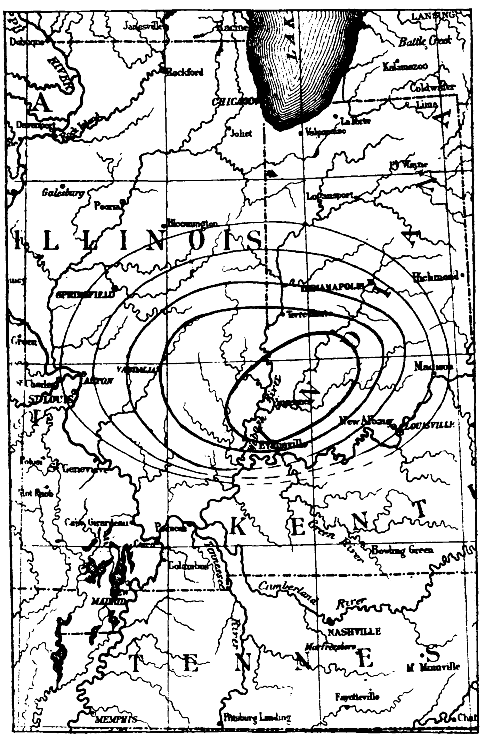
The disturbed area embraces about 35,000 square miles, and is elliptical in shape, the major axis lying nearly east and west. It is limited to the southward by the valley of the Ohio, and was but slightly felt south of the river. The reported directions of movement are, as usual, very inconsistent and of little value. It is generally reported that two distinct shocks were felt, each of a few seconds' duration, and with a small but very noticeable interval between them. A low rumbling was also generally observed as preceding and accompanying the shocks.

With the exception of Professor Mendenhall's



THE INDIANA EARTHQUAKE.

observation, the times given are not accurate enough to be of much utility. Coseismal lines, therefore, cannot be obtained for this earthquake. The speed with which a shock travels is so great, and the area and distances, relatively speaking, are so small, that it would require numerous time-determinations of very great precision to warrant any attempt to fix the coseismals.

Mr. Everett Hayden has 'weighed' the intensities, and has plotted, with his usual care and intelligence, the isoseismals herewith given. The closed curves are neither symmetric nor co-axial, and this seems to be certainly attributable, not to uncertainties of the reports alone, but to real asymmetry in the distribution of the force of the shocks, and to a real shifting of the axes of the figures as the elastic waves of energy spread out. It is not easy to make any comparison between this earthquake and others which from time to time occur in the valley of the Ohio, for it is the only case since the New Madrid earthquakes of 1811–12 when definite data in sufficient quantity have been gathered which would serve as the basis of such an estimate. In a general way, it may be said, however, that the intensity of the disturbance in the central portions was, on the whole, about equal to that exerted in the southern portion of Ohio, central Tennessee, and Kentucky by the Charleston earthquake of Aug. 31, 1886.

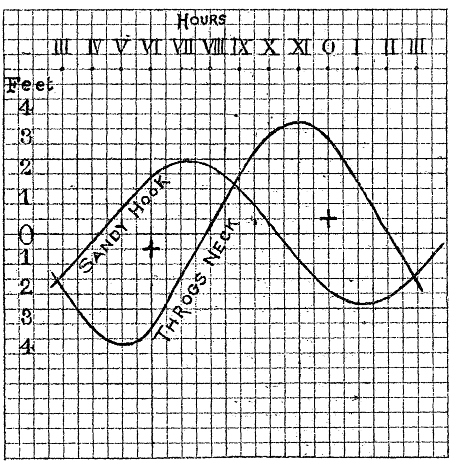
CIRCULATION OF THE SEA THROUGH NEW YORK HARBOR.

Two derivations of the tide enter New York harbor, one by way of Long Island Sound, the other by way of Sandy Hook Bar. The one that traverses the sound is much obstructed and 'crowded,' so that it arrives upon the scene four hours behind the other, and much augmented in 'range.'

These two tides meet, or pass into each other, at Hell Gate, and give to the city portion of the East River a composite 'rise-and-fall' and a peculiarly local system of tidal currents. The general scheme of this meeting and composition is to be found in the annual report of the coast survey for 1867, much as I should give it to-day, so I will not enter upon it here, but offer the accompanying diagram as the types of the tidal profiles.

The two figures are serpentine curves whose elements are those of the tides given in the tables of published charts for the two entrances to New York. From this diagram we observe that about three lunar hours after the moon's transit, the surface of the sound is at the same elevation as the sea at Sandy Hook. Later, they differ, and more and more widely, till at the sixth hour a maximum difference of height is reached, which exceeds five feet. Then a decline takes place, till at the ninth hour the sound and Sandy Hook Bay are again upon the same level. After this a slope in the opposite sense develops, reaching a maximum about the time of the next transit. The first slope, that between three hours and nine, is towards the sound, i.e., the sound continues through this interval to be lower than the harbor. The second slope is towards the harbor, and one may remember it easily as that which reaches its maximum at the 'southing of the moon,' and creates the 'ebb-current,' so called.

Referring again to the diagram, it will be seen that the two lunes, or spaces between the type-curves, are equal, i.e., the slopes creating the flood-current and the ebb-current, alternately, are equal in amount and duration. There is the same 'head' for one stream as for the other. But there is a very important difference in the positions of these lunes, which affects materially the relative values of the slopes they represent. I have marked with a cross the centre of each, and it will be observed that the right-hand lune is one foot above the other, — which means that the ebb (westerly) current is in deeper water and greater transverse section than the flood. It is, therefore, the larger stream, and, having greater 'hydraulic mean depth,' it is at most points the quicker also. The East River is delivering more water into New York harbor than it carries back again to the sound.



Although the Hudson and other rivers flow into New York harbor, and slightly raise its level, the conditions illustrated in our diagram are very nearly realized in the seasons when the fresh-water discharge is at a minimum. One of these seasons is the autumn ; the other is mid-winter, when the land-waters are ice-bound. At such times, the greater velocity being westward, and the greater depth of water being that of the westerly flow, there is, as a net result, a circulation of sea-water through the harbor from the sound to the ocean. In mid-winter this circulation, renewing the water before it can get chilled, and lowering the freezing-point, by mixing sea-water with the river discharge, serves to keep the port open to commerce. One may form some estimate of the value of the three or four degrees difference of freezing-points between sea and river waters, when it is remembered that in severe winters Halifax, Portland, and Boston have not closed before Philadelphia or even Baltimore.

This circulation also aids in maintaining the channels over the bar, which could not exist if the ebb and flood were equal, i.e., if there were no 'net-gain' of the sands swept to and fro ; for the bar is but a broken portion of the *cordon littoral* of which Sandy Hook and Coney Island are dry parts. Its channels are maintained by a slight preponderance of the seaward flow, as our observations distinctly show.

Another and nearly related advantage of this circulation is, that the heavier sea-water runs low, and sweeps the bed of the harbor ; whereas, were the harbor tideless, the river outflows would be superficial on reaching the basins, and these basins would in course of time fill up. This superficial flow of fresh waters on reaching the sea is a well-know phenomenon. The clear sea-water, with the full density of the ocean, may be pumped up from a few feet below the entirely fresh water of the surface at the mouths of many rivers, notably those of great discharge.

The fresh waters that enter from the Hudson and other streams play an insignificant part in the physics of the harbor ; but the circulation of the sea by way of the East River, although small in quantity, is the element which determines the superiority of New York harbor over nearly all the 'sand-barred inlets' of the world. It is this circulation which keeps the port open in winter and sweeps the sand from its threshold.

HENRY MITCHELL.

THE RECENT ERUPTION OF MAUNA LOA.

MAUNA LOA is again in eruption after an interval of six years since the lava-stream of 1881, which so closely grazed the town of Hilo. The present flow is on the south-west side of the mountain, entering the sea immediately north of the flow of 1868, or, rather, two miles from it. The source is about twelve miles farther up the mountain than in 1868, or twenty miles from the sea. An aneroid observation gave 5,700 feet elevation for the lower end of the fissure. The points of emission ranged for three miles along the vertical fissure, which appeared to extend some two miles higher.

On the evening of Jan. 16 a sharp jet of lava was observed shooting up from the Mokuaweoweo 'caldera' at the summit of Mauna Loa to an immense height, lasting ten minutes, with gradual subsidence. This is the common precursor of a flow from a lower point. The actual flow