

ON THE DEEP OCEANIC DEPRESSION OFF MORETON BAY.

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DURING the year 1875 I had the honor of laying before this Society, in my Anniversary Address, an account of the scientific researches carried on by Captain Nares, R.N., and the officers of the Scientific staff on board H.M.S. "Challenger," supplemented afterwards by "Notes" founded on reports of subsequent observations by Captain Thomson, R.N., who succeeded Captain Nares on the occasion of that officer's appointment to the command of the Expedition to the Arctic Ocean.

The topics treated of in my Address had reference principally to the Atlantic Ocean, with only scanty notices of the Pacific. The supplementary notes had more special allusion to the Pacific and the seas connected with it, and discussed Dr. Carpenter's deductions from some of the observations and experiments made by Captain Belknap on board the United States steamer "Tuscarora," in those parts of the Pacific with which we are more particularly interested.

Since that paper was read, in December, 1875, the "Tuscarora" arrived in Port Jackson, and I lost no time in visiting her then commander, Captain Miller, who had been commissioned by the United States Government to make researches, not on the extensive scale undertaken by the "Challenger," but chiefly for a safe submarine telegraph line to Fiji and New Zealand.

I was received very kindly by Captain Miller, and having learned the interest I took in such researches, he gave me satisfactory information and showed me the results as placed upon the chart. On requesting to be furnished with an Abstract of soundings from Fiji to Australia, it was courteously accorded by Captain Miller, who asked me to make no public announcement till after the middle of April, as he very properly wished his communication to be sent to the American Government.

In reserving my notice of the "Tuscarora's" work till the month of July I have not transgressed the limits to which her commander's permission extended. The particulars to be mentioned do not, however, include that portion of the intended line which would have connected Fiji with New Zealand, because, on its being known that a cable had been laid between that country

and this, that part of the "Tuscarora's" work was countermanded, and therefore no comparison can be instituted between the line now in operation and the one intended by the United States. After a brief stay in these waters, the "Tuscarora" sailed, as I understood, for San Francisco; but I believe she had not reached that port at the date of late advices.

I consider it only right to offer this explanation to the Society before I mention the contents of Captain Miller's communication, which is, though brief, of considerable importance, as pointing out some peculiarities in the ocean bed off the southern part of the coast of Queensland.

It is to be borne in mind that the instruments on board the "Tuscarora" were not of the elaborate character of those on board the "Challenger," some of which in operation I had the pleasure of witnessing in a dredging excursion off this coast; but they appeared to me to be amply sufficient for the purpose intended. Nor were there any means of obtaining the information so diligently sought for, as to the inhabitants of the deep ocean, by Professor Thomson and his able assistants. Nevertheless, Captain Miller had collected some interesting objects for future examination.

ABSTRACT of Soundings for Submarine Cable between Kandavu Island, Fiji Group, and Brisbane, Queensland, obtained by Commander Miller, in U.S. steamer "Tuscarora."

Date.	No. of Cast.	Lat.	Lon.	Depth in Fathoms.	Nature of bottom.	Remarks.
1876						
Jan.		S.	E.			
25	76	19°11'	177°41'	1647	Yel-br. ooze	Position taken from bearings in British Admiralty Chart, No. 2,691.
	77	19°29'	176°53'	1915	Yel-br. ooze and coral.	
26	78	19°46'	176°10'	1723	No specimen	Stray line fouled cylinder.
	79	20°04'	175°24'	1763	Br. ooze and blk. sand.	
	80	20°21'	174°42'	1625	Br. ooze and sand.	Small specimen.
27	81	20°44'	174°00'	1460	Ditto.	
	82	21°03'	173°22'	1875	Coral.	
	83	21°20'	172°35'	1950	Br. ooze and sand.	
28	84	21°35'	171°48'	1372	Coral	Small specimen.
	85	21°48'	170°56'	1398	Br. ooze and sand.	
29	86	21°58'	170°13'	2165	Ditto	Small specimen.
	87	22°11'	169°25'	1627	White coral and sand.	
	88	22°36'	168°52'	747	Coral and lava ...	Off Walpole Island.
30	89	22°54'	168°11'	1009	White coral.	
	90	23°05'	167°40'	483	Coral and shells...	Isle of Pines in sight.
	91	23°16'	167°09'	460	Hard coral.....	No specimen. Cylinder came up flattened.
	92	23°22'	166°41'	1176	White coral.	
31	93	23°33'	165°56'	1938	Yel-br. ooze and white coral.	
	94	23°41'	165°04'	2055	Yellowish ooze.	
Feb.						
1	95	23°48'	164°19'	1400	White coral.	Wire parted reeling in.
	96	23°88'	163°26'	1575	Coral and sand.	
	97	24°35'	162°53'	930	No specimen	
2	98	24°58'	162°12'	645	White coral and sand.	
	99	25°06'	161°27'	810	Ditto.	
3	100	25°11'	160°41'	993	White coral and sand.	
	101	25°18'	159°52'	715	Ditto	
	102	25°30'	159°09'	1383	White coral	To Light-house, Cape Moreton, S. 73° W., 355 miles.*
6	103	26°12'	156°04'	2634	Brown mud	S. 73° W., 320 miles.
	104	26°31'	155°07'	2682	Ditto	S. 68° W., 149 miles.
	105	26°03'	154°23'	2610	Ditto	S. 72° W., 95 miles.
9	106	26°18'	154°08'	2485	Ditto	S. 42° W., 76 miles.
	107	26°32'	153°51'	562	Brown mud and sand.	S. 42° W., 58 miles.
						S. 42° W., 36 miles.

* N.B.—The bearings to the light-house, Cape Moreton, were measured for me by Captain Hixson.

On reference to my last year's Address it will be seen that the "Challenger," when 30 miles from Kandavu, had a depth of 1,350 fathoms over red ooze. In the "Abstract" we find that the "Tuscarora" had yellow brown ooze, at a depth of 1,647 fathoms, in a position about 30 miles west from Kandavu. The observations from the two ships are therefore so far connected.

It is to be remarked, however, that in the "Tuscarora's" soundings between the Fiji Group and New Caledonia, coral and coral sand frequently occurred, and that the depths were very unequal, only one reaching below 2,000 fathoms, whilst on 3rd February, 1876, at a distance equivalent to 48 miles of latitude, the soundings between the Isle of Pines and Queensland deepened 668, from 715 to 1,383 fathoms, which would give a descending slope much steeper than that on our Western Railway line from its highest point to the sea. Moreover, the depression deepens again in a mean direction of N. 71 E. from Cape Moreton, in Queensland, and, in 225 miles of distance, to a depth of more than three vertical miles from the surface, and this within 95 miles from the Cape; rising again in less than 60 miles to less than three-quarters of a mile in depth in the same general direction.

This proves the existence of a very deep channel, not 100 miles wide, commencing about 36 miles from Cape Moreton. Connecting with the above calculation the "Challenger's" observations, we learn that it does not extend far to the northward, since the ridge from Sandy Cape to New Caledonia, &c., mentioned in my "Notes," cuts it off at about 1,300 fathoms, which is nearly the depth of the north-east slope at about 200 miles distance. This deep channel would therefore appear to have a direction towards that point of the compass. The absence of red clay and ooze from the "Tuscarora's" soundings is curious, but it is in agreement with the general depth assigned to deposits of that colour in the "Challenger's" observations, which occurred below 2,500 fathoms, and there are but three "Tuscarora" soundings between Kandavu and Brisbane exceeding that depth, against which we read "brown mud," "brown," and "yellow-brown," and "white," being the only colours noted outside the Queensland coast depression. It is, however, possible that colours may be variously estimated by different observers, as one of the "Tuscarora's" bottles contained what, to my eyes, appeared to have a reddish tint.

Soundings brought up by H.M.S. "Herald" off Fiji, many years ago, and supplied to me on board by Dr. Macdonald, F.R.S., were filled with *foraminifera*. The colour of the deposit now is a light grey, after long drying in my cabinet. As white coral was dredged by the "Tuscarora" only 320 miles N. 73 E. from Cape

Moreton, the reefs that stud the ocean around the New Caledonia Group extend much nearer to the Australian coast than many persons imagine, and betray the approach to the deep depression just mentioned, the north-eastern edge of which seems to be that of an uneven plateau or ridge in one spot, about 355 miles from Cape Moreton, only 253 fathoms lower than the ocean bed at a distance (on nearly the same bearing) of 36 miles from Cape Moreton. The bottom of the depression is thus about 91 miles wide, on each side of which there is an equal rise and fall of about 41 feet to the mile, and this is about the mean general steepness of the Blue Mountain Range in New South Wales along the railway line, from the summit to the waters of Port Jackson. These calculations are not, of course, given by Captain Miller; but I submit them merely to illustrate the probable slope of the coral reefs towards the west in the area referred to and the contour of the depression.

As the immediate coast of Queensland is comparatively low in the part indicated, this great depression appears contradictory to the usual idea of shoal water off a low coast; but I would explain it, as I do the condition of the sea bottom off the Illawarra coast, as showing a double escarpment with an intervening comparatively level plain or plateau from the mountain summit to the deepest sea bottom. One other inference is that our coast current streams along from the north-eastward over this deep depression and spreads its eddies under the impulse of winds. It would be very interesting to be able to state the depth of water in this current as well as the temperature below it from actual experiments. Judging from what has been determined respecting the Gulf Stream of the Atlantic, which is only 100 fathoms thick, that off our own coast is probably still more superficial. Nevertheless it must have a powerful influence in modifying the climate of the coast region, which is shown by the winter temperature of the water in Port Jackson.*

The depression in question is greater than that between our southern line of coast and New Zealand, as determined by the "Challenger."

* During many years I have made comparative observations (but at irregular intervals, and in various localities, on the ocean in the line of the current) and have found the sea-water generally higher in temperature than the air. I prefer, however, to quote here from a "Comparative table of temperatures of sea-water and air" in Port Jackson, supplied at my request by my excellent and accomplished colleague, H. C. Russell, Esq., Astronomer, from whose data, giving the temperatures for every month in the last six years (1870-1875 inclusive) I collect that the mean for water is 65.1, for air 62.85; and that the maximum for water was 73.6, and for air 73.2; and the minimum for water was 56.1, and for air 51.2—all showing the influence of the ocean water.

The conformation of the part of the ocean-bed off Moreton Bay, as thus explained, is due to purely geological causes, of which the existence is illustrated by the escarpments and ravines yet extant on the land—the ooze and clay and coral sand brought up by the sounding apparatus and dredge being mere submarine superficial deposits, covering and partly filling the bottom of the depression. This analogy of conformation between the depths of the sea and the heights of the land is paralleled by the distribution of life (as has been shown by Dr. Hooker) on the ocean ridges and depths, only in reverse order to that on the land. “The ocean,” he says, “thus mirrors one of the most striking features of the distribution of terrestrial life, and, mirror-like, it turns the picture upside down.”

If we travel inland from Cape Moreton on the same general bearing exhibited before, we shall find an almost equal slope from the high lands at the heads of the drainages to Moreton Bay as appears on the slope of the Blue Mountains towards Port Jackson; for in 1853 I made the elevation of the granite domes near Maryland, by barometrical observations, 3,727 feet, and the dividing range between the Condamine and Dumaresq Rivers, at the head of the latter, 3,120—Mount Melbourne being 3,829, and Moubullon, or Craig’s Range, 3,640 feet—Mount Cordeaux, according to Cunningham, being 4,100 feet, which is very near the height of the land above the tunnel on Mount Clarence, which itself is 3,658 feet. The relations of land and sea appear then to be nearly exactly equivalent to those in the southern coast region of New South Wales, since, though there are higher points in New England and in Maneroo, than those already mentioned, yet the general elevations are much the same in both districts, and as off Moreton Bay there is a deep depression, so there is another off Mount Dromedary and Twofold Bay. What relation these depressions have to each other is not yet fully ascertained; but it is nearly certain that the bases of New Holland and New Zealand meet somewhere about half way between them, and the stages of ascent are precipitous or with long inclined slopes, the deepest depressions lying as it were on each side of a submarine plateau.

In my view, the combined phenomena as exhibited by the opposite coasts of these countries (which formerly extended further into the ocean)—by coral reefs and other conditions—induce the conclusion that great rents and denudation in the earliest periods of our geological history were the result of depression and submergence, affording channels for ocean currents, deep receptacles for cold stagnant water, and passages for such surface currents as that which bathes New South Wales with a stream warmed in latitudes nearer the Equator than that of Sydney or Brisbane. Much of the history of that stream has to be discovered, but the fact elicited respecting the submarine valley north-easterly from

Cape Moreton is an item in the account. I have thought it, therefore, worthy of especial notice.

If, for the sake of illustration, we could raise New Holland, New Zealand, New Caledonia, and New Guinea, to one uniform additional height of some 2,600 fathoms above the ocean, we would, I think, perceive similar features on the surface, so formed, to those which are now exposed, and be able to show what can now be only surmised, that the remark of Dr. Hooker before referred to is strictly true; and also, that in examining critically the present surface of the land, we can reproduce what the ancient surface was which is now buried beneath the waters. And from the examination of such portions of the ocean-bed as have been sounded, we may gain valuable hints in the endeavour to account for many of the superficial phenomena of the still exposed and denuded dry land.

In corroboration of this view of the subject, I will conclude with a quotation from a very important work of Mr. Alfred Russell Wallace, just published, "*On the Geographical Distribution of Animals, with a study of the relations of living and extinct Faunas, as elucidating the vast changes of the earth's surface.*"

"The well-known fact" (says that accomplished writer, vol. i, p. 35) "that nearly three-fourths of the surface of the earth is occupied by water, and but little more than one-fourth by land, is important as indicating the vast extent of the ocean by which many of the continents and islands are separated from each other. But there is another fact which greatly increases its importance, namely, that the mean height of the land is very small compared with the mean depth of the sea. It has been estimated by Humboldt that the mean height of all the land surface does not exceed a thousand feet, owing to the comparative narrowness of mountain ranges, and the great extent of alluvial plains and valleys; the ocean-bed on the contrary, is not only deeper than the tops of the highest mountains which rise above its surface, but these profound depths are broad sunken plains, while the shallows correspond to the mountain ranges, so that its mean depth is, as nearly as can be estimated, 12,000 feet."*

It being no part of the present subject to go further into the former connection of Australia with New Zealand, the remarks of Mr. Wallace, founded on the relationship established between certain portions of the Faunæ of those countries, as evidenced by those of the intermediate islands, have not been alluded to on this occasion, but he offers sound reasons for the belief formerly

* "This estimate has been made for me by Mr. Stanford, from the materials used in delineating the contours of the ocean bed on our general map. It embodies the results of all the soundings of the "*Challenger*," "*Tuscarora*," and other vessels, obtainable up to August, 1875." [The *Abstract* above given is, therefore, additional to those mentioned by Mr. Wallace.]

expressed by me that such a former connection is highly probable, notwithstanding the enormous depression now existing between New Zealand and Australia.

Mr. Wallace shows that even now the land on the face of the globe "is nearly continuous, and that it is possible to go from Cape Horn to Singapore and the Cape of Good Hope without ever being out of sight of land, and, owing to the intervention of the numerous islands of the Malay Archipelago, the journey might be continued under the same conditions as far as Melbourne and Hobart Town." (p. 37.)



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