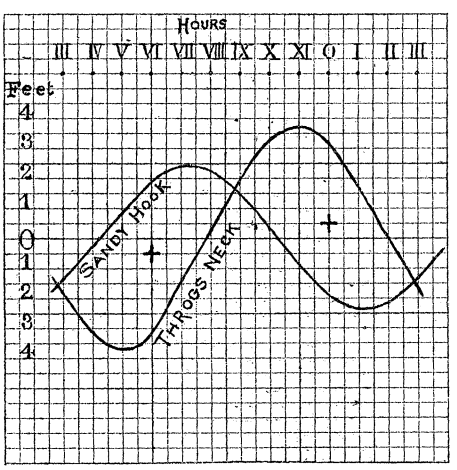
Referring again to the diagram, it will be seen that the two lunes, or spaces between the type-curves, are equal, i.e., the slopes creating the flood-current and the ebb-current, alternately, are equal in amount and duration. There is the same 'head' for one stream as for the other. But there is a very 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.

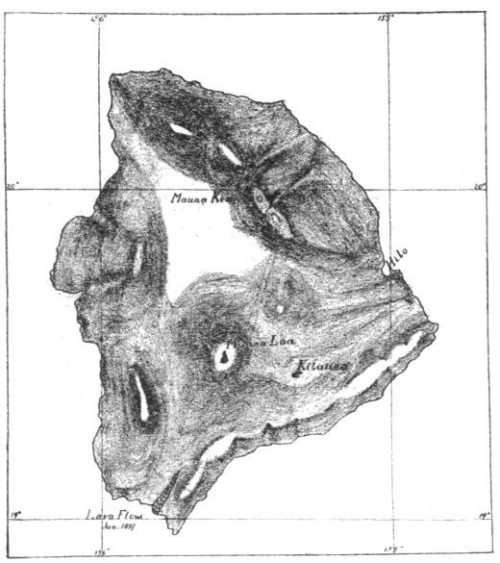
THE RECENT ERUPTION OF MAUNA LOA.

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

began on the 18th, more than halfway down the south-west flank, as above stated. It was extremely copious, rising in several large fountains from one hundred to two hundred feet high, and reached the sea in twenty-six hours. The width of the somewhat crooked and irregular stream probably averages three-fourths of a mile, which is about its width on the seashore.

I was unable to reach the scene until Feb. 2, when it had just ceased to flow, and there remained only the hideous scoria embankment — 'monstrum horrendum, informe, ingens, cui lumen ademptum.' Until the previous night the fountain had continued to be a powerfully brilliant object, and the streaming lava conspicuous on the



slopes. Spots of glowing cinder were still to be seen on the front of the embankment, as our steamer laid by for daylight. Our tourist crowd of two hundred people landed in the morning. No difficulty was experienced in traversing the many square miles of piled scoria in any direction, except the incredible raggedness of the surface. Occasional pits or rents disclosed the fiery interior. The lava seemed to be of unusually high specific gravity, judging by samples of wave-assorted fragments on the many beaches in the coves of the sea-front. The embankment seemed to average about thirty feet in depth above the old lava of the foot-plain of two miles, tumbling over a low precipice of twenty feet, having filled out from three hundred to five hundred feet into water of thirty fathoms, along four thousand feet of shore, making about thirty acres of new land. No cinder-cones had been formed by the contact with the sea on this occasion, although six or seven such stood in the immediate vicinity, one having risen out of the sea at the flow of 1868, and immediately been united by lava to the land.

This new flow is almost exclusively *aa*, or clinker. The neighboring flow of 1868, equally sudden and copious, was *pahoehoe*, or smooth, hummocky lava. The new flow appears to abound in olivine. Unlike the eruption of 1868, which was preceded by long-continued and destructive earthquakes, there was little premonition this time, and no very serious damage was done to the large sugar-mills a few miles distant, except the rupture of one reservoir in the vicinity of the mud-avalanche of 1868. In actual quantity of lava emitted, the present is largely in excess of the other. Experienced observers in Hilo are confident that this is only a temporary intermission of flow, and that activity will speedily be resumed, with probably a *pahoehoe* flow, such having been the general history of previous large eruptions, like those of 1881 and 1855.

I desire to note particularly the presence of a heavy stationary line of dark cloud, lying precisely over the line of the whole flow from the sea to high up in the mountain. This cloud remained without change of form or position during the twenty hours of our presence in the vicinity, and served to mark the position of all parts of the flow with great precision. Although a little puffing of steam was rising along the sea, nothing but dry heat ascended from any point inland, save two very small columns of sulphurous smoke four miles up. In walking over the flow, currents of highly heated air had to be avoided, but no steam was observed, nor smoke, nor troublesome fumes of any sort. Yet a dense and massive condensation of vapor was constantly going on directly overhead. I judged the source of this vapor to be solely and entirely from the inflowing currents of air with their ordinary charge of water-vapor. These were drawn in and driven up from the immense heated surface, and, on reaching the necessary height, precipitated their contents into the dark cloud-bank, just as naturally as the sea-breeze piles its clouds daily against the mountain-flank all along that coast. It needs to be understood that the evolution of heavy cloud above lava is no positive proof that steam is rising from that lava. The inflowing air-currents may supply all the vapor seen.

A similar but smaller cloud-bank was seen resting over Kilauea's fire-lakes as we steamed past late that afternoon. On the early morning of the eruption of 1868, I observed its glow from the distance of 143 miles at Lahaina, and obtained a good altitude of the enormous cumulus-cloud of vapor rising from its heat With due correc-

tions, this gave an estimated height of seven miles. Probably steam from the boiling sea was contributing to this cumulus. About six square miles of glowing surface were then radiating heat, all near the sea, the point of emission being only seven miles back, and 3,500 feet up. I judged, however, that the chief source of the vapor was the one above named, — inflowing atmospheric currents. That cumulus was naturally blazing with incessant lightning, visible even after sunrise at that immense distance. Some brownish smoke could be distinguished around the lowest part of the snow-white pile of cumulus. Previous to the actual outflow of 1868 an enormous emission of smoke had taken place, which densely shrouded Lahaina and the whole group for many days, objects one mile distant being invisible to us when at the thickest, and a very distinct odor of sulphur being present.

The present eruption was first announced to us at Honolulu by the pervading smoke, continuing from the 20th to the 30th of January. The smoke is evidently first discharged into the upper current, and transported far to the east-north-east before settling down into the trade wind, which brings it back upon us. S. E. BISHOP.

THE RIVIERA EARTHQUAKE.

THE accompanying sketch-map shows the scene of the late destructive earthquake. The centre of the disturbance was in the Italian province of Porto Maurizio and the adjoining French Departement des Alpes Maritimes. Two severe shocks in quick succession occurred on Feb. 23 at 6 A.M. They did a great deal of damage all along the coast, and were felt far inland. The heaviest loss of life and property was sustained in the district of Oneglia, 570 persons being killed and 156 injured. The villages of Diano-Marina, Diano-Castello, and Bajardo were almost destroyed. In the province of Genoa thirty-four persons were killed and thirty-seven injured, and in the Departement des Alpes Maritimes eleven persons were killed. The following reports show the extent of the disturbance: at Toulon two violent shocks were felt at 6 A.M., the first shock of fifteen seconds duration, the second of twelve seconds. The movements were from west to east. At Cannes three shocks were felt at the same hour. At Cuneo and Turin they did considerable damage. Earthquake shocks were observed in south-eastern France, Switzerland, Piedmont, Lucca, and Corsica. On Mount Vesuvius the instruments did not indicate any dis-