FRIDAY, APRIL 13, 1883.

THE NEW YORK STATE SURVEY.

SOME of the readers of SCIENCE are doubtless familiar with the work of the state survey of New York, and will be interested in the reports of its progress, which will be published from time to time for the information of our readers. But the work has been going on so quietly that many are unacquainted with the history of the survey, and the scope of its work. It is therefore as an introduction to occasional reports of progress that we publish a short sketch of the survey.

Several governors of New York had in vain called the attention of the legislature to the importance of such a survey. In the autumn of 1875 the matter was taken up by the American geographical society, which caused an investigation to be made into the character of the best existing maps. Having found them grossly erroneous, and productive of grave practical evils, the geographical society appointed a committee to secure, if possible, the necessary legislation to organize a state survey. This resulted in the passage of a law, organizing the survey under the direction of commissioners, who appointed Mr. James T. Gardiner, formerly geographer of the U. S. geological survey, to be director.

The first work of the director was a thorough examination of the evils which the state survey was expected to remedy; and his plan for the work is based on the results of this inquiry.

The report for 1876 showed that "although the boundaries of eleven counties, having over sixty corners, were examined in whole or part, yet only two corners were found marked with any authentic monuments. . . . The northwest corner of Albany county was originally marked by a dead hemlock-tree. This disappeared many years since, and no monument indicates the spot where it stood. A few old blazed trees alone remain as evidence of the western line of Albany county. . . . The original north-east corner of Montgomery county was a stake in a cultivated field. It has disappeared, and nothing marks the point."

Concerning local and private surveys, the observations and recommendations of the report are of importance to the whole country. It says: "The want of a permanent system of landmarks, whose distance and direction from one another are exactly known, renders positions of all lines very uncertain. Starting-points from which the surveyor is expected to begin his work are very often in doubt by many feet: he has, therefore, no object in running lines accurately, as it is evident, that, if the initial point of a survey is wrong, all points on the lines will be wrongly located, even when chaining and compass work are absolutely correct. . . . An examination of the present method of surveying lands must convince any engineer that its necessary imperfections are the principal sources of those annoying and expensive quarrels and litigations about boundaries with which all land-owners are painfully familiar. These troubles are by no means peculiar to American experience. Perishable landmarks and imperfect surveying have produced uncertain boundaries in every civilized country. Throughout Europe and India this evil has been perfectly remedied by basing all land-surveys upon a system of permanent monuments located by accurate triangulation. We must continue to waste force and money in quarrels and lawsuits over uncertain lines, until we apply the only cure which civilized Europe has found permanently satisfactory."

The accuracy of the best maps of the state was next tested, and they were found to represent the towns from one to three miles from where they really are. "If the purpose of maps is to describe truthfully boundary-lines, towns, and topographical features, as they actually exist on the earth's surface, then the maps of this state are proved to be false witnesses; and the sooner their character is known and condemned, the earlier may improvement be looked for."

The report proceeds to show that a sufficient remedy will never be applied through the exer-

tions of local authorities, or the enterprise of private map-publishers: "The radical difficulty with our modern surveys lies not in want of capacity, integrity, or ambition among the local surveyors, but in the want of a system of lines measured with absolute precision, and permanently marked, which can be made a base of all surveys, and can furnish checks at short distances, and keep errors within certain well-defined limits."

A trigonometrical survey of this nature, whenever completed, will be used in a great variety of ways, entirely independent of any topographical mapping that may be founded upon it. In pursuance of this policy, the survey has been confined to trigonometrical work.

The triangulation is based on that of the U. S. coast and geodetic survey, which had been extended across Massachusetts to the Hudson; certain stations on the Hudson River series of coast-survey triangles having been connected both with the New England and Fire Island bases. Comparison of results from these different lines of measurement shows that the positions of points overlooking the Hudson River valley are known with great exactness, and may therefore be used as starting-points for most accurate surveying.

The lines of principal triangulation are being pushed into the settled parts of the state as rapidly as possible, in order to set tertiary stations for use of local surveyors, wherever property is most valuable, and to save boundaries whose loss seems imminent. Principal stations being once established, the subdivision in smaller triangles, and determination of public boundaries, can proceed at separate places whenever demanded by the exigencies of special regions, and can be done at the expense of individuals, towns, and counties.

The Hudson valley is already well supplied with principal stations by the U. S. coast survey. The state survey has therefore planned to lay out a series of principal triangles extending from Albany westward through the central and western counties of the state; and another from the lower part of the Hudson, through what is known as the southern tier of counties. The first of these, or the central series of triangles, begins at the coast-survey stations, Rafinesque and Helderberg; the first being north-west of Troy, and the latter west of Albany on the Hudson River. The distance between these points, which is the base of this system of triangles, is about 36,966 metres. The triangulation beginning at the Hudson runs westward, spanning the valley of the Mohawk River, and the valleys which continue this great depression westward across New York. Along the shore of Lake Ontario, from Oswego to Buffalo, the U. S. lake survey has measured a small but accurate chain of triangles, a part of their main chain along the lakes. With this lake-survey triangulation, the scheme of the state survey was connected south of Oswego; the distance between the lake-survey stations, Victory and Clyde, being the joining line, and, in fact, forming a base from which work was begun on the western part of the state-survey chain, before connection was made with the Hudson River section.

The measurement of the angles of the larger triangles is done with 12-inch horizontal circles divided by Troughton and Simms of London. One of them was, however, mounted by Fauth and Co. of Washington. The Fauth theodolite has three reading microscopes divided to seconds, and a telescope of 23 inches focal length with object-glass of $2\frac{1}{2}$ inches diameter. The Troughton and Simms theodolite has two reading microscopes divided to seconds. The angles of the smaller secondary, and of the tertiary triangles, are measured with 8-inch Troughton and Simms circles with two reading microscopes divided to seconds. These instruments have also vertical circles divided and read in the same way as the horizontal.

A complete system of trigonometrical levelling is carried on in connection with the secondary and tertiary triangulation, the zenith distances being observed with the 8-inch circles. Measurement of the horizontal angles of each class are repeated until the probable errors are within the limits prescribed by the U. S. coast survey and the British ordnance

survey. The secondary stations along the Mohawk valley are from four to seven miles apart. Where tertiary work has been done, the stations are from half a mile to a mile distant from each other.

In the matter of marking stations, the New York survey has departed widely from the method of the U. S. coast survey, which has preserved its points by burying in the ground within eighteen inches of the surface a pot, jug, or other object, leaving no surface mark whatever. The state-survey stations are marked by sinking a hole five feet deep, in the bottom of which is placed an earthen pot of truncated-cone shape, with centre mark, and stamped with the letters 'N. Y. S. S.' The earth is rammed about and above this for about four inches. A granite monument six inches square by four feet long is then placed in the hole, and its centre adjusted over the pot. The upper extremity of the stone, which projects above ground, is dressed, and the same letters and the number which designates the station are cut deeply into it. Diagonal grooves on the top of the stone mark its centre.

The monuments are of one pattern, and from a single quarry. These stones, deeply embedded in the earth, are very difficult to move or destroy without the perpetrator of such an act being detected. They are easily found by local surveyors or others wishing to identify the points. The action of freezing and thawing unequally on the north and south sides of the stones will eventually throw them over toward the south. Any disturbance of this kind can be detected by the edges being out of plumb; and the stone can be recentred over the pot, which, being below frost-line, can never move. In addition to the deeply buried pot and stone, two witness-pots are buried from twelve to eighteen inches deep, and three feet from the station. On their tops are stamped arrows which point to the station.

The work of the survey is carried on by a director and a permanent corps of trained assistants divided into three parties, — two for observing angles of the primary and secondary triangles, and one for signal-building. Assistant O. S. Wilson, formerly of the U. S. northwest boundary survey, and Assistant Horace Andrews, jun., formerly of the U. S. coast survey, have charge of the observing parties; and Assistant O. H. Bogardus, of the signal-building party. In addition to the regular force, from six to nine heliotropers are employed in summer. During the winters the assistants are engaged in reducing the results, and the preparation of maps and reports, in the offices of the survey in the state capitol at Albany.

In the bill providing for the expenses of the state government, an annual appropriation of $15,800 is now made to carry on the survey.

This sketch of the causes which brought about the New York state survey, the purposes for which it was instituted, its guiding policy, its plans, grade of precision, methods, and organization, is essential to a right understanding of the results of the work whose progress will be described hereafter.

GLACIAL PHENOMENA IN OHIO.

PROF. G. F. WRIGHT of Oberlin read a paper before the Boston society of natural history on the 7th of March, giving the results of his work last summer in determining the exact southern boundary or terminal moraine of the glaciated area of Ohio. The course of this boundary-line is shown upon the accompanying map, and is a continuation of that traced by him and Professor Lewis the previous year across Pennsylvania.

The terminal moraine in Ohio is not everywhere so prominent in its features as it is south of New England, through Cape Cod, the Elizabeth Islands, and Long Island; but the southern boundary of the glaciated region is everywhere very sharply defined, and the limits of the ice can be traced with nearly as much certainty as the shores of the ocean. At various places in Stark, Holmes, Fairfield, and Ross counties there are vast piles of glaciated material at the very limit of the glaciated region. All that portion of Ohio north and west of the line above described is covered with the material which was ground up underneath, and transported by the moving ice. This consists of unstratified fine clay, containing scratched stones and fragments of rock of various kinds from the north. The average depth of this