windward of the town, because it afforded a clear view, and was less dirty than other eligible sites. It also was a safe position in case of a possible earthquake or tidal wave, by which Arica had already been twice visited with disastrous effect. In digging for a foundation for the transit pier, several mummies of the ancient Peruvians were unearthed at a depth of a foot. They had evidently belonged to the poorer class of people, as their wrappings were composed of coarse mats, instead of the fine cloth with which the wealthier people were usually interred. One was the body of a female with long hair, which had been turned to a reddish yellow color by the alkali in the soil. The whole coast of Peru is barren and desolate, except in the river valleys, it being seldom visited by rain, while it is nearly always overhung with heavy clouds and fog banks, which render astronomical work exceedingly difficult. Even when partially clear in the day time, it generally becomes cloudy at night. Many times the observer would be at his place before sunset ready to seize the first suitable star revealed by the darkness, only to be baffled by thick banks of cloud which would cover the entire sky in from five to ten minutes.

In northern Peru, with a latitude of about five degrees south, is the town of Paita. It is an assemblage of mud-colored houses, at the foot of high, mud colored bluffs. On top of these bluffs is a perfectly barren table land extending inland and up and down the coast for many miles. Before visiting it the observers were informed that its one good point was the perfect astronomical weather which always prevailed. Clouds were unknown, and such a thing as rain had never been heard of. The extreme dryness of the atmosphere was so favorable to health that no one ever died, and when a consumptive invalid was imported by the inhabitants in the hope of starting a cemetery, he blasted their expectations by recovering. Judge then of their feeling, when upon arriving at this delightful place, they were met with the information that while it was true that the sky was, in general, perfectly clear both by night and day, yet about once in seven years, rain could be expected, and that the year then present was the rainy one. And sure enough it did rain. The usually dusty streets became rivers and quagmires, the rocky valleys in the vicinity were transformed into roaring torrents, and the table land usually an arid desert became a swamp with a rank growth of vegetation. However by using every opportunity and snatching stars between clouds and showers the work was finally completed.

Upon arriving in Pânama shortly after this experience, the party was met with the pleasant intelligence that yellow fever was prevalent, and that the foreigners were dying like sheep. Nearly every day of the party's stay, some one died of sufficient importance to have the church bells tolled for his funeral, while of the ordinary people little notice was taken. Every morning, the writer remembers passing a carpenter's shop where nothing was made but coffins, and the supply was evidently not equal to the demand, for finally the proprietor began to import them, apparently by the ship load. The weather however was delightful, and the nights were the most perfect, astronomically speaking, that could be desired.

The observers who went from Japan to Vladivostok were obliged to wait several weeks at Nagasaki, before an opportunity offered for proceeding to their destination, and when they finally arrived, the getting away again was a problem. Communication with the outside world by water was only open during the summer months, and even then it was more accidental than otherwise. The party established the observatory however, and settled down to work, letting the future take care of itself. In the early part of the work, rather an amusing incident occurred. As the community was full of all sorts and conditions of men, Koreans, Chinamen and Russian exiles, the last not political but criminal offenders ; it was thought wise to have a sentry stationed at the observatory to guard against any possible harm to the instruments. So the Governor of the town was asked to furnish a soldier for that purpose, which request was readily granted, and one night the sentry was posted with orders to let no one touch the observatory. These orders he construed literally, and when the observers appeared to commence their night's work, he kept them off at the point of the bayonet. His only language being Russian with which the observers were not familiar, it was impossible to explain the true state of affairs, and it was only after hunting up an interpreter and communicating with his commanding officer that an entry was finally effected. A good deal of bad weather was experienced at this place, but at the end of six weeks enough observations had been made for the required purpose, and the party was fortunate enough to secure passage to Nagasaki, in a small steamer that had brought a load of coal out from Germany.

In the expedition to the Asiatic coast one of the most interesting experiences was the trip to Manila in the Philippine Islands. This is quite a large town when intact, but a great portion of it is usually in the condition of being shaken down by an earthquake or blown over by a typhoon. The inhabitants are full of energy, however, and find time between downfalls to build up again. The cable from Hong Kong lands at a point about one hundred and twenty miles from Manila, and the writer was directed to proceed thither, with a chronometer and chronograph for the purpose of transmitting time signals. The first part of the journey was made in a small coasting steamer uncommonly dirty, and occupied about thirty-six hours. At the end of that time the village of Sual in the Gulf of Lingayen was reached. This was distant from the cable station about thirty miles, and the remainder of the journey was made in a native boat, with mat sails, and bamboo outriggers, part of the time through channels between numerous small islands and for some distance in the open sea. The progress was slow, but it was a pleasant way of traveling, except for the sleeping accommodations which were primitive ; consisting of a palm leaf mat thrown over a platform made of split bamboo, in which all the knots had been carefully preserved.

About three days, including stoppages, were consumed in this thirty mile voyage, and the traveler finally reached his destination to be received with the greatest hospitality by the staff at the telegraph station, and just in time to allay the fears of the observers at Hong Kong and Manila who had begun to think him lost. About three weeks were spent here, and as the work only occupied a short time at night, the days were pleasantly passed in exploring the surrounding country, making friends with the natives, shooting and photographing the scenery. The return to Manila was by the same route and occupied nearly the same length of time.

The measurement from Singapore to Madras was over one of the longest lines of cable ever used for this purpose, the distance being about 1600 nautical miles. The Atlantic cables used by Dr. Gould in 1866 were a little more than 1,850 miles in length. There was an intermediate station at Penang about 400 miles from Singapore, where all the work of the line was repeated. For the longitude measurement however the cables were connected through to form an unbroken line. The mirror was the only instrument that could be used and even with this the signals were feeble and much affected by earth currents.

The observing parties have never been troubled by wild beasts, but while at Saigon in Cochin, China, a rifle was always kept handy for use in case of the appearance of a tiger. The observatory here was located near the edge of a jungle, and alongside the telegraph station, on the veranda of which a large tiger had been shot by one of the operators only a short time before.

In the expedition of last winter to Mexico and Central America, the principal annoyance was caused by insects which were numerous and malignant. At Coatzacoalcos they were found in the greatest abundance, though the whole isthmus of Tehuantepec is alive with them. Fleas and mosquitoes were expected of course, but added to this were numerous others much worse. Of the family of "ticks" four varieties were seen and felt, ranging in size from almost microscopic to a length of a third of an inch. The most numerous were about as large as a grain of mustard seed, and one who walked or rode through the bushes or high grass would find himself literally covered. One of the worst insects encountered was the "nigua" which is in appearance something like a small flea. It burrows into the toes and soles of the feet, lays a number of eggs, which hatch and produce painful sores. A gruesome story is current in that region, about an enthusiastic English naturalist, who found specimens of these encamped in his feet, and concluded to take them home in that way, in order to observe the effect, but died of them before reaching England. All the party were afflicted with these pests, but were always fortunate enough to discover them and dig them out with the point of a knife before any bad results were experienced. The village of Coatzacoalcos is prettily situated, the climate, especially in winter, is very agreeable and the river offers a commodious harbor, but as long as the insects are so unpleasant, few people will care to live there if they can avoid it.

There have been directly determined by these various expeditions, about forty secondary meridians. Many more positions depend upon these, so they may be said to have made a large addition to our accurate knowledge of the earth's surface. Telegraphic facilities are being constantly extended, and as the Bureau of Navigation has now a very complete outfit for this work, which only needs occasional repairs, it is hoped that it may be kept up for some time in the future.

REPORT—GEOGRAPHY OF THE LAND.

By Herbert G. Ogden.

In my annual report a year ago, I presented to you briefly our knowledge of the great geographic divisions of the world. It might be instructive to continue the subject this evening by relating the additional information we have acquired during the year; but as the items are not of great value and the most important are more in the form of rumors than of facts, I have restricted myself more to the interests of the western hemisphere, and particularly to those affecting the United States.

In Europe we have still the visions of war that have agitated her peoples for years past; the decapitation of the Turk, and division of his European empire to appease the ambition of "friendly powers." It is not until we pass by this civilized section and reach the far east, that we recognize the dawn of progress in the year; the birth of events that may in time increase the happiness and welfare of many people.

The influence of the United States in extending the principle so early enunciated, "that all men are born free and equal" has been most marked. The western hemisphere is virtually under the rule of men chosen by the people, and though we cannot claim that in all instances the result has been satisfactory, there has, nevertheless, been a steady advance; political disturbances have become less frequent and with prolonged tranquillity the arts of peace, commercial enterprise and internal improvements, have received an impetus that will wed more strongly the advocates of personal liberty to their ideal God.

Educated men in both hemispheres predict ultimate success or failure for our form of government and advance cogent arguments in support of the views they express. The complications of the great economic questions that confront us afford texts for arguments that cause many to doubt the wisdom of entrusting the welfare of a great nation to the votes of the masses; nevertheless, the people are firm in the belief that they can conduct their own affairs; and those whom they intrust with temporary power are seldom so short-sighted as not to realize that a violation of the trust will meet with certain retribution. Those appointed to govern must also be teachers, and if in the enthusiasm of a new creed it shall be shown they have taught the people error instead of truth, a national uprising sweeps them from control, and for a time conservatism becomes the guide. To the people of the old world, the apparent prosperity that has followed our system doubtless receives the most earnest thought; and the contrast to their own condition excites their desires to experiment themselves in more liberal forms, and reap the rewards they believe have followed such measures in America.

While American methods may extend their influence in this manner to European nations, and even to the nations of Asia, we should not rest self-confident of the superiority of our institutions, and that they alone are the permeating influence that inspire so many with the thoughts of liberal government that brings disquiet to crowned heads. The application of recent discoveries and inventions, to the affairs of every-day life, have raised the power of the individual and caused such a general increase of intellectual vigor, that independence of rulers by divine right is no longer a cause for wonder, but is considered by the intelligent as the natural state for the modern man.

Since the expedition of Com. Perry our influence in Japan has been marked, and this most progressive of the Eastern nations has sought counsel and advice from new America and the men who constitute the nation. But the progressive people of these isles have been too earnest in their efforts to advance, to rely solely upon one set of men, or the example of one nation, and we find they have been gathering in that which is good from all sections of the civilized world. The record of their progress, however, bears the stamp of America, and we may justly claim that it was the influence of freedom that first led these interesting people into the paths they have followed with such gratifying results, and which many believe will culminate in the establishment of a powerful and enlightened nation. Recent advices announce the formation of a legislative body, organized on the principle of the Congress of the United States—a step that indicates Japan may yet find a place in the category of states that are destined to exert a marked influence in the control of human affairs.

How different is the neighboring empire of China. Within a stone's throw, almost, of the advancing civilization of Japan, inhabited by a people of marked ability but restricted by race traditions to a condition of inactive conservatism, that seems almost to preclude the possibility of material advance in centuries to come. The population of this empire is so great that the density has been averaged at two and three hundred persons per square mile, and in some districts that it is as great as seven hundred. We can readily conceive the poverty that must exist in such an average population for such an extended area. And we may realize the cries of distress that come from great calamities by the experiences in our own history, even modified as they have been by our superior facilities for affording relief, and the comparative insignificance of the numbers who have required assistance. Recall for a moment one of the great floods of the Yellow river, where thousands have perished and tens of thousands have been rendered destitute within a few hours, and conceive the sufferings, hardships, and greater number that must yet succumb before those who survived the first great rush of the waters can be furnished relief; remembering that the means of intercommunication are the most primitive, and that the immediate neighbors of the sufferers are in no condition to render more assistance than will relieve the most urgent necessities of a comparatively insignificant number. May we not, then, if only from a humanitarian point of view, greet with pleasure the reception of the imperial decree authorizing the introduction in the empire of useful inventions of civilized man, and directing the construction of a great railroad through the heart of the empire, with Pekin as one of the termini. This road will cross the Yellow river, affording relief to this populous district in time of disaster; and it is understood will eventually be extended to traverse the empire, forming a means of rapid communication between distant provinces. We may believe, also, that in time it will be the medium of opening to us a new region for geographic research, not in the celestial empire alone, but also in the rich fields of central Asia that are now being occupied by Chinese emigration.

Doubtless the greatest geographic discoveries of the age have been made in central Africa. It was but a few years ago that we were in doubt as to the true sources of the Nile, and the location of the mouths of great rivers that had been followed in the interior, was as much a mystery as though the rivers had flowed into a heated cauldron and the waters had been dissipated in mist, by the winds, to the four corners of the earth. It was then that grave fears were aroused for the safety of Livingstone, who had done so much, and whose efforts it was hoped would yet solve the great geographic problems his travels had evolved. A man, patient in suffering, and with a tenacity of purpose that overcomes the greatest obstacles, he had endeared himself to those who sought knowledge from his labors, and it was, therefore, with unfeigned regret that men spoke of the possibility that calamity had overtaken him, and that the work of the last years of his life would possibly be lost. The editor of an influential New York journal, sympathizing with the deep interest that was felt, and doubtless actuated to some extent by the notoriety success would bring to his journal, determined upon organizing an expedition to ascertain Livingstone's fate, and thus brought before the world the hitherto obscure correspondent Henry M. Stanley. The rare good judgment that selected Mr. Stanley for the command of such a hazardous expedition was more than demonstrated by subsequent events. The first reports that Livingstone had been succored were received with incredulity, but as the facts became known incredulity gave way to unstinted praise, and Mr. Stanley was accorded a place among those who had justly earned a reward from the whole civilized world.

A few years after his return from his successful mission for the relief of Livingstone, he was commissioned in the joint interests of the *New York Herald* and *London Daily Telegraph,* to command an expedition for the exploration of central Africa. Traversing the continent from east to west, he added largely to our knowledge of the lake region and was the first to bring us facts of the course of the Congo. This expedition placed him before the world as one of the greatest of explorers, and it seems, therefore, to have been but natural that, when a great humanitarian expedition was to be organized nearly ten years later to penetrate into the still unknown regions of the equatorial belt for the relief of Emin Pasha, that he should have been selected to command it. How faithfully he performed this task we are only just learning, and our admiration increases with every new chapter that is placed before us. That he was successful in the main object of the expedition is self-evident, having brought Emin Pasha and the remnant of his followers to the coast with him. The expedition has also been fruitful in geographic details, and though we have not as yet the data to change the maps to accord with all the newly discovered facts, we may feel assured of their value. Perhaps the best summary of the more important discoveries can be given in the explorer's own words, which I have taken from one of his recent letters :

"Over and above the happy ending of our appointed duties we have not been unfortunate in geographical discoveries. The Aruwimi is now known from its source to its bourne. The great Congo forest, covering as large an area as France and the Iberian peninsula, we can now certify to be an absolute fact. The Mountains of the Moon, this time beyond the least doubt, have been located, and Ruwenzori, 'The Cloud King,' robed in eternal snow, has been seen and its flanks explored and some of its shoulders ascended, Mounts Gordon Bennett and MacKinnan Cones being but great sentries warding off the approach to the inner area of 'The Cloud King.'

"On the southeast of the range the connection between Albert Edward Nyanza and the Albert Nyanza has been discovered, and the extent of the former lake is now known for the first time. Range after range of mountains has been traversed, separated by such tracts of pasture lands as would make your cowboys out west mad with envy. And right under the burning equator we have fed on blackberries and bilberries and quenched our thirst with crystal water fresh from snow beds. We have also been able to add nearly six thousand square miles of water to Victoria Nyanza.

"Our naturalist will expatiate upon the new species of animals, birds and plants he has discovered. Our surgeon will tell what he knows of the climate and its amenities. It will take us all we know how to say what new store of knowledge has been gathered from this unexpected field of discoveries. I always suspected that in the central regions, between the equatorial lakes, something worth seeing would be found, but I was not prepared for such a harvest of new facts."

The exploration of Africa, however, has not been confined to the central belt. Expeditions have been developing the southern section of the continent ; the French have been active in the watershed of the Niger, and in the east there seems to have been a general advance of English, Germans, Portuguese and Italians. The latter, it is stated, have acquired several million square miles of territory in Mozambique, an acquisition that would indicate our maps have heretofore given this particular division of territory an area much too insignificant.

We also learn that Capt. Trevier, a French traveler, has crossed the continent by ascending the Congo to Stanley Falls, thence southeasterly through the lake region to the coast at some point in Mozambique, in a journey of eighteen months ; a journey that must bring us a harvest of new facts.

On the western hemisphere there has been considerable activity in a variety of interest, tending to develop the political, commercial and natural resources.

Four new states have been admitted to the American Union, and measures have been introduced in the Congress looking to the admission of two more. These acts mark an era in the progress of the great northwest significant of a national prosperity that a generation ago would have been deemed visionary. We have also to record a tentative union formed by the Central American states, that at the expiration of the term of ten years prescribed by the compact, we may hope will be solidified by a bond to make the union perpetual. In South America a bloodless revolution presented to the family of nations a new republic in the United States of Brazil. All thoughtful men must at least feel a throb of sympathy for Dom Pedro, who in a night lost the allegiance of his people and the rule of an empire. Sympathy, perhaps, that he does not crave, for history affords us no parallel of a monarch who taught his people liberalism, and knowing it could but lead to the downfall of his empire. It seems to be true, also, that although depriving him of power, the people whom he loved and ruled with such liberality, have not forgotten his many virtues, and that the Emperor Dom Pedro will be revered in republican Brazil as heartily as though his descendants had been permitted to inherit the empire. We cannot tell if the new order of affairs will prove permanent, but the education of the Brazilians in the belief that a republic was inevitable, gives strong grounds to hope the experiment of self-government will not be a failure. The influence the successful establishment of this republic is to exert in other parts of the world is a problem that has already brought new worries to the rulers of Europe, and not without a reason, for a republican America is an object lesson that the intelligence of the age will not be slow to learn.

The assembly of the "Three Americas Congress" in Washington, is also an event that may wield an influence in the future. Perhaps it may not be seen for years to come, but it lays the foundation for commercial and geographic developments that would redound to the credit of the western hemisphere.

We have seen during the year the virtual failure of the Panama Canal company ; for it is unreasonable to believe that a corporation so heavily involved with such a small proportion of its allotted labor accomplished, can secure the large sum that would be requisite to continue operations to completion. The failure of this company has imparted a fresh impetus to the Nicaragua scheme and ground was broken on this route in October last. As the Nicaragua route presents many natural advantages and is free from such stupendous engineering works as were contemplated at Panama, we may hope for its completion. The surveys were conducted with deliberation and have evidenced great skill on the part of those who supervised them, so that we may reasonably expect the construction will proceed with the same care, and resolve the question of success into the simple problem of cost.

A partial account has been furnished by Dr. Nansen of his journey across Greenland a year ago. The result will be disappointing to those who anticipated the discovery of open country with green fields and the general reversal of the Arctic conditions. He describes the region as being covered with a great shield of ice, dome-like in shape, and which he estimates to have a maximum thickness of six or seven thousand feet. For a great part of his journey he traveled at an elevation of about eight thousand feet, and the cold at times was so intense that he believes the temperature must have been at least 50° below zero on the Fahrenheit scale. No land was visible in the interior and he estimates the highest mountains must be covered with at least several hundred feet of snow ice. The expedition was one of great danger, and we may say was accomplished only through the good judgment of the explorer. The scientific results have not yet been considered, but the explorer suggests it is an excellent region to study an existing ice field, and estimates that persistent observations might prove productive of value in the science of meteorology.

The Canadians have been active during the year in the exploration of the vast territory to the northward of their supposed habitable regions. In the report of Dr. Dawson relating the result of his labors in the northwest, up to the date of its compilation, we find much that is new and a great deal that is of interest. We cannot enter into the details of his itinerary, but we may note as one fact that surely will excite surprise, the conclusion he reaches that there is a territory of about 60,000 square miles, the most part to the northward of the sixtieth parallel, in which agricultural pursuits may be successfully followed in conjunction with the natural development of the other resources of the territory. This does not imply that it may become an agricultural region, and should hardly be construed as more than a prediction that the pioneers who attempt to develop the region need not die of starvation.

We have also to record as a matter of interest in the Arctic region, the successful establishment of the two parties sent out by the United States to determine the location of the 141st meridian, the boundary line between Alaska and the British Provinces north of Mt. St. Elias. The parties are located on the Yukon and Porcupine rivers above their confluence at Ft. Yukon. They are well equipped, and it is expected they will explore a considerable territory and bring back with them valuable information beyond the special object of the expedition. Indeed, it may be said, this is but the beginning of a thorough examination of Alaskan territory, that will eventually form a basis for the demarkation of the international boundary. This country is full of surprises in its details, and whatever examinations are made must be thorough to be effective. Only recently, a small indentation, as it has been carried on the maps since Vancouver's time, and known as Holkham Bay, has been found to be a considerable body of water, extending back from Stephen's passage in two arms, each nearly thirty miles in length and nearly reaching the assumed location of the Alaska boundary. So perfectly is the bifurcation and extension of the arms hidden by islands, that it was only during the past summer when in the regular course of work the shores of the bay were to be traversed, that the extent of the bay became known.

The determination of the boundaries of the land areas on the surface of the earth has ever been a matter of the greatest interest to the students of geography. It was the incentive that led the daring navigators of old to undertake the perilous voyages that in these days read like romances ; and in the light of the more perfect knowledge we now have of the hidden dangers to which they were exposed, we may pass by their shortcomings in the admiration we must feel for their heroism and endurance. To these men we owe our first conception of the probable distribution of the areas of land and water, but the lines they gave us were only approximate ; and had not scientific effort followed in their tracks we may reasonably believe the progress of civilization would have been retarded by generations. True it is, also, that even to-day we have not that precise knowledge that is requisite for the safety of quick navigation, nor to calculate the possibility of the future improvement of undeveloped regions. The commerce of the world in coming years will demand the accuracy in the location of distant regions as great as we now have in civilized centres, for time will be too precious to lose a day of it in the precautions that the navigator must now follow in approaching undeveloped coasts. That these truths have guided those who seek to do their share for the future in the labor of the present, we have ample evidence in the activity of all civilized governments during the last century. It is a source of shame and infinite regret that our own government has done so little in this vast field : that the intelligence of our people has not been awakened to put forth their energy in so good a cause, that would eventually increase their own prosperity. But we have not been altogether inactive and complaint must be in the quantity, not the quality of our labors. The establishment of "definite locations," for the control of sections and regions, is the first step in eliminating errors that have been committed and in providing greater accuracy in the future. At a recent meeting of the Society we had a paper presented on this subject, from which we can judge of the good work that has been done by our navy in these determinations, and gain an insight of the similar labor that has been prosecuted by other nations. The bands of electric cables that girdle the earth, afford the most approved means of ascertaining the longitudes of these positions ; and if we but study a cable chart, it will be found the work yet to be accomplished before the facilities the cables now afford are exhausted, is not inconsiderable. We hope, therefore, this good work may be continued, and that surveying and charting the regions thus approached, will shortly follow. There is much labor of this character still required on our own continent, and we will be delinquent in our duty as a progressive people if we do not follow the good beginning already made to its legitimate conclusion.

The duties of government are manifold, and for the benefit of those governed must include legislation that will make manifest the natural resources of the State. The geographic development and political advancement of our own country in the century of our national existence, is a marked instance of the wisdom of preparing for the future by such acts as legitimately fall within the province of legislation.

The new nation began her existence under extraordinary circumstances. With only an experimental form of government, she was to develop a vast region of unknown resources; but happily imbued with the belief that "knowledge is power," it was not long before systematic efforts were put forth to learn the wealth we had and how it might be utilized. The congress of the confederation provided the first act in 1785, for the organization of the land surveys and land parcelling system, that title to the unoccupied territories in the west might be securely vested in the individual. We have record of the stimulus this act gave to the settlement of a large territory, and raised the demand for surveys in the still further west, developing the geography of a vast region that has since become the home of millions of people. The original act was amended as early as 1796, and since then has frequently been added to in the effort to meet the new conditions evolved in the rapid development of the country. Other great regions were explored by the army, sometimes under special acts, until finally we had learned with some degree of reliability, the general adaptability of our whole territory. The discovery of the great mineral wealth of the west, and the improved means of communication afforded by the construction of continental railways, however, imposed new conditions and it was found more detailed information would be necessary to meet the demands of the increasing population. We thus reached another stage where expeditions equipped for scientific investigation were organized, and through their labors brought us knowledge of still greater value; and to-day we see these merged into one body in the geological survey, whose special duty is the scientific exploration and study of our great territory.

While this had been passing in the interior, bringing life to unoccupied regions, the districts on the coast that had long been settled, were also struggling with new problems. The material progress of the civilized world, and the pressure from the regions behind them that had been recently peopled, demanded greater commercial facilities. Early in the century, almost coincident with the establishment of the land surveys, provision had been made for the survey of the coasts, and although through various causes it was not vigorously prosecuted until a third of the century had passed, when the time came for its economic use in meeting the new conditions imposed by the general progress of the nation, the knowledge had been gained that was essential to advance and develop the great interests affected. The improvements required, however, could only be secured through active exertion, the actual work of man ; but so pressing has been the want and so persistent has been the labor, that should we chart the results it would be a surprise to those who believe the "local geography" has not been changed.

The demands upon the older communities arising from the increase in commercial and industrial enterprise, have caused them too, to feel the want of more detailed information of their surroundings, and they have, in consequence, undertaken more precise surveys of their territories, generally availing themselves of the assistance offered by the general government. This work will doubtless extend in time to all the States, and be followed, when its value has been made manifest, by the detailed surveys of precision that have been found necessary as economic measures in the civilized States of the old world.

It is rarely we can foresee the full results of great national enterprises ; the special object that calls forth the exertion may be readily comprehended, but the new conditions evolved from success, and sometimes from only the partial accomplishment of the original design, may be factors in governing the future beyond our power to surmise.

The work of improving the navigation of the Mississippi River, is an instance of this character so marked, and apparently destined to extend its influence through so many generations, that a brief record of the change it has effected in geographic environment will not be without interest, and, perchance, not without value.

The area drained by the Mississippi river and tributaries, is forty-one per cent. of the area of the United States, exclusive of Alaska ; and by the census of 1880 the population of this great district was forty-three per cent. of the whole Union. It seems probable that a large proportion of this population is directly interested in the river system, and if we add to it the number of those who are indirectly benefited, we should doubtless find a majority of our people more or less dependent upon its maintenance. It is only to the alluvial valley, however, the great strip from Cairo to the Gulf, that I wish particularly to call your attention this evening. This is really the great highway for traffic ; the cause of the great work that has been prosecuted ; and the scene of the geographic development that will mark an epoch in the history of the river.

Ten years ago the importance of the improvement of this water-way was so forcibly impressed upon Congress, that an act was passed organizing a "Mississippi River Commission," to make an exhaustive study of the whole subject and submit plans for the improvement of the river and to prevent the destructive floods that are of almost annual occurrence. Or in the language of the act: "It shall be the duty of said Commission to take into consideration and mature such plan or plans, and estimates, as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi river; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service."

Large sums of money had already been expended by the general government in local improvements, but no consistent plan had been developed that would be an acceptable guide in conducting operations along the whole river, when this act went into effect. It is not necessary to refer here to the various systems that were presented to the Commission for consideration; nor to enter upon the details of the plan finally adopted; our record being more the effects and primary causes, than the intermediary processes through which the results have been produced. The general plan followed by the Commission has been the construction of works in the bed of the river, to form new banks where a contraction of the river bed has been deemed necessary; and the erection of levees, with grading, revetment, and other protection of the banks, in localities where the natural banks seem particularly liable to give way under the pressure of a great flood. The object of such works being to control the river by confining the low water channels in fixed lines, causing the recurrence of the scour in low water stages in the same channel in successive low waters; and preventing the diversion of the stream into new channels during high water stages by overflow of the banks. A diversion of the stream would leave the works in the bed of the river below of no greater value than as monuments to the energy and skill displayed in the details of their construction, and preclude the ultimate benefit that may be derived from these works in permanently lowering the bed of the river. The probability of such diversion of the water, however, seems to have been reduced to a minimum, through the conservative action of the Commission in coöperating with the States having jurisdiction over the alluvial bottoms, in reorganizing their levee systems and thus securing the greatest control over the volume of water brought down in the flood seasons, that is possible by the construction of well planned and substantially built levees. It having been demonstrated that the levees subserve a double purpose, that they are essential in the general plan to improve the navigation of the river adopted by the Commission, and are likewise needed to render the bottom lands habitable, it is not surprising that we find the State authorities and the Commission jointly engaged in their construction.

It has thus been brought about that the effort to improve the navigation of the river for the general welfare, has resulted in such great changes in the geography of the locality, that a large district has been reclaimed for agricultural purposes. The alluvial valley of the Mississippi river has an area of thirty thousand square miles, and is naturally divided into four great basins that have been designated the St. Francis, Yazoo, Tensas and Atchafalaya. Two of these basins are now fairly protected from the overflows of the Mississippi, by the levees that have been constructed, or repaired, incidental to the work of the Commission, viz: the Yazoo basin extending from below Memphis to the mouth of the Yazoo river; and the Tensas basin from the high land south of the Arkansas river to the mouth of the Red river; and the Atchafalaya basin, from the Red river to the gulf, has been protected on the Mississippi fronts. These three basins have an aggregate area of nearly twenty thousand square miles that is now reasonably secure from inundation. Measures have also been instituted by the State authorities looking to the reclamation of the St. Francis basin; and the work is half accomplished on the White river section.

Nearly the whole of this valley was under protection thirty years ago, but the disasters of the late civil war, and subsequent inability of the people to repair the damaged levees, resulted in the practical abandonment of many sections, and it was not until about ten or twelve years ago that the protective works again presented an appearance of continuity. The supposed security, however, was of short duration, as the great floods of 1882 overtopped the works in more than one hundred and forty places, causing such widespread destruction that cultivation of the soil was rendered impossible over large districts. The floods of succeeding years but added to the misfortunes of the valley, and land values became so depreciated that sales were impracticable, taxes could not be collected, and there was a general feeling that square miles of fertile land must be given over to the destructive agencies of the great river that had made it.

It was while suffering under this distressing situation that the work of the Mississippi River Commission was brought forward as a possible means of salvation. With a recuperative power that seems almost marvelous, the people have contributed of their labor and their means, until now this great area of nearly twenty thousand square miles has been once more reclaimed, and seems to have entered upon an era of prosperity that will eclipse the prophecies of even the most sanguine. It is believed that the levees that have now been constructed will prove reasonably secure. They have been built for a double purpose; and the proportion of the expense incurred by the general government, about one-third, under the direction of the Commission, has insured a supervision and inspection by competent engineers such as was not exercised in the earlier history of such works on the river.

We cannot foretell the developments that will follow the improvement of this water way and the reclamation of the alluvial bottoms on an enduring basis. That the works erected by the Commission will maintain an increased depth of water at the low stages of the river, seems to be demonstrated, as during the low water of November last a depth of nine feet was found on the Lake Providence and Plum Point bars, an increase of thirty-three and forty-four per cent. respectively. When the depths on the other bars have been increased in like proportion the free navigation of the river will be assured, and we may point to the result as one of the greatest engineering achievements of modern times.

The increased value of the land adjacent to the river redeemed from waste, more than doubled on the average, and in many instances quadrupled; the replenishing of the state and county treasuries by the collection of taxes on land that was before unremunerative; and the building of railroads through sections where it had been impracticable to maintain them before in consequence of their liability to destruction by the periodic floods; are marked evidences of the material prosperity that has already followed the great work. During the last four years, forty thousand settlers have taken up lands in the Yazos basin alone, and it was estimated that in the fall of 1889 twenty thousand more would seek homes in the same district. These settlers have been mostly negroes from the worn out high lands to the eastward. If the change in their environment proves beneficial to the individual we may expect an increased migration, that may in turn be an aid in solving the political problem involved in the citizenship of the negro.

The settlement of these bottom lands will also influence the prosperity of many commercial centers, as trade statistics indicate the general abandonment of the plantations that followed the great floods of 1882, caused a marked diminution in the shipments by the lower river, as well as in the receipts from that section; and that the partial reclamation of the lands and restoration of agricultural pursuits has already influenced the receipt and distribution of commercial products.

The project to reclaim by irrigation large districts of the arid region of the west, if successfully accomplished, may also exert an influence in the political and commercial relations of the future that cannot now be foretold. Two-fifths of the territory of the United States has been classed as arid; not in the sense that there is no water, for the greatest rivers on the continent have their sources almost in the midst of the region; but rather that the water is not available for enriching the ground. The rainfall is generally not in the season when the crops would require it, or is too small and uncertain for the husbandman to depend upon it. The whole region is not of this character; many districts are susceptible of the highest cultivation as nature has left them, and others have been redeemed by the application of the water supply through the simpler devices customary in irrigated countries; until now nearly all the districts have been occupied that are susceptible of agricultural pursuits, either in the natural state or by irrigation, unless water is secured by means generally beyond the reach of the individual or combination of individuals who may use it. And yet, it is believed there are millions of acres of rich land that may be redeemed and converted to the support of a large population, by the application of capital in the construction of works of irrigation. The progress of the surveys of the region, therefore, that have been instituted by the general government, are watched with absorbing interest. The districts susceptible of such extensive improvement are only approximately known, and as it is only through these surveys their availability will be made manifest, the importance of the work can hardly be overestimated. The prosperity of several states will be largely influenced by the success of operations of this kind within their borders, and in turn their greater development and increased wealth, must react upon the older communities and benefit them, on the principle that the healthful growth of a single member is strength to all.

The science of geography, as taught in the present day, is more comprehensive than the brief descriptions and delineations of the areas of land and water that satisfied the early explorers. The great strides that have been made in scientific research during the past century have opened new fields, and men are no longer content to picture that only which they can see. The varied features of the earth's surface, transformations now in progress and those which may be deduced from the facts we can observe, have led to many theories of the construction of the earth, ancient forms upon the surface and possibilities, if not probabilities, in the future. To ascertain the form of the earth has alone been the cause of heroic labor, and yet we have hardly passed the point that we can give it in probable terms with the general dimensions. Observations warrant the assumption that, discarding the accidents of nature—even the highest mountains—the sphere is far from being perfect. That it is flattened at the poles is now accepted as the true condition, but we have reason to believe, too, that this is not the only departure from the perfect sphere. The more thorough the research and precise the observations, the more certain does it appear that the crust has a form as though there had been great waves of matter that had been solidified. To locate the depressions of these great waves and measure their depths, to point to the crests and measure their extent, is a problem for the future to solve. Their study is claimed to be within the legitimate sphere of geography; and not until they have been satisfactorily answered can we assert the geographer is even approaching the end of the facts his science has yet to utilize.

In pre-historic geography we have had two papers presented to the Society during the past year, relating to the orographic features of the earth's surface in times past compared with the localities as we may see them to-day. In the first instance the comparison is evolved from an effort to trace the origin and growth of the rivers of Pennsylvania; and the second, in a description of the famed district around Asheville, North Carolina. These have a substantial interest to us, treating as they do of localities so well known ; and they illustrate, too, the resources of induction in bringing to our view the probable wonders of ancient geographic forms.

The constitution of the interior of the earth is a subject of great interest in the science of geography, as many of the visible forms upon the crust have been wrought by the power of the agencies within it. The discussion has been warm in the past, and doubtless will be resumed with unabated interest as we find new phenomena for the argument. The apparent lull that has followed the promulgation of the theory, three years ago, that under the crust we should find a fluid, or semi-fluid, surrounding a solid nucleus, may not be of long duration. This hypothesis probably comes nearer to satisfying the conditions imposed by the physicist and geologist, than those which have preceded it, and may be accepted for the present ; unless the processes of nature by which it is conceived this state of the interior of the earth has been produced, shall be demonstrated to have continued for sufficient time to have caused a condition of equilibrium and possible solidification of the whole sphere ; when we might expect it to be repudiated by those who oppose the theory of isostacy, but commended by the physicists as supporting their claim that the earth must be substantially a solid even now. If we accept Mr. Frederick Wright's suggestion, isostacy may have an important bearing on the cause of the ice sheets that covered such great areas ; a suggestion that opens to the vision of the imagination an orography beside which the grandest landscape we may see to-day would pale into insignificance. This is believed to be a new application of the isostatic theory, and may be a possible solution of a much vexed question when an initial cause for such great upheavals can be advanced that will not be inconsistent with other accepted conditions.

Theories are modified by new facts, and in any attempt to demonstrate the constitution of the interior of the earth, the increase of temperature with the depth is an important factor. The recent measures, therefore, in Germany, that indicate the figures generally accepted are not reliable, may be received with interest. The shaft was sunk especially for the purpose of observing temperatures at different depths, and every precaution that former experience had suggested seems to have been taken to secure accuracy. The greatest depth reached was about one mile. An elaborate discussion of the results fixes the increase of temperature at 1° F. for each 65 ft. increase of depth. This is about 15 ft. greater than the figures that have heretofore been given ; a difference so large that we may question if they will be generally accepted until verified by further observations made with equally great care.

In conclusion permit me to note the fact that the United States was for the first time represented in the International Geodetic Association, at the meeting recently held in Paris ; and also to record the successful conclusion of the fourth International Geographical Congress that assembled in Paris in August last. The reports from the Congress indicate a wide range of subjects discussed, and lead us to believe the interest in our science is progressive, and must receive the hearty appreciation of all who are inspired by the nobler instincts to develope the great sphere on which we live ; that the riches, the beauties, and above all the grandeur of Nature, may be made manifest to ourselves and for our posterity.

REPORT—GEOGRAPHY OF THE AIR.

By Gen. A. W. Greely.

It is with a feeling of increased responsibility, shared doubtless by the Presidents of other sections, that the Vice-President of the Geography of the Air brings before you his modest annual contribution in one branch of geographical science.

We live in an age so imbued with earnest thought, and so characterized by patient investigation, that an eager gleaner in scientific fields finds at the very outset his mind filled with the garnered grain of golden facts. The more cautious searcher often follows with uncertain mind, and doubtless in his backward glances sees many fairer and heavier sheaves than those he bears with full arms, from the fruitful harvest. If, then, you do not find here dwelt on such geographical phases as you judge most important, attribute the fact I pray you, not to neglect, but to lack of observation, or to the exercise of an undiscriminating judgment.

First let us turn to the higher class of investigations, wherein that handmaid of science, a true and noble imagination, comes to supplement exact knowledge, to round out and give full form and perfect outline, either shaping a number of disjointed and apparently heterogeneous facts into a harmonious series, or evolving from a mass of confusing and seemingly inexplicable phenomena a theory or law consistent therewith.

In this domain Professor Ferrel's book on Winds is probably the most important theoretical meteorological discussion of the past year. It owes its value to the fact that it puts into comparatively simple and popular form the processes and results of his intricate mathematical investigations of the motions of the air, published by him years since, and later elaborated during his service with the Signal Office.

In connection with the subject of winds, Professor William M. Davis has formulated an excellent classification, depending first, on the ultimate source of the energy causing the motion ; second, on temperature contrasts which produce and maintain winds ;

and third, on their periodicity and the time of the first appearance of the motion.

Professor Russell, appropriately it seems to me, remarks regarding the landslide winds, that avalanche would be a better term than landslide as applied to winds associated with fallen masses of earth or snow.

With the enormous amounts of accumulated tabulated matter, and numerous studies bearing on isolated meteorological phenomena, it is a specially important consideration that some students pay constant attention to the investigations of the laws of storms. From such researches definite advances in theoretical meteorology may be made and fixed laws determined, which may be of practical utility with reference to the better forecasting of the weather. In the United States Signal Office, Professor Abbe has brought together the results of his studies and investigations for the past thirty years, under the title, "Preparatory studies for Deductive Methods in Storm and Weather Predictions." This report will appear as an appendix to the annual report of the Chief Signal Officer of the army. Professor Abbe finds that the source and maintaining power of storms depend on the absorption by clouds of solar heat, and in the liberation of heat in the cloud during the subsequent precipitation, which, as he endeavors to show, principally influences the movement of the storm-centre.

In this method one takes a chart showing current meteorological conditions, and the permanent orographic features of the continent; lines of equal density are also drawn for planes at several elevations above sea-level. On these latter, and on the lines of the orographic resistance, are based intermediate lines of flow, which show where conditions are favorable to cooling and condensation. The amount of condensation and its character, whether rain or snow, are estimated by the help of the graphic diagram. Numbers are thus furnished that can be entered on the chart and show at once the character of the new centre of buoyancy, or the directions and velocity of progress of the centre of the indraft and the consequent low barometer.

It is hoped that this work of Professor Abbe's may be, as he anticipates, of great practical as well as theoretical value. Steps are being taken to test the theoretical scheme by practical and exhaustive applications to current work.

Tiesserenc de Bort has continued his work, of improving weather forecasts for France, by studying the distribution of the great and important centres of high pressures, which prevail generally over the middle Atlantic ocean, and, at certain periods of the year, over Asia, Europe, and North America. His studies have proceeded on the theory that the displacements of centres of high pressure, whether in Asia, over the Azores, near Bermuda, in North America, or in the Polar regions, set up a series of secondary displacements, which necessarily cause storm centres to follow certain routes. M. de Bort concludes that a daily knowledge of the relation of these centres and their areas of displacement will eventually enable skilled meteorologists to deduce the position of unknown and secondary centres. He has endeavored to reduce these various displacements to a series of types and has made very considerable progress in this classification. Daily charts covering many years of observations have been prepared, and these separated, whenever the characteristics are sufficiently pronounced, into corresponding types. This plan of forecasting necessitates extended meteorological information daily, which France obtains not only from Russia, Algeria, Italy and Great Britain, but, through the coöperation of United States, from North America. The daily information sent by the Signal Office shows, in addition to the general weather over the United States and Canada, the conditions on the western half of the North Atlantic ocean, as determined by observations made on the great steamships, and furnished voluntarily by their officers to the Signal Office through the Hydrographic Office and the New York Herald weather bureau.

The study of thunder storms has received very elaborate and extensive consideration. M. Ciro Ferari in Italy finds that almost invariably the storms come from directions between north and northwest, the tendency in northern Italy being directly from the west, and in the more southern sections from the northwest. The velocities of storm movements are much greater from the west than from the east, considerably more so in the centre and south of Italy than in the north ; and in the months, largest in July.

The velocity of propagation increases with greater velocities of the winds accompanying the storms, with also greater attendant electrical intensity. The front line of propagation while more often curved, is sometimes straight and sometimes zigzag, and appears to undergo a series of successive transformations, more or less affected by the topographical nature of the country passed over.

Ferari thinks their principal cause is to be found in high temperatures coincident with high vapor pressures. Thunder storms, he considers, are essentially local phenomena, superposed on the general atmospheric phenomena. A principal general cause of thunder-storms in Italy is the existence of a deep depression in northwest Europe, with a secondary depression in Italy dependent on the first. This secondary feeble area remains for several days over upper Italy, and nearly always is followed by thunder storms. Minimum relative humidity precedes, and maximum follows a storm, while the vapor pressure conditions are exactly reversed. Ferari notes, as one matter of interest, the passage of fully developed thunder storms from France into Italy over mountains 4,000 metres (13,000 feet) in elevation.

Dr. Meyer, at Gottingen, has investigated the annual periodicity of thunder storms, while Carl Prohaska has made a statistical study of similar storms in the German and Austrian Alps. The latter writer thinks they are most likely to occur when the barometer is beginning to rise after a fall, thus resembling heavy down-pours of rain.

In connection with Schmucher's theory on the origin of thunder storm electricity, Dr. Less has been able to satisfactorily answer in the affirmative an important point in the theory, as to whether the vertical decrement of temperature is especially rapid. Less finds evidences of very rapid decrement of temperature during thunder storms, as shown by the examination of records of 120 stations for ten years.

Mohn and Hildebrandsson have also published a work on the thunder storms of the Scandinavian peninsula. The rise in the barometer at the beginning of rain, they agree with Mascart in attributing largely to the formation of vapor and the evaporation of moisture from rain falling through relatively dry air.

A. Croffins has discussed thunder storms at Hamberg from observations for ten years. He believes that all such storms are due to the mechanical interaction of at least two barometric depressions.

As a matter of interest bearing on the much discussed phenomena of globular lightning, an incident is recounted by F. Roth, where a man feeding a horse was struck by lightning and lost consciousness. The man states that he felt no shock, but was suddenly enveloped in light and that a ball of fire the size of his fist, traveled along the horse's neck. This points to the fact that "ball" lightning is probably a physiological phenomenon.

In view of the recent extended interest in the question as to whether the climate of the United States is permanently changing, it should be remarked that this question has lately been under consideration with regard to Europe. Messrs. Ferrel, Richter, Lang, Bruchen and others conclude, from an examination of all available data, that there is no permanent climatic change in Europe. In connection with this discussion in Europe, long series of vintage records, going back to the year 1400, have been used. Apart from the ocean borders, extensive simultaneous climatic changes occur over extended areas, which changes—as might be expected—are more accentuated in the interior of the continents. These changes involve barometric pressure, rainfall and temperature, which all recur to that indefinite and complex phenomenon—the variation in the amount of heat received by the earth. The idea is advanced that these oscillations have somewhat the semblance of cycles, the period of which is thirty-six years. It may easily be questioned, however, in view of the fragmentary and heterogeneous character of the data on which this assumption is based, whether the error in the observations is not greater than the range of variation. Blanford, in one of his discussions, has pointed out that the temperature or rainfall data in India can be so arranged as to give a cycle with a period of almost any number of years, but, unfortunately, the possible error of observation is greater in value than the variations.

As to the United States, it is pertinent to remark that the Signal Office is in possession of temperature observations in Philadelphia, covering a continuous period of one hundred and thirty-two years. The mean annual temperature for the past ten years is exactly the same as for the entire period.

There have been criticisms in years past that the climatological conditions of the United States have not received that care and attention which their importance demanded. Much has been done to remedy defects in this respect, although, as is well known here in Washington, the general law which forbids the printing of any works without the direct authority of Congress, has been an obvious bar to great activity on the part of the Signal Office.

Within the year the rainfall conditions of twelve Western States and Territories have been published with elaborate tables of data and fifteen large charts, which set forth in considerable detail the rainfall conditions for that section of the country. In addition the climatic characteristics of Oregon and Washington have been graphically represented; and rainfall maps,—unfortunately on a small scale,—have been prepared, showing for each month, the average precipitation of the entire United States, as determined from observations covering periods varying from fifteen to eighteen years.

In Missouri, Professor Nipher has prepared normal rainfall charts for that State, unfortunately on rather a small scale. In New York, Professor Fuertes, and in Michigan, Sergeant Conger, of the Signal Service, have commenced maps showing, by months, the normal temperatures of their respective States on maps of fairly open scale. Work of a similar character has been carried on in Pennsylvania under the supervision of Professor Blodget, well known from his climatological work. In other directions and in other ways, work of a similar character is in progress.

Without doubt too much is anticipated from pending or projected irrigation enterprises in the very arid regions of the West. These unwarranted expectations must in part result from a failure on the part of the investors to consider the general question of these enterprises, in its varied aspects, with that scientific exactness so essential in dealing theoretically with extended subjects of such great importance.

Everyone admits the correctness of the statement that the amount of water which flows through drainage channels to the sea, cannot exceed the amount which has evaporated from adjacent oceans and fallen as precipitation on the land. Further it is not to be denied that the quantity of water available in any way for irrigation must be only a very moderate percentage of the total rainfall which occurs at elevations *above*, and perhaps it may be stated *considerably above*, that of the land to be benefited.

Elsewhere it might be appropriate to dwell in detail upon the importance of cultivated land in serving as a reservoir which parts slowly with the water fallen upon or diverted to it, and in avoiding the quick and wasteful drainage which obtains in sections devoid of extensive vegetation or cultivation; and also that water thus taken up by cultivated lands must later evaporate and may again fall as rain on other land. But the pertinence of meteorological investigations in connection with irrigation and this annual address, relates much more directly to important questions of the manner by, and extent to which, precipitation over the catchment basins of the great central valleys fails to return in direct and visible form, through the water courses, to the Gulf of Mexico.

The inter-relation of rainfall and river outflows is one of peculiar interest, in connection with the important matter of irrigation now under consideration in this country.

Probably more attention has been paid to this subject in the valley of the Seine, by Belgrand and Chateaublanc, than in any other portion of the globe. One of the curious outcomes of Chateaublanc's observations, is one bearing on the maximum value of the floods in the Seine for the cold season, from October to May, by which he says that the reading of the river gauge at Port Royal is equal to 12.7 minus the number of decimetres of rainfall which has fallen on an average throughout the catchment basin during the preceding year. This curiously shows that the intensity of the winter floods of the Seine is inversely proportional to the quantity of rain of the *preceding* year.

Sometime since, John Murray, Esq., in the Scottish Geographic Magazine, treated generally the question of rainfall and river outflows. The annual rainfall of the globe was estimated to be 29,350 cubic miles, of which 2,343, falling on inland drainage areas, such as the Sahara desert, etc., evaporate. The total annual discharge of rivers was estimated at 7,270 cubic miles. In the case of European drainage areas between a third and a fourth of the rainfall reaches the sea through the rivers. The Nile delivers only one thirty-seventh of the rainfall of its catchment basin, while tropical rivers in general deliver one-fifth.

The Saale river of Germany, from late data based on 45 rainfall stations in its catchment basin, during the years 1883 to 1886, discharged 30 per cent. of its rainfall.

During the past year Professor Russell, of the Signal Office, has determined carefully the rainfall and river outflow over the most important part of the United States, the entire catchment basin of the Mississippi river and its tributaries. This work was done as preliminary to formulating rules for forecasting the stage of the water several days in advance on the more important of the western rivers in the United States. The river outflows at various places on the Mississippi and Missouri and Ohio rivers, were tabulated from data given in the reports of the Mississippi and Missouri River Commissions. The tables were largely derived from the results of the measurement of current velocities. As gauge readings were taken at the time of discharge or outflow measurements, the discharges or outflows can be told approximately at other times when only the river gauge readings are known. The results for the outflow of rivers derived from measurements made under the supervision of these commissions, are of a high order of accuracy, and it is not probable that the results deduced from the gauge readings are much in error. Of 1881 and 1882, during which years measurements were made, 1881 was a year of great flood in the Missouri river, while the Mississippi river was not flooded. The year 1882, on the other hand, was marked by a great flood in the lower Mississippi river, with a stage in the Missouri much above the average. The rainfall in the six great valleys of the Mississippi, during the entire years 1881 and 1882, was charted from all observations available, and its amount in cubic miles of water calculated with the aid of a planimeter.

In connection with this investigation, and as a matter of value in showing the forces which are in operation to affect the river outflow, the fictitious or possible evaporation of the six great valleys referred to were calculated, in cubic miles of water, from July, 1887, to July, 1888, and also the average amounts of water in the air as vapor, and the amount required to saturate the air in the same valleys during the same period.

During the year 1882, the year of great flood in the lower Mississippi valley, the outflow at Red River Landing, La., was 202.7 cubic miles, of which the upper Mississippi river above St. Louis furnished 16 per cent., the Ohio 43, and the whole Missouri above Omaha, 4 per cent. The upper Missouri valley (that is, from the mouth of the Yellowstone up to the sources), and the middle Missouri valley (from the mouth of the Platte to the Yellowstone), each furnished only about 2 per cent. of the entire amount of the water which passed Red River Landing. The lower Mississippi valley, including the Arkansas, etc., furnished 32 per cent.

During March, April and May, 1882, the time of highest stage of the water of the lower Mississippi, the outflow at Red River Landing and through the Atchafalya measured 82.7 cubic miles.

During this time there flowed through the upper Mississippi river above St. Louis, 14 per cent. of the amount; through the Ohio, 38 per cent., and through the Missouri 6 per cent.; while the rivers of the lower Mississippi valley contributed 41 per cent. The water that passed Omaha was 1.92 cubic miles, or 2 per cent. of the flow of the whole Mississippi during the same time. The water which flowed from the upper and middle Missouri valleys during March, April and May, 1882, was for each valley, probably only 1 per cent. of the water that flowed through the lower Mississippi river. The flood of the lower Mississippi was undoubtedly due to the great discharge of the Ohio, supplemented by heavy river inflow below the mouth of the Ohio, and the unusually heavy rainfall in the lower Mississippi valley.

The ratios of river outflow to rainfall over the catchment basins, as derived by Professor Russell from the two years' observations, 1881 and 1882, were as follows:

Upper and Middle Missouri valleys, about 335,000 square miles, 13 per cent.

Lower Missouri valley, about 210,000 square miles, 12 per cent.

Entire Missouri valley, about 545,000 square miles, nearly 13 per cent.

The upper Mississippi valley, about 172,000 square miles, 33 per cent.

Ohio valley, about 212,000 square miles, 40 per cent.

Lower Mississippi valley, about 343,000 square miles, about 27 per cent.

The above percentages, while showing the averages for two entire years, and so of decided value, are not to be depended upon for special years or months. For instance: in the Ohio valley in 1881, the outflow was 33 per cent., while in 1882 it was 50 per cent., and as the rainfall in 1882 was 180 cubic miles against 151 cubic miles in 1881, it appears evident that a much greater proportional quantity of water reaches the rivers during seasons of heavy rainfalls than when the precipitation is moderate or scanty.

Evaporation is also a very potent cause in diminishing river outflow, and as this depends largely on the temperature of the air and the velocity of the wind, any marked deviation of these meteorological elements from the normal, must exercise an important influence on the ratio of outflow to rainfall.

In connection with Professor Russell's work it is desirable to note that Professor F. E. Nipher has lately made a report on the Missouri rainfall based on observations for the ten years ending December, 1887, in which he points out as an interesting coincidence that the average annual discharge of the Missouri river closely corresponds in amount to the rainfall which falls over the State of Missouri. From Professor Nipher's figures it appears that the discharge of the Missouri river in the ten years ending 1887, was greatest in 1881 and next greatest in 1882, so that the averages deduced from Professor Russell's report of the outflow of the Missouri are too large, and should be somewhat reduced to conform to the average conditions. In different years the average of the discharge in the outflow of the Missouri varies largely, as is evidenced by the fact reported by Professor Nipher, that the discharge in 1879 was only 56 per cent. of the outflow in 1881.

In New South Wales, under the supervision of H. C. Russell, Esq., government astronomer, the question of rainfall and river discharge has also received careful attention, especially in connection with evaporation. The observations at Lake George are important, owing to the shallowness of the lake (particularly at the margin); its considerable surface area (eighty square miles), its moderate elevation (2,200 feet), and the fact that it is quite surrounded by high lands. Observations of the fluctuations of this lake have been made from 1885 to 1888, inclusive. In the latter year the evaporation was enormous, being 47.7 inches against a rainfall of 23.9 and an in-drainage of 5.3 inches, so that the total loss in depth was 18.5 inches for the year. It appears that the evaporation in different years on this lake varies as much as 50 per centum of the minimum amount. According to Russell the amount of evaporation depends largely on the state of the soil, going on much faster from a wet surface of the ground than from water; with dry ground the conditions are reversed. In 1887, the outflow from the basin of Lake George, the drainage from which is not subject to loss by long river channels, was only 3.12 per centum of the rainfall.

In the Darling river, above Bourke, says Russell, the rainfall is measured by 219 gauges. The average river discharge, deduced from observations covering seven years, is only 1.45 per centum of the rainfall, and in the wettest year known the discharge amounted only to 2.33 per centum of the rainfall, and has been as low as 0.09 per centum in a very dry year. In the Murray basin the average discharge relative to the rainfall is estimated to be about 27 per centum from a record of seven years, and has risen as high as 36 per centum in a flood year.

In connection with the regimen of rivers, it appears a proper occasion to again refute the popular opinion that the spring and summer floods of the Missouri and Mississippi valleys result from the melting of the winter snows. This is an erroneous impression which I have combatted since 1873, when my duties required a study of the floods of the entire Mississippi catchment basin. It is only within the last two years, however, that the meteorological data has been in such condition that the opinion put forth by me could be verified, namely: that the floods of the late spring and early summer owe their origin almost entirely to the heavy rains immediately before and during the flood period. Occasionally a very heavy fall of snow precedes extended general rains; but in this case the snow is lately fallen and is not the winter precipitation.

Referring to the Missouri valley, the section of the country where the winter snowfall has been thought to exercise a dominating influence in floods, it has elsewhere been shown by me that about one-third of the annual precipitation falls over that valley during the months of May and June. In either of the months named the average precipitation over the Missouri valley is greater than the entire average precipitation for the winter months of December, January and February.

Woiekoff thinks that the anomalies of temperatures shown in forest regions, particularly in Brazil—with its abnormally low temperatures, are due to heavy forests promoting evaporation, and by causing the prevalence of accompanying fogs thus prevent more intense insolation. He considers this an argument for the maintenance of forests to sustain humidity and distribute rain over adjacent cultivated land, as well as to maintain the fertility of the soil, which diminishes rapidly by washing away of the soil after deforestation.

W. Koppen has devised a formula for deriving the true daily temperature from 8 A. M., 2 P. M. and 8 P. M. observations in connection with the minimum temperature, in which the minimum has a variable weight dependent on place and month. The results of Koppen's formula tested on six stations in widely different latitudes, indicate that it is of value.

Paulsen's discussion of the warm winter winds of Greenland is interesting. These unusual storm conditions last three or four days, or even longer, the temperature being at times from 35° to 40° Fahr. above the normal, and they appear principally with winds from northeast to southeast, which Hoffmeyer believes to be *foehn* winds. Paulsen contends that the extensive region over which these winds occur make the *foehn* theory untenable, and that a more reasonable explanation of these winds is to be found in the course of low areas passing along the coast or over Greenland. This appears evident from the fact that not the easterly winds only but the southerly winds share this high temperature, and that as low areas approach from the west, at first the regions of the Greenland coast within its influence have south to southwest winds.

The question of wind pressures and wind velocities is a most important one in these days of great engineering problems, particularly in connection with the stability of bridges and other large structures.

Experimental determination of the constants of anemometric formulæ have recently been made both in England and this country. From results obtained in the English experiments it was concluded that the very widely used Robinson anemometer is not as satisfactory and reliable an instrument as a different form of anemometer devised by Mr. Dines. These conclusions, however, are not sustained by the American experiments, which were made by Professor C. F. Marvin, Signal Office, by means of a whirling apparatus, and under the most favorable circumstances, which yielded highly satisfactory results. Professor Marvin has lately made very careful open air comparisons of anemometers previously tested on the whirling machine, which have shown that, owing in part to the irregular and gusty character of the wind movement in the open air, taken in connection with the effects arising from the moment of inertia of the cups, and the length of the arms of the anemometer, the constants determined by whirling machine methods need slight corrections and alterations to conform to the altered conditions of exposure of the instruments in the open air. This latter problem is now being experimentally studied at the Signal Office, and final results will soon be worked out.

Professor Langley has also made very elaborate observations of pressures on plane and other surfaces inclined to the normal, which it is believed will prove important contributions to this question, but the results have not yet been published. It is important in this connection to note experiments made by Cooper on the Frith of Forth Bridge, where a surface of 24 square metres, during a high wind, experienced a maximum pressure of 132 kilogrammes per square metre, while a surface of 14 square decimeters showed, under similar conditions, 200 kilogrammes per square metre, by one instrument, and 170 by another. The opinion expressed by Cooper that in general the more surface exposed to the wind, the less the pressure per unit of surface, seems reasonable, and if verified by more elaborate experiments must have an important bearing.

There are questions in connection with which even negative results are of an important character, particularly when such results are quite definite, and tend to remove one of many unknown elements from physical problems of an intricate character. In this class may be placed atmospheric electricity, with particular reference to its value in connection with the forecast of coming weather. The Signal Office, through Professor T. C. Mendenhall, a distinguished scientist peculiarly fitted for work of this character, has been able to carry out a series of observations, which have received from him careful attention, both as to the conditions under which the observations were made and in the elaboration of methods to be followed.

Professor Mendenhall also supervised the reduction of these observations, and after careful study presented a full report of the work to the National Academy of Sciences, in whose proceedings this detailed report will appear. Professor Mendenhall says, "Taking all the facts into consideration, it seems to be proved that the electrical phenomena of the atmosphere are generally local in their character. They do not promise, therefore, to be useful in weather forecasts, although a close distribution of a large number of observers over a comparatively small area would be useful in removing any doubt which may still exist as to this question." It may be added that Professor Mendenhall's conclusions bear out the opinions expressed to the speaker, in a discussion of this question, by Professor Mascart, the distinguished physicist.

It has been generally admitted that the aqueous vapor in the atmosphere plays a most important part in bringing about the formation of storms and maintaining their energy. It has been frequently commented on by the forecast officials of the Signal Service, that storms passing over the United States were in general preceded by an increase in moisture, but unfortunately little effort had been made on the part of previous investigators to determine any quantitative relation between the actual humidity and the amount of precipitation or its relation to the storm movement. It has long been regretted that the direct relations of this to other meteorological phenomena were not more fully defined. During the past year Captain James Allen, of the Signal Office, has endeavored to apply the results of his investigations and theories to the practical forecasts of storm conditions. Captain Allen has carefully studied the relations of the potential energy of the surface air, as represented by the total quantity of heat it contained, to the movement of storm centres and the extent of accompanying rain areas. In his first investigations the potential energy per cubic foot was estimated as follows: Supposing the air to have been originally 32° and the moisture in it as water at 32°, the total quantity of heat applied to reduce to the state of observation will be $A = \frac{(t-32)}{6} + Q$ in which A is total heat per unit volume; t is the temperature of the air, Q the total heat of vapor, and the specific heat of air at constant volume being taken as one-sixth (.168). From Regnault's formula we have $Q = 1091.7 + .305(t-32)$.

For the mechanical equivalent we have $J = 772A$. If we divide J by the pressure estimated in pounds per square foot, it will give the height through which the pressure can be lifted if all the heat is spent in work by expanding the air.

An approximate expression for the upward velocity V may be obtained from Torrecelli's theorem from which we have $V^2 = 2gh$, h in this case being being the height through which the pressure would be lifted if all the heat is spent in work. The theory has been that the storm centre will move over that section of the country where V is the greatest, and that the time of occurrence and amount of rain have a relation of conformity to the changes in Q and its actual amount.

Auxiliary charts were also made showing for each station the following following values of Q:

1st. Highest Q not followed by rain in 24 hours.

2d. Greatest plus change in Q not followed by rain in 24 hours.

3d. Lowest value for Q followed by rain in 12 hours.

A tentative application of the theory during December, 1889, has given very encouraging results. The problem can be approached in many different ways, but the basis of the solution is the determination of the actual energy of the air, both potential and kinetic, as well as differences of potential.

Probably the most important event of the past year to general meteorological students has been the publication of Part I, Temperature, and Part II, Moisture, of the Bibliography of Meteorology, under the supervision of the Signal Office, and edited by Mr. O. L. Fassig. The two parts cover 8,500 titles out of a total of about 60,000. This publication renders it now possible for any investigator to review the complete literature of these subjects, not only with a minimum loss of time, but with the advantage of supplementing his own work, without duplication, by the investigations of his predecessors. The publication is a lithographic reproduction of a type-written copy, the only available method, which leaves much to be desired on the grounds of appearance, space and clearness.

The experiments of Crova and Houdaille on Mount Venteux, elevation 1,907 metres, and at Bedoin, 309 metres, are of more than transient interest since they fix the solar constant at a height of 1,907 metres, at about three calories; agreeing with the value obtained by Langley on Mt. Whitney, Cal.

With this brief allusion to the important phenomena of sun-heat, whereon depend not only the subordinate manifestations pertaining to this section, but those relating to all other departments, this report may appropriately close.

TREASURER'S REPORT.

YEAR ENDING DECEMBER 31, 1889.

C. J. BELL, TREASURER, in account with NATIONAL GEOGRAPHIC SOCIETY.

Balance on hand as per last account		$626.70

RECEIPTS.

To amount of annual dues for 1889	$865	
" " " " 1890	20	
To Life Members	50	
	—	935.00
Note for $1,000 with interest paid off, Nov. 16, 1869		1,032.08
Sale of Maps		1.41
Surplus from Field Meeting		25.35
		$2,620.54

INVESTMENTS ON HAND, DEC. 31, 1889.

Note dated March 27, 1889, for the sum of $750, with interest @ 6%, due March 27, 1890. Secured by real estate.

DISBURSEMENTS.

	By Cost of Magazine, No. 2	$174.46	
	" " " No. 3	233.66	
	" " " No. 4	197.28	
	" Directory of Society	28.35	
	" Rent of Hall at Cosmos Club	45.00	
	" Printing, Stationery and Postage	108.72	
	" Sundries	13.00	
1889.		———	800.47
Mar. 26.	By Loan on collateral		1,000.00
	" Note for $750 and interest, from March 27, 1889, for 1 year @ 6%, due March 27, 1890		756.25
	Balance in Bank		63.82
			$2,620.54

REPORT OF AUDITING COMMITTEE.

December 27, 1889.

To the National Geographic Society:

The undersigned, having been appointed an auditing committee to examine the account of the Treasurer for 1889, make the following report:

We have examined the Treasurer's books and find that the receipts as therein stated are correctly reported. We have compared the disbursements with the vouchers for the same and find them to have been properly approved and correctly recorded We have examined the bank account and compared the checks accompanying the same. We find the balance (beside the sum of $756.25 invested in real estate note) as reported by the Treasurer ($63.82) consistent with the balance as shown by the bank-book ($82.82), the difference being explained by the fact that there are two outstanding checks for the sum of $19.00 not yet presented for payment.

Bailey Willis,
R. Birnie, Jr.,
Willard D. Johnson,
Auditing Committee.

REPORT

OF THE

RECORDING SECRETARY.

The first report of the Secretaries was presented to the Society, December 28, 1888. At that time the Society had a total membership of 209. Since that date this membership has been increased by the election of 36 new members ; it has been decreased by the death of 3 and by the resignation of 14. The net increase in membership is thus 19 and the present membership is 228, including 3 life members. The deceased members are, Z. L. White, G. W. Dyer and Charles A. Ashburner.

The number of meetings held during the year was 17, of which 15 were for the presentation and discussion of papers ; one was a field meeting held at Harper's Ferry, W. Va., on Saturday, May 11, 1889, and one, the annual meeting. The average attendance was about 65.

The publication of a magazine begun last year, has been continued, and three additional numbers have been published, being Nos. 2, 3 and 4 of Vol. I. Copies of the numbers have been sent to all members and also to about 75 American and foreign scientific societies and other institutions interested in Geography. As a result the Society is now steadily in receipt of geographical publications from various parts of the world.

Respectfully submitted,

HENRY GANNETT, *Recording Secretary.*

NATIONAL GEOGRAPHIC SOCIETY.

ABSTRACT OF MINUTES.

Nov. 1, 1889. Twenty-seventh Meeting.

A paper was read entitled, "Telegraphic Determinations of Longitudes by the Bureau of Navigation," by Lieutenant J. A. Norris, U. S. N. *Published in the National Geographic Magazine, Vol. 2, No. 1.*

Nov. 15, 1889. Twenty-eighth Meeting.

A paper was read by Ensign Everett Hayden, U. S. N., entitled, "Law of Storms considered with Special Reference to the North Atlantic," illustrated by lantern slides. It was discussed by Messrs. Greely and Hayden.

Nov. 29, 1889. Twenty-ninth Meeting.

A paper was read by Mr. H. M. Wilson entitled, "The Irrigation Problem in Montana." Discussion was participated in by Messrs. Dutton, Greely and Wilson.

Dec. 13, 1889. Thirtieth Meeting.

The paper of the evening was by Mr. I. C. Russell upon "A Trip up the Yukon River, Alaska," and was illustrated by lantern slides.

Dec. 27, 1889. Thirty-first Meeting—2d Annual Meeting.

Vice-President Thompson in the chair. The minutes of the first annual meeting were read and approved. Annual reports of the secretaries and treasurer and the report of the auditing committee were presented and approved. The following officers were then elected for the succeeding year :

President—GARDINER G. HUBBARD.

Vice-Presidents—HERBERT G. OGDEN, [land]; EVERETT HAYDEN, [sea]; A. W. GREELY, [air]; C. HART MERRIAM, [life]; A. H. THOMPSON, [art.]

Treasurer—CHARLES J. BELL.

Recording Secretary—HENRY GANNETT.

Corresponding Secretary—O. H. TITTMANN.

Managers—CLEVELAND ABBE, MARCUS BAKER, ROGERS BIRNIE, JR., G. BROWN GOODE, W. D. JOHNSON, C. A. KENASTON, W. B. POWELL and JAMES C. WELLING.

Jan. 10, 1890. Thirty-second Meeting.

The annual reports of Vice-Presidents Ogden and Greely were presented. *Published in the National Geographic Magazine, Vol. 2, No. 1.*

Jan. 24, 1890. Thirty-third Meeting.

A paper was read entitled, "The Rivers of Northern New Jersey," with notes on the "General Classification of Rivers," by Professor William M. Davis. The subject was discussed by Messrs. Davis, Gilbert and McGee.

Feb. 7, 1890. Thirty-fourth Meeting.

The annual report of Vice-President Merriam was presented. A paper on "Bering's First Expedition," was read by Dr. W. H. Dall.

Feb. 21st, 1890. Thirty-fifth Meeting.

Held in the Lecture Hall of Columbian University. The annual address of the President, Mr. Gardiner G. Hubbard, was delivered, the subject being "Asia, Its Past and Future." *Published in "Science," Vol. XV, No. 371.*

Feb. 28th, 1890. Special Meeting.

Held in the Lecture Hall of Columbian University. A paper was read by Lieut. Com'dr Chas. H. Stockton, U. S. N., entitled "The Arctic Cruise of the Thetis During the Summer and Autumn of 1889," which was illustrated by lantern slides.

March 7th, 1890. Thirty-sixth Meeting.

A paper was read by Mr. Romyn Hitchcock, entitled "A Glimpse of Chinese Life in Canton."

OFFICERS.

1890.

President.

GARDINER G. HUBBARD.

Vice-Presidents.

HERBERT G. OGDEN.
EVERETT HAYDEN.
A. W. GREELY.
C. HART MERRIAM.
A. H. THOMPSON.

Treasurer.

CHARLES J. BELL.

Secretaries.

HENRY GANNETT.
O. H. TITTMANN.

Managers.

CLEVELAND ABBE.
MARCUS BAKER.
ROGERS BIRNIE, Jr.
G. BROWN GOODE.
W. D. JOHNSON.
C. A. KENASTON.
W. B. POWELL.
JAMES C. WELLING.

MEMBERS OF THE SOCIETY.

a, original members.
l, life members.
* Deceased.
In cases where no city is given in the address, Washington, D. C., is to be understood.

ABBE, PROF. CLEVELAND, *a*, *l*,
Army Signal Office. 2017 I Street.

ABERT, S. T.,
1928½ Pennsylvania Avenue.

AHERN, JEREMIAH,
Geological Survey. 804 Tenth Street.

ALLEN, DR. J. A.,
American Museum Natural History, New York, N. Y.

APLIN, S. A., JR.,
Geological Survey. 1513 R Street.

ARRICK, CLIFFORD, *a*,
Geological Survey. 1131 Fourteenth Street.

*ASHBURNER, PROF. CHARLES A.

ATKINSON, W. R., *a*,
Geological Survey. 2900 Q Street.

AYRES, MISS S. C., *a*,
502 A Street SE.

BAKER, PROF. FRANK, *a*,
Life Saving Service. 1315 Corcoran Street.

BAKER, MARCUS, *a*,
Geological Survey. 1905 Sixteenth Street.

BALDWIN, H. L. JR., *a*,
Geological Survey. 125 Sixth Street NE.

BARCLAY, A. C.,
Geological Survey. 1312 G Street.

BARNARD, E. C., *a*,
Geological Survey. 1773 Massachusetts Avenue.

BARTLE, R. F.,
947 Virginia Avenue SW.

BARTLETT, COMDR. J. R., U. S. N., *a*,
Providence, R. I.

BARTLETT, P. V. S.,
Geological Survey. 806 Seventeenth Street.

BASSETT, C. C., *a*,
Geological Survey. 929 New York Avenue.

BELL, A. GRAHAM, *a*,
1336 Nineteenth Street.

BELL, CHAS. J., *a*,
1437 Pennsylvania Avenue. 1328 Nineteenth Street.

BERNADOU, ENS. J. B., U. S. N.,
Office of Naval Intelligence. 1908 F. Street.

BIEN, JULIUS, *a*,
139 Duane Street, New York, N. Y.

BIEN, MORRIS, *a*,
Geological Survey. Takoma Park, D. C.

BIRNIE, CAPT. ROGERS, JR., U. S. A., *a*,
Ordnance Office. 1341 New Hampshire Avenue.

BLAIR, H. B., *a*,
Geological Survey. 1831 F Street.

BLODGETT, JAMES H., *a*,
Census Office. 1237 Massachusetts Avenue.

BODFISH, S. H., *a*,
Geological Survey. 58 B Street NE.

BOUTELLE, CAPT. C. O., *a*,
Coast and Geodetic Survey. 105 Fourth Street NE.

BRENT, L. D.,
Geological Survey. 1741 F Street.

BREWER, H. G., *a*,
Hydrographic Office. Meridian Avenue, Mt. Pleasant.

BROWN, MISS E. V.,
1312 R Street.

BURTON, PROF. A. E., *a*,
Massachusetts Institute of Technology, Boston, Mass.

CARPENTER, Z. T., *a*,
1003 F Street. 1009 Thirteenth Street.

CHAPMAN, R. H., *a*,
Geological Survey. 1207 L Street.

CHATARD, DR. THOS. M., *a*,
Geological Survey. The Portland.

CHESTER, COMDR. COLBY M., U. S. N.,
Navy Department.

CHRISTIE, PETER H.,
Geological Survey. 811 Ninth Street.

Clark, A. Howard,
National Museum. 1527 S Street.

Clark, E. B., *a*,
Geòlogical Survey. Laurel, Md.

Colonna, B. A.,
Coast and Geodetic Survey. 23 Grant Place.

Colvin, Verplanck, *a*,
Albany, New York.

Court, E. E.,
Hydrographic Office. Seventeenth Street, Mt. Pleasant.

Craven, Ens. John E., U. S. N.,
Hydrographic Office. 1313 Twenty-second Street.

Cummin, R. D., *a*,
Geological Survey. 1105 Thirteenth Street.

Curtis, William Eleroy, *a*,
513 Fourteenth Street. 1801 Connecticut Avenue.

Darwin, Chas. C., *a*,
Geological Survey. 1907 Harewood Avenue, Le Droit Park.

Davidson, Prof. George, *a*,
U. S. Coast and Geodetic Survey, San Francisco, Cal.

Davis, Arthur P., *a*,
Geological Survey. 1910 Larch Street, Le Droit Park.

Davis, Mrs. Arthur P.,
1910 Larch Street, Le Droit Park.

Davis, Prof. Wm. M., *a*,
Cambridge, Mass.

Day, Dr. David T.,
Geological Survey. 1411 Chapin Street.

Dennis, W. H., *a*,
Coast and Geodetic Survey. 12 Iowa Circle.

Diller, J. S., *a*,
Geological Survey. 1804 Sixteenth Street.

Douglas, E. M., *a*,
Geological Survey. Takoma Park, D. C.

Dow, John M.,
Pacific Mail S. S. Co., Panama, U. S. Colombia.

Duke, Basil, *a*,
Geological Survey. 1831 F Street.

Dunnington, A. F., *a*,
Geological Survey. 1000 North Carolina Avenue SE.

Durand, John,
164 Bd. Montparnasse, Paris, France.

Dutton, A. H., *a*,
Hydrographic Office. 1338 Nineteenth Street.

DUTTON, CAPT. C. E., U. S. A., *a*,
Geological Survey. 2024 R Street.

DYER, LIEUT. G. L., U. S. N.,
Navy Department.

EDSON, J. R., *a*,
1003 F Street. 1705 Q Street.

ELLICOTT, ENS. JOHN M., U. S. N.,
Office of Naval Intelligence. 3009 P Street.

ELLIOTT, LIEUT. W. P., U. S. N., *a*,
Coast and Geodetic Survey.

FAIRFIELD, G. A., *a*,
Coast and Geodetic Survey.

FAIRFIELD, WALTER B., *a*,
Coast and Geodetic Survey.

FARMER, ROBERT A.,
Geological Survey. 1312 G Street.

FERNOW, B. E., *a*,
Department of Agriculture. 1843 R Street.

FISCHER, E. G., *a*,
Coast and Geodetic Survey. 436 New York Avenue.

FITCH, C. H., *a*,
Geological Survey. 3025 N Street.

FLETCHER, L. C., *a*,
Geological Survey. 1831 F Street.

FLETCHER, DR. ROBERT, *a*,
Army Medical Museum. The Portland.

FOOT, SAM'L A.,
Geological Survey. 918 H Street.

GAGE, N. P., *a*,
Seaton School. 401 Fourth Street.

GANNETT, HENRY, *a*,
Geological Survey. 1881 Harewood Avenue, Le Droit Park.

GANNETT, S. S., *a*,
Geological Survey. 401 Spruce Street, Le Droit Park.

GILBERT, G. K., *a*,
Geological Survey. 1424 Corcoran Street.

GILMAN, DR. D. C., *a*,
Johns Hopkins University, Baltimore, Md.

GOODE, G. BROWN, *a*,
National Museum. Lanier Heights.

GOODE, R. U., *a*,
Geological Survey. 1538 I Street.

GOODFELLOW, EDWARD, *a*,
Coast and Geodetic Survey. 7 Dupont Circle.

Gordon, R. O., *a*,
Geological Survey.

Granger, F. D.,
Coast and Geodetic Survey.

Greely, Gen. A. W., U. S. A., *a*,
Army Signal Office. 1914 G Street.

Griswold, W. T., *a*,
Geological Survey. Cosmos Club.

Gulliver, F. P.,
Geological Survey. 811 Ninth Street.

Hackett, Merrill, *a*,
Geological Survey. 318 Third Street.

Harrison, D. C., *a*,
Geological Survey. 1326 Corcoran Street.

Harrod, Major B. M.,
Miss. River Commission, New Orleans, La.

Hasbrouck, E. M.,
Geological Survey. 1305 R Street.

Haskell, E. E., *a*,
Coast and Geodetic Survey. 1418 Fifteenth Street.

Hayden, Ens. Everett, U. S. N., *a*,
Hydrographic Office. 1802 Sixteenth Street.

Hayes, C. Willard,
Geological Survey. 1616 Riggs Place.

Hays, J. W.,
Geological Survey. 2225 Thirteenth Street.

Heaton, A. G.,
1618 Seventeenth Street.

Henry, A. G., *a*,
Army Signal Office. 948 S Street.

Henshaw, H. W., *a*,
Bureau of Ethnology. 13 Iowa Circle.

Herrle, Gustav, *a*,
Hydrographic Office. 646 C Street NE.

Herron, W. H., *a*,
Geological Survey. 1008 H Street.

Hill, Geo. A., *a*,
Naval Observatory. 2626 K Street.

Hill, Prof. R. T.,
State Geological Survey, Austin, Tex.

Hinman, Russell,
In care Van Antwerp, Bragg & Co., Cincinnati, O.

Hodgkins, Prof. H. L., *a*,
Columbian University. 1511 Tenth Street.

HODGKINS, W. C.,
Coast and Geodetic Survey. 416 B Street, NE.

HOLLERITH, HERMAN,
Room 48 Atlantic Building. 3107 N Street.

HOPKINS, C. L.,
Department of Agriculture. 1004 H Street.

HORNADAY, W. T., *a*,
National Museum. 405 Spruce Street, Le Droit Park.

HOWELL, E. E., *a*,
48 Oxford Street, Rochester, N. Y.

HOWELL, D. J., *a*,
District Building. Alexandria, Va.

HUBBARD, GARDINER G., *a*,
1328 Connecticut Avenue.

HYDE, G. E.,
Geological Survey. 330 Spruce Street, Le Droit Park.

IARDELLA, C. T., *a*,
Coast and Geodetic Survey. 1536 I Street.

JENNINGS, J. H., *a*,
Geological Survey. 824 I Street NE.

JOHNSON, A. B., *a*,
Light House Board. 501 Maple Avenue, Le Droit Park.

JOHNSON, J. B.,
Howard University. 2460 Sixth Street.

JOHNSON, S. P.,
Geological Survey. 501 Maple Avenue, Le Droit Park.

JOHNSON, W. D., *a*,
Geological Survey. 501 Maple Avenue, Le Droit Park.

JUNKEN, CHARLES,
Coast and Geodetic Survey. 140 B Street, NE.

KARL, ANTON, *a*,
Geological Survey. 1230 Eleventh Street.

KAUFFMANN, S. H., *a*,
1421 Massachusetts Avenue.

KENASTON, PROF. C. A., *a*,
Howard University.

KENNAN, GEORGE, *a*,
1318 Massachusetts Avenue.

KENNEDY, DR. GEORGE G., *l*,
284 Warren Street, Roxbury, Mass.

KERR, MARK B., *a*,
Geological Survey. 1708 M Street.

KIMBALL, E. F.,
Post Office Department. 411 Maple Avenue, Le Droit Park.

KIMBALL, S. I., *a*,
Life Saving Service. 411 Maple Avenue, Le Droit Park.

KING, F. H.,
University of Wisconsin, Madison, Wis.

KING, PROF. HARRY, *a*,
Geological Survey. 1319 Q Street.

KING, WILLIAM B.,
906 F Street. 1328 Twelfth Street.

KNIGHT, F. J., *a*,
Geological Survey.

KNOWLTON, F. H., *a*,
Geological Survey.

KOCH, PETER, *a*,
Bozeman, Mont.

LACKLAND, W. E., *a*,
Geological Survey. 1305 Corcoran Street.

LAMBERT, M. B.,
Geological Survey. 1431 Rhode Island Avenue.

LEACH, BOYNTON,
Hydrographic Office. 2028 P Street.

LERCH, R. L., *a*,
Hydrographic Office. 936 K Street.

LINDENKOHL, ADOLPH, *a*,
Coast and Geodetic Survey. 19 Fourth Street SE.

LINDENKOHL, HENRY, *a*,
Coast and Geodetic Survey. 452 K Street.

LIPPINCOTT, J. BARLOW,
Geological Survey. 1802 M Street.

LONGSTREET, R. L., *a*,
Geological Survey. 1536 I Street.

LOVELL, W. H.,
Geological Survey. 413 Spruce Street, Le Droit Park.

MCCORMICK, JAMES,
Geological Survey. 1001 Eleventh Street.

MCGEE, W J, *a*,
Geological Survey. 2410 Fourteenth Street.

MCGILL, MISS MARY C.,
336 C Street.

MCKEE, R. H., *a*,
Geological Survey. 1753 Rhode Island Avenue.

MCKINNEY, R. C., *a*,
Geological Survey. 1120 Thirteenth Street.

MAHER, JAMES A., *a*,
Johnson City, Tenn.

MANNING, VAN. H., JR., *a*,
Geological Survey. 1331 N Street.

MARINDIN, H. L.,
Coast and Geodetic Survey.

MARSHALL, ROBERT B.,
Geological Survey. 1431 Rhode Island Avenue.

MATTHEWS, DR. WASHINGTON, U. S. A., *a*,
Army Medical Museum. 1262 New Hampshire Avenue.

MELVILLE, ENG. IN CHIEF, GEO. W., U. S. N., *a*, *l*,
Navy Department. 1705 H Street.

MENDENHALL, PROF. T. C.,
Coast and Geodetic Survey. 220 New Jersey Avenue SE.

MENOCAL, CIV. ENG. A. G., U. S. N., *a*,
Navy Department. 2012 Hillyer Place.

MERRIAM, DR. C. HART, *a*,
Department of Agriculture. 1919 Sixteenth Street.

MINDELEFF, COSMOS,
Bureau of Ethnology. 1401 Stoughton Street.

MINDELEFF, VICTOR,
Bureau of Ethnology. 2504 Fourteenth Street.

MITCHELL, PROF. HENRY, *a*,
18 Hawthorne Street, Roxbury, Mass.

MOSMAN, A. T., *a*,
Coast and Geodetic Survey.

MULDROW, ROBERT, *a*,
Geological Survey. 1511 Rhode Island Avenue.

MURLIN, A. E.,
Geological Survey. 1550 Third Street.

NATTER, E. W. F., *a*,
Readville, Mass.

NELL, LOUIS, *a*,
Geological Survey. 1118 Virginia Avenue SW.

NILES, PROF. W. H.,
Massachusetts Institute of Technology, Boston, Mass.

NORDHOFF, CHARLES, *a*,
701 Fifteenth Street. 1731 K Street.

OGDEN, HERBERT G., *a*,
Coast and Geodetic Survey. 1324 Nineteenth Street.

PARSONS, F. H., *a*,
Coast and Geodetic Survey. 210 First Street SE.

*PATTON, PRES. W. W., *a*.

Peale, Dr. A. C., *a*,
Geological Survey. 1446 Stoughton Street.

Peary, Civ. Eng. R. E., U. S. N.,
League Island Navy Yard, Philadelphia, Pa.

Penrose, R. A. F., Jr.,
State Geological Survey, Little Rock, Ark.

Perkins, E. T., Jr., *a*,
Geological Survey. 1831 F Street.

Peters, Lieut. G. H., U. S. N., *a*,
Navy Department.

Peters, William J., *a*,
Geological Survey. 1831 F Street.

Phillips, R. H.,
1511 Vermont Avenue.

Picking, Capt. Henry F., U. S. N.,
Hydrographic Office. Baltimore, Md.

Pierce, Josiah, Jr.,
Geological Survey. 806 Seventeenth Street.

Powell, Major J. W., *a*,
Geological Survey. 910 M Street.

Powell, Prof. Wm. B., *a*,
Franklin School Building.

Prentiss, Dr. D. W., *a*,
1101 Fourteenth Street.

Pumpelly, Prof. Raphael,
U. S. Geological Survey, Newport, R. I.

Renshawe, Jno. H., *a*,
Geological Survey.

Ricksecker, Eugene, *a*,
Seattle, Wash.

Ritter, H. P., *a*,
Coast and Geodetic Survey. 1905 Sixteenth Street.

Roberts, A. C., *a*,
Hydrographic Office.

Rodman, Ens. Hugh, U. S. N.,
Hydrographic Office. 2015 Hillyer Place.

Russell, I. C., *a*,
Geological Survey. 1616 Riggs Place.

Sargent, Prof. C. S., *a*,
Brookline, Mass.

Schley, Capt. W. S., U. S. N., *a*,
Navy Department.

Scudder, Sam. H., *a*,
Cambridge, Mass.

SHALER, PROF. N. S., *a*,
Cambridge, Mass.

SIEBERT, J. S.,
Hydrographic Office. 1911 Harewood Avenue, Le Droit Park.

SINCLAIR, C. H.,
Coast and Geodetic Survey.

SINCLAIR, J. C.,
4 Lafayette Square.

SMITH, EDWIN, *a*.
Coast and Geodetic Survey. Rockville, Md.

SMITH, MIDDLETON, *a*,
Army Signal Office. 1616 Nineteenth Street.

SOMMER, E. J., *a*,
Coast and Geodetic Survey. 330 A Street SE.

STEIN, ROBERT,
Geological Survey. 710 Eleventh Street.

STEJNEGER, LEONHARD, *a*,
National Museum.

STOCKTON, LT. COMDR. C. H., U. S. N., *a*,
Navy Department.

SUTTON, FRANK,
Geological Survey. 702 Nineteenth Street.

THOMAS, MISS MARY VON E., *a*,
Coast and Geodetic Survey.

THOMPSON, PROF. A. H., *a*,
Geological Survey.

THOMPSON, GILBERT, *a*,
Geological Survey. 1448 Q Street.

THOMPSON, LAURENCE, *a*,
In care Northern Pacific R. R. Co., Seattle, Wash.

THOMPSON, LIEUT. R. E., U. S. A., *a*,
Army Signal Office. 2011 N Street.

TITTMANN, O. H., *a*,
Coast and Geodetic Survey. 1019 Twentieth Street.

TOWSON, R. M., *a*,
Geological Survey. 1446 N Street.

TWEEDY, FRANK, *a*,
Geological Survey. 1311 M Street.

URQUHART, CHAS. F., *a*,
Geological Survey. 1538 I Street.

VASEY, DR. GEORGE, *a*,
Department of Agriculture. 2006 Fourteenth Street.

VINAL, W. I., *a*,
Coast and Geodetic Survey. 152 D Street SE.

Von Haake, Adolph,
Post Office Department. 1215 L Street.

Walcott, C. D., *a*,
Geological Survey. 418 Maple Avenue, Le Droit Park.

Wallace, Hamilton S., *a*,
Geological Survey. 1813 M Street.

Ward, Lester F., *a*,
Geological Survey. 1464 Rhode Island Avenue.

Weed, Walter H., *a*,
Geological Survey. 825 Vermont Avenue.

Weir, J. B., *a*,
1602 L Street.

Welling, Dr. James C., *a*,
Columbian University. 1302 Connecticut Avenue.

White, Dr. C. H., U. S. N.,
Navy Department.

Whiting, Henry L.,
Coast and Geodetic Survey. West Tisbury, Mass.

Wilder, Gen. J. T., *a l*,
Johnson City, Tenn.

Wilder, Miss Mary,
Johnson City, Tenn.

Willis, Bailey, *a*,
Geological Survey. 1617 Riggs Place.

Willis, Mrs. Bailey,
1617 Riggs Place.

Wilson, A. E.,
Geological Survey.

Wilson, H. M., *a*,
Geological Survey. Cosmos Club.

Wilson, Thomas,
National Museum. 1218 Connecticut Avenue.

Winslow, Arthur,
State Geological Survey, Jefferson City, Mo.

Winston, Isaac,
Coast and Geodetic Survey. 1325 Corcoran Street.

Woodward, R. S., *a*,
Geological Survey. 1804 Columbia Road.

Yarrow, Dr. H. C., *a*,
814 Seventeenth Street.

Yeates, Chas. M., *a*,
Geological Survey. 1706 F Street.

Vol. II. No. 2.

THE NATIONAL GEOGRAPHIC MAGAZINE.

NATIONAL GEOGRAPHIC SOCIETY
INCORPORATED A.D. 1888.

PUBLISHED BY THE

NATIONAL GEOGRAPHIC SOCIETY.

WASHINGTON, D. C.

Price 50 cents.

CONTENTS.

Published May, 1890.

PRESS OF TUTTLE, MOREHOUSE & TAYLOR, NEW HAVEN, CONN.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

Vol. II. 1890. No. 2.

THE RIVERS OF NORTHERN NEW JERSEY, WITH NOTES ON THE CLASSIFICATION OF RIVERS IN GENERAL.

By William Morris Davis.

Outline.—Rivers of different kinds: consequent, antecedent, superimposed, subsequent, adjusted.—Topography of Northern New Jersey. —Revived and superimposed rivers in New Jersey.—Drainage of the Watchung crescent.—Re-arrangement of superimposed rivers by the growth of subsequent streams.—Application of this principle to the Green river in the Uinta mountains: Powell's and Emmons' theories.—The Green river probably superimposed and its branches re-arranged by the growth of subsequent streams.—Anaclinal and reversed rivers in New Jersey.

Northern New Jersey is drained by several streams which rise in the Archean Highlands, flow southeastward across the central Triassic plain and reach the sea near the inland margin of the Cretaceous formation.

What kinds of rivers are these? Such a question can hardly be answered until we have examined rivers in many parts of the world, gaining material for a general history of rivers by induction from as large as possible a variety of examples; and until we have deduced from our generalizations a series of critical features sufficient to serve for the detection of rivers of different kinds wherever found.

The generalizations here referred to may be presented in the form of a classification, following the ideas of Powell, Gilbert, Heim, Löwl and others, as follows :

Consequent rivers.—Those that have in their birth, at the time of their original establishment on the country which they drain, selected courses in accordance with the constructional slopes of the surface ; for example, the Red River of the North and such of its branches as flow on the even surface of the lacustrine plain of Lake Agassiz ; the several streams that drain the broken lava blocks of Southern Oregon ; certain streams and rivers of the Jura that drain the synclinal troughs of those mountains. Consequent streams may be divided into definite and indefinite groups. Definite consequent streams are those that follow well defined constructional channels, such as the axial line of a synclinal trough, or the lowest point of an anticlinal arch between two synclinal basins ; they are defined in location as well as in direction. Indefinite consequent streams are those that flow down constructional slopes, such as the flanks of an anticline, but whose precise location depends on those minor inequalities of surface that we term accidental ; they are defined in direction but not in location ; and they are as a rule branches of definite consequent streams.

Antecedent rivers.—Those that during and for a time after a disturbance of their drainage area maintain the courses that they had taken before the disturbance. In Powell's original definition of this class of rivers, he said that the valleys of the Uinta mountains are occupied by "drainage that was established antecedent to the corrugation or displacement of the beds by faulting or folding."* No limit is set to the amount of corrugation or displacement or to the strength of the faulting or folding. It therefore seems advisable to consider what variations there may be from the strongly marked antecedent type ; one extreme being in those cases where the displacement was a minimum and the perseverance of the streams a maximum, the other where the displacement was a maximum and the successful perseverance of the streams a minimum, or zero. The simplest examples of antecedent rivers are therefore found in regions that have been broadly elevated with the gentlest changes of slope, so as to enter a new cycle of topographic development, all the streams retaining their previous courses, but gaining ability to deepen their former chan-

* Colorado river of the West, 163.

nels down to the new baselevel; such streams may be called "revived." Examples of revived streams are very common; nearly all the streams of the Highlands of New Jersey are of this kind; all the streams of central and western Pennsylvania seem to belong in the same class. From these simple and common examples, we shall some day, when our knowledge of rivers is better developed, be able to form a complete series leading to what is generally understood as the typical antecedent river, which has outlived deformation as well as elevation without suffering either deflection or ponding. Large rivers of strong slope, well enclosed in steep-sided valleys, or in other words vigorous adolescent rivers have the best opportunity to persist across a belt of rising or writhing country,* because a great deformation would be required to throw them from their courses. Small streams or large ones of faint slope in an open low country are more easily deflected. From the typical antecedent river, the series may be continued by examples in which even the larger streams are less or more ponded or deflected by the deformation, until at the end of the series there is a complete extinction of the antecedent drainage and the establishment of an entirely original consequent drainage. The perfectly typical antecedent river, in the middle of this series, is certainly of rare occurrence, and is perhaps unknown.

Consequent streams, whose course is taken on a relatively thin, unconformably overlying mass, for a time preserve their initial courses, even though they may be quite out of accord with the underlying structures on which they have descended. Such streams were first recognized by Marvine, and afterwards named "superimposed," "inherited" or "epigenetic" by various authors. A full collection of examples of this class should begin with streams that depart from true consequent courses only locally, where they have discovered a small portion of the underlying formation, like the Merrimack at Manchester and other water-power towns of New Hampshire, where the stream has sunk upon rocky ledges beneath the surface drift and sands; or like the Mississippi and other rivers in Minnesota which have in places cut through the drift sheet to the underlying crystallines. The series would conclude with streams that have stripped off the cover on which they were consequent, and have thus become superimposed on the underlying formation in their whole length.

* Stur's expression "Gebirgshub oder Gebirgschub" suggested to me the terms here employed.

There is a curious intermediate type of drainage lately recognized by McGee in the southern states, a superimposed drainage that is not inconsequent upon the buried surface beneath the unconformably overlying surface layer. It occurs in regions where a well-marked drainage had been established ; a brief submergence then allowed the deposition of a relatively thin mask of sediments ; an elevation brought the masked surface up again, and as it rose, the streams took possession of lines essentially identical with the courses of their ancestors, because the mask of newer deposits had not extinguished the antecedent topography. McGee proposes to call such streams "resurrected."

Rivers of all classes as a rule develop during their adolescence and more mature growth certain "subsequent" branches that were not in any way represented in the early youth of the system. Thus the indefinite members of the consequent drainage of the Jura mountains have developed subsequent streams on soft beds of monoclinal and anticlinal structures, where there could not possibly have been any consequent drainage lines at the birth of this system, unless we admit the supposed fracturing of the anticlinal crests, which seems unnecessary to say the least. Even in the simplest style of drainage, growing on a level surface, many of the branches must be "subsequent," or as McGee has called them in such cases, "autogenetic."

Rivers of all classes are subject to spontaneous re-arrangement or adjustment of their courses to a greater or less extent, in accordance with the weaker structural lines. This results from the migration of divides and the consequent abstraction or capture of one stream by another. The capture is generally made by the headward development of some subsequent branch. But after this kind of change has advanced to a certain extent, the divides become stable, and further change ceases. The rivers may then be said to be maturely adjusted. Under certain conditions, chiefly great initial altitude of surface, and great diversity of structure, that is, in mountainous regions, the changes arising from adjustments of this spontaneous kind are very great, so that the courses of a river's middle age may have little resemblance to those of its youth, as Löwl has pointed out and as I have tried to show in the case of the Pennsylvanian rivers. It may be difficult to recognize in such cases whether the youthful courses of a river system were consequent, antecedent or superimposed. Adjustments of this kind were not discussed by Powell, although he makes brief mention of what I have called subsequent streams. The first appreciation that I gained of river adjustments came from the writings of Löwl; but I have since found that the general principles governing their opportunity were stated by Gilbert in his monograph on the Henry Mountains of Utah (pp. 141, 149), and by Heim in his Mechanismus der Gebirgsbildung (i, 272, etc., ii, 79, 320).

Where do the rivers of northern New Jersey stand in this general scheme of river classification? We must again postpone the answer to the question, while reviewing the history of the general geographical development of the region.*

The topography of northern New Jersey may be briefly described as made up of valleys and lowlands that have been etched in the now elevated surface of what may be called the Schooley peneplain on the Cretaceous baselevel. The topographical atlas of New Jersey should be constantly referred to, in order to follow such a statement as this; but in order that the reader may without undue difficulty apprehend the meaning of my descriptions and recognize the various localities yet to be named without the trouble of searching for them on the maps of the atlas, I have attempted to draw a generalized bird's eye view of northern New Jersey, as it would be seen by an observer about seventy miles vertically above the center of southern New Jersey. The meridians are vertical and east and west lines are horizontal, but oblique azimuths are foreshortened. The result is hardly more than a geographical caricature, and I publish it in part to experiment upon the usefulness of so imperfect an effort. An active imagination may perceive the long even crest line of Kittatinny Mountain on the northwest, rising beyond the rolling floor of the Kittatinny Valley, as the great Alleghany limestone lowland is here called; then come the Highland plateaus, of accordant altitude one with another, but without the mesa-like margin that my pen has not known how to avoid indicating. The Central plain lies in the foreground, diversified by the various trap ridges that rise above its surface; First and Second mountains of the double Watchung

* The more detailed statement of this history may be found in an essay prepared by the author with the collaboration of Mr. J. W. Wood, Jr., of the class of 1888 in Harvard College, the study being undertaken as a joint thesis by instructor and student in a second course in Physical Geography. The essay is published in the Proceedings of the Boston Society of Natural History, 1889.

crescent near the Highlands; Sourland Mountain in the southwest; and Rocky Hill, the southwestern re-appearance of the Palisades intrusive trap sheet, lying a little nearer to us. The Central plain is also diversified by the Fall-line, a slight but rather distinct break in its surface from Trenton (Tr.) on the Delaware to a little below New Brunswick (N. B.) on the Raritan. The important drainage lines are: the Delaware, forming the western boundary of the State, trenching Kittatinny Mountain at the Water Gap, cutting a deep transverse valley through the Highlands where it receives longitudinal branches, and a shallower trench across the Kittatinny lowland and the Central plain; the Raritan, whose north and south branches head in the Highlands, while the Millstone joins it from south of the fall-line, cutting through Rocky Hill near Princeton (Pr) on the way; and the Pequannock-Passaic, rising in the Highlands, gathering tributaries in the low basin behind the Watchung ridges, and escaping to the front country as a single stream, the Passaic, through deep gaps at Patterson. The terminal moraine, marking the furthest advance of the second glacial invasion of post-tertiary time, is indicated by an irregular dotted band crossing the State, from the Narrows of New York Bay, which it defines, on the east, passing over Second Mountain by the gap at Summit (S), rising midway in the Highlands over Schooley Mountain, and traversed by the Delaware at Belvidere (B).

The Schooley peneplain is indicated by the crest and summit altitudes of Kittatinny Mountain, the Highland plateaus and the trap ridges. This peneplain once lay low and essentially horizontal, the practically completed work of the processes of denudation acting on a previously high land through a long period of time: it is now lifted and tilted, so that its inland portion rises to the height of the Highlands, which are its remnants, while its seaward portion descends slowly beneath a cover of unconformable Cretaceous beds, southeast of the fall-line, and thus hidden sinks gently beneath the Atlantic shore. The cover of Cretaceous sediments was laid on the southeastern part of the old peneplain during a moderate submergence of its seaward portion, before the elevation and tilting above mentioned (fig. 2, p. 93). Much of the cover has been worn away since the time of elevation (figs. 3–6, p. 95), which gave opportunity for the opening of deep valleys on the soft limestones and slates among the hard crystalline rocks of the Highlands; and for the production of the broad

N.Y.
N.Y. Bay
Palisades
Hudson
Staten Island
Raritan Bay
Nk
Ez
Rahway
Moraine
Ay
Raritan
Pt
Second Mt.
First Mt.
Pequannock
Bn.
Rockaway
Great Swamp
Upper Passaic
Ambrose's Br.
N.B.
Lawrence Br.
Manalapan
BB
CENTRAL PLAIN
FALL LINE
Millstone
Rocky Hill
Pr.
Stony Br.
Assanpink Cr.
Tr.
Sourland Mt.
N. Br.
S. Br.
Highlands
Schooley's Mt.
Musconetcong
Pohatcong
Kittatinny Valley
Kittatinny Mountain
Delaware
Triassic
Archean
Moraine

FIG. 1.

Kittatinny Valley lowland or peneplain on the wide belt of limestones beyond the Highlands; and furthermore for the development of a broad baselevelled plain on the weak Triassic shales and sandstones, where the old peneplain has been almost entirely destroyed. The Cretaceous cover remains only near the coast, where it stood too low to be attacked while the valleys and lowlands just described were carved out. An interesting peculiarity in the relation between the newer baselevel plain on the Triassic area and the old Cretaceous peneplain is that their surfaces mutually intersect at a small angle along the line which now marks the visible contact between the Triassic and Cretaceous formations: the newer plain standing beneath the eroded portion of the older one northwest of this line, while it rises above the buried part of the older one and obliquely truncates its Cretaceous cover to the southeast of the line. Finally, the land as a whole has been raised a little since the making of the newer plain, and shallow valleys interrupt its broad surface. It is no longer a true plain; it has become a pastplain. A few words may be allowed me concerning these terms, peneplain and pastplain. Given sufficient time for the action of denuding forces on a mass of land standing fixed with reference to a constant baselevel, and it must be worn down so low and so smooth, that it would fully deserve the name of plain. But it is very unusual for a mass of land to maintain a fixed position as long as is here assumed. Many instances might be quoted of regions which have stood still so long that their surface is almost reduced to its ultimate form; but the truly ultimate stage is seldom reached. We can select regions in which the valley lowlands have become broad and flat, the intermediate "doab" hills have wasted away lower and lower until they are reduced to forms of insignificant relief; and yet the surface still does not deserve the name of plain as unqualifiedly as do those young lands newly born from seas or lakes in which their geometrically level surfaces were formed. I have therefore elsewhere suggested* that an old region, nearly baselevelled, should be called an almost-plain; that is, a peneplain.

On the other hand, an old baselevelled region, either a peneplain or a truly ultimate plain, will, when thrown by elevation into a new cycle of development, depart by greater and greater degrees from its simple featureless form, as young narrow valleys

* Amer. Jour. Sci., xxxvii, 1889, 430.

are sunk beneath its surface by its revived streams. It therefore no longer fully deserves the name that was properly applicable before its elevation. It must not again be called a peneplain, for it is now not approaching and almost attaining a smooth surface, but is becoming rougher and rougher. It has passed beyond the stage of minimum relief, and this significant fact deserves implication, at least, in a name. I would therefore call such a region a pastplain. The area of the weak Triassic shales was, until its late elevation, as good an example of an ultimate baselevelled plain as any that I have found ; but now it is a pastplain, as any one may see while traveling across it on the train : its doabs are broad and continuous, and its valleys are relatively narrow and shallow. The Kittatinny lowland is intersected by streams whose valleys sink below its generally even, gently rolling surface ; but it was never so smooth as the Triassic plain. It was only a peneplain, and it is now a roughened peneplain. Perhaps the more adventurous terminologist will call it a past-peneplain ; but I dare not venture quite so far as that. When the Highlands were lowlands, their surface well deserved the name of peneplain ; but they were lifted so long ago into so high a position that they are now cut into a complicated mass of rugged uplands. They no longer deserve the name of peneplain ; and if in preceding paragraphs I have referred to them as constituting an old peneplain, it is because no satisfactory name has yet been applied to the particular stage of development of plains and plateaus in which they now stand. Having tried in vain to invent a term with which to name the Highlands, let me now advertise for one in the pages of our Magazine.

WANTED : a name applicable to those broken, rugged regions that have been developed by the normal processes of denudation from the once continuous surface of a plain or peneplain. The name should be if possible homologous with the words, *plain*, *peneplain* and *pastplain;* it should be of simple, convenient and euphonious form ; it must be satisfactory to many other persons than its inventor ; and its etymological construction should not be embarrassed by the attempt to crowd too much meaning into it. The mere suggestion that it was once a plain and that it is now maturely diversified will suffice.

The topography of northern New Jersey is therefore, like its structure, polygenetic. It exhibits very clearly a series of forms developed under three different geographic cycles, and closer search will doubtless discover forms belonging to yet other cycles, less complete and of briefer duration than these three. There is the tilted and deeply eroded peneplain of the Highlands, whose initial form may be called the Schooley peneplain, from the distinct exhibition of one of its remnants on Schooley's mountain; this was the product of Jurassic and Cretaceous denudation. There is the younger central baselevelled plain, developed during Tertiary time, or thereabouts, on the weaker Triassic and Cretaceous beds; and the associated valleys of the same age that have been sunk into the weakest rocks of the Highlands. There are the shallow valleys in the Central plain, of the latest post-tertiary cycle, requiring the name of this region to be changed from plain, as it was lately, to pastplain, as it is now. The first cycle, in which the Schooley peneplain was produced, witnessed the accomplishment of a great work; it included in its later part, besides various other oscillations, the sub-cycle when the seaward or southeastern part of the peneplain was gently submerged and buried to a slight depth under Cretaceous deposits. The second cycle was shorter; being a time sufficient to baselevel the softer beds, but not seriously to consume the harder parts of the preexisting surface. We are still in the third cycle, of which but a small part has elapsed. The question with which this essay opened may now be taken up.

The streams and rivers of northern New Jersey may be examined, with the intention of classifying them according to their conditions of origin, to their degree of complexity as indicated by the number of geographic cycles through which they have lived, and to the advance made toward their mature adjustment.

The Musconetcong may be taken as the type of the Highland streams. It flows southwestward along a narrow limestone valley between crystalline plateaus on either side, entering the Delaware a little below Easton, Pa., (E, fig. 1). It drains a country that has been enormously denuded, and during the Jura-Cretaceous cycle of this deep denudation, there must have been time for it and its fellows to become thoroughly adjusted to the structure of the region; it must be chiefly for this reason that it flows so closely along the weak limestone belt, and has its divides close by on the adjoining harder crystallines, (M, fig. 2). Whatever its origin, it has lost every initial feature that was discordant with the deep structures that it discovered beneath the initial surface; it is maturely adjusted to its environment. It endured to an old age during the baseleveling of the Schooley peneplain, and is now a "revived" stream, in at least its second cycle of work. Most of the other streams of the Highlands and the country farther inland are also of this well adjusted, revived kind. The streams of the Kittatinny valley lowland show not only the first revival of the kind just described, but also a second revival, in consequence of the recent uplift that has introduced the third cycle of development; this not being so clearly manifested in the Highlands, where the rocks are harder, and the valleys of the second cycle are narrower.

Look now at the drainage of the crescentic Watchung mountains; the curved edges of two great warped lava-flows of the Triassic belt. The noteworthy feature of this district is that the small streams in the southern part of the crescent rise on the back slope of the inner mountain and cut gaps in both mountains in order to reach the outer part of the Central Plain. If these streams were descended directly or by revival from ancestors antecedent to or consequent upon the monoclinal tilting of the Triassic formation, they could not possibly, in the long time and deep denudation that the region has endured, have down to the present time maintained courses so little adjusted to the structure of their basins. In so long a time as has elapsed since the tilting of the Triassic formation, the divides would have taken their places on the crest of the trap ridges and not behind the crest on the back slope. They cannot be subsequent streams, for such could not have pushed their sources headwards through a hard trap ridge. Subsequent streams are developed in accordance with structural details, not in violation of them. Their courses must have been taken *not long ago*, else they must surely have lost their heads back of the second mountain; some piratical subsequent branch of a larger transverse stream, like the Passaic, would have beheaded them.

The only method now known by which these several doubly transverse streams could have been established in the not too distant past, is by superimposition from the Cretaceous cover that was laid upon the old Schooley peneplain. It has already been stated that when the Highlands and this region together had been nearly baseleveled, the coastal portion of the resulting peneplain was submerged and buried by an unconformable cover of waste derived from the non-submerged portion: hence when the whole area was lifted to something like its present height, a new system of consequent streams was born on the revealed sea bottom. Since then, time enough may have passed to allow the streams to sink their channels through the unconformable cover and strip it off, and thus superimpose themselves on the Triassic rocks below: we should therefore find them, in so far as they have not yet been re-adjusted, following inconsequent, discordant courses on the under formation. The existing overlap of the Cretaceous beds on the still buried Triassic portion of the old Schooley peneplain makes it evident that such an origin for the Watchung streams is possible; but it has not yet been independently proved that the Cretaceous cover ever reached so far inland as to cross the Watchung ridges.

Want of other explanation for the Watchung streams is not satisfactory evidence in favor of the explanation here suggested. There should be external evidence that the Triassic area has actually been submerged and buried after it was baselevelled to the Schooley peneplain and before it was uplifted to its present altitude; other streams as well as the ones thus far indicated, should bear signs of superimposition; and if adjustment of the superimposed courses has begun, it should be systematically carried farthest near the largest streams. I shall not here state more than in brief form, the sufficient evidence that can be quoted in favor of the first and second requisites. Suffice it to say that the overlap of the Cretaceous beds (which contain practically no Triassic fragments) on the bevelled Triassic strata at Amboy and elsewhere indicates submergence after baselevelling; and that the pebbles, sands and marls of the Cretaceous series point clearly to the Highlands as their source. The submergence must therefore have reached inland across the Triassic formation at least to the margin of the crystalline rocks. Some shore-line cutting must have been done at the margin of the Highlands during Cretaceous time, but the generally rolling surface of the old peneplain leads me to ascribe its origin chiefly to subaërial wasting. Moreover, the North Branch of the Raritan, between Mendham and Peapack (* Fig. 1) and the Lockatong (L), a small branch of the Delaware on the West Hunterdon sandstone plateau, give striking indications of superimposition in the discordance of their courses with the weaker structural lines of their basins, so unlike the thoroughly adjusted course of the Musconetcong and its fellows, the Pohatcong, the Lopatcong, and others.

The third requisite of the proof of the inland extension of the Cretaceous, and the resulting superimposed origin of the Watchung streams may be stated in detail, as being more in the line of this essay: has the adjustment that accompanies superimposition systematically advanced farther near the large streams than near the small ones? The character of this adjustment should be first examined deductively. Given a series of streams of different volumes, flowing southeastward, in the direction of the present dip of the remnant of the Cretaceous cover, over the former inland extension of this superposed formation; how will these streams react on one another when they sink their channels into the underlying Triassic formation?

The conditions during the formation of the cover of Cretaceous beds are illustrated in fig. 2, where the Triassic portion of the

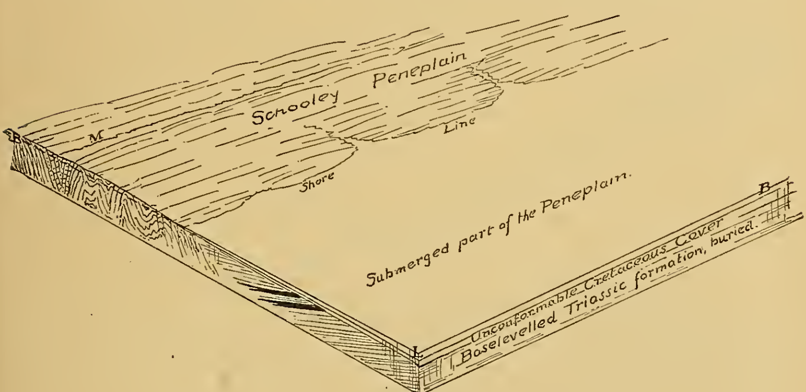


FIG. 2.

peneplain is submerged, and the shore-line of the transgressing ocean has reached the margin of the crystalline rocks. The waste from the crystallines is spread out as a series of gravels, sands and marls on the baselevelled Triassic area.

Then follows the elevation and tilting of the peneplain with the cover on its back; and with this regression of the sea, there is an equivalent gain of new land; a smooth gently sloping plain is revealed as the shore line retreats; streams run out across it from the crystalline area, or begin on its open surface, growing mouthward as the land rises. Three such streams, A, C, D, are shown in fig. 3; their opportunity for deep valley-cutting is indicated by the depth of the new baselevel, BL, below the general surface of the country. While these streams are deepening their channels in the Cretaceous cover, which is unshaded with marginal contour lines in the figures, their subsequent, autogenetic branches are irregularly disposed, because there is no lateral variation of structure to guide them; but after a time, the baselevelled surface of the buried Triassic beds is reached, as is shown by linear shading in the valley bottoms of figs. 4, 5, 6, 7. The growth of the subsequent branches then developed, will be along the strike of the Triassic softer beds, that is, about square

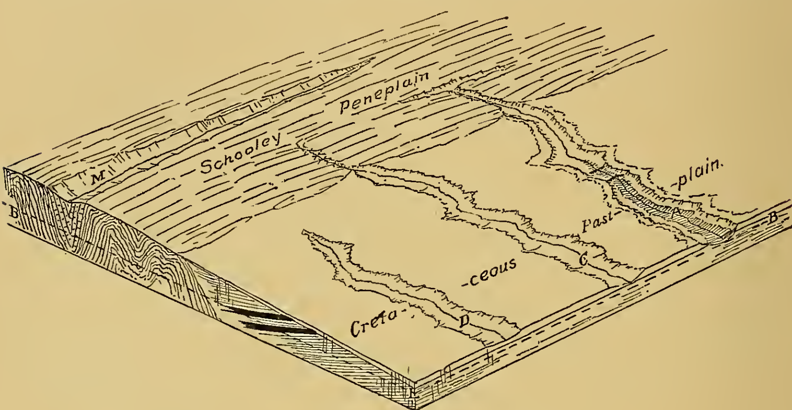


Fig. 3.

to the course of the three transverse streams under consideration. The most rapid growth will be found on the branches of the largest stream, A, because it will most quickly cut down its channel close to the baselevel of the time and thus provide steep sloping valley-sides, from which the subsequent branches cut backwards most energetically. In due time the main streams discover the particularly resistant transverse lava sheets in the underlying formation; and then the subsequent branches of the largest transverse stream on the up-stream side of the obstructions, for example, F and G, fig. 4, will have a great advantage over those of the smaller streams. The most rapidly growing subsequent branch, G, fig. 5, of the largest transverse master stream, A, may grow headwards so fast as to push away the divide, X, which separates it from the head of the opposing subsequent branch, J, of the next adjacent smaller transverse stream, C, and thus finally to capture and divert the headwaters, H, of the smaller transverse stream to the larger one, as in fig. 6.

The divide creeps while the two opposing subsequent branches are in contest ; it leaps when the successful subsequent branch reaches the channel of the conquered stream. The first stream captured in this way must necessarily be the nearest to the large stream. The diversion of the considerable volume of headwaters, H, to the channel of the small subsequent branch, G, causes it to

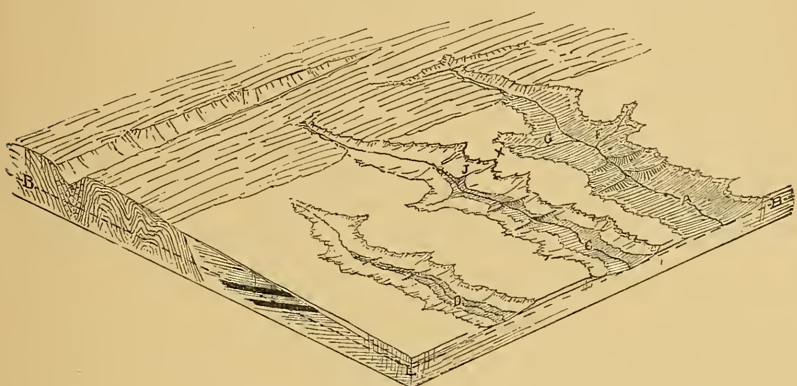


FIG. 4.

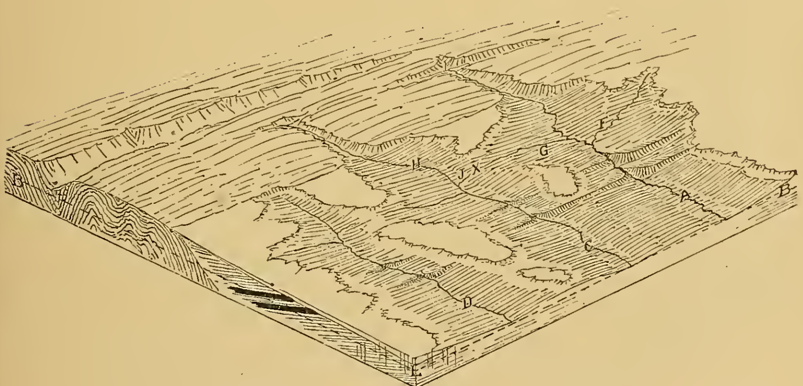


FIG. 5.

deepen its channel rapidly; the same effect is perceptible in H for a distance above its point of capture and diversion : the increased load of sediment thus given to G will be in great part dropped in a fan-delta where it enters the flat valley of the master stream, A, (fig. 6).

Gaining strength by conquest, other captures are made, faster for a time, but with decreasing slowness as the head of the diverting subsequent branch recedes from the original master: and at last, equilibrium may be gained when the headwater slope of the diverting branch is no greater than that of the opposing subsequent branch of the next uncaptured transverse stream. After the capture of a transverse stream has been effected in this way, the divide, Y, between its diverted upper portions, H, fig. 6, and

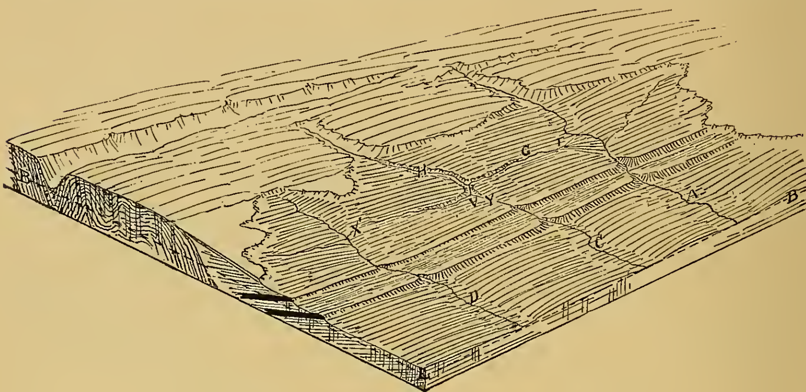


Fig. 6.

its beheaded lower portion, C, will be pushed down stream by the growth of an inverted stream, V. This goes on until equilibrium is attained and further shifting is prevented on reaching the hard transverse lava sheets, Z, fig. 7; here the divide is maturely

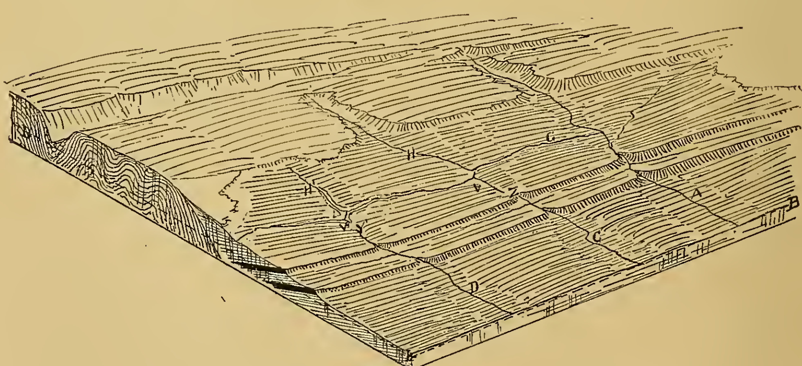


Fig. 7.

established. In the case of a system of transverse streams, C, D, etc., fig. 7, successively captured by the subsequent branch of a single master, the divides (Z, Y′), between the inverted (V, V′)

and beheaded (C, D) portions of the captured streams will for a time present different stages of approach to establishment. The divide on the line of that one of the original streams, C, that is nearest to the master stream, A, may reach a final stable position, Z; while on the next stream further away from the master, the beheaded portion, D, may still retain a short piece above the gap in the upper lava sheet, not yet secured by the inverted stream, V′; and a third stream, further away still from the master (not shown in figure 7) might remain uncaptured and independent.

It is by such tests as these that we may hope to recognize the occurrence of partial adjustment in the streams of the Watchung crescent as a result of their superimposition on the Triassic formation from its former Cretaceous cover. The greater the degree of complexity in the tests proposed, the more confidence we shall have in the theory when the tests successfully meet the facts. Hence the reason for deductively carrying out the theoretical conditions to their extremest consequences in order to increase the complexity of the tests that are to be confronted with the facts. This, as a matter of method, seems to me of great practical importance in any attempt to decipher the past progress of geographical development.

The admirable contoured topographic maps of New Jersey, issued by the Geological Survey of that state under the leadership of the late Professor George H. Cook, afforded means of applying the deductive tests above outlined without the necessity of plodding over all the country concerned; but however good the maps are, it is hardly necessary to say that they can be interpreted with a better appreciation of the facts that they represent after an excursion on the ground has given the student some personal acquaintance with it. This I have tried to gain on various occasions, maps in hand.

Atlas sheet number six, including the Central red-sandstone area, and the five-mile-to-an-inch geological map of the state present in the clearest manner the facts of form and structure involved in our problem; and to my mind, the correspondence between theory and fact is very striking. The Pequannock-Passaic is the master transverse stream of the region: its preëminence was probably due in the beginning to its gathering, from the unsubmerged Highlands, a greater amount of drainage than belonged to any other stream that ran southeastward down the gentle slope of the newly revealed Cretaceous cover. It was at that time a compound, composite river :* compound because it drained areas of different ages ; composite, because these areas were of different structures. Existing examples of compound, composite rivers are seen in the Catawba, the Yadkin-Pedee, the Cape Fear and the Neuse rivers of North Carolina, which all rise on the inland crystalline area, and traverse the coastal quaternary plain before reaching the sea. But unlike these, there must have been, when the old submerged land rose with the Cretaceous cover on its back, numerous small streams whose drainage area lay entirely within the Cretaceous plain. These were simple streams, flowing over a structure of one kind and one age. Their modern homologues are seen in the Maurice, the Great and Little Egg Harbor and the Wading rivers of southern New Jersey, and I suppose also in various relatively short streams of North Carolina, such as the Lumber, Great Cohera and Moccassin.

It cannot be supposed that the original Pequannock-Passaic possessed the large southern branch, which I shall call the upper Passaic, by which Great Swamp is now drained ;† for had this been the case, the divides between the branches of the upper Passaic and the heads of the small streams that now still cross both of the trap ridges, must have long ago been driven to a stable position on the crest line of the inner ridge. The upper Passaic member of the Pequannock-Passaic system must be regarded as a branch of subsequent development, guided by some of the softer Triassic beds when they were reached beneath the Cretaceous cover, and very successful in capturing and diverting other transverse streams that were smaller than its master. For some distance on either side from the Pequannock-Passaic gap in the trap ridges at Patterson, the existing streams are perfectly adjusted to the Triassic structure ; that is, the ridges are persistent divides, and the lateral subsequent branches of the master flow along the strike of the softer shales and sandstones, except where lately thrown off their courses by glacial drift barriers. This I interpret as meaning that the Pequannock-Passaic master

* See terminology suggested by the author. Nat. Geogr. Mag., i, 1889, 218.

† It should be recognized that the present round-about drainage of the Great Swamp is a post-glacial feature, determined by the morainic barrier that crosses the basin from Summit (S) to Morristown (M) : the preglacial drainage of the southern part of the inner crescent was undoubtedly of a simpler and more direct pattern.

stream hereabouts made so early a capture of adjacent superimposed streams that all traces of their initial discordant courses have been obliterated by the development of structurally accordant subsequent streams.

The Watchung ridges extend only about eight miles northward of the Paterson gaps, but reach thirty miles southwestward. It is therefore chiefly in the latter direction that we may expect to find examples of incomplete adjustment following superimposition and capture. At Milburn, there is a deep gap in First mountain, and opposite this at Summit (S, fig. 1) a partly drift-filled gap in Second mountain: this I am disposed to regard as the former outlet of the Rockaway-Rahway river, which on account of its considerable size was not captured by the Passaic until it had cut its passage across the trap sheets almost to a safe depth. The diverted upper portion—the Rockaway—now joins the Passaic; its crooked course from the Highlands via Boonton (Bn) being a post-glacial irregularity; the beheaded lower portion—the Rahway—heads on the ridge of Second mountain, retains the pair of subsequent streams between the two ridges, and flows in diminished volume to the sea: the divide between the two portions being in its mature stable position on Second mountain.

South of the Milburn gap, there are three streams that maintain water gaps in First mountain, and five head branches of these three streams rise behind the crest of Second mountain. These must be interpreted as remnants of streams that once rose further inland, and whose upper courses have been captured by the victorious upper Passaic; but it is noteworthy that here, at the greatest distance from the gap of the master stream at Paterson, the divides between the diverted and beheaded portions of these southern streams should lie in unstable positions, back of the crest line of Second mountain. This is exactly what the hypothesis of a superimposed origin for these streams would require; and if the complexity of accordance between deduction and fact here presented be duly considered, I believe new confidence may be gained in the hypothesis of superimposition, already rendered likely from other evidence.

The rectangular courses of the streams that cross First and Second mountains southwest of Milburn do not militate against their initial obliquely superimposed courses; for, as Gilbert has shown, oblique courses across tilted beds, alternately hard and soft, will gradually shift until they follow rectangular courses, along the strike of the soft beds and square across the strike of the hard beds. Middle Brook, at the southern bend of First mountain near Bound Brook (B, B), presents the peculiarity of branching east and west while on the trap sheet of the mountain: this may be due to a retention here, where the dip is moderate, of an initially superimposed bifurcation ; or to guidance by fractures at this point where the course of the mountain changes rather abruptly ; the facts at hand do not serve to make choice between these alternatives.

The lesson of greatest importance in this study lies, to my mind, in the gradual development of accordant subsequent streams in a region where the unchanged superimposed drainage would show no such accordance. Similar adjustment of subsequent streams to structural features may characterize drainage systems that were originally antecedent: and with this principle in mind, I have recently read over with renewed interest Powell's classic study of the Green river where it crosses the Uinta mountains.* The Green river and the smaller streams of its lateral cañons and valleys are all regarded as antecedent. Let us examine the arguments on which this conclusion rests.

The Green river itself rises many miles north of the Uinta range, traverses a relatively low basin before reaching the flank of the mountains, and then instead of turning away, it boldly enters the great uplift and trenches it from side to side in a profound cañon, flowing out to the southwest on its way to the Colorado. There is relatively low ground at the eastern end of the range, several thousand feet lower than the summits of the range on either side of the Green river cañon, and many thousand feet lower than the restored crest of the great uplift ; but the river does not follow this open round-about course. Powell says that the river cut through, instead of running around, the great obstruction, because it "had the right of way ; . . it was running ere the mountains were formed." Had the mountain fold been formed suddenly, it would have turned the river around it to the east ; "but the emergence of the fold above the general surface of the country was little or no faster than the progress of the corrasion of the channel." . . . . . "The river preserved its level, but the mountains were lifted up. . . . . The river was the saw

* Exploration of the Colorado river of the west, Washington, 1875. 152–166. See also the geological map in the Geology of the Uinta mountains, 1876.

which cut the mountains in two" (152, 153). If this interpretation is correct, the Green river would be the type of a perfect antecedent stream : but it appears to me that the case is probably overstated in that respect. Perhaps it would have been more deliberately stated in a later volume if Powell's intention of describing more fully the three chief kinds of drainage of the region had been carried out.* Not having seen the region, my comments may have little value ; but the context of Powell's report, the description of the immense series of lacustrine beds, over a mile thick, north of the mountains, and the eastward deflection of the river where it traverses the mountains all seem to me to indicate that the Green was by no means continuously successful in maintaining its antecedent course across the uplift. It is by no means a typical antecedent river. The great series of lacustrine beds up-stream from the cañon, with conglomerates where they rest on the northern flank of the mountains, are fully recognized in the report, and must mean that the upper portion of the river was for a time shut back, or ponded. During part of this time, there may have been no overflow across the growing mountains, for the lower lacustrine beds contain fossils indicative of brackish water.† The intermittent growth of the mountains and the repeated return of lacustrine conditions, with gradually freshening water, is indicated by the strong unconformities that occur at various points in the lacustrine beds, and by the change in the fossil fauna. It must be conceded from this that the upper portion of Green river was repeatedly ponded back by mountain growth across its middle course ; we therefore have not now any close indication of its pre-lacustrine course above the mountains ; the ancient, or pre-Uinta, upper portion of the river was extinguished by the lacustrine sediments, and to that extent the Green river departs from the perfect antecedent type.

In the second place, if the original Green river existed upon the upper surface of the beds that were at a subsequent date raised to form the Uinta uplift, it does not appear to be clearly proved that its course at that early time was closely coincident with its present course in the mountainous area. The first deformations of the mountain growth may have temporarily interrupted its flow, as is made likely by the lacustrine deposits

* Geol. Uinta mountain, page v.

† Geology of the Uinta mountains, 1876, 84 ; Chapter III, by C. A. White.

already referred to; and when the rise in the level of the waters of the lake overtook the uplift, probably at a time of slower mountain growth than that which first formed the lake, the point of overflow may have been many miles to one side of its previous drowned-out course. The moderate elevation of the eastern end of the range, where it connects with the Yampa plateau, may possibly have then been a little higher than a point farther west, where the overflow was consequently located. This is perhaps hardly as probable as the postulates involved in arguing a truly antecedent course for the river; but its impossibility is not as strictly proved as would be necessary before a definite conclusion as to the continuous persistence of an antecedent river could be finally accepted. Such continuity of action must be rare and should be rigorously demonstrated if possible.

It must, moreover, be remembered that Emmons* is of the opinion that the Colorado river is not antecedent at all, but is superimposed on the eastern portion of the Uinta range from a course that it had chosen upon a sheet of horizontal sediments—the Wyoming conglomerate—which he supposes once stretched unconformably all over the previously deeply eroded surface of the uplifted range, where the cañon is now cut. He quotes facts of two kinds in evidence of this; first, the remnants of the Wyoming conglomerate still lie on ridges as high as those that enclose the river cañons; second, the Green and certain of its branches possess tortuous courses, out of accord with the structure of the range. It might be added that the wide open valley of Brown's park, in the middle of the range is best explained as the product of a pre-Wyoming cycle of erosion by rivers that were extinguished when the Wyoming beds were laid over the mountains. The strongest objection to Emmons' conclusion seems to be the great amount of erosion that it requires; erosion sufficient not only to remove the Wyoming conglomerate from nearly all its former overlap on the Uinta range, where it had buried and extinguished a pre-Wyoming drainage, but also to carry away a vast extension of the formation at the same height north of the range. It may be best to conclude that both antecedent and superimposed processes must be called on: for one must hesitate before admitting that the Wyoming beds stretched all across the country north and east of the Uinta range up to the height at which the remnants are now found on the range;

* Fortieth Parallel Survey, ii, 1877, 194, 205, 206.

it seems more likely that some part of the height of these remnants is due to a relatively local elevation. As far as this is the case, it gives reason for regarding the Green as an antecedent river ; that is, antecedent to the local elevation of the Wyoming beds, but long posterior to the elevation of the Uinta range : but as the river now flows—according to Emmons' theory—on beds lying unconformably below those on which its course was chosen, it is for this reason to be classed as superimposed.

The Green river therefore certainly departs from the type of an antecedent stream; the departure is distinct in its repeated ponding, whereby its upper course was broadly and indeterminately shifted from its original location; and is at least possible if not probable in its defeat at the line of uplift and subsequent superimposition on a new line of overflow. The mountains wrenched the saw that afterwards cut them in two.

A study of the Jura drainage, of which a fuller account may be given at some future time, has led to the provisional conclusion that many of its streams show a combination of consequent and antecedent characteristics. They appear to be consequent on the early stages of the deformation but antecedent to its later growth, and for this kind of a stream I have no satisfactory name to suggest at present.

Heim has shown that the Reuss and the adjacent smaller transverse streams of northern Switzerland near Lucerne are in part persistent across a series of folds, and in part slightly shifted from one course to another and ponded in Lake Lucerne; but unless the other ranges of the Alps rise hereafter faster than they have heretofore, the geologist of the future will reasonably regard the more mature Reuss as an essentially successful antecedent river.

The Sutlej and other rivers that escape from the inner valleys of the Himalaya by deep gaps in the outer ranges, are described by Medlicott as antecedent to the elevation of the ranges through which they flow: their antecedent origin being argued from the delta-like structure of the upturned beds in the outer gorges, as if the rivers were now cutting down the deformed deltas of an earlier time ; but the heavy gravel and sand deposits in their upper valleys indicates that they were nearly if not quite ponded for a time during the deformation.

Rivers seem to have the habit of cutting down their upturned deltas. Bonney refers to several such examples among the rivers that flow northward from the Alps, and transect particularly thick portions of the upturned marginal conglomerates and sandstones, which he regards as the deltas formed by the same rivers at an earlier time, when the mountain folding had not extended outward as far as it does now from the axis of the Alps. I have suspected that the same kind of evidence might be used to indicate that the Delaware above Trenton, between Pennsylvania and New Jersey, is in part of even pre-Triassic origin ; for where it now enters the Triassic belt, there is a particularly heavy and coarse sandstone, sometimes conglomeratic. Being a large stream, it might persist in an anaclinal course through the northwestward monocline formed by the Jurassic uplift of the Triassic beds, although the smaller streams of the region were then probably extinguished, to be replaced by a new system consequent upon the new order of things.

Large rivers, more or less persistent in the face of opposing disturbance, therefore appear to be generally recognized; but it is noticeable that those quoted from the Himalaya and the Alps presumably occupied, at the time of disturbance, well enclosed valleys, from which it would have been difficult for them to escape backwards or laterally; and that, even if successful in the end, they for a time suffered defeat or ponding of greater or less extent and duration. There is no evidence that the Green river was well enclosed immediately north of the Uinta mountains at the time of their first elevation; hence the likelihood of its temporary ponding or enclosure is increased.

It is stated by Powell that not only the Green but even the smaller streams of the Uintas are of origin antecedent to the mountains. He writes: "the explanation of the cañons of Green river will assist us in understanding the origin of the lateral valleys and cañons. The streams were there before the mountains were made—that is, the streams carved out the valleys and left the mountains. The direction of the streams is indisputable evidence that the elevation of the fold was so slow as not to divert the streams, although the total amount of elevation was many thousands of feet. Had the fold been lifted more rapidly than the principal streams could have cut their channels, Green river would have been turned about it, and all the smaller streams and waterways would have been cataclinal" (Colorado River, 162).

This appears to me an unproved conclusion, and the evidence of it needs careful attention. It appears that there are several streams which descend from the crest of the mountains towards the flanks, but instead of running all the way out to the margin of the fold, they turn along the strike of a monoclinal valley, and thus reach the main river by a short cut. Such streams are cataclinal for a time, then monoclinal. It is in reference to these that it is said, "the streams were there before the mountains were made;" and again that "the drainage was established antecedent to the corrugation or displacement of the beds by faulting and folding" (163). In approaching this conclusion, Powell says these streams cannot be consequent; for "valleys consequent upon the corrugation, which was one of the conditions of the origin of the Uinta mountains, could not have taken the direction observed in this system; they would have all been cataclinal, as they ran down from the mountains, and turned into synclinal valleys at the foot, forming a very different system from that which now obtains" (166). Nor can the streams be superimposed, for the "later sedimentary beds, both to the north and south, were found not to have been continuous over the mountain system, but to have been deposited in waters whose shores were limited by the lower reaches of the range" (166). Therefore the discordant streams must be antecedent.

It appears to me that the possibility of error in this argument lies in the omission of all consideration of the migration of divides and the resulting adjustment of stream courses to deep internal structure; but at the time of the exploration of the Colorado river, this important process in the development of rivers was not understood. It now seems only natural that the original, consequent, cataclinal streams, flowing down the slopes of the range from crest to flanks, should have permitted the opening of subsequent monoclinal branches on the soft beds that they discovered; and that the shifting of divides in these monoclinal valleys should have led to the capture of several cataclinal streams by that particular one of the subsequent branches that grew out from the master stream, the Green river itself. Thus it must happen that the streams "which head near the summit of the range, and, running down the flank, turn into the Green river, are, in their upper courses, cataclinal, and when they turn to follow the strike of the rocks into Green river, are monoclinal" (161): this being a normal result of river work in cutting down the thousands of feet of rocks of various hardnesses, here concerned. The smaller streams of the Uinta range are therefore certainly not of necessity antecedent to the Uinta uplift: the probability is that they were originally purely consequent, and that at present they are nicely adjusted to the structures that they have discovered.

I have learned so much from the doctrine of baselevelling, as presented in Major Powell's writings, that I shall hope to profit by the lesson of the Uinta drainage as well: that is, the possibility that an apparently sound conclusion may be overturned when new processes that bear upon it are discovered. It is here said that the drainage of the Watchung crescent in New Jersey is an example of partial adjustment following a superimposed origin: hence the necessity of watching closely for the discovery of new principles in the history of river work that may call for a revision of this conclusion.

There are two other examples of peculiar accidents in the history of rivers in New Jersey, to which I wish to call attention; both of them in the latest cycle of the development of the State, that is, in the cycle which has changed the central region from its even baselevelled lowland surface, to the pastplain as we now see it. Like the uplift of the Schooley (Highland) peneplain, the uplift of the Central plain, in passing from the second to the third cycle, was not uniform throughout, but was greater in one place than in another. In the neighborhood of the lower Raritan river, a distinct though gentle slope to the northwest is apparent in the unconsumed surface of the pastplain; but this strong river runs southeastward against the slope; it is an anaclinal stream. The tilting of the pastplain is moderate, and its rocks are weak; the river is large and strong. Its anaclinal course is therefore best explained by regarding it as a mild example of an antecedent stream. But Ambrose's brook, a small stream to one side of the Raritan, flows northwest with the gentle slope that was given to the pastplain. Ambrose's brook therefore most likely is not a survivor from the previous cycle, but is a new stream consequent on the slight deformation by which the latest cycle here considered was ushered in. Manalapan and Assanpink are apparently of the same kind. (See fig. 1).

The Millstone river appears to be intermediate as respects origin between the Raritan and Ambrose's brook. It appears still to lie for the most part in the channel that it occupied before the elevation and tilting of the baselevelled Central plain, but the tilting of the plain seems to have reversed its direction of flow. It rises near the center of the State and flows northwestward till it joins the Raritan near Somerville, and on the way it crosses from the thrown or depressed to the heaved or elevated side of the "fall-line,"* and passes through a deep gap in the trap ridge of Rocky Hill back of Princeton. I believe there is no other Atlantic river which runs against the fall-line in this way ; and it is certainly at first sight remarkable that a stream of moderate size like the Millstone should have held its own against a displacement that sufficed to deflect great rivers like the Delaware and the Susquehanna from their courses.

The Millstone appears to have been a stream of the normal kind in the previous cycle, before the tilting of the Central plain, when it probably ran southeastward with its fellows, and carried off its share of waste in the baselevelling process of that time. No other supposition than this seems consistent with the general history of the region. It was during that cycle that the deep gap was cut in the Rocky Hill trap ridge. Then came the deformation of the baselevelled plain, the relatively recent elevation and gentle tilting that have permitted the streams to carve it into a pastplain ; and with this, the dislocation along the fall-line. The inclination of the interstream surfaces of the pastplain leaves no doubt that it was tilted to the northwest, and to this tilting we must ascribe the present direction of the Millstone flow : but why did not the accompanying dislocation on the fall-line throw this moderate sized stream off of its track and divert it southwestward to the Delaware at Trenton, or northeastward to the Raritan below New Brunswick. The effect of the dislocation appears with considerable distinctness along a line from Trenton towards Amboy, in the less altitude of the general surface of the pastplain to the southeast than to the northwest of the line, the difference of altitude of the two parts being about a hundred feet. The persistence of the Millstone against such a dislocation seems to require that we should postulate a slower and smaller movement here than that which deflected the Delaware.

The reversed course of the Millstone cannot be regarded as an example of inversion following a capture of its ancient northern headwaters by a branch of the Raritan ; for in such a case, surely the inversion could not have progressed farther south than the

* For an account of the "fall-line" displacement, see McGee, Seventh Ann. Rep., U. S. G. S., 1888, 616.

hard trap ridge of Rocky Hill, where a stable divide would have been formed: nor can the Millstone be regarded as an original stream, first developed and consequent upon the deformation of the Central plain, for in that case, it should consist of two separate parts; one part running from the actual head of the river to the fall-line, where it would turn southwest and cross the faint flat divide that separates it from the Delaware; the other part beginning by Princeton north of the fall-line, and running thence north to the Raritan. The continuity of these two parts in the actual Millstone seems to be explicable only by regarding the river as the upper portion of a single larger river that had reached an old age in the previous cycle; it was then broken in two at the head of the present river where the greatest elevation of the Central plain occurred, and thus had its former head waters reversed from a southeast to a northwest direction of flow across and against the fall-line break by the tilting of the plain. Only in this way can the deep gap in Rocky Hill be explained. The river is thus consequent on the tilting of the plain, and yet antecedent to the accompanying faulting. It cannot be called an original stream, for it had an ancestor in its very channel. It is not a purely consequent stream, for it runs against the heaved side of a fault. It is not a strictly antecedent stream, for it flows in a direction determined by a disturbance that occurred late in its life. It is too exceptional a stream to have a generic name. We cannot expect to find many others like it.

The result that has been of the greatest interest to me in these studies is the discovery of well-recorded and peculiar histories in the commonplace small-sized rivers of our Atlantic slope. We have looked for some years to the west as the region where river history should be illustrated, because it was there that the pioneers in this branch of study taught us the lessons on which our further work must depend. But home study as well as distant travel has its rewards, and with the progress of good topographic work on this side of the country we confidently await much instruction from a close acquaintance with the curious histories of many of our rivers which we know now only by name.

Harvard College, January, 1890.

Supplementary Note.—Professor Albrecht Penck of Vienna has published a valuable essay on "Die Bildung der Durchbruchsthäler" (Verein zur Verbreitung naturwissenschaftlicher Kenntnisse in Wien, 1888) from which the following historical notes are taken to illustrate the gradual overthrow of the fracture theory of cross valleys by the introduction of the idea that rivers can sometimes cut down their beds as fast as the land is uplifted or upfolded beneath them.

Ferd. Römer. Die jurassische Weserkette. Zeit. d. deutsch. geol. Gesellsch., ix, 1857, 581. The deepening of valleys by rivers and streams must keep pace with the gradual elevation of continental masses. The Porta Westphalica has thus been cut by the Weser in the Wiehen-Weser range, in the northeastern part of Westphalia.

A similar suggestion was briefly made a little later by Bischoff, to explain the gorge of the Rhine below Bingen. Lehrb. d. chem. u. phys. Geol., 2 Aufl., i, 374, 382: and again independently for the same river by Dücker. Zeitschr. d. Gesellsch. f. Erdk. Berlin, v, 1870, 183.

Gümbel explained the course of the Altmühl, a branch of the Danube which crosses the Frankish Jura in northwestern Bavaria, by supposing its course was defined before and maintained during the deformation of the range. Bavaria: Landes- und Volkskunde des Königreichs Bayern, 1865, iii, 756.

Medlicott recognized that many streams flowing from the inner Himalaya are older than the outer ranges, and showed reason for believing that they held their places while the outer ranges were tilted up. Mem. Geol. Survey India, iii, 1865, 6, 122, 127, 157, 163. A little later, he applied the same explanation to some Alpine rivers. The Alps and the Himalayas, a geological comparison. Q. Journ. Geol. Soc., London, xiv, 1868, 47, 52.

Wynne explains the Indus and adjacent rivers as of greater age than the elevation of the Salt Range in northwestern India. Mem. Geol. Survey India, xi, 1875; xiv, 1878.

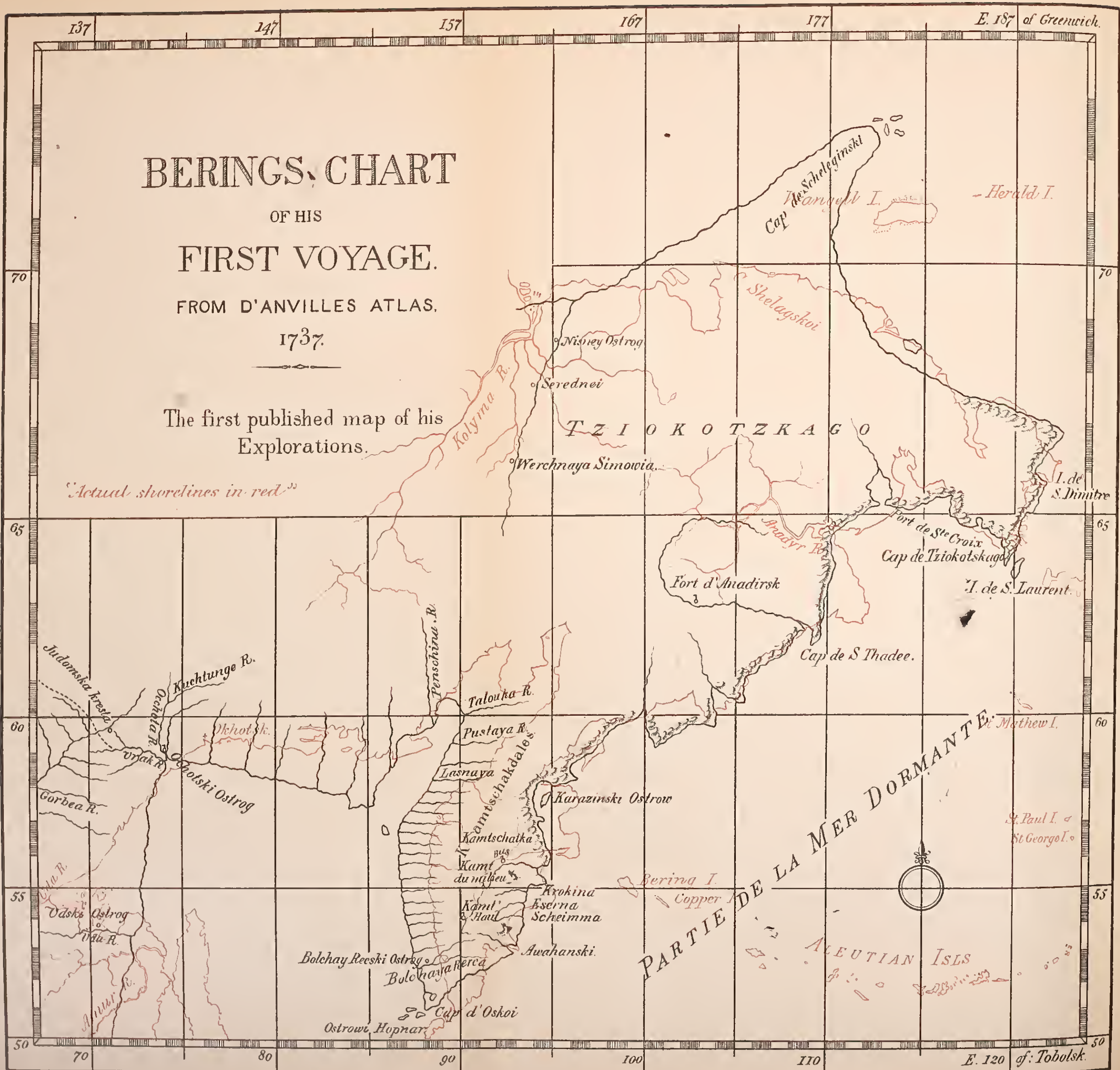
Rütimeyer recognized the possibility of uprising ranges being cut down by transverse rivers, but regarded the occurrence as a rare one, thinking that lakes would generally appear behind such a growing barrier. He emphasized the idea that erosion works upstream, which Löwl has later developed farther. Ueber Thal- und Seebildung, Basel, 1869; 2 Aufl., 1874.

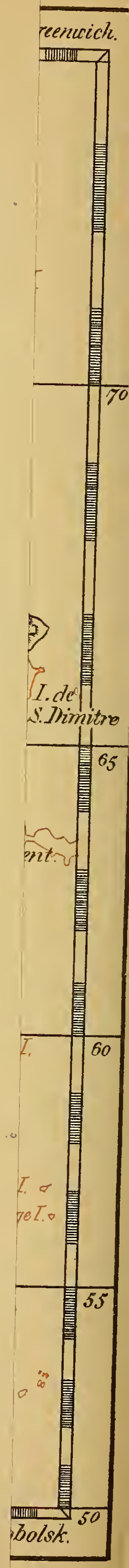
Tietze regarded the persistence of rivers across growing ranges as the rule rather than the exception. Die Bildung von Querthälern. Jahrb. d. k. k. Geol. Reichsanst., 1878, 581.

Hayden was perhaps the first to point out in this country the antecedent origin of certain headwaters of the Missouri in Montana, where the mountain ranges are frequently cut across by deep cañons. Amer. Journ. Science, xxxiii, 1862, 305. Hayden's Sixth Report, 1872 (1873), 85.

Reference may be made also to White, Hayden's Tenth Report, 1876 (1878), 52 ; Peale, id., 167 ; Bechler, id., 372. General discussion of valley making is given by Green, Geology for students and general readers, London, 1876 ; Hartung, Zeitschr. Gesellsch. f. Erdkunde, Berlin, 1878, 308.

In spite of the early date of some of these essays, the idea of the antecedent origin of rivers did not gain general recognition and acceptance till it was strongly stated by Powell.


BERINGS CHART
OF HIS
FIRST VOYAGE.
FROM D'ANVILLES ATLAS.
1737.
The first published map of his Explorations.
"Actual shorelines in red"
E. 187 of Greenwich.
137
147
157
167
177
70
65
60
55
50
80
90
100
110
E. 120 of Tobolsk.
Cap de Schelaginski
Wrangell I.
Herald I.
C. Shelagskoi
Kolyma R.
Nisney Ostrog
Serednei
TZIOKOTZKAGO
Werchnaya Simowia.
I. de S. Dimitre
Anadyr R.
Port de Ste Croix
Cap de Tziokotskago
Fort d'Anadirsk
I. de S. Laurent.
Cap de S Thadee.
Judomska kresta
Kuchtunge R.
Ochota R.
Penschina R.
Talouka R.
Okhotsk.
Urak R.
Ochotski Ostrog
Pustaya R.
Lasnaya
Kamtschakdales
Karazinski Ostrow
St Mathew I.
Gorbea R.
PARTIE DE LA MER DORMANTE
St Paul I.
St George I.
Kamtschatka
Kamt du milieu
Krokina
Bering I.
Copper I.
Udsks Ostrog
Uda R.
Kamt' & Haut
Escrna
Scheimma
Awahanski.
ALEUTIAN ISLS
Bolchay Reeski Ostrog
Bolchaya Rerca
Amur R.
Cap d'Oskoi
Ostrowi Hopnar


reenwich.
70
I. de
S. Dimitre
65
ent.
60
ge I.
55
50
bolsk.

A CRITICAL REVIEW OF BERING'S FIRST EXPEDITION, 1725–30, TOGETHER WITH A TRANSLATION OF HIS ORIGINAL REPORT UPON IT. With a Map.

By Wm. H. Dall.

Contents. — Introductory remarks. – Instruments and Methods. — Sources of information.—Translation of Bering's Report.—Bering's List of Geographical Positions.—An Itinerary of the Expedition.—Annotated Synopsis of the Voyage compiled from all accessible data. —Comparative Table of Geographical Positions.—Resumé of the results of the Expedition.

In 1648 the tide of exploration and adventure setting eastward through Siberia, impelled the fitting out of seven small trading boats on the Kolyma river. Three of these, in charge of Simeon Deshneff, Gerasim Ankudinoff and Feodor Alexieff, respectively, reached Bering Strait. Ankudinoff's boat was wrecked on East Cape, but his party was accommodated on the others. There were hostilities with the Chukchi, the two boats were separated, and Deshneff's alone finally reached Kamchatka. Next year he constructed the trading post on the Anadyr river subsequently known as Anadyrsk.

There is a tradition that in 1654 a trader named Taras Stadukin followed Deshneff's route, made a portage across the neck of East Cape, circumnavigated Kamchatka, discovered the Kurile Islands, and finally reached the Gulf of Penjina in safety.

In 1711 an emissary named Peter Iliunsen Popoff was sent to East Cape by the Russians to induce the Chukchi to pay tribute. In this he failed, but brought back an account of islands beyond East Cape, and of a continent reported by the Chukchi to exist beyond these islands. Some statements which he made in regard to the people of this continent were regarded by geographers of the last century as fictitious, but with our better knowledge, they set the seal of authenticity upon Popoff's report and show that his journey was really made.

The political disorders which prevailed in Western Russia about this period, prevented any attention from being directed to the reports of these explorations, which were preserved in the archives at Yakutsk. Somewhat later the attention of geographers was directed toward this unknown corner of the world and the subject was brought to the notice of Peter the Great. He took great interest in it, drew up instructions for an expedition with his own hand and delivered them to Count Apraxin with orders to see them executed. A few days later, in January, 1725, he died; but the Empress desiring to carry out all the plans of her deceased husband as closely as possible, ordered their execution. Fleet-Captain Vitus Ivanovich Bering was nominated to the command of the expedition and Lieutenants Martin Spanberg* and Alexie Chirikoff to be his assistants.

This expedition forms the subject of this paper. It has been treated of by various geographers and biographers, but so far the original report of Bering, printed in 1847 in the Russian language, has never been faithfully translated into any other language; while his map has never, in its entirety, been published at all. Reduced sketches derived from the maps and more or less mutilated and garbled versions of the report have appeared in sundry collections of voyages, and upon these the latest contributions to the history of the expedition have been in great part based.

Believing that the original report is a document of sufficient historic and geographic interest to be made accessible to those who do not read Russian, and that the errors of existing works make a critical review of the subject desirable, I have translated the document in question and prepared a general review of the present state of our knowledge in regard to the expedition.

Bering's Report being written in archaic and badly spelled Russian, with a singular disregard of punctuation and other literary niceties, the translation presented unusual difficulties, in solving which I have had the kind coöperation of that excellent Russian scholar Mr. J. Curtin. I am indebted to the Reverend Father Richards, president of Georgetown University, and Father Maas of Woodstock College, Md., for valuable information in regard to the church festivals and saints, whose names were utilized in the nomenclature of Bering's new discoveries. To Mr. Marcus Baker, Messrs. Gannett and Woodward, and Mr. C. C. Darwin of the Geological Survey; Dr. S. Hertzenstein of the Zoological Museum of the Academy of Sciences, St. Petersburg; Baron Nordenskiöld of Stockholm, and Baron Robert Klinckofström; Drs. Holm and Stejneger of the U. S. National Museum, and Prof. Julius Olson of Madison, Wisconsin, I am

* So spelled by Bering himself.

indebted for numerous favors and courteous assistance, and to all of these gentlemen I desire to express my thanks.

In conclusion I desire to state that I am well aware this paper cannot be regarded as a finality, but as a contribution to the geographical history of North America it will not be without its value, while the fact that I have myself spent parts of three summers in scientific exploration of the coast visited by Bering and first charted by him, has greatly helped me in my discussion of minor details of his work.

Instruments and Methods.

In considering the work done by the expedition it is very necessary to bear in mind the character of the instrumental outfit, if any, which they might have possessed, and the state of the science of navigation at the time.

When Bering and his two cartographers left St. Petersburg in February, 1725, the astronomical instrument in use by navigators was the Davis quadrant or "backstaff," in which the sun's altitude was measured by sighting without a telescope or tube on the shadow cast by the sun from one projection of the instrument upon another, the observer's back of course, being turned to the luminary. The only alternative to this was the still older astrolabe with which the observer had to look along the two lines of his angle at the same time, and which also depended upon sights or spurs attached to a frame. The reflecting quadrant of Hadley was not invented until 1731 and telescopes were not used on the instruments of navigation until somewhat later. There were no chronometers or reliable watches or clocks for use in dividing intervals of time. Even after the Hadley quadrant came into use, time was noted by a pendulum vibrating seconds, which could not be used on ship-board.

A futile attempt had been made by means of tables of variation of the compass to determine the longitude by comparison with observed variation in the field. Results by this method approached the truth accidentally, if at all. Lunar observations were the only means of getting an approximation to the longitude except the occultations of Jupiter's satellites, both methods being impracticable on board ship, with the instruments then employed.

In 1731 the astronomer Halley proved* that at that date it was still impossible to find the longitude correctly by the moon, the

* Phil. Trans. 1731, No. 421.

lunar tables being so inaccurate that an error of several hundred miles was quite possible and an accurate determination would depend upon the respective errors of instrument, observation and the lunar tables happening to balance one another. Halley ventured to express the hope that the tables may be so amended that an error may scarce ever exceed three minutes, which would correspond to a degree and a half of longitude, amounting at the equator to a distance of a little less than one hundred miles. Messerschmidt, who preceded Bering as an explorer of Eastern Siberia, was according to Middendorf (Sib. Reise, iv. 1, p. 56) thirty-two degress out in his determination of the longitude, and the eastward extent of Asia in this region was underrated by that amount or thereabouts, on many maps.

One other means of approximating to the meridian remained, in the observation of eclipses. This from the comparative rarity of these occurrences in the case of the sun and moon, could with the imperfect instruments of those days be available but seldom. Owing to the difficulty of determining the exact time of the first and last contacts the longitudes computed by these observations were liable to quite as great inaccuracy as those computed from the lunar tables. Still an ordinary spyglass would enable an observer to note the time within a minute or two, and, if he was possessed of the local time, a simple comparison with the observed time of the eclipse in some locality where the longitude was known would give a fairly good determination, considering the instruments and methods of those days. Of the four eclipses of the moon occurring in 1728–9 two might have been observed without difficulty by Bering, one would have been invisible to him, and one might barely have been noted, but in all probability was not observed by him. In none of the published reports of the expedition is any mention made by Bering or his officers of the occurrence or observation of an eclipse, which seems very singular if by such an observation he was enabled to correct an error of 30° in the longitude of northeastern Siberia. However, Middendorf states (Sib. Reise, iv. 1, p. 56) that "Bering and his lieutenant in the years 1728 and 1729 observed in Kamchatka* two eclipses of the moon," by which they corrected the longitude. He gives no authority for this statement.

* It is possible that an eclipse observed at Ilimsk in Middle Siberia by Chirikoff is thus erroneously referred to.

Euler, who had access to the archives of the Admiralty College, while engaged on a Geography of Russia, mentions (Philos. Trans., No. 482, p. 421) that he was informed that Bering observed an eclipse "at Kamchatka." This letter of Euler's is copied by Campbell in Harris' Voyages (vol. II, Book III, p. 1024) and the expression "at Kamchatka" has led to the statement that these observations were made at the fort or village of Lower Kamchatka. This is an error since Bering gives no longitude for the fort in his table of geographical positions. It must be remembered that the name Kamchatka at that period was applied not merely to the peninsula as at present, but also to the whole region of northeastern Siberia, the governor of Kamchatka being located at Okhotsk. So to come within the probable meaning of the phrases used by Middendorf and Euler it is only necessary to suppose that the observations were made somewhere in that region. Lauridsen (Danish edition, note 34, p. 186) refers to a paper of Struve (Bull. phys.-math. Acad. St. Petersb., I, 1842, p. 290) containing a table of geographical positions in Russia, in connection with these alleged observations of Bering. An examination of Struve's paper does not bear out the implication of Lauridsen's reference, as Struve not only makes no mention whatever of Bering's observations there but specifically states that the first observations of precision made in this part of Siberia were those of Krassilnikoff who accompanied Bering's second expedition in 1741. It would seem extraordinary that a determination so important for geography as that of Bering and his companion should be unknown to so distinguished an astronomer as Struve who must have had access to all the archives of the early explorations by Russia. But it may be perhaps accounted for by the facts that Bering's observations were necessarily of a very rough and primitive character—as it is certain he had no instruments of precision; and that, for that reason, they were not received with entire confidence; so that Struve may have considered them insufficiently exact to be included with those of Krassilnikoff and others made with more modern appliances.

From the note in regard to the eclipses which is kindly contributed by Mr. Marcus Baker and from the other circumstances, it is evident that if Bering and his party made the observations alluded to, the eclipses noted were the partial eclipse of Feb. 25 (local calendar), 1728, of which he might have observed the last contact, or the total eclipse of Feb. 14, 1729, of which he might have observed the first contact and the totality. At the time of the last eclipse he was at Lower Kamchatka post, and as, in the list of positions handed in with his Report in 1730, no longitude is entered for this locality, it would seem that choice is reduced to the first of the two mentioned ; which occurred when Bering was either at Bolsheretsk or on his way from that place to Lower Kamchatka, which he reached about a month later. Campbell's table of positions is credited by him to the year 1728, but my own opinion is that it was really derived (with various errors, interpolations, etc.) from Bering's table of 1730.

The ordinary method of getting the longitude of a place, and that upon which Bering originally depended, as his itinerary table shows, was by a continuous record of the distances and directions traveled from a point of known longitude. This record would afford the data from which the distance on a mean parallel, by means of a traverse table, could be computed. Laborious, imperfect, and slow as it was, it was the only sure reliance of the traveler in those days. Whether Bering observed an eclipse or not, it is certain that his original dependence was upon his itinerary, that his report was based upon that and that this part of his work was done as well as the nature of the method would permit. His silence about the eclipse may be due to the fact that he depended not upon astronomical but upon pedometric observations, to which the eclipse may have afforded some corrections. At any rate the pedometric determination of the distance between Tobolsk and Okhotsk or the peninsula of Kamchatka was in itself a tremendous undertaking.

I find by a rough calculation from Bering's data that the longitude resulting from his itinerary from Tobolsk to Okhotsk is 77° 36′ E. The distance in a straight line is about 2,390 miles, but by the route Bering traveled the distance is a little more than 3,746 miles. The longitude in Bering's List of Positions is 76° 07′, which differs from the pedometric measurement by 1° 29′ (or about 45 miles). On Bering's map, Okhotsk is located in longitude 74° 30′ E. of Tobolsk, while the most modern observations for Okhotsk put it in 142° 40′ E. of Greenwich or 75° 40′ E. of Tobolsk. So that Bering's pedometric measurement was nearly 60 miles in excess ; his revised table (as corrected by the eclipse ?) 27 miles in excess ; and his map about 30 miles in error in the opposite direction. These discrepancies show the inexactness of the methods then in vogue and also that the pedometric method was not very much worse than the others in its results. Although there are several typographic or other errors in his table of itinerary which render exact comparisons impossible, it may be said that the error of the pedometric method, including the passage by sea from Okhotsk to Kamchatka, averages about two degrees or sixty geographical miles. In the cases of Okhotsk and Bolsheretsk the error is one of excess; in the case of the cape at the mouth of the Kamchatka river and of the turning point of the expedition north of Bering Strait, the result is too small by about the same amount.

That his chart and his revised list of positions should differ as they do, is quite as likely the result of the careless way in which the minutiæ of such work were generally regarded at that day, as to any difference of date, or of intentional modification.

To conclude our review of the instrumental means and methods then in use, it may be said that the compasses in use at that day were comparatively roughly made and more or less inaccurate. The variation was determined in a given latitude by the azimuth of the Polestar or the sun at setting observed by means of sights attached to the rim of the compass, which was a method accurate enough for the general purposes of navigation. The distance run was measured on shipboard by the log which was in about the same form and perfection as at present, being a very ancient invention.

The survey of a general coast-line was made by compass bearings on prominent points, repeated from successive stations, the distances of the ship's course being determined by the log and the courses by compass, with corrections for current and the variation. The lines thus obtained were checked by latitude observations made with Davis' backstaff when the weather permitted.

Apart from any of the methods mentioned it seems to have been overlooked that Bering might have corrected the longitudes of the N.E. Siberian coast by the ordinary dead reckoning kept on board his vessel, provided he started by adopting the longitude for the southern part of Kamchatka peninsula which was in common use on many of the charts of his day. Though it is true that the maps of that part of Siberia north and northeast from the Okhotsk sea were many degrees in error in the longitude, this observation does not hold good in regard to the southern end of Kamchatka. The work of the Jesuit fathers in China had already determined fairly well the position of China and Korea, while rude outlines of the northern islands of Japan, Sakhalin, the Kuriles and the south end of Kamchatka, were added to these on maps of Asia. The outlines are often very incorrect but it is quite evident what is intended. In nearly all early maps of this region which I have been able to consult, as for instance those of N. de Witt, I have found the south end of Kamchatka in approximately correct longitude. For instance, in the Novissimae Ephemerides of Manfredio, published at Bonn the same year that Bering left St. Petersburg, and which might well have been sent to him before he sailed, we find two charts of the paths of solar eclipses (Plates ii and iii). On these charts the meridian of 180° from Ferro passes across what is unmistakably the south end of Kamchatka, though northeastern Siberia remains a blank. This would be a sufficient starting point and is quite as correct as Bering's determinations; in fact is within a few miles of the modern longitudes for the same part of the peninsula. Dead reckoning along the shores of the peninsula, corrected by latitude observations, would have done all that was necessary to correct the meridian without observing any lunar eclipse, provided the surveyor started with such an assumption as Manfredio's or De Witt's charts supply.

Sources of Information.

The general History of China [etc.] Done from the French of P[ere]. DuHalde [by R. Brookes]. London, John Watts, 1736. 4 vols. 8° with maps and ills.

This is referred to in the following text by the letter B.

This is the first English translation from the original French edition of the "Description géographique et historique de l'empire de la Chine" by the father J. B. Du Halde, published at the Hague in the same year as the above translation. The text of the original French I have not been able to consult, though, so far as Bering's voyage is concerned, there does not seem to have been any material abridgment in the translation above cited, for an opportunity of consulting which I am indebted to the Librarian of Congress.

The maps and charts of the original French edition were separately printed in an atlas by themselves, for the use of those who might desire to do without the text, under the following title:

Nouvel Atlas de la Chine, de la Tartarie Chinoise, et du Thibet: contenant Les Chartes générales & particulieres de ces Pays, ainsi que la Carte du Royaume de Corée; (etc.): Rédigées par

M[r] D'Anville, Géographe ordinaire de sa Majesté très Chrétienne, Précedé d'une description de la Boucharie, Par un Officier Suedois que a fait quelque sejour dans ce Pays. A la Haye, chez Henri Scheurleer MDCCXXXVII. Folio, 12 pp. 42 charts.

The chart of Bering forms sheet 42, and differs from the others in being on Mercator's projection which indicates that it was copied directly from an original as stated in the text, and not redrawn. It is 20¾ by 9⅜ inches on the neat-lines and is entitled :

"Carte des Pays traversé par le Cap[ne]. Beerings depuis la ville de Tobolsk jusqu'a Kamtschatka."

Beneath the title is a table of four transliterated Russian terms for fort, post, village and convent, with their French equivalents. This and certain peculiarities in the transliteration of proper names make it certain that the original chart was in Russian and that the transliteration was done by some one not perfectly familiar with both languages. There are a few errors of the engraver in rendering single letters "c" appearing for "t" and "r" for "e" in a few places. The longitude is reckoned in degrees east from Tobolsk to which 67° degrees when added will give practically the meridian east from Greenwich. The transcriber of the map from the Russian appears to have been a Dane, G. Kondet.

That part of this chart east from 112° E. Gr. has been fairly reproduced by Lauridsen (Chart I) with the omission of some unimportant names and the addition of a signature (not the ordinary autograph) of Bering. This is reproduced with a different running headline to accompany Olson's translation.

The fourth volume of Brookes' translation (pp. 429–440) contains

"A succinct narrative of Captain Beerings's Travels into Siberia :"

with a reduction of the above-mentioned map, on which there is no trace of the island of St. Demetrius, even its name, which alone appears on the Du Halde map, is here omitted. Otherwise this version of the map does not differ from Du Halde's, more than one copy of a drawing usually differs from another. When Bering started on his expedition he was accompanied by two cartographers (Bergh, First Voy. of the Russ. pp. 2–5, fide Lauridsen) Luzhin and Potiloff, and to one or both of them under Bering's direction the construction of the map in question was probably due.

When Bering made his report it was accompanied by a list of positions for important places visited by the Expedition.

Dr. Campbell, while gathering material for his second edition of Harris' Voyages, procured a copy of this unpublished list of positions and prints it in his account of Bering's travels, with the comment that it was sent by Bering from Kamchatka, before his return to Russia, and to the Senate at St. Petersburg, to which Bering did not report. Whether due to the transcriber or the printer there are several very obvious errors in the list as printed by Campbell, and when it is compared with Bering's own list we see that there are also several interpolations.

But the positions adopted in the chart, said by Du Halde to have been brought to St. Petersburg by Bering on his return (a statement confirmed by the mention of a chart in the report itself), are not identical with the positions enumerated in the list. This leads to the suspicion that Bering's first chart was not published, and that the chart issued was due to a recomputation and revision of his data. This suspicion is made stronger by the statement of Lauridsen, who gives no authority, however, that Bering's chart was made in Moscow in 1731,* though this may merely mean that some of the copies which were distributed to various personages were so prepared.

These manuscript copies of the chart and report were sent to various foreign courts. as a matter of general interest, by the Russian authorities. The copy used by Du Halde was communicated to him by the King of Poland who had received it as a "Present worthy of his regard and curiosity" (Du Halde, iv, p. 439, Brookes' ed.). Other copies were sent to Sweden and probably to England and other countries. In the journal, "Ymer," of the Swedish Society for Anthropology and Geography (1884, p. 93) is a short notice by E. Dahlgren of three manuscript copies of Bering's chart of his first expedition, or rather of charts embodying its results. Two of these charts are in the Royal archives of Sweden and measures 58 x 135 cm. One of them is ornamented with ten colored drawings of natives of Siberia. The other is without these but does not seem to be a copy of the first as it has a number of soundings between St. Lawrence and the Diomede Islands which are not on the former, and some names which are peculiar to it. Both have many more names than are given on the chart published by Du Halde. Both of the manuscripts have a legend referring to the coast from the Kolyma eastward, on the north coast of Siberia, to the effect that it is put down from older charts and information, doubtless furnished by the archives at Yakutsk. The third copy is in the possession of Baron Robert Klinckofström, of Stafsund, Sweden.

Through the kind offices of Baron Nordenskiöld and the generosity of Baron Klinckofström, the last mentioned chart has been forwarded to the writer through the Smithsonian Institution for examination. It appears to be essentially the same as the second of the two charts referred to as comprised in the Royal Swedish Archives. The result of my examination of it leads me to the belief that there were two different charts sent out in manuscript by the Russian authorities. The first, which I regard as the earlier, and which is certainly more accurate, shows the island of St. Demetrius in its proper place in accordance with Bering's Report and list of positions. It formed the basis of

* Lauridsen, Am. ed., p. 57.

Campbell's engraving which will be referred to later, and of the chart which appears in the various editions of Du Halde. It is possible that this represents the original chart prepared by Bering in Kamchatka during the winter of 1728–9. The second and probably later form of the chart is represented by the Klinckofström chart, upon which the name and island of St. Demetrius have vanished and a smaller island in the corresponding latitude is represented close to the Siberian coast and westward from the meridian passing through the eastern extreme of East Cape. This island is named the island of St. Diomede. If it is intended as a revised position for the island of St. Demetrius of the other chart and of Bering's Report, it is in conflict with the facts and with the position assigned to St. Demetrius in the report. No one who had sailed between St. Demetrius and East Cape could have sanctioned such a position for the island with honesty. If a different island is intended the question arises, Why is St. Demetrius omitted? This second chart is obviously the basis upon which in D'Anville's chart of Asia (1753) the configuration of the eastern extreme of Siberia is based, and I suspect that the chart of the Imperial Academy of Sciences at St. Petersburg and the reproduction of Jefferys, were also derived from it as far as this region is concerned.

It would be rash, in the absence of authentic information which only the Russian archives can supply, to hazard an opinion as to the origin of the important difference between these charts. I may return to this point later. Apart from this, it may be added that the northern coast of Siberia from East Cape west to Cape Shelagskoi is represented as mountainous throughout its extent. A legend states that it is laid down from older charts and information. This relieves Bering from the responsibility for the fictitious or at least grossly erroneous and exaggerated form and direction given to Cape Shelagskoi on his chart. The west coast of the Okhotsk sea and part of its northeastern shores not visited by Bering are stated to be laid down from "information." This map is not dated and the blank space in the title left for Bering's autograph has never been filled. No name of draughtsman or place or authority of issue are indicated upon it. It measures 51 by 20¼ inches between the neat-lines. It is in black and white, the mountains washed in, the only color being small green trees as a conventional sign for wooded country. A copy of the earlier chart fell into the hands of Dr. Campbell and was published by him in his edition of Harris' Voyages,* together with a version of the report which is more or less mutilated and to which the editor to make his book more readable has

* HARRIS, JOHN. Complete collection of Voyages and travels [etc.]. London, T. Woodward [and others] 1748. 2 v. folio, maps and plates, Vol. 2, pp. 1016–1041, is devoted to a discussion of Bering's discoveries, entitled: Book III, Section VIII. "A distinct account of part of the northeast frontier of the Russian Empire, commonly called the country of Kamschatka or Kamschatska including the voyages of Captain Behring for discovering toward the East [etc.], collected from the best authorities both printed and manuscript."

added certain flowers of rhetoric which detract from its accuracy. Campbell's copy of the map is the most perfect yet published and the only one showing the island of St. Demetrius in its proper place.

In Du Halde's copy and those derived from it the eastern border of the chart has cut off the island, though in some of them, as in that of 1736, the name remains. The only fault to be noted in Campbell's edition of Bering's map is the omission by the engraver of the small bay named Preobrazhenia by Bering and which, though it is not named, appears on the other editions of the map. The title is as follows :

"An exact chart of all the countries through which Capt. Behring travelled, from Tobolski Capital of Siberia to the country of Kamtschatka."

The size of the map is 7 × 12¾ inches. It extends on the east to the meridian of 126° east from Tobolsk which enables the "Isle of St. Demetrius" (our present Big Diomede) to appear in its proper place. The editions previously reported have all stopped at the 124th meridian, thus cutting off the island, whose name sometimes appeared and sometimes did not.

It will be observed that Dr. Campbell in this paper was the means of introducing the erroneous and obnoxious Germanized spelling of Bering's name into English literature. This is a pretty good indication that he had no autographic documents from Bering himself, and that his manuscripts were obtained from German sources, or at least had been transcribed into the German language. In his thorough search of the literature of the subject and lengthy discussion of the results, Dr. Campbell undoubtedly gathered the fullest account of the first expedition which had up to that date been printed. In order to enliven his history of the proceedings, the good Doctor occasionally rises to flights of fancy, and the theories he held were long since proved erroneous.

There are several other English translations of Du Halde's China, of which the following is the most important :

"A description of the empire of China and Chinese-Tartary, together with the kingdoms of Korea, and Tibet : containing the geography and history (natural as well as civil) of those countries. From the French of P. J. B. Du Halde, Jesuit. Illustrated with general and particular maps, and adorned with a great number of cuts. With notes geographical, historical and critical, and other improvements, particularly in the maps, by the Translator." London, Edward Cave, 1741. 2 vols. folio, maps and ills.

This edition does not show the name of the translator, but he was evidently a man of no small attainments as a geographer and cartographer, and introduced numerous improvements and corrections into the charts of D'Anville, which accompanied the original edition of Du-

Halde. A copy of this was presented to the library of Harvard College by the province of New Hampshire in 1765–6, for an opportunity of examining which I am indebted to the courtesy of Mr. Justin Winsor, the Librarian.

The text of this edition, compared with that of 1736, is as much as possible abridged, yet contains nothing not in the original, but the map exhibits certain additions to be noted. This map is entitled,

"A Map of Capt. Beerings' travels from Tobolskoy to Kamchatka between y^e^ years 1725 and 1730. With improvements by y^e^ Editor." It contains the following note by the editor. "Capt. Beerings probably observ'd y^e^ Lat.^d^ in y^e^ Principal places thro' w^ch^ he pass'd, tho' two Observations only are mentioned in his Journal. But M^r^ Kyrilow in his Map of the Russian Empire does not follow y^e^ Author in this respect for instance he places Ilimski 1° 30′ more north, Yakutskoy 2° more south, and Cape Chiokotskago 1° more south than Cap^t^. Beerings; likewise other places in Proportion. I have reckon'd y^e^ Long^d^ of Tobolskoy from Paris according to an Eclipse of y^e^ Sun observed at Hamburg and Tobolskoy, mentioned by Mr. Strahlenberg in his account of y^e^ Northern parts of Europe and Asia. This is all that can be done till y^e^ return of y^e^ Russian Mathematicians sent to make observations and discoveries throughout Siberia." Then follows a line "Inscribed to Francis Gashrey Esq^r^."

The main body of the chart is that of Du Halde's original and the scale is the same, but the height of the neat-lines is only 8⅝ inches. Bering's track from Okhotsk to Bolsheretsk, across Kamchatka, northward to 67° 18′; also his track eastward from Kamchatka in 1729 and around the peninsula to Bolsheretsk and Okhotsk; are indicated by dotted lines. The two latitudes noted in Bering's journal are indicated on this map by a +, and the northern one is placed near the Asiatic coast in latitude 118° E. from Tobolsk. At the top of the map the supposed Paris meridians* are indicated, a difference between Paris and Tobolsk being assumed of 70° degrees, which is about five degrees too much. There are also sundry infelicities in the transliteration of the names from the French of D'Anville.

A chart which deserves notice, though almost wholly fictitious, being chiefly devoted to the spurious discoveries of the alleged Admiral de Fonte, was issued by J. N. de L'Isle with the concurrence of M. P. Buache, or at his suggestion. It appeared at Paris, in 1752, and was copied for Jefferys' (2d) edition of Voyages from Asia to America in 1764. I do not know if this copy appeared in the first edition, but presume it did.

*In the Campbell map these are taken as east from London with an allowance of 67° between London and Tobolsk.

For present purposes the interesting features of this map are as follows:

Opposite the eastern extreme of the Chukchi peninsula there is represented part of America with the legend, "Terres vues par Mr. Spanberg in 1728, frequentées à présent par les Russes, qui en apportent de très belles fourrures." In the English edition the legend is "Seen by Spanberg 1728." Four islands are represented in the strait between Asia and America, corresponding in a general way to the four now known to exist there. Connected with America and north of the Chukchi peninsula is land with an island off it corresponding not badly to Wrangell and Herald Islands, and marked "Discovered in 1722." It is possible that this land is a hypothetical compound of the land reported by the Chukchis east of the strait with that which they knew to be visible in clear weather from Cape Yakan, more or less confused accounts of which had long been current among persons interested in these regions.

The next chart of note in this connection was published by D'Anville, the royal geographer of France, who had previously prepared the original map of Bering for publication. He issued a general map of Asia, in three parts, each of two leaves which could be joined together, of which the first part appeared in 1751 and the third part in 1753, entitled:

Troisième Partie de la Carte / d'Asie,/contenant / La Sibérie et quelques autres parties / de la Tartarie, / Publiée sous les Auspices de Monseigneur / Louis-Philippe d'Orléans / Duc d'Orléans / Prémier Prince du Sang. / Par le S^r^. d'Anville, / Sécrétaire de Son Alt^s^. Sereniss^s^. / MDCCLIII. / Avec Privilége./

This map is in two sheets (each 20 × 21 inches), the engraving of the geographical part by Guill. de la Haÿe and of the ornamental title by De Lafosse. The longitude is reckoned from Ferro, and the map is constructed on a scale of 23 French leagues to 60 geographical miles. The boundaries are colored and the sea shore shaded with short horizontal lines. It is on the polyconic projection.

This map includes many of the additions to geography in eastern Siberia which were due to the members of the great Siberian expedition. The courses and branches of the rivers especially were augmented and corrected as well as named. The branches of the Anadyr River were represented and named, but as no new information in regard to the coast had been received at that date, this river was still mapped as entering the sea to the south and west of Cape Thaddeus, as erroneously laid down by Bering, who confounded with the Anadyr a small river which does come in here, and passed the estuary of the true Anadyr without seeing it. The coast lines are essentially those of Bering. Beyond the basins of the Kolyma and Anadyr is marked "Terre inconnue"; a small supplement in the north-east corner of the map, on half the scale of the map, represents the north-east extreme of Asia as delineated by Bering. This little supplement is of considerable interest as it gives fuller information than that which appears on the original publication of Du Halde, perhaps from a more modern version of Bering's chart, as previously suggested.

Several names appear for the first time in cartographic history, upon this map. Preobrazhenia Bay ; Bolshoia River falling into Holy Cross Bay, and the "Isle de St. Diomide" are among these. The Island of St. Demetrius is omitted, as well as its name. The Island of St. Diomide is placed about on a line between East Cape and Cape Chukotski, to the westward of the meridian of East Cape. There is a discrepancy averaging about five minutes in latitude and longitude between the positions on this map and those on the second version of the Bering manuscript charts. But in the main these differences are, I suspect, merely due to carelessness in copying, and the general harmony between the two leads to the belief that the D'Anville outline for this region was based on the second version of the manuscript.

The differences of position for points on this part of the coast are numerous. I have noted them in the comparative table of positions herewith. They may be chiefly owing to slips in transferring from the Mercator to the Polyconic projection ; but some of them are due to new information, probably derived from the surveyors of the second expedition. Bering island appears on the map, in about its proper place, though Copper island is not indicated, nor are any of the Aleutians shown. I suspect this is the first publication of a cartographic kind on which Bering island is laid down, as the map of the Imperial Academy of Sciences, embodying the geographical results of Bering's Voyage to the coast of America, was not engraved until a year later, while De L'Isle's of 1752 does not contain them.

The island between Cape Shelaginski and East Cape off the northern coast, on Bering's map, is omitted by D'Anville. The Kamchatkan peninsula in latitude 56° is represented to have a width of 180 miles, while Bering made it 270 miles.

A most important contribution to the subject appeared in Müller's Historical Collections known as the "Sammlung Russische Geschichte" and published at St. Petersburg (Kayserl. Academie der Wissenschaften, 1732–64. 8°. Nine volumes.) Des dritten Bandes (erstes, zweytes und drittes Stück, pp. 1–304, 1758) contains the original account of the Russian Voyages toward America from which the work of Jefferys has, with some errors and omissions, been translated. As far as regards Bering's first voyage, there is only one error of consequence made by Jefferys, which will be noted in its place. This book is extremely rare, and the only copy in America which I have been able to find after much enquiry, is in the library of the Smithsonian Institution.

The first volume of this series has the title

"Eröffnung eines Vorschlages zu Verbesserung der Russischen Historie Durch den Druck eines Stückweise herauszugebenden Sammelungen von allerly zu den Umstanden und Begebenheiten dieses Reichs gehorigen Nachrichten. St. Petersburg, bey der Keyserl. Academie der Wissenschaften, 1732."

The succeeding volumes have the running title "Sammlung Russische Geschichte" with the number of the parts subjoined but no other title-page.

The account of the Russian Voyages is stated by Müller to have been prepared at the direction of the Empress and endorsed by the Academy of Sciences. It contains invaluable material on the early explorations, which, if it had not been for Müller's painstaking researches, would have been totally lost, as the archives of Yakutsk from whence the data were derived by Müller were subsequently destroyed by fire. The errors which occur in it are chiefly due to Müller's endeavor to utilize the inexact geographical data of the Promyschleniks and Cossacks by combining them with the less detailed but more precise observations of later observers. In this attempt he added many valuable details to the charts, but at the same time introduced several errors. The exaggerated distances reported by the first explorers who were unable to correct their estimates by observations of precision, distort those parts of the map due to their reports. The peninsula of Aliaska becomes hugely exaggerated as does the Shelagskoi promontory on the Arctic Sea. But no unprejudiced person can read Müller's account without perceiving his great caution in accepting unreservedly these imperfect contributions, the really important additions which he made to cartography, the preciousness of the facts which he rescued from oblivion, and his desire to be fair to everybody.

The insinuations of malice and of a desire to injure Bering by means of this account given by Müller, which Lauridsen attributes to the latter, appear to be entirely the product of a suspicious temperament and an excited imagination. Certainly I have seen nothing anywhere cited which lends to such suspicions any tint of probability. The facts cited in support of them can easily be otherwise explained, if one desires to view the subject judicially, and for the most part are not quite thoroughly understood by the Danish author.

One error upon which the latter lays great stress, is due to a manipulation of the record, originated or at least adopted by Bering himself, and which is incorporated in the map and report which all authors agree proceeded directly from Bering's own hand.

The next map of importance was issued by the Imperial Academy of Sciences, St. Petersburg in 1754. It was made under the inspection of Gerhard Friedrich, Staatsrath von Müller, who revised and corrected it subsequently, when an edition dated 1758 was issued. This map comprised the geographical results of the great Siberian expedition sent out by the Russian government; of Bering's voyages; and of the records of the hunters (Promishleniks) and traders in northeastern Siberia preserved in the archives of Yakutsk. The sources of this map are fully explained by Müller in the "Russian Discoveries" (Jefferys' translation, p. 108 et seq.). I have not been able to examine a copy of the original map, and have therefore relied on the English version of it which is to be found in Jefferys' translation, second edition, London, 1764.

Among the improvements introduced on this map may be specified, the correction of the shores of the Okhotsk Sea, and Gulf of Penjina, the correcter location of the mouth of the Anadyr river and its estuary, the introduction of the results of the voyages of Gvosdeff, Bering and Chirikoff to the northwest coast of America, and a multitude of details relating to northeastern Siberia. The island of St. Deomid (Diomede) is not represented though its name appears on the 65th parallel in Bering Strait. The island may have been on the original map and carelessly omitted by Jefferys' engraver on his copy. Among the errors, or rather mistaken hypotheses of others, which are suggested in this map by dotted lines, are the extension westward to 174° E. of Greenwich, of the peninsula of Aliaska which is also given a wholly uncalled-for width; and the northward extension of the coast on each side of Bering Strait. In the former case the cartographer was misled by the errors of the map of Bering and Chirikoff's last voyage and rumors reported by other navigators; and in the second case he followed Bering in adopting an erroneous position and exaggerated form for the coast eastward from Koliuchin Bay, due to the uncorrected sketches of the Cossacks and traders. The northern extension of the American coast opposite, was purely hypothetical and for this Müller must be held responsible. Many of the western Aleutians are exaggerated in size and erroneous in position but the chart of Bering's last voyage, and the exaggerated reports of the hunters who followed him, must be held responsible for this, in the main.

The work in which this chart appears is largely derived from Müller's "Sammlung russische geschichte," St. Peterburg, 1758, vol. iii, Parts I–III (cf. antea). The first edition is entitled, according to bibliographies:

"Voyages from Asia to America for completing the discoveries of the northwest coast of America. A summary of voyages made by the Russians on the frozen sea. From the high Dutch of S[taatsrath]. Muller by T. Jefferys. London: T. Jefferys, 1761." lxvi, 76 pp. 4°, with four maps.

The second edition which is that referred to in this paper is entitled

"Voyages from Asia to America, for completing the discoveries of the northwest coast of America. To which is prefixed, a summary of the Voyages made by the Russians on the Frozen Sea, in search of a northeast passage. Serving as an explanation of a map of the Russian discoveries, published by the Academy of Sciences at Petersburgh, [etc.] London: T. Jefferys, 1764," viii, 120 pp. 4°, four maps.

A French translation by Dumas, with the author's initials misprinted G. P. instead of G. F., was printed at Amsterdam in 1766. It consisted of two volumes, 18mo, with a map. A Danish translation, by Morten

Hallager, was issued at Copenhagen in 1784, as a portion of a volume relating to northern explorations. Bibliographers seem to have been puzzled by the discrepancy of initials, not recognizing that the S. in Jeffery's volume stood for a title and not a name. Another work important in its collection of facts bearing upon the general question of the explorations eastward by the Russians, was published by the archdeacon of Wilts, Rev. William Coxe in 1780. This was followed by a second edition during the same year. A third edition accompanied by a Supplement of 57 pages was printed in 1787 and a fourth in 1803. There were two apparently distinct translations of the book printed at Paris in 1781, and a German edition at Frankfurt and Leipzig in 1783. The third edition which is the best and most correct appeared both in octavo and quarto form, and is that to which reference is made in this paper. It is entitled:

"Account of the Russian discoveries between Asia and America. To which are added the Conquest of Siberia, and the history of the transactions and commerce between Russia and China, [etc.]. London: T. Cadell, 1787."

410 pp. 8° [or 4°] with four charts and one plate; to which is added, consecutively paged:

"A comparative view of the Russian discoveries with those made by Captains Cook and Clerke, and a sketch of what remains to be ascertained by future navigators. London: T. Cadell, 1787." 3 l. unp., 417–456 pp. 8°.

The latter was also separately issued. Among the maps contained in this work of Coxe's are a reduced copy of the general map of Russia issued by the Imperial Academy of Sciences, St. Petersburg, 1776, and a chart of Synd's Voyage toward Chukotski Noss.

The latter is the only chart of Synd's voyage (1764–1768) which is accessible, and it is vouched for as authentic by Dr. Coxe. Compared with later charts it is, of course, extremely imperfect yet there is in it enough resemblance to the truth to enable us to recognize what was intended in many instances. In the northeastern part of the chart, the latitudes are exaggerated and the longitudes contracted in a very erroneous manner. Nevertheless we recognize East Cape, here named "Prom. Tschukotskoi;" the two islands now called the Diomedes but here left nameless; a large island, moved eastward out of place, but doubtless intended for Arakam Island, is called "I. Diomedis;" while among a crowd of islets (referable to the hills of St. Lawrence Island seen through a fog and laid down very inaccurately), the name "S. Diomedis" appears again. The American coast was seen and landed upon; Cape Prince of Wales and the shore south and east from it are recognizable. The island of St. Mathew was discovered and named, though placed a degree too far south. The island of St. Paul in the

Pribiloff group was discovered by Synd, put in its true latitude, and named Preobrazhenia or Transfiguration Island. It is about seven degrees out in relative longitude and fourteen in absolute longitude. One cannot doubt however that it was the island now known as St. Paul when we recall the fact that there are no other islands than the Pribiloff group, in that latitude or within that general area of Bering Sea. The southern Cape of the Chukchi Peninsula, Chukotski Cape of Bering and Müller is represented two degrees too far south. Preobrazhenia Bay is not recognizable but the name is transferred to the bight west and north of Cape Bering of our present charts. This part of the coast was not however approached by Synd, who spent much time on the coast of Kamchatka. On his chart this peninsula is represented better than we should have expected from the rudeness of the rest.

The map of the Academy shows the influence of those who discredited the near approach of America to eastern Siberia ; notwithstanding the explorations of Deshneff, Gvosdeff and Synd, the American shore of Bering Strait has disappeared altogether. The eastern portion of the Chukchi Peninsula is indented by a host of hypothetical inlets, and defended by an unrecognizable archipelago of nameless islands. The far-stretching chain of islands, among which Bering's second expedition was so long entangled, excepting those confirmed by Krenitzen and Levasheff (who sailed far north of the southern arc of the chain) is also absent. Excepting that the fictitious peninsula north from Chukchi land is effaced, the map in its main features for this region is less accurate than that of Bering, and does not compare very favorably with that of Müller. And yet but shortly after its publication, the explorations of Cook and Clerke recorded the facts which should, when published, exalt the memory of the older geographers and scatter the hypotheses which for a time prevailed against them.

Their explorations are included in

"A voyage to the Pacific Ocean, undertaken by the command of his Majesty, for making discoveries in the northern hemisphere, [etc.], performed under the direction of captains Cook, Clerke and Gore, in his Majesty's ships the Resolution and Discovery, in the years 1776–1780. London, for T. Nicol and T. Cadell, 1784–5." 3 volumes 4° and atlas folio."

This is the edition ordered by the Admiralty. Of this celebrated work, said to have been written from the explorers' manuscripts by Bishop Douglas, there have been many editions. In the Bulletin of the Société de Géographie, Paris, 1879, pp. 481–540, is a bibliography by James Jackson.

The most interesting points in regard to Cook's explorations about Bering Strait are comprised on the chart (vol. ii, p. 467) entitled :

"Chart of Norton Sound and of Bherings Strait made by the East Cape of Asia and the west point of America."

On this chart the main features of the coast on either side of the strait are correctly indicated, though several of the inlets and bays are wanting. The Diomedes and Fairway Rock of modern charts are located but left without names, King's Island is named; Arakam was not recognized as an island nor was Point Chaplin (Indian Point) observed. St. Lawrence Island was seen in foggy weather. Its isolated hills connected by very low flat land led Cook into the error of supposing that it comprised several islands, one of which he correctly referred to that named St. Lawrence by Bering and the rest he lumped under the name of Clerke's Islands. A single fictitious island midway between St. Lawrence and King's appears on the chart, but is not named or mentioned in the text. St. Lawrence Bay is named and discovered. Bering and Müller's Chukotski cape is correctly identified. East Cape is well delineated, and the name Serdze Kamen (Heart-Rock) originally given to a cliff or bluff point at the entrance of Holy Cross Bay is transferred to a point on the Arctic shore of the peninsula. There is a confused and somewhat curious history connected with the use of the names Serdze-Kamen and Chukotski Cape. After the travels of Deshneff, Popoff and others and the reception at various times of information from the natives, it was pretty generally understood among the hunters and traders of this region that the extreme of Asia was a cape or point on or near which the Chukchi dwelt, or which they described, which was not definitely located, and which was vaguely known as the Chukchi Cape or the Cape of the Chukchis, Chukotski Noss in the Russian tongue. Cape Serdze Kamen will be found on the chart of Billings' Voyage. It was the point where the Chukchis successfully defended themselves against the invading Russians who sought to force them to pay tribute. Beyond it, for the Russians all was mysterious Chukchi country with an unknown coast. This cape being their *ne plus ultra* it is probable that it was more or less confounded by these illiterate and ignorant hunters with the supposed eastern Cape of Asia, otherwise the Cape of the Chukchis as used by Müller. Admit this and it is not difficult to frame an hypothesis which shall account for the confusion, without recourse to the absurd charges with which Lauridsen attempts to soil the reputation of Müller, Steller and others.

When Bering named a cape near which he met a baidar-load of Chukchi who gave him some geographical information (among other things that the coast made a turn after passing it) he called this cape with great propriety the Cape of the Chukchis, as observed by Cook (ii, p. 474) and with no reference to the legendary Cape of the Chukchis above referred to.

But when Müller and others more familiar with the records of the earlier explorers came to make maps, they naturally applied the legendary name to the cape which they supposed to be the eastern end of Asia, and beyond which the coast makes a turn to the west. Müller believing in a great cape or peninsula on the northern coast of the Chukchi country supposed this to be the true Cape Chukotski, and to the eastern Cape of Bering he left the name of Serdze-Kamen, probably knowing little about the original Cape Serdze. And as Bering, by the ambiguity of his journal, gave color to the idea that he had rounded East Cape and pursued the north coast west of it for a few hours before turning homeward, what more natural than that those little acquainted with the region should speak of his turning back from near Serdze-Kamen? Thus Cook, following out the same idea derived from his study of the map and journal in Harris, transferred the name to a point in the latitude at which Bering turned back, on the coast which he supposed him to have surveyed. There is plenty of confusion here but no just ground for supposing malice in it.

A publication which throws much light upon Bering's voyage of 1728 was printed by Vasili Nikolaievich Bergh (or Berkh) a well known writer on geographical matters in connection with Russian history. It is in the Russian language and the title may be translated as follows:

First Sea Voyages of the Russians undertaken for the settlement of this geographical problem—Are Asia and America united?—and performed in 1727, 28 and 29, under the command of fleet captain of the first rank, Vitus Bering. To which is added a short biographical account of Captain Bering and some of his officers. St. Petersburg, Academical printing office, 1823. 8°. 3 pr. l. iv, 126 pp. 1 map. Russian text.

This book was printed, as many private books are, at the printing office of the Imperial Academy of Sciences, but was not published or printed by the Academy. The only copies I know of are those in the library of the Academy and one in the British Museum library, neither of which I have been able personally to consult. But through the kind offices of Dr. S. Hertzenstein, of the Zoological Museum of the Academy, I learn that Bergh found in the Archives of the State Admiralty Department the logbook of midshipman Peter Chaplin entitled, "Midshipman Peter Chaplin's journal of the Kamchatka expedition of 1725–1731." From this MSS and from the notes of G. F. Müller and Admiral Nagaieff, Bergh compiled his work. Chaplin's journal is not reprinted verbatim but only paraphrased by Bergh who adds his own commentary on the subject matter, and occasionally gives extracts from Chaplin whose logbook seems to have been kept in a model way.

An effort will be made to obtain a copy of the original logbook,* but for the present we are obliged to be content with what of authenticity

* Simultaneously with the proofs of this paper the work of Bergh has been communicated to me through the liberality of the University of Upsala, Sweden. The results of a critical examination of it will form the subject of a later paper as the present publication cannot be delayed.

remains to the data which have been translated or paraphrased by Bergh, Lauridsen and Olson, necessarily submitting to more or less modification in the process.

The most authentic and important document for the history of this voyage is naturally the official report handed in by Bering himself and printed in the Journal of the Military Topographical Depot of the Russian Army, volume x, pp. 67–79, St. Petersburg, 1847.

This journal is a quarto and the report is printed *verbatim et literatim* if one may judge by the archaic and mispelled words with which it is adorned. It comprises Bering's report including his instructions, a table of geographical positions, and a painfully detailed table of routes and distances by which his position in Kamchatka was computed. This report has never been translated in full and unmodified, the original is thought to have been lost. The present publication is not referred to by Lauridsen and was apparently unknown to him. I have therefore thought it worth while to prepare an English version of the report and geographical table which are incorporated in this paper.

The result shows that the previous versions of the report which have appeared were more or less mutilated or colored by the editors printing them, probably with the view of making the report of more popular interest to their readers but with injurious results to its historic value for reference.

We now come to the latest contributions to the subject. If it were not for the deficiencies in them, which seem to me serious, this paper would not have been prepared, but it seemed to be a pity that the sources of information in regard to Bering, accessible to those who do not read Russian should not be both more impartial and more accurate.

Vitus J. Bering og de Russiske opdagelsesrejser fra 1725–43. Af P. Lauridsen. Udgivet med understöttelse af den Hielmstierne-Rosencroneske stiftelse. Kjöbenhavn. Gyldendalske Boghandels forlag (F. Hegel & Sön). Fr. Bagges bogtrykkeri, 1885. Small 4°, six prel. l. 211 pp., 4 sheets of charts, one plate, one wood-cut.

This work is an attempt at a life of Bering which should combine an account of his career with a reversal of the generally received opinion in regard to his indecision of character. It embodies a general polemic against those who at different times have criticised the explorer. It contains a paraphrase of some portions of Bergh's work which had not previously been accessible in any language except the Russian, yet which would have been much more valuable in the shape of exact translation and quotation. The author labored under the disadvantages of not understanding the language in which all the original records both printed and in manuscript are written; of having little or no familiarity with nautical surveying or cartography; and of being apparently unacquainted with the best modern charts of the region. His criticisms of others are couched in very heated and not altogether parliamentary language, and he is the victim of a narrow spirit of nationalism which is sometimes mistaken for patriotism. Nevertheless he has brought together a great deal of information; it is evident, in spite of his violent criticisms, that he has not intended to be unfair, since he puts on record in several instances evidence damaging to his own views which would not otherwise have come to light; and he has certainly exhibited Bering's valuable qualities in a manner which will do much towards rehabilitating his reputation.*

Review: Bulletin of the American Geographical Society for 1885. New York, the Society, 1885. pp. 285–298.

This review forms part of a "Reply to criticisms upon the voyage of the Vega around Asia and Europe," by Baron A. E. von Nordenskiold, translated from the Swedish by Vere A. Elfwing. It is addressed only toward certain points in Lauridsen's work, and contains valuable corrections of certain errors therein, and information in regard to the work

* I may take opportunity in this place of replying to certain criticisms of Mr. Lauridsen on the chronological chapter of my work on Alaska and its Resources published in 1870.

That chapter was and was stated in its introductory paragraph to be a compilation from the authorities on the subject. It contained no original matter except that relating to explorations subsequent to 1865.

For Bering's two voyages I consulted the report on the Russian Discoveries printed by order of the Empress and under the auspices of the Imperial Academy of Sciences at St. Petersburg, prepared by the distinguished geographer Müller, himself a member of the second expedition and personally acquainted with the actors in those scenes. No more authoritative printed document exists on the subject. The supposed errors animadverted upon by Mr. Lauridsen are either taken directly from Müller, or are inferences drawn from his report. Some of them the critic has misunderstood or misconstrued, which from the necessarily extreme condensation of my table is particularly easy. The expression of surprise that Bering passed through Bering Strait without seeing the Diomedes, was warranted by the fact that Bering nowhere mentions their name or speaks of seeing any islands in their location, nor are they on his earliest printed charts. This point, however, will be more fully dealt with later. If I were to re-write that chapter I should probably modify the criticisms of Bering's character which appear in it; but at the time it was written I was fresh from four years' exploration in the same region, and was particularly impressed with his failure to secure better results when to do so would have been so easy, as well as directly in the line of his duty.

of Strahlenberg and the other early cartographers of Eastern Siberia. It is a translation of a paper published in *Ymer* for 1885, to which for exact accuracy reference should be made.

Russian explorations, 1725–1743. Vitus Bering: the discoverer of Bering Strait. By Peter Lauridsen (etc.). Revised by the author and translated from the Danish by Julius E. Olson (etc.). Chicago, S. C. Griggs & Company, 1889. 8° xvi, 223 pp., 2 cuts, 2 folding sheets of maps.

This edition is a good deal condensed, especially in the matter of references, and does not have all the illustrations of the original. There are also a good many slips or typographical errors, which affect its value as a work of reference. Some of those important in connection with the present paper are as follows: page 31, line 4, "60° 50′ N." latitude should be "62° 50′." On the last line of the same page "longitude" should be "latitude." Page 32, after "cloudy weather" in the second line from the bottom, the whole remaining record of August 15th is omitted altogether. The sentence beginning "From noon" relates to August 16th, nautical reckoning. Page 33, line 5, "30° 19′ east" should be "30° 17′ east;" line 20 after "half west" should be inserted "south by east, by compass." Page 51, line 4 from bottom, "latitude" should be "longitude."

Review: Nation (The) New York, vol. xlix, No. 1275, p. 454. Dec. 5, 1889.

I may add that a number of references to Russian articles treating of Bering will be found in my Bibliography of charts and publications relating to Alaska and adjacent region, published by the U. S. Coast Survey in 1879.

Report of Fleet-Captain Bering on his Expedition to the Eastern Coast of Siberia.

To the most Serene Sovereign, the high and powerful, the Empress of all the Russias :

A short relation of the Siberian Expedition upon which was sent

Of your Imperial Majesty the most humble servant and fleet-captain, W. I. Bering.

On February 5 of the late year 1725 I received from her Imperial Majesty the Empress Ekaterina Alexievna, of happy and well-deserving memory, the autographic instructions of his Imperial Majesty Peter the Great, of happy and well-deserving memory, a copy of which is hereunto affixed.

Instructions.

(1.) There should be built on the Kamchatka [River], or at some other place adjacent, one or two boats with decks.

(2.) With these boats [you are directed] to sail along the coast which extends northwards and which is supposed (since no one knows the end of it) to be continuous with America.

(3.) And therefore [you are directed] to seek the point where it connects with America and to go to some settlement under European rule, or if any European vessel is seen, learn of it what the coast visited is called, which should be taken down in writing, an authentic account prepared, placed on the chart and brought back here.

The following were the instructions given me by the former General Admiral Count Apraxin, in which were written : "Artisans, laborers and whatever, in my opinion, is necessary for the expedition, are to be demanded from the chancellor's office of the government of Tobolsk and monthly reports sent to the Imperial Admiralty College."

Before receiving these instructions, January 24, a lieutenant and 26 men of my command had been ordered to service on the expedition by the Admiralty College with the necessary equipment for 25 wagons. The whole number of my command sent out amounted to 33 men who were ordered to Vologdie and from St. Petersburg to Tobolsk by a route which passed through the towns here named : through Vologdie, Totma, Upper Ustiuk, Solwichergodsk, Kaigorodok, Solkamsk, Verkhoturia, Turinsk, Epanchin and Tiumen.

On the 16th day of March we arrived at Tobolsk and were there until the 15th day of May because of the lateness of the season interfering with travel. During the delay at Tobolsk requisitions were made for the necessary outfit for the expedition.

May 15th we left Tobolsk by water down the Irtish to Samarovska Yama, on four boats of the kind called by the Siberians "dostcheniki," on which were loaded all the outfit brought from St. Petersburg or obtained at Tobolsk; together with a chaplain, commissary, sub-officers and thirty-four soldiers.

I had previously sent a garde-marine officer, on a small boat furnished by the Tobolsk authorities in obedience to the orders of the Naval College, to the proper settlements where the preparation of freight-boats had been ordered on the Yenisei and Uskut rivers, and I ordered him to sail to Yakutsk.

From Samarovska Yama the Obi river was ascended to Surgut and to Narim, and thence the Ket river to Makovska post. From Tobolsk to Makovska as we traveled live Ostiaks who were formerly idolaters, but, since the year 1715, through the labors of the Metropolitan of Tobolsk they have been converted to the true faith. From Makovska post to Yeniseisk the route lay overland. From Yeniseisk to the Ilima-mouth we proceeded also in four boats by way of the Yenisei and Tunguska rivers. On the Tunguska there are three rapids and several shoals; rapids be it understood where across the whole width of the river large rocks stand high in the water, with a passage only in one or two places; and shoals, similarly under water and above water but composed of small stones, alternate with rapids and with places where the water in the river is shallow for the distance of one or two versts, and which are not surmounted without a great deal of labor. From Yeniseisk in pursuance of orders from Tobolsk we took thirty men, carpenters and smiths.

On the Ilima river, on account of rapids, bars and shoal water, the barges could not be taken to Ilimsk. For a certain distance only small canoes were available, for which reason the heaviest part of the outfit was reserved to be sent by sledges in winter.

Lieut. Spanberg, with a party of thirty-nine carpenters and laborers, went by land from Ilimsk by the Uskut to the river Lena, to prepare during the winter fifteen barges on which the command and its equipment should be floated down to Yakutsk.

I remained with the rest of the party near Ilimsk just below the Uskut, because at Ilimsk there are few houses and on account of the difficulties involved in a winter journey to Yakutsk, from the deficiencies of transportation, the deep snow and the severe cold, which prevented us from proceeding.

To these reasons [was added] the necessity, according to the orders from the authorities at Tobolsk, of drawing the provisions for the expedition from Irkutsk and from Ilimsk down to Yakutsk because at the latter place grain is not cultivated. During our wintering at Ilimsk I made a sledge journey to Irkutsk to advise with the local Voivod who had previously been Voivod at Yakutsk and who understood what would be needed by us in transporting our outfit from Yakutsk to Okhotsk and Kamchatka, since I did not possess any actual information in regard to that region. During the last days of winter travel I went over to the Uskut and obtained from Irkutsk twenty additional carpenters and smiths for the work of the expedition and two coopers from Ilimsk.

On the Tunguska, Ilima and Lena rivers to the Vitim live the so-called Tunguses, people who own reindeer which they use as draught animals, while those who do not own deer live near the rivers on fish and travel in canoes made of birch bark. These people are idolaters.

From Uskutsk on fifteen barges, in the spring of 1726, we descended the Lena to Yakutsk. From the river Vitim down to the Lena, on both banks live Yakuts with a smaller proportion of Tunguses. The Yakuts possess herds of cattle, plenty of horses and cows by which they subsist, and are contented with the product of their herds, depending but little on fish except where their cattle are too few. They pay an idolatrous reverence to the sun and moon as well as to birds, such as the swan, eagle and crow. They also hold in great honor their own fortunetellers, known hereabouts as *shamani*, each of whom owns small idols or figures which they call *shaitan*. By their own account these people are of Tartar origin.

On reaching Yakutsk in boats I required the aid of all the people of my command. Thirteen flat-bottomed barges which had been constructed at Uskutsk, under Lieut. Spanberg, proceeded by water on the Lena down to the Aldan to ascend that river, the Maya and the upper Yudoma. Such a cargo could hardly have been transported to that distance overland on horseback where but little in the way of subsistence was obtainable from land or water. The Cross of Yudoma might only be reached with great difficulty, but if successful the expense would be less than if the material had been carried on the backs of horses. I myself with a few people crossed from Yakutsk to Okhotsk with pack horses, as is the general custom. The load or pack taken is only about five puds to one horse, less than by the telega [ordinary cart], the deep mire and high mountains to be traversed not permitting more, though my supplies amounted to 1600 puds. At the post called Okhotsk is a Russian village of only ten houses, and Lieut. Chirikoff was left to winter at Yakutsk with orders to come overland to the Okhotsk post in the spring.

In the last days of December, 1726, a message asking for assistance was received from Lieut. Spanberg, who had been dispatched by the river, saying that the boats had failed to get within 450 versts of Yudoma Cross and were frozen in on the Gorbeh River, where he was transporting by sledges a cargo of outfit indispensable to our party. I sent at once, from among those who were wintering with me at the post of Okhotsk, a party with dogs and supplies and brought in the Lieutenant to the post on the first day of January, 1727, but without any of the outfit, he having left the Gorbeh river November 4th, 1726. His command had been obliged by hunger to eat the flesh of their horses and even the rawhide harness, the skin of their fur clothing and the untanned uppers of their shoes. Their cargo was all left at four different places along the route, which lay through uninhabited country. The only addition to their means which they had been able to secure, was some of our own flour, to the amount of 150 puds, which on my overland journey I had been obliged to leave near Yudoma Cross on account of the death of some of my pack-horses.

Along the rivers Aldan and Maia live Yakuts of the same stock as those of the Lena and Yudoma rivers. But near and around the post of Okhotsk wander the seaside Tunguses and some Lamuts with their herds and many reindeer, who travel about winter and summer where their deer can find pasturage ; and some pedestrian Tunguses who live near the sea and rivers and are professional fishermen as among the Yakuts.

February 1, ninety men with some dogs and sledges were collected and sent under Lieut. Spanberg to bring in the outfit left behind by the Yudoma river, and by the 1st of April about half of it had been transported safely to Okhotsk. Since more remained I sent twenty-seven men to Yudoma Cross to bring over the rest of the material on pack-horses from that place, who returned in May.

In this region in winter time from Yakutsk to Okhotsk and other distant places people always travel on foot in parties of eight or ten, hauling their own sledges after them. Those belonging to our command, when sent from Gorbeh to Okhotsk, brought down ten or fifteen puds or more, the snow being seven feet deep in places and travelers in winter being obliged to dig out a camp every evening, down to the ground to keep warm.

June 30, Lieut. Spanberg in his newly built vessel sailed across the sea to the port of Bolsheretsk with a cargo of outfit and supplies and the material for the shipbuilders and workmen of our command, sent to Kamchatka to get out the timbers for a vessel, being ordered to return again for us.

July 3d, Lieut. Chirikoff arrived from Yakutsk with 2300 puds of flour, according to my instructions.

August 21, we loaded the new vessel which had returned from the land of Kamchatka, and another old boat which had been at Bolsheretsk, with the flour, and the whole command then at Okhotsk proceeded across the sea to Bolsheretsk. The officer who had been left to guard the provisions which had not arrived from the wintering place on the Gorbeh river was directed to float them down again and take a receipt from the authorities at Yakutsk and endeavor, the following year, to deliver to the command in Kamchatka some part of the provisions, iron and tar.

It was necessary to take the supplies from the mouth of the [Bolshoia] river to the post of Bolsheretsk by water in small boats. At the post were fifteen houses inhabited by Russians. For the ascent of the shallow river small boats had been built as I desired that the outfit and the most necessary part of the provisions should be transported to the upper Kamchatka post, a distance of 120 versts by water. The transportation between Bolsheretsk and Upper and Lower Kamchatka in winter was entirely carried on by the use of the native dogs. Every evening it is necessary to dig out the camp in the snow, in order to get shelter from whirlwinds of snow which in this region are called *poorga.* If one makes camp in an open place free from snow, these snow squalls are liable to overwhelm the party and they may perish.

At Upper Kamchatka there are seventeen and at Lower Kamchatka fifty houses, at another place [Middle Kamchatka] where there is a church are fifteen houses, and in all these settlements there are not over 150 Russian subjects, who live by the collection of the *yassak* [tribute money], beside those who were brought to the country on our expedition.

In coming over to Bolsheretsk we brought 300 puds of whale blubber obtained from a whale cast up by the sea, which served us as money, together with the Circassian tobacco which is here commonly so used.

In the southern part of Kamchatka live Kuriles, in the northern part Kamchadales, whose language is peculiarly their own with but few introduced words. Of these people some are idolaters, others believe in nothing and are strangers to all honesty. The Russians who live in Kamchatka and the indigenes grow no grain and have no domestic animals except draught dogs. They dress and subsist upon what they can get, principally fish, roots and berries, in summer time wild fowl and large marine animals. At present in the wilderness of Yakutsk, the convent, which is of the same age as the Kamchatka churches, cultivates barley, hemp and turnips. Here only turnips are grown by the people of the three settlements, but they grow very large, in Russia they are smaller, here there may be four turnips to a pud. I brought with me on my journey some rye which was sowed around the establishments near us, but whether it ripened or not I did not ascertain. The frost strikes early into the ground in this region and the absence of cattle renders it difficult for the people to plow.

The natives described and from whom the yassak [tribute] is collected, belong to the Russian Empire and are all savages. They are known for their dirt and bad passions. If a woman or any animal brings forth twins then one of them is smothered, the hour it is born, and it is regarded as a great fault if one does not smother one of the two.

The Kamchadales are very superstitious. If there is any one who is very ill, even a father or mother, or near the point of death, they will carry them out into the woods and leave them without nourishment for a week together whether it be winter or summer, from which treatment many die. The dead are not covered with earth but are dragged out and left to be eaten by dogs. The house of a man who has died is abandoned. Among the Kariak people it is the custom to burn the body, although this is forbidden.

By the time of our arrival at the Lower Kamchatka post the ship-timber for our vessel was in large part prepared, and upon the 4th of April, 1728, was put upon the stocks for the vessel, which, with God's help, was finished by the 10th of July, the timber being hauled by dogs. Tar was made from the native tree which is called *Listvennik* [spruce], since the tar which we should have brought with us had not arrived.

Before this it was not known here that tar could be obtained from the native trees. So also for the sea voyage, the deficiency of spirit made from grain was supplied by a liquor distilled from herbs, and salt was made by boiling sea water. To increase our store of sea provisions, in place of cow's butter, fat was tried out from fish, in place of meat fish was salted. The vessel was provisioned with everything needful for forty men for a year. On the 14th day of July we went out of the mouth of the Kamchatka river into the sea, in obedience to the autographic orders given me by his Imperial Majesty Peter the Great, as the map constructed for that purpose will show.

August 8th, having arrived in north latitude 64° 30′, eight men rowed to us from the shore in a skin-boat, enquiring from whence we came and what was our business there. They said they were Chukchi, (whom the Russians of these parts have long known) and as we lay to they were urged to come to the vessel. They inflated some floats made of sealskin and sent one man swimming to us to talk, then the boat came up to the vessel and they told us that on the coast lived many of their nation; that the land not far from there takes a decided turn to the westward, and they also said that at no great distance from where we were, we should see an island. This proved true, but we saw nothing valuable upon it except huts. This island in honor of the day we named St. Lawrence, but we were not able to see any people upon it, though an officer was sent in a boat from the vessel on two occasions to look for inhabitants.

On the 15th of August we arrived in the latitude of 67° 18′ and I judged that we had clearly and fully carried out the instructions given by his Imperial Majesty of glorious and ever deserving memory, because the land no longer extended to the north. Neither from the Chukchi coast nor to the eastward could any extension of the land be observed. If we should continue on our course and happen to have contrary winds we could not get back to Kamchatka before the close of navigation and might be obliged to winter in that region, not only without a harbor, but where no fuel could anywhere be obtained, where the native people do not acknowledge the authority of the Russian government, but are wholly independent and united against us in refusing to pay tribute.

From the mouth of the Kamchatka river and all the way to this place along the seacoast wind elevated mountains, resembling a wall in steepness, and from which the snow does not disappear in summer.

On the 20th of August four canoes were observed rowing toward us, containing about forty people who were Chukchi of the same sort as those whom we had met before. They brought for sale meat, fresh water, fish, fox skins, of which fifteen were of the white fox, and four walrus teeth, which my people bought of them for needles and flint-and-steels. They said that some among them had been overland with reindeer to the Kolyma river and that they never went by sea to the Kolyma; but, at a great distance, by the seashore lived some of our people, born Russians, people whom they had known for a long time, and one of them said that he had been at the Anadyr post to trade. To other questions they gave the same answers as the Chukchi previously seen.

On the 2d of September we entered the mouth of the Kamchatka river and wintered at the post of Lower Kamchatka.

On the 5th of June, 1729, having repaired the vessel which had been laid up, we went out of the mouth of the Kamchatka river and put to sea to the eastward, because the inhabitants of Kamchatka declared that on fine days land could be seen across the sea. Though none of our own people had observed it, we went out to determine the authenticity of the information. We sailed nearly 200 versts and saw not the slightest trace of land. We sailed around the south point of Kamchatka to the mouth of the Bolshoia river, making a chart of this part which had not previously been delineated. From the mouth of the Bolshoia river we sailed across the sea to the post of Okhotsk having left at Lower Kamchatka and at Bolsheretsk, out of the supplies received by us from the authorities of Yakutsk, flour, meal and dry salt meat to the amount of 800 puds.

On the 23d of July the vessel reached the mouth of the Okhotsk river, where the outfit and supplies of the expedition were turned over to the governor and I, with my command, on hired horses, crossed over to Yudoma Cross and thence in canoes down the Aldan river, crossing over at Belskoi and below, and carrying everything on pack horses over to Yakutsk.

The whole journey occupied the time from Okhotsk, July 29th, to Yakutsk on the 29th of August. We remained in Yakutsk until September 3d, and from September 10th until October 1st traveled in two barges on the Lena when we were arrested by ice at the settlement of Peleduie. Here we were detained until the 29th of October, by the absence of snow and the presence of small ice in the Lena. When the ice solidified we proceeded to Ilimsk and from Ilimsk to Yeniseisk on the Tunguska river, stopping at Russian settlements; and from Yeniseisk to Tomsk with Russians and converted Tartars; from Tomsk to Chausk Ostrog, Russian settlements; from Chausk to Tari by the Barabinskoi steppe; from Tari to Tobolsk by the Irtish river among the Tartars; arriving at Tobolsk January 10, 1730. From Tobolsk for St. Petersburg we left on the 25th of the same month, following the same route by which we originally reached Tobolsk from the capital. We arrived in St. Petersburg March 1, 1730.

Note.—The extensive tabular itinerary covering two quarto pages, showing the details of the route traversed in going to Kamchatka, the distances and directions from point to point (except during the sea voyages), the native tribes in the region traversed, etc.—is not reproduced, as it contains no information of importance in the present connection. The other table, showing the astronomical position estimated for the more important places is herewith transcribed.

To get the approximate Greenwich longitude 67° should be added to the longitudes in the table which are reckoned from Tobolsk.

I have provided a tabular itinerary, which shows the dates of the events of the expedition, derived from Bering's Report and from other sources, which are indicated by letters. B stands for Brookes' edition of Du Halde; H for Campbell's version in Harris; M for Müller's account; and L for Lauridsen. The astronomical events are taken from Oppolzer's standard catalogue of solar and lunar eclipses.

It will be noted in the following tables there are a few discrepancies of single days compared with Lauridsen's account or other authorities. These I take to be due to the use in the ship's journal of the nautical day in which the nautical second day of the month begins on the first calendar day at noon and ends at noon on the second calendar day, so that events occurring during the first twelve hours of the nautical day would have a date one day later than the true calendar date.

Catalogue of the towns and notable Siberian places put on the chart through which the route passes, with their latitude and longitude, the latter computed from Tobolsk.

Cities and Places.	Latitude N.	Long. E. of Tobolsk.
Tobolsk	58° 05′	00° 00′
Samarofska Yama	60 17	00 30
Town of Surgut	60 51	5 18
Town of Narim	58 48	14 35
Ketskoi post	58 19	— —*
Losinoborski convent	58 17	— —*
Makoffska post	58 03	23 13
Yeniseisk	58 20	25 12
Kashim convent	58 37	32 00
House of Simakhina, Ilima river mouth	57 25	35 16
Ilimsk	56 40	36 44
Ust Kutskoi post	56 40	38 26
Kirinski post	57 50	41 01
Yakutsk	62 08	57 53
Okhotsk post	59 13	76 07
Mouth of Bolshoia river, Kamchatka	52 42	89 51
Upper Kamchatka post	54 48	— —*
Lower Kamchatka post	56 11	— —*
Mouth of Kamchatka river	56 03	96 10
Cape St. Thaddeus	62 20	111 32
West cape, Holy Cross bay	65 35	115 15
East cape, Holy Cross bay	65 28	115 37
Preobrazhenia bay	65 01	120 30
Chukotski cape, east end	64 25	122 55
St. Lawrence island	64 00	122 55
St. Diomede island	66 00	125 42
Place from which we turned back	67 18	126 07
South cape of Kamchatka	51 10	89 51

* These longitudes absent from Bering's own report are supplied by Campbell in his list, probably from the chart.

In the Table of positions the addition of 67° will reduce the longitudes to E. of Greenwich. It is probably from this table that Dr. Campbell derived his list, in Harris, which is, barring

Itinerary for Bering's First Expedition.

Dates corrected to ordinary calendar, beginning at midnight.

1725.	Authorities.	Date. Old Style.	Date. New Style.
Advance party under Chirikoff left St. Petersburg	H. L.	Jan. 24.	Feb. 4.
Bering followed	B. L. M.	Feb. 5.	Feb. 16.
Bering arrived at Tobolsk	B. H. L. M.	Mar. 16.	Mar. 27.
Bering left Tobolsk	Bering.	May 15.	May 27.
Bering arrived at Ilimsk, where they spent the winter of 1725–6	L.	Sept. 29.	Oct. 10.
Lunar eclipse obs. at Ilimsk	Chirikoff.	Oct. 10.	
1726.			
Bering arrived at Yakutsk	L.	Mid. June.	End June.
Bering left Yakutsk	L.	Aug. 16.	Aug. 27.
Bering reached Okhotsk	L.	Sept. 30.	Oct. 11.
Bering's provision train arrived at Okhotsk	L.	End Oct.	Mid. Nov.
1727.			
Spanberg reached Okhotsk (Jan. 6, L).	M. H.	Jan. 1.	Jan. 12.
Vessel *Fortuna* launched at Okhotsk	L.	June 8.	June 19.
Spanberg sailed for Bolshoia river	M. H. L.	June 30.	July 11.
Chirikoff arrived at Okhotsk	B. M. L.	July 3.	July 14.
Spanberg returned with Fortuna	L.	Aug. 11.	Aug. 22.
Bering and party sailed for Bolshoia river (Lauridsen says August 19).	B. M. H.	Aug. 21.	Sept. 1.
Bering arrived at Bolshoia river	M.	Sept. 2.	Sept. 13.
Bering arrived at Bolsheretsk	L.	Sept. 4.	Sept. 15.
1728.			
Partial eclipse of moon, visible in Kamchatka, last contact 7^h 41^m P. M.	Oppolzer.	Feb. 14.	Feb. 25.
Bering arrived at Lower Kamchatka	L.	March 11.	Mar. 22.
Vessel Gabriel put on the stocks	B. H. M.	April 4.	April 15.
The Gabriel launched (Lauridsen says she sailed to the mouth of the river July 9)	B. H. M.	June 10.	June 21.
The expedition left the river to commence explorations	B. H. L.	July 13.	July 24.
The expedition sailed northward	M.	July 14.	July 25.
Bering reached his northernmost point and started on his return	M. H. B. L.	Aug. 15.	Aug. 26.
They reached the Kamchatka river on their return	H. L.	Sept. 2.	Sept. 13.
1729.			
Total eclipse of the moon, visible in this region, beginning at 6^h 06^m A. M.	Oppolzer.	Feb. 2.	Feb. 13.
Bering sailed E. from Kamchatka river (Lauridsen says July, which is erroneous)	M. H.	June 5.	June 16.
Bering steered to the southwest	L.	June 8.	June 19.
The party arrived at Bolsheretsk		July 2.	July 13.
Bering sailed for Okhotsk	L.	July 14.	July 25.
Bering arrived at Okhotsk	M. Ber.	July 23.	Aug. 3.
Bering left Okhotsk	H.	July 29.	Aug. 9.
Total eclipse of the moon same day, but not visible in this part of Asia	Oppolzer.	July 29.	Aug. 9.
1730.			
Bering arrived at St. Petersburg	H. M. B. L.	March 1.	Mar. 12.

some additions, errors, and mistranslations, much the same. As Bering does not give any longitude for Lower Kamchatka post it is highly improbable that he observed it at that place, by means of a lunar eclipse or otherwise.

Chirikoff's observation of a lunar eclipse at Ilimsk made that point 30° 13′ east longitude from Tobolsk or, approximately, 97° 13′ east from Greenwich. His pedometric observations placed Ilimsk in 103° 44′ E. Gr. On recent charts Ilimsk is in about 104° E. Gr., so that the eclipse observation was in error about 6½ degrees. The meridian used on the voyage of 1728 was that of Lower Kamchatka, based on pedometric observations from Ilimsk computed by means of a traverse table. These, according to Chirikoff's journal, gave for the Lower Kamchatka post a meridian of 126° 01′ 49″ east from St. Petersburg or about 156° 02′ east from Greenwich, which is in error about six and a quarter degrees. Discarding the eclipse observation and using only the pedometric observations from Tobolsk to Lower Kamchatka the result for that place is 162° 33′ E. Gr., which is very near the truth. I have no doubt that this result is what was finally used in the chart (though not in the original report) and, therefore, that all the observations of Lauridsen and others in regard to the alleged eclipse in Kamchatka are based on a misunderstanding and without value.

Synopsis of the Voyage.

The dates are reduced to the Julian calendar from the nautical account. The longitude is stated in degrees east from Greenwich.

June 10/21, 1728. The vessel, which was named the *Gabriel*, was launched at the Lower Kamchatka fort and loaded with a year's supply of provisions for forty men (B. C. H. M.). She resembled the packet boats used in the Baltic.

Notes.—This vessel was constructed of the Kamchatkan spruce, a species according to Kittlitz closely resembling *Abies canadensis* of America. There is also a smaller species, *A. mertensiana*, and by distillation of these two trees the deficiency in their supply of tar or pitch was made up. The rigging, sail-cloth, oakum and anchors had been transferred with great labor from Tobolsk. The planking and timbers were doubtless fastened with trenails and not with spikes, so the amount of iron used was much smaller than it would be in most modern vessels. The provisioning of the expedition is the subject of a fanciful paragraph garbled from Bering's original report, which has been quoted by every one of the historians of the voyage from D'Anville to Lauridsen. I transcribe it from Brooke's translation of 1736, pp. 437–8.

"The provisions consisted of Carrots for want of Corn (=grain or wheat), the fat of Fish uncured served instead of Butter and salt fish supplied the place of all other meats."

Campbell in Harris' Voyages, p. 1020, still further enlarges this statement and Lauridsen puts it

"Fish oil was his butter and dried fish his beef and pork. Salt he was obliged to get from the sea," and "he distilled spirits from 'sweet straw.'"

This gives a totally false idea of the supplies provided for the expedition. Bering received from Yakutsk over forty-two tons of flour, and large numbers, fifty at a time, of the small Siberian cattle were driven on the hoof to Okhotsk where their flesh was partly dried and partly salted. On his return he delivered surplus supplies to the proper officers in Kamchatka and at Okhotsk ever 30,000 lbs. of meal, flour and salt meat. There were at that time no carrots to be had in Kamchatka as Bering himself testifies. Salted salmon then as now, formed a staple article of diet in Kamchatka and was without doubt included in his stores. The delicate fat obtained by boiling the bellies of the salmon, is annually prepared in Kamchatka and is regarded to this day as a great delicacy (cf. Voyage of the *Marchesa*, 2d edition, p. 135.) A store of it might without any hardship be furnished to the commander for use as butter. Salt he obtained as it is usually obtained by evaporating sea-water, and the absence of strong drink of European origin was supplied by a distillation of the stalks of the bear's foot or "sweet herb" of the Cossacks (*Heracleum dulce* Kittlitz), long used for that purpose by the Russians in Siberia and from which, even in modern times, according to Seemann, the Kamchadales secured additions to their scanty supply of syrup or sugar.

The supplies then of the expedition, were not inferior to those in common use at sea at that period, and as far as health is concerned were certainly less likely to result in an invasion of scurvy than the use of salt beef and pork alone would have been.

It must be remembered that the fare on naval vessels all over the world in those days, was rude and coarse to a degree now long unknown and that it was not until the voyages of Cook, nearly half a century later, that the antiscorbutic and varied regimen, now usually enforced by law in maritime nations, was even thought of.

The force crowded together on the little *Gabriel* is enumerated by Lauridsen presumably from the account of Bergh.

It consisted beside the commander, of Lieutenants Martin Spanberg and Alexie Chirikoff; Second Lieutenant Peter Chaplin, Doctor Nieman, a quartermaster, eight sailors, a worker in leather, a rope maker, five carpenters, a boatswain, two cossacks with a drummer and nine marines, six servants, stewards, etc., and two Kariak interpreters, a cabin boy and a pilot, in all forty-four persons.

It is not clear from Lauridsen's account whether in the above list are or are not included the two mates, Richard Engel and George Morison, or the cartographer Potiloff, who started with Bering from St. Petersburg. Luzhin was left behind, being ill.

July 13/24. The variation of the compass was determined to be 13° 10′ easterly (L.). In the afternoon (being the 14th nautical reckoning) the vessel left the Kamchatka river. (B. C. H.) They steered to the northeast along the coast, which was kept in sight to the north and west, in from nine to twelve fathoms water. As the point of departure Cape Kamchatka was determined to be in north latitude 56° 3′ (M. L.)

Notes.—The variation of the compass in 1885 was 2° 30′ easterly (Schott). As will be seen by the Table of Positions, the latitude above given for the cape is not the same as that adopted by Bering on his chart. The depth mentioned shows that the Gabriel must have kept within a few miles, probably not exceeding ten, from the shore and the very slow progress made, as indicated by the log, not much exceeding two miles an hour gives rise to the suspicion that, in the early part of the voyage, in order to keep their survey continuous, they probably lay to during the hours of darkness. Off Karaginski Island the variation of the compass was determined to be the same as at the mouth of the Kamchatka river.

From this date to the 27th, the accessible authorities give no data, and the expedition probably pursued its way uneventfully.

$\frac{\text{July 27}}{\text{Aug. 7}}$. This day a prominent Cape was passed at a distance of some three miles. [It was named St. Thaddeus, after the saint on whose holy day it was again seen on the return voyage.] Many grampus, porpoises, seals and sealions were seen (L.).

Notes.—This Cape St. Thaddeus is not the cape of the same name on modern charts, but the cape now known as Cape Navarin. This is evident from Bering's chart. Bering's position for the cape is in error about fifteen miles in latitude and three degrees in longitude on his chart, while in the list of positions, the error is only about five miles of latitude and half a degree in longitude.

From near Cape Thaddeus Bering stood across Anadyr Gulf, out of sight of the low land, missing Anadyr Bay, and thereby falling into the error of placing on his chart the mouth of the Anadyr River south of the cape. The error was subsequently corrected by G. F. Müller.

Lauridsen observes (American edition, p. 30), that "having sailed past the Anadyr River without quite being able to find their bearings, in regions of which they had not a single astronomical determination," etc. This is absurd. They had a compass and there is no reason why they should not find their bearings, and it is certain they were there to make observations and not to verify those already made. No apology is needed for Bering's determination to press more rapidly northward. It was in accordance with common sense, considering the lateness of the season and the uncertainty of what they had to accomplish before the season closed.

Aug. 1/12. Festival of the Holy Cross. The expedition saw land to the northward and soon after entered a great bay which they named Holy Cross Bay. This they explored to the river at its head which they named Bolshoia (Great) River, and on the western point of entrance the latitude was, Aug. 2/13, observed to be 65° 35′ north, while the longitude by dead reckoning was estimated at 182° 15′ east of Greenwich, and the magnetic variation $\frac{3}{4}$ of a point easterly.

Notes.—Lauridsen says (p. 31, American edition) that in Holy Cross Bay the Gabriel spent two days under sail in search of fresh water and a place to anchor." This is extremely singular, as there is an anchorage immediately at the entrance to the bay, on the starboard hand, and runs of fresh water are abundant. The application of an obvious correction* to the list of positions given by Campbell makes the position at the western elbow or spit, at the mouth of Holy Cross Bay, that which is given above. This position is over a degree too far west and over six miles too far south. But Lauridsen (quoting Campbell without observing the blunder?) not stating the source of his information, gives a position (N. Lat. 62° 50′) which is two hundred and twelve miles too far south and the English translation improves upon this by making it 60° 50′, or three hundred and thirty two miles south

* In Harris' Voy., 2d ed., ii, p. 1021, Bering's table of positions is printed :

Nischuvi Kamschatska Oostrog, (N. Lat.) 56° 11′ (Lon. E. Tobolsk),	98° 30′
The Mouth of the river of the Apostle *Thadeus* and the Cape	56° 03′, 96° 10′
The Elbow of the river *Swetoi Krest*	62° 20′, 111° 32′
Eastern Point	65° 35′, 115° 15′

This should read, errors and misplacements corrected :

	Lat.	Long.
Nizhni Kamschatsk Ostrog	56° 11′,	95° 30′
The mouth of the River (Kamchatka)	56° 03,′	96° 10′
The Cape of the Apostle *Thaddeus*	62° 20′,	111° 32′
The western cape (or spit) of Svietoi Krest Bay	65° 35′,	115° 15′

The words in parentheses are added by the writer for clearness. It is somewhat surprising that in using this table nobody seems to have recognized these errors.

of the truth, or two hundred and sixty-five miles south of the entrance to the bay as platted on Bering's own chart.

Bering's table in his report and Bering's chart as printed by D'Anville differ from each other fifteen miles in latitude and two degrees and twenty-five minutes or nearly seventy-five miles in longitude. The chart is the more correct, but it differs more than thirty miles in latitude and nearly a degree in longitude from the modern observations of Lütké and Rodgers for the same locality. After leaving Holy Cross Bay, the voyage was continued to the southeast along the "high and rocky coast" of which Lauridsen (probably paraphrasing Bergh) says that "every indentation was very carefully explored." This is obviously a flight of fancy, since a good part of this coast is low and sandy, while there is no indication of two excellent harbors which it affords, on any of the charts of Bering or his successors in that century.

Aug. 6/17, 1728. This day, the festival of the Transfiguration, found the Gabriel entering a small bay, which on that account was named Transfiguration (Preobrazhenia) Bay. Here they anchored (L.). Lieutenant Chaplin was sent ashore for water and found native huts but no people.

Notes.—This bay has never been surveyed, and on the best modern charts is merely indicated, while on many others it is omitted altogether or the name transferred to the anchorage north of Cape Bering or to Plover Bay. Bering's position for the spit at the entrance of Transfiguration Bay is two degrees and a quarter too far east and sixteen miles too far north by the table, but his chart gives the position much more closely, with a difference from Rodgers' chart of not exceeding five miles.

Aug. 7/18. They proceeded along the coast in a south-south-easterly direction.

Note.—The total eclipse of the moon of this date could hardly have been observed by Bering, since the moon must have been close to the horizon and first contact of the shadow occurred only about five minutes before the moon set. As Bering does not mention it, it is not likely that he noted the eclipse.

Aug. 8/19. At seven in the morning a skin-boat (umiak or bidarrá) was observed to be launched from the shore, eight men getting into it and rowing toward the vessel (B.). They approached within hail, and were understood, through the aid of the Kariak interpreters on board the Gabriel, to enquire whence the vessel came and what was the object of the expedition in entering these waters. After much persuasion one of the natives left the skin-boat and swam, sustaining himself on two inflated seal-skins tied by a pole, to the Gabriel and came on board and the others, seeing that no harm befel him, came nearer the vessel shortly afterward (M. B. C.). The interpreters had some difficulty in understanding all the natives said, but it was gathered from their conversation that these people called themselves Chukchi (or by an analogous name) ; that they were acquainted with the Russians, by report or otherwise, that there were numerous settlements of their people along this shore ; that the Anadyr River lay far to the west (L.) ; that to the south and east lay an island which would soon be visible to the people on the Gabriel if they continued on the course they were then steering ; that in the vicinity of this island the shore of the mainland changes its direction and extends beyond to the north and then to the westward (B. M. C. H.). The man who had boarded the vessel was given some presents and sent back to the native boat, in the hope that he would persuade his comrades to come on board the Gabriel, but, suspecting some evil design, the natives pulled away toward the shore and disappeared. According to Bergh, Chaplin's journal expresses regret that more important information could not be obtained owing to the difficulty in interpreting what was said by the Chukchi. At noon the latitude was estimated to be 64° 30′. In the afternoon the cape mentioned by the Chukchis was seen.

Notes.—The account given in Bering's report, and variously rendered by Müller, Brooks, D'Anville and Campbell, differs in several details from that given in Chaplin's journal and described by Bergh and Lauridsen. The various English versions of both fail in clearly rendering the important point gained by this interview with the natives, which was, that, at a short distance, the main coast changes its direction and turns to the north and west. These Chukchis pointed the way to the strait for the party on the *Gabriel*, and their account proved to be accurate in every particular.

The people of this part of the coast call themselves *Tsau-chú*, which is their tribal name. The similar name of another branch living near the Anadyr River has been corrupted into the word Chuk-chi, by the Russians, from which we derive our general name for these people. Lauridsen says "Breden var 64° 41′" which in the American edition stands, "the longitude (sic) was 64° 41′." But the original and all the variants of Bering's own report make the latitude 64° 30′ which is correct. If it had been 64° 41′ they would have been north of their own position for Transfiguration Bay, from which their course had been S.S.E., therefore the 41′ is certainly erroneous.

On Bering's chart he refers to the point of the coast where the shore changes its direction under the name *Chukotskago Noss*, which means the promontory of the Chukchi, though this is not the same as the

Chukchi Cape of the Anadyr Cossacks, who so denominated the eastern extreme of Asia, which they knew from report and by the voyage of Deshneff. There can be no reasonable doubt that Bering named his cape after the people who had described it to him, although the imperfections of the record leave this to be inferred. Bering's map gives the latitude of the south extreme of the cape as about 64° 02′, and it is erroneously represented as extending south of the latitude of the northwest end of St. Lawrence Island. Its real latitude is about fifteen miles further north. Cook made it 64° 13′. Chaplin's journal (according to Lauridsen) makes it 64° 18′, which would agree with the latest surveys very nearly, though the coincidence must be regarded as a happy accident in view of their imperfect tables, instruments and methods. Bering's report places its eastern extreme in 64° 25′ and (wrongly) in the same longitude as the west end of St. Lawrence Island.

Aug. 10/21. St. Lawrence's day. The island referred to by the Chukchi was seen and the vessel stood toward it, about two o'clock in the afternoon. Twice, an officer with a four-oared boat was sent to reconnoiter the coast more closely, but he saw only what appeared to be huts without inhabitants (C.). The island (of which only the northwest hilly portion was seen, owing to the hazy weather) was named after the patron saint of the day and the course of the vessel was changed to the northward.

Aug. 11/22. At noon the latitude was estimated at 64° 20′, and at sunset an attempt was made by the determination of the magnetic variation to get the longitude (L.).

Notes.—An illustration of the want of care with which Lauridsen has weighed his comments, it may be pointed out that he claims (p. 32, Am. Ed.) that on reaching latitude 64° 20′ the *Gabriel* was in Bering Strait, while two pages later, on her return southward, he declares her to have got out of the strait on reaching latitude 64° 27′! As a matter of fact, at the present day, the whalers and traders of this region consider that Cape Chaplin (more commonly known as Indian Point) forms the southwest point of entrance to the strait; and this point is situated in latitude 64° 25′ and E. longitude 187° 40′, as determined by the writer in 1880. This is perhaps the point referred to by Bering as the eastern point of his Chukotskoi Cape.

The magnetic method of determining the longitude would give correct results only accidentally, as previously explained. The result announced by Lauridsen for the present occasion is 25° 31′ east from Lower Kamchatka Ostrog or 187° 51′ east from Greenwich, which would be within a few miles of the latest determinations. But it is obvious from Bering's map that he could not have made his position less than 28° 45′ east from Lower Kamchatka, and the position above given is perhaps an interpolation from modern sources, which has been misunderstood or mistranslated. As Lauridsen has paraphrased, not quoted, it is impossible in the absence of Bergh's original to determine who is responsible for the incongruity. An interpolation seems the more likely since Bering himself gives the longitude as 189° 55′ E. Gr.*

Aug. 12/23. From noon of the 11th to noon of this day, the Gabriel sailed sixty-nine miles, but the difference of latitude was only 21 miles. The wind was light to fresh and the weather overcast (L.).

Notes.—If the above statement be taken literally with the assumption that they were at noon of the 11th in latitude 64° 20′ and E. longitude 188° from Greenwich, it would give their position for noon of the 12th as 64° 49′ and longitude 190° 45′ E. Gr., which does not at all accord with the subsequently narrated course, etc. If we proceed on the hypothesis that it means that the log recorded 69 miles and that only 29 miles were made good (which might easily happen if the polar current were running strong on the west side of the strait) and that their course was parallel with the Siberian shore in a general way they would have been, at noon of August 12th, in latitude 64° 49′ and longitude 188° E. Gr. or thereabouts, which agrees very fairly with the known circumstances.

Aug. 13/24. A fresh breeze and cloudy weather. The *Gabriel* sailed the whole day with no land in sight and the difference in latitude was only 78 miles at noon, reckoned from noon of the 12th. The wind diminished toward night.

Notes.—On the same hypothesis as to the meaning of "difference in latitude" as the words are used by Lauridsen, the *Gabriel* at noon of the 13th would have been ten or twelve miles south from East Cape and in about latitude 65° 55′. If the words are to be taken literally, as a navigator would use them, the Gabriel would have been about fifteen miles to the northward and eastward of East Cape, which agrees much less with the subsequently detailed circumstances. With the nautical day beginning at noon on the 13th according to Lauridsen the weather began to be calm and cloudy which would check their progress.

Aug. 14/25. This is the festival of Saint Demetrius of Africa. A current was experienced during this day which was estimated to have helped the vessel northward eight miles and three quarters. This current ran from south-southeast to north-northwest. From noon of the 13th to noon of this day the vessel sailed 29 miles in addition to the current drift. At noon the latitude was estimated

* A glance at Bergh shows that this statement of Lauridsen is simply a blunder. Bergh only says they obtained the magnetic variation (25° 31′ easterly) by an *amplitude* observation! Longitude is not mentioned, nor Kamchatka.

to be 66° 41′ and high land was visible astern. At three o'clock in the afternoon high mountains were observed to the southward. which, says Chaplin, "were probably on the continent."

Notes.—Under any hypothesis either the run of the vessel was underestimated or the latitude was overestimated. Adding the estimated run to the position attained under our hypothesis for the 12th and 13th it will put the *Gabriel* at noon, August 14th, in about north latitude 66° 24′ and longitude E. Gr. 191° 30′. Chaplin's reckoning as given by Lauridsen would have put the *Gabriel* more than fifty miles off shore when the land spoken of would have been out of sight. Our hypothesis puts her about twenty-eight miles N.E. true from East Cape when the high land of either shore, under favorable circumstances, might have been seen even if the sky were overcast. Clouds do not interfere with seeing, unless attended by fog or haze. During this day the *Gabriel* had sailed between East Cape and the islands now known as the Diomedes; the shore being near by. Why then should it be noted in the log that "high land was seen astern" at noon? The high land of Siberia they had seen and sailed along for days in full sight of it. It seems to us that this excludes the idea that the log refers to the Siberian highland and that what was seen was the loom of land not before seen, as of the Diomedes or even of America. It may not have been clear to the commander and yet have been marked enough for the subordinate officer to have put it in his log, with the dead reckoning and daily notes.* On several old charts mention is made of land seen by Spanberg which is supposed to have been America, after Gwosdeff had confirmed the existence of the American mainland in that direction and Synd had landed upon it. This suggestion is not unimportant in connection with the subsequent conduct of Bering and will be referred to again in its proper connection. The further fact that all early printed versions of Bering's list of positions, refer to the modern Diomedes only as the island of *St. Demetrius* and that this day was the festival of that obscure saint, lends further confirmation to the above suggestions.

Aug. 15/26. The *Gabriel* appears to have continued to sail in a northeasterly direction until three o'clock in the afternoon, having been aided by the current to the extent of 8¾ miles and sailed 65 miles; many whales were seen and the depth averaged between 23 and 36 fathoms. Since the 13th the water had appeared whitish or discolored. The wind was moderate and the weather cloudy. Between noon and three o'clock the vessel made seven miles against a head wind. The position of the *Gabriel* at that time was estimated to be in north latitude 67° 18′ and 30° 17′ east longitude from the town of Lower Kamchatka (C. corrected).

* Lauridsen gets over the discrepancy by putting the word "still" before "seen" (Am. Ed., p. 41), but there is nothing in the original sources to confirm this view of the matter.

Note.—The nautical day Aug. 15 extending from noon of the 14th to noon of the 15th is altogether omitted from the American translation of Lauridsen's book. The position for the turning point estimated by Chaplin is manifestly by dead reckoning, as the sky was cloudy. It was not adopted in the list of positions published by Campbell in Harris' Voyages nor on Bering's map. In the former the longitude he adopts is 27° 37′ east of Lower Kamchatka fort, and this agrees exactly with the point on the coast in Du Halde's engraving of Bering's map where the mountains cease to be put down near the shore, the point on the north coast of Siberia where Lauridsen, and Chaplin as quoted by him, say Bering did not go, and the point which has been generally regarded as Bering's farthest!

If we apply the distance and direction from Chaplin's journal to the course of the *Gabriel* platted from his preceding data, literally, it will put the turning point of the voyage in N. latitude 67° 32′ and E. longitude 193° 37′ or thereabouts, which is about thirty-five miles off the American coast southwest from Cape Seppings. But if we do this the position is far from agreeing with Chaplin's. By applying the hypothetical correction which we have heretofore used, the position would be in latitude 67° 24′ and E. longitude 193° 15′ from Greenwich or 31° east from Lower Kamchatka fort, agreeing more nearly with Chaplin. On the other hand the position off Cape Seppings agrees better with Chaplin's figures for the remainder of the day.

At this point the commander of the expedition determined to turn homeward. The *Gabriel* was put on a course S. by E. by compass (S. by W. ½ W. true, the variation allowed being 2½ points easterly) before a brisk seven knot breeze, making better time than is recorded for any part of her outward voyage.

Notes.—Lauridsen says* that, in terminating the outward voyage, Bering "announced that as he had now accomplished his task it was his duty, according to his orders, to return." Müller and other authori-

* Bergh (p. 54) quotes Chaplin's journal, which says: "At three o'clock Captain Bering announced: *that it was necessary for him, in spite of his instructions, to turn back*, and put the vessel about with orders to steer S. by E. by compass." The italics are Bergh's, who adds that, in the journal of Lieut. Chirikoff, the same statement is made in the same words. I transliterate the italicized phrases according to the schedule for Russian letters published in *Nature*, Feb. 27, 1890. "Chto nadlezhit emu protiv ukazu vo ispolnenie vozvratit'sya." This plain statement, which proves that (at the moment) Bering recognized that he was not fulfilling his orders, is suppressed by Lauridsen and of course by Bering himself when he came to prepare his official report. Lauridsen however is not satisfied with suppressing the truth, which would have weighed so heavily against his hero and his argument, but, with the truth in his possession, he has inserted in his book a statement which is diametrically opposed to it as above cited.

ties quote, more or less modified in the translation, the reasons given in Bering's report. But, as there is no reason to suppose these were uttered to the ship's company officially at the time, a consideration of them may be deferred until the total results of the voyage are discussed. The course set, according to Chaplin's journal, would, if made good, have carried the *Gabriel* east of the Diomedes and close to Cape Prince of Wales. The northwesterly current referred to by Chaplin and recognized by most navigators who have since visited those seas, would have carried the vessel more to the westward, as was actually the result, and it was probably allowed for.

August 16/27. Saint Diomede's day. The *Gabriel* had kept on her course with a free wind making more than seven knots (miles) an hour. At nine in the morning they found themselves off a high promontory on the west, where there were Chukchi habitations. On the east and seaward they saw an island, which it was proposed to call after the saint of the day. At noon the vessel had made since the previous noon 115 miles and had reached latitude 66° 02′. Continuing on their way, with a fresh breeze and cloudy weather, they sailed along the Asiatic coast near enough to observe many natives and at two places they saw dwellings. At three P. M. very high land and mountains were passed (probably the highlands near St. Lawrence Bay).

Notes.—From 3 P. M. Aug. 15th to 9 A. M. Aug. 16th is 18 hours, which at seven knots an hour (allowing the alleged excess to be the equivalent of the drift caused by the current) would amount to 126 miles. Deduct from this the seven miles sailed between noon and 3 P. M. Aug. 15th in the opposite direction and we have remaining 119 miles made on the homeward voyage at a time when the *Gabriel* was between the Diomedes and East Cape, or at least in plain sight of both. But three hours later, at noon, according to Lauridsen, they had made only 115 miles in all, although the breeze was fresh and fair. From Chaplin's position for the turning point to latitude 66° 02′ off East Cape is 96 miles. From our hypothetically corrected position for the turning point, off Cape Seppings, the distance would be to the same place 126 miles, or thereabouts. It is evident that there is a miscalculation, or an error in the record here, which, without further data, it is not possible to correct.

It is certain that Bering with whom the right of naming any new island would have rested, did not then name the island above mentioned after St. Diomede. On all copies of the earlier version of his chart it appears if at all under the name of the Island of St. Demetrius. From this we may suspect that he identified it with the high land seen Aug. 14th, St. Demetrius' day, while others on board, suspecting they were not the same proposed the name of Diomede for the present island ; regarding the high land as something distinct. If the hardy and self-willed Spanberg was the one who reported the land Aug. 14th, and if he saw the high land about Cape Prince of Wales, as several old charts allege, he would have been the last to admit that the relatively small and adjacent island now seen, should be identified with his discovery.

Aug. 17/28. The breeze having been strong and fair an observation at noon indicated that the latitude was 64° 27′ and that the *Gabriel* had sailed 164 miles since noon of the 16th. In the afternoon the weather was clear and the wind became light. (The *Gabriel* must have come out of the strait this afternoon).

Notes.—A distance of 164 miles from the position of the previous noon would have put the *Gabriel* in latitude 63° 38′. The distance on the general course sailed by the *Gabriel* from 66° 02′ to 64° 27′ is about 107 miles. It is possible that in copying or printing 104 miles has become transmuted to 164 miles. There is an obvious error here of some kind.

Aug. 18/29. (Lauridsen does not refer to any record for this day, but it is probable that the wind continued light and the weather fair and that the *Gabriel* was slowly working her way westward and southward in the vicinity of Cape Chukotski.)

Aug. 19/30. In the afternoon being in the vicinity of the place where they had met the Chukchi boat on the outward voyage, four baidars were seen with their crews pulling for the vessel, which accordingly lay by for them to come up with her. There were ten natives to each baidar, or forty in all. They brought reindeer meat, fish, and fresh water in large bladders for sale for which they were suitably rewarded, while the crew of the *Gabriel* obtained from them skins of the red and the polar foxes and four walrus teeth, which the natives bartered for needles, flint-and-steel for striking fire, and iron. These Chukchi told them that they went over land to trade at the Kolyma River, carrying their goods with reindeer, and that they never went by sea. They had long known the Russians and one of them had even been to the Anadyrsk fort to trade. From this man they had hopes of gaining valuable information but he could tell them nothing more than they had learned from the first Chukchis who had been questioned.

Aug. 20/31 to $\frac{\text{Aug. 29}}{\text{Sept. 9}}$. (For this period the documents accessible to me give no information, but the *Gabriel* was doubtless pursuing her homeward way uneventfully along the coast of Kamchatka.)

$\frac{\text{Aug. 30}}{\text{Sept. 10}}$. A heavy storm arose with fog and the *Gabriel* finding herself dangerously close to the shore anchored near the land to ride it out. A note in Harris indicates that they may have been near Karaginski Island.

$\frac{\text{Aug. 31}}{\text{Sept. 11}}$. At one P. M. the storm had abated, but in weighing anchor the cable had been so chafed by the rocky bottom that it parted and they lost the anchor, and were obliged to put to sea without recovering it.

Sept. 1/12, 1728. At five o'clock in the afternoon they approached and at seven the next morning entered the mouth of the Kamchatka river, thus ending the voyage.

Note.—The *Gabriel* was secured in a slough of the river and the party went up the river to the fort of Lower Kamchatka where Bering passed the winter.

It is certain that the residents of Kamchatka and others more or less familiar with the reports of Cossack explorations in Chukchi-land were not altogether satisfied with the summary manner in which exploration had been given up by Bering, and his apparent assumption that there was no adjacent land to the eastward except small islands. More or less such discussion and criticism could hardly have failed to reach his ears, and his reflections may have led him to think that, after all, he had been too hasty. Trees not indigenous to Kamchatka had been seen floating near the shores, no heavy breakers ever proceeded from the eastward and it was even alleged that land or the loom of land might be seen to the east from the coast mountains in very clear weather. On account of these and other reasons* which were urged by residents of the country, Bering determined to make a new trial. Instead of proceeding directly to Okhotsk across Kamchatka he fitted out the Gabriel for another voyage. Beside the fact that Luzhin, one of his cartographers, had explored the Kurile Islands lying next to Kamchatka, the vessel *Fortuna* during Bering's absence had doubled Cape Lopatka and was anchored in the Kamchatka River when Bering entered it on his return. It was therefore evident that the straits were navigable and the return voyage might be made that way. Spanberg was ordered to Bolsheretsk "on account of illness" (L.), and it is possible he took the *Fortuna* back there since she had already returned to Bolsheretsk when Bering reached that port, on his way to Okhotsk.

* The natives even claimed that a man had been stranded on the coast of Kamchatka in 1715, who stated that his own country lay to the eastward and contained forests with high trees and large rivers. (Lauridsen, op. cit. Am. ed. p. 51). Bering himself states that he made the search of 1729 at the instance of the Kamchatkan residents.

Lauridsen has ascribed to Bering's own initiative the willingness to make another search for land as if these ideas were original with him. It is evident that this is unjustified and fanciful. Müller's account shows that the incitement to a second attempt proceeded from the residents of the country and that Bering complied with their suggestions; and Bering says so himself in his report.

On June* 5/16, 1729, the *Gabriel* left the mouth of the Kamchatka River and stood to the eastward, directly off shore. She continued on this course about forty-eight hours, sailing a distance variously estimated at from ninety to one hundred and thirty miles. The weather was foggy, no land was seen, the wind shifted to dead ahead at east northeast, and on the third day Bering gave up the search and steered for the southern coast of Kamchatka, the extreme of which is marked by the point known as Narrow (Ooskoi) Cape, or more generally as Shovel (Lopatka) Cape, from its low square termination. He determined the latitude of this cape, and passing through the strait south of it reached Bolcheretsk on the west coast of the peninsula on the second of July. Most of this time was probably spent in tracing the form of the southern part of Kamchatka. Half way between the Kamchatka River and the coast the variation was observed to be one point easterly, and off Avatcha Bay three-quarters of a point easterly.

In the American translation of Lauridsen it is said (p. 51) that Bering fixed the difference of latitude (for which one should read longitude) between Bolcheretsk and Lower Kamchatka Ostrog at 6° 29′. But on Bering's maps the difference is only 3° 50′, while in his list of positions no longitude is assigned to Lower Kamchatka post. In Campbell's list it stands at 8° 39′, which the correction of an evident error of 98° for 95° reduces to 5° 39′. The true difference of longitude according to the latest charts is about 5° 25′. Where Lauridsen got his figures he does not state. Campbell, in Harris, states that Bering was the first navigator to double Cape Lopatka, but the *Fortuna* had made this voyage in 1728, though her commander is not known.

At Bolsheretsk Bering left a crew for the *Fortuna* which had returned thither; turned over some of his surplus stores to the local authorities and on the 14/25 July sailed from the Bolshoia River for Okhotsk. Here he arrived $\frac{\text{July 23}}{\text{Aug. 3}}$ and after some days spent in turning over government property to the local officials and procuring his horses and outfit, he left Okhotsk $\frac{\text{July 29}}{\text{Aug. 9}}$ on the overland journey to St. Petersburg. The second eclipse of the moon for the year occurred on this day, but during hours of daylight, and hence was invisible in this part of Asia.

After an uneventful but successful journey Bering arrived in St. Petersburg Mar. 1/12, 1730, bringing with him, according to Du Halde, the map and report he had prepared upon his explorations.

* Lauridsen says July, which is erroneous.

TABLE OF GEOGRAPHICAL POSITIONS DERIVED FROM BERING'S FIRST VOYAGE, REDUCED TO GREENWICH, E. LONGITUDE.

Meridian used in the original,	Tobolsk.	Tobolsk.	Tobolsk.	Ferro.	Ferro.	Greenwich.
Amount used for reduction,	+67°.	+67°.	+67°.	−18°.	−18°.	
Source of the data,	Bering* MS.	Campbell.[1]	Du Halde.	D'Anville.	Müller.	Modern charts.
Date,	1730?	1730?	1736.	1753.	1758.	1852–88.
	° ′	° ′	° ′	° ′	° ′	° ′
Okhotsk	58 54	59 13	58 54	-- --	59 20	59 20[19]
	141 30	143 07	141 20	-- --	141 15	142 40
Bolsheretsk, Kamchatka	52 35	52 42	52 40	52 40	52 54[13]	52 51
	155 28	156 51	155 25	155 30	156 30[14]	156 50
Upper Kamchatka settlement	54 10	54 48	54 10	53 40	54 28	-- --
	157 10	158 00	157 15	156 30	156 55	-- --
Lower Kamchatka settlement	55 46	56 11	55 50	56 05	56 20	56 15
	159 28	162 30[2]	159 15	159 00	159 30	162 15
Cape, at Kamchatka river-mouth	55 52	56 03	55 40	56 00	56 10	56 00
	162 05	163 10[3]	162 10	159 20	160 20	163 05
Cape Thaddeus (Navarin)	61 50	62 20	62 00	62 05	62 25	62 15
	176 05	178 32[4]	176 00	171 14	175 20	179 02
West point, entrance Holy Cross Bay	65 16	65 35	65 15	65 15	65 30	65 28
	179 40	182 15[5]	180 00[11]	175 10	178 45	181 12
Mouth of river, Holy Cross Bay	66 00	-- --	65 50	65 45	66 15	66 22
	179 40	-- --	179 50	175 00	178 15	180 45
Transfiguration Bay (east entrance)	64 45	65 01	64 40	64 25	-- --	64 45
	185 15	187 30	185 10	180 00	-- --	185 15
Cape Chukotski, of Bering	63 55	64 25	64 02	64 10	64 35	64 14
	186 55	189 55[6]	186 10	181 10	185 10	186 50

N. W. point St. Lawrence Id.	63 50	64 00	64 02	64 00	64 15	63 52
	187 00	189 55	187 20	181 20	186 05	188 27
St. Demetrius Id. (Big Diomede)	65 42	66 00	-- --	66 00	-- --	65 50
	189 05[12]	192 42[7]	-- --	183 20[12]	-- --[15]	190 25
East Cape of Asia	66 40	67 18	66 45	66 30	66 45	66 05
	189 40	193 07[8]	189 45	184 00	187 25	190 30
Bering's farthest	not	67 18	-- --	-- --	66 45[16]	-- --
	indicated.	193 07[9]	-- --	-- --	187 25	-- --
Petropavlovsk, Avacha Bay	53 10	53 12	53 15	52 50	52 55[17]	53 02
	160 02	159 50	157 00	158 55	158 13	158 39[21]
Cape Uskoi, or Lopatka[10]	50 50	51 10	51 10	51 20	51 20[18]	50 52
	155 05	156 51	155 10	156 00	157 00	156 47

[1] Date of Campbell's Harris' Voy., 1748; date of table of positions, 1728; fide Campbell, 1021, col. 2.
[2] Campbell has 98° 30′ E. of Tobolsk, an error (?), for 95° 30′ (=162° 30′ E. Gr.) Bering omits this position.
[3] Campbell's confusion of two entries is here corrected from Bering's Report.
[4] Confused with preceding entry by Campbell. [5] Campbell's confusion here corrected.
[6] The southern end of the cape is assumed to be meant.
[7] The island is omitted by Du Halde and Müller, but appears on Campbell's version of Bering's chart.
[8] Campbell, p. 1024; omitted by Bering from his report. [9] Campbell, p. 1022; also Bering's Report.
[10] Oskoi (error for Ooskoi), on most early charts; sometimes Osnoi (error for Uzhnoi = southern).
[11] Bering gives both east and west points of entrance in his table.
[12] St. Diomide on the chart. [13] Determined in 1741 by Krassilnikoff to be 52° 55′ and 156° 24′ E. Gr.
[14] From the chart; on p. 114 Müller has 156° 10′. [15] Name St. Deomed on chart, but no island represented.
[16] From Jeffrey's copy of the chart; on p. 47 of text N. Lat. 67° 18′ appears but no longitude is given.
[17] From the chart; on p. 114 of text it is given as 53° 01′ 45″. Krassilnikoff (see note 13), made it N. Lat. 53° 01′ and 158° 10′ E. Lon. from Greenwich, from eclipses of Jupiter's satellites.
[18] From the chart; the text, p. 114, makes it 51° 03′.
[19] The positions in this column are taken from the most recent charts of the U. S. Coast Survey and the U. S. and Russian Hydrographic bureaux.
[20] U. S. Coast Survey, 1880, Marcus Baker, observer; his position is reduced to the N. W. extreme of the island by adding 5′ of latitude and deducting 30′ 35″ in longitude. See Bull. Phil. Soc. of Washington, iv, p. 133, 1882, and U. S. Coast Survey Report for 1880, App. No. 16.
[21] Lieut. Onatsevich in Report Russ. Hydrographic office, 1878.
* This column is taken directly from Baron Klinckofström's manuscript copy of Bering's chart.

Resumé of the Results.

Bering had brought a party, together with supplies and material, over the rough and difficult but long-traveled routes to Okhotsk. Wherever he went he found settlements and roads such as they were. He transported his material to Bolsheretsk and from there across the peninsula to Lower Kamchatka settlement. It would have been much easier and shorter to have doubled the peninsula and taken his stores by sea; one of his party had already explored the straits near Cape Lopatka, but there was the chance of disaster in this plan and, with his stores on *terra firma*, Bering cannot be blamed for taking the land route; especially as the difficulties would not inconvenience him personally. He succeeded in getting his stores and shipwrights to the place designated and there prepared himself for the voyage. In all this there was difficulty and trouble enough of a certain kind. That it all was surmounted with success is very creditable to Bering and his officers. But to call it exceptionally heroic or extraordinary, is to forget the hundreds of others who preceded Bering, without the strong arm of the government at their backs, who made the trails he followed, who founded the settlements at which he rested, who raised the dogs, the horses and the cattle which were used or consumed by his party.

Whatever praise we may feel due to Bering and his companions, and it is certainly no stinted allowance, the appreciation of their struggles cannot fail to include with justice, the still more remarkable and nearly forgotten pioneer labors of the undaunted Siberiaks, who paved the way, not only for Bering's weary journey, but for the slow yet never ceasing march of civilization.

After leaving port Bering traced the shores of Kamchatka and eastern Siberia as far as East Cape. Thence he sailed in a northeasterly direction. At 3 p. m., Aug. 14th, land was seen astern; the vessel continued in the same direction until 3 p. m. the next afternoon, having, at most, sailed about twenty-four hours out of sight of land but in shallow water. Bering then concluded he had gone far enough to show the separation of Asia from America, or any land to the eastward. No doubt he was influenced by the testimony of the residents of Kamchatka who knew the work which had been performed in this region by Deshneff and others, and also by the fact that the native testimony all pointed the same way. If he was convinced of the truth of this testimony he would have been disposed to accept as conclusive evidence which would not be so regarded by critics. All the evidence shows Bering as faithful to the letter of his orders, honest, patient with the ill-doing or insubordination of others, but perfectly satisfied with the accomplishment of what he had been specifically directed to perform, and with a tendency to limit the specifications to the narrowest construction they would bear. He adventured nothing beyond. In the arbitrary government under which he served, with the violent competition between foreign officers in the Russian service for promotion in rank and pay, who can criticise him for the prudence and caution which kept him well within his instructions? I certainly do not. But to say that he was a cautious, prudent and sagacious officer, is a different thing from asserting he was a daring, adventurous and heroic explorer. I have not been able to discover anything in his career justifying the latter estimate of his character.

At all events in the present case it must in time have occurred to him, or have been suggested by his officers or by the Kamchatkans after his return that the mere sailing off shore in admittedly shallow water for twenty-four hours, was not an absolutely conclusive proof that the continents were separated. Here was a man with a new vessel, a full crew, a year's provisions for all hands, who has come half around the globe, taking three and a half years to do it, building ships and at no end of labor of one sort and another; all this to get into the region where there is a question to be answered; and when he gets there he barely gives twenty-four hours to searching for that answer with a month of the season still available for work; and then starts for home without settling the question; with a right conclusion, it is true, but not of his own discovery, and without securing definite proof to defy critics.

Leaving out of account the continent within half a day's sail which he fairly ran away from, ignorantly, where is there anything adventurous, daring or heroic in such conduct?

It is evident that if Bering had sailed along the coast which the Chukchis said extended to the westward, instead of going off shore, away from it, he would have confirmed that part of their testimony, and given high probability to the assumption of their correctness in the rest.

As it was, he left the question in a state so unsettled as to be a subject of debate for nearly half a century; even authorities so friendly as Dr. Campbell assuming with great confidence that Bering's conclusions as to the separation of the two continents were erroneous. It was not until the voyages of Captain Cook and his associates were given to the world in 1784 that the matter was settled beyond controversy.

Even in regard to the details of his voyage it was only through Bergh's publication of Chaplin's logbook of the voyage in 1823, that the public were informed as to what Bering did, and it was only in 1847 that the unmutilated, but still ambiguous Report of 1730 was accessible even in Russian typography.

We find that all the authorities who published in the last century copies of Bering's map and accounts of his expedition arrived at what Lauridsen calls an "interesting misunderstanding."

This misunderstanding was that he had sailed along the Chukchi coast, as above suggested, and that his farthest point was in latitude 67° 18′ on the coast of northeastern Siberia.

How was it possible that men of such exceptional intelligence as Du Halde and D'Anville and Müller, and Hazius, and Euler and Campbell were all so deceived?

The facts are as follows:

(1) The verbatim Report of the voyage, the logbook of the expedition, Bering's chart in its entirety, were inaccessible to the public for many years; the chart has never been fully engraved for publication.

(2) The fragments of the Report which were circulated in print were ambiguous in their language or erroneously modified; while the published reductions of the chart which got into print were misleading, or even erroneous.

(3) Two conflicting versions of the manuscript chart were circulated and appear to have been officially sent out. That which appears to be the later of the two is in some details quite erroneous and at variance with Bering's report as printed and with the facts derived from Chaplin's logbook, these two constituting the only authentic original information which has yet reached the public in printed form. But these two sources of correct data about the expedition were not printed until long after the charts had been widely circulated, while the extracts from the Report which appeared in print, even under so friendly an editor as Dr. Campbell were so modified as to support rather than expose the original error. How this arose there may be something in the Russian archives to explain, or, if not, the case

seems insoluble. Whatever conclusion one arrives at, it is difficult to acquit Bering of all responsibility for the misconception, if, as Lauridsen claims, he was responsible for the chart of Du Halde in the form it was engraved.

In his report he states that their northernmost latitude was 67° 18′, that "all along the seacoast to this place wind elevated mountains." On turning to the Du Halde chart we find the range of mountains continued along the Chukchi coast until it reaches the latitude of 67° 18′ where it stops. If Bering drew the chart so, it would have been deception, but it is quite as probable that the editor modified the chart in engraving it, to correspond to his understanding of Bering's ambiguity. As this would present nothing questionable to the reader, in the absence of the details omitted by Bering, it would have been nothing surprising if Campbell's interpolation of a false longitude for Lower Kamchatka, in his list of positions, might have been, not a typographical error, but an attempt to make the position agree with this erroneous assumption. If it was a pure accident, the coincidence is extraordinary. Of course Bering never was on this coast but Du Halde's map is so engraved as to lead directly to the false inference that he had been.

Again Bering says in his Report that at his turning point the land no longer extended to the north and that no projecting points could be observed in any direction. Since he had deliberately sailed away from the shores without attempting to follow their trend this observation would be absurd unless we suppose it addressed to a reader who took it for granted that the vessel was still skirting the coast. There is no mention in his Report of the fact that he had sailed away from the coast, nor of the still more important fact that the soundings showed that the water was comparatively shallow and discolored. Of course in the absence of direct proof of the separation of Asia and America this last evidence would tend to indicate that Bering was only in a bay or shallow arm of the sea and that he suppressed it shows, if not a want of candor, at least an injudicious reticence.

The map for the day when it was made (in the earlier version) was a good one, and is appropriately praised by Cook, who had a copy of Campbell's Harris on his vessel when exploring in the same region fifty years later.

In his report of the trip eastward from Kamchatka in 1729, Bering says nothing about the weather being foggy or stormy, but merely asserts that he sailed nearly 200 versts and saw no trace of land. He leaves it to be inferred that he could have seen land if it had been there to see, which if the weather was foggy was not true.

The impression which these facts leave upon the mind is that Bering did certainly frame his language so as to convey the idea that his evidence of the separation of the two continents and of the absence of land eastward from Kamchatka was more conclusive than it was in reality.

That this was done to avoid criticism seems a natural inference. That an examination of his list of positions would have shown the location of the point whence he turned back to be to the eastward of the easternmost of his reported land is true, but his list of positions was not published with his report, does not agree with his maps, and when published by Campbell was garbled, as I have shown.

That the truth, however, did get out and that criticism was not successfully avoided, is a matter of history. There can be little doubt that Bering's anxiety to undertake the second expedition, which followed, was stimulated by a desire to set these criticisms (which would naturally be magnified by his enemies) finally at rest.

It may be suggested that Bering's report was modified by the authorities, though why they should make these particular modifications is not very evident. Bering was the only person who could profit by them and the natural conclusion is that he should be held responsible.

In pointing out that some of Bering's acts are vulnerable to criticism I am far from desiring to sully his memory or give the idea that he was not entitled to great praise for what he accomplished, much of which was admirably done.

I wish merely to apply a gentle corrective to the exaggerated and injurious flattery and undiscriminating praise which has been injudiciously indulged in by his latest biographer.

If the interest in the subject be stimulated by discussion from these opposing points of view, so as to result in the publication of some of the material still hidden in the Russian archives I shall be more than repaid for the time I have devoted to the question, even if the publication of the original data should show some of my conclusions to be ill founded or erroneous.

Note—The reception of the original work of Bergh while reading the proofs of these pages has enabled me to correct several errors of previous writers, but it was too late to incorporate here the additional material which Bergh's work affords. This will enable me to add, in a future publication, some historical data which have never appeared in English and which are necessary to complete the record. I desire in this place to express my gratitude for and appreciation of the liberality of the authorities of that ancient seat of learning, the University of Upsala, as exhibited in their willingness to send such a valuable document to a foreign student half around the world for purposes of historical research.

Supplementary Note by Marcus Baker.

ON THE ALLEGED OBSERVATION OF A LUNAR ECLIPSE BY BERING IN 1728–9.

Bering was in Eastern Siberia, Kamchatka and the adjacent waters in 1728 and 1729. Could he have observed a lunar eclipse there at that time?

According to the ephemeris of Manfred* published at Bonn in 1725 there were two partial eclipses of the moon visible in Europe in 1728, and two total eclipses of the moon in 1729.

In regard to these four eclipses the ephemeris furnishes the following data:

	1728, Feb. 24.	1728, Aug. 19.	1729, Feb. 13.	1729, Aug. 8.
Eclipse begins	18^h 32^m	4^h 07^m	7^h 45^m	12^h 02^m
Total immersion	-- --	-- --	8 46	13 02
Middle of eclipse	20 0	5 35	9 35	13 52
Emersion begins	-- --	-- --	10 24	14 42
Eclipse ends	21 29	7 03	11 25	15 42
Digits eclipsed	9 51 S.	7 45 N.	19 46	19 44 S.
Sun rises	18 36	-- --	-- --	-- --
Sun sets	-- --	6 49	-- --	-- --
Eclipse	Partial	Partial	Total	Total.
Sun's declination	−9° 38′	+12° 42′	−13° 16′	+16° 09′
" hourly motion	+ 0.9	− 0.8	+ 0.8	− 0.7

* Manfredius (Eustachius). Novissimae ephemerides motuum coelestium e Cassinianis tabulis ad meridianum Bononiae supputatae auctoribus Eustachio Manfredio (etc.) Tomus 1. ex anno 1726 in annum 1737 (etc.) 4° *Bononiae*, MDCCXXV.

In this table the calendar is Gregorian, the time is apparent or true sun time, the day is reckoned from noon and the hours are counted continuously through the entire 24.

The present observatory in Bonn is in

Latitude 50° 43′ 45″ N.
Longitude 0^h 28^m 23^s E. from Greenwich.

At the date of the *first eclipse* Bering was on his way across the southern end of Kamchatka from Bolsheretsk to Lower Kamchatka. This would make his position somewhere near latitude 55° N. and longitude 160° or 10^h 40^m E. from Greenwich.

He was therefore 10^h 12^m east of Bonn for which we have the elements of this eclipse as computed by Manfred. With this data together with the latitude and sun's declination we have the following data for the eclipse in the region where Bering was.

Beginning of eclipse	4^h 44^m
Middle of eclipse	6 12
End of eclipse	7 41
Sun sets	5 07

This means that the sun set, bearing about W. by S. ½ S., and the moon rose in partial eclipse, bearing about E. by N. ½ N., at 5^h 07^m after apparent noon or 23 minutes after the eclipse had begun. The eclipse lasted for 2^h 34^m after sunset, or until 7^h 41^m in the evening, thus rendering observation of the last contact plainly visible.

At the date of the *second eclipse of 1728*, August 19, Bering was at sea somewhere in the vicinity of the strait which bears his name. Assuming his position to have been latitude 65° N. and longitude 188° or 12^h 32^m E. from Greenwich, equal to 12^h 04^m E. from Bonn, and as before taking the data from Manfred's ephemeris we have as follows :

Beginning of eclipse	16^h 11^m
Middle of eclipse	17 39
End of eclipse	19 07
Sun rises	16 04

It thus appears that the first contact of this partial eclipse of the northern limb of the moon may have been just barely visible to Bering. The moon bearing about SW. by W. was entering the earth's shadow about five minutes before the sun's rising and its own setting. If much importance attaches to determining the possibility to Bering of observing this eclipse then a more precise calculation is needful.

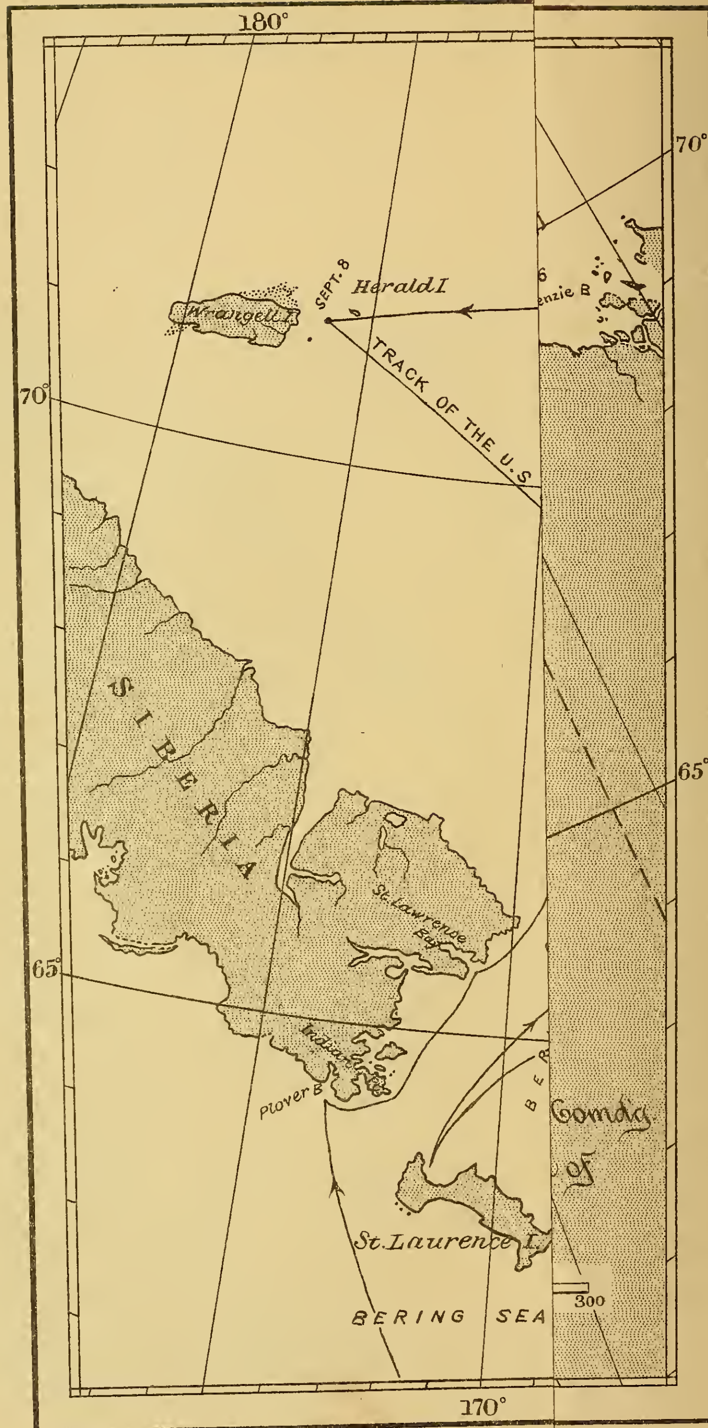
At the date of the *first lunar eclipse of 1729*, February 13, Bering was at Lower Kamchatka, in latitude 56° 03′ N. and longitude 162° 15′ or 10^h 49^m E. from Greenwich equal to 10^h 21^m E. from Bonn. For this place we have from Manfred :

Eclipse begins	18^h	06^m
Total immersion	19	07
Middle of eclipse	19	56
Emersion begins	20	45
Eclipse ends	21	46
Sun rises	19^h	21^m

Thus it appears that this total and almost central eclipse of the moon lasting 3^h 40^m began at Bering's station 1^h and 15^m before sunrise of February 14, the total immersion occurring 14 minutes before sunrise. It is manifest, therefore, that Bering might have observed this eclipse.

The *second lunar eclipse of 1729* occurred August 8, when Bering was in or near Okhotsk and about returning to Europe. We may assume his position to have been latitude 59° 20′ N. and longitude 142° 40′ or 9^h 31^m E. from Greenwich, equal to 9^h 03^m E. from Bonn. This eclipse was also total and almost central, but at Bering's station was wholly invisible, beginning at 9^h 05^m A. M. and ending at 12^h 45^m P. M.


The Arctic Cruise
of the U.S.S. "Thetis"
Lieut. Comdr. Chas. H. Stockton, U.S.N., Comdg.
in the summer and autumn of
1889.
TRACK OF THE U.S.S. THETIS
SIBERIA
ALASKA
Wrangell I.
Herald I.
SEPT. 8
SEPT. 7
SEPT. 6
SEPT. 10
PACK ICE
Icy Cape
Point Barrow
AUG. 14
AUG. 12
AUG. 14-17
AUG. 16
Herschel I.
Mackenzie B.
C. Lisburne
Pt. Hope
KOTZEBUE SD.
C. Blossom
BERING STRAIT
C. Prince of Wales
P. Clarence
King I.
NORTON SOUND
St. Michaels
St. Lawrence Bay
Indian Pt.
Plover B.
St. Laurence I.
BERING SEA
YUKON DELTA
YUKON RIVER
SEA MILES
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.



HOTO-LITHO., WASHINGTON, D. C.

Vol. II. No. 3.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

NATIONAL GEOGRAPHIC SOCIETY

INCORPORATED A.D. 1888.

PUBLISHED BY THE

NATIONAL GEOGRAPHIC SOCIETY,

WASHINGTON, D. C.

Price, 50 cents.

CONTENTS.

PRESS OF TUTTLE, MOREHOUSE & TAYLOR, NEW HAVEN, CONN.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

Vol. II. 1890. No. 3.

THE ARCTIC CRUISE OF THE U. S. S. THETIS IN THE SUMMER AND AUTUMN OF 1889.

By Charles H. Stockton.

A German writer of note once said, in the course of a discussion upon certain French characteristics, that "the trouble with the French people is,—they do not *know* Geography."

Whether this is still true of the French, as a nation, or whether the authority may be considered a good one, it is not pertinent for me here to say; but I feel that of the nations of the world, this country, above all others (England, perhaps, alone excepted), should not have the want of knowledge of geography classed among its national failings.

We have, however, very much geography yet to learn, as individuals and as a nation; not only of countries beyond our own but particularly of our own continent and our own domain, while commercial geography is almost an unknown and forbidden study.

Professional geographer as I am, as member of the naval service, I find that every cruise adds to my geographic knowledge, and in giving an account of the cruise during last summer of the ship which I had the honor to command, I trust that I may be enabled to present some geographic facts as interesting to my fellow-members of the Geographic Society as they were novel and instructive to myself.

Before beginning my narrative, however, let me give you an idea of the extent of the shore-line of the territory or semi-colonial province along which so much of our cruise was made.

Alaska has an area of about 580,000 square miles, consisting of a large mainland with a coast-line 6,650 miles in length, and also of more than 1,100 islands, with a coast-line of 2,950 miles, the entire coast-line being 9,600 miles. The coast-line of the rest of the United States, including islands, is only 6,580 miles, thus making the coast-line of Alaska 3,020 miles more than the coast-line of all of the rest of the United States.

Of this great country the part known best and visited annually by tourists is that insignificant portion of southeastern Alaska which consists of the Alexander archipelago and its neighboring main coast-line, differing in its scenery, topography, climate, and native inhabitants, from the greater part of this vast territory.

It is fortunate, however, that this corner of Alaska is so easily and comfortably reached by the summer traveler, as, with the exception of the coast-line and inlets between Sitka and Kodiak, which includes the Fairweather ground and the St. Elias range of mountains, this portion contains perhaps the finest and most striking scenery and the largest and grandest glaciers in the territory, if not in all North and South America.

The U. S. S. Thetis was assigned in 1889 to the duty of looking out for the commercial and whaling interests of the United States in Bering sea and the Arctic ocean, to which was subsequently added the duty of assisting in the establishment and erection of a house of refuge in the vicinity of Point Barrow, the most northerly point of our Arctic possessions. The duty assigned to the Thetis did not include the protection of the sealing interests of the United States, nor of those interests enjoyed by the Alaska Commercial Company as the regular lessees from the United States of the Pribyloff group of islands. This was confided to the Revenue Marine Service of the Treasury Department.

The Thetis left San Francisco on the 20th of April, 1889, and after a detention of a month at Tacoma, upon the placid waters of Puget sound, awaiting supplementary orders, reached Port Tongass, in extreme southeastern Alaska, on the 31st of May, and Sitka, the territorial capitol, upon the 2d of June. After a stay of six days at the latter place the vessel left for the island of Ounalaska, one of the Aleutian chain, which was safely reached, after a stormy passage, early on the morning of the 17th of June.

The revenue-steamer Richard Rush, commanded by Captain Shepherd, was found at anchor at this place, having arrived a few hours before the Thetis ; she had entered upon the duty of patrolling Bering sea, between Ounalaska and the Pribyloff group, for the protection of the sealing interests. The seals approach the hauling-out grounds and breeding places upon the islands of St. Paul and St. George in lanes, as it were, from the Pacific, reaching Bering sea by means of the various passages between the Aleutian islands, and converging as they approach the Seal islands, the position of which seems so well known to them. The "marauders," as the men on the sealing schooners are called who hunt them on their way north, shoot them from small boats, killing the many in order to procure the few.

Ounalaska, or rather the village and harbor of Iliuliuk, upon the island of Ounalaska, is the principal and most frequented harbor in the Aleutian islands, and from its position is a most convenient port for coaling, watering and provisioning en route to the Seal islands, St. Michaels (at the mouth of the Yukon river), the anchorages in and near Bering strait, and the Arctic ocean. This harbor is the headquarters of all of the districts of the Alaska Commercial Company, and is the principal coaling and distributing station and rendezvous of their vessels in Alaska. The company here affords facilities in the way of buoyage, wharfage, etc., which are not only useful to their own vessels but of great service to government and other vessels whose duty or interests call them to these waters.

The revenue steamer Bear was to be met by us at Ounalaska, in order that we could take from her any portion of the stores and material to be used in the constructing and provisioning of the house of refuge at Point Barrow that her commanding officer desired to transfer to us.

While awaiting the arrival of the Bear, the Thetis was watered and coaled and prepared for the northerly trip before her. An opportunity offered me by the delay was availed of to inspect the store-houses of the Alaska Commercial Company at this point. The most interesting of the store-houses was that containing the skins and furs collected in the various parts of the district of which this place was the dépôt. The finest of the furs was that of the sea-otter, probably the most valuable fur in the world, a very superior skin of that animal having been sold at the great fur market in London for £170. Such otters are found in the vicinity of Ounalaska and the outlying rocks and islands as far east as Kodiak, and are becoming more and more difficult to obtain, causing greater risk and hardships every year to the Aleuts, who hunt these animals as a principal means of livelihood.

Besides the otters the store-house held the furs of the beautiful silver-gray fox, and those of the blue, the cross, and the snowy white Arctic fox. There were also black and brown bear skins, beaver, and fur-seal, the latter, though the greatest and most profitable source of revenue to the Company, being by no manner of means among the more valuable of the raw furs.

To exchange for furs collected, either directly by natives or by independent traders, the Alaska Commercial Company has a large assortment of stores, provisions, and goods, worthy of a large country-store, or a Macy's in miniature, which are sold to the natives for money or in exchange for the furs they bring to the company. And just here can be seen the commercial aspects of civilization : as the natives become used to the luxuries and comforts of a civilized and semi-civilized state of life, their wants and their purchases increase and the securing of one otter-skin will not, as in times past, satisfy their wants or the requirements of their wives and families. Hence they become both greater producers and consumers, more otters are hunted for, and the Company is the gainer.

The houses in which the Aleuts and Creoles reside at Ounalaska were found to be well built of frame, sufficiently large and fairly clean. The old houses of earth and sod standing near by show the great improvement that has been made of late years in the method of living.

Upon the 22d of June the Revenue Steamer Bear came in to the anchorage, and the Thetis and the Bear, once companion ships in the Greely Relief Expedition, met again in the far north.

Upon conference with the commanding officer of the Bear, Captain M. A. Healy, it was found that he did not consider it desirable to break the bulk of his cargo and share the stores for the refuge-station with us ; hence, being free to pursue our course, we left on the 24th of June for the island of St. Paul, one of the Seal (or Pribyloff) islands.

We arrived at these islands on the evening of the 25th of June, after groping around in the heavy and almost constant fog and mist that envelop them. During our short stay at St. Paul we were able to see a drive of seals from a rookery and the killing, skinning, and packing, which followed; but what we found to be the most interesting was the visit to the rookeries, both from the inshore side and from boats along the sea front. The systematic partition of the grounds, the formation of the harems, the exclusion of the young males, and the aggressive conduct of the older ones, all proved most interesting and novel. This, however, has been described so often that I will not here repeat it.

Leaving these islands, so unlike any others in the world, we proceeded to the north and west to St. Mathew Island, a large and uninhabited island in the middle of Bering sea. The object in visiting this island was twofold, the first being to ascertain if there were any shipwrecked persons upon the island, the other being to verify the statement made upon the chart we possessed that the island was infested with polar bears. Upon our arrival and landing upon the island we found plenty of old tracks but no recent evidences of the existence of polar bears. This was ascertained after honest and fatiguing endeavor to find them by parties of officers and men from the ship, who scoured the eastern part of the island, both upon the hills and upon the low tundra, but without success.

St. Mathew island is probably the southern limit of the solid ice in winter in this part of Bering sea, the ice below it to the southward and toward the Aleutian chain being made up of newer ice and detached floes of well broken ice. It is surrounded by the ice during seven months of the year, and generally enveloped with fog during the remaining five months. Winds and rains sweep over it during the summer, the low land being composed of wet, grassy tundra, while the higher elevations are formed of scoriæ and volcanic rock.

A large quantity of drift-wood found piled up upon the steep shingle beaches probably came down the Yukon river from the interior of Alaska, there being no growth of trees upon this desolate land.

After leaving St. Mathew island we stood over to the Siberian side of Bering sea, in order to ascertain the whereabouts of the whaling fleet, and, if possible, to gather some news concerning the fate of the whaling bark "Little Ohio," a vessel that had been missing since the previous autumn.

Plover bay, Cape Tchaplin and St. Lawrence bay, upon the Siberian side, were all visited in turn, but without success, and I then determined to pass through Bering strait and enter the Arctic ocean. This was done upon the 3d of July, after a heavy snow-storm in the morning, followed, later in the day, by a fog so dense that we passed through the straits without seeing land on either side, or the Diomede islands, in the middle.

Entering the Arctic we pushed on toward Point Hope, to the northward of which the "Little Ohio" had last been seen. On the morning of the 4th of July the land about Point Hope was sighted and soon afterwards we met our first ice, coming out in floes from Kotzebue sound, stretching some distance from the shore and slowly moving to the northward and westward with the current.

Skirting along this ice with the hope of getting around it to the northward of Point Hope, without success, we entered it, and after working through it for several miles with considerable difficulty we finally cleared it and came to anchor off the native village at Point Hope, finding there two whalers who had just preceded us, and obtaining the news that the bark "Little Ohio" had been wrecked directly opposite the point where we were then at anchor. Taking on board, the next day, those survivors of this shipwreck who still remained at this place, we left for St. Michaels, near the mouth of the Yukon river, there to transfer the survivors to the steamer of the Alaska Commercial Company, and to send the news of this sad disaster to the Navy Department and to the world. In passing through the ice outside of Point Hope the first polar bear of the season was sighted, posing upon a high floe of ice. A few shots settled his case and his body was fortunately secured, his skin now forming one of the trophies of the cruise.

On our way back through Bering strait we found the vexatious combination (to be met with again and again in the cruise) of a heavy fog, much drift ice, and an opposing current.

Reaching St. Michaels we found there two steamers of the Alaska Commercial Company at anchor, besides several river-steamers, and a summer rendezvous of natives from the coast, miners from the interior, and traders and missionaries from the Yukon,—all here to meet their annual mails and supplies. In addition there was a party of government surveyors to determine the boundary-line, an account of whose early journey has been given to the Society by Mr. Russell. There were seventy-three tents, by actual count, pitched about St. Michaels at the time of our stay, the abodes of these temporary residents.

St. Michaels is the most northerly settlement and trading post of the Alaska Commercial Company. It is the outlet of the Yukon river trade and also the source of supplies for the country bordering upon the Yukon and its many tributaries, reaching in this way a portion of the Northwest Territory of the Dominion of Canada, west of the Rocky Mountains.

In the winter-time the post consists of the offices and store-houses of the Alaska Commercial Company, with a few residences for their white employees, and a small native village.

Small, light-draught, stern-wheel steamers ascend the Yukon and its tributaries for a distance of 1,700 miles, reaching the mouth of that river in part by an inside channel and in part by sixty miles of outside coasting.

After a short stay at St. Michaels we proceeded to Port Clarence, where a large number of the whaling fleet were met, consisting of seven steam-whalers, six sailing whalers, one trading vessel, and a sailing tender. From the tender these vessels receive coal, provisions, and supplies, sending back to San Francisco the oil and whale-bone of the spring catch.

Port Clarence is the best, as it is the last, harbor on the American side before reaching the Arctic, where no harbors exist worthy of the name, west of Herschel island. There is no native settlement of any size on the bay, but natives assemble here from the surrounding country and islands to trade with the whale-ships in summer.

Leaving Port Clarence we ran to the southward by King island to St. Lawrence island, in search of a sailing tender that was long over-due; returning, after a short stay off the village near Cape Prince of Wales, we again entered the Arctic ocean. As it was too early to go to Point Barrow we proceeded to Kotzebue sound and Hotham inlet. In the vicinity of the latter place, every year, a summer rendezvous of natives occurs for trading purposes, the Eskimos from the Diomedes and Cape Prince of Wales bringing articles of trade from Siberia, while the Eskimos from Point Hope bring articles obtained from the whalers; these Eskimos are met by the inland natives from the rivers that flow into Hotham inlet and Kotzebue sound, principally from the Kowak, the Noatak and Salawik rivers. The nearest available anchorage we found was Cape Blossom, from which place we visited the rendezvous and were visited in turn by the natives. We had now been enjoying for some time twenty-fours hours of daylight, the midnight-sun having lighted our way to and from Point Hope during our first visit to that place.

Leaving Cape Blossom upon the 24th of July we stood out of Kotzebue sound for the northward, running the greater part of the time in a heavy fog. We passed Point Hope on the 25th, Cape Lisburne on the 26th, and anchored off Cape Sabine early in the morning of the 27th of July. Near by was a very wide vein of lignite coal, from which the Thetis had been coaled the previous year and to which the name of "Thetis coal mine" had been given. This had been worked during the present summer, also, and a party of natives who were encamped near by had furnished coal to some of the whalers.

Being now in the vicinity of a stream known to the natives as the Pitmegea, I went in a whaleboat to examine its mouth and entrance, as this stream was unknown to but few whites and did not exist upon any charts or maps. It was found to have but three feet of water on the bar at its entrance, but after crossing this a depth of six feet was found. The stream was found so full of bars and shoals that we could ascend but a short distance after entering it. The river and its narrow valley were very winding, the general course being northwest from its source to the coast. After the spring thaw, and the rains that follow, the stream rises to a depth sufficient for the natives to ascend and descend it with their light-draught skin-boats for a distance of about forty miles. Its length is estimated to be over one hundred miles. The river had been explored the previous year by John W. Kelly, who was this summer employed on board the Thetis as the official interpreter, and to him I am indebted for the following description of the ice-cliff existing upon the banks of the Pitmegea, and also of a peculiarly built stone hut near the source of one of the tributaries.

Ice-Cliff on the Pitmegea.

This ice-cliff is about twenty-five miles from the mouth of the Pitmegea, at a place where the hills run their spurs out to the banks of the river, closing the picturesque valley that stretches away to the sea-coast in an almost unbroken width of a mile. A glacier faces southward, and receives the full benefit of the sunlight during the short polar summer. Gales have deposited particles of soil and débris of plants, along with their seeds, upon the surface of the ice to a depth of from four inches to a foot. The snow-fall of winter soon vanishes before the June sun, while the light covering above the glacier preserves it intact. Vegetation is warmed into life in a remarkably short time, and the brown coat left by the receding snow is almost miraculously transformed to a robe of green and studded here and there with bright polar flowers, there being buttercups, dandelions, yellow poppy, bright astragals, gentians, daffodils and marguerites. The latter are small and unobtrusive, making a showing in a modest way as if they wished to apologize to their sister flowers for their appearance among them. Like beautiful orphan girls, one cannot resist a compassionate tenderness of feeling toward them. But these innocent little flowers, chaste as the ice field upon which they grow, bloom in the polar garden with as much right as the glacier's gentian. Besides flowers, there are the hardy grasses whose roots penetrate the light covering of soil to the ice-bed, whence they derive their nourishment. A few Arctic willows are to be seen, but they only grow about a foot in length, and trail upon the ground. The Pitmegea river is gradually cutting into the glacier, receding from its opposite bank and leaving a bed of gravel behind. During the summer the ice melts away, leaving the protruding soil above it like the eaves of a house; when it protrudes too far for the strength of the grass roots, it topples over into the river. At the freezing in September, icicles freeze from the overhanging sod to the river ice below, forming a narrow portico four miles in extent.

Old Stone Hut.

On the highest peak at the source of Ikuk creek, a southerly tributary of the Pitmegea, are the ruins of a hut and smaller outhouse, the like of which has never been met with in Northwestern Alaska. Above the grass line, past perpetual beds of snow, up where wild storms sweep away ice, snow, and soil, where only a few gray lichens are to be seen, man, at some former time, has placed a habitation. On the crest of the mountain there is a ragged limestone comb twelve feet high, cracked and shattered into flakes by the vigor of the polar winters. On the south side of this comb, sheltered from the prevailing north winds, excavations have been made into the rock. Taking the comb of rock for one side of the house, the other side of the semicircle has been built up with flat stones, laid up like bricks in masonry, but without mortar. Moss and soil have been in all probability used here instead of mortar, but years of fierce winds have blown it out from the crevices. The structure is conic in shape, after the manner of a Greenlander's snow-hut. This one is about seven feet in diameter. Facing its entrance is a smaller house of similar construction, most likely used as a shelter for game. Winter storms have crumbled away the roofs of both so that they have fallen in, and the fragments of stones are partially covered with soil. The whole bears the impression of age, and no natives have been found who have ever heard of it. From the summit of this peak a splendid view is obtained of the surrounding country, the Arctic ocean, and herds of passing reindeer.

Gold has been found near the Pitmegea, at the head of the same creek and tributary, it being contained in sulphurets of iron, which exist in large quantities in that vicinity, there being from $3.50 to $8.00 worth of gold in a ton ; the country is all but impassable, however, and this, together with the shortness of the season, would prevent any mining with profit.

Our party returned from the Pitmegea with a few ptarmigan and ducks, and upon our arrival the ship was at once gotten under way and we stood to the northward for Point Barrow. Drift-ice was constantly passed, but fortunately so scattered as not to form any obstruction to free navigation.

On the next day we enjoyed a superb Arctic summer's day, and began to fall in with the whaling fleet on the way north to Point Barrow. Fifteen vessels were sighted and passed, most of them vessels under sail. Rounding the dangerous Blossom shoals and the Icy cape of Captain Cook, we stood to the northeast, finding generally clear water, with scattered drift-ice. Upon the floes we found great quantities of walrus, in some cases stretched at full length, sound asleep. One huge fellow remained so undisturbed at our approach that he was supposed to be dead, but a well aimed Irish potato aroused him so rudely that he quickly slid off the floe and disappeared beneath the water.

Pushing on we passed Pt. Belcher at 9.30 in the evening, in the fog and rain, and came to heavy masses of ice over which a low fog had settled. With some delay and difficulty we worked out of both the fog and the ice and at five o'clock in the morning sighted four vessels—steamers—at anchor off the village of Ootkavie at Cape Smyth, 8 miles from Point Barrow, and the site of Captain Ray's Signal Service meteorologic station of some years ago, the house that sheltered the party being still standing. One of the steamers proved to be our old friend the "Bear," which had passed to the northward when we had returned southward from the Arctic with the survivors of the "Little Ohio." The other vessels were made out to be steam-whalers, and at seven o'clock we anchored near them, off the site determined upon for the house of refuge.

Finding the Bear had commenced to discharge her stores and materials, all of our facilities were at once used in tending her assistance, our steam launch Achilles (now, as of yore, the child of the Thetis) being busily at work towing boats to and fro, while our men and mechanics, with officers, were busily engaged in aiding the construction of the house of refuge.

Our arrival at Cape Smyth and vicinity of Point Barrow was on the 29th of July, the Bear having arrived on the 27th, the Saturday previous. While we were lying at anchor engaged in the erection of the house of refuge, the rest of the whaling fleet, both sail and steam, gradually arrived and came to anchor off the coast, reaching from Cape Smyth to Point Barrow. After a short stay the steamers went on to the eastward of Point Barrow, following along the ice-pack, which was in sight from Point Barrow, until they reached the heavier ice off Point Tangent. When the last of the whaling vessels had arrived, a fleet of forty-seven vessels carrying the American flag had assembled within sight of the most northerly point of the United States, composed of steamers, barks, brigantines and schooners. These vessels, manned by about twelve hundred men, I venture to say formed the largest assemblage of vessels and men under the American flag to be found anywhere during that year. I cannot speak too highly of the skill, seamanship, courage, and endurance of the whaling masters. They are a fine body of American seamen.

The scene on shore was one of abnormal activity for this region, the erection of the house of refuge, the hasty landing and transportation of stores (in which the whalers assisted), the movements of the Eskimos about their village (which was dotted with the white summer tents of the residents and the visiting inland Eskimos), and the clustering and trading about the Whaling

Company's station (Ray's old station), gave a life and movement which was as shortlived as the season. Fortunately the weather proved most favorable and the heavy ice kept off shore while the stores were landed; the wind then freshened, but communication could still be kept up and the work of erection went on.

The site of the house of refuge is within a few hundred yards of Ray's old house and near the village, and its keeper, Captain Borden (an old New Bedford whaler) was busy in putting his house in order before the autumn should come on. During our stay at this place we were enabled to make a hydrographic survey of the anchorage, which demonstrated that the contour of the bottom is constantly changed by the ploughing and planing done by the heavy ice grounded and driven up by the pressure of the mighty ice-pack, under the influence of northerly winds and gales.

And here let me say a word about the ice of this part of the Arctic ocean. The ice in summer consists of floes and fields of various sizes, which are cemented together in winter by the young or newly frozen ice. No icebergs exist in this part of the Arctic, as there are no glaciers near the sea coast to form them. The shore along the entire Arctic coast of Alaska shows evidence of former glacial action, but the only glaciers to be found are in the southeastern part of the territory.

The Arctic pack, which never melts, consists of hard blue ice, made up of fields and floes of comparatively level ice, which are surrounded and interspersed with hummocks varying from ten to forty feet in height. These hummocks are formed by the broken and telescoped ice resulting from the collision and grinding together of heavy ice-floes, the hummocks being often rounded and smoothed in outline by heavy falls of snow.

In the spring, under the influence of the prevailing southerly winds and northerly currents, the packs break off from the shore and move to the north, the position of the southern edge varying in latitude with the season and the winds.

The shore-ice, which remains fast to the coast line after the pack moves off, gradually breaks up as the season advances, and, becoming scattered, is taken to the northeastward from the vicinity of Point Barrow and northwestward from the vicinity of Herald island and Wrangel land.

Sometimes a long line of heavy floe-ice from the pack grounds in the shallow water near the shore during northerly winds, pressed from behind by the force and weight of the entire northern pack. It is gradually forced up, ploughing its way through the bottom, at the same time rising gradually along the ascent of the bottom toward the land. The effect of this solid wall of cold and relentless blue ice slowly rising and advancing upon those imprisoned between the ice and the shore is one of the most sublime and terrible things that can be experienced.

The normal current running north through Bering strait forks a short distance to the north, one branch going through Kotzebue Sound and thence along the mainland by Cape Seppings, Point Hope, and Icy cape, to Point Barrow, at which point it goes off to the unknown northeast; the other branch, to the northwestward along the Siberian coast, and thence to the northward toward Herald island. The whalers burned by the Confederate vessel Shenandoah near Bering strait were found in the vicinity of Herald island.

The only portion of the whalers at the time actively cruising had gone to the eastward of Point Barrow. On that day a seaman named Tuckfield returned from the Mackenzie in a whaleboat, and reported the ice conditions unusually favorable as far east as Mackenzie Bay, in the vicinity of which he had wintered. He was a seaman belonging to the whaling station and had been reported to me by a missionary I met at St. Michaels as having visited his station at Rampart house, upon the Porcupine river, a branch of the Yukon.

Upon the 8th of August the house of refuge was virtually finished, and as my orders were to devote my time to the whaling fleet, after the completion of this structure, I concluded to cruise after and with the vessel to the eastward of Point Barrow, leaving the Bear to remain with the vessels lying at anchor off Cape Smyth and Point Barrow. As Tuckfield wanted to go east with his Eskimo guide, I took him and his whale, boat and whaling outfit on board, leaving Cape Smyth on the evening of the 8th. The ice in sight at the time was somewhat scattered, but plentiful, and entering it about nine o'clock we slowly stood on a course parallel to the land. We were occupied in working through this ice all night and all of the next day; it was not the pack ice but shore ice broken off from the vicinity of Point Tangent, Smyth bay, and Harrison bay. At times we found it so closely packed together by current and wind that we had to turn back and work our way closer inshore. Three vessels under sail were sighted during this time off Tangent point, and by this time we had also demonstrated the uselessness of Little Joe Tuckfield as an ice pilot or prophet. The winds were very light and we had now gotton out of the strong northeast current running off Point Barrow. On the night of the 9th we passed off the north of the Colville river, the water offshore becoming very muddy.

The first important error found in the charts and maps of this region was found here by the observation of the non-existence of the Pelly mountains. This observation was confirmed upon our return by the concurrent testimony of the whaling masters who had cruised here, and the natives who hunt in the neighborhood. The mountains certainly do not exist where placed by the charts, and I judge that some small hummocks near the beach were mistaken for a far off range of mountains, when Dease and Simpson first explored this coast in 1837.

Early on the morning of the 10th of August we sighted the first steam whaler, and as we steamed toward her we skirted along some long low islands parallel to the coast line and stretching from the Return reef of Sir John Franklin to the mouth of the Colville river. The islands, one being about three miles long, are not shown upon the charts, and not having any known names were designated as the Thetis islands.

The steam-whaler was found to be the Balæna, commanded by Captain Everett Smith, one of the most intelligent of the whalemen of the Arctic. He was anchored off Return reef, which he was enabled definitely to locate by the traditions of the natives. It was at this point that Sir John Franklin, in one of his earliest boat journeys, was obliged to turn back while endeavoring to explore the coast from Mackenzie bay to Point Barrow. After a long interview with Captain Smith, from which I gathered much information as to the ice-conditions and the probable positions of the steam-whalers to the eastward, he returned on board of his ship, and the good ship Thetis once more turned her head to the eastward.

Soon afterwards another steam-whaler was sighted, made fast by ice-anchors to an ice-floe; we did not stop, but, exchanging colors, proceeded on our way. The ice seemed to be getting thicker, and shortly afterwards a third whaler was sighted, at anchor off a small low island, with apparently heavy ice ahead. As the weather seemed uncertain I determined to anchor for the night in the vicinity of the island.

The steamer was found to be the whaler Beluga, commanded by Captain Brooks, and the island, though nameless, was marked by a wooden cross, from which fact it was called Cross island. Captain Brooks stated that he had been struggling with the ice to the eastward of Cross island, the day before, in company with some other steam-whalers who had left him and gone to the eastward, so he had turned back and anchored off Cross island. I sounded out the vicinity of the island, finding shoal water to the southward, too shoal for the Thetis to anchor in, and so I remained upon the west side. The wind shifting, our position became insecure on account of the masses of ice drifting toward us; the whaler left the anchorage, stood out into the heavy ice, and made fast to a high hummocky floe. Seeing no good place near by, I held on with the chain on the steam windlass, ready to leave in a moment. Heavy ice coming down and grounding close by on both sides, we left and got out the ice-anchors to a heavy floe, where we rode out the gale until early in the morning, when we were obliged to move on, as the ice packed about our rudder. After moving again and again the wind fell away, the day cleared up, and the ice began to scatter and disappear about the island, the leads to the eastward looking more promising.

The next day at 5 in the morning, in company with our whaling friend, we left the vicinity of Cross island and, entering the ice, stood toward the northeast. The ice-floes grew heavier and larger as we progressed and the canal-like leads more confused, until at 10 o'clock the lead stopped and we both made fast to a very large, long, hummocky floe, at least ten miles in length, several miles in breadth, and aground in 80 feet of water. The day was mild and clear, and, after both of the ice-anchors had been secured and the rope-ladders lowered over the bows, a number of the officers and men went on the ice, the men playing foot-ball and snow balling, while the officers posed for their photographs. This is the time that we were reported (by a steam-whaler that we had passed) as being in a position of extreme danger, and the news was taken to the outside world.

About 4 o'clock in the afternoon we started ahead with the Beluga; the Thetis, now taking the lead, rammed her way through some pack-ice and reached another lead going inshore, the Beluga following very slowly after us. We continued forcing our way until we got into clear water by Lion reef. At midnight we made fast to a small floe and after an anxious night (caused by ice-floes setting against our stern and rudder) we proceeded, followed at a long distance by the Beluga, which joined us in the afternoon at Camden Bay, and we anchored there for the night. We found that the Beluga in attempting to follow us had gotten on an ice-foot, or protruding spur, and bent her propeller-blades, and had finally to seek another lead out, to the westward of where we had rammed through. As we ran from off Lion reef to Camden bay we sighted the beautiful ranges of mountains close to the coast known as the Franklin and Romanzoff mountains, making an agreeable change in the topography of the shore, which had been low and monotonously flat since leaving Point Hope and the vicinity of Cape Lisburne. We found here that the shore-line was put upon the charts too far north, as our position near Flaxman island, on the west side of Camden bay, was well inland of the coast-line and reefs. Camden bay was the last wintering place of Collinson, in the Enterprise, upon his return from his search for Sir John Franklin, and here we fell in with the track of this distinguished navigator, whose cruise is so little known and whose efforts have been so much eclipsed by his fellow voyager, McClure, who has the distinction given him of being the actual discoverer of the Northwest passage, and who was, indeed, with his little body of men in 1850–1854, the first as well as the last to pass from the Pacific to the Atlantic, north of the American continent.

Upon a long point named Collinson point, and upon the neighboring island known as Barter island, are to be found, during the summer, encampments and rendezvous of Eskimos, who meet there for purposes of trade, similar to the same rendezvous in Kotzebue sound. Here the Alaskan and the Mackenzie river Eskimos meet, also the Lucia or Prat river Indians, who are nomads and come from the vicinity of the Porcupine and Prat rivers, and whose winter rendezvous and habitation is at the Rampart house, a Hudson Bay Company's station and Church of England mission, upon the Porcupine. They are mostly professing Christians and are related to the Athabascans, or Rock mountain Indians, in family. There are no permanent settlements here or elsewhere between the vicinity of Herschel island and Point Barrow. The country is sterile, affording but little upon which to live, the sea also having little or no animal life in its waters. The Eskimos give to this part of the Arctic ocean a native name which signifies *the sea where there is always ice.*

Early the next morning, August 14th, at 5 o'clock, we pushed on in company with the Beluga, standing out of Camden bay and delaying a short time off Barter island, to communicate with the natives. At noon, while off Manning point, the smoke of several steamers was seen to the eastward, and when they had come up we found all but two of the steam-whalers that had gone east. They were led by the steamer William Lewis, commanded by Captain Albert Sherman, probably the boldest and most active of the Arctic whalers. They were all in the cabin of the Thetis in a short time, and I found that they had reached Mackenzie bay and the vicinity of the Mackenzie river. The two missing ones, the Orca and Thrasher, had last been seen in the vicinity of Herschel island. The ice-conditions were reported to be better than those we had passed through. After reflection I considered it my duty, as it was my desire, to go on to the eastward to ascertain the cause of the detention of the two missing whalers, and as time was precious I determined to run on, day and night. By this time night had assumed the conditions of twilight, and the stars had begun to appear in the skies. The threatening appearance of the weather detained us at first, but at 9 o'clock in the evening we got under way, and with her colors hoisted the good ship started again on her easterly course, followed in about half an hour by our old friend and companion, the Beluga. Before leaving we had hoisted out the whale-boat with Joe and native friends, who had been joined at this point by the women of the family. Joe was uncertain about his movements here, and as he expected to secure stores from some of the whalers I left him in their company.

We found the shore bolder as we progressed, and the mountains nearer the coast; as a result, the ice generally sets directly and in heavy masses on the shore without grounding, and this point has never been passed before by the whalers, but fortunately a wide lane was open. The sight of the mountains, standing in their silent and gloomy grandeur, was peculiarly impressive, and our inability to make a closer examination and exploration is to be regretted. So far as I can ascertain, no white man has ever penetrated these mountainous regions, which are known upon the maps in turn under the varying names of the Romanzoff, British, Buckland and Richardson mountains, being so named by Sir John Franklin during his boat journey along the coast. The British mountains are at the extreme northeastern corner of our territory of Alaska, reaching also across the boundary-line into British America. We passed Demarcation point, where our boundary-line reaches the Arctic ocean, early upon the morning of the 15th of August, and commenced again our cruising in British waters. The character of the shore remained the same, the mountains, however, showing little traces of snow, testifying in this way both to the extreme mildness of the winter and our approach to the valley of the Mackenzie. A few Eskimo huts were seen as we came up to the shoal ground developed by our lead in the vicinity of the mouth of the Malcolm river. The lead was constantly going while we were in these waters, and the ship was steered by it as much as by our compass. In fact the three L's (latitude, lead, lookout) are the great necessities for navigation in these unknown regions, as the three R's are supposed to be in elementary schooling. At 11 o'clock in the morning Herschel island was sighted, this large island forming the western boundary of Mackenzie bay, or, as the ancient explorers often termed it, Mackenzie sea. At 1.30 in the afternoon we anchored off the southwest end of the island inside some grounded ice and off a long gravelly spit, thickly covered with heavy drift-wood from the Mackenzie river.

The island is about 500 feet in height and has a rounded outline, sloping gradually down from the center upon all sides. It shows the appearance of former glacial action, and appears to be an ancient moraine covered with a black vegetable mould. The vegetation was confined to grasses and small Arctic flowers, diminutive in size, delicate in color, and evidently shortlived.

Soon after we anchored a party was sent on shore to erect a sign to mark our visit; it consisted of a board with the name of the ship and the date of the visit in brass letters; under the staff supporting it there are placed in a glass bottle the names of the officers and men of the ship. The Beluga joined us soon after our arrival, and when the party from shore had returned we got under way to continue our look for the two whalers. Captain Brooks came on board the Thetis and shared my perch and lookout in the foretop, while his ship followed, in charge of his mate. As we reached the bluffs at the north end of the island we saw a noble expanse of open water stretching to the northward as far as the eye could reach. The ice was still heavy to the westward and northwestward, but to the north, beyond the light, scattering ice through which we were going, was clear sea, the waves leaping in the beautiful Arctic sunshine.

We looked with eagerness to the sea which stretched, apparently, to the north pole, and then headed to the southward into Mackenzie bay.

After three hours' steaming from our first anchorage we reached the southeast side of the island and found the two missing whalers lying quietly at anchor, Captain Brooks giving a hearty and relieved cry of *Sail ho!*, when the vessels were seen, and we were all pleased to see them safe and secure. We came to anchor close by them and the two captains were soon on board. They reported that they had remained behind to watch for the return of whales from the northeastward, but so far without any success. They had determined to remain until September, and contemplated the possibility of wintering at this place. Soon after we anchored, Eskimos who lived at the mouth of the Mackenzie came on board, and they looked at the ship with the greatest surprise and interest. They had not seen vessels before this summer, though the traditions concerning the "Enterprise" and "Investigator," under Collinson and McClure, still survived.

Sleeping soundly that night, for the first time in many days, the following morning boat parties were dispatched to complete the circumnavigation of the island and to make running surveys in the vicinity.

A small, snug harbor was found and surveyed near-by our anchorage, capable of receiving vessels of less than 16 feet draught; this was named Pauline cove. It would prove a fairly good place for one of the light-draught steamers going up this year to use as winter-quarters.

The waters between Herschel island and the mainland were found after examination too full of shoals and sand- and gravel-bars to form a ship-channel. A rise and fall of tide of three feet was found, and the ship swung regularly to an ebb and flood.

While the boats were out sounding I went ashore and, climbing nearly to the top of the island, had a beautiful view of the clear and open water of Mackenzie bay, to the east and northeast; while to the southeastward were the islands clustering about the shallow mouth of the Mackenzie, and directly to the south were the British and Buckland mountains, merging gradually into the Rocky mountains and the great chains which form the backbone of the American continent.

The temperature of the water and air was found higher upon this side of the island, and I have no doubt but that the climate of the vicinity of Mackenzie bay is materially modified by the comparatively warm water coming out in great volume from the Mackenzie river. The strong current running to the northward from the river would naturally sweep the ice out of the bay and to the northward, as far as the vicinity of Banksland and the extreme northern Arctic.

Where it goes to and where it ceases is now a matter of conjecture. It is to be hoped that the drift-floats which were launched by us from this point, and from various points between here and Herald island, may contribute something to the solution of this question.

As the chances of being shut in by the ice were easily among the possibilities to the whalers who were in our company, and with whose fate our companion the Beluga had joined for the time, the whole question of supplies and retreat was gone over with the whaling masters. A retreat up the valley of the Mackenzie, the Porcupine, and Yukon, seemed feasible, as reindeer were to be found in this vicinity in the winter months.

As the masters of the whalers would not return with me to the eastward, I determined to start back, in order to make my westerly cruise with the sailing fleet. Recalling the boats, we got underway, standing first to the northeast to put over our first drift-float clear of the tidal influence of the waters immediately about Herschel island, and in the open water and northerly current of the Mackenzie. These floats were made of wood about two feet long and nine inches thick, with the name of the ship, the date, and the words, *for drift*, cut upon the face. In a cavity at one end of the float, plugged with soft wood, there was placed a copper cylinder containing a letter requesting the finder to inform the U. S. Hydrographic office at Washington, the nearest U. S. Consul, or the commanding officer of the Thetis, the time and place where the float was found.

After launching the float upon its unknown journey, a lookout was sent to the highest masthead: from there it was reported that to the northward and northeastward there was nothing in sight but open water, neither ice nor ice-blink was visible, and the western entrance to the Northwest passage stretched before us invitingly, as clear and as free as the waters of our own Chesapeake bay. But I had reached my limit, and turning back, to the regret of many on board, faced once more the icy sea that lay before us toward Point Barrow and the westward.

The weather, however, was superb, clear, cold, and sunny, during the day, while in the now darkening shades of the evening for the first time the moon appeared, silvering most beautifully the chain of mountains along the coast and the fantastic shapes of the grounded ice.

On the 17th we began to meet and overtake the whalers, who still delayed in the vicinity of Camden bay, waiting for whales. Five were passed, some cruising and some fast to the ice-floes. After communicating with them and informing them of our probable movements, we kept on to the westward. The ice-conditions were favorable and we made very good headway, making fast to an ice-floe, off our old island-friends of the midway group, on the evening of the 17th of August.

The wind is always a subject of constant watchfulness and anxiety in this part of the Arctic ; it virtually makes the currents and brings down the ice, or sends it off and clears a narrow lane along the shore-line. A northerly shift of wind caused a desire to push on, and passing on we sighted Return reef again and skirted along the long and narrow island which now bears the name of the Thetis. Passing the mouth of the Colville we steamed at a good rate of speed through Harrison bay and found there the wind blowing strong from the west, bringing much ice with it and accompanied by a cold fog. The outlook being discouraging I determined to press on for Point Barrow, not very far distant. The early morning of the 19th of August opened cloudy, overcast, and cold, with a gale and snow from the westward, the ice increasing in quantity and size.

There being no protection from the wind this side of Point Barrow, I ordered full speed so as to get to the point and beyond it before the almost inevitable shift to the northward which would bring the ice down and shut us out. The leads between the ice-floes became narrower and fewer in number, and but little better outlook was found as we edged inshore as far as the shoal water would allow us to go. At this time we sighted as many as eight polar bears on the ice, but this was no time to hunt "bear." Coming to the end of our lead we rammed through some pack-ice into another one, which, however, again led into water too shoal for us. Finding from my perch aloft that the ice seemed even heavier to the west, I determined to stand back to the eastward into the more open water we had left by the lead we had come through; but it was too late: this lead had closed and we were prisoners in the pack. There being no other place to go, I reluctantly selected the largest pool, or pocket, got out our ice-anchors, and made fast to a heavy floe, to await further developments. It was found to be in slow motion, and four times during the night we had to move to avoid the heavy floes closing in around us. From this time, the 19th, until the morning of the 24th, we were close prisoners in the heavy pack which had set down with the wind, now northerly, between Point Barrow and Point Tangent.

In the words of the Ancient Mariner of Coleridge:

> "The ice was here, the ice was there,
> The ice was all around;
> It cracked and growled, and roared and howled,
> Like noises in a swound."

By incessant watchfulness, almost constant movement, vigorous ramming, faithful working of the engines, and (most important of all) a favorable shift of wind, the good ship, under Divine Providence, escaped without damage or accident. Fortunately within easy reach of land and but twenty-five miles from Point Barrow refuge-station, I had no undue anxiety for life; but I have no hesitation in stating that the readiness, endurance, and subordination of the officers and men of the ship shown in the bringing out of the ship intact from the ice pack, after nearly five days' imprisonment, entitle them to great credit from the proper authorities and justify their commanding officer in the present expression of his high appreciation of their conduct and his warm feelings toward themselves.

About noon of the 25th of August, after a night of hard ramming, we anchored off the west side of Point Barrow, greeted by salutes from the whalers anchored there and by the hearty congratulations of the masters, who soon came on board and learned for the first time that Mackenzie Bay had been reached.

We found that the sailing fleet had gone to the westward, after having been shut in by the ice coming down on Point Barrow and Cape Smyth for several days, during our absence. The few whalers that remained had been watching us from their crows' nests during our imprisonment, but were unable, of course, to afford us any assistance, each ship having to work out her own salvation: companion-vessels are of great service only in case of damage or abandonment. Fortunately, the steam-whalers remaining behind us did not have the pack set down upon them in the shallow bights in which they were cruising, and the long continued north-easter which aided us in our escape enabled them to find leads to get through, not very long after we had escaped. We remained at Point Barrow for a week until they had all returned, except the two most easterly ones, left at Herschel island. As their return was so uncertain, at the end of a week I dropped down to the house of refuge at Cape Smyth, landing provisions to fill the deficiency in their stores, and went to the westward, first going to Icy cape to erect a needed beacon as a warning of the vicinity of Blossom shoals.

Leaving this vicinity on the 5th of September for the northward and westward, and rounding Blossom shoals, we stood to the north, reaching the supposed vicinity of the edge of the ice pack that night. As the nights were now dark we lay-to until morning, when the rapid fall of the temperature of the water and the lessening wind gave indications of its proximity, and a half hour's steaming brought us to the rugged white outline of the pack. Along this we skirted, having reached our highest north (less than 72° N. latitude).

All of that day and the next we continued our course, sighting a portion of the sailing fleet of whalers on the 7th. Communicating with them of our proposed movements and whereabouts during the rest of September and the beginning of October, we then stood to the westward. I must not forget to mention an interesting incident that occurred. A schooner stood down to us from the fleet, and was recognized as the schooner Jane Grey, picked up by the Thetis when under the command of my predecessor the previous summer in the ice—abandoned. She had been righted, pumped out, repaired, and restored to her owner, who had literally sold his farm and put his all into the vessel. As he came within hail our notification was given him, but I noticed that he fairly danced with impatience during its delivery, which was accounted for at the end of the message by his bringing out his men, who were gathered behind the foresail, and giving hearty and prolonged cheers for the Thetis which fairly rang in the silent Arctic air. To this we responded and then went on our way.

We now left the pack and steered through open water for Herald island, which we sighted at half past twelve the next day, the 8th of September ; as we approached it closely the bareness and forbidding appearance, which had been concealed at first sight by the bluish dimness of the outline, became very marked. Its sides were almost inaccessible, except from the western end, and it was free from ice, an almost exceptional state of affairs. In close seasons it is impossible to reach it, and, even more than Point Barrow, it may be shut out of the world by ice that refuses to move during the short summer.

We passed the island late in the afternoon within a comparatively short distance, standing on to the west with the hope of seeing Wrangel land before dark. At half past five land was reported ahead from aloft, and soon the high snowy peaks and mountainous outline of Wrangel land was sighted from deck. It stood out beautifully in the late Arctic afternoon, and as we approached it more closely its outline became more and more fantastic and brilliant. At sunset we were a little over ten miles distant, and at dark, as we turned to the southeast for Point Hope, we exchanged hearty congratulations upon our successful passage from Mackenzie Bay to Wrangel land. Arriving at Point Hope upon the evening of the 10th of September, we found that many of the hunting parties had returned from the interior, and preparations were going on for the winter season.

The natives of Point Hope, like the Eskimos generally of northwestern Alaska, have no tribal or other form of government except what exists by control of the head man, oomalik, or chief, whose superiority arises from his wealth and influence. The previous chief had lived a life that made him a terror to the community. His rule was by force alone and by the influence of the rifle, which was his inseparable companion. After a career distinguished for license, murder and robbery, he had come to a timely end by being assassinated by the brother of a wife he was tormenting to death. Since his death, up to the time of our stay in September, anarchy had prevailed. On account of the very indifferent treatment received by the survivors of the wrecked whaler "Little Ohio" from the Eskimos at Point Hope the previous winter, I determined to appoint a head man or chief who would be charged with the responsibility and duty of caring for any shipwrecked persons or destitute whites. Anokolut, who was appointed by me and whose appointment was afterwards confirmed by the Governor of Alaska, had married the niece of the previous chief, and was the best whaleman and hunter of

Herald Island, bearing about W. by S. (magnetic).
From a photograph by Assistant Paymaster J. Q. Lovell, U. S. N.

the district. He had been in the employ of the whaling station established the previous year at Point Hope, and had been satisfactory in all his dealings with the whites. His wife was a very superior woman, and their desire for civilized usages was so great that a bread-pan of tin, some granite-ware bowls, and candles, were given and eagerly accepted as contributing to make their domestic lives more comfortable and civilized. An urgent request was made for a cooking-stove, which I promised to give them if I should return the following summer.

The Eskimo lamp which serves as a light, and to some extent as a stove, is a crescent-shaped stone utensil with a shallow trough scooped out; this is a receptacle for the whale-oil, the wick being some native moss laid along the edge of the lamp and trimmed from time to time, the supply of oil being kept up by a lump of blubber suspended over the lamp. The light being indifferent, candles are welcomed as a great improvement and a marked relief to the over-taxed eyes of the men and women during the long nights of the Arctic winter.

During our stay at Point Hope we found much of interest in connection with the Eskimos living there. Their long winters give them an opportunity to keep alive their traditions in their daily meetings in the council-house, and they give an account of their early days in this wise: In the beginning the people had heads like ravens, with eyes in the upper part of their breasts. All the world at this time was wrapt in gloom, with no change of day and night. At that time there lived a powerful chieftain on top of the highest peak. In his hut were suspended two balls that were considered very precious and were therefore carefully guarded. One day, the chief being absent and the guards asleep, some children who had long admired the beautiful balls knocked them down with a stick and they rolled across the floor of the hut and down the side of the mountain. The noise awakened the guards, who hurried after them, while their extraordinary beauty attracted the attention of the people, who also rushed after them, a wild struggle ensuing for their possession; this ended in the breaking of the balls. Light sprang from one and darkness from the other; these spirits of light and darkness claimed sole dominion, but, neither yielding, a compromise was made by which they agreed to an alternate rule. The violent struggle for the mastery so disturbed the world that the anatomy of the people and the surface of the earth were both changed. Light being upon the earth, men began to catch whales in the sea and to carry the flesh and bones to their mountain-homes. One family wandering over the country recently risen from the sea came down upon Point Hope: finding vegetation springing up and whales abundant, they built a hut and made it their home. From this originated the settlement at Point Hope. Their modern history goes on in this wise: Point Hope being favorably situated for whaling and hunting the seal and walrus and for obtaining the reindeer, it naturally became a center of power and population. In the latter part of the eighteenth century, as well as can be determined, the village upon Point Hope, known by the natives as Tigara, had a population of 2,000 souls, with six council-houses. At that time the Eskimos residing upon the Noatok, or Inland river, began to encroach upon the territory of the Tigaramutes until matters came to the pass that about the beginning of this century a great land- and boat-fight took place between the Tigaramutes and the Noatokmutes near Cape Seppings, in which the Tigaramutes were defeated and forced to yield a large portion of the territory formerly controlled by them. So crushed were the Tigaramutes that they lost one-half of their population, which led to the gradual abandonment of all the outstanding villages. Since this time the population has gradually decreased, the diminution being materially aided by the contact of whites, who are principally represented here by the crews of the whaling ships, rendezvousing during the early summer.

As a rule the Arctic coast Eskimos are short in stature, the average height of ten men measured at Point Hope being 5 feet 5.8 inches, and of ten women, 5 feet 2.4 inches. The legs are short in comparison to the length of the body and are always much bowed, this being due to the manner in which they are carried in infancy upon their mother's back, the legs being brought tightly around under the mother's arms. The feet and hands of the women are generally well shapen and small.

All of the Eskimos have good teeth, but as they are subjected to severe usage they deteriorate in every way. They are used as substitutes for pincers, carpenter's vices, and fluting machines. They are used in drawing bolts, untying knots, holding the mouth-piece of a drill, shaping boot-soles, and stretching skins. When they become uneven from constant use in this way, the unevenness is corrected by a levelling down by means of a file or a whetstone, until they finally reach a level too low for mechanical purposes.

Between sixteen and twenty-two years of age the male natives have their lips pierced under each corner of the mouth for labrets.* The incision is made and at first sharp-pointed pieces of ivory are put in ; when the wound heals the hole is gradually stretched by inserting larger labrets until half an inch in diameter is reached. The poorer natives wear labrets made of coal, walrus ivory, common gravel, and glass stoppers which they obtain from ships and adapt to this use. The stopper of a Worcestershire sauce bottle is very useful for the purpose. The richer ones have agate labrets, the most valued one, however, consisting of a white porcelain-like disk 1½ inches wide, in the center of which is mounted a turquoise nut, hemispherical in shape, nearly an inch wide, fastened with a spruce gum obtained from the interior. We could not ascertain where the turquoise or porcelain-like disk was obtained. The Eskimos say they have always been in the country, and sell them only with the greatest reluctance.

Tattooing is general among the women, and is apparently a custom of great antiquity. At the age of six one narrow line is drawn down the center of the chin from the lower lip downward, powdered charcoal being used as coloring matter. At twelve years the line is broadened to half an inch, and a narrow line made parallel to it on each side. But I will not detain you by giving other particulars.

On the 20th of September the Thetis left Point Hope for the south, the rugged season of the Arctic ocean having fully set in. Strong winds and gales from the northeast had compelled us to move from the northern to the southern side of Point Hope, where better protection and anchorage had been found. On the 21st of September we passed out of the Arctic ocean and through Bering Strait, reaching Ounalaska again on the 26th of September. After remaining there until the beginning of October the ship returned to Sitka, and after a prolonged stay in the waters of southeastern Alaska we finally reached the Golden gate of San Francisco, shortly after midnight on the 7th of December.

* *Labrets* is the name used along the coast for the lip-ornaments worn by the natives.

The cruise of the Thetis was remarkable in several respects, among others in that, thanks to the open season, her stanch build, and successful battling with the ice-pack, she was enabled to reach Mackenzie bay, in British North America, the first government vessel to carry the American flag in those waters. She also made the long stretch from Mackenzie bay to Herald island and Wrangel land in one season, never before done, and she had the honor of being the first vessel of any kind to follow the entire main coast line of Alaska from Port Tongass, in extreme southeastern Alaska, to Demarcation point, in the Arctic ocean.

THE LAW OF STORMS,

CONSIDERED WITH SPECIAL REFERENCE TO THE NORTH ATLANTIC.

By Everett Hayden.

(Abstract of a paper read before the National Geographic Society, Nov. 15, 1889.)

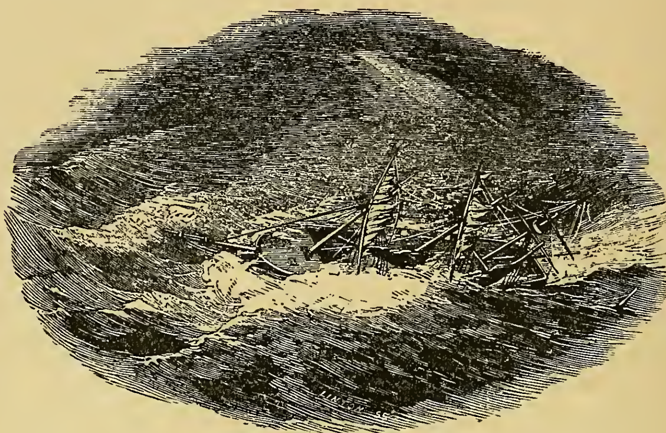
In preparing an abstract of this paper it is of course difficult to adhere very closely to the original, inasmuch as that was illustrated by forty-five lantern slides, while it is only practicable to present a few plates with this abstract. I may therefore be permitted to give only a general outline of the subject, with perhaps a more detailed discussion of one or two of the most notable recent hurricanes off our Atlantic coast.

The term "Law of Storms" is applied to the code of rules that should govern the action of the master of a vessel when he has reason to suspect the approach of a dangerous storm. It will be seen that this definition, like the code itself, is somewhat vague. So many considerations enter as factors in the question that it is wholly impossible to lay down any rules that shall be applicable alike to a high-powered, well-manned steamship, and to a heavily-laden, poorly-equipped and short-handed sailing vessel. Disregarding such differences of conditions (which are, of course, of vital importance in each individual case, but which cannot be discussed in a brief general essay), the two grand divisions of the subject may be compared to *grand strategy* and *field tactics.* By this I mean that a broad, comprehensive view of the whole subject of ocean storms—their regions, seasons, size, severity, and tracks—is one very important part of the navigator's duty in planning a long campaign, or voyage; and, secondly, the handling of his vessel when actually in the fight—the coolness, clear-headedness, and trained experience that utilizes every resource of the best seamanship and navigation in a fearful struggle with the fury of a hurricane—all of these are also an essential part of the education of the ideal sea-captain.

Thanks to the progress of meteorologic research it is comparatively easy nowadays for anyone to get a very good general idea of the great hurricane regions of the globe, and the seasons when these dreaded tropic cyclones prevail in each of these regions. The evidence on this subject is cumulative and practically conclusive, so that it is universally known and recognized that the hurricane months are the summer months in each hemisphere ; hurricanes originate in the tropics, move westward, then poleward into the temperate zones, and finally eastward in higher latitudes, receding gradually from the equator ; moreover, the essential difference between hurricanes north and south of the line is as follows : In the Northern Hemisphere the rotation of the cyclonic whirl is *against* the hands of a watch, and in the Southern, *with.* The noted hurricane regions are the West Indies, coast of China and Japan, Bay of Bengal (especially in May and October, at the time of the change of the monsoons), and the South Indian Ocean (about Mauritius). Less noted regions are the South Pacific (East of Australia), the North Pacific (west of the Mexican coast), and the Arabian Sea. In planning a distant voyage a navigator should therefore consider the hurricane regions through which he must pass, just as he considers the prevailing winds—the trades, monsoons, and ocean currents.

The handling of a ship in a hurricane is a very different sort of a thing from this general survey of the entire field, and, without the eminently practical qualities that we all associate with a good officer of the navy or mercantile marine, no mere theoretic knowledge can avail much. And yet this is one of those cases where practice and theory should go hand in hand,—not theory as something vague and unreal, but theory as based upon a firm foundation of observed facts. If a vessel encounter a hurricane, certain conclusions can be drawn from observations of the shifts of wind, the fluctuations of the barometer, the appearance of the clouds, and the direction of the ocean swell ; the master of that vessel will undoubtedly draw such conclusions, and store them away in his mind as part of his fund of experience upon which to base action at some future time. But if he can consider his own observations, while fresh in mind, in connection with the observations made on board many other vessels that encountered the same storm, and modify or verify his conclusions by such comparison, there cannot be a doubt but that the lesson will be of far greater value. Sailors lead a rough life, and their training is often acquired by experience alone. Moreover, there are certain things that tend to discourage effort on the part of junior officers, even on board naval vessels : they realize that their duty is not to originate orders but to execute them, and sooner or later they get out of the habit of reflecting upon the action taken to avoid a storm or manoeuver in one, not knowing at the time what considerations lead to the action that was taken, and not always having anything brought forcibly to their attention to indicate with certainty whether the action was well-considered or ill-advised. Upon finally attaining command themselves they are not, therefore, as well posted as they might otherwise have been. I mention these things to explain the undoubted fact that comparatively few masters of vessels are well posted in certain very important additions to the old law of storms, as it was discovered by Redfield and enforced by Reid, Piddington, Thom, and other early writers. In fact, of all the navigators of various nationalities who have charge to-day of the commerce of the world, probably four-fifths are wholly ignorant of the progress that has been made in this direction in the past fifty years. That such is the case is not, in my opinion, wholly their fault : it is owing to the fact that far too little attention has been paid to clear, forcible, and convincing explanation; it is the fault of the teachers, no less than the scholars,—of meteorologists who talk over the heads of their audiences, instead of stating facts and conclusions in a way to command attention and respect from the practical men who furnish the data, and who deserve some tangible results in return for their long years of voluntary observation.

It is difficult to put this matter very clearly to those who are not familiar with the conditions that govern the management of a vessel at sea, and I shall only attempt to do so in a very general way. It should be understood, first of all, that a hurricane is an enormous whirlwind, so large, in fact, that its circular nature was generally recognized only about fifty years ago. At the immediate center of the whirl there is a calm space, from five or ten to thirty or forty miles in diameter, generally with blue sky and bright sunlight. Within a short distance of this central calm the wind blows with frightful violence, and here a vessel is driven along in absolute helplessness, enveloped in midnight darkness, buried in a flying mass of foam and spray, with every sound annihilated by the roar and shrieks of the elements. The core of the hurricane, as this region has been called, is small, relative to the entire area, and it thus happens that a few miles may make all the difference between shipwreck and safety. The question is, then, to avoid getting into the core, or heart, of the hurricane. It is evident enough that if the wind blow in a strictly



A ship in the heart of a cyclone. From Reid's "Law of Storms."

circular direction around the center, the bearing or direction of the center must be at exactly right angles (eight points) to the right (or left) of the direction of the wind. In other words, in the Northern Hemisphere (where the direction of rotation is against the hands of a watch) the center bears eight points to the right of the wind (that is, to the right of the direction from which the wind blows); in the case of a hurricane off our coast, for instance, if the wind be NE. at Hatteras the center would bear (according to the 8-point rule) SE. Considering, further, that the entire whirl has a progressive motion along a path, or track, if an observer at Hatteras find that the NE. wind freshens rapidly, without any shift or change of direction, it is equally evident that the center of the storm is approaching directly toward that point. In a similar situation at sea, a shipmaster would naturally see that his vessel was in a position of great danger: evidently the best thing to do would be to run before the wind, thus getting out of the way of the approaching hurricane. This simple case will explain pretty clearly, I think, how rules were at once formulated and adopted, as soon as Redfield had proved the approximately circular character of these storms.

Without going further into this subject, inasmuch as this 8-point rule is perhaps the most important of all the rules—indeed, all of them follow directly from it,—suppose that subsequent research, based upon careful observation and the accurate charting of hundreds of reports from vessels in similar storms in various oceans, proved conclusively that the wind in a hurricane does not blow in strictly circular whirls, but rather spirally inward, so that with a NE. wind off Hatteras the center bears probably S SE., or even South : evidently this is a matter of vital importance to the navigator, and all the old rules should be remodeled to suit the discovery. Such is, indeed, actually the fact, and in most cases nothing could be worse than to run directly before the wind ; in any event it would be dangerous, and in the case of a slow-moving cyclone it might readily lead the vessel directly into the core of the hurricane. This is known to have been the case in many instances, and vessels have thus been drawn into the inner whirls of hurricanes and kept there for several days, making one or more complete revolutions around the center before they could extricate themselves. In fact, they might never have gotten out, if the storm itself had not moved off and left them.

The first of the accompanying plates, entitled,

West Indian Hurricanes, and other North Atlantic Storms,

gives a brief and yet complete résumé of what is perhaps the best modern practice. In these brief statements the attempt has been made to put concisely, intelligibly, and *completely* (if one will but read each and every sentence as carefully as they were written), the very latest, most important, and best-established facts, with which every navigator should be familiar. The paragraph entitled "Intensified trade-wind belt," for instance, is very important. A close consideration of the caution expressed in these few lines may prevent a serious mistake that might be made by a too rigid adherence to the old rules. The idea is as follows : It has been proved by Meldrum, from his studies of Mauritius hurricanes, that the SE. trade-winds blow toward a part of the *track* of a hurricane, rather than at right angles to the direction of its center, and it is therefore unsafe to assume that the center bears at right angles to the wind, or that, because the trade wind increases in strength without any decided change of direction, the center is approaching directly toward the vessel. This principle might naturally be expected to hold for similar storms in other regions, and Abercromby, in a thorough study of the whole subject, has shown that such is the case, although he states that "the position of this belt [of intensified trades] differs in every hurricane region, so that a special set of rules are necessary for each country." It seems to me, I must say, that in the absence of such special rules the law may safely be assumed to be general; its importance to navigators is certainly very great, and its principal effect must be to urge the greatest caution in making any attempt to cross the track of a hurricane, from the dangerous to the navigable semicircle.

The next plate,

THE HURRICANE OF NOVEMBER 25, 1888,

is a very instructive illustration of an actual hurricane, and one of the most severe on record off our Atlantic coast. The spiral lines have been added to bring out conspicuously the wind-circulation, and several features will at once attract attention: the elongated shape of the storm, along a north and south line (the direction of motion); the wide region where there is a southeasterly gale (exactly analogous to the belt of intensified trades); the long sweep of northeasterly winds along the coast; and the marked variation from a strictly circular whirl. The right-hand side is the dangerous semicircle, and it is here that the navigator is called upon to decide whether he shall dare make the attempt to run before the wind and cross the track of the storm; the left-hand side is the navigable semicircle,—not very *navigable* in this particular case, we may well believe, with no sea-room to the westward, a fearful N NE. gale, and a terrific sea. This is a case where every resource of seamanship and navigation may fail to save a ship, as the loss of the steamship "Samana" and a dozen other strong vessels, with all on board, bears sad testimony. Let me quote a few lines from a thrilling report by Captain Drew, of the American ship "Sea Witch" (this vessel's position is plotted on the chart about lat. 32°N., long. 75°W.): "Nov. 24: Hurricane from NE.; our position a perilous one, the ship rolling heavily and filling the decks with water; an awful gale, the worst we have ever had,—how will it end? At 3 P. M., the sun out a moment through the thick sky. Nov. 25: Still blowing a hurricane, with awful squalls of rain; the seventh day of the gale. No side-lights can burn; the binnacle-light goes out as fast as we can light it. One blast from the north blew our brand-new lower-maintopsail away like brown paper. We performed the critical manœuver of wearing ship, which saved the vessel: we were foundering." Verily, this was "out of the jaws of death," and probably there were few more sincere thanksgiving services than those held on board this vessel on Nov. 29th, 1888, as recorded in her log. One other report may be referred to here, as it is of especial interest. It is from the British steamship "Effective," whose position is plotted about half way between Bermuda and New York. At this time the wind was S SE., force 8, and the storm center was moving directly toward her. We learn from Captain Crosby's report that by noon, local time, the wind was strong from south; at 4:30 P. M., a hard gale from east, moderating until midnight, barometer falling very rapidly. Nov. 26th, very heavy gale from NE., ship heading bow to sea; noon, wind east, barometer 28.60; 5 P. M., wind N NE., 28.20; 10 P. M., SW.; midnight, W., 28.20. This report illustrates the experience of a vessel close to the line of sudden shift of wind from SE. to N NE., and sustains very well the spiral lines drawn on the chart, just where there is an absence of data on the chart itself.

Lack of space does not allow of further details, and I must go on to the next plate,

The St. Thomas–Hatteras Hurricane of Sept. 3–12, 1889.

This plate is copied exactly from a Supplement issued with the Pilot Chart for October, 1889 (published Sept. 27th), with only the addition of the tracks of the two storms (as indicated by later data) and the tracks of a few vessels (see small charts dated Sept. 3, 4-7, 10). Considering the early date of publication, the wide expanse of ocean covered by the charts, and their essential accuracy (as indicated by later data), it must be acknowledged, I think, by anyone who is at all acquainted with the difficulties incident to this sort of work, that this supplement to the Pilot Chart hit more closely to the truth in this matter than would probably be possible under similar circumstances in one case out of ten. Had later data materially modified conclusions drawn at such an early date, it could not have been a matter of surprise, although this prompt publication would still have served a most valuable purpose in interesting navigators to contribute data likely to help us in establishing the facts. Indeed, the following quotations from the Pilot Chart and Supplement illustrate exactly what was desired, and what was actually accomplished by this publication: "This preliminary publication, issued two weeks after the storm reached our coast, well illustrates the cordial support this office receives from masters of vessels in its efforts to collect and utilize data regarding marine meteorology. It is desired to collect as complete data as possible regarding this storm, in order to publish a final report, and the present publication will be useful as a good working basis for a more complete detailed study of the hurricane." Also, "Special attention is called to the fact that this preliminary publication is only intended to give a brief outline of the facts as indicated by data received up to date of publication." Moreover, the name, nationality, and rig of every vessel whose report had been received in time to be used was published, and every statement made in the accompanying text was based on an exhaustive study of all the data.

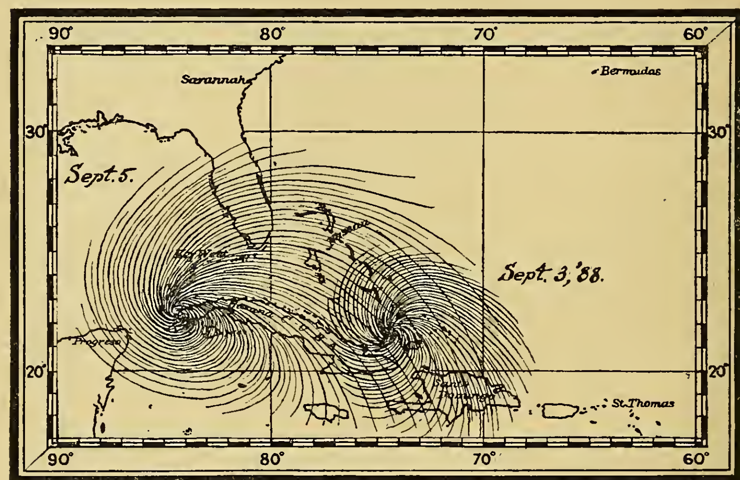
It is interesting to note how slightly the very complete data now at hand have modified this hastily-prepared history, and all the circumstances urge similar quick work and prompt publication in every case, before other storms and other conditions have dulled public interest and directed attention elsewhere. The track of the easternmost of the two storms, as plotted on the first little chart, shows that it moved more rapidly than was anticipated, and recurved farther north: the fact is, its very existence was not even suspected till *two hours* before the final draft of the maps was made, and then only because the German steamship "Savona," from Baltimore for Brazil, suffered such damage from the hurricane on Sept. 5th (see chart dated Sept. 3rd for position) that she was obliged to run in to St. Thomas for repairs, and our consul, Mr. M. A. Turner, forwarded her report by the first steamer to New York. The following is a brief extract from this report, beginning at 10 P. M., Sept. 4th: "Full hurricane, ship lying in trough of sea, laboring heavily and shipping much water. Cargo shifted; jettisoned 600 barrels of flour and 60 tons of coal. Broke steam steering gear and wheel, found rudder adrift, 3 feet of water in the hold, foundations of engines seriously loose and getting worse. Bore up for St. Thomas."

It is impossible, in the space at my disposal, to refer even briefly to the reports of the few vessels whose tracks are plotted on the charts: the stanch steamship "Earnmoor," foundering in the heart of the hurricane on Sept. 5th, eleven of her crew of thirty escaping in an open boat, and of these only seven surviving that fearful drift of twenty-three days; the "Sépet," between the two storms and escaping both; the "Lassell," from the tropics to Block Island, all the way in the grasp of the hurricane, without a sight of sun, moon, or stars, to fix her position; the "Ada Bailey," rolling in the long swell off Hatteras and watching the early indications of the approaching storm for nearly a week before it struck her; the "Hernan Cortes," forced to stand off into fearful danger by the still greater danger of a lee-shore at Hatteras; and the "City of New York," "Teutonic," and "City of Rome," starting on their Titanic race from Liverpool for New York the day after this great hurricane swept past St. Thomas, and reaching their goal with it, and in spite of all its fury. I must dismiss this whole interesting history with the following abstract of the report of Capt. Simmons, of the British brigantine "Victoria," whose original report is brief and to the point, like all the rest (see track of the "Victoria," northwest from St. Thomas, on the first small chart):

I passed through the cyclone, resulting in the total loss of the spars, sails, etc., of my vessel. The SE. sea became so heavy that I was obliged to heave-to. The sky was one sheet of dark gray, at times approaching black. The lightning was excessive only during the latter part of the storm; it appeared as a continuous quivering sheet around a great part of the horizon, extending about 10° above it and lasting many seconds, unaccompanied by thunder; the compass could not be read, the card spinning so that the points were indistinguishable. The lowest barometer reading was 27.86 (aneroid, corrected by comparison at Boston shortly before and at Halifax the following month).

The importance to navigators of a true appreciation of the law of storms—not the mere memorization of a set of rules, but an intelligent comprehension of the subject—is now perhaps clearly evident to the reader: at any rate, that is the object I have aimed at, rather than a mere formal statement of generally accepted principles and an abstruse discussion of isobars and gradients.

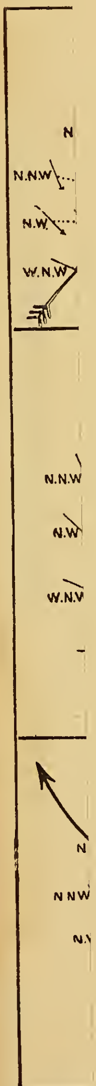
It will be seen that *the probable bearing of the center, as indicated by the direction of the wind at a single station*, is the great question, so far as the navigator is concerned. There are men who want and must have a hard-and-fast rule,—an 8-point, a 10-point, or a 12-point rule—something to act on without thought, while every nerve is strained to save the ship's spars, sails, boats, engines, and cargo, from damage or destruction. Under such circumstances, I think that perhaps the safest general plan is to use the old 8-point rule, but *applied to the low clouds, instead of to the wind.* This is equivalent, generally speaking, to a 10-point rule, applied to the wind. That any such rule, if intended for general application, is only roughly approximate, goes without saying, or ought to do so, at least. The angle of bearing changes in different parts of the storm, it varies with the quadrant, with the latitude, with different storms, and with various other conditions, too numerous to be mentioned or even wholly known. One good general rule is that in rear of a hurricane the wind blows somewhat decidedly toward it; and yet that there are marked exceptions is well illustrated by the chart of the hurricane of November 25, 1888, already referred to. As a good example of the wind circulation in a hurricane in the tropics the accompanying diagram is of interest. This represents two days



The Cuban Hurricane of September, 1888, illustrating the surface wind-circulation on September 3d and 5th, at noon, Greenwich mean time.

(the 3d and 5th) of the great Cuban hurricane of September, 1888, the intervening day (September 4th) being omitted, for the sake of clearness. Its severity is sufficiently indicated by the fact that it caused the loss of fully a thousand lives in Cuba, and destroyed property of the estimated value of $5,000,000 in the single province of Sagua. Now take any point on any one of these spiral lines, and observe the bearing of the center: in rear of the storm, especially, the 8-point rule is hardly applicable, and action based upon it might result disastrously.

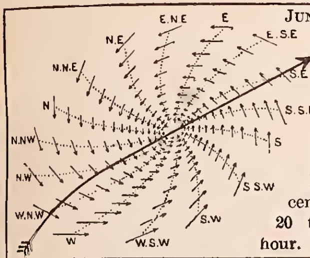
Expl
atlanti
TRACK,



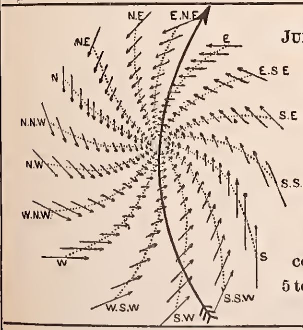
WEST INDIAN HURRICANES, AND OTHER NORTH ATLANTIC STORMS.

From the Pilot Chart of the North Atlantic Ocean, August, 1889, with Additional Paragraphs.

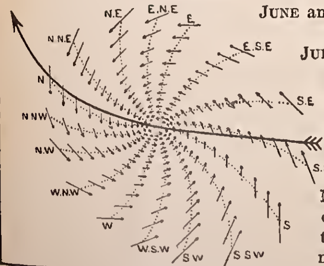
Explanation.—These diagrams are for practical use in West Indian hurricanes. The upper one will also answer for ordinary storms along the trans-atlantic route. The small arrows fly with the wind, the direction being stated at the end of each dotted line; the long arrow on each diagram is the STORM TRACK, that is, the probable path of the cyclone through the belt of latitude to which the diagram applies.



JUNE and OCTOBER, lat. 23° to 55° JULY and SEPT., lat. 29° to 55°. AUGUST, lat. 33° to 55°. STORM TRACK, N NE. to E NE. Motion of storm center along track, 20 to 30 miles per hour.



JUNE and OCTOBER, lat. 20° to 23°. JULY and SEPT., lat. 27° to 29° AUGUST, lat. 30° to 33. STORM TRACK, N NW. to N NE. Motion of storm center along track, 5 to 10 miles per hour.



JUNE and OCTOBER, lat. 10° to 20°. JULY and SEPT., lat. 10° to 27° AUGUST, lat. 10° to 30°. STORM TRACK, W. by N. to N NW. Motion of storm center along track, about 17 miles per hour.

[*Edition of July, 1890.*]

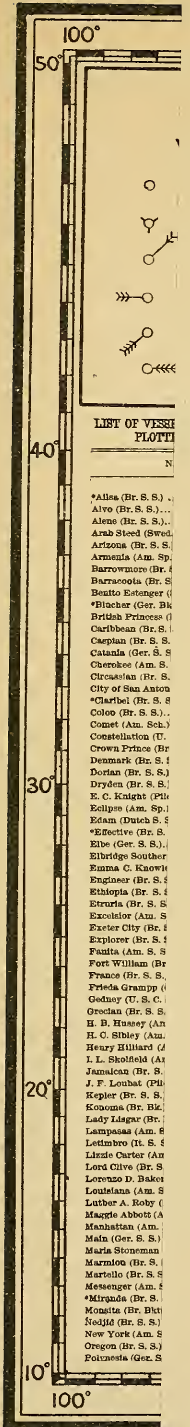
Use of the Diagrams.—When a falling barometer, freshening rain squalls, &c., indicate a hurricane, select the proper diagram (according to the MONTH and LATITUDE), plot your position upon it by means of the direction of the wind, and thus ascertain the approximate bearing of the storm center. The probable storm track is indicated by the long arrow. If the wind shift, plot your position by means of the new wind-direction (nearer the center if the wind has freshened and the barometer has fallen). In this way you can readily observe every change of position relative to the storm center, and decide what action to take, according to the character of your vessel, the lay of the land, &c. These storms vary greatly in size, but are smallest and most violent in the tropics, where the cloud ring averages about 500 miles in diameter and the region of stormy winds 300 miles, or even less. You can therefore only roughly estimate the DISTANCE of the center, although its BEARING can be obtained from the diagrams with a high degree of probability. There is also considerable variation in the direction of motion and the velocity of the storm along its track, but the general tendency is as stated herewith.

Cyclonic Circulation.—One of the most important indications that an approaching storm is of hurricane violence is the marked cyclonic circulation of the wind, lower and upper clouds, etc. This may be easily appreciated by remembering that a cyclone of any great intensity is an ascending spiral whirl, with a rotary motion (in the Northern Hemisphere) against the hands of a watch, as shown on the diagrams The surface wind, therefore, blows spirally inward (*not* circularly, except very near the center); the next upper current (carrying the low scud and rain clouds), in almost an exact circle about the center; the next higher current (the high cumulus), in an outward spiral—and so on, up to the highest cirrus clouds, which radiate directly outward. The angle of divergence between the successive currents is almost exactly two points of the compass. Ordinarily, with a surface wind from N., for instance, the low clouds come from N., also; on the edge of a hurricane, however, they come from N NE., *invariably*. In rear of a hurricane, the wind blows more nearly inward; with a SE. wind, for instance, the center will bear about W., the low clouds coming from S SE. (two points to the right of the wind), etc. Great activity of movement of the upper clouds, while the storm is still distant, indicates that the hurricane is of great violence. If the cirrus plumes that radiate from the distant storm are faint and opalescent in tint, fading gradually behind a slowly thickening haze or veil, the approaching storm is an old one, of large area; if of snowy whiteness, projected against a clear blue sky, it is a young cyclone of small area but great intensity.

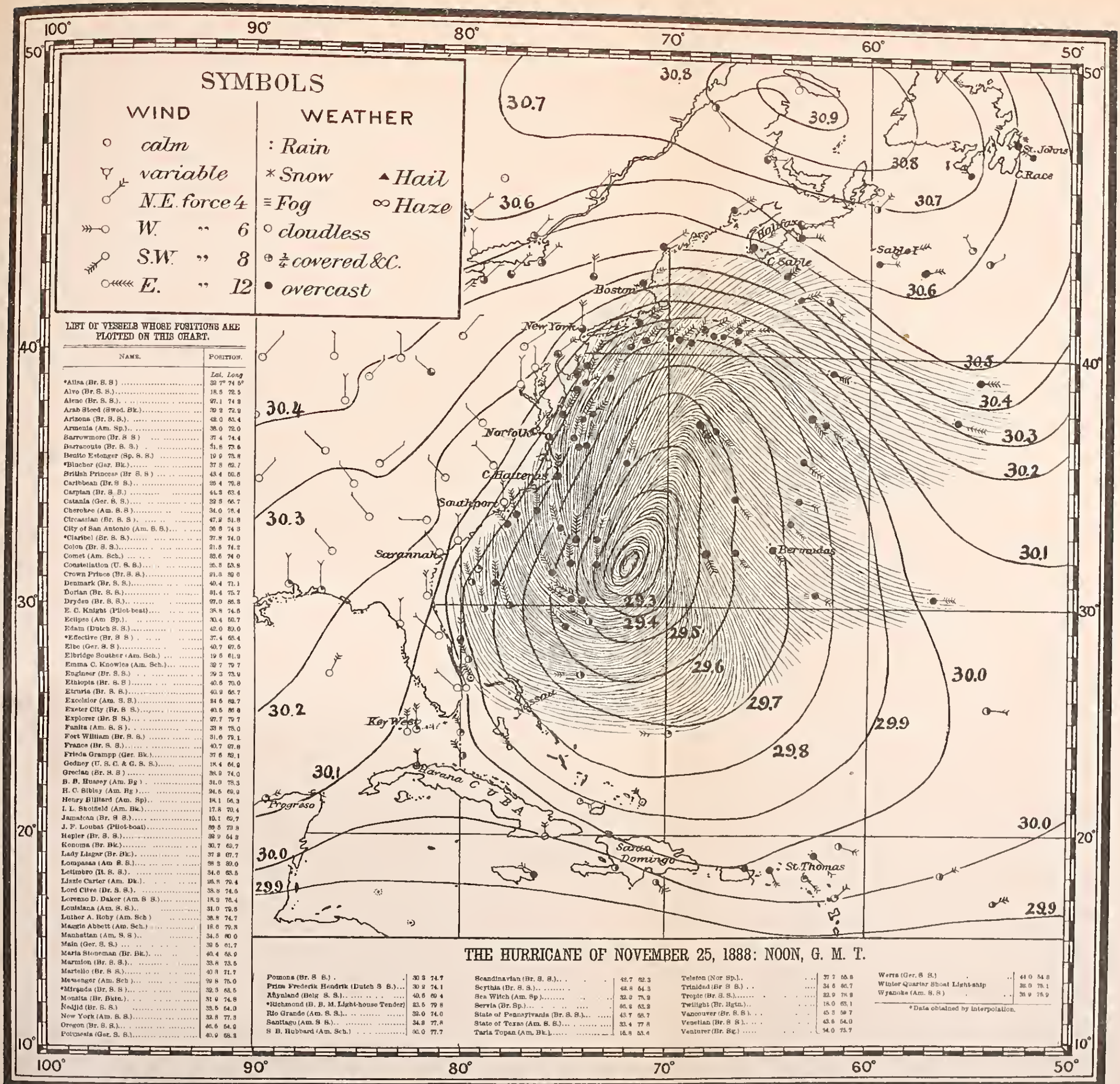
Intensified Trade-wind Belt.—Another very important fact (established by Meldrum, at Mauritius) may be stated thus: When a hurricane is moving along the equatorial limits of a trade-wind region, there is a belt of intensified trades to windward of its track: not until the barometer has fallen about six-tenths of an inch it is safe to assume that, because the trade-wind increases in force and remains steady in direction, you are on the track of the storm. By attempting too early to cross its track, running free as soon as the wind begins to freshen, you are liable to plunge directly into the vortex of the hurricane.

General Information.—Hurricanes are especially liable to be encountered from July to October, inclusive, in the tropics (north of the 10th parallel), the Gulf of Mexico, and Gulf Stream region. Earliest indications: Barometer above the normal, with cool, very clear, pleasant weather; a long, low, ocean swell from the direction of the distant storm; light, feathery cirrus clouds, radiating from a point on the horizon where a whitish arc indicates the bearing of the center. Unmistakable signs: Falling barometer; halos about the sun and moon; increasing ocean swell; hot, moist weather, with light variable winds; deep red and violet tints at dawn and sunset; a heavy, mountainous cloud bank on the distant horizon; barometer falling more rapidly, with passing rain squalls.

Brief Rules for Action.—If the squalls freshen without any shift of wind, you are on the storm track: run off with the wind on the starboard quarter and keep your compass course (see caution in paragraph entitled "Intensified Trade-wind Belt"). If the wind shift to the right, you are to the right of the storm track: put the ship on the starboard tack and make as much headway as possible, until obliged to lie-to. If the wind shift to the left, you are to the left of the storm track: bring the wind on the starboard quarter and keep your compass course; if obliged to lie-to, do so on the port tack. In scudding, always keep the wind well on the starboard quarter, in order to run out of the storm. Always lie-to on the coming-up tack. Use oil to prevent heavy seas from breaking on board.

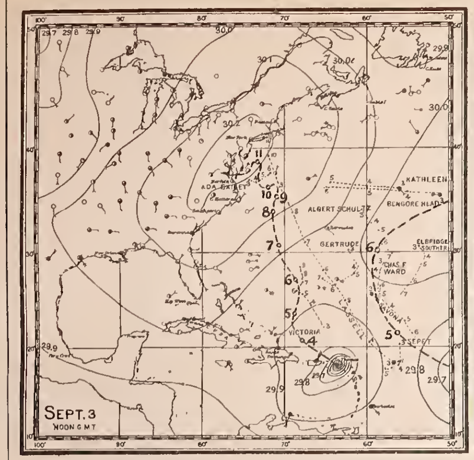


THE HURRICA
to call special atte
this particular hu
careful considerat
evidence can be p
better, although t
when there is a h
that the center be
this steady SE. wi
has fallen about
of the storm; by

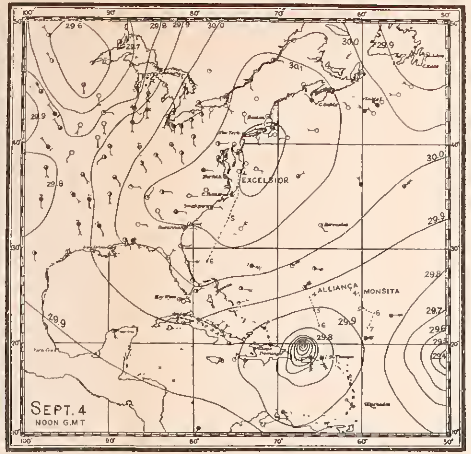


THE HURRICANE SEASON.—June may be fairly said to be the first of the five hurricane months in the North Atlantic, and the above diagram is presented in order to call special attention to the Law of Storms, especially to certain important modifications of the old laws. The spiral lines indicate the general wind-circulation in this particular hurricane, and the complete data presented on the Chart must convince any one that conclusions based upon such evidence must be worthy of the most careful consideration. This hurricane was one of the most severe on record off our Atlantic coast, and, though much larger than a hurricane in the tropics, similar evidence can be presented to show that the 8-point rule is seldom a safe guide for obtaining the bearing of the center; a 10-point or even a 12-point rule is generally better, although the 8-point rule is fairly correct if applied to the direction of the low clouds, rather than the wind. The long sweep of NE'ly winds along the coast, when there is a hurricane below Hatteras, is a very characteristic and important feature. With a NE'ly wind off Block Island, for instance, it should not be assumed that the center bears SE.: the Chart shows that it may be almost due south. There is likewise a wide region where the wind is from the SE., and a vessel running before this steady SE. wind would plunge deeper and deeper into the hurricane. Similarly in the trades, to windward of the track of a hurricane: not until the barometer has fallen about 6-tenths of an inch is it safe to assume that, because the trade-wind increases in force and remains steady in direction, you are on the track of the storm; by attempting too early to cross its track, running free as soon as the wind begins to freshen, you are liable to plunge directly into the vortex.

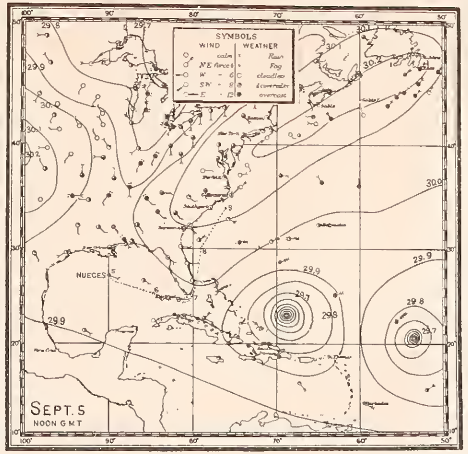
THE ST. THOMAS-HATTERAS HURRICANE OF SEPTEMBER 3-12, 1889.



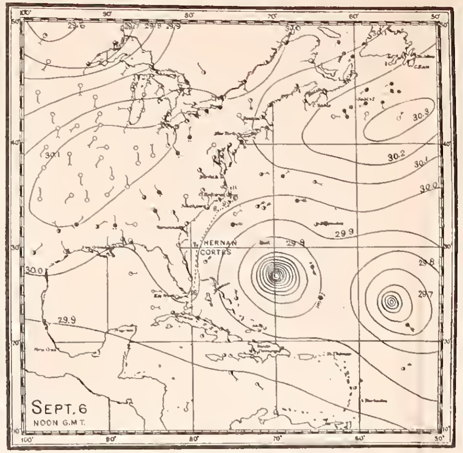
Sept. 3.—A hurricane of great intensity is passing close to the northward of St. Thomas, moving about W. NW. Lowest barometer at St. Thomas during the day, 29.97. Steepest observed barometric gradient (between St. Thomas and Puerto Rico), .75 inch in 85 miles. The cyclone is a large one, and of terrific energy,—an enormous whirlwind more than 500 miles in diameter, with a central calm area about 16 miles in diameter. It was experienced with destructive violence amongst the Windward Islands, from Martinique to Barbuda, on the 2d, and the vortex passed over St. Christopher's about midnight, the central calm lasting from 10.15 p. m. of the 2d till 12.45 a. m. of the 3d. There are evidences of another hurricane about 1,000 miles eastward of the first, moving about W. NW.



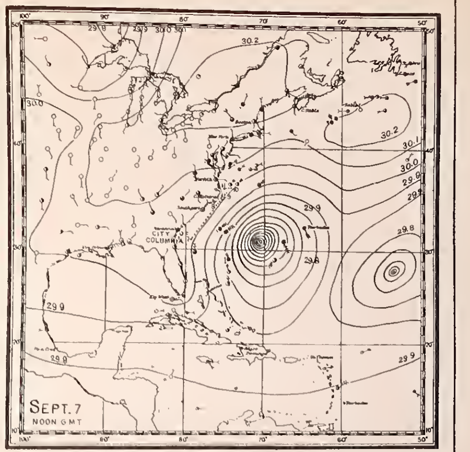
Sept. 4.—The hurricane is central north of Puerto Rico, where strong northerly, westerly, and southerly gales are experienced, but not of full hurricane force. During the forenoon its massive, towering cloud-bank is clearly visible from Turk's Island, 300 miles away, causing great alarm till it is seen to be moving well to the northward of the island. A violent storm in Santo Domingo this afternoon seems to be either an offshoot from the cyclone or the effect of another storm crossing the island to join the great hurricane—possibly a storm that was felt at Curaçao the previous day. The second hurricane has continued its motion toward W. NW. and its present position is clearly indicated about the eastern limits of the Chart.



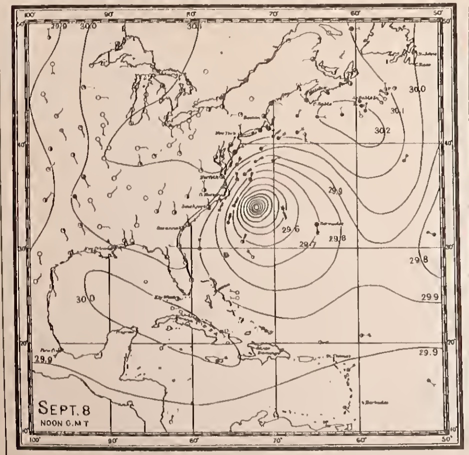
Sept. 5.—The hurricane is moving rather slowly along a northwesterly course, toward Hatteras. The enormous seas started by the great whirlwind during its progress thus far have overspread almost the entire western half of the Atlantic: heavy northeasterly swell at Jamaica and through the Windward Channel; northeasterly and easterly, all along the Bahama Islands and northern Florida; very heavy surf at Bermuda; long rolling swell from S. SE. off Hatteras, perceptible as early as the 2d and increasing daily; long, low southerly swell off Nantucket as early as the 4th, when the storm-center was 1,300 miles away. The second hurricane is moving northwestward, and is beginning to recurve about 600 miles S. E. from Bermuda.



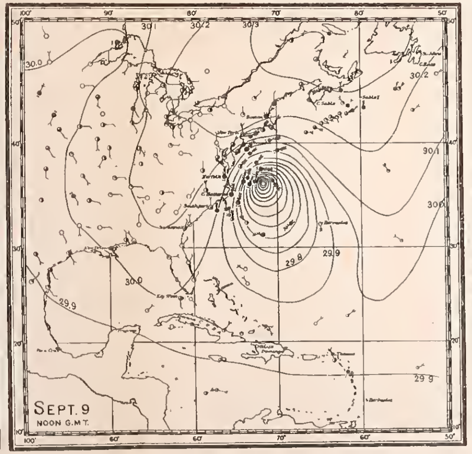
Sept. 6.—The concentric isobars on the Chart show that the hurricane is now central about midway between Bermuda and Eastern Cuba, with barometric pressure at the center probably below 28.40. All the characteristics of a tropical cyclone are still exhibited, and to a marked degree: storm area noticeably circular in outline; very steep gradients and enormous wind velocities near the center; sudden shifts of the wind in terrific squalls; heavy driving rain mingled with foam caught up from the crests of the waves; sky of inky blackness, with masses of flying scud so low as to touch the masts. Close by, in front, and on either side, calm, sultry, hazy weather, with a tremendous swell rolling in from the direction of the distant but massive cloud-bank of the hurricane. A long ridge of high pressure is building up to the northward of the hurricanes.



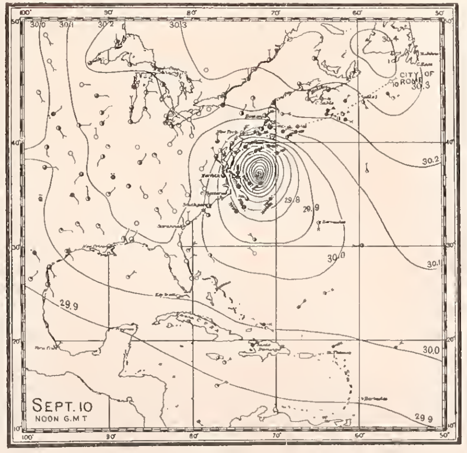
Sept. 7.—The hurricane continues its slow but steady march toward Hatteras. Yesterday morning the observer at Santiago de Cuba reported the cyclone recurving. This morning the meteorologist at Havana, 900 miles away, reports the cyclone's movements, guided by the motions of the upper clouds,—the cirrus veil that overspreads the entire sky with a thick haze, and the long feathery plumes of cirrus cloud that are faintly visible above it, radiating from the distant storm. The influence of the great hurricane begins to be felt along the outer edge of the Gulf Stream, below Hatteras. A heavy surf is rolling in on the coast all the way from Cape Florida to Block Island, and the long southerly swell has reached beyond Sable Island to Cape Breton. The second hurricane is moving NEd., and a ridge of high pressure is extending Sd. between the two.



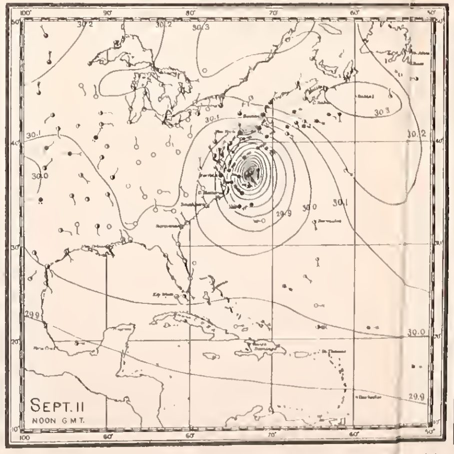
Sept. 8.—The hurricane is central about the axis of the Gulf Stream, off Hatteras. The area of high barometer in advance is retarding its northward progress, and preventing it from recurving to the northeastward. The heavy surf and the increased height of the tides, due to the storm-wave of the hurricane, begin to attract general attention and to cause damage along the low-lying portions of the coast between Norfolk and Newport; warm, moist ocean air is being driven in over the cold inshore current, and dense fogs are encountered off the coast north of the 35th parallel. The storm is losing a little of its tropical intensity, but its area is increasing and winds of hurricane force are raging over a vast area between Hatteras and Bermuda.



Sept. 9.—The storm is still raging with great violence between Nantucket, Hatteras, and Bermuda. Tremendous seas and tides are driving in on the coast. It is blowing with hurricane force close in shore near Hatteras. The storm-center is still moving northward, but more slowly, and the great area of high barometer into which the hurricane has forced its way stands fast, the pressure rising to 30.30 over the Gulf of St. Lawrence and the isobar of 30.00 reaching south on either side well down toward the tropics. To the northwestward, northward, and northeastward, close to the outer limits of the great whirlwind, warm, sultry weather prevails, with calms or light, variable winds, hazy weather, and barometer above the normal.

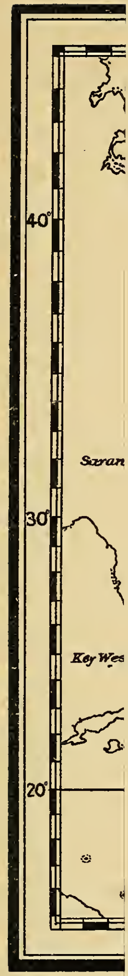


Sept. 10.—The hurricane seems to be gathering all its strength for a last desperate struggle to force its way along its normal track to the northeast. The wind-arrows plotted on the Chart illustrate very graphically the marked circular character of the great whirlwind. The storm-wave, or general elevation of the oceanic surface caused by the in-rushing and whirling winds, and the reduced barometric pressure (acting as a partial vacuum), bank up the water in the bight of the coast about Sandy Hook, and cause the greatest floods on record at many places along the eastern coast of New Jersey and the southern shore of Long Island.



Sept. 11.—The barometric pressure at the storm-center has increased noticeably. The low area is filling up, and the barometric gradients are very much less steep. Very few winds of full hurricane force are reported. The storm-center has moved in toward shore, however, and stormy winds are still felt along the coast. The clouds are breaking away in places, and the cyclonic circulation is no longer so well marked. The warm waters of the Gulf Stream have been driven in toward the coast off Block Island by the long-continued and furious southeasterly gales to the right of the storm track, and, mingling with the cold in-shore current, cause dense fogs and squally, unsettled weather.

Sept. 12.—The great hurricane has blown itself out, and although a few reports still give a force of wind as high as 10 of Beaufort's scale, the storm has practically ended. Its remnants drift inland during the 13th and 14th, with cloudy, rainy weather in eastern Virginia and Maryland. It leaves a mountainous cross sea that lasts for several days, a coast line strewn with wreckage and already some twenty additions have been made to the list of derelicts and drifting wrecks whose positions are plotted on the Pilot Chart as a caution to navigators. How many vessels it wrecked at sea can never be fully known, but its entire track is marked by wrecks and wreckage.

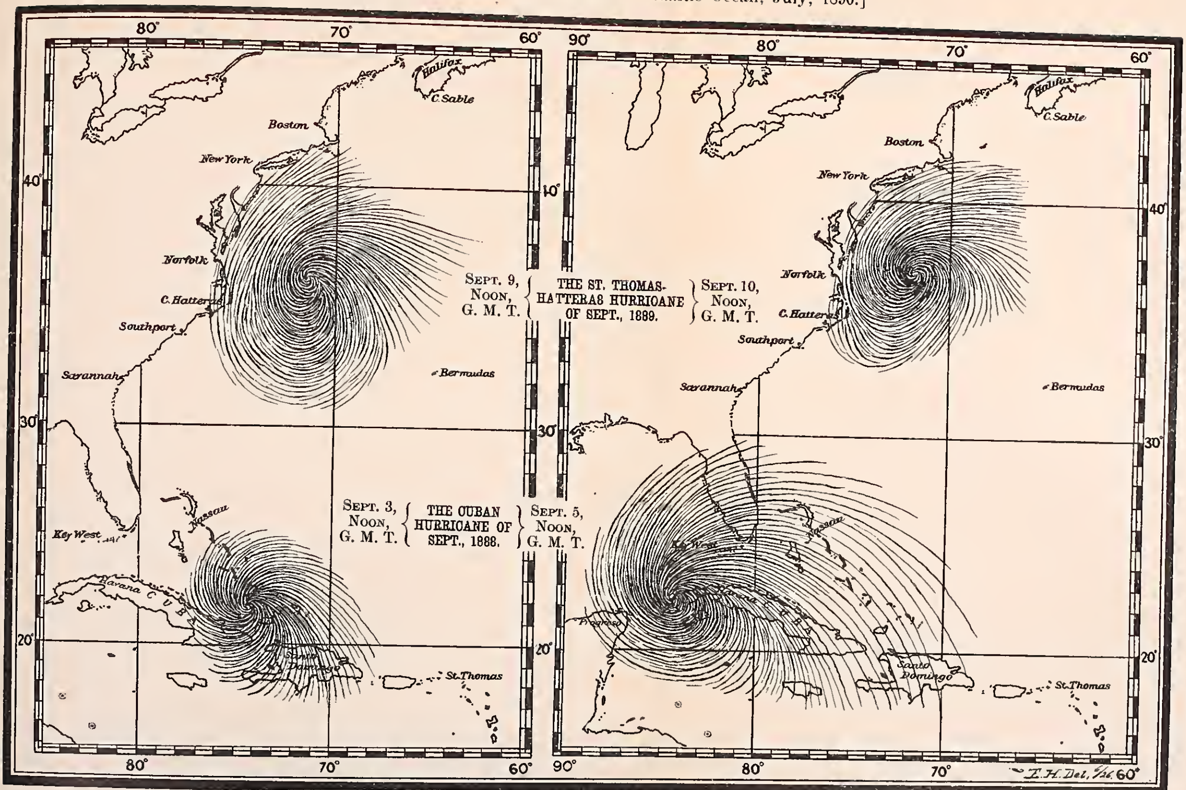


The abov
during the pre
hurricane (No
notice is that t
the wind. Ai
speaking, in tl
center may be
Perhaps the b
the right of th
and the angle

It will be
departure fron
storm in this
case. In the
be noted, how

Masters
G. M. T., are

[From the Pilot Chart of the North Atlantic Ocean, July, 1890.]



HURRICANES IN THE NORTH ATLANTIC.—TYPICAL CIRCULATION OF THE WIND, FROM ACTUAL OBSERVATION.

The above diagrams have been prepared from a large number of observations in order to illustrate the actual circulation of the wind in hurricanes, as a practical guide for navigators during the present hurricane season. The small chart that was presented on the Pilot Chart last month gave all the observations upon which the spiral lines were based for that particular hurricane (Nov. 25, 1888), and the same method has been followed here, only the observations themselves are omitted, for the sake of clearness. Perhaps the most important point to notice is that the surface wind blows in an inward spiral curve, and not circularly, except very near the center. The center therefore generally bears more than eight points to the right of the wind. Another very important point is the fact that although the 8-point rule is nearly true when the wind is anywhere from *North to South by way of West* (that is, generally speaking, in the navigable semicircle), it is liable to be a very poor guide when the wind is from any point in the first or second quadrant. With the wind from NE, for instance, the center may bear anywhere from South to SE.; with the wind East it may bear from SW. to South; and with the wind SE. it may bear SW., West, or even (in the tropics) W NW. Perhaps the best general rule is that the center bears about eight points to the right of the direction from which the low clouds come, or, what is practically the same thing, eight points to the right of the wind at the moment of a sudden shift in a heavy squall; after such a shift the wind will remain steady in direction for a time, but the center is meanwhile moving along and the angle of bearing changes until the next shift, when it goes again to eight points, and so on.

It will be noticed that the northernmost of these two hurricanes was moving very slowly during the two days selected for illustration: had it been moving faster, the in-draught (or departure from the circular direction) would no doubt have been somewhat less in advance and considerably greater in rear than what is indicated. It is exceptional also to find a storm in this region growing smaller, as this seems to have done on Sept. 10th; it died out altogether in a few days, instead of continuing its motion toward E NE., as is usually the case. In the tropics the usual progressive motion is about W. by N., and this, together with the steady increase in size, is well illustrated in the case of the Cuban hurricane; it should be noted, however, that the interval is here two days, and not one, as in the upper diagram.

Masters of vessels are earnestly requested to keep regular observations for this Office during the hurricane season, even if only position, wind, weather, and barometer, at noon, G. M. T., are noted. A single additional report often adds greatly to the completeness of the data used in preparing these diagrams.

J. B. Bernadou
Ensign U. S. Navy

The next and last plate, entitled,

HURRICANES IN THE NORTH ATLANTIC.—TYPICAL CIRCULATION OF THE WIND, FROM ACTUAL OBSERVATION,

gives a still more complete illustration of the wind-circulation in hurricanes, with a brief discussion of the application of the 8-point rule. Especial attention is called to the statement made thereon (referring, of course, to hurricanes in the North Atlantic, but no doubt true for the entire Northern Hemisphere) that

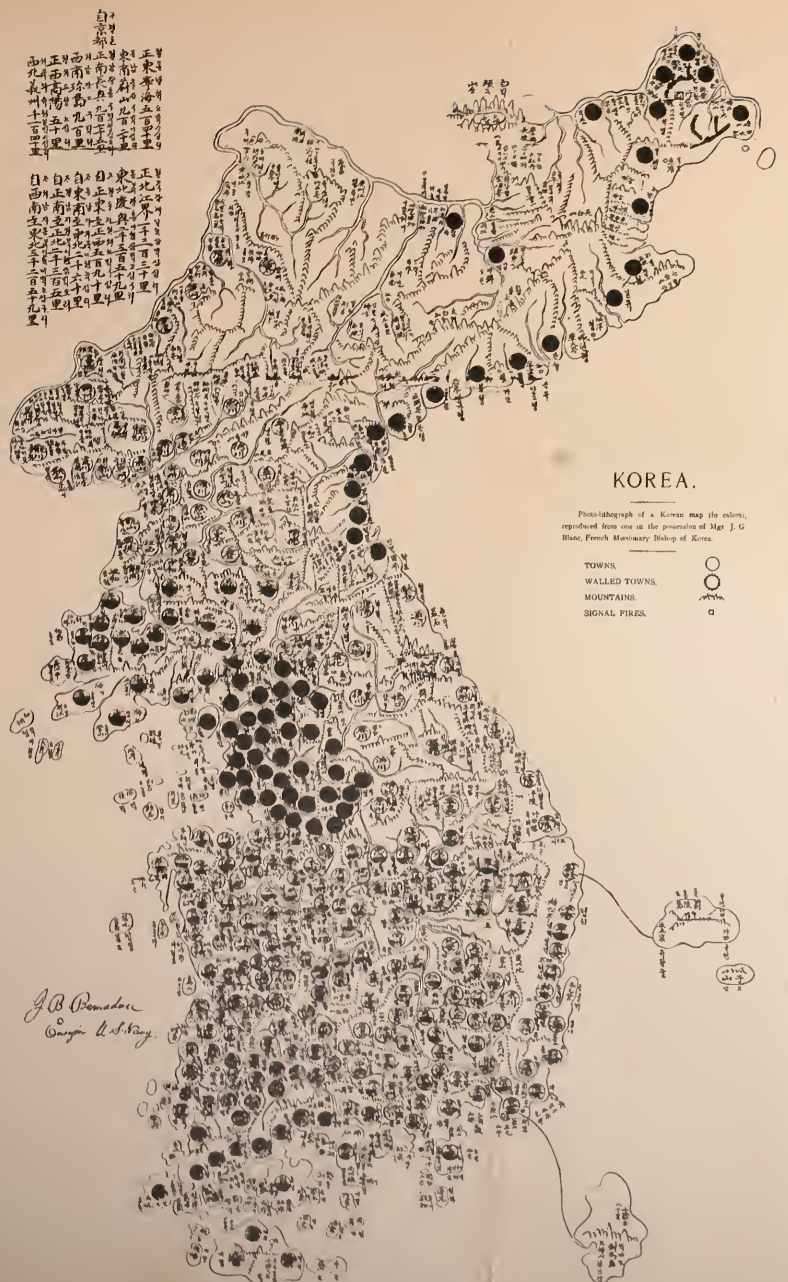
"although the 8-point rule is nearly true when the wind is anywhere from north to south by way of west (that is, generally speaking, in the navigable semicircle), it is liable to be a very poor guide when the wind is from any point in the first or second quadrant."

Also to the following, which is applicable to the Southern Hemisphere by the substitution of "to the left" for "to the right:"

"Perhaps the best general rule is that the center bears about eight points to the right of the direction from which the low clouds come, or, what is practically the same thing, eight points to the right of the wind at the moment of a sudden shift in a heavy squall; after such a shift the wind will remain steady in direction for a time, but the center is meanwhile moving along and the angle of bearing changes until the next shift, when it goes again to eight points, and so on."

Such diagrams, carefully prepared from complete and reliable data, are of far greater practical value to navigators than volumes of explanation: they appeal to the eye and will live in memory long after ideas conveyed by printed words have been forgotten.

Finally, let us look for a moment at two sketches that I have made to give a graphic and I hope not incorrect idea of the cloud formation and the internal structure of a hurricane. In both sketches the vertical scale is of course greatly exaggerated. The first illustrates particularly the great cloud bank (with the "bull's eye," or clear central space, shown in cross-section); the storm-wave or general elevation of the surface of the ocean caused by the spirally in-blowing winds and low barometric pressure (the cause, oftentimes, of fearful floods along low-lying coasts); and the probable, or possible, circulation of theupper atmosphere over the whirl, together with the direct and reflected rays of a vertical sun as they pour into the central calm. The second sketch is to aid a clear mental conception of



KOREA.

Photo-lithograph of a Korean map (in colors), reproduced from one in the possession of Mgr J. G Blanc, French Missionary Bishop of Korea.

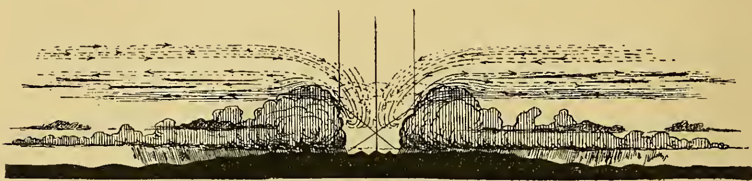
PROVINCE OF

KYÖNG-SANG-DO.

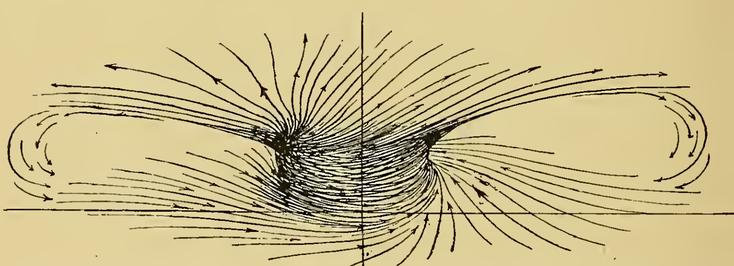
SOUTHEASTERN KOREA.

PHOTO-LITHOGRAPH OF A KOREAN MAP.

the actual motions of the particles of air as they flow inward below, whirl about the central core and flow outward above; this may help to free the mind from an erroneous idea that may be suggested by thinking of or seeing the enormous, piled-up, apparently stationary mass that constitutes the *barra*, or cloud-bank of the hurricane, but which is really only the stationary and visible *locus* where the conditions are such that the whirling, rushing masses of humid atmosphere condense their tons of aqueous vapor and leave it, as they pass upward and outward.



Sketch, in cross-section, to illustrate the cloud-formation, storm-wave, etc., in a hurricane. The dotted lines represent the probable circulation of the upper atmosphere.



Sketch, in perspective, to illustrate graphically the lower-atmosphere-wind-circulation in a hurricane. The inward spiral at the base is the surface wind.

It is analogous to the cloud-cap, or banner, that hangs stationary over a lofty mountain peak, although if you visit the peak you may there find a living gale of wind.

In both of these sketches my object has been to try to convey an idea of the marked individuality, symmetry, and intensity of a tropic cyclone, and its grasp upon and intimate connection with the ocean, which it joins to the upper atmosphere by a huge, hollow trunk, with widely extended roots and spreading branches, —no doubt an enormous and effective conductor of atmospheric electricity, too, whose power is quickly shattered and destroyed by contact with the land; the notable absence of thunder (illustrated by the report of the "Victoria," quoted above) is of interest in this connection. If I have succeeded in this, and thereby given a clearer idea to the casual reader or suggested a fertile train of thought to any physicist, I shall feel more than repaid for the effort.

I have thus attempted little more than to touch upon the practical side of this great question, and this in a popular way, to induce my readers to follow me to the end. The many other interesting questions that might be raised and discussed must here be left untouched. Our efforts in the Hydrographic Office must be primarily to help the navigator, and only secondarily to try to collect and publish facts for the scientist to study at his leisure. The causes of these terrific storms are of interest to us as they may help us to predict their coming, rather than for the proof of any theory, or the gratification of any pet idea. And if Science will but improve the Law of Storms, as practical men use it for the guidance of their vessels and the safety of the lives and cargoes intrusted to their care, it will be one more welcome proof that theory and practice go hand in hand.

THE IRRIGATION PROBLEM IN MONTANA.

By H. M. Wilson.

The development of the irrigation resources of a region under the supervision of the Government, requires study of the social and political conditions and of the industrial occupations of its inhabitants.

The determination of the best plan for the utilization of its waters and agricultural lands is a problem in irrigation engineering. The solution of this problem calls for an intimate knowledge not only of the best methods of construction, but also of the values of its various agricultural products and soils; for a knowledge of its rainfall, evaporation, and steam volumes and of the duty of water. It further requires such an understanding of the topography of the region as will enable the engineer to determine the area of the catchment basin of each stream, and to intelligently select sites for the construction of canals and storage reservoirs and to determine from what source of water supply each district may be best irrigated.

Experience and practice in various parts of the world have already proven that irrigation enterprises, undertaken on a large scale by private capital have seldom been remunerative investments, in fact, have frequently been financial failures. This is due to many causes among which may be mentioned the fact that, though all the irrigable land may be finally settled and the works made to do their highest duty, taxes must be paid for many years and considerable sums expended annually for maintenance before the entire amount of available water is utilized, and interest is realized on the whole expenditure.

Most of the successful irrigation enterprises undertaken in the United States owe their prosperity to the ownership and sale of lands under their canals. In order to secure a proper remuneration to the capital which provides the water, and an efficient water service to the farmer who uses it with justice to both interests, State legislation must fully define the rights and responsibilities of appropriators, the units and methods of measuring the flow of streams, granting the right of way and appointing proper officers to see that the various laws are enforced.

That irrigation enterprises will have great and rapid development in Montana in the near future will be readily perceived from the facts shown later on in this article, while I am fully convinced that it is now entering on that period. The histories of both California and Colorado have shown that great mining activity have brought to them a large population who were enabled to gain a livelihood by mining pursuits, while the demand for farm products created by the miners, caused these people to turn their attention to agriculture, which is now rapidly surpassing in money value the output of the mines.

In California in the "fifties" mining was the supreme and only occupation, to-day agriculture is her mainstay; in the early "seventies" the same was true of Colorado, and now agriculture is rapidly becoming her most important industry. While Montana is to-day in the van in mining resources and output, the time for the supremacy of agriculture within her borders has received an increased impetus by her recent accession to Statehood.

In Montana the irrigation problem presents some features which are scarcely encountered in any other country.

Usually irrigation is practiced in semi-tropic and desert regions where though water is scarce, the climate is such that a great variety of agricultural products usually of the better paying varieties can be raised, in consequence of which enormous sums may be spent in irrigation works, thus imposing a heavy tax per acre on the land for their construction, and still, such is the productiveness of these regions, that the lands will yield fair profits.

In Montana the reverse is the case, water is generally abundant though sufficiently inaccessible in the larger streams to require extensive works in order to render it available, while the land though equally abundant also, will owing to the climate admit of the cultivation only of the less profitable crops, mainly hay, grain and potatoes, in consequence of which the cost of construction of the irrigation works becomes a question of vital moment, since a tax of a few cents per acre one way or the other will render the pursuit of agriculture a success or a failure, and decide the fate of the irrigation enterprises.

It is probable that $10.00 per acre for a water right in perpetuity, or $2.00 per acre per annum for the use of water is the maximum charge which the crops will bear.

Agricultural and Mineral Resources.

It will be advisable now to take a hasty glance at the State of Montana, and see what are her agricultural capabilities and what need exists for irrigation as a factor in their development.

According to the report of the State Auditor for 1888 there were in that year 143,700 horses and mules valued at $4,900,000 ; 488,500 cattle valued at $9,060,000 ; 1,153,000 sheep valued at $2,165,000 ; 3,741,000 acres of improved lands, valued inclusive of improvements at $12,300,000 ; 55,000 town lots valued with improvements at $14,940,000 ; and including all kinds of personal and real property a total assessment for the State of $67,500,000.

There were raised in the State during the same year 770,000 bushels of wheat on 26,000 acres, an average yield of about 30 bushels per acre ; 3,000,000 bushels of oats on 85,000 acres, an average yield of over 35 bushels per acre ; 843,000 bushels of potatoes on 3700 acres, or 230 bushels per acre ; and 6,000,000 lbs. of all other vegetables on 450 acres ; 235,000 tons of hay were cut, and 7,500 bushels of apples and other fruits were raised, while 4,500,000 lbs. of wool were sheared.

The gross receipt of the quartz mills were $20,300,000, the value of the product of the reduction furnaces was $15,900,000 in bullion, and the coal mines produced 500,000 bushels of coal.

The wool product for the present year, 1889, exceeded in amount that of any other State west of the Missouri River, and its quality was such that it brought a higher price per pound than that of any other western State, the price paid in California ranging from 15 to 17 cents per pound against 20 to 23 cents paid in Montana.

The accompanying table will show the relative value of the production of precious metals in the three leading States during 1887, from which it will be seen that Montana led Colorado by $4,200,000, and California by $15,580,000.

1887.	Montana.	Colorado.	California.
Silver	$15,500,000	$15,000,000	$1,500,000
Gold	5,230,000	4,000,000	13,000,000
Copper	8,970,000	400,000	180,000
Lead	630,000	6,730,000	70,000
Totals	$30,330,000	$26,130,000	$14,750,000

Since 1887 Montana has been rapidly gaining in its lead, especially in the production of copper, and it now leads not only in the total value of the precious metals produced, but also in the values of the silver and copper products separately, and is only surpassed by California in the production of gold.

While as shown above Montana produces large quantities of vegetables and grain, its heavy mining population and vast herds of live stock furnish a home market for all of its present product, in fact, during this year many hundreds of tons of hay and carloads of grain are being imported from the eastern States to feed the range stock during the coming winter.

Topography.

The topography of Montana is very different from what is generally supposed by those who are not familiar with it, and this erroneous impression is largely due to the fact that the country is very mountainous in the older inhabited and better known portion of the State, which lies in its southern corner near the Idaho and Wyoming lines ; this region was first inhabited by those pioneers of western civilization, the prospector and miner, and in consequence of this and of the wild grandeur of the Yellowstone National Park, the generally preconceived notions of the topography and resources of the State are of forests and streams teeming with game and fish, and rugged mountains occupied by a few isolated mining camps and cattle ranches.

On the contrary there are scattered over various parts of the State many large towns, two of which, Butte and Helena, have each about 20,000 inhabitants, while only one-fourth of the area of the State is over 5,000 feet in altitude, and at least two-thirds of it is below 4,000 feet.

The mountainous district of the State, which occupies but two-fifths of the total area, is in the southwestern portion ; these mountains are in fact but the last remnants of the great rockies breaking down from Wyoming and Idaho and terminating in the broad flat plains of the Saskatchewan River on the north, and of the Missouri River on the north and east.

It is in these great mountain ranges that the Clarke's Fork and Snake Rivers, two of the principal branches of the Columbia, after rising in the western and southern portions of the State join the Columbia on its way to the Pacific Ocean ; among these mountains in the northern portion of the State the Saskatchewan River rises and flows thence to the Arctic Ocean ; while the great Missouri and one of its principal branches, the Yellowstone River, rise in these mountains and after flowing northward nearly to the British line turn and flow eastward and join the Mississippi on its way to the Atlantic.

The highest mountains in Montana are in Park, Gallatiin, Madison and Beaver Head Counties, in which latter the furthermost branches of the Missouri, the Beaver Head and Big Hole Rivers, which form the Jefferson river, have their sources at the summit of the Rocky mountains, and it was here that those intrepid explorers, Lewis and Clarke, first crossed the Continental Divide in 1805 to the headwaters of one of the branches of the Snake river.

In these counties a few of the highest peaks reach an elevation of 11,000 feet, and from here the main range of the Rockies bears off to the north in a long, continuous and rugged ridge of sandstone and porphyry, with extensive beds of limestone north of the headwaters of the Dearborn River, and gradually falling off in elevation, until near the British line the highest peaks are less than 7,000 feet above the sea.

From this same axial point in the southwest corner a main spur or branch of the Rockies, called the Bitter Root Mountains, bears northwesterly and falling away in height, gives out with an elevation of 2,200 feet in northern Missoula County where the Clarke's Fork river leaves the State, cutting across the foot of this range.

East of Madison and Jefferson Counties, and along the southern border of the State, are numerous short mountain ranges, often 10,000 feet and sometimes 11,000 feet in elevation, which have generally a north and south trend and fall off near the middle of the State to a continuous, broad, and nearly level high prairie, or as it is locally called "bench land," which continues to fall slowly in the same direction.

Do not imagine that these great ranges of mountains are wild and uninhabited for such is not the case ; they are merely great mountain masses, and between, among and on top of them are other minor ranges of mountains, usually having symmetrical and regularly sloping sides, which are separated by broad, level and very fertile valleys, everywhere inhabited and cultivated by the aid of irrigation, while herds of cattle, horses and sheep graze on the hillsides.

Even among the roughest mountains a man may travel alone on horseback sure of finding shelter and food somewhere in the course of a day's journey, as was done by the author during the past summer, when he rode over 2,000 miles in various parts of the State. In the more rugged places mining camps may be met with when everything else fails.

At present these mountain valleys are the more thickly inhabited portions of the country, both because of the mines and because farming pursuits are more cheaply and conveniently followed owing to the greater abundance of small and easily controlled streams of water, which render irrigation possible even by the poorest settler. Only in the southern portions of Gallatin and Park Counties are the mountains so forbidding as to be uninhabited, and then in limited areas only.

One of the remarkable characteristics of the Montana mountains is their great regularity and smoothness of contour. It is probable that ice action during the glacial period may have planed off the irregularities, so characteristic of the elsewhere rugged outline of the Rocky Mountains. Between these symmetrical ranges of mountains lie the broad and fertile valleys before referred to. These are generally valleys of construction, and in some former geologic period were occupied by lakes whose beds have since been drained by the streams, as they cut their way out of the mountains.

It is the extensive deposits from the ancient lakes which give to these valleys their fertile soils, while the unusual mildness of their climate is largely due to the fact that they are seldom over 5,000 feet in altitude, and the high mountains surrounding them shelter them from the severe winds which, sweeping over the plains of Dakota, become the much dreaded "blizzards."

East of the Tongue River and north of the Yellowstone and Missouri Rivers, the level bench lands are everywhere below 3,500 feet in elevation, and often below 2,500 feet, and are very dry and devoid of water, though covered by an abundant growth of fine bunch grass. These bench lands are traversed by a few narrow, deep "couleés" or "washes" having bluff banks 50 to 300 feet high, dry during most of the year, though roaring torrents in the early spring months.

It is on these bench lands that irrigation will find its greatest field, for here is a comparatively mild climate owing to the low altitude, and here the soil is fertile, warm and deep.

Area and Kinds of Lands.

The total area of Montana is 146,080 square miles, or 93,491,200 acres. Of this vast empire 31,373,000 acres or about one-third of the whole is agricultural land, while of this 18,157,000 acres or a little less than one-fifth of the entire area is irrigable land, so classified not only because it will, if provided with water, raise profitable crops, but also because, in my opinion, water can with proper management be provided for it.

Of the total area of the State only about 1,200,000 acres or less than one-sixteenth of the irrigable area may be easily cultivated, by this I do not mean that this whole amount is now reclaimed, but that it may with the means liable to be employed by private parties with limited capital, be readily brought under cultivation by the same methods by which most of the lands in Montana are now irrigated.

The amount of land actually under cultivation, according to the assessment of 1888, was 348,070 acres, and this should probably be increased by about one-half, since the farmers doubtless greatly underestimated the amounts of their cultivated lands to the assessor: perhaps then, 500,000 acres under cultivation would be nearer the truth.

It is estimated that three-fourths of the remaining 75,000,000 acres not classed above as irrigable, or say 55,000,000 acres, which is nearly two-thirds of the total area of the State, will, with the increased facilities for watering live stock and for domestic use offered by the highest state of irrigation development, become valuable as grazing land, since it is naturally covered with an abundant growth of bunch grass, and only needs better facilities for watering and for the establishment of home farms, to cause it to be entirely occupied for grazing purposes.

Nearly, or quite all, of the lands above classified as agricultural and pasture lands, are now covered with an abundant growth of bunch grass, occasional patches of sage brush or prickly pear, and devoid of any timber other than patches of willows and cottonwoods along the streams, or a few isolated clumps of scrub pines and junipers on the highest lands.

About 10,000,000 of the remaining 20,000,000 acres are excellent timber lands and are situated on the slopes and sides of the higher mountains, though west of the Continental Divide the valleys and flat bench lands are sometimes covered with timber.

The remaining 10,000,000 acres may be classed as barren and rugged mountain peaks and some little barren "bad lands" near the southeastern corner of the State, and the broken and rough cut banks of rivers, "couleés," etc.

It is in these more rugged mountain regions that the great gold, silver and copper deposits are found.

Climate.

The climate of Montana is far more moderate and agreeable than is generally supposed, the spring and fall months in the valleys, which are the principal inhabited and cultivated portions, being delightfully mild and pleasant, with frost generally only at night, though these last till May and begin in early October.

The accompanying table shows the dates of the first and last killing frosts at Helena, also the mean monthly temperature at Helena, which place is chosen as a typical station, its altitude being 4,262 feet. From this table, which extends over a period of ten years, from 1880 to 1889, inclusive, with few interruptions, it appears that the earliest killing frost occurred on September 6th, 1881, and the latest killing frost on May 3d, 1888, but these were very exceptional frosts, the average dates for the same periods being September 26th and April 26th. The maximum temperature during the same period occurred in July, 1886, and was 103 degrees in the shade, while no other year showed a higher temperature than 97 degrees ; and the average maximum temperature for the ten years was 94 degrees. The minimum temperature for the same period was –40 degrees, occurring in February, 1887, while the average minimum for ten years was –29 degrees. Great ranges of temperature are sometimes experienced, however, especially in local areas in the higher mountain valleys, where unusual frosts and snow flurries have occurred, though rarely, killing potatoes and other tender crops even in July and August.

On September 5th of this year in the upper Madison Valley above 6500 feet of elevation, a temperature was experienced in the forenoon of 70 degrees, while at about 8 o'clock on the same evening, a snow squall occurred during which the thermometer must have fallen several degrees below the freezing point ; by 9 o'clock on the following morning all of the snow had disappeared and the temperature had greatly moderated.

The summer months in these mountain valleys are always agreeably warm during the day time, while the nights are cool and pleasant. In the winter the climate is very cold, though not so uncomfortable as the temperature would indicate, owing to the

Monthly Mean Temperatures at Helena, Mont.

	1880.		1881.		1882.		1883.		1884.		1885.		1886.		1887.		1888.		1889.	
	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.	Mean Temp.	Killing Frost.
January			9.8		20.0		18.5		11.6		21.0		10.1		20.6		5.3		16.7	
February			25.8		24.4		14.1		14.6		28.2		34.5		5.0		35.0		25.2	
March			39.4		31.1		34.2		29.1		40.6		29.1		40.3		23.2		39.1	
April			47.6		40.5		40.4		41.6		45.7		42.9		42.4	20th	48.8		49.2	
May			55.4		50.4		49.8		53.9		51.0		54.9		51.5		50.1		53.2	
June			61.4		60.7		61.8		62.9		56.8		61.1		57.6		58.8		63.4	
July	66.3		68.3		66.8		67.9		62.5		64.7		69.9		66.6		67.1		66.8	
August	63.7		66.1		71.4		67.2		66.8		64.1		68.1		63.0		65.3		67.2	
September	56.7		54.6	6th	60.1	29th	59.2	20th	49.7	6th	55.4		52.9	29th	56.0		61.2		55.2	
October	46.3	22d	37.9		41.7		38.9		47.0		47.5		43.3		42.9	8th	46.6		50.7	
November	19.3		28.8		30.9		33.0		36.4		39.1		29.4		33.9		24.2		31.4	
December	9.0		30.8		27.3		27.4		7.0		31.1		27.1		23.0		23.6		22.6	
Mean, Annual			43.8		43.8		42.7		40.3		43.6		43.8		41.9		42.1		45.0	

dryness of the atmosphere and the absence of very high winds in the mountain valleys. The more exposed plains to the north are subject to the frequent and agreeable visits of the famous "Chinook" winds, which blow from the west, and under whose influence heavy falls of snow disappear in a single day.

The following table shows the mean annual rain-fall at various Signal Service stations in Montana, and from these it will be seen that during a period of ten years the maximum rain-fall for the entire State has only been 20.33 inches in 1880, while the minimum has occurred during 1886 and was but 12.52 inches; the average precipitation for this period was 15.25 inches.

Mean Precipitation in Montana during Growing Season.

	Ft. Assinaboine.	Ft. Benton.	Ft. Buford, N. D.	Ft. Custer.	Ft. Keogh.	Helena.	Ft. Maginnis.	Ft. Missoula.	Poplar River.	Ft. Shaw.	Average.
Growing season of '80		7.33	12.82	9.77	8.87	2.63					8.28
" " " '81		7.05	5.81	3.90	5.67	7.15		3.70		5.78	5.58
" " " '82	4.47	1.29	5.01		3.64	1.96		2.78		4.23	3.00
" " " '83	2.63	4.25	3.94				2.27		1.65	4.17	3.16
" " " '84	17.22	5.69	3.46	6.31		8.09	2.90		5.80	4.30	6.72
" " " '85		9.57	10.33	6,07		6.29	5.98		7.14	6.49	7.41
" " " '86	2.52	2.94	2.65	5.13		1.91	3.56		2.67	2.87	3.03
" " " '87	12.13		8.00	2.96		5.88	9.47		8.67		7.85
" " " '88	7.10		10.16	8.22	7.28	4.37	10.54		8.16		7.98
" " " '89	5.03		3.48	2.90	2.27	2.00	7.47	1.74	2.23	1.91	3.23
	7.21	5.45	6.57	5.66	5.55	4.48	6.03	2.74	5.19	4.25	5.23

Growing season, May 15 to August 15.

Annual Rainfall in Montana, 1880–1888.

	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
Ft. Assinaboine			12.76	15.10	25.67		11.48	18.94	13.99
Ft. Benton	16.00	16.81	10.18	13.01	13.13	14.94			14.00
Ft. Buford, N. D.	23.25	13.90	12.73	10.82	7.37	15.56	10.24	15.43	14.70
Ft. Custer	19.65	11.88			16.60	9.34	13.25	12.18	14.00
Ft. Keogh	15.64	11.44	10.13						
Helena		19.94	10.32		19.18	10.99	12.63	14.05	10.14
Ft. Maginnis				13.29	9.00	13.96	15.44	26.00	25.70
Ft. Missoula		20.56	13.24						
Poplar River						10.25	11.93	7.41	15.51
Ft. Shaw			14.77	14.21	12.64	13.64	12.56		
Ft. Ellis	30.16	17.55	19.28	15.72	22.02	32.63			
Virginia City	17.29								
	20.30	16.01	12.93	13.69	15.73	15.41	12.79	15.67	15.45

Moreover, from the first table, showing the average monthly precipitation at the Helena station, it will be seen that but 4.48 inches fall during May 15th to August 15th, inclusive, which is the growing season when the crops require moisture.

The information regarding evaporation is as yet very meagre, but from four stations observed in different parts of the State during August, September and October, it appears that the total average evaporation for the three months was 18 inches, and from the best information obtainable it appears that the total annual evaporation is 36 inches, that is to say, the surface of the water in a lake or reservoir will be lowered by evaporation 3 feet in a year.

Why Montana is an Arid Country.

It has been stated by Major J. W. Powell, that in a general way the line between the humid and arid regions, or the amount of precipitation below which irrigation becomes necessary for the cultivation of crops, is from 24 to 28 inches per annum. This of course depends largely on the distribution of the rainfall, the proportion falling during the growing season, the humidity of the atmosphere, the character of the soil, etc.

The average annual precipitation in Montana is 14.92 inches, while the total average precipitation during the growing season is but 5.23 inches ; from these considerations alone it is evident that the State lies wholly in the arid region.

This statement is further born out by the fact that no native farmer will settle a ranch or undertake to raise any kind of crops without facilities for irrigating, since experience has taught them all, that, though there may occasionally be an exceptionally wet season in which they can raise good crops without artificial aid, still, the years when crops depending wholly upon rain-fall for their moisture would be entirely lost, are so frequent as to render farming without irrigation very hazardous and unprofitable.

Soil.

The soil along the stream bottoms at a slight elevation above their beds is usually a heavy, black, clayey loam, and though rich and fertile is soon clogged by water, and then in drying, cakes on the surface, killing the young plants. On this account the irrigators seldom water these bottom lands until after the crop has acquired a healthy growth, preferring to trust to the early rains to force the young sprouts above the surface, rather than run the risk of its crusting and thus preventing them from breaking through.

These bottom lands though really the poorest for irrigating, are nearly the only lands now cultivated, because of the greater ease and cheapness of supplying them with water. From two to three tons of hay and from 35 to 50 bushels of grain per acre are raised even on these inferior soils.

The best, and by far the more abundant agricultural lands, are the "bench lands," these are situated high above the stream beds and the soil is usually a warm open, rich, sandy-loam, several feet in depth and usually underlain by a deep bed of gravel. Though in irrigating, this soil at first requires more water, it will, owing to its excellent natural drainage, last for all time and will neither clog with water nor cake on the surface.

It is these bench lands which will be rendered irrigable by government aid and surveys, though to develop them will require large amounts of capital; still, they are so extensive in area that the work can generally be conducted on a grand and economical scale.

Duty of Water.

From the meagre information now obtainable it is probable that in average soils and for the staple hay, grain and vegetable crops in Montana, about one cubic foot of water per second, flowing during the irrigating season, will be sufficient for 100 acres; this quantity is known as the "duty of water."

The irrigating season lasts about three months. While the crops are maturing during part of May, June and July, they will receive two or three waterings, and in early September the hay lands are again watered in order to start the growth of grass before the frosts.

In case all the surplus water of a given stream is stored, the duty of that stream will be increased by the amount of water now flowing to waste during the remaining nine months, and as a portion of this time is the flood period, owing to the melting of the snows in the mountains and to the spring rains, this storage water will increase the duty of the stream at least five-fold; that is, five times as many acres may be irrigated by the stream as at present, provided that storage capacity can be found for all of its waste waters.

In considering the duty of a stream it must be remembered that there is a great loss of water by seepage through the sides of a canal and evaporation from its surface, between the headworks and the irrigated lands, this loss may amount to from 25 to 35 per cent., according to climate, soil, and the length and cross-section of the canal.

Present State of Irrigation—Progress and Laws.

The earlier stages of irrigation development are better illustrated in Montana than in any other State in the Union.

There irrigation practice and laws are exceedingly crude and remain so chiefly because of the abundance of water, and the ease and facility with which it can be diverted to the land ; as a consequence of this latter fact the laws were framed in the most liberal spirit, declaring right of eminent domain, acknowledging the right of priority in appropriating the waters, and further stating, that any person having a ditch leading to irrigable lands may use the waters of the territory for irrigation.

The latest law, framed in 1885, is a very slight improvement ; it requires persons appropriating water, to post the usual notice in a conspicuous place ; to file with the county recorder a notice of appropriation, with names and proper description of place, stream, etc., and that work must be commenced within forty days of the posting of the notice and be prosecuted with due diligence until completed.

Persons who have heretofore acquired title to the use of water, may within six months from the passage of this law file a statement of the above facts in the office of the recorder, but failure to do this shall not forfeit his rights.

Provision is made for the measurement of water, using that very uncertain and elastic unit, the miner's inch, and defining the same.

The difficulties arising under these laws will be appreciated, when I state that it is impossible to construct a rating flume that will measure the number of inches of water flowing in a large stream, by the method provided in the law.

Then, because previous appropriators are not compelled to record the amount of water appropriated, and those acquiring titles under the first law now invariably claim much more water than they need, in fact often appropriate and even record more water than there is flowing in the stream. This is owing to the fact that they were not at first compelled to construct their works, "with due diligence until completed," nor to make ditches of capacities capable of carrying the volumes claimed, and above all because there is no officer having the power to measure the quantities of water diverted or to see that the works are prosecuted with due diligence. Endless and unsatisfactory litigation results, hastened by the occupation of lands lower down on some stream which in a very dry season may not flow sufficient water for all the appropriators who have acquired titles, whereupon the later settlers who have recorded their appropriations claim the water, while those who diverted water before the passage of the last law claim the right to it, though unrecorded, and as a consequence the case is carried to the courts, often with unjust and always with expensive results.

During the past exceptionally dry season these conditions led to much bitter litigation, often to bloodshed, and equally often to financial ruin owing to the supply of water being insufficient to mature the crops planted.

Water being very abundant in the smaller mountain valleys has led to great wastefulness in its use, the irrigator after applying what water his crops needed, instead of turning it back into the stream for the use of settlers lower down, generally turns his ditch loose on the open prairie and allows the water to run to waste. Then wasteful methods of applying the water to the crops are employed, and owing to the cheap and hasty construction of a vast number of small ditches the loss by seepage is very great; it has been estimated that there is on an average a ditch for every 200 acres of land cultivated, making a total of about 2500 irrigating ditches in the State.

In the last two years there has been a marked increase in the interest taken in irrigation enterprises, and though this has resulted in the formation of several large companies, which intend to take water by long and expensive canals to sections now uncultivated, yet in these cases are universally seen the same crude methods employed in first beginnings, without the aid and advice of experienced engineers. Large canals are being constructed at great cost, capable of carrying many times the amount of water flowing in the stream appropriated, whereas a much smaller and less expensive one would have carried the entire water supply. Again small canals have been constructed to carry small volumes of water very long distances, often 50 to 80 miles, while in reality owing to the great percentage of loss by seepage and evaporation, little or none of the water entering at the headgates will ever reach the irrigable lands.

Such illy advised projects are to be even more deplored than the smaller operations before spoken of, since the certain ultimate failure of this class of enterprise will result in discouraging capitalists from investing in even well-planned irrigation projects, and will retard the construction of valuable and necessary works.

Possible Irrigation Enterprises.

During the past season the author made an extensive though hurried reconnoisance of Montana, in the progress of which he rode on horseback 2,200 miles and traveled 3,700 miles by rail, examining with some degree of detail all of the central counties and making a few hasty trips into Choteau, Dawson and Custer Counties. In the course of this reconnoisance the sites for sixty storage reservoirs, having a combined storage capacity of about 3,250,000 acre feet were carefully examined, and lines of ten great irrigating canals approximately decided on. It may be well to state here that an acre-foot of water is a very convenient unit of measure adopted by the U. S. Geological Survey in speaking of the contents of large reservoirs, and refers to a body of water one acre in superficial area and one foot in depth.

In every case these proposed reservoirs are so situated, that their storage water will be convenient to large bodies of irrigable land, which, without some such provision for water supply must forever remain uncultivated, but which with irrigation from these reservoirs will ultimately become thickly inhabited and very productive regions. The same statements apply to the canals projected, though of course detailed surveys may prove the impracticability of some of these works as financial investments.

Mention will be made of a few of the more important of these projects ; those which appear most likely to prove financial successes.

North of the Yellowstone and between it and the Musselshell and Missouri Rivers is an immense high bench land, traversed by a few long couleés, dry excepting in the times of melting snow or heavy spring storms, and then raging torrents for a period of a few days or hours. This bench land between the couleés is flat topped and has a regular and gentle slope to the eastward, falling about six feet per mile, a little more rapidly north of Big Timber, and decreasing in grade to the eastward. The general elevation of this bench above the Yellowstone River varies from 600 feet north of Stillwater, to 300 feet north of Miles City, and includes about 11,000,000 acres, of which at least 5,225,000 acres are of the best quality for agricultural purposes and readily accessible by the great canal. In all this vast area there is not even sufficient water for the few horses and cattle which range on it, and they are compelled to congregate near the occasional pools and springs scattered at long intervals over it.

From numerous examinations made hastily with aneroid and hand-level, it seems likely that a great canal can be taken from the Yellowstone, somewhere in the neighborhood of Livingston, or lower down the river, and led upon the summit of the bench with a diversion line not over 100 miles in length. Taken out at Livingston the canal would encounter no difficult construction, and would chiefly consist in earth excavation with very little rock work. It would require a few fills and flumes in crossing the larger side streams, such as the Little and Big Timber, Otter and Sweet Grass Creeks. It would reach the summit somewhere north of Merrill at an altitude of about 4,400 feet and thence could be conducted with an easy alignment eastward, with occasional falls to loose grade.

The water flowing in the Yellowstone River at Livingstone during the irrigating season this year averaged 2,300 cubic feet per second, which, with an allowance of thirty per cent. for loss by seepage and evaporation in the canal, would leave about 1,600 second feet at the point of utilization or sufficient to irrigate 160,000 acres.

The average normal discharge from Yellowstone Lake is 700 second feet, and a dam about 300 feet long and less than ten feet high, constructed below the outlet of the lake, would store the outflow from October to May, inclusive, eight months, a total including flood discharges of at least 600,000 acre feet, an amount which, allowing for loss by evaporation in the lake, and by seepage and evaporation in the canal, would irrigate 425,000 acres, in addition to the 160,000 acres previously mentioned. Besides this volume probably half as much more can be readily stored on the Lamar and Gardner Rivers, and the other branches of the Yellowstone which join it above Livingston, bringing the total area of reclaimed land to nearly 1,000,000 acres.

There are many similar and even better opportunities for irrigation development, such as the construction of a canal from the West Gallatin River near Bozeman. This canal would require no expensive diversion line, as its waters would become immediately available at the headworks, and by appropriating the 500 second feet of water flowing in the river, would reclaim at a minimum cost 50,000 acres, or twice the amount of land now cultivated there. Storage on the Upper Gallatin River would greatly increase the amount of reclaimed land.

Storage reservoirs can be easily constructed on the headwaters of the Beaver Head River, whereby at least 150,000 acres could be added to the 25,000 acres now under cultivation in the Beaver Head Valley near Dillon.

A canal requiring no diversion line can be taken out on the east side of the Missouri River near Toston, which will irrigate all of the good land in the Missouri Valley, at least 100,000 acres, This canal would require some fills and aqueducts in crossing the various side steams such as Deep and Duck Creeks, and Confederate Gulch.

Detailed surveys have been made during the past summer on the Sun River which indicate that storage will add some 250,000 acre feet to the amount of water in that stream now available for irrigation. There are at least 600,000 acres of good agricultural land between the Dearborn, Sun, and Teton Rivers, which must forever remain barren of cultivated products unless provided with water by means of storage on these streams, and the surveys above alluded to indicate that by this means 160,000 acres of this land can be reclaimed by the Sun River alone.

Mention might be made to many more similar projects, such as the construction of a simple canal from the Missouri River to irrigate Chestnut Valley, south of Great Falls, whereby 120,000 acres would be reclaimed ; or one from the Upper Madison River whereby 230,000 acres of the Madison Valley might receive water, but the foregoing will suffice to show the possibilities of irrigation development in Montana.

It would be doing the resources of a great and vast area of Montana injustice if reference were not made to the Milk River country, the great Indian reservation of 17,680,000 acres in the northern part of the State which has recently been open to settlement. This region has not been examined by the author, but from conversations with a number of its well-informed inhabitants it appear that the soil is very fertile, and that during average moist years excellent crops can be raised there without irrigation. This last statement, however, should not be too readily accepted. It is probable that some storage water may be retained in the hills along the British line, though its development will doubtless involve international questions.

A Glance at the Future.

This interesting subject cannot be passed by without a little castle building, and accordingly an attempt will be made to show what the future of Montana may owe to irrigation.

It has just been shown how and where 1,750,000 acres may be added to the area at present under cultivation ; many times this amount, however, can be reclaimed. Settled as closely as a large irrigated district would naturally be, these 1,750,000 acres will be increased by about 15 per cent. or 262,500 acres, the area which will be occupied by roads, buildings, and towns ; that is to say over 2,000,000 acres will be rendered capable of sustaining the highest degree of settlement, though in reality this amount will be much greater since a large portion of the land will not be directly irrigated, since it will indirectly receive sufficient moisture from the neighboring fields to render it serviceable for pasturage.

It has been claimed by various authorities that a homestead of forty acres is abundant for the support of a family, assuming this estimate to be correct, then 2,000,000 acres will support 50,000 families ; at five persons each this would give a farm population of 250,000. This number of farm workers would require a town and village population of one and one-half more, or our 2,000,000 acres would add in all 375,000 people to the State.

On the same basis the 18,000,000 acres which have been classified as irrigable land, (and this estimate is below that of the Montana Society of civil engineers and other authorities), would support 3,120,000 inhabitants.

Vol. II. No. 4.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

PUBLISHED BY THE

NATIONAL GEOGRAPHIC SOCIETY,

WASHINGTON, D. C.

Price, 50 cents.

CONTENTS.

Published, AUGUST, 1890.

PRESS OF TUTTLE, MOREHOUSE & TAYLOR, NEW HAVEN, CONN.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

Vol. II. 1890. No. 4.

KOREA AND THE KOREANS.

BY J. B. BERNADOU.

(Abstract of lecture, with the addition of some new material.)

THE Koreans are to be noted among nations for the possession of two very different vehicles for the expression of thought, which they put to nearly parallel uses for general needs of communication : a simple and very perfect alphabet, and a complex system of hieroglyphics. The alphabet they owe to the Buddhist priests, missionaries, who took the idea of letters from their sacred books, and developed the Korean symbols for the writing of tracts and prayers ; the hieroglyphics came from the mother country and civilizer, China.

The needs of a simpler mode of writing for the intelligent, non-literary classes of Japan, had led in that country to a similar development ; but there progress stopped at a syllabary, and the alphabetic stage was not reached.

Until within the past few years the development of accurate maps and charts of Korea has been retarded, partly from a lack of reliable information concerning Korean proper names, and partly from the absence of systematic surveys of the coast. Very recently, however, the difficulties of map making have been considerably lessened through the efforts of students of the Korean language, who have developed exact systems of transliteration, by the application of which the sounds of Korean proper names may be correctly expressed in our own letters. At the present day it would seem possible, therefore, to fix, by common consent, upon a general, systematic orthography for Korean proper names, to be used upon the charts prepared by all those nations employing Roman letters ; and this without serious danger of clashing with previously developed national systems, or having to undo much work done by others.

The system of transliteration developed by Mr. E. M. Satow, of the British Diplomatic Service, which has been put to practical use by that gentleman in his work entitled "List of Korean Geographical Names," would seem well adapted to meet future needs. It gives a simple series of equivalents for Korean sounds, and is remarkably free from diacritical marks. Mr. Satow's system has recently been employed by English and German authors, while efforts to extend its application would seem to have met thus far with no opposition.

The French system of transliteration, which antedates the one above referred to, was developed by the French Roman Catholic Missionaries in Korea, and has been employed by them in their admirable works the "Grammaire Coréenne" and the "Dictionnaire Coréen," by far the most important yet prepared upon the language, and the first given to the outer world. The missionaries aimed at reproducing native speech, and to this end faithfully copied symbols representing shades of sound that are not to be appreciated by the foreign ear, and which in fact are often neglected in conversation by the Koreans of the present day—for the Ön-mun, or native alphabet, has long since lost its purely phonetic character. The simplicity of the French system is marred, therefore, by the use of a multiplicity of letters, which, appearing in the form of aggregations of consonants or of vowels, are more apt to mislead than to guide.

Inasmuch as the proper names upon native maps, which are invariably written in the Chinese, may be correctly rendered into English, whereas attempts at the systematic transliteration of Chinese characters have generally failed, it may be well to allude to the points of difference in the two cases. The possibility of the transliteration of Korean depends upon the following : (1) that the Korean pronunciation of Chinese characters is independent of the pitch of the voice or *tone ;* (2) that the native alphabet is especially constructed with a view to the easy reproduction of the Korean pronunciation of the same ; (3) that the Korean pronunciation of these characters is quite uniform throughout the whole extent of the country ; (4) that the Korean equivalents may be readily transliterated into English. All that is necessary, therefore, in fixing a geographic name is to have it written correctly in Chinese and in the Ön-mun. From the latter the English equivalent may be readily obtained. The need of the Chinese form arises from the fact that but few of the natives spell correctly, while many of them write Chinese well ; so that it becomes necessary to refer both writings to some authority, by whom the native spelling may be verified.

Wide spread as is the use of the Chinese nomenclature, it is none the less evident that the system is an artificial one, and that its employment must end somewhere. In those parts of the country that are the least explored, and where educational facilities are wanting, in the mountain fastnesses of the north, and among the many islands of the Yellow Sea, important geographic names occur that possess no Chinese equivalents : native words capable of being written only in the Ön-mun and which derive their origin from local peculiarities. To ascertain these correctly the services of an educated Korean are required ; and it may be added here that no surveying party on the Korean coast should be without the services of a native guide, capable of speaking a few words of English. Such a man may be picked up at an open port. He would be useful in many ways : in preventing the destruction of signals from superstitious motives by the natives ; in ascertaining from fishermen the existence of dangers in the intricate coast waters ; in marking the position of towns and villages not to be seen from their sea approaches ; and in securing supplies of fresh provisions.

The preliminary study of the geography of an eastern country necessitates the comparative examination of data gathered from widely different sources : the early partial surveys of the coasts by mariners, and the rough maps made by the natives themselves. Inasmuch as large sections of the Korean coasts are as yet hardly examined, and since it is only within the last few years that foreigners have been allowed to penetrate into the interior, it follows that no accurate map of the land exists. In selecting bases for future developments it becomes necessary, therefore, to examine the various approximate representations, and to determine which of them is best adapted to aid the work in hand.

Many writers upon Korea seem prone to attribute the mapping of the country to the result of explorations and observations made by foreigners. I believe this assumption to be erroneous and think it can be readily proven that, although the Koreans may have known practically nothing of the outside world up to the time of the treaties, some twenty years ago, they had, nevertheless, long before this formed an excellent idea of the configuration of their own country. The first important work accomplished by outsiders was the survey of the common boundary of Korea and China by the Jesuits, acting under the orders of the Chinese Emperor Kang-hsi, in the year 1709. Severity of climate and roughness of country prevented the party from making more than a preliminary examination of the districts that they passed through, but a few fair determinations of latitude and approximations to longitude were obtained, and the general direction of the boundary determined. With the aid of these data, supplemented by information from native sources, a map was constructed, in which the Korean peninsula was connected with the general system of the world's coördinates and proper names were given in our own alphabetic characters. This map, which forms the basis of most of the representations of Korea in use at the present day, shows its origin in the transliteration of proper names in accordance with the Mandârin Chinese and not the Korean pronunciation of the Chinese characters employed to represent them.

The information from Korean sources which the missionaries must have utilized in completing their work was doubtless attained by them in the form of native maps. Of these there are several good ones in use at the present day, two of which would seem especially worthy of notice: (1) the large map of twenty sheets dividing the peninsula into sections by parallel lines drawn from east to west, and (2) a map giving the country in eight sheets, by provinces. The key to the latter, showing the entire kingdom, as well as one of the expanded sheets showing the Kyöngsang province in the southeast, and the Nakdong river, the most important stream of the land, are appended to this paper, and will serve to indicate the progress independently attained by the Koreans in the art of map making. These plates have been reproduced from a copy of an original now in the possession of Mgr. J. G. Blanc, the French Missionary Bishop of Korea, to whom it served as an accurate guide at the time of his perilous entry into the country, fifteen years ago, during a period of severe persecutions.

The preface of the Korean geographer, which is written in Chinese upon one of the sheets, is of interest, as it illustrates the object of the work, enumerates the classes of data utilized and alludes to difficulties contended with. I therefore quote it here.

"The geographies of my country are quite numerous, but all maps are influenced to a certain extent by the limit of the paper employed in their construction, and so distances are very incorrectly given. Thus ten or more ri (Korean unit of distance—about $\frac{2}{5}$-mile) are sometimes represented as two or three hundred ri ; while sometimes two or three hundred ri are represented as two or three. The bearings given are also incorrect. Such a map offers great disadvantages to people who attempt to learn about their country. Therefore I have taken all care in constructing this one, both as to direction and distances of places, as well as to the situations of mountains and rivers. For distances I have made a scale in which one hundred ri are taken as one ja (Korean foot), and ten ri as one poun (Korean inch, ten to the foot). I have laid off distances in all directions from the capital, so that the general shape and position of the eight provinces are correctly represented. The islands, however, are only placed in direction with reference to the provinces to which they belong, without regard to actual distances. Where mountain ranges and rivers are represented as boundaries, they are necessarily repeated upon the sheets of adjoining provinces. In the measurement of distances one ja represents one hundred ri in level places, and from one hundred and twenty to one hundred and thirty ri where the mountains are high."

The assumption that the unit of scale represents an increased distance in mountainous regions is a peculiarity of Chinese as well as of Korean maps. Travelers who employ either are obliged in estimating days' journeys to consider the character of the country ahead before applying the unit of measurement.

An examination of the various conventional features of Plate I and II will afford much information concerning the official subdivision of the country for governmental purposes, and will serve to indicate the facilities of communication that exist in a country where there are no railroads, and where almost every important route extends in a direction normal to that of the flow of the greater number of rivers. The eight provinces of the kingdom are exhibited upon Plate I as groups of towns, each group being displayed upon the original in a different color, all of which, as shades of various intensities, are fairly well reproduced upon the photo-lithographs. Each town is denoted by a circle of very exaggerated dimensions, large enough to allow its name to be written in Chinese characters in the enclosed area. The apparent multiplicity of characters upon the present map is due to the fact that all names are given in the native Ön-mun, as well as in the Chinese. The employment of the former is unusual and in the present case was resorted to at my own instance, in order to render the map more generally useful to foreigners. Each town is the seat of government of an officer who is subordinate to a provincial governor. The strength of any portion of Korea may therefore be reckoned in the native way as so many "cities," by the word "city," being understood both the seat of government and the adjacent lands over which the governor holds sway. The walled towns, which are quite uniform in type throughout the whole extent of the country, deserve especial mention. They are represented on the map as circles with serrated edges, and a glance at the provincial sheets will show that they are quite numerous, each province possessing from six to twenty of them. The number is greatest along the coast of the Yellow Sea and to the southward, facing Japan.

As secondary fortifications may be mentioned the San-söng, or mountain walls, as they are called, built at the least accessible points of the interior ranges, generally in proximity to some thickly settled district. The more ancient are relics of the feudal period, when Korea was governed by petty princes each with his castle upon a rock; the more modern, witnesses of the Japanese invasion of two hundred years ago, when they were either pillaged by the enemy or else held by the people as places of refuge. A number of the San-söng are marked upon the present map ; those of lesser importance are omitted.

Not the least curious among Korean institutions is the system of communication maintained at the present time. At the yok, or post stations, represented on the map by diminutive circles, are kept numbers of the small active native horses, well fed and in good condition, attended by staffs of native couriers who are ready to receive orders from the station-master and spring into saddle upon a moment's notice. The service is well patronized and the couriers frequently employed, partly at the instance of the government, who desire to promote the efficiency of the system, and partly owing to the general accumulation of private needs of various kinds. A letter or parcel is thus rapidly transmitted from relay to relay, moving onward by day and night—except in certain mountainous districts of the north, where the fear of the tiger prevents night travel. Supplies of fruit and game for the royal table are forwarded in this manner to the capital from the most distant parts of the kingdom.

The pong-wa, or signal-fire stations, are indicated upon the map by small squares placed at the summit of the mountains. They are especially numerous in the coast districts, where their sites are chosen with great care, in such manner that the fires that are lighted at each station at night-fall may be observed at some advanced point of the interior, whence a single fire may be again flashed on, to form a member of a more extended group. And so the lights proceed, re-collected and re-forwarded until the final combinations are gathered into a final group at the capital, to show that all is well throughout the kingdom.

The faint network of lines extending over the whole country, as shown in the map of the southeastern province, represents the chief public highways, upon the determination of whose length and relative bearing the development of the map is based. In general, roads in Korea are well maintained, and during the greater part of the year are in fair condition. It would be found impossible to take a wheeled vehicle of any kind over them, however ; for such use they are not intended, travel in Korea being performed afoot, or with the aid of horse or sedan. During the summer rains the streams rise rapidly ; the waters pour down from the mountains, each rivulet becomes a torrent and the bridges are swept away. When the floods subside the local authorities compel the peasants to turn out in force and make the necessary repairs ; delays of travel are thus reduced to a minimum.

Korea is preëminently a mountainous country. With the exception of the alluvial plains at the mouths of the rivers, low ranges of mountains with narrow intervening valleys are found everywhere, and are characteristic. The main chain, forming the back-bone of the peninsula, is not clearly defined, as it is formed principally by the overlappings and intersections of minor chains, so that it is quite irregular as to direction, but a glance at the sources of the rivers, considered with reference to the intervening line of water-sheds, shows that it springs from the mountains of Siberia at the north, follows for some distance the line of the eastern coast and then strikes inland, trending to the southward and westward until it reaches the shores of the Yellow Sea. The loftiest ranges, therefore, are in the northern and eastern provinces. At the centre of the northern boundary is Paik-du-san, the "white-headed mountain," in whose slopes rise the Yalu, Tuman, and Songari rivers, the two former defining the western and eastern sections of the frontier, the latter a tributary of the Amur, an important stream of southern Siberia. According to Messrs. James, Younghusband, and Fulford, of the British Indian and Consular services, who visited it in May, 1886, Paik-du-san is "a recently extinct volcano with a lovely pellucid lake filling the bottom of the crater, surmounted by a serrated edge of peaks rising about 650 feet above the surface of the water. The height of the loftiest of these was found to be about 7,525 feet above the level of the sea."

Besides the rivers of the frontier are others of the interior that deserve a passing mention. The mountainous nature of the country, as well as its proximity to the sea, implies the existence of numerous secondary water courses, but these as a rule are insignificant in size and so shallow as to permit of navigation only throughout limited portions of their extent. Among the larger streams that lie wholly within the country is the Taidong, flowing through Phyöng-an-do, the northwestern province, rising in the central ranges of the peninsula and flowing into the Yellow Sea. During the greater part of the year it is navigable as far as the city of Phyöngyang for native craft of the largest size. In midsummer its waters rise rapidly during a short rainy season ; then quickly subside, the river resuming its former limits. To this sudden shoaling may be attributed the loss of the schooner Sherman, captured by the Koreans in 1871, the vessel going aground without warning at a place where a few hours before abundant water had been found.

The Han, the river of the capital, lies about one hundred miles to the southward of the Taidong, and flows westwardly in a nearly parallel direction thereto, from the central ranges of the peninsula into the Yellow Sea. Its many branches join in a common estuary near the centre of the Yellow Sea coast, and their collective drainage area comprises a large portion of central Korea. Still farther to the southward is the Keum, traversing a fertile rice-growing country, while at the extreme south is the

Nakdong. The latter is one of the most important streams of Korea, and the facilities that it affords for communication and interchange have done much towards rendering the district through which it flows one of the most fertile and prosperous of the land.

The coasts of Korea are forbidding to the mariner and seem well adapted for the preservation of the seclusion that it has been so long the national policy to maintain. On the east, facing Japan, unbroken lines of steep hills, void of harbors, bend abruptly into the deep waters of the Japan Sea. To the westward countless outlying islands extend seaward many miles, liberally interspersed with rocks and shoals, between which eddy swift streams of tide-water. The terrors of the Maelstrom would find their counterpart in many a Korean whirlpool, which, forming in the vicinity of some submerged ledge, will cause a large vessel to heel suddenly well over, and will swing her many points off her course in a way to make the stoutest hearted captain tremble for the safety of his charge.

The climate of Korea exhibits wide ranges of temperatures and hygroscopic conditions. In the northeast province, Ham-kiung-do, the winter is as rigorous as that of Nova Scotia; at the extreme south, on the island of Quelpaert, it somewhat resembles that of Louisiana. The warmth of Quelpaert is due to the proximity of the Kura-siwo, or Black Stream of Japan, the Gulf Stream of the Pacific, part of which is here turned into a cul-de-sac, from which it escapes with difficulty. One result of this is the creation of a stormy region near the island, where the mariner may at all times look for a hard blow. A characteristic feature of Yellow Sea coasts are the Chang-ma, or mid-summer rains, which set in with fair regularity in July and during their month's duration resemble in phenomena and general effects the periodic rains of the tropics. The winters, in all but the southern parts of the country, are long and severe and set in with great suddenness. As an illustration of the rapidity of this change I remember that on one occasion I was ferried across the Han river near the capital at a time when the only indication of cold weather was a film of ice along the river banks, and that within forty-eight hours afterwards I rode back across the river ice on horseback, over the line of the former ferry.

Careful meteorologic records have now been kept at the open ports for more than five years; at Che-mul-po, on the Yellow

Sea (the seaport of the capital, Söul); at Fusan, to the south; and at Gensan, to the northeast. Stations are needed on the Yellow Sea coast farther to the northward, at the extreme northeast, at points in the interior, and especially on the island of Cheju, or Quelpaert, whose weather reports may some day prove as valuable to the Japanese as those from Bermuda would now be to the navigator of the western waters of the Atlantic. All the above mentioned places are easily accessible and doubtless soon will receive attention. In fact, to the navigator of these regions this island of Quelpaert is almost of the importance that Hatteras is to the navigator of our own coast.

As an important factor of Korea's future prosperity, and one that will enter largely into the determination of her future position among the nations of the east, may be mentioned her mineral resources. These yet remain in an almost undeveloped condition. The most easily accessible deposits and out-croppings, which are worked by the natives in primitive ways, afford evidence of an abundant and varied supply of the useful ores and minerals widely distributed throughout the whole extent of the land. Many localities, moreover, are well known to the people for their especial products. Thus the Phyöngyang province, in the northwest, facing China, possesses abundant deposits of coal, iron, and lime. Samples of this coal, which is but little used by the people, were collected several years ago from twelve different localities, and I remember that some of the Phyöngyang gatherings were tested on board the U. S. S. Alert, but were found to have suffered so greatly from exposure to the weather as to be comparatively valueless, even for experimental purposes. Limestone is common in this district, and in the town of Phyöngyang I have noticed the use of caustic lime in the streets as a disinfectant. The iron produced at Yöngpyön, fifty miles to the northward of this city, which is reduced in the native way with charcoal, is remarkable for its malleability and purity. Inasmuch as all these deposits are of very great extent and lie near the sea coast, and in proximity to waters easily navigable by larger craft, it may be assumed as probable that the time will soon arrive when the iron of Korea will largely supply the ship-yards and machine shops of northern China. Silver is found in at least four localities; copper is worked in paying quantities in two; galena is widely distributed; and zinc-blende has been found near the capital. Sulphur is said to occur in Kyŏng-sang-do; no ore of mercury is known to the Koreans, who import their supplies of the metal and its preparations from China.

At the time of the opening of Korea by treaty, 1870–80, an impression seems to have prevailed quite generally that the country was extremely rich in gold, that great quantities of the precious metals were soon to be exported, or that mines of great richness would be found and worked. The years that have elapsed since this date have partly served to prove the fallacy of these assumptions, yet the doubt is not yet fully removed. Gold is now known to occur in many places in moderate quantities: in alluvial deposits, from which it may be washed by simple mechanical process, and in quartz veins, from which it is extracted in small quantities by crude and laborious methods of rock-pulverizing and washing. A small constant demand for the metal has always existed, for jewelry and gilding—the latter quite a common decorative process, which up to the present seems to have required the use of pure gold even for the crudest applications. The mines remain for the greater part unworked, however, for three reasons: (1) the native dislike for altering the geomantic conditions of any locality by digging holes in the ground; (2) the laws forbidding the search for the metal, for gold mining in Korea is a government monopoly; (3) the inability of the peasants to find a market for the gold that they surreptitiously work. There has always existed a chance of disposing of it by crossing the border into China, and there has probably long been a small steady export in this way; and a port has been opened near the capital where reside Chinese and Japanese merchants who must find a way of converting the Korean copper cash into some medium of exchange easily negotiable abroad, and who for this purpose have been known to purchase gold from the Koreans at a considerable premium. I have examined a number of specimens of Korean gold which had been brought to Che-mul-po and had passed into the hands of foreign merchants there. In several cases I found small pieces of quartz clinging to flat laminated grains of the metal of considerable size.

In answer to inquiries that I made from time to time during a residence of more than a year in Korea I was told by the Koreans of a number of localities where gold was supposed to be abundant. I have endeavored to show these collectively upon a small map (Fig. III) giving the Korean names of the towns and districts with their English equivalents and the names of the provinces of the kingdom in which the places are situated. I was told repeatedly that the metal was most plentiful at Tan-chhön, in the Ham-kiung province. Concerning this locality our Korean geographer says, "at Ma-un, west of Tan-chhön, much gold is found. The mountains there are lofty and precipitous."

Fig III.

Sketch - Map of Korea

Localities where gold has been found are marked, ●

THE ORDNANCE SURVEY OF GREAT BRITAIN—ITS HISTORY AND OBJECT.

By Josiah Pierce, Jr.

I. The Institution of National Surveys.

The earliest surveys were not laid down as maps but consisted of catalogues of property which are called "terriers;" of these the Domesday Book is the earliest extant. Had the art of surveying been properly understood at the time of the Norman conquest there would probably have been a Saxon cadastre along with the Domesday Book, which was ordered by William the Conquerer in the year 1085.

"After this had the king a very large meeting, and a very deep consultation with his council about this land, how it was occupied, and by what sort of men. Then sent he his men all over England, into each shire, commissioning them to find out 'how many hundreds of hides were in the shire; what land the king himself had, and what stock upon the land, or what dues he ought to have by the year from the shire.' Also he commissioned them to record in writing, 'How much land his archbishops had, and his diocesan bishops, and his abbots, and his earls; and though I may be prolix and tedious, what and how much each man had, who was the occupier of land in England, either in money or in stock, and how much money it was worth.' So very narrowly indeed did he commission them to trace it out, that there was not a single hide nor a yard of land (the fourth part of an acre), nay, moreover, (it is shameful to tell, though he thought it no shame to do it) not even an ox, a cow, or a swine was there left, that was not set down in his writ, and all the recorded particulars were afterwards brought to him."—*Saxon Chronicle, by Ingram.*

The publication of the Domesday Book was ordered first by George III. in 1767, and completed in 1783. After the discovery of the art of photozincography it was reproduced "in facsimile" in 1864–5, under the direction of Lieut.-Gen'l. Sir Henry James, then director of the Ordnance Survey.

Little change (in the art of mensuration or surveying) seems to have been made until the early part of the 17th century when simple boundary line maps accompanied the terriers of the surveys made in Ireland in 1634, by order of Lord Stafford, then viceroy. Great improvements were introduced about that time in Sweden by Gustavus Adolphus, which must have become known to Cromwell, for in 1654, the "Down Survey," as it was called, comprised maps of the townlands, and baronies over two-thirds of the surface of Ireland, that is, comprehending about 20,000,000 of English acres.

It may not be uninteresting or irrelevant to bestow a few remarks upon the development and methods of surveying in the seventeenth century, many of which have descended with little modification to the present day.

When man first conceived the idea of owning real property the art of geometry or surveying became a necessity. Interest in other worlds than our own, and the measurement of time, led to the development of the science of astronomy, and of graduated instruments for measuring angles. Many of the most refined modern instruments are but slight modifications of original Arabian models, and the practice of linear surveying, or the subdivision of land into triangles, and geometrical figures, whose area could be computed, has been carried on without modification for centuries.

The greatest development took place after the introduction of artillery in the methods and instruments used for trigonometrical surveying or range-finding. Every principle which is to-day known and applied in the construction and use of modern trigonometrical surveying instruments can be traced in a modified form to the construction and application of the instruments of the sixteenth and seventeenth centuries.

In the practice of artillery, the first important question is the distance or range of the enemy. As in war it was clearly impossible to obtain the same by direct linear measurement, instruments were devised for measuring the range trigonometrically, all based on the calculation of a single triangle, the base and two angles of which could be measured. These instruments were simply modified to the extent of furnishing in the instrument itself a constant base or angle so that only one or at most two measurements were necessary.

The one instrument that has received the greatest development in the modern type is the quadrant, a simple graduated arc from whose center was suspended a plumb-line, or which carried a movable arm with raised sights for measuring horizontal or inclined angles. This arm has retained the name alhidada derived from the Arabic.

Such was the trigonometrical instrument used by the earliest navigators and astronomers for determining latitudes, and by surveyors and artillerists for finding ranges.

In the latter part of the 16th century Thomas Digges, surveyor and author, conceived the idea of combining two such graduated arcs in one instrument, the one placed horizontally and the other in a vertical plane, the whole supported on a rigid stand or tripod, and he called the same his *Theodolitus*, which is said by DeMorgan to have been the origin of the name of the modern instrument.

In the earliest books in the practice of artillery and of surveying, the crescent of the dreaded Moor appears in the woodcuts illustrating range finding or trigonometrical surveying generally floating over the tower of some captured castle or town, which it is desired to bombard. This clearly demonstrated that the chief use of trigonometrical instruments was for military purposes.

Among the instruments of surveying of this period which became practically obsolete in England in the present century, but which is most widely used elsewhere, is the plane-table, unquestionably one of the earliest instruments invented for measuring or recording angles.

At the period 1570, when the Germans claim that it was invented by Pretorius, a professor of the University of Nuremburg, it was unquestionably in use in England, and it is mentioned by Thomas Digges, in his *Pantometria*, published in 1590, as a platting instrument for such as are ignorant of arithmetical calculations. On the relative merits of the theodolite and plane table authorities still differ.

Throughout Europe great activity in the development of the practical applications of geometry soon followed the exchange of ideas brought about by the introduction of printing.

Side by side with the important geographical discoveries of the age came the minor improvements in scientific instruments which rendered national surveys and geodetic operations possible at a later period.

With trifling modifications the instruments devised by Durer, Newton, and Gallileo are in common use to-day.

Gradual improvements can be traced in the application of surveying to military and civil purposes, to mapping the campaigns of Louis XIV. and Marlborough, and laying down the forfeited estates in Ireland by William III., until in 1729 the first national survey on a large scale, for public and private purposes, was commenced in Savoy and Piedmont by Victor Amadie II., whereon nine years were occupied.

The method of large surveys obtained the name of Cadastre (Terrier map). It was suggested for France in 1763, but was only commenced in that country in 1793. The exact derivation and meaning of the French term "cadastre" are not free from dispute. Some authorities refer it to the verb "cadrer" to square or correspond with, all objects on a large scale, plan, or cadastre being shown in their true position and proportions, whereas in a mere topographical map similar accuracy is impossible, and certain features must need be exaggerated for the sake of distinctness.

The *Dictionaire des Dictionaires* on the other hand derives *cadastre* (formerly capdastre) from the mediæval-Latin word capitastrum (from caput "head," because formerly people were taxed, and afterwards property) and defines it as "a public register, containing the quantity and value of landed property, names of owners, etc., and which serves for the assessment of the tax on property in proportion to its revenue."

In the *Recueil des Lois et Instructions sur les contributions directes*, the *cadastre* is defined as "a plan from which the area of land may be computed, and from which its revenue may be valued."

This, there is no doubt, is the sense in which the word is used on the Continent, while in England it is taken as denoting generally a survey on a large scale.

It was not until long after the organization of the Ordnance Survey that it became a cadastral survey. Its organization at first was distinctly for military purposes, and the extension of its operations to cover all national needs only attained after years of discussion, and struggle for existence.

The credit of originating and carrying into execution the first tangible project for a systematic topographical survey of part of the kingdom is divided between two engineer officers, both at the time holding distinguished positions on the staff of the British army. The idea would seem to have followed close upon the sanguinary termination at Culloden of the "forty-five" rebellion, by which the fate of the house of Stuart was decided, in the reign of George the Second.

It was doubtless the outcome of that unhappy rising for it contemplated a general map of the Scottish highlands, precisely those parts of the country in which the heart and soul of the insurrectionary movement had all along centered. The difficulties of moving troops through these wild mountain districts, and without any clear knowledge of the passes connecting the glens and fastnesses, or of the correct distances intervening, would have been enormously lessened by the possession of good maps.

The survey of this wild and inaccessible region was undertaken in 1747 by Lieutenant-General Watson, an engineer, ably assisted by William Roy, who afterwards played a distinguished part in the earlier geodetic work of the Ordnance Survey.

The map, at first intended to be confined to the Highlands only, was at last extended to the Lowlands and thus made general in what related to the mainland of Scotland, the islands (except some lesser ones near the coast), not having been surveyed.

It is spoken of by Lieutenant-Colonel White, in his excellent book on the Ordnance Survey, as a "piece of work which appears to have been excellently carried out as far as it went, qualified by the remark of Roy that owing to the comparative inferiority of the instruments used and the inadequacy of the annual grants provided for the survey it is rather to be considered as a magnificent military sketch than a very accurate map of the country."

The survey of Scotland was interrupted by the breaking out in 1755 of another of England's intermittent wars with France, that which gained her Canada, and the work was never completed.

"On the conclusion of the peace of 1763," writes General Roy, "it came for the first time under the consideration of government to make a general survey of the whole island at the public cost." But, for reasons not assigned, the twelve years' interval of peace before the outbreak in 1775 of the American War of Independence was allowed to pass away without anything being done.

There the matter remained in abeyance until, after renewed hostilities with France and Spain, peace was negotiated in 1783.

The trigonometrical survey of Great Britain may be said to have been begun one hundred and six years ago.

Astronomers of that day were desirous that the difference of longitude between the Greenwich and Paris observatories should be ascertained by trigonometrical measurement; and under the auspices of the king and of the Royal Society, General Roy, R. E., in April, 1784, began the task by the measurement of a base line on Hounslow Heath which was to serve us the starting point of a series of triangles to be extended to Dover and across the channel.

This work was carried out, a connection with the French triangulation being established in 1786.

Soon after this the government decided on having a general survey made of the entire kingdom, on the scale of one inch to one mile for military purposes, and General Roy's triangulation in the southeastern counties became the basis of the Great Triangulation, which was gradually extended over the whole of the British Isles and finished in 1853.

The one-inch survey was carried northward through England and Wales under the successive superintendence of artillery and engineer officers, and by 1824 had reached the southern borders of Yorkshire and Lincolnshire.

At this time it became necessary that a survey of Ireland should be made on a large scale as a basis for general land valuation. On the recommendation of Colonel Colby, then director, the scale of six inches to one mile was agreed upon; the work in England was suspended and the force transferred to Ireland.

It appears from a report of Colonel Colby, in 1840, that the purposes for which the English and Irish surveys were designed were gradually developed and not all originally known.

The principal triangulation, on which the survey of South Britain had been based, was partly designed for astronomical purposes, and partly for a map on small scale.

The detail plans were commenced by officers of the Royal Engineers, partly for the purpose of practicing them in military drawing, and partly for the purpose of making plans for the use of the Ordnance.

The publication of some parts of this map on the scale of one inch to one mile created a desire among the public to possess better maps than had formerly existed.

This led to the employment of civilian surveyors to advance the progress of the map, and it was found necessary at great additional expense, to revise and correct these contract plans.

The work did not possess the accuracy demanded by the admiralty in forming the basis of their coast surveys for the Geological Survey or the civil engineers. As a military map its publication during war was suspended, and its continuance became a matter of doubt in time of peace.

At one time the gentlemen of Lincolnshire and Rutlandshire proposed to the government to proceed with the map of their district out of its regular turn, upon condition of their becoming subscribers for a certain number of copies. These gentlemen partly wished for the map for their use in hunting, and partly for the improvement of the country in marking out the drainage of the fens.

Prejudices existed, which could be traced back to the Norman conquest and Domesday Survey—against the right of a surveyor to enter a private estate, and in the early contract plans for the English maps the surveyors neglected the survey of the lesser streams, to obviate the inconvenience of trespassing and to save themselves trouble.

These were some of the causes of delay, expense and insufficiency which had operated against the earlier surveys.

The survey of Ireland began in 1825 under far more favorable circumstances than the Ordnance map of England and Wales. The triangulation commenced from a more accurate baseline than any preceding triangulation, and was designed to serve as a basis for any future survey in any scale, however large.

The House of Commons passed an act defining its principal object, prescribing a legal mode for ascertaining the boundaries which were to be surveyed, granting the surveyors power to enter lands for the purposes of the survey, and preventing the removal of the objects used.

The earlier methods of military surveying were abandoned, and new instruments and a system were devised for its execution.

It is important to note that the organization of the Irish survey marked an important epoch in the history of the Ordnance Survey, viz: its change from a topographic to a cadastral survey.

In Ireland, subordinate to the parishes, there is an internal division of smaller denomination called townlands, which are very frequently, but not uniformly, conterminous with property.

The townland was the lowest unit of taxation for country purposes, of an average size of 200 or 300 acres, and originally the map was to be simply a topographic map, containing the boundaries of the townlands, the roads, the streams and the houses, with a view to the valuation of Ireland for the county assessment. The six inch was considered to be the smallest scale that could be available for that purpose.

There was no intention in the original Irish survey to insert the fields, but when the valuation began, it was found by the valuators that additional minuteness was necessary to enable them to subdivide the townlands into the qualities of lands of which they consisted, and more especially that the boundary between the cultivated and uncultivated portions ought to be inserted on the maps with great accuracy.

This rendered necessary a very extensive revision which was undertaken in 1830, and it became a survey by fields instead of townlands.

This was clearly a wide and most important departure from the original intention of the six inch survey in Ireland, and it is not to be doubted that General Colby, who would not trust to paper measurements for the areas of entire townlands, would have adopted at the very outset, for his manuscript plans of these minute subdivisions, a scale much larger than that of six inches to one mile.

The engraving of the six inch survey appears to have resulted from a demand for six copies of one sheet for valuation purposes when it was found that it would be as cheap to engrave it as to make that number of copies.

So valuable did the six inch map of Ireland prove for many purposes over and above that for which it had been originally designed, that, in 1840, when the Irish survey was completed, and that of England resumed, the Government gave their consent to the adoption of the same scale for the unsurveyed parts of Great Britain.

By 1851, Yorkshire, Lancashire, the Isle of Lewis, and several counties in the south of Scotland were finished on the six inch scale.

Then began that long controversy which has been well termed the "battle of the scales" and which for eleven or twelve years retarded the progress of the survey and led to a large waste of public money.

During the time that the Ordnance Surveyors were engaged in making their six inch map of Lancashire and Yorkshire they were called upon and employed to make, at the expense of the land owners, twenty-three plans of parishes and townships on the scale of twenty-six and $\frac{2}{3}$ inches to one mile for tithe commutation.

It was even found that the plan of London, made for the Metropolitan Commissioners of Sewers, on the scale of sixty inches or five feet to one mile was inapplicable to house drainage within the area.

Between 1851 and 1852 no fewer than three select committees and one royal commission deliberated on the scale for the survey, and fourteen blue books were presented to Parliament.

The main point of the controversy was whether the six inch or some larger scale was best fitted for the national map. A host of persons eminent in science were consulted on the subject, and a great diversity of opinion was found to exist, the weight of evidence, however, inclining by a majority of four to one, to a scale of from 20 to $26\frac{2}{3}$ inches to a mile.

In 1853 a statistical conference held at Brussels and attended by twenty-six delegates from the chief States of Europe considered the question of national maps or cadastres, and pronounced unanimously in favor of a scale of $\frac{1}{2500}$th of nature equivalent to about $25\frac{1}{3}$ inches to a mile, recommending at the same time that the cadastre on this scale should be accompanied by a more general map on the scale of $\frac{1}{10,000}$ equivalent to about six $\frac{1}{3}$ inches to a mile, and thus very nearly corresponding to the six inch scale of the Ordnance Survey.

The scale finally adopted of $\frac{1}{2500}$, on which the whole of England has at last been surveyed, is one which corresponds with that adopted for the national maps and plans of the chief countries for Europe. Lastly it possessed the incidental advantage that a square acre is to all practical intents represented on the plans by a square inch.

Among the many public purposes which the national map was expected to subserve are the following: the valuation of property for the equitable adjustment of taxation and assessment; the sale and transfer of land and the registration of title; railway and other civil engineering work, such as the construction of roads aad canals, large sanitary and drainage schemes, military engineering works, hydrographical, geological and mineral surveys; the reclamation and improvement of waste lands, and of land from the sea; transactions affecting land as between landlord and tenant; statistical surveys, the setting out and adjustment of parochial and other public boundaries and so forth.

It has been amply proved on the best evidence that a map, with levels, on a scale of something like twenty-five inches to one mile is the smallest which can properly fulfill all these requirements.

In the organization and equipment of the Ordnance Survey, as it exists to-day, no pains are spared to secure the utmost precision and economy in its methods of field work and publication.

After more than a century of development and the completion of the cadastral map, let it not be supposed that its mission is at an end, for it is proposed to make a complete revision of all the cadastral work at least once every twenty years.

This is rendered necessary by the constant changes in property boundaries, and the growth of population—which may be gathered from the fact that the city of London increases in population at the rate of about 50,000 a year, and that eighty or more miles of new streets are added in the same time.

II.

The Ordnance Survey of Great Britain as it exists to-day is a remarkable Publishing Bureau, from whose presses are given the most elaborate and accurate series of maps which any country possesses.

Maps not alone confined to the representation of the physical features of the country, but containing every detail of interest or value for civil or military purposes.

It has justly gained the commendation of the French that it is "a work without precedent, and should be taken as a model by all civilized nations."

The principal scales of publication adopted by the Ordnance Survey are: (1) A general map on the scale of one mile to one inch. (2) County plans on the scale of six inches to one mile. (3) Cadastral or Parish plans for the whole country on the scale of $\frac{1}{2500}$ or about $25\frac{1}{3}$ inches to one mile, on which one square inch on the plan represents an area of one acre. (4) For towns of over 4000 inhabitants a scale of $\frac{1}{500}$ of actual length on the ground or $10\frac{56}{100}$ feet to one mile.

On the latter scale the city of London with its environs could not be well shown on a sheet of paper less than 300 feet long by 200 wide.

When the facts are taken into consideration, that the Ordnance Survey is a cadastral one, in other words, that one of its many objects is the measurement and definition of all existing boundaries, political, municipal, parochial or private, and a survey and valuation of property for assessments, that its maps are accepted in courts of law as authoritative on such questions, then the problem of the scales of publication is the most important one to be considered.

As an illustration of the relation of the scale of a map to the amount of detail, which can well be represented on it without confusion, assume for a moment that an observer is stationed in a balloon, which can be raised or lowered or placed at any desired height above the ground, and in addition that he is provided with a horizontal screen on which he is able to trace the details of the landscape below. The eye of the observer well represents the lens of a camera, and the screen the focussing plate. Therefore to produce a perfect image or map of the ground below it will be necessary to assume that all parts are stationary, balloon, plate and eye. For convenience assume that the eye remains over the centre of the screen at a distance of two feet. At a height of four miles above the ground the scale of the image on the screen would be exactly six inches to one mile, or a reproduction of the popular county map, on which every detail of importance such as houses, roads, paths, and fences is shown, and the smallest scale on which any attempt is made to preserve the relative proportions of such details.

On such a scale the 1/100th part of an inch represents a distance of very nearly nine feet on the ground and consequently however accurate the map might be in its projection, as an image showing the relative positions of all objects of importance on the ground, the scale is clearly too small for the measurement of areas for valuation purposes, and it is but a reproduction of the larger cadastral map.

Again assume that the balloon is stationed at a height of twenty-four miles above the ground, and that the observer places his eye at the same distance of two feet above the screen and attempts to construct a map from the image on the screen, which is now reproduced at a scale of one mile to one inch, or the exact scale of the general map. It needs but little imagination to foretell that houses would be mere specks, roads, faint lines, and forests, masses of color, in other words, that it would be more instructive to consult the general map, on which all details are magnified to be clearly visible and topographic features brought out with great distinctness than to attempt to trace with unaided eye, from the image of objects at a distance of twenty-four miles, the course of streams or roads through forest or moor, or to judge of the relative elevations or modeling of the ground from the values of light and shade. Without an intimate local knowledge of the county there would be nothing to indicate the name or boundaries of villages, or estates or the political and other subdivisions of the land, which are most clearly indicated on the map, in unmistakable styles of lettering.

Another and more serious problem which would be lessened as the balloon receded from the earth would be the distortion in perspective produced by the irregularities of the surface. The higher points being nearer the balloon would appear in the image on larger scale than the lower, and only in the case of a perfectly level country, would it be possible to produce a map without distortion by the method proposed, and then only for a limited area. As the balloon receded, the relative differences of elevation would bear a smaller and smaller proportion or ratio to the distance, in other words, the distortion would grow less until at an infinite distance it might be neglected.

We might conceive that the observer was stationed at an infinitely great distance, and provided with a series of magnifying lenses of suitable powers to produce maps of any desired scale, yet, beyond a limited area, he would still be confronted with the problem of eliminating the distortion produced by the curvature of the earth.

Such is the conception of an accurate map which is an attempt to produce on a plain surface or sheet of paper, a horizontal projection of objects on the ground, which will show the relative positions of every detail on any desired scale with as little distortion as possible, and on which distances may be measured in any direction, and areas computed with a degree of accuracy only limited by the scale.

When a survey of a small area is made, such as an estate or parish, which bears but a small proportion in area to the surface of the earth, curvature is neglected, distortion due to this cause being imperceptible, but in the survey of a large country it is of primary importance.

Returning to the conception of an observer stationed at an infinite distance his position with refer nce to the new general one-inch map of England and Wales would be in the plane of a meridian passing through Delamere in Cheshire, and the published quarter sheets would be a series of rectangles each 18 miles by 12 miles, containing an area of 216 square miles whose edges were parallel to, and at right angles to the central meridian.

Those of Scotland and Ireland have for each country a central meridian and projection.

In viewing the county maps of six inches to one mile and larger scales, it would be necessary to assume that the observer was stationed over the center of each county except that, where two or three counties lie so well north and south of one another, the same meridian serves for more than one.

In the reproduction by photography of the maps on the scale of one mile to one inch from those of larger scale, these facts, that different planes of projection are used for the latter, have to be taken into consideration.

In countries of larger areas than England it is more customary to assume a central meridian for each sheet, in other words, the observer would be stationed in the zenith of the center of each sheet and would sketch but a limited area. The successive planes of projection, represented by the maps, would resemble the facets of a diamond, and it would be impossible to combine with any degree of precision a large number together in one plane surface. On the other hand, the whole of the one-inch series of England and Wales of Scotland or Ireland register perfectly, and the distortion due to curvature cannot be great, as the combined area of the three countries bears but a small ratio to the whole surface of the globe.

Attention has been called to the fact that viewed from a balloon in ordinary sunlight the minor features of topography become flattened and indistinct.

If, therefore, we regard a sheet of the one-inch map held at a distance of two feet from the eye as the picture of a country seen at the distance of twenty-four miles, we see that details, that would be invisible from above, are brought out with great distinctness on the map and every detail of topography is shown in bold relief. In other words the map is a diagram rather than a picture.

In the representation of relief on the one inch series, two systems are common, contours and hachures. Contours represent the successive shore lines which water at rest would form in following the modelling of the ground at successive stages or elevations. If now we assume that the water, having reached the highest point, is allowed to retreat steadily to sea level the paths which the particles of water would take from all points of the surface are those which the engraver would endeavor to reproduce in the shade lines of a hachured map. In addition he would adopt an arbitrary scale of shade increasing with the steepness of the slopes, from white on a horizontal surface to dead black on slopes of forty-five degrees, or greater, to produce the effect of a model of the surface illuminated from above.

In the Irish maps this effect is bolder and more artistic, an illumination from the northeast quarter having been carried out. The shade lines still preserve the paths of particles of water in motion on the surface, the color values being deeper on the eastern and southern slopes, shadows have even been projected across valleys and horizontal surfaces are in half tone, producing much the same effect as the illumination of the country at sunset in midsummer.

The Irish maps exhibited are considered the finest specimens of careful hill shading and will bear critical examination. For comparison with these, other topographic maps are exhibited of many scales and countries.

So far attention has simply been drawn to a few of the problems of map-making, which are, briefly :

1st. The reproduction on a finite scale on a plain surface, of the natural features of the terrain, with all the artificial boundaries and objects added by man, so far as the scale permits.

2d. The extension of such a series of maps to cover a large area of country still carried out with as little distortion as possible.

3d. The reproduction of such maps on suitable scales to meet all demands.

If the conception is still carried out that the map, at a distance of two feet, is but the image of the ground viewed from above, then the cadastral map of England, from which areas of fields and estates are measured for valuation purposes, would represent a view of the country from above at a range of 5,000 feet or nearly one mile, and a town plan, an image at 1,000 feet or a possible view from a series of Eiffel towers.

This suggestion of an observer stationed in a balloon will not have been valueless if it draws attention to the fact that vastly more information is given on the map than it would be possible for any single observer to discover from an elevated station with an unobstructed view, the map being the compilation of the results of hundreds of observations by many workers, and that its scale and the amount and character of the detail shown have been specially designed to meet definite ends.

It is beyond the limits of the paper to enter into the theory or practice of surveying, or to say more than a few words of the delicate and refined operations necessary in carrying out the geodetic or trigonometrical work of a national survey which binds together the many parts to make a complete whole.

The principal triangulation of the British Isles was begun in 1784 and finished in 1852. Two magnificent 3-feet theodolites made by Ramsden, one for the Royal Society, the other for the Master General of the Ordnance, an 18-inch theodolite also by Ramsden, and 2-feet theodolite by Troughton and Simms were used in these observations.

In the principal triangulation of Great Britain and Ireland there are 218 stations, at 16 of which there are no observations, the number of observed bearings is 1554—and the number of equations of condition, 920.

In order to avoid the solution of this enormous number of equations, containing 920 unknown quantities, the network covering the kingdom was divided into a number of blocks, each presenting a not unmanageable number of equations of condition. These calculations, all in duplicate, were completed in two years and a half, an average of eight computers being employed. Many of the sides of the principal or primary triangulation are of great length, 66 of them exceeding 80 miles, while 11 measure more than 100 miles, the longest being 111 miles, that from Sea Fell to Sheir Donard. So great, however, had been the accuracy of the observers' work, that the average amount of correction of the observed angles was no more than $0''.6$, and the measured length of the Salisbury base differed from its length as computed from the Irish Base, 350 miles distant, by a difference of only five inches.

The secondary triangulation interpolates points at shorter distances apart ranging down to five miles, the observations being made with theodolites of 12-inch circle. These triangles again are broken up into smaller ones of sides from one to two miles in length, for the use of the surveyor who is to follow and measure between the stations with the chain ; and a further subdivision of the trigonal spaces is made in towns to points about 10 chains apart, where the survey is to be made on the very large special scale. In the two last cases, 7 inch instruments suffice for the measurement of the angles.

Levelling.

From 1839 to 1855, lines of initial levelling extending all over England, Scotland and Ireland were run, and the observed altitudes of the bench marks were reduced by the method of least squares.

In England and Scotland, these levels are based on the Ordnance Datum at Liverpool, which is approximately the mean tide level of that place ; in Ireland, they are based on the low water level at Dublin, which is about 8 feet below the mean level round the coast of Ireland.

The detail levelling is carried out contemporaneously with the progress of the cadastral survey. Starting from the marks on the initial series, lines are run along nearly all the turnpikes and parish roads, and bench marks cut at intervals of about a quarter of a mile.

The whole of the bench marks of the initial levelling are shown in position on the 25-inch manuscript plans, and their heights given to the nearest tenth of a foot. Surface heights, to the nearest foot are also marked on the plans, at frequent intervals between the bench marks.

Contouring.

Contrary to the custom in other countries, the contours of the English survey have all been surveyed and levelled on the ground, checked by the numerous bench marks, the standard of accuracy demanded in levelling being two-tenths of a foot.

Owing to the expense of the process, about $1.25 per lineal mile, only the 100 foot contours have been surveyed, except where greater detail is required for military purposes; which information is not furnished to the public.

Hill Shading.

The hill features for the one inch maps are first sketched in the field by the military method of slopes and sketch contours or proof impressions of the contoured sheet.

Finished drawings from the field sketches are then made on cardboard impressions from the one inch outline plates, and finished as guides for the engraver to work by.

Beautiful and delicate in finish as is all the work of the copper-plate engravers on the Ordnance Survey, there is perhaps no branch in which they so peculiarly excel as in their delineation of hills on the one inch maps.

III.

It is impossible in the limits of a single paper to attempt to describe the methods and processes of publication which are carried at the headquarters of the Ordnance Survey at Southampton.

Carefully prepared treatises on the subject have been written by officers engaged in the work, and for clear and concise description none are better than the series of articles by Captain H. Sankey, R. E., published in *Engineering*, in 1888.

There are two points of great interest in connection with the Ordnance Survey which cannot be neglected. The one its military organization, and the other the economy of its methods of publication.

Of its military organization, which has continued since the first surveys were made for military purposes, it may be said that the conservative precision of its methods of field work are best adapted for military control and discipline. Under the successive superintendence of highly educated officers of the Royal Engineer Corps, whose patriotic efforts have been to secure efficiency and economy in the service, the country has greatly profited.

Many of the improvements and inventions that have made possible the publication of maps of all scales at the lowest possible cost, are the results of experiments made by these officers.

It should not be forgotten in addition that as a branch of the War Office and the Publishing Department of the Intelligence Branch, military supervision is essential. Its offices are therefore not open for public inspection except on proper introduction.

The author had the rare privilege of spending three months at the Southampton office in 1888, through the introduction of the director of the Geological Survey, and the request of our recent minister in London, Mr. Phelps.

Nothing could have exceeded the courtesy and hospitality of the director of the survey, Sir Charles W. Wilson, and the officers in charge of the various departments, not alone in granting the necessary authority to inspect every branch of the work, but in lending personal aid and men for that purpose.

Great interest was also expressed in the topographic surveys of this country which differ so essentially from the Ordnance Survey. In the former, field work and methods are directly adapted to the scale of publication ; in the latter, the largest scale of publication governs the operations of the survey, and the smaller scales are reduced by photography, with a gradual elimination of unnecessary details from the larger to the smaller scales until finally the topographic map of the country, on the scale of one mile to one inch is produced, which possesses an accuracy and character that could be obtained by no other method.

To illustrate this important subject there are exhibited a series of experimental and complete maps and diagrams which will well repay careful examination. They were prepared and collected at the Ordnance Survey at Southampton expressly for this purpose and with the kind permission of the present director, Colonel Sir Charles W. Wilson, R. E., C. B.

The author desires to state that many of the paragraphs of the paper, particularly those relating to the history of the Ordnance Survey, have been extracted from the following works and reports on the subject :

1. The Ordnance Survey of the United Kingdom, by Lieut.-Col. P. Pinkerton White, R.E.

2. The Ordnance Survey of the Kingdom, by Capt. H. S. Palmer, R.E.

3. Methods and processes adopted for the production of the maps of the Ordnance Survey, by Lieut.-Genl. Sir Henry James, R.E., F.R.S.

4. Reports of Col. Colby and others in the Blue Books presented to Parliament—1850–1860.

GEOGRAPHIC NOMENCLATURE.

REMARKS BY HERBERT G. OGDEN, GUSTAVE HERRLE, MARCUS BAKER, AND A. H. THOMPSON.

MR. OGDEN: It was expected that Professor Mendenhall would be with us this evening to address the society on the subject of Geographic Nomenclature but he is unavoidably absent, having been called to Philadelphia, and has requested me to represent him, and present to you an apology for his absence.

Professor Mendenhall has been greatly interested in this question since he assumed charge of the Coast and Geodetic Survey. Questions of orthography and nomenclature have been before him almost constantly, and the variety of views elicited in response to his inquiries confirmed him in the opinion that the subject is of serious import. He has had, of necessity, to decide a great many cases for publications which were being made: finally a long list relating to Alaska came from the Hydrographic office, which led to a discussion and the suggestion that a board should be formed consisting of representatives from the different departments and bureaus in Washington that were interested in this matter, and that were issuing maps, charts and other publications requiring geographic names. It is too true that the different bureaus are now using the same names spelled in different ways, sometimes different names for the same place, and the same name for different places; indeed, the confusion is so great you may even read publications relating to the same locality and at first not realize the fact.

The object that Professor Mendenhall had in view in organizing a board was to secure harmony; that all might come together; and that when a question arose between different bureaus it might be referred to this board to settle, with the concurrence of all. Such a board would also secure stability, as no bureau would undertake to make changes in names that have been accepted, as may now be the case when a bureau falls under new management, or the determination of the questions is referred to new officers without experience. This board, as proposed, was to be formed by representatives from the Hydrographic Office, Smithsonian Institution, War Department, Geological Survey, Coast and Geodetic Survey, Light-house Board, The National Geographic Society, Post Office Department, and the General

Land Office. All these bureaus or departments gave their assent except the Post Office Department and the General Land Office; but we may hope that these departments will eventually be represented, when the practical usefulness of the board has been demonstrated by its decisions.

There are three, perhaps four classes of cases that cause the most trouble in geographic names. In the first class, those cases where we are certain of the name itself—that is, we agree in the pronunciation, but disagree in the orthography; in the second class, where there is no question as to the orthography, but where there is a question as to what name should be used—that is, several names are given to the same point, to the same body of water, or to the same island; in the third class, where there is no question as to the name or the orthography, but a question as to the place to which the name applies—that is, there is no dispute as to the name, but it is applied to different places; this class is sometimes modified by questions as to the geographical limits to which a name applies—that is to say, the area to be indicated by the name; for instance, some body of water or a range of mountains, and may be designated a fourth class.

To cite a few instances of these classes: we have the question of Wood's "Hole" and Wood's "Holl;" for many years it was called Wood's Hole, recently it would seem to be the conclusion that it should be called Wood's Holl; we formerly had "Hurl" Gate, and now "Hell" Gate; "Princess" Bay was at one time spelled "Prince's" Bay, the error arising, doubtless, from the pronunciation; we also have "Body's" Island or "Bodies" Island; we have a peculiar case on the North Carolina coast, "Pamplico" Sound has generally been used, now we have "Pamlico" Sound, legalized by the State legislature; on the coast of Virginia we have the case of "Metomkin," which has frequently been written "Metompkin" and "Matomkin;" in California we have Point Conception, whether it should be spelled with the "c," or with the "t," in the last syllable; we also have "Point Boneta" or "Bonita;" should Yaquina be spelled with one "n" or two ("nn"); Coos Bay, with "k" or "c." This name, I understand, is sometimes pronounced "Co-os," as though it had two syllables; if the spelling of this name was governed by the rules of the Royal Geographical Society the "K" would be used for the hard "C," but "Coos" has been adopted by the State legislature and will probably be retained.

One of the most singular perversions is found in "Bering Sea;" the explorer wrote his name "Bering," and yet we find it is customary, almost everywhere, to spell it "Behring."

In the second class of cases, where we have different names for the same place, we may cite Bangs Island, at the entrance to Portland harbor; an effort was made not long ago to change this name on the Coast Survey charts to Cushing's Island, the evidence was so strong that an order was issued to effect the change, when the supporters of "Bangs" produced additional evidence and secured the retention of that name. On the coast of Florida we had two Saint Joseph's Bays, and a comparatively modern name, "Anclote Anchorage," was presented to take the place of a part of one of them, which led to designating the rest of the bay "Saint Joseph's Sound," Sound being more appropriate for the locality. We have also some notable instances on the Pacific coast, as "Cape Orford" or "Blanco;" "Cape Gregory" or "Arago;" "South Farallon" or "Southeast Farallon;" and in Alaska there are instances too numerous to mention.

In the third class of cases, the locality to which the name applies, we may cite "Isle-au-Haut" Bay and "East Penobscot" Bay, on the coast of Maine; "Hempstead" Bay, on the coast of Long Island, a bay which is almost filled with small islands, rendering it most difficult to satisfactorily define the limits; "Chincoteague" Bay, on the Jersey coast, is an instance of growth; it was at one time called "Assateague," and although "Assateague" was retained for many years as applicable to the upper part of the bay, it has finally been restricted to a very small cove in Assateague Island. On the Pacific coast there are a great many instances, possibly one of the most difficult relates to the limits of Admiralty Inlet, how far it extends into Puget sound? Again, to the northward, is what for years has been called "Washington" Sound, an effort is being made to change it to "Possession" Sound, the latter name, I believe, was once applied to a portion of the area; perhaps we shall eventually see both names on the chart. The difficulty of defining the limits to which a name applies may be experienced in dealing with "Hampton Roads," or "Tybee Roads;" apparently simple problems, but who will undertake to define the exact limits of these famous roadsteads?

These questions, even when stated in their simplest form, are oftentimes very complex, for several of the general classes I have referred to may be included in one question, and when we attempt to determine that which is best they become very perplexing. In seeking advice we are met with a variety of views ; some will maintain that we should take the nick-names given by the fishermen ; some prefer names that have been recognized independent of nick-names ; some will abhor corruptions, while others prefer the corruptions, if expressive and in general use. The experts are very prone to hunting up the root, or, if necessary, to constructing one, and throwing out everything that will not conform with it. The fact that our country was settled by French, Spanish, and English, and that many names are derived from the Indian dialects, also causes peculiar difficulties in treating some sections. The rules of the Royal Geographical Society can be a great help, so far as they are applicable ; they seem to have been used in the modern spelling of "Dakota"—for the man-of-war we had of this name some years ago, it was spelled "Dacotah," but in the name of the States recently admitted to the Union, "k" has been substituted for the hard "c" and the final "h" has been dropped. There is also great disagreement as to the propriety of the use of the possessive case ; some will not admit it at all, others would like to drop the apostrophe and retain the "s" in certain cases for euphony: this is a question that requires special consideration in each case, as the omission of the possessive will sometime give the name a descriptive meaning not at all applicable to the locality or feature. The propriety of personal names is also questioned by many, and may lead to continued discussion in Alaskan nomenclature, where explorers and surveyors have been so liberal in bestowing new names on the same places. It would seem to be a good rule in selecting a new name to follow the old Indian custom of describing the place. An opportunity for an expressive nomenclature seems to have been lost in the north-west in transferring so many of our eastern names, instead of selecting new names from the rich native vocabularies.

As different bureaus may be governed by different principles, and may not even be consistent in their own rulings, through new principles that may come in by the frequent change of personnel, it has heretofore been impracticable to secure uniformity, and disputed questions have been carried along for years. The board that has been organized is in the direction of developing uniformity in the practice of all. It is no easy task, but if guided by a generous spirit, willing to yield a little here and there, its object may be successfully accomplished.

We cannot foresee to what extent the board will be called upon. It has not power to take the initiative ; but we hope its rulings will prove acceptable ; that it may establish a reputation that will be recognized by the people as well as by the departments interested in its organization ; and that eventually rules may be recommended for the nomenclature of our own country that may be an acceptable guide in the determination of new names, as well as in the interpretation of those now in question.

Mr. Herrle : Any one conversant with the state of geographic nomenclature of a large part of the world cannot fail to appreciate the difficulties in the way of the establishment of a comprehensive and uniform system of writing geographic names, that would be acceptable to all nations using the Roman alphabet in their literature. But while some advance towards international uniformity has been made within the last five years, we are still very far from it ; we may, however, at least rejoice in the prospect of the general acceptance of a uniform system in geographic orthography by all writing the English language.

I refer to the action of the British Hydrographic Office and of the Royal Geographical Society in 1885, when they adopted certain *main* principles to guide the orthography of geographic names, and thereby took an important and far-reaching step in the line of a reform which had already been too long delayed.

In France a reform in geographic nomenclature had been earnestly agitated by Édouard de Luze since 1880, and soon after the publication of the system adopted by the Royal Geographical Society, the Société de Géographie appointed a commission which, in 1886, reported a system for the guidance of French geographers.

In Germany, we also find individual attempts made (Egli, Kirchhoff, Ewald and others) to bring system into the orthography and pronunciation of geographic names, primarily with a view to secure uniformity in text books and in the teaching of geography in schools.

No doubt influenced by the action of the British and French geographic societies the Imperial German Hydrographic office in 1888 also established rules for guidance in its future publications.

We thus see three of the principal nations of Europe inaugurate a reform, the beneficial effects of which will not, however, become apparent until a sufficient time has elapsed, that is, until the British, French and Germans have had time to apply the rules in their publications, and particularly in the construction of new and in the correction of old charts. No reform of this nature can be carried through by the stroke of a pen, but a generation's life-time will be required to accomplish it.

The adopted rules which lay down a general phonetic principle only require, of course, perfection in details, so as to furnish an unerring guide in the treatment of names belonging to special languages.

If we compare the British, French and German systems, we can clearly see a gravitation towards uniformity in the spelling of foreign geographic names that are not originally written in the Roman alphabet. Each of the three systems contains important concessions to the others; the British, by adopting the continental vowel system, and the French and German, by representing certain phonetic values differently from the old way, so as to approach the British system. In the French system, this is particularly the case in regard to the letters *ou*, *c*, *ch*, *g*, *q*, *th*, *tch*, *w* and *y*, and in the German system in regard to the letters *c*, *j*, *q*, *ch*, *sh* and *y*.

There is very little doubt that English and French geographers will readily adopt the systems set up by their foremost geographic societies; but whether scientific Germany will be willing to follow in the wake of its Hydrographic Office, we will probably learn after the next meeting of the German Geographic Congress.

If we compare the British, French and German systems further, we find also a perfect agreement in the treatment of the geographic names of those nations that use the Roman alphabet in their literature, they differing only as to exceptions from the rules of old forms of names, which, through long usage, are held almost sacred. The spirit of conservatism tends to retard every reform, and this one makes no exception from the rule. It is, however, to be regretted that neither the British, nor the French, nor the Germans have set any fixed limit to permissible exceptions, leaving, apparently, everybody to decide for himself what is meant by "long usage."

If a radical departure from past usage is perhaps too objectionable to many, this much could be done at present to greatly reduce the list of exceptions, leaving it to the future to smooth over the remaining cases: let all names which are now written but slightly different from their national form and which are easily recognized in the latter form, be corrected, and extirpate all gross corruptions. Also lessen the number of exceptions in those foreign names which are readily understood when written in accordance with the adopted phonetic rules : as Kalkutta for Calcutta, Mekka for Mecca, Kutch for Cutch, Selebes for Celebes, Bonni for Bonny, etc.

Another notable agreement in the British, French and German Hydrographic Office systems is found in their declarations in regard to diacritical marks in the writing of foreign geographic names. The British say that a system which would attempt to represent the more delicate inflections of sound and accent would become so complicated as to defeat itself. They therefore recommend only the use of the acute accent to denote the syllable on which stress should be laid. The German Hydrographic Office has adopted the same view. The French Commission in its deliberations expressed decided opposition to the adoption of Lepsius' or any similar system, and finally adopted besides the "*tilde*" and "*crêma*," only the accent "*circonflex*" and the "*apostrophe*," signs of which the two last are ordinarily employed in the writing of the French language. "In our country," the French commission says, "a native of the Normandy and one of the Provence do not employ exactly the same sounds in pronouncing, for instance, Marseille, Enghien, or Montrichard, and, in foreign lands, we find still greater diversity in this respect." Therefore, we should use diacritical marks with the greatest economy, and only when they are indispensable.

It is of course not to be expected that a certain school of geographers, who are in favor of the strict application to geographic names of a simplified form of Lepsius' standard alphabet, will acquiesce in this view, but it is to be hoped that all practical minded geographers will agree to reserve the extended use of diacritical alphabets for purely linguistic literature only.

In the meanwhile, the United States has not been idle, and the Hydrographer, Captain Henry F. Picking, U. S. N., has taken the initiative by the appointment of a board to consider and report a system of orthography for foreign geographic names for guidance in the compilation of the Hydrographic Office charts, sailing directions and notices to mariners, which as we know cover all parts of the world.

The Hydrographic Office, by its daily experience with the subject matter, is thus peculiarly fitted to inaugurate a reform, and it is hoped that the board, profiting by what the British, French and Germans have already done, will report rules, that may become generally satisfactory to American geographers.

In our own country the territory of Alaska needs special attention in regard to settling the orthography of its geographic names of Russian origin. Russian names have always been more or less of a bugbear in geographic literature, since so great a number of them appear in different forms. The difficulties of transcribing Russian names so as to reproduce the correct pronunciation are well enough understood. In the first place the Russian alphabet contains 36 letters, of which 12 are vowels and diphthongs, 3 are semi-vowels, and the balance, consonants. In this alphabet, there are 12 elements which have no exact equivalents in the English alphabet, and, on the other hand, there are 4 English sounds (*j*, *w*, *x* and *h*) not represented in the Russian alphabet. Hence, whatever system is employed, we can only hope to give the pronunciation approximately. Many of the Russian names found to-day in English and American maps and publications show, by the way in which they are rendered, an utter absence of knowledge of the grammatical construction of Russian on the part of those who originally transcribed them. There are few other languages in which case and gender play such an important part in the terminal inflections of proper names as in this great Slavonic idiom. Any one not conversant with the Russian declensions should not, therefore, attempt to transcribe Russian geographic names into English, as he will be sure to blunder. On Russian maps, for instance ; Behring Strait reads, "Beringov Proliv ;" Behring Sea, "Beringovo More ;" Kamchatka Bay, "Zaliv Kamchatkii;" Herald Island, "Ostrova Gheralda;" etc.

By the by, I cannot exactly understand why the spelling of the name of *Behring* should, within the last few years, have been changed on American and English maps to *Bering*. The navigator of this name, *Veit Behring*, was a native of Germany, in the service of Russia, and it is safe to say that his name contained the letter *h*. Naturally, in transcribing his name into Russian, the *h* had to drop out, as that letter is missing in the Russian alphabet.

The excellent system of transcribing Russian names into English, published in a recent number of *Nature*,* having already been accepted by English and American representatives of various scientific institutions, it is greatly to be desired that English and

* February 27, 1890.

American geographic societies should express their views of it at an early day. The system is easily brought in harmony with the general principles adopted by the Royal Geographical Society, by a simple declaration in regard to the diacritical marks by which, mainly for the purpose of facilitating correct re-transliteration of Russian names, the vowels *i*, *ī*, *ĭ*, *e* and *ė* and the silent semi-vowels are sought to be distinguished in the written names. For the benefit of those unacquainted with the system of transliterating Russian, published in *Nature*, it is reprinted at the close of this paper.

A few words more in regard to the treatment of the Russian geographic names found in Alaska. This territory will in the course of time contain a large English-speaking population, and its geographic names of Russian and Eskimo origin should, in a certain sense, no longer be classed by us under the category of foreign names.

The future official orthography of Alaska might, therefore, be treated liberally, that is to say, complicated spelling following from a strict transliteration might be simplified to a certain extent, as has been done with the spelling of many aboriginal Indian names.

Of the geographic nomenclature of Asiatic countries none has become so rapidly well known as that of the Japan Archipelago, and we can already now class Japan among the countries having an official geographic nomenclature in Roman character.

Within less than twenty years, the wonderfully progressive Japanese have established a geographic service for the survey of their domain, and a hydrographic service for the survey of their coasts and navigable waters. They have now published several hundreds of nautical charts, which are as good and practical as any published by other nations.

On those Japanese charts, which are based exclusively on their own surveys, the names are printed in the signs of the '*Kana*' with the transliteration of the name in Roman character added. It is this feature which has materially helped us to a better and correct knowledge of their geographic names. Within the last few years the *Romaji-Kwai** has made immense progress, and I understand that the society's system forms already part of the instruction in a number of schools in Japan. Hence, we may

*Society for the introduction of the Roman character for writing the Japanese language.

look forward to the day when Japanese books printed in Roman characters will supersede, to a large extent, the books in the signs of the '*Kana*.'

One of the best authorities for writing and pronouncing the names of the districts, cities, towns and villages of Japan is a very recent publication* by our honored countryman, Mr. W. N. Whitney, interpreter at the U. S. Legation at Tokyo, who compiled this admirable book with great care and labor from the official records of the Japanese empire. It not only contains the names in the original Japanese print, but what is of chief value to us, also the transcription, in accordance with the *Romaji-Kwai* system. We cannot do better, at present, than to follow this book in determining the orthography of geographic names in Japan.

In not so satisfactory a state as the orthography of Japanese geographic names is that of the countries adjacent to Japan. Considering that Asiatic names have been transcribed phonetically by explorers and surveyors of different nationalities, at different periods of time, and who were often but little, or not at all, acquainted with the languages they had to deal with, it is not surprising that many of the names we find on the charts should have been written utterly wrong. That such was the case on even comparatively recent surveys is, for instance, illustrated by the change in the nomenclature on the French plan of Cape Koan Lan, in the Gulf of Tongking (Plan No. 3721). In this French survey of 1878 the same names on the editions of 1879 and 1886, respectively, are rendered thus :

1879.	1886.
Cap Cua-Lam.	Cap Koan Lang.
Ile Capuitao.	Caï-puï-tao.
Ile Soum-La-Too.	Siong-Lai-Tao.
Ile Laito-San.	Lai-Tao.
Ile Foum-Lung.	Ile Fong Wong.

Such differences in spelling, and examples of pleonasm, as are indicated by these names, are found on the charts of all nations, but, under the beneficial working of the systems adopted by the British, French and Germans, similar errors are rapidly being corrected, and progress is being made towards international uniformity in the spelling of all geographic names.

* A concise Dictionary of the principal *roads, chief-towns* and *villages* of Japan, with *populations, post-offices*, &c.; together with Lists of *Ken*, *Kōri*, and *Railways*. By W. N. Whitney, M.D., Interpreter of the U. S. Legation, Tokyo.

Owing to the number of languages and alphabets in use in the Indian empire, the orthography of its geographic names has for a long time been in controversy. As we see from the "British System," the Royal Geographical Society has decided to spell Indian names in accordance with "Hunters' Imperial Gazetteer of India," a decision which, in view of the fact that the spelling in the Gazetteer is not always in harmony with the adopted rules, is to be regretted. But we can at the same time understand the difficulties of the situation, and appreciate the strong love of the British for old forms and long usage. The differences between the system and the Gazetteer are, however, not radical, since the continental vowel system is followed; still, it would be just as easy to write Kalkutta, Kutch, etc., for Calcutta, Cutch, etc., as it is to write Korea for Corea, and thus be consistent with the rules.

Geographic names in Malay and its branches we know mainly through Dutch, British and Spanish surveyors, and their status may be judged from the prefatory remarks in Maxwell's grammar of Malay, published in 1882, wherein he says, that the spelling of Malay words in the native character is hardly yet fixed, though the Perso-Arabic alphabet has been in use since the 13th century, and that those *follow but a vain shadow* who seek to prescribe exact modes of spelling words, regarding which even native authorities are not agreed, and of which the pronunciation may vary according to locality.

On the charts published by the Batavian Hydrographic Office, the Malay names are rendered in accordance with the Dutch phonetic system of transliteration (only that the sound of *g* is always hard) and as this differs from the British phonetic system in several particulars, it is clear that certain corrections must be applied to the spelling of "*Dutch*" Malay names to facilitate the approximately correct pronunciation of such names by English speaking peoples. But a source of trouble is the seeming uncertainty of the Batavian geographers themselves in regard to the orthography of many names, since it is a frequent occurrence to find the same names variously rendered on charts, or in sailing directions issued at short intervals of time.

We can see, from what has been said above, that chances for disagreement in the rendering of geographic names, originating in countries that do not use the Roman alphabet for their literature, are numerous, and hence, the occurrence of errors in the application of a new system should not be too harshly condemned; nor would the culprits deserve to be dealt with according to the law laid down by the municipal council of the good old Swiss town of Küssnacht, which not very long ago issued a decree that the final *t* in the name of their town should be dropped in all official communications, and that any local official failing to obey this decree should be fined.

Mr. Baker: In the preparation of a map, the last things to go on are the names. If the map covers a region of country long known or thickly settled most of its features already have names. But comparison of several maps of, or writings about, a region almost invariably reveals confusion, contradictions and errors in the names. The same feature often bears different names on different maps. The same name has various spellings, and the names on the map may in their turn not agree with local usage. Examples of this confusion abound everywhere, and are a source of constant perplexity to the geographer.

The names are often misapplied. The name of one cape or mountain peak through accident, carelessness, ignorance, or by intent is often found attached to some other cape or mountain peak. A small feature's name may be extended to cover much more than that to which it fittingly belongs; or a name rightly applicable to a large tract may be wrongly restricted to a small one. In the hands of the map-maker geographic names may be regarded as labels loosely attached and easily misplaced. Handled by many writers, both careful and careless, these labels become misplaced or lost; and in replacing these misplaced labels or in restoring lost ones much confusion and many errors arise. The newspaper writer writing hurriedly, the magazine writer without hurry, or the book writer working deliberately, each in turn finds that the investigation of questions relating to geographic names carries him away from his subject. If a question arises respecting a non-geographic term the dictionary can be appealed to and, right or wrong, followed without discredit. But with many or most of the questions about geographic names, in the United States at least, we have no adequate dictionary or "authority" to appeal to. As a consequence in most cases the writer takes indifferently what is nearest to mind or hand and thus produces new varieties in names, variants upon old ones or quite new ones. Such names are called corrupt until usage and familiarity removes the stigma and the corrupted name having grown respectable is adopted.

A foreign name may be transliterated by one writer and translated by another. This course gives rise to two or more forms. The absence of uniform usage in transliterating, causes diversity in one case, and in the other as several translations are possible, and mistakes probable, various forms arise.

The progress of all science is intimately associated with questions of nomenclature. Modern progress in biologic science dates from the adoption of the binomial system, and it is not too much to expect that progress in geographic science will similarly be found to be intimately associated with a study of geographic names and the principles which should control in their adoption and use.

The object aimed at in these notes is to draw attention to the importance of the subject and to arouse discussion ; the purpose of the discussion being to ascertain if there be not certain guiding principles which may serve to aid in solving the numerous and perplexing questions relating to geographic nomenclature.

What is a geographic name ? Without attempting a categorical answer to this question I would say that geographic names seem to me to bear a strong resemblance to the names used in biology. They are generic and specific. To designate any specific geographic feature we usually use two words, *one* a descriptive term, such as river, island, lake, pond or mountain, and the *other*, a specific name indicating what particular pond, lake, or mountain is designated. The term Mississippi River is a compound name, in which river may be regarded as a part of a proper name. It is the name of a genus, whereas the term Mississippi is the specific designation. Of course it will happen in geographic names, as in biologic, that certain features or objects become so well known that a single name, either the generic or the specific will be used by itself to designate the object. We speak of Maine without prefixing the generic term "State of," the specific name being sufficiently characteristic. On the other hand here in Washington references to "the Avenue" meaning Pennsylvania Avenue are familiar to all. In this case the generic term is used for particular specification. These exceptional usages, however, do not appear to me to invalidate the general principle that the designation of geographic features consists in general of a specific and of a generic name.

The origin of generic terms has been much studied. The origin of specific names has been studied but little and the present notes relate chiefly to this class. Specific names may be said to have two distinct origins, *first*, those of formal origin where the name has been given *pro forma* and published in a book or map relating to the region by its discoverer, or by the earliest explorers. This covers the case for a small body of names. *Second*, there is a very large body of names which appear to have arisen without such formal origin, and to have, as it were, grown up by common consent in the usage of the people of the region.

That which it seems profitable to discuss here, and now, is the principles which should be adopted and followed in the selection of the names which are to go upon the map; principles which will enable one to discriminate when usage is divided, between that which should be adopted and that which should be rejected. To make this clear, a few instances of the peculiar questions which arise may be cited, and then some of the guiding principles stated which it might be possible to adopt and to follow.

The river which flows along the western edge of New York City is locally known as the North River. Shall this be called the North River, or Hudson River, or Hudson's River? And if this geographic name is printed in the text of a book, will you print river with a capital letter or a small letter? It must be borne in mind that this question is asked not for the purpose of immediate or categorical answer, but for the purpose of eliciting thought and discussion upon the principles which should control the answer.

In 1793 Vancouver entered and mapped Port Townsend, which he formally named Port Townshend. At the present time the city situated upon that harbor, as well as the harbor itself, is universally known as Port Townsend, the "*h*" in the original being omitted. This is a clear and specific case, where the name formally applied by the original explorer is now modified in its orthography by usage. What form of the name shall be adopted? The former or original name or the present modified name? And if the original name is to be adopted, shall we proceed similarly in all cases and go back to the original form?

In the case of names which have undergone transformations through ignorance or through usage, shall an attempt be made to restore the original orthography? Take the case in Missouri of the stream called Bois Brule, or burnt wood, and which has become in the usage of the residents in that part of the world Bob Ruly, and is so spelled in the local publications, and so pronounced in the local usage.

When Champlain sailed along the heel of Cape Cod and discovered the extensive shoals which vex the navigation in those waters, he put upon his chart the statement *mal barre*, and a number of later maps applied this name to the southernmost point of the heel of Cape Cod as Malabar, and so it stood for 100 years or more as Malabar and may even be found upon some current publications. In the Coast Survey publications it is uniformly called Monomoy.

Again on the north shore of Martha's Vineyard is a place formerly known by the Indian word Kiphiggon. On the modern maps this place is called Cape Higgon. Shall we in this case adopt the practice of the purists and restore the earlier form? In this same locality are four small harbors, called by the sailors *Holes*; namely Holmes' Hole, Wood's Hole, Robinson's Hole, and Quick's Hole. In current usage, except among seamen, Holmes' Hole has disappeared and been replaced by Vineyard Haven. Wood's hole has been converted into Wood's Holl, though still pronounced hole; while Robinson and Quick still remain holes. In this case shall we attempt to be consistent, or in other words to be uniform?

In the vicinity of New Haven there is a hill occupied many years ago by Coast Survey parties, and called in their records Rabbit Rock. Surveying parties last year in searching for this station inquired diligently in the vicinity and failed to find any information respecting it for some time. The place, however, is well known to all the people for many miles around as Peter's Rock, and this name appears on the county atlas of New Haven, published in 1856. I suppose the name Rabbit Rock has found earlier publication on Coast Survey charts or in its reports, though I have not verified this supposition. But assuming that it has been so published, shall we now call that hill Rabbit Rock or Peter's Rock?

Allegany County, New York, is spelled Allegany. A post office in Sierra County, California, is spelled Alleghany; the city of Allegheny near Pittsburg, Pennsylvania, is spelled Allegheny. Shall these names be allowed to stand unchanged, or should an attempt be made to reduce them all to one form?

In the last century, the place we now know as Sitka was known to the English as Norfolk Sound, to the French as Tchinkitane Bay, and to the Russians as New Archangel. The earliest of these names being Norfolk Sound. Is there any doubt in this case as to the advisability of retaining the name Sitka?

The great sea between Northeastern Asia and Northwestern America, at one time known as the Sea of Kamchatka, and now known as Bering Sea, has been variously written Bhering Sea, Behring Sea, Beering Sea, Bering Sea, as well as all these forms with the addition of the apostrophe "s." I will not ask what is the correct name, as the question in this form seems to imply that there is a correct form, and all other forms are erroneous. The question should rather be, what form is it advisable to adopt with the view, let us hope, of securing its general adoption?

And this leads up to the question of possessives generally in specific geographic names. Many specific geographic names have the possessive form, while many others do not. Is it advisable to attempt to secure uniformity of usage in this regard? I will frankly avow my own conviction which has resulted from more or less consideration and study of the matter to be, that the use of the possessive form should be discouraged and abandoned as far as practicable. While it seems to me unwise to lay down a hard and fast rule, yet there are a very large number of cases in which the possessive form may be dropped to advantage and without, I think, arousing any general opposition to the practice. When the theory held that the King owned all, and geographic features were named for the royal family or for the nobility, the possessive form was very frequently used indicating possession or ownership, and this in cases where such possessive form has now disappeared from the maps. Why should not the possessive form be used to denote possession only? A pond, a hill, a swamp, lying on Smith's land may be properly designated as it often is, as Smith's pond, Smith's hill, etc. But nobody would think of saying Madison's Place, or Washington's Monument. There appears to be a certain principle involved. Those particular features which are of a public character, such as states, counties, towns, streets, parks, etc., which are named for individuals are almost universally named without the possessive form. And this commends itself as a reasonable practice. Without, therefore, cutting off possessives from all names where usage has now fixed them with considerable firmness, there yet remains a considerable body of geographic names in which the possessive form remains, but which are not strongly intrenched in public usage. In such cases it seems to me we may advantageously drop the possessive form. Let us say Donner Lake, not Donner's Lake, Hudson Bay, not Hudson's Bay, James Bay, not James' Bay, Baffin Bay, not Baffin's Bay, etc., etc.

Mr. Thompson : I hardly know how I came to be brought into this discussion. The Secretary caught me in his net unawares and unprepared. I do not propose to trespass long on your time, nor do I suppose I shall add anything to a philosophical discussion of geographic nomenclature. I only wish to call your attention to a few principles that obviously should be followed in the selection of new geographic names and to show some absurdities and difficulties which are liable to occur if the sentiment in favor of Indian nomenclature is allowed full liberty. A geographic name should be short, euphonic, pronounced as spelled, and have a meaning or express some sentiment to help fix it in the memory. Especially should these principles govern when we consider that in childhood, in our school-days, we obtain by far the greater portion of our geographic knowledge.

The old Spanish explorers followed these rules largely in their geographic nomenclature, and although "Saint" and "Sierra" occur with alarming frequency, there is always some reason for the appellation ; either they saw a line of peaks cut the horizon or the christening occurred on the natal day of the holy martyr. "Rio Dolores" and "Las Animas" are certainly better than "Sorrow Creek" or "Soul Wash," and even "Purgatoire"—though the Colorado cow-boy corrupts it into "Picket Wire"—is better than "Cottonwood Creek."

Some Indian names are very expressive, characterizing topographic features. In northern Arizona is a steep volcanic neck or needle, its sharp sides rising in one step twelve hundred feet above the surrounding country. From the base of this pinnacle, two long lava dykes stretch on either hand in a gentle curve across the mesa. The resemblance to the spreading wings of a bird is striking, and the Navajo Indian calls the rock "A-ga-thla"—the "Flying Bird." A name well worthy, it seems to me, of being placed on the maps of that region, as it is on the one I hold in my hand. But on the same map, close along side, is "Te-ze-ba-a-kit Lake," a barbarous appellation—unspellable, unpronounceable and unlovely. Nor can I say less in denunciation of "Zilh-le-ji-ni Mesa"—a name that needs intimate acquaintance with wigwam smoke and Navajo gutturals to handle lingually. But what shall we say of "Boo-koo-dot-klish Cañon ;" the Navajo name for what the white man calls with better propriety, it seems to me, for our maps, "Bluestone Wash." "To-go-hol-tas-e Spring" could hardly be worse in English. And here is "Sa-hot-soid-be-azh-e Cañon" (pronounce it as you please or can) sandwiched between "Gothic Wash" and "Gypsum Valley"—one hardly knows which to prefer, Indian or English.

Cañon del Muerto"—the Cañon of the Dead—so named from the discovery of mummified or rather dessicated Indian bodies in its cliffs—seems very appropriate, but its brother cañon—"Cañon de Chelly," pronounced Cañon de Shay, will be neither spoken nor written correctly.

On this same map are shown two small mesas, crowned with forests and standing beautiful and symmetric in the landscape. They attract attention at once and the Indian, with a fine sense of appropriateness, names them "Son-sa-la"—the "Twin Stars"; another name well worthy of being retained. Some patriotic American has named the deep gorge separating the "Stars" "Washington Pass," a good example of the right name in a wrong place.

The sense of broad humor that often characterizes the Indian leads him to sometimes give the inquirer a name expressive of contempt or bearing a meaning hardly translatable to ears polite —"Nic-doit-so-e Peak" is an example—and I confess, with considerable humiliation, that I was the victim in this case.

I present these instances, Mr. Chairman, to emphasize the necessity of adopting some guiding-principles to aid us in the selection of geographic names.

APPENDIX.

Rules for the Orthography of Geographic Names.

CONTRIBUTED BY MR. HERRLE.

British System—French System—German System—Alphabets, Russian-English ; English-Russian.

British System.

Rules adopted in 1885, by the Royal Geographical Society at London, for the Orthography of Native Names of Places.

Taking into consideration the present want of a system of geographical orthography, and the consequent confusion and variety that exist in the mode of spelling in English maps, the Council of the Royal Geographical Society have adopted the following rules for such geographical names as are not, in the countries to which they belong, written in the Roman character. These rules are identical with those adopted for the Admiralty charts, and will henceforth be used in all publications of the Society.

1. No change will be made in the orthography of foreign names in countries which use Roman letters : thus Spanish, Portuguese, Dutch, etc., names will be spelt as by the respective nations.

2. Neither will any change be made in the spelling of such names in languages which are not written in Roman character as have become by long usage familiar to English readers : thus Calcutta, Cutch, Celebes, Mecca, etc., will be retained in their present form.

3. The true sound of the word as locally pronounced will be taken as the basis of the spelling.

4. An approximation, however, to the sound is alone aimed at. A system which would attempt to represent the more delicate inflections of sound and accent would be so complicated as only to defeat itself. Those who desire a more accurate pronunciation of the written name must learn it on the spot by a study of local accent and peculiarities.

5. The broad features of the system are that vowels are pronounced as in Italian and consonants as in English.

6. One accent only is used, the acute, to denote the syllable on which stress is laid. This is very important, as the sounds of

many names are entirely altered by the misplacement of this "stress."

7. Every letter is pronounced. When two vowels come together, each one is sounded, though the result, when spoken quickly, is sometimes scarcely to be distinguished from a single sound, as in *ai*, *au*, *ei*.

8. Indian names are accepted as spelt in Hunter's Gazetteer.

The amplification of the rules is given below :—

Letters.	Pronunciation and Remarks.	Examples.
a	*ah*, *a* as in *father*	Java, Banána, Somáli, Bari.
e	*eh*, *e* as in *benefit*	Tel-el-Kebír, Oléleh, Yezo, Medina, Levúka, Peru.
i	English *e*; *i* as in *ravine*; the sound of *ee* in *beet*. Thus, not *Feejee*, but	Fiji, Hindi.
o	*o* as in *mote*	Tokio.
u	long *u* as in *flute*; the sound of *oo* in *boot*. Thus, not *Zooloo*, but	Zulu, Sumatra.
	All vowels are shortened in sound by doubling the following consonant.	Yarra, Tanna, Mecca, Jidda, Bonny.
	Doubling of a vowel is only necessary where there is a distinct repetition of the single sound.	Nuulúa, Oosima.
ai	English *i* as in *ice*	Shanghai.
au	*ow* as in *how*. Thus, not *Foochow*, but	Fuchau.
ao	is slightly different from above	Macao.
ei	is the sound of the two Italian vowels, but is frequently slurred over, when it is scarcely to be distinguished from *ey* in the English *they*.	Beirút, Beilúl.
b	English *b*.	
c	is always soft, but is so nearly the sound of *s* that it should be seldom used.	Celebes.
	If *Celebes* were not already recognized it would be written *Selebes*.	
ch	is always soft as in *church*	Chingchin.
d	English *d*.	
f	English *f*. *ph* should not be used for the sount of *f*. Thus, not *Haiphong*, but	Haifong, Nafa.
g	is always hard. (Soft *g* is given by *j*).	Galápagos.
h	is always pronounced when inserted.	
j	English *j*. *Dj* should never be put for this sound.	Japan, Jinchuen.
k	English *k*. It should always be put for the hard *c*. Thus, not *Corea*, but	Korea.
kh	The Oriental guttural	Khan.
gh	is another guttural, as in the Turkish	Dagh, Ghazi.
l, m, n	As in English.	
ng	has two separate sounds, the one hard as in the English word *finger*, the other as in *singer*. As these two sounds are rarely employed in the same locality, no attempt is made to distinguish between them.	

Letters.	Pronunciation and Remarks.	Examples.
p	As in English.	
q	should never be employed; *qu* is given as *kw*	Kwangtung.
r	As in English.	
s		
t		
v		
w	....	Sawákin.
x		
y	is always a consonant, as in *yard*, and therefore should never be used as a terminal, *i* or *e* being substituted.	Kikúyu.
	Thus, not *Mikindány*, but	Mikindáni.
	not *Kwaly*, but	Kwale.
z	English *z*	Zulu.
	Accents should not generally be used, but where there is a very decided emphatic syllable or stress, which affects the sound of the word, it should be marked by an *acute* accent.	Tongatábu, Galápagos, Paláwan, Saráwak.

FRENCH SYSTEM.

Rules Adopted in April, 1886, by the Société de Géographie at Paris, for the Orthography of Native Names of Places.

The geographic names in countries in which the Roman character is employed in writing (which includes the néo-Latin, Germanic, and Scandinavian languages) shall be written in the orthography of the country to which they belong.

The following rules apply solely to geographic names in countries without a written language, and to geographic names in countries where another than the Roman character is employed in writing.

Names of places for which the orthography, through long usage, has become consecrated shall, however, be excepted from the rules. Examples: La Mecque, Naples, Calcutta.

The rules in detail are:

1. The vowels *a*, *e*, *i*, and *o* are pronounced as in French, Spanish, Italian, and German. The letter *e* shall never be mute.
2. The French sound of *u* shall be represented by *u* with a *tréma* like the German *ü*.
3. The French sound *ou* shall be represented by *u*, as in Italian, Spanish, and German.

4. The French sound *eu* shall be represented by the character *œ* and be pronounced as in *œil.*

5. The lengthening of a vowel sound shall be indicated by the '*accent circonflexe*' (^), and the shortening by an '*apostrophe*' (').

6. The consonants *b*, *d*, *f*, *j*, *k*, *l*, *m*, *n*, *p*, *q*, *r*, *t*, *v*, and *z* are pronounced as in French.

7. *g* and *s* have always the hard French sound, as in *gamelle*, *sirop.*

8. The sound represented in France by *ch* shall be written *sh.* Examples: *Kashgar*, *Shérif.*

9. *Kh* represents the strong and *gh* the soft Arabic guttural.

10. *Th* shall represent the articulation in the English word *path* (Greek θ), and *dh* the sound of *th* in the English word *those* (Greek δ).

11. Unless the letter *h* is employed to modify the sound of the letter preceding it, it shall always be aspirated; it should, therefore, never have an apostrophe in names beginning with it.

12. The *i* semi-vowel shall be represented by an y, pronounced as in *yole.*

13. The semi-vowel *w* is to be pronounced as in the English word *Williams.*

14. The double sounds *dj*, *tch*, *ts* shall be written with the letters which represent the sounds of which they are composed. Example: *Matshim.*

15. The *ñ*, n with a *tilde*, is to be pronounced like *gn* in *seigneur.*

16. The letters *x*, *c*, and *q* are not to be employed as duplicates, but the letter *q* may serve to represent the Arabian *qaf*, and the *äïn* could be represented by a double dot.

The idea is to indicate, by means of the characters above given as near as possible the local pronunciation without attempting a complete reproduction of all sounds heard.

GERMAN SYSTEM.

Rules Adopted in 1888 by the Imperial German Hydrographic Office, for the Orthography and Pronunciation of Foreign Geographic Names.

The names from nations who use the Roman or German alphabet are to be rendered in the native form, excepting such for which a German orthography has been generally adopted, as Kopenhagen, Neapel, Genua, etc. Other foreign names which are generally known and whose orthography has been generally adopted, as Zanzibar, not *Sansibar;* Zulu, not *Sulu,* will not be changed.

The letters are pronounced as follows :

a, as *a* in *Vater.*

å, between *a* and *o* (*Ålands Inseln*).

e, as in *Eden.*

i, as in *Ida.*

o, as in *Brot.*

u, as in *nur.*

ä, (æ, Ae)
ö, (œ, Oe) } retain their German sounds.
ü, (ue, Ue)

ai, as in *Kaiser.*

au, as in *auch.*

ao, not quite as *one* sound.

ei, as in *Ei.*

b, d, g, h, j, k, l, m, n, p, r, s, t, w, x and z retain their German sounds.

f, retains its German sound ; also for *ph,* but the latter will not be used.

c, always soft (as *z*). For the sound of *k*, *c* is not to be used.

j̈, for the English *j* (*dj*).

q, will not be used ; it is replaced by *k ;* respectively by *ku.*

ch, as *tsch.*

sh, as *sch.*

y, is only used for the consonantal sound, not for *i.*

gh, oriental guttural sound (*Dagh, Ghazi*).

kh, oriental guttural sound (*Khan*).

v, is always soft ; not to be used to give the sound of *f.*

When a vowel is to be pronounced clear and open the following consonant will be doubled : (*Tanna, Mekka, Bonny*). To lengthen a vowel sound, it will not be doubled, but if the vowel is repeated each will be pronounced separately (*Nuuluha, Oosima*).

But one accent (') will be used to indicate if particularly necessary, that is, in exceptional cases, the syllable on which stress is to be laid (*Matupí*).

RUSSIAN-ENGLISH.

Russian Capital	Russian Small	Written Capital	Written Small	English equivalents	Russian Capital	Russian Small	Written Capital	Written Small	English equivalents
А	а	А	а	*a*	Ф	ф	Ф	ф	*f*
Б	б	Б	б	*b*	Х	х	Х	х	*kh*
В	в	В	в	*v*	Ц	ц	Ц	ц	*tz*
Г	г	Г	г	*gh*	Ч	ч	Ч	ч	*ch*
Д	д	Д	д	*d*	Ш	ш	Ш	ш	*sh*
Е	е	Е	е	*e*	Щ	щ	Щ	щ	*shch*
Ж	ж	Ж	ж	*zh*					
З	з	З	з	*z*	Ъ	ъ	Ъ	ъ	*Not indicated at end of word.*
И	и	И	и	*ī*					
І	і	І	і	*i*	Ы	ы	Ы	ы	*ui*
К	к	К	к	*k*					
Л	л	Л	л	*l*	Ь	ь	Ь	ь	*Not indicated at end of word.*
М	м	М	м	*m*					
Н	н	Н	н	*n*	Ѣ	ѣ	Ѣ	ѣ	*ye*
О	о	О	о	*o*	Э	э	Э	э	*é*
П	п	П	п	*p*	Ю	ю	Ю	ю	*yu*
Р	р	Р	р	*r*	Я	я	Я	я	*ya*
С	с	С	с	*s*	Ѳ	ѳ	Ѳ	ѳ	*th*
Т	т	Т	т	*t*	Ѵ	ѵ	Ѵ	ѵ	*æ*
У	у	У	у	*u*	Й	й	Й	й	*ĭ*

ENGLISH-RUSSIAN.

a	А	*ī*	И	*p*	П	*yi*	Ы
b	Б	*ĭ*	Й	*r*	Р	*v*	В
ch	Ч	*k*	К	*s*	С	*ya*	Я
d	Д	*kh*	Х	*sh*	Ш	*ye*	Ѣ
e	Е	*l*	Л	*shch*	Щ	*yu*	Ю
é	Э	*m*	М	*t*	Т	*z*	З
f	Ф	*n*	Н	*th*	Ѳ	*zh*	Ж
gh	Г	*o*	О	*tz*	Ц	ʿ	Ъ
i	І	*œ*	Ѵ	*u*	У	ʿ	Ь

Vol. II. No. 5.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

PUBLISHED BY THE

NATIONAL GEOGRAPHIC SOCIETY,

WASHINGTON, D. C.

Price, 25 cents.

CONTENTS.

April, 1891.

THE

NATIONAL GEOGRAPHIC MAGAZINE.

Vol. II. 1890. No. 5.

ANNOUNCEMEMT.

The NATIONAL GEOGRAPHIC SOCIETY was organized in January, 1888, "to increase and diffuse geographic knowledge." It is incorporated under the laws of the District of Columbia, and has at present an active membership of about four hundred.

The publication of a magazine was early determined upon as one of the means of increasing and diffusing geographic knowledge; and two volumes of *The National Geographic Magazine* have been published in the form of a quarterly journal.

During the past two years it has been found that the form of publication adopted at the outset meets but imperfectly the needs of the Society: in the first place, since the season of active work in the Society includes the winter months only, there was an excess of material for the two earlier numbers and a dearth of material for the two later numbers of the volume; and in the second place, the necessity for holding articles until sufficient material for a number was received sometimes led to delay in publishing interesting and important matter. Accordingly it has been decided to discontinue the quarterly form and to publish the *Magazine* in the form of a series of brochures, each issued promptly as possible after reception of the material. The details of this modified form of publication are set forth elsewhere in this number of the *Magazine*.

While the *National Geographic Magazine* is edited by and constitutes the organ of the NATIONAL GEOGRAPHIC SOCIETY, it is not limited to this function; and, as was announced in the first number of the journal, "its pages will be open to all persons interested in geography in the hope that it may become a channel of intercommunication, stimulate geographic investigation, and prove an acceptable medium for the publication of results."

With the adoption of the modified form of the journal the publication year was changed from one determined by the working season of the SOCIETY to the calendar year; and it is to cover a hiatus in the SOCIETY's records growing out of this change that this fifth number of Volume II is issued.

The National Capital seems to be a natural and appropriate place for an association of national character, and the aim of the founders has been therefore to form a continental rather than a local Society. That this aim has measurably succeeded is indicated by the fact that although the NATIONAL GEOGRAPHIC SOCIETY is only three years old there are 57 non-resident members, distributed over 27 states and territories.

One of the means adopted by the NATIONAL GEOGRAPHIC SOCIETY for increasing geographic knowledge has been that of exploration. In the spring of 1890 an expedition was sent out by the Society to explore and survey the Mt. St. Elias alps of Alaska. The results of the expedition include (1) new determinations of altitude and geographic position for Mt. St. Elias and neighboring peaks; (2) a topographic map of a considerable part of the Mt. St. Elias range with its southwestern foothills and the slopes thence to the shores of the Pacific; (3) an investigation of the glaciers of this alpine region; (4) researches into the geology of the region; and (5) a study of the range and its climatal and other conditions so complete as to prepare the way for detailed surveys of the entire region.

A report on the Mt. St. Elias expedition, comprising about 150 pages of letter-press with 20 plates and a number of other illustrations, has just been sent to press as a part of Volume III of the *National Geographic Magazine.*

As another means of carrying out the purposes of the SOCIETY, regular fortnightly meetings are held for presenting scientific and popular communications on geographic subjects, some of which are published in the *National Geographic Magazine.* The Society also provides for the delivery of public lectures in Washington upon explorations in little-known countries and upon other geographic subjects. Within a few months lectures have been delivered under the auspices of the Society by eminent explorers or students on the following subjects :

The Explorer in Egypt ;

Buried Cities of Ancient Egypt ;

Life among the Australian Cannibals ;

A Journey through China, Mongolia and Thibet ;

Korea and the Koreans ;

Results of the Mt. St. Elias Exploring Expedition.

The SOCIETY has in preparation a physical atlas of the United States.

There is no geographic or number limitation to membership in the SOCIETY. The *National Geographic Magazine* is sent free to members.

Correspondence with the SOCIETY should be addressed to Mr. Marcus Baker, Secretary, No. 1330 F Street, Washington, D. C.

PROCEEDINGS

OF THE

NATIONAL GEOGRAPHIC SOCIETY.

ABSTRACT OF MINUTES.

March 21, 1890. *37th meeting.*

Meeting held in Assembly Hall of the Cosmos Club. President Hubbard in the chair. Attendance, 50.

Article V, paragraph one, of the By-laws was amended so as to read "The annual dues of active members shall be five dollars and of corresponding members two dollars, payable during the month of January, or, in the case of new members, within thirty days after election."

A discussion was then had on the subject of Geographic Nomenclature, participated in by Messrs. H. G. Ogden, Gustave Herrle, Marcus Baker and A. H. Thompson. *Published in The National Geographic Magazine.* 8°. *Washington, D. C. August, 1890. Vol. 2, no. 4, pp. 261–278.*

Mr. L. R. Klemm made some remarks on "A new method of developing geographic facts in teaching."

April 4, 1890. *38th meeting.*

Meeting held in Assembly Hall of the Cosmos Club. Vice-President Hayden in the chair. Attendance, 25.

Mr. Robert Stein read a paper on "Turkish rule in Armenia," which was discussed by Mr. H. Garabed of Sis, Cilicia, Asia Minor, and by Mr. Kenaston. *Not published.*

April 11, 1890. *Special meeting.*

Meeting held in the Lecture Hall of the National Museum. Vice-President Hayden in the chair. Attendance, 850.

Ensign J. B. Bernadou, U. S. N., addressed the Society on "Korea and the Koreans." His lecture was illustrated by lantern slides. *Revised and published in The National Geographic Magazine. 8°. Washington D. C. August, 1890. Vol. 2, no. 4, pp. 231–242.*

April 18, 1890. *39th meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. Vice-President Hayden in the chair. Attendance, 90.

Ensign Hugh Rodman, U. S. N., read a paper on "Icebergs and field ice in the North Atlantic." The communication was illustrated by lantern slides. *Published by the U. S. Hydrographic Office with this title—No. 93. Report of ice and ice movements in the North Atlantic Ocean, by Ensign Hugh Rodman, U. S. N., under the direction of Capt. Henry F. Picking, U. S. N., Hydrographer. 8°. Washington, government printing office. 1890. 26 pp. 1 folder, 4 maps.*

The paper was briefly discussed by Mr. Hayden.

May 2, 1890. *40th meeting.*

Meeting held in the Lecture Hall of the National Museum. Vice-President Ogden in the chair. Attendance, 450.

Mr. W. W. Rockhill read a paper giving an account of "A journey through Mongolia, China and Thibet," made by him in 1888–1889. The communication was illustrated by lantern slides. The material embodied in this paper with much more on the same subject has been *published in The Century. 8°. New York, 1890, Nov. Vol. 41, no. 1, pp. 1–17; Dec. no. 2, pp. 250–263; Jan. 1891, no. 3, pp. 350–361; Feb. no. 4, pp. 599–606; Mar. no. 5, pp. 720–730.*

May 7, 1890. *Special meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. President Hubbard in the chair. Attendance, 50.

This was a special meeting called to consider the following propositions.

First: Methods of increasing membership.

Second: The employment of a salaried assistant secretary.

Third: The establishment of a monthly periodical.

Fourth: The formation of sections, or auxiliary societies, throughout the country.

Messrs. Baker, Blodgett, Gilbert, Goodfellow, Hayden, Hornaday, J. B. Johnson, W. D. Johnson, Kenaston, McGee, Ogden, Gilbert Thompson, Weed and Welling took part in the discussion of these propositions. There was unanimity of sentiment as to the desirability of increasing the membership and employing a salaried assistant secretary and editor.

With regard to the third and fourth propositions sentiment was divided.

Action was taken by the adoption of the following :—

Resolved: That the members of the Society pledge themselves severally to use their best endeavors to obtain two new members each for the Society, within the next ten days and report their names to the Secretary of the Society.

Resolved: That a committee of five, of which the President shall be chairman, be appointed by the President for the purpose of devising plans and raising means for carrying out the purposes for which the Society is organized.

The President named as such committee,

Messrs. Gardiner G. Hubbard, *Chairman*,
Marcus Baker,
Henry Gannett,
A. W. Greely,
Everett Hayden.

May 16, 1890. *41st meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. Vice-President Hayden in the chair. Attendance, 50.

Mr. Josiah Pierce, Jr., read a paper on "The Ordnance Survey of Great Britain—its history and object," which was illustrated by numerous maps and drawings. The paper was discussed by Messrs. Baker, Bartle, Gannett, Gilbert, W. D. Johnson, Littlehales, Gilbert Thompson and the author. *Published in The National Geographic Magazine. 8°. Washington, D. C. August, 1890. Vol. 2, no. 4, pp. 243–260.*

——— Summer Vacation. ———

November 26, 1890. *Special meeting.*

Meeting held in Lincoln Music Hall. Hon. W. T. Harris presided. Attendance, 800.

Mr. I. C. Russell delivered an address on the results of the exploration made by him under the auspices of the National Geographic Society, last summer, in the vicinity of Mt. St. Elias, Alaska. The address was illustrated by wall maps and lantern slides. A full report of this exploration *will be published in The National Geographic Magazine. An article on the subject is also expected to appear in The Century, April, 1890.*

November 28, 1890. *42d meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. President Hubbard in the chair. Attendance, 90.

The chair announced the election to membership since the meeting of May 23, 1890, of 148 new members.

Mr. Mark B. Kerr read a paper on the results of his surveys last summer in company with Mr. I. C. Russell in the vicinity of Mt. St. Elias, Alaska. The paper was discussed by Messrs. Abbe, Baker, Dall, Gannett, Gilbert, Ogden and Woodward. *Revised and published in Scribner's Magazine. 8°. New York, 1891, March, Vol. 9, no. 3, pp. 361–372.*

Mr. I. C. Russell exhibited a painting of Taku Glacier, Alaska, made by Mr. Keith, of San Francisco, and made a few explanatory remarks thereon.

December 12, 1890. *43d meeting.*

Meeting held in the Lecture Hall of the Columbian University. Vice-President Hayden in the chair. Attendance, 200.

Ensign J. M. Ellicott, U. S. N., delivered an address, illustrated by lantern slides, on "Surveys executed by the U. S. S. Ranger in Lower California." *Not yet published.*

December 19, 1890. *Special meeting.*

Meeting held in the Lecture Hall of the Columbian University. Vice-President Ogden in the chair. Attendance, 100.

The President, Gardiner G. Hubbard, delivered his annual address, on the subject "South America." *Published in The National Geographic Magazine. 8°. Washington, D. C. March, 1891. Vol. 3, pp. 1–30.*

December 26, 1890. *44th (3d annual) meeting.*

Meeting held in the Assembly Hall of the Cosmos Club.

The annual report of the Secretaries was presented. *Printed on pages 296–298.*

The annual report of the Treasurer was presented and referred to an auditing committee consisting of Messrs. P. H. Christie, R. D. Cummin and S. A. Aplin, Jr. *Printed on pages 299, 300.*

The annual election of officers, for 1891, was then held with the following result:

President—Gardiner G. Hubbard.

Vice-Presidents—H. G. Ogden [land];
Everett Hayden [sea];
A. W. Greely [air];
C. Hart Merriam [life];
Henry Gannett [art].

Treasurer—Charles J. Bell.

Recording Secretary—Marcus Baker.

Corresponding Secretary—C. A. Kenaston.

Managers—Rogers Birnie, Jr.,
G. K. Gilbert,
G. Brown Goode,
W. D. Johnson,
W J McGee,
T. C. Mendenhall,
W. B. Powell,
B. H. Warder.

January 9, 1891. *45th meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. President Hubbard in the chair. Attendance, 30.

Report of the auditing committee appointed at the last meeting was presented and adopted. *Printed on page 301.*

Article IV of the By-laws was amended by striking out the following clause: "The Vice-Presidents, together with the two Secretaries, shall constitute a committee of the Board of Managers on Communications and Publications."

Vice-President Hayden, Department of the Sea, and Vice-President Merriam, Department of Life, presented their annual reports. *Not yet published.*

January 23, 1891. *46th meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. President Hubbard in the chair. Attendance, 35.

Vice-President Greely, Department of the Air, and Vice-President Ogden, Department of the Land, presented their annual reports. *Not yet published.*

February 6, 1891. *47th meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. President Hubbard in the chair. Attendance, 50.

The meeting was devoted to an account of the U. S. S. Pensacola expedition to the west coast of Africa.

Mr. Cleveland Abbe described the cruise in general terms and gave some account of the geodetic surveys executed in and the climate of South Africa.

Mr. Heli Chattelaine, of Switzerland, read a paper on the Dialects and Folk-Lore of the Portugese portion of West Africa.

Mr. Frank H. Bigelow read a paper on the island of Ascension.

February 13, 1891. *Special meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. Vice-President Greely in the chair. Attendance, 225.

Hon. Geo. B. Loring, Ex-U. S. Minister to Portugal, delivered an address upon the "Kingdom of Portugal." *Not published.*

February 20, 1891. *48th meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. Vice-President Hayden in the chair. Attendance, 40.

Mr. F. H. Newell read a paper on "Natural Gas and Oil in the Eastern United States." This paper was discussed by Mr. W J McGee.

Mr. C. D. Walcott read a paper on "The North American Continent during the Cambrian." This paper was discussed by Messrs. Gilbert and McGee. It is planned to publish the paper in *The National Geographic Magazine, Vol. 3.*

February 27, 1891. *Special meeting.*

Meeting held in the Assembly Hall of the Cosmos Club. Vice-President Greely in the chair. Attendance, 225.

Major C. E. Dutton, U. S. A. delivered an address upon "The Hawaiian Islands: their scenery, volcanoes, people, and politics, with a few words about the reciprocity treaty with the United States."

Foregoing abstract prepared by the secretaries March 2, 1891.

NATIONAL GEOGRAPHIC SOCIETY.

THIRD ANNUAL REPORT OF THE SECRETARIES.

Presented to the Society, December 26, 1890.

Membership.—The Society was organized in January, 1888, with a total membership of 165.

At the close of its first year, in December, 1888, the membership was 209. At the close of the second year, in December, 1889, the membership was 228; and the present membership is 392.*

Since the last annual meeting the membership has been increased by the election of 190 new members. It has been decreased by the resignation of 10 members, by the death of 1 member (Capt. C. O. Boutelle) and by the dropping of 15 members for non-payment of dues. The net increase has thus been 164, and the present total membership is 392 as above stated.

This membership is classified as follows:

Active members	331
Corresponding members	57
Life members	4
Total number of members	392

At the beginning of the year, corresponding members paid no dues. On March 20 of this year, however, the By-Laws were so amended as to require these members to pay annual dues of $2.00, such payment entitling them to the publications of the Society.

Meetings.—The Society has held 22 meetings during the year, of which, 13 were regular meetings for the reading and discussion of papers, 4 were public lectures at which an admission fee

* The membership has since increased to 399, as shown by the summary on p. 334.

was charged, 1 was a field meeting at the Great Falls of the Potomac on May 21, 1 was a special meeting for considering ways and means for increasing the Society's usefulness, 1 was the meeting for presentation of the annual address of the President for 1889 (delayed by reason of absence of the President from the city), 1 was the meeting for the presentation of the President's address for 1890, and 1 the annual meeting for the election of officers and transaction of business.

At the regular meetings for the reading and discussion of papers, the average attendance was 170, the highest being 850 and the lowest 25.

The Board of Managers have held 23 meetings for transacting the business of the Society, of which 13 were regular and 10 were special meetings. The highest attendance of the 17 members composing the Board was 13, and on several occasions there has been no quorum.

Changes in the Board.—On November 5, the Recording Secretary, Mr. Henry Gannett, resigned, and the Board of Managers filled the vacancy by electing Mr. Marcus Baker in his place. The Board then elected Mr. Gannett as one of the Managers. On December 9, Mr. O. H. Tittmann resigned the office of Corresponding Secretary, and Dr. J. C. Welling resigned from the Board of Managers. The vacancies thus created have not been filled.

Explorations.—In the month of May the Board of Managers decided to send a party to the vicinity of Mt. St. Elias, Alaska, for the purpose of making geographic and geologic exploration and survey. Funds for the purpose were obtained in part from the treasury of the Society, in part from private subscription and in part from the coöperation of the U. S. Geological Survey. Mr. I. C. Russell, Geologist of the U. S. Geological Survey, was placed in charge of the party and of geologic work, and Mr. Mark B. Kerr, Topographer, also of the U. S. Geological Survey, was sent in charge of the topographic work.

Through the kindly coöperation of the U. S. Navy Department and of the U. S. Revenue Marine, both of which furnished transportation, the party reached the field of work and was brought away at the close of their labors without mishap or loss of time. The party, consisting all told of nine persons, were enabled to spend about three months in exploration and survey of a most interesting and unknown region filled with gigantic mountains smothered in glaciers. An area of several hundred square miles was mapped, mountain peaks climbed, heights measured, photographs made and numerous and interesting notes obtained. A final report of this, the Society's first venture in exploration, is now in preparation and its publication by the Society is expected in a short time.

Publications.—During the year the Society has published volume II of the National Geographic Magazine. This volume contains 285 pages, together with maps and illustrations, and was issued in four numbers, in April, May, July and August.

Marcus Baker,
C. A. Kenaston,
Secretaries.

REPORT OF THE TREASURER.

PRESENTED TO THE SOCIETY, DECEMBER 26, 1890.

To the President and Members of the National Geographic Society:

I have the honor to submit herewith my annual report showing receipts and disbursements for the fiscal year ending December 26, 1890.

As will be seen by the report, the receipts from dues for 1890 amount to $\$1289^{00}$ against $\$865^{00}$ for 1889, showing an increase of $\$424^{00}$.

The assets of the Society consist of—

Note of M. N. Thompson, secured by deed of trust,	$750 00
Cash with Bell & Co.	41 62
Dues for 1890, unpaid	260 00
	$1051 62

Respectfully submitted,

C. J. BELL, Treasurer.

The Treasurer in account with the National Geographic Society.

1890.			
	To balance on hand, December 26, 1889		$63 82
Dec. 26.	" cash rec'd for dues of 1889	$95 00	
	" " " " 1890	1289 00	
	" " " " 1891	62 00	
	" " " " 1892	5 00	
	" " " Life Membership	50 00	
			1501 00
	" " from Lectures		834 38
	" " " Interest on Loan		45 00
	" " " Sales of Magazines		38 75
			$2482 95
1890.			
Dec. 26.	By cash paid for Magazine, No. 1, Vol. 2	$148 10	
	" " " " 2 "	215 80	
	" " " " 3 "	188 53	
	" " " " 4 "	140 83	
			$693 26
	" " Expenses of Lectures		815 30
	" " Subscription to Alaska Explor. Fund		517 66
	" " Printing, Stationery, Postage, etc.		308 66
	" " Clerk hire		65 00
	" " Cosmos Club Rent		33 00
	" " Sundries		8 45
	" balance on hand (on deposit with Bell & Co.)		41 62
			$2482 95

Washington, D. C., 26th December, 1890.

REPORT OF THE AUDITING COMMITTEE.

PRESENTED TO THE SOCIETY JANUARY 9, 1891.

To the President and Members of the National Geographic Society:—

We, a committee appointed at the annual meeting of the Society to audit the accounts of the Treasurer for the year ending December 31, 1890, beg to submit the following report :

The statement of the receipts, consisting of dues from members, receipts from lectures, interest on loan and sale of magazines, has been examined and found correct.

The vouchers for expenditures and checks in payment therefor have been examined, compared and found correct.

We have examined the bank book, showing the account with Messrs. Bell & Co., and found the balance to be $41.62 as stated.

The Treasurer also showed us a note for $750 which is mentioned as part of the assets of the Society.

P. H. CHRISTIE,
ROBT. D. CUMMIN,
S. A. APLIN, JR.,
Committee.

SUMMARY OF REPORTS ON THE MT. ST. ELIAS EXPEDITION.

During the year 1890, the National Geographic Society made its first venture in exploration. This venture consisted in raising funds, organizing and sending to the vicinity of Mt. St. Elias, Alaska, a small party in charge of Mr. I. C. Russell to make geographic and geologic studies. The following is a condensed account of the enterprise, taken largely from reports of committees and other records not otherwise published.

During the spring months of 1890, the Board of Managers of the National Geographic Society considered from time to time ways and means for carrying out the declared purpose of the Society "to increase and diffuse geographic knowledge." The advisability of undertaking some exploratory work was discussed. That geographic knowledge could be *diffused* by lectures and by publications was obvious. But to *increase* geographic knowledge other means were clearly necessary. Exploration seemed the most obvious mode for accomplishing this increase. What particular exploration should be undertaken was then considered. A proposition to aid in continuing the researches of Mr. W. W. Rockhill, in Thibet, was made but was given up on account of the expense, which seemed beyond the means of the Society. Later a proposition by Mr. W. D. Johnson that the Society should send a party to the vicinity of Mt. St. Elias, Alaska, was submitted and adopted provisionally, the proviso relating to success in securing the necessary funds. This proposition was submitted to the Board of Managers May 20, and adopted May 23, 1890.

Four days later, viz., on May 27, 1890, a largely attended special meeting of the Board went over the whole matter. It was submitted that the probable cost of the expedition would be about $3500; that of this sum about $2500 had already been paid or pledged and that 13 persons had signed a joint note for $1000 by which to secure the needful balance and insure the departure of the expedition. Furthermore it was submitted that the Secretary of the Navy had directed the U. S. S. Pinta to transport the party from Sitka to Yakutat Bay and return, and the Director of the U. S. Geological Survey had authorized the detail of Mr. I. C. Russell, geologist, and Mr. Mark B. Kerr, topographer, for the scientific work of the expedition.

A long and earnest discussion was had on the advisability of starting the expedition out on this basis. The lateness of the season and the low condition of the funds were urged as reasons for delaying till next year. It was finally decided, however, by a vote of 7 to 5 to adopt the proposition now and start the expedition forthwith.

Thus, by the aid and coöperation of the U. S. Geological Survey and of the Secretary of the Navy, the expedition was organized. Mr. I. C. Russell, geologist, was placed in charge, and Mr. Mark B. Kerr was assigned as topographer of the party. The plan of work was to proceed to Yakutat Bay and to study and map as large an area in the vicinity of Mt. St. Elias as practicable. It was also planned to redetermine the height of the mountain, and, if practicable, to ascend it.

The party consisted all told of ten persons ; Messrs. Russell and Kerr before mentioned, Mr. E. S. Hosmer, a volunteer assistant from Washington, and seven camp hands, hired in Seattle, of whom James H. Christie was foreman. On June 17, they sailed on the steamer Queen for Sitka, where, on arriving, they found the U. S. S. Pinta in readiness to take them to Yakutat, in accordance with instructions previously received from the Secretary of the Navy. They were at once transferred with all their outfit from the Queen to the Pinta, and sailed for Yakutat Bay, arriving June 25, in fog and rain.

Three days later the party, with all stores and equipment, had been landed ; and bidding good-bye to the courteous officers of the Pinta, they entered upon the serious work of the season.

The area to be examined was found to consist of a majestic mountain range, trending southeast and northwest, in front of which was a broad, ice-covered plateau. The range is snow-clad down to a level of 1500 feet above the sea, and is filled with glaciers of vast magnitude. Excursions into this area and a study of its glacial and geological phenomena were at once begun. At the same time Mr. Kerr measured a base line and began the work of mapping the region. A system of triangulation starting from this measured base was carried on, the prominent peaks were located by intersection, and heights were determined by vertical angles. Sketches and photographs were taken from many points, and before the season closed, sufficient material was gathered to make a fairly good map of an area of about 1000 square miles.

The topographic work having been well started and a base camp established, the party took up the line of march toward Mt. St. Elias. On the first of August they found themselves midway between Yakutat Bay and St. Elias, but still at the base of the mountains. Most of the way to this point the journey had been made over crevassed ice. The party continued to push on, and after twenty days of very severe labor above the snow line reached and camped at the base of St. Elias. From this camp, at an elevation of about 9,000 feet, the party started at 3 o'clock in the morning for the final climb to the summit of the mountain, but were beaten back by a prolonged and severe storm with heavy fall of snow. Two days later a second attempt was made, but another snow storm broke over the mountains as suddenly as the first. The deep snow accumulated by these two storms prevented all further progress, and the party reluctantly turned back. They continued to travel about in the region, while wending their way slowly back to Yakutat, gathering interesting and valuable geographic and geologic data. On the 20th of September they arrived at Yakutat Bay, having had almost continuous stormy weather since the attempted climb of the mountain. Two days after their arrival at Yakutat the U. S. Revenue Cutter Corwin, Capt. C. L. Hooper commanding, was seen steaming up the bay. Acting on his own judgment, and knowing that the explorers would fare badly if left at Yakutat until winter set in, Capt. Hooper had come from Sitka especially for the party, which was taken on board Sept. 24, and conveyed directly to Port Townsend, Washington, where it arrived October 2 and disbanded, Messrs. Russell and Kerr returning to Washington.

Various newspaper accounts of this expedition have been published, as well as articles in several magazines, notably in Scribner's, and the Century. The full official report with map and illustrations will be published hereafter in the *National Geographic Magazine.*

BY-LAWS.

As adopted with Amendments up to January 9, 1891.

Article I. Name.

The name of this Society is the "National Geographic Society."

Article II. Object.

The object of this Society is the increase and diffusion of geographic knowledge.

Article III. Membership.

The members of this Society shall be persons who are interested in geographic science. There may be three classes of members, active, corresponding, and honorary.

Active members only shall be members of the corporation; shall be entitled to vote and may hold office.

Persons residing at a distance from the District of Columbia may become corresponding members of the Society. They may attend its meetings, take part in its proceedings, and contribute to its publications.

Persons who have attained eminence by the promotion of geographic science may become honorary members.

Corresponding members may be transferred to active membership, and, conversely, active members may be transferred to corresponding membership by the Board of Managers.

The election of members shall be entrusted to the Board of Managers. Nominations for membership shall be signed by three active members of the Society; shall state the qualifications of the candidate; and shall be presented to the Recording Secretary. No nomination shall receive action by the Board of Managers until it has been before it at least two weeks, and no candidate shall be elected unless he receive at least nine affirmative votes.

Article IV. Officers.

The Officers of the Society shall be a President, five Vice-Presidents, a Treasurer, a Recording Secretary, and a Corresponding Secretary.

The above mentioned officers, together with eight other members of the Society, known as Managers, shall constitute a Board of Managers. Officers and Managers shall be elected annually, by ballot, a majority of the votes cast being necessary to an election; they shall hold office until their successors are elected; and shall have power to fill vacancies occurring during the year.

The President, or, in his absence, one of the Vice-Presidents, shall preside at the meetings of the Society and of the Board of Managers; he shall, together with the Recording Secretary, sign all written contracts and obligations of the Society, and attest its corporate seal; he shall deliver an annual address to the Society.

Each Vice-President shall represent in the Society and in the Board of Managers a department of geographic science, as follows:

Geography of the Land.
Geography of the Sea.
Geography of the Air.
Geography of Life.
Geographic Art.

The Vice-Presidents shall foster their respective departments within the Society; they shall present annually to the Society summaries of the work done throughout the world in their several departments.

They shall be elected to their respective departments by the Society.

The Treasurer shall have charge of the funds of the Society, shall collect the dues, and shall disburse under the direction of the Board of Managers; he shall make an annual report; and his accounts shall be audited annually by a committee of the Society and at such other times as the Board of Managers may direct.

The Secretaries shall record the proceedings of the Society and of the Board of Managers; shall conduct the correspondence of the Society; and shall make an annual report.

The Board of Managers shall transact all the business of the Society, except such as may be presented at the annual meeting. It shall formulate rules for the conduct of its business. Nine members of the Board of Managers shall constitute a quorum.

Article V. Dues.

The annual dues of active members shall be five dollars, and of corresponding members two dollars, payable during the month of January, or, in the case of new members, within thirty days after election.

The dues of members elected in November and December shall be credited to the succeeding year.

Annual dues may be commuted and life membership acquired by the payment of fifty dollars.

No member in arrears shall vote at the annual meeting, and the names of members two years in arrears shall be dropped from the roll of membership.

Article VI. Meetings.

Regular meetings of the Society shall be held on alternate Fridays, from November until May, and excepting the annual meeting they shall be devoted to communications. The Board of Managers shall, however, have power to postpone or omit meetings, when deemed desirable. Special meetings may be called by the President.

The annual meeting for the election of officers shall be the last regular meeting in December.

The meeting preceding the annual meeting shall be devoted to the President's annual address.

The reports of the retiring Vice-Presidents shall be presented in January.

A quorum for the transaction of business shall consist of twenty-five active members.

Article VII. Amendments.

These by-laws may be amended by a two-thirds vote of the members present at a regular meeting, provided that notice of the proposed amendment has been given in writing at a regular meeting at least four weeks previously.

STANDING RULES OF THE BOARD OF MANAGERS.

ADOPTED JANUARY 16, 1891.

1.—The President, Vice-Presidents and Secretaries of the Society shall hold like offices in the Board of Managers.

2.—The President shall have power to call special meetings of the Board of Managers and to appoint special committees. He shall, also, at the beginning of each year appoint a Standing Committee, of three persons, on Communications; a Standing Committee, of three persons, on Publications; and three delegates, of which he shall be chairman, to serve on the Joint Commission.

3.—The Treasurer shall receive all dues and other income of the Society; shall keep its accounts; and shall disburse its funds under the direction of the Board of Managers.

4.—One of the Secretaries shall act as the Secretary of the Board and the other as Secretary of the Society; and both Secretaries shall be excused from serving on committees.

5.—The Committee on Communications shall receive and consider all communications, and propositions relating to communications, designed for delivery before the Society, and shall prepare programmes for all meetings.

6.—The Committee on Publications shall have charge of the publications of the Society.

7.—At the beginning of each year the Secretary shall submit an estimate of the revenues of the Society for the current year, whereupon, the Board shall make itemized appropriations for the different classes of regular expenditures. All expenditures not included in these regular allotments must be specially authorized by the Board. Charges against the regular allotments will be paid by the Treasurer upon the certification of the officer or chairman of the committee incurring the expenditures.

8.—The names of proposed members, recommended in conformity with Article III of the By-Laws, may be presented at any meeting of the Board of Managers and shall lie over at least two weeks before final action.

9.—The order of business at the regular meetings of the Board of Managers shall be as follows :

a. Reading of minutes.

b. Communications from the President, Secretaries or Treasurer and action thereon.

c. Reports of committees and action thereon.

d. Election of members.

e. Nominations for membership.

f. Miscellaneous business.

10.—The order of business for each regular meeting of the Society shall be as follows :

a. Reading of the minutes of the last meeting.

b. Notice of the election of new members and other notices and correspondence of the Society.

c. The presentation of papers and their discussion.

11.—The order of business for the annual meeting shall be as follows :

a. The reading of the minutes of the last annual meeting.

b. The presentation of the annual reports of the Secretaries.

c. The presentation of the annual report of the Treasurer.

d. The selection of a committee to audit the accounts of the Treasurer.

e. The announcement of a posted list of the names of members who are entitled to vote for the election of officers.

f. The election of a President.

g. The election of five Vice-Presidents, in the order named in the By-Laws.

h. The election of a Treasurer.

i. The election of a Recording Secretary.

j. The election of a Corresponding Secretary.

k. The election of eight Managers.

l. Unfinished business.

m. The reading of the rough minutes of the meeting.

The election of officers shall be as follows :

In each case nominations shall be made by an informal ballot : the result of each informal ballot having been announced, the first formal ballot shall be taken. An informal ballot may be made formal by a majority vote. Each of the Vice-Presidents shall be elected to his position separately.

In the ballot for Managers, as many names may be written on the ballot as there are Managers to be elected, and those persons receiving a majority on each formal ballot shall be declared elected. If more than the number to be elected receive a majority, those receiving the greatest number of votes shall be declared chosen.

12.—It is not permitted to report the proceedings of the Society for publication, except by authority of the Board of Managers.

13.—These rules may be amended by a majority vote, notice having been given two weeks in advance.

RULES RELATING TO PUBLICATION.

Adopted by the Board of Managers February 6, 1891.

Form of Publication.

Section 1. The National Geographic Society will continue to publish a serial entitled *The National Geographic Magazine.*

Sec. 2. This serial shall be published in covered parts or brochures, consecutively paged for each volume. The brochures shall be designated by volume numbers and limiting pages; and each shall bear a special title setting forth the contents and authorship, as well as the title of the serial and the seal and imprint of the Society, and, in addition, the precise date of publication.

Sec. 3. A brochure may consist of a single memoir or article, in which case twenty-five copies will be furnished to the author without charge, and the author may order or authorize the order of any additional number of copies; and the shorter papers, abstracts, reviews, notes and miscellaneous matter may be collected and issued as brochures uniform with those containing the memoirs.

Sec. 4. The brochures of the serial shall be arranged for gathering into volumes, each comprising the issue of a calendar year; and about the close of each year there shall be published in a brochure arranged to complete the volume a title-page, a list of contents, and an index for the corresponding volume, together with an abstract of the proceedings of the Society and lists of officers and members for the year, and a copy of the by-laws and rules governing the Society.

Matter of Publication.

Sec. 5. The matter published in the National Geographic Magazine, may comprise: (1) original communications prepared by members or guests of the National Geographic Society presented at meetings by title or otherwise; (2) original communications or memoirs prepared for the Magazine either by members or non-members, whether presented before the Society or not; (3) translations or abstracts of important foreign publications relating to geography, reviews of geographic works, items of geographic intelligence, etc.; (4) abstracts of papers read and discussions made before the Society, prepared or revised by authors; (5) administrative records of the Society, including condensed minutes of meetings prepared by the secretaries; (6) lists of members, by-laws and rules, resolutions of permanent character, etc.; and (7) title pages, lists of contents and indexes for each volume.

SEC. 6. Matter designed for publication in the National Geographic Magazine may be transmitted to the Committee on Publications either direct or through the secretaries or other officers of the Society: soon as may be thereafter the Committee shall decide on the desirability and expediency of publication, or refer the matter to the Board of Managers for decision; if the matter is accepted it shall be published soon as practicable; if rejected it shall be returned to the author. Communications from non-members and translated memoirs shall be published only upon unanimous vote of the Committee on Publications or by specific authority from the Board of Managers. The Committee on Publications or the Board of Managers may refer any communication to special committees for examination.

SEC. 7. Matter offered for publication in the National Geographic Magazine becomes thereby the property of the National Geographic Society and shall not be published elsewhere prior to publication in the Magazine except by consent of the Society.

SEC. 8. Matter accepted for publication in the National Geographic Magazine shall be either printed and issued soon as possible as a memoir-brochure or reserved for the next brochure of miscellaneous contents (or magazine-brochure) at the option of the Committee on Publications. Proofs of letter-press and illustrations shall be submitted to authors or persons designated by authors whenever practicable; but printing shall not be delayed more that one week by reason of absence or incapacity of authors.

Manner of Publication.

SEC. 9. The text of each brochure of the National Geographic Magazine shall begin under its proper title on an odd-numbered page bearing at its head the title of the serial, the volume, the limiting pages, and the date of publication; each such brochure shall be accompanied by the illustrations pertaining to it, the plates consecutively numbered for the volume ; and each brochure may contain a synoptic list of contents prepared by the author and, at the option of the Committee on Publications, an alphabetic index, provided the same be prepared by the author. Each brochure shall be enclosed in a cover conforming nearly as may be to the present covers of the serial, bearing at the head of its title-page the title of the serial, the volume, the limiting pages, the date of publication, and, below, the seal and imprint of the Society ; other cover pages may bear a list of the publications of the Society; but nothing else of bibliographic or other permanent value shall be printed on the covers unless the same be printed also in the body of the volume to which the brochure belongs.

Sec. 10. The author of each memoir shall receive twenty-five copies without charge and shall be authorized to order, through the committee on Publications, any edition of exactly similar brochures in exactly similar covers to be printed as author's separates at cost of paper and press work ; but no author's separates of the memoir-brochures shall be issued except in this regular form.

Sec. 11. At least two magazine-brochures may be published during each year, the first about the close of the meeting season of the Society, and the second about the close of the calendar year.

Sec. 12. Authors of papers in the magazine-brochures shall have the privilege of ordering, through the Committee on Publications, at their own cost, any number of separate copies, provided these separates bear the original pagination and a printed reference to the serial and volume from which they are extracted.

Sec. 13. About the end of each year a volume-title-page, general lists of contents and illustrations of the volume, lists of officers and members of the Society, the by-laws and rules, an abstract of the proceedings for the year, and a general index to the volume shall be printed and issued as a separate brochure. All of this matter except the index shall be arranged for binding at the beginning of the volume under a distinct Roman pagination ; but the index shall take the regular Arabic pagination at the end of the volume. The title-page shall bear the name of the Committee on Publications ; and the obverse shall bear the imprimatur of the Board of Managers and the printer's card.

Sec. 14. The bottom of each signature and of each initial page shall bear a signature mark giving an abbreviated title of the serial, the volume and the year; and every page shall be numbered, the initial and sub-title pages at the bottom.

SEC. 15. The page-head titles shall be: on even-numbered pages, name of author and catch title of paper; on odd-numbered pages, catch title of contents of page.

SEC. 16. All brochures shall be trimmed at top, side and bottom.

SEC. 17. The typography, paper and general make up shall conform, except as herein otherwise specified, nearly as may be to the National Geographic Magazine as heretofore published.

SEC. 18. The date of publication of each brochure shall be that upon which the edition is delivered to the Committee on Publications.

SEC. 19. The brochures shall be distributed immediately by the Committee on Publications to members of the Society, subscribers, and exchanges from a list furnished by the Secretaries; and the undistributed copies of each edition shall be turned over to the Secretaries.

SEC. 20. The regular edition shall be seven hundred and fifty copies for the Society, and twenty-five copies for authors.

SEC. 21. The Committee on Publications shall keep a record of all matter published wholly or in part under the auspices of the Society whether the same be author's editions of the memoir-brochures, author's extracts from the magazine-brochures, or any other matter printed from type originally composed for the Magazine.

SEC. 22. The Magazine shall be mailed free to members of the Society not in arrears for dues more than six months, and also to exchanges, and for an annual price of three dollars to regular subscribers. The separate brochures may be sold, to the number of not more than ten to each individual, at an advance on cost of 25 per cent. to members and 75 per cent. to non-members of the Society; and either separate brochures or complete volumes may be sold to dealers at the usual discount for matter of the same class.

SEC. 23. The Committee on Publications may introduce at discretion advertisements of proper character, on pages provided for the purpose not taking the regular pagination of the Magazine, at the usual rates for such service.

OFFICERS OF THE SOCIETY.

1891.

President.

GARDINER G. HUBBARD.

Vice-Presidents.

HERBERT G. OGDEN.
EVERETT HAYDEN.
A. W. GREELY.
C. HART MERRIAM.
HENRY GANNETT.

Treasurer.

CHARLES J. BELL.

Secretaries.

MARCUS BAKER.
C. A. KENASTON.

Managers.

ROGERS BIRNIE, JR.
G. K. GILBERT.
G. BROWN GOODE.
WILLARD D. JOHNSON.
W J McGEE.
T. C. MENDENHALL.
W. B. POWELL.
B. H. WARDER.

*

MEMBERS OF THE SOCIETY.

MARCH 25, 1891.

---

a, original members.
c, corresponding members.
l, life members.
* Deceased.
In cases where no city is given in the address, Washington, D. C., is to be understood.

ABBE, PROF. CLEVELAND, *a*, *l*,
Army Signal Office.

ABERT, S. THAYER (Silvanus Thayer),
1108 G Street.

ACKERMAN, ENS. A. A. (Albert Ammerman), U. S. N., *c*,
Navy Department.

ACKLEY, LIEUT. COMDR. S. M. (Seth Mitchell), U. S. N.,
Coast and Geodetic Survey.

ADDISON, A. D. (Arthur D———)
Metropolitan Club.

AHERN, LIEUT. GEORGE P. (George Patrick), U. S. A., *c*,
Fort Shaw, Mont.

AHERN, JEREMIAH,
Geological Survey.

AINSWORTH, J. T. (Judah Throop),
Geological Survey.

ALLEN, DR. J. A. (Joel Asaph),
American Museum Natural History, New York, N. Y.

ALTON, EDMUND,
Wormley's Hotel.

APLIN, S. A., JR. (Stephen Arnold),
Geological Survey.

ASPINWALL, REV. J. A. (John Abel),
17 Dupont Circle.

ATKINSON, W. R. (William Russum), *a*,
Geological Survey.

AYRES, MISS S. C. (Susan Caroline), *a*,
502 A Street SE.

Babb, Cyrus C. (Cyrus Cates),
Geological Survey.

Bailey, William E. (William E———), *c*,
Seattle, Wash.

Baker, Dr. Frank, *a*,
Smithsonian Institution.

Baker, Marcus, *a*,
Geological Survey.

Baldwin, H. L., Jr. (Harry Lewis), *a*,
Geological Survey.

Barclay, A. C. (Alexander Campbell),
Geological Survey.

Barker, Comdr. A. S. (Albert Smith), U. S. N.,
Navy Department.

Barnard, E. C. (Edward Chester), *a*,
Geological Survey.

Barnes, Charles A. (Charles Adams), *c*,
P. O. Box 1198, Seattle, Wash.

Barroll, Lieut. Henry H. (Henry Harris), U. S. N., *c*,
Navy Department.

Bartle, R. F. (Rudolph Francis),
947 Virginia Avenue SW.

Bartlett, Comdr. J. R. (John Russell), U. S. N., *a*,
Providence, R. I.

Bartlett, P. V. S. (Pliny Van Syckle),
Geological Survey.

Bass, D. W. (Daniel Waldo), *c*,
15–17 Starr-Boyd Building, Seattle, Wash.

Bassett, C. C. (Charles Chester), *a*,
Geological Survey.

Batchelder, C. F. (Charles Foster), *c*,
7 Kirkland Street, Cambridge, Mass.

Bauer, Louis A. (Louis Agricola),
Coast and Geodetic Survey.

Bausch, Paul,
War Department.

Baxter, David N. (David N———), *c*,
Seattle, Wash.

Bell, A. Graham (Alexander Graham), *a*,
1336 Nineteenth Street.

Bell, A. Melville, (Alexander Melville),
1525 Thirty-fifth Street.

Bell, C. J. (Charles James), *a*,
1437 Pennsylvania Avenue.

BENNETT, ASST. ENG. F. M. (Frank Marion), U. S. N.,
Navy Department.

BERNADOU, ENS. J. B. (Jean Baptiste), U. S. N., *c*,
Navy Department.

BIEN, JULIUS, *a*,
P. O. Box 3557, New York, N. Y.

BIEN, MORRIS, *a*,
Geological Survey.

BIGELOW, PROF. FRANK H. (Frank Hagar),
Nautical Almanac Office.

BIRCH, CHARLES E. (Charles Edwards),
Hydrographic Office.

BIRNIE, CAPT. R., JR. (Rogers), U. S. A., *a*,
Ordnance Office.

BLAIR, H. B. (Herbert Buxton), *a*,
Geological Survey.

BLODGETT, JAMES H. (James Harvey), *a*,
Census Office.

BODFISH, SUMNER H. (Sumner Homer), *a*,
58 B Street NE.

BOURSIN, HENRY,
Douglas City, Alaska.

*BOUTELLE, CAPT. C. O. (Charles Otis), *a*.

BOWERS, DR. STEPHEN, *c*,
Ventura, Cal.

BRECKINRIDGE, GEN. J. C. (Joseph Cabell), U. S. A.,
War Department.

BREWER, H. G. (Harrison Gaston), *a*,
Hydrographic Office.

BRITTON, A. T. (Alexander Thompson),
1419 G Street.

BUCKLEY, MISS M. L. (Margaret Lamiea),
Bureau of Pensions.

BURNETT, CHARLES A. (Charles Albert), *c*,
620 Burke Building, Seattle, Wash.

BURTON, PROF. A. E. (Alfred Edgar), *a*,
Massachusetts Institute of Technology, Boston, Mass.

CAMPBELL, M. R. (Marius Robison),
Geological Survey.

CANTWELL, LIEUT. J. C. (John Cassin), U. S. R. M., *c*,
1818 Sacramento Street, San Francisco, Cal.

CARPENTER, H. W. (Henry Wilson),
Geological Survey.

*Carpenter, Z. T. (Zachary Taylor), *a*,

Chamberlin, Prof. T. C. (Thomas Chrowder), *c*,
University of Wisconsin, Madison, Wis.

Chapin, Dr. J. H. (James Henry),
Meriden, Conn.

Chapman, R. H. (Robert Hollister), *a*,
Geological Survey.

Chatard, Dr. Thomas M. (Thomas Marean), *a*,
Geological Survey.

Chenery, Lieut. Comdr. Leonard, U. S. N., *c*,
University Club, New York, N. Y.

Chester, Comdr. C. M. (Colby Mitchel), U. S. N., *c*,
Navy Department.

Christie, James H. (James H———), *c*,
Olga, Wash.

Christie, P. H. (Peter Harrison),
Geological Survey.

Clark, A. Howard (Alonzo Howard),
National Museum.

Clark, E. B. (Elias Buckner), *a*,
Geological Survey.

Clark, Dr. William B. (William Bullock), *c*,
Johns Hopkins University, Baltimore, Md.

Clover, Lieut. Richardson, U. S. N.,
Hydrographic Office.

Colonna, B. A. (Benjamin Azariah),
Coast and Geodetic Survey.

Colvin, Verplanck, *a*,
Albany, N. Y.

Conant, A. W. (Arnold William), *c*,
Seattle, Wash.

Cook, Fred. W. (Frederick William), *c*,
P. O. Box 140, Sault de Ste. Marie, Mich.

Corse, William B. (William Beverly),
Geological Survey.

Cottman, Lieut. V. L. (Vincendon Lazarus), U. S. N., *c*,
Navy Department.

Court, E. E. (Emil Edward),
Hydrographic Office.

Craven, Lieut. John E. (John Eccleston), U. S. N.,
Hydrographic Office.

Croffut, W. A. (William Augustus),
Geological Survey.

Cummin, Robt. D. (Robert Dodge), *a*,
Geological Survey.

Cummings, Prof. G. J. (George Jotham),
Howard University.

Cunningham, John M. (John M———), *c*,
Cosmos Club, San Francisco, Cal.

Curtis, William E. (William Eleroy), *a*,
2 Lafayette Square.

Dall, Wm. H. (William Healey),
National Museum.

Daly, Hon. Charles P. (Charles Patrick),
84 Clinton Place, New York, N. Y.

Darton, N. H. (Nelson Horatio),
Geological Survey.

Davidge, Walter Dorsey, Jr.,
1 Corcoran Building.

Davidson, Prof. George, *a*, *c*,
U. S. Coast and Geodetic Survey, San Francisco, Cal.

Davis, A. P. (Arthur Powell), *a*,
Geological Survey.

Davis, Prof. W. M. (William Morris), *a*,
2 Bond Street, Cambridge, Mass.

Dawson, Miss A. B. (Annie Beatrice),
Geological Survey.

Day, Dr. David T. (David Talbot),
Geological Survey.

Denny, A. A. (Arthur Armstrong), *c*,
1328 Front Street, Seattle, Wash.

Diebitsch, Emil,
District Engineer Department.

Diller, J. S. (Joseph Silas), *a*,
Geological Survey.

Dobbins, J. W. (John William),
U. S. Geological Survey, Lamar, Colo.

Douglas, E. M. (Edward Morehouse), *a*,
Geological Survey.

Dow, Capt. John M. (John Melmoth),
83 W. Seventy-first Street, New York, N. Y.

Dunnington, A. F (Abner F), *a*,
Geological Survey.

Durand, John,
164 Bd. Montparnasse, Paris, France.

DUTTON, MAJ. C. E. (Clarence Edward), U. S. A., *a*,
Ordnance Office.

DYER, LIEUT. G. L. (George Leland), U. S. N.,
Navy Department.

EDMANDS, PROF. J. RAYNER (John Rayner),
Harvard University, Cambridge, Mass.

EDSON, JOHN JOY,
1003 F Street.

EDSON, JOSEPH R. (Joseph Romanzo), *a*,
1003 F Street.

EELLS, CHARLES P. (Charles P———), *c*,
Pacific-Union Club, San Francisco, Cal.

EIMBECK, WILLIAM,
Coast and Geodetic Survey.

ELDRIDGE, G. H. (George Homans),
Geological Survey.

ELIOT, CHARLES,
50 State Street, Boston, Mass.

ELLICOTT, ENS. JOHN M. (John Morris), U. S. N.,
Office of Naval Intelligence.

EMMONS, LIEUT. GEO. T. (George Thornton), U. S. N.,
Navy Department.

EVANS, H. C. (Henry Cotheal),
804 Eleventh Street.

FAIRCHILD, PROF. H. L. (Herman LeRoy), *c*,
University of Rochester, Rochester, N. Y.

FAIRFIELD, GEORGE A. (George Albert), *a*,
Coast and Geodetic Survey.

FAIRFIELD, W. B. (Walter Browne), *a*,
Coast and Geodetic Survey.

FARENHOLT, LT. COMDR. O. W. (Oscar W———), U. S. N.,
Navy Department.

FARMER, R. A. (Robert Andrews),
Geological Survey.

FERNOW, B. E. (Bernhard Eduard), *a*,
Department of Agriculture.

FEUSIER, H. E. CLERMONT (Henry Edward Clermont),
Geological Survey.

FISCHER, ERNST G. (Ernst George), *a*,
Coast and Geodetic Survey.

FISCHER, L. A. (Louis Albert),
Coast and Geodetic Survey.

FITCH, C. H. (Charles Hall), *a*,
Geological Survey.

FLETCHER, LIEUT. F. F. (Frank Friday), U. S. N.,
Navy Department.

FLETCHER, L. C. (Louis Cass), *a*,
Geological Survey.

FLETCHER, DR. ROBERT, *a*,
Army Medical Museum.

FLINT, COL. WESTON,
1101 K Street.

FLOYD, FRED. W. (Frederick William),
539 W. Twentieth Street, New York, N. Y.

FOOT, SAM'L A. (Samuel Alfred),
Geological Survey.

FOSTER, PROF. RICHARD,
Howard University.

FRASER, DANIEL,
458 Pennsylvania Avenue.

GAGE, N. P. (Nathaniel Parker), *a*,
Seaton School

GANNETT, HENRY, *a*,
Geological Survey.

GANNETT, MRS. HENRY (Mary Chase),
1881 Harewood Avenue.

GANNETT, S. S. (Samuel Stinson), *a*,
Geological Survey.

GILBERT, G. K. (Grove Karl), *a*,
Geological Survey.

GILL, DELANCEY W. (DeLancey Walker),
Geological Survey.

GILL, WILSON L. (Wilson Lindsley), *c*,
Room 57, 115 Broadway, New York, N. Y.

GILMAN, DR. DANIEL C. (Daniel Coit), *a*,
Johns Hopkins University, Baltimore, Md.

GILMAN, D. H. (Daniel H———), *c*,
Seattle, Wash.

GOLDIE, R. H. (Robert Henry), *c*,
P. O. Box 1110, Seattle, Wash.

GOODE, DR. G. BROWN (George Brown), *a*,
National Museum.

GOODE, R. U. (Richard Urquhart), *a*,
Geological Survey.

GOODFELLOW, EDWARD, *a*,
Coast and Geodetic Survey.

GOODISON, PROF. JOHN,
State Normal School, Ypsilanti, Mich.

GORHAM, GEO. C. (George Congdon),
929 New York Avenue.

GRAHAM, ANDREW B. (Andrew Butler),
1230 Pennsylvania Avenue.

GRANGER, F. D. (Frank DeWolf),
Coast and Geodetic Survey.

GREELY, GEN. A. W. (Adolphus Washington), U. S. A., *a*,
Army Signal Office.

GRISWOLD, W. T. (William Tudor), *a*,
Geological Survey.

GROEGER, G. G. (Gustaf George), *c*,
310 Chamber of Commerce Building, Chicago, Ill.

GULLIVER, F. P. (Frederic Putnam),
Geological Survey.

HACKETT, M. (Merrill), *a*,
Geological Survey.

HALE, L. P. (Ledyard Park), *c*,
Canton, N. Y.

HARRIS, DR. T. W. (Thaddeus William),
Harvard University, Cambridge, Mass.

HARRISON, D. C. (Dabney Carr), *a*,
Geological Survey.

HARRISON, PROF. T. F. (Thomas F———), *c*,
806 Broadway, New York, N. Y.

HARROD, MAJ. B. M. (Benjamin Morgan),
City Engineer's Office, New Orleans, La.

HART, PROF. ALBERT BUSHNELL,
Harvard University, Cambridge, Mass.

HASBROUCK, E. M. (Edwin Marble),
Census Office.

HASKELL, E. E. (Eugene Elwin), *a*,
Coast and Geodetic Survey.

HAWKINS, GEO. T. (George Thomson),
Geological Survey.

HAYDEN, EVERETT, U. S. N., *a*,
Hydrographic Office.

HAYES, DR. C. WILLARD (Charles Willard),
Geological Survey.

HAYS, J. W. (John Willis),
Geological Survey.

HAZARD, D. L. (Daniel Lyman),
Coast and Geodetic Survey.

HEATON, A. G. (Augustus George),
1618 Seventeenth Street.

HENRY, A. J. (Alfred Judson), *a*,
Army Signal Office.

HENSHAW, H. W. (Henry Wetherbee), *a*,
Bureau of Ethnology.

HERRLE, G. (Gustave), *a*,
Hydrographic Office.

HERRON, WM. H. (William Harrison), *a*,
Geological Survey.

HILL, PROF. R. T. (Robert Thomas),
P. O. Box 567, Austin, Texas.

HINMAN, RUSSELL,
806 Broadway, New York, N. Y.

HITCHCOCK, PROF. C. H. (Charles Henry), *c*,
Dartmouth College, Hanover, N. H.

HODGKINS, PROF. H. L. (Howard Lincoln). *a*,
Columbian University.

HODGKINS, W. C. (William Candler),
Coast and Geodetic Survey.

HOLDEN, PROF. E. S. (Edward Singleton), *c*,
Lick Observatory, Mount Hamilton, Cal.

HOLDEN, MRS. L. E. (Delia E———), *c*,
The Hollenden, Cleveland, O.

HOLLERITH, HERMAN,
501 F Street.

HORNADAY, W. T. (William Temple), *a*,
44 Niagara Street, Buffalo, N. Y.

HOSKINS, PROF. L. M. (Leander Miller), *c*,
University of Wisconsin, Madison, Wis.

HOSMER, EDWARD STURGES,
1330 L Street.

HOTCHKISS, MAJ. JED. (Jedediah),
346 E. Beverly Street, Staunton, Va.

HOWARD, ENS. W. L. (William Laurestien), U. S. N., *c*,
Navy Department.

HOWELL, E. E. (Edwin Eugene), *a*, *c*,
48 Oxford Street, Rochester, N. Y.

HOWELL, D. J. (David Janney), *a*,
918 F Street.

HUBBARD, GARDINER G. (Gardiner Greene), *a*,
1328 Connecticut Avenue.

HYDE, G. E. (George Edwin),
Geological Survey.

HYDE, JOHN,
Census Office.

IARDELLA, C. T. (Charles Thaddeus), *a*,
Coast and Geodetic Survey.

INGRAHAM, E. S. (Edward S———), *c*,
Seattle, Wash.

JENNEY, PROF. W. P. (Walter Proctor),
Geological Survey.

JENNINGS, J. H. (James Henry), *a*,
Geological Survey.

JEWETT, W. P. (William Parker), *c*,
180 E. Third Street, St. Paul, Minn.

JOHNSON, MISS ALICE BURGES,
501 Maple Avenue.

JOHNSON, A. B. (Arnold Burges), *a*,
Light House Board.

JOHNSON, E. KURTZ (Erastus Kurtz),
1600 Massachusetts Avenue.

JOHNSON, H. W. (Harry Woodruff),
805 H Street.

JOHNSON, J. B. (James Bowen),
Howard University.

JOHNSON, REV. J. G. (James Gibson),
381 Dearborn Avenue, Chicago, Ill.

JOHNSON, JEROME F. (Jerome Fletcher),
1326 F Street.

JOHNSON, DR. JOSEPH TABER,
1728 K Street.

JOHNSON, S. P. (Stuart Phelps),
Geological Survey.

JOHNSON, WILLARD D. (Willard Drake), *a*,
Geological Survey.

JUDD, JOHN G. (John Gough),
420 Eleventh Street.

JUDSON, EGBERT, *c*,
402 Front Street, San Francisco, Cal.

JUNKEN, CHARLES,
Coast and Geodetic Survey.

JUNKEN, CHAS. A. (Charles Alexander),
Army Ordnance Office.

JÜSSEN, EDMUND,
Geological Survey.

KARL, ANTON, *a*,
Geological Survey.

KAUFFMANN, S. H. (Samuel Hay), *a*,
1421 Massachusetts Avenue.

KAVANAUGH, MISS K. (Katherine),
Sixth Auditor's Office.

KENASTON, PROF. C. A. (Carlos Albert), *a*,
Howard University.

KENNAN, GEORGE, *a*,
1318 Massachusetts Avenue.

KENNEDY, DR. GEO. G. (George Golding), *l*,
284 Warren Street, Roxbury, Mass.

KENNON, LIEUT. L. W. V. (Lyman Walter Vere), U. S. A.,
War Department.

KERR, H. S. (Halbert Stevens), *c*,
Salt Lake City, Utah.

KERR, MARK B. (Mark Brickell), *a*,
402 Front Street, San Francisco, Cal.

KIMBALL, E. F. (Edward Fenno),
Post Office Department.

KIMBALL, DR. E. S. (Edward Sullivan),
713 Twelfth Street.

KIMBALL, S. I. (Sumner Increase), *a*,
Life Saving Service.

KING, PROF. F. H. (Franklin Hiram),
University of Wisconsin, Madison, Wis.

KING, PROF. HARRY, *a*,
Geological Survey.

KING, WM. B. (William Bruce),
P. O. Box 593.

KING, WILLIAM R. (William Robinson),
Department of Agriculture.

KLAKRING, ALFRED,
Hydrographic Office.

KNAPP, HON. LYMAN E. (Lyman Enos),
Sitka, Alaska.

KNIGHT, FRED. J. (Frederick Jay), *a*,
Geological Survey.

KOCH, PETER, *a*,
Bozeman, Mont.

KRAMER, WILLIAM,
Geological Survey.

KÜBEL, S. J. (Stephen Joseph),
Geological Survey.

LACKLAND, W. E. (William Eason), *a*,
Geological Survey.

LADD, G. E. (George Edgar),
State Geological Survey, Jefferson City, Mo.

LAMBERT, M. B. (Marcus Bachman),
Geological Survey.

LAMBORN, DR. ROBERT H. (Robert Henry),
32 Nassau Street, New York, N. Y.

LEACH, BOYNTON,
Hydrographic Office.

LINDENKOHL, A. (Adolphus), *a*,
Coast and Geodetic Survey.

LINDENKOHL, H. (Henry), *a*,
Coast and Geodetic Survey.

LIPPINCOTT, J. BARLOW (Joseph Barlow),
Geological Survey.

LITTLEHALES, G. W. (George Washington),
Hydrographic Office.

LONGSTREET, R. LEE (Robert Lee), *a*,
Geological Survey.

LOOKER, HENRY B. (Henry Brigham),
918 F Street.

LOOMIS, HENRY B. (Henry Bradford), *c*,
Seattle, Wash.

LOVELL, W. H. (William Henry),
Geological Survey.

LYONS, JOSEPH,
1003 F. Street.

McCARTENEY, LIEUT. CHAS. M. (Charles Macklin), U. S. N.
Hydrographic Office.

McCORMICK, JAMES,
Geological Survey.

McDONALD, COL. MARSHALL,
Fish Commission.

McDOWELL, W. O. (William Osborne), *c*,
20 Spruce Street, Newark, N. J.

McGEE, W J, *a*,
Geological Survey.

McGILL, MISS MARY C. (Mary Cecelia),
336 C Street.

McKEE, REDICK H. (Redick Henry), *a*,
Geological Survey.

McKINNEY, R. C. (Robert Christian), *a*,
Geological Survey.

McLAUGHLIN, DR. T. N. (Thomas Notley),
825 Fourteenth Street.

MACKAYE, J. M. (James Medbery),
Census Office.

MAHER, JAMES A. (James Arran), *a*,
P. O. Box 35, Johnson City, Tenn.

MANNING, VAN. H. JR. (Vannoy Hartrog), *a*,
Geological Survey.

MARINDIN, HENRY L. (Henry Louis),
Coast and Geodetic Survey.

MARSHALL, R. B. (Robert Bradford),
Geological Survey.

MASON, PROF. O. T. (Otis Tufton),
National Museum.

MATTHEWS, DR. W. (Washington), U. S. A., *a*,
Fort Wingate, N. M.

MEANY, EDWARD S. (Edward S———), *c*,
Seattle, Wash.

MELVILLE, ENG. IN CHIEF GEO. W. (George Wallace), U. S. N., *a*, *l*,
Navy Department.

MENDENHALL, PROF. T. C. (Thomas Corwin),
Coast and Geodetic Survey.

MENOCAL, CIV. ENG. A. G. (Aniceto Garcia), U. S. N., *a*,
Navy Department.

MERRIAM, DR. C. HART (Clinton Hart), *a*,
Department of Agriculture.

MERRILL, PROF. J. A. (James Andrew), *c*,
State Normal School, Warrensburg, Mo.

METZGER, F. P. (Frederick Philip),
Geological Survey.

MINDELEFF, COSMOS,
Bureau of Ethnology.

MINDELEFF, VICTOR,
Room 55, 918 F Street.

MITCHELL, PROF. HENRY, *a*,
18 Hawthorne Street, Roxbury, Mass.

MITCHELL, J. W. (John William),
3234 N Street.

MOSMAN, A. T. (Alonzo Tyler), *a*,
Coast and Geodetic Survey.

MUIR, PROF. JOHN,
Martinez, Cal.

MUNSON, T. V. (Thomas Volney), *c*,
P. O. Drawer M, Denison, Tex.

MURLIN, A. E. (Arlington Elliott),
Geological Survey.

NATTER, E. W. F. (Ernst Wilhelm Franz), *a*,
Readville, Mass.

NELL, LOUIS (Louis Maximilian), *a*,
Geological Survey.

NEWELL, F. H. (Frederick Haynes),
Geological Survey.

NILES, PROF. WM. H. (William Harmon),
Massachusetts Institute of Technology, Boston, Mass.

NOETZEL, G. (Gregor),
Hydrographic Office.

NORDHOFF, CHARLES, *a*,
Ensenada, Lower California, *via* San Diego, Cal.

NORMAN-NERUDA, L. (LOUIS), *c*,
Devonshire Club, St. James Street, London, England.

OGDEN, HERBERT G. (Herbert Gouverneur), *a*,
Coast and Geodetic Survey.

O'HALORAN, T. M. (Thomas Michael),
Hydrographic Office.

O'HARE, DANIEL P. (Daniel Patrick),
Geological Survey.

OTIS, WILLIAM H. (William Hartshorn),
U. S. Geological Survey, Lamar, Colo.

OSBORN, LIEUT. A. P. (Arthur Patterson), U. S. N., *c*,
Navy Department.

PALMER, T. S. (Theodore Sherman),
Department of Agriculture.

PARKER, E. W. (Edward Wheeler),
Geological Survey.

PARSON, REV. W. E. (William Edwin),
309 New Jersey Avenue SE.

PARSONS, FRANCIS H. (Francis Henry), *a*,
Coast and Geodetic Survey.

PEALE, DR. A. C. (Albert Charles), *a*,
Geological Survey.

PEARY, CIV. ENG. R. E. (Robert Edwin), U. S. N.
League Island Navy Yard, Philadelphia, Pa.

PELLEW, HENRY E. (Henry Edward),
1637 Massachusetts Avenue.

PENROSE, R. A. F., JR. (Richard Alexander Fuller),
State Geological Survey, Little Rock, Ark.

PERKINS, E. T., JR. (Edmund Taylor), *a*,
Geological Survey.

PETERS, LIEUT. G. H. (George Henry), U. S. N., *a*,
Navy Department.

PETERS, WILLIAM J. (William John), *a*,
Geological Survey.

PHELAN, W. W. (Warren Waverley), *c*,
108 S. Fifth Street, Brooklyn, N. Y.

PHILLIPS, R. HENRY (Robert Henry),
Room 110, 1419 New York Avenue.

Pickering, Prof. E. C. (Edward Charles),
Harvard Observatory, Cambridge, Mass.

Picking, Capt. Henry F. (Henry Forry), U. S. N.,
Tompkinsville, N. Y.

Pierce, Josiah, Jr.,
Cosmos Club.

Piper, Charles V. (Charles V———), *c*,
Seattle, Wash.

Powell, Maj. J. W. (John Wesley), *a*,
Geological Survey.

Powell, Prof. W. B. (William Bramwell), *a*,
Franklin School.

Prentiss, Dr. D. Webster, (Daniel Webster), *a*,
1101 Fourteenth Street.

Prince, Hon. L. Bradford (L——— Bradford), *c*,
Santa Fé, N. M.

Procter, Prof. John R. (John Robert), *c*,
State Geological Survey, Frankfort, Ky.

Pumpelly, Prof. Raphael,
U. S. Geological Survey, Newport, R. I.

Rankin, Dr. J. E. (Jeremiah Eames)
Howard University.

Reid, Prof. Harry Fielding, *c*,
Case School of Applied Science, Cleveland, O.

Renshawe, Jno. H. (John Henry), *a*,
Geological Survey.

Rice, Prof. William North, *c*,
Wesleyan University, Middletown, Conn.

Richmond, Chas. W. (Charles Wallace),
Department of Agriculture.

Richter, Miss C. M. (Clara Marie),
Dead Letter Office

Ricksecker, Eugene, *a*, *c*,
P. O. Box 289, Seattle, Wash.

Ritter, H. P. (Homer Peter), *a*,
Coast and Geodetic Survey.

Robbins, Prof. A. G. (Arthur Graham), *c*,
Massachusetts Institute of Technology, Boston, Mass.

Roberts, A. C. (Arthur Carr), *a*,
Hydrographic Office.

Rochester, Gen. Wm. B. (William Beatty), U. S. A.,
1320 Eighteenth Street.

Rock, Miles,
1430 Chapin Street.

Rodman, Ens. Hugh, U. S. N.,
Naval Observatory.

ROGERS, JNO. B. (John Baxter), *c*,
79 Flood Building, San Francisco, Cal.

ROSSE, DR. IRVING C. (Irving Collins),
1701 H Street.

ROTCH, A. LAWRENCE (Abbott Lawrence),
3 Commonwealth Avenue, Boston, Mass.

RUSSELL, ISRAEL C. (Israel Cook), *a*,
Geological Survey.

SARGENT, PROF. C. S. (Charles Sprague), *a*,
Arnold Arboretum, Brookline, Mass.

SCHAAP, C. H. (Christian Henry), *c*,
P. O. Box 32, Sitka, Alaska.

SCHLEY, CAPT. W. S. (Winfield Scott), U. S. N., *a*,
Navy Department.

SCHMIDT, FRED. A. (Frederick Andrew),
504 Ninth Street.

SCIDMORE, MISS ELIZA RUHAMAH,
1502 Twenty-first Street.

SCUDDER, PROF. S. H. (Samuel Hubbard), *a*,
Cambridge, Mass.

SHALER, PROF. N. S. (Nathaniel Southgate), *a*,
25 Quincy Street, Cambridge, Mass.

SHEPARD, J. L. N. (J——— L——— N———), *c*,
402 Front Street, San Francisco, Cal.

SINCLAIR, C. H. (Cephas Hempstone),
Coast and Geodetic Survey.

SINCLAIR, J. C. (John Collins),
718 Arch Street, Philadelphia, Pa.

SLOAN, ROBERT S. (Robert Sage), *c*,
Oswego, N. Y.

SMITH, EDWIN, *a*,
Coast and Geodetic Survey.

SMITH, REV. ERNEST C. (Ernest C———), *c*,
Lake View and Baxter Streets, Seattle, Wash.

SMITH, EVERETT, *c*,
526 Burke Building, Seattle, Wash.

SMITH, MIDDLETON, *a*.
P. O. Box 572.

SNELL, MERWIN-MARIE (Merwin-Marie Fitzporter),
Catholic University of America.

SOMMER, E. J. (Ernest Julius), *a*,
Coast and Geodetic Survey.

SPENCER, JAS. W. (James William),
Geological Survey.

Stanley-Brown, Joseph,
Geological Survey.

Stedman, J. M. (John Moore),
Department of Agriculture.

Stein, Robert,
Geological Survey.

Stockton, Lt. Comdr. C. H. (Charles Herbert), U. S. N., *a*,
Navy Department.

Stone, James S. (James Savage), *c*,
131 Vernon Street, Newton, Mass.

Struve, Henry G. (Henry G———), *c*,
Seattle, Wash.

Sutton, Frank,
Geological Survey.

Tarbell, L. L. (Luther Lewis), *c*,
Custom House, Boston, Mass.

Taylor, Jas. L. (James Lochermann),
1300 Pennsylvania Avenue.

Thomas, Miss Mary von E. (Mary von Erden), *a*,
69 Clinton Street, Cincinnati, O.

Thompson, Prof. A. H. (Almon Harris), *a*,
Geological Survey.

Thompson, Gilbert, *a*,
Geological Survey.

Thompson, Laurence, *a*,
Care H. S. Huson, N. P. R. R., Tacoma, Wash.

Thompson, Capt. R. E. (Richard Edward), U. S. A., *a*,
Army Signal Office.

Tittmann, O. H. (Otto Hilgard), *a*,
Coast and Geodetic Survey.

Towson, R. M. (Richard Mathew), *a*,
Geological Survey.

Tuttle, Prof. A. H. (Alfred H———), *c*,
Charlottesville, Va.

Tweedy, Frank, *a*,
Geological Survey.

Urquhart, Chas. F. (Charles Fox), *a*,
Geological Survey.

Van Hise, Prof. C. R. (Charles Richard), *l*,
U. S. Geological Survey, Madison, Wis.

Vasey, Dr. George, *a*,
Department of Agriculture.

Vinal, W. Irving (Washington Irving), *a*,
Coast and Geodetic Survey.

VON HAAKE, A. (Adolph),
Post Office Department.

WADDEY, JOHN A. (John Alby),
Hydrographic Office.

WALCOTT, CHAS. D. (Charles Doolittle), *a*.
National Museum.

WALLACE, HAMILTON S. (Hamilton Stone), *a*,
Geological Survey.

WANAMAKER, HON. JOHN,
Post Office Department.

WARD, DILLIS B. (Dillis B———), *c*,
Seattle, Wash.

WARD, PROF. HENRY A. (Henry Augustus), *c*,
16 College Avenue, Rochester, N. Y.

WARD, LESTER F. (Lester Frank), *a*,
National Museum.

WARDER, B. H. (Benjamin Head),
1515 K Street.

WEED, WALTER HARVEY, *a*,
Geological Survey.

WEIR, JOHN B. (John Bradford), *a*,
The Clarendon.

WELLING, DR. JAMES C. (James Clarke), *a*,
Columbian University.

WEST, PRESTON C. F. (Preston Carpenter Firth), *c*,
Calumet, Mich.

WHITE, DR. C. H. (Charles Henry), U. S. N.,
Care A. B. Gilman, Bradford, Mass.

WHITING, HENRY L. (Henry Laurens),
U. S. Coast and Geodetic Survey, West Tisbury, Mass.

WILDER, GEN. J. T. (John Thomas), *a*, *l*,
Johnson City, Tenn.

WILDER, MISS MARY,
Johnson City, Tenn.

WILLENBÜCHER, EUGENE,
Coast and Geodetic Survey.

WILLENBÜCHER, W. C. (William Christian),
Coast and Geodetic Survey.

WILLIAMS, C. A. (Charles Augustus),
1301 Eighteenth Street.

WILLIAMS, WILLIAM, *c*,
University Club, New York, N. Y.

WILLIS, BAILEY, *a*,
Geological Survey.

Willis, Mrs. Bailey (Altona H. Grinnell),
1006 Twenty-second Street.

Willits, Hon. Edwin,
Department of Agriculture.

Wilson, H. M. (Herbert Michael), *a*,
Geological Survey.

Wimpffen, L. F. v. (Lebrecht Felix von),
Hydrographic Office.

Winchell, Prof. N. H. (Newton Horace), *c*,
120 State Street, Minneapolis, Minn.

*Windom, Hon. William.

Winslow, Prof. Arthur,
State Geological Survey, Jefferson City, Mo.

Winston, Isaac,
Coast and Geodetic Survey.

Woodward, R. S. (Robert Simpson), *a*,
Coast and Geodetic Survey.

Wright, Ens. Benjamin, U. S. N.,
Hydrographic Office.

Yeates, Chas. M. (Charles Marion), *a*,
Geological Survey.

Young, F. A. (Frederic Albert),
Coast and Geodetic Survey.

Summary.

Active members, ...	324
Corresponding members, ...	70
Life members, ...	5
Total,	399

INDEX TO VOLUMES I AND II.

(An * signifies that articles are referred to by title only.)