

NOTES ON AN ABNORMAL WAVE OCCURRENCE ON THE NORTHERN CAPE BRETON COAST.—BY D. S. McINTOSH, B. A., M. Sc., Professor of Geology, Dalhousie University, Halifax, N. S.

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The occurrence which formed the basis of this paper, while relatively of little importance, is thought by the writer to be of sufficient interest to be recorded in the Transactions of the Institute.

In a small indentation on the northern coast line of Cape Breton Island between Cape St. Lawrence and Bay St. Lawrence, is situated the little settlement of Meat Cove. It has no harbor, and the boats of the fishermen, after each trip, are hauled up on the beach beyond reach of the waves.

From correspondence with Mr. Joseph O'Brien, of Dingwall, Aspy Bay, supplemented by personal observation, Mr. A. H. McIntosh, of Pleasant Bay, furnished the writer with the following description of the wave phenomenon:

The monthly bulletin issued by the Department of Marine and Fisheries, Ottawa, gives the total catch of fish for Canada, also the kinds of fish, quantities and values. It also aims at giving such information as weather conditions during the month, loss of life, boats and gear among the fishermen.

In the copy for June 1914, we find this entry: "Nine boats were lost at Meat Cove, Victoria County." Had the facts connected with this loss been given they would have interested the readers of the publication. The following statement is given as what occurred. "On the evening of the night on which the boats were lost, the fishermen had

hauled them up on the beach to a place where they were considered to be in safety. A light wind began to draw from the land, and all the usual signs in which fishermen believe promised a fine night. Judge of the surprise of those men when on coming to the beach in the very early morning not only were their boats gone, but they were not even in sight on the sea. Eventually, one or two were found along the shore, but others were found only after some days had elapsed, picked up at great distances from the starting-place. The marks on the beach showed plainly that the tide had come up very much higher than usual, and while at this place, it seemed to have been the highest, it was also noted as an unusually high tide at Pleasant Bay on the west, and Bay St. Lawrence and Aspy Bay to the eastward. One man near Bay St. Lawrence, at about eleven o'clock, saw it come in the form of two large seas succeeding each other, and rushing on shore. A fishing schooner lying some two miles off shore also reports several heavy seas striking the vessel about the hour mentioned; otherwise the night was calm. Some six years before, this same vicinity was visited by something of the same nature, but as it came in the day, it occasioned no loss."

The above account shows plainly that the disturbance was abnormal. That it falls outside the category of tide phenomena is evident. It occurred on a calm night and consisted of a succession of high waves which continued for a brief period of time. Tidal waves of the nature of a bore or as the result of conflicting currents are in the highest degree improbable as an explanation. In searching about for a probable cause, one recalls some well-known and strikingly disastrous effects of great abnormal sea-waves.

In 1755, Lisbon was laid in ruins by an earthquake which had its origin about 50 miles off the coast. About half an hour after the shock, a succession of high waves, one of which had a height of 60 feet, reached the city and added

to the destruction wrought by the earthquake. The waves were felt with diminishing effects at great distances, even north as far as Norway, south beyond the Madeira Islands, and west in the West Indies.

Japan was visited by a severe earthquake in 1854. Its focus was also evidently off the coast, for about a half hour after the shock, a series of waves thirty feet high struck the shore and destroyed the town of Simoda. From this spot the waves radiated with diminishing force, travelling the whole breadth of the Pacific to California.

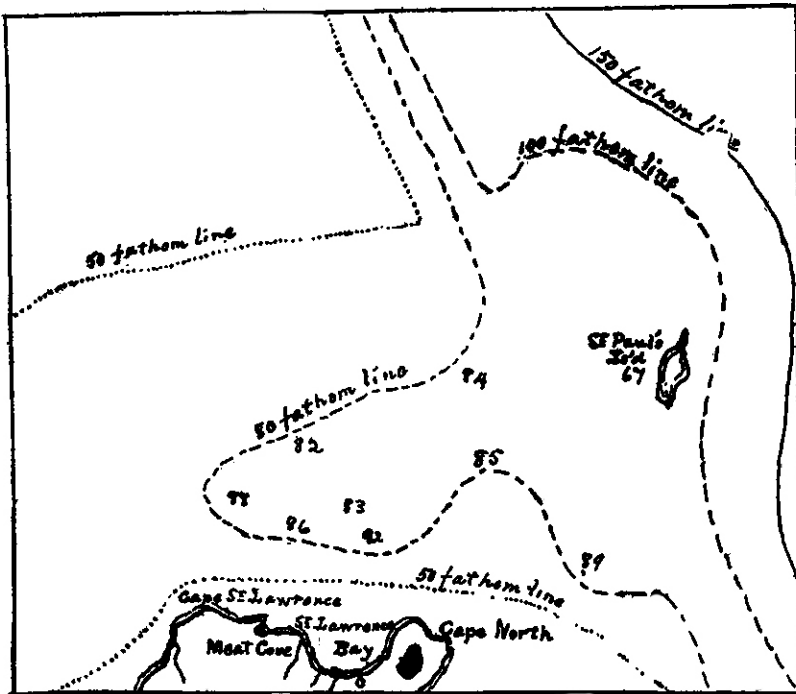
The Coast of Peru was devastated by a great earthquake in 1868. The seat of disturbance was likewise off shore, for in less than half an hour a succession of waves fifty or sixty feet high rushed in and increased the work of destruction of the earth-waves. These waves were felt thousands of miles from the seat of origin, even as far as the coast of Japan, 10,000 miles away.

Many other cases of such waves have been observed and recorded by tidal gauges, such as that of 1877 at Iquique in Northern Chile, and that of 1885 around Krakatoa. The great disturbance of 1896 in the North Pacific will be recalled by many, where 175 miles of the Japan Coast were laid waste. A great amount of shipping was destroyed and 27,000 people lost their lives.

These waves are caused by a dislocation of the earth's crust beneath the sea. The break occurs most often where the water deepens rapidly, as in the case of the western coast of South America where a few miles off shore the water suddenly plunges from the edge of the continental shelf to the ocean abyss. Similarly, off the Japan Islands the descent from the land platform to the Tuscorora Deep is very abrupt. The evidence is abundant and strong that such a condition of land and sea makes a line of weakness in the earth's crust and here may, and does, occur faulting or slipping. As

observed from the shore, the sea, during a disturbance of this kind withdraws from the land, and then returns with great speed and height causing great destruction.

In the opinion of the writer, the cause of the disturbance in Northern Cape Breton was a slipping of the rock, either solid or unconsolidated material, off the coast of Meat Cove. The accompanying map shows the locality where the disturbance was greatest, and the adjoining areas.



It is seen that a short distance east of St. Paul's Island the water deepens very rapidly. Here is the western margin of the submerged channel of the old St. Lawrence river. The 100-fathom line approaches to within about a mile of the island. Here, where there is a declivity of steep grade, a slipping or break in the bottom might be looked for. No

record of the disturbance, however, is obtained from St. Paul's Island, and, moreover, the description of the phenomenon localizes it rather between the island and the adjoining Cape Breton coast. The *isobathic* lines constructed from the chart show the 50-fathom line about two miles off Meat Cove, with the 80-fathom line about an equal distance beyond that. Here, in all probability, was the seat of the disturbance. A deepening of 80 fathoms in about 4 miles gives a gradient of about 1 foot in 44 feet or a  $2\frac{1}{4}\%$  grade. The depths as given on the chart within the area bounded by the 80-fathom line suggest an uneven bottom where may be found steep slopes. Doubtless a large thickness of unconsolidated material has accumulated on the sea bottom. A sliding of this along the slope or a break in the solid rock would give the necessary impetus to the water to produce the waves.

When weather indications point to a calm night, boats are hauled up by the fishermen just beyond the range of high tides. The average difference between high and low water at Meat Cove, we may take as about four feet. To sweep the boats away would require an additional height of water of, say, three or four feet. Waves, therefore, of six or eight feet must have rolled in upon the shore to accomplish the work recorded. If the ordinary proportion between height and length of wave were preserved, the length of these waves must have been sixty or eighty feet. A slip of a belt of rock a hundred or so feet in width on the sea bottom near the 80-fathom line, or within the area bounded by this line would cause a gravitational movement to the water from the landward direction, followed by a return of the water, in the form of a succession of high waves. These waves would diminish in force as they radiated from the place of origin, as was observed to the eastward and westward of Meat Cove. Did the dislocation produce a rise in the sea

flow, the water would be lifted and the accompanying phenomena would be of the same nature as those that would occur in the case of the downward movement.

From the occurrence of a similar wave disturbance at Bay St. Lawrence some years before, as reported, it would be inferred that the surface of the sea bottom is unstable off the coast of Northern Cape Breton, and that such disturbances may recur until the area has arrived at a state of stability.