

ART. XXXVIII.—*Notes on the Geology of Moorea and Rurutu Islands.*

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[*Read before the Otago Institute, 4th November, 1913.*]

THE island of Moorea, or Eimeo, appears to have been first visited by Captain Cook in the year 1777, though it had been discovered by Captain Wallis ten years previously, and named by him Duke of York Island. Cook anchored in the harbour called by him Taloo, on the northern side of the island. This harbour is now called Papetoai, while another similar bay, also on the north side of the island, is often called Cook's Bay, though the great navigator never actually took his ships into it. Though Cook did not visit the island before 1777, he had during his first voyage sent one of his boats, under the charge of Lieutenant Gqre, to make observations on the occasion of the transit of Venus in 1769. Cook himself made similar observations at Point Venus, in Tahiti. Lieutenant Gore reported that he had been well received by the Natives, though he regarded the island as not very fruitful.

Apparently the next vessel to visit the island was the ship "Duff," under the charge of Captain Wilson, during the missionary voyage to the South Seas. A plate showing the appearance of Taloo Bay is given on page 83, "Missionary Voyage to the South Seas" (Wilson, 1799).

In Cook's Voyages the rocks are said to be bluish, with little particles of mica. In Wilson's Voyage the only reference that I can find to geology is the following: "The island appears to have suffered great convulsions, either from earthquakes or from other violent causes. Most of the hills are high, with broken rugged sides, particularly about Taloo Harbour, from the entrance of which they have a very striking appearance."

Ellis, in his "Polynesian Researches" (vol. 1, p. 18), says, "In the varied forms its mountains exhibit, the verdure with which they are clothed, and the general romantic and beautiful character of its scenery, this island surpasses every other in the Georgian or Society Groups."

These extracts give a vivid and an exact idea of the highly picturesque appearance of the island. The remarkable effects of subaerial erosion in forming the pinnacled peaks, the piercing shape of the aiguilles and the precipitous sides of the valleys have excited the wonder and admiration of all geologists who have visited these tropical islands of the Pacific Ocean.

As is the case in Tahiti, Rarotonga, and in all of the high islands of the eastern Pacific, Moorea is entirely formed of volcanic rocks, but all indications of the form of the original volcano have been lost. The lava and scoria slopes of the volcanoes have been cut up by the erosive action of the tropical rains and torrents into steeple-shaped peaks, separated by the most profound valleys, with sides so steep that they cannot be scaled.

Moorea is triangular in shape, each side of the triangle being about eight miles in length. It is surrounded by a continuous coral reef about a mile distant from the shore, and on it islands are situated here and there. It appears that up to the present time no detailed information has been available in regard to the rocks of which it is composed.

The only place that I was able to visit was the Bay of Putoa, on the south-east side. At the head of this bay is the village of Afareaitu, one of the early missionary settlements—where, in fact, the first printing-press in the South Sea Islands was installed, in the year 1817.

A narrow strip of flat land separates the hills from the beach. This is formed mainly of the gravel brought down by the two small streams from the pinnacled mountains a little more than a mile distant. The gravel-flat extends a little distance back into the valleys, which appear to have been formed when the land stood at a higher level. The rock at the lower end of the spurs is a basalt, which, though generally fine-grained, contains relatively large crystals of olivine. The stones in the bed of the small stream are, however, phonolite of a trachytoid nature, and they evidently come from lava-flows at relatively high levels. High up on the hills are to be seen outcrops of massive lava-flows with the same colour and the abrupt appearance that is so characteristic of the phonolitic rocks in Raiatea and Huaheine. When seen in thin section this rock is found to be composed of small microlites of feldspar. Between these there can occasionally be seen a few minute crystals of nepheline, though in much smaller quantity than in the corresponding rock from Huaheine.* Aegerine augite is quite plentiful, and it has an extinction-angle of 40° . A good deal of magnetite is present.

The island of Rurutu, one of the Tubuai group of islands included in the French possessions in the Pacific Ocean, lies in latitude $22^\circ 27'$ S. and $151^\circ 21'$ W. longitude. It is six miles long and three miles long, and rises in a sharp peak to an elevation of 1,300 ft. The island was discovered by Cook in 1769, and Tupia, who was then a passenger in Cook's ship, called it Ohiteroa. It is, however, noticeable that in Tupia's map of the South Sea Islands published in Forster's "Observations made during a Voyage round the World" Rurutu is the name given to an island placed in a group including O Rimatarra and O Reevavai, which are obviously intended for the islands now known as Rimatarara and Raivavae. This group is, however, in his map placed to the north-west of Tahiti, whereas it actually lies some three hundred miles to the south of that island. Rurutu seems to be the name that is almost universally used for this island, and, seeing that it is the name used by Tupia himself for the island in his map, it appears to be probable that he mistook this island for some other when it was first sighted.

The reef that surrounds the island is almost in touch with the shore, and it is not penetrated by any good passages. So far as the geology of Rurutu is concerned, the only statement that I can find is that of Ellis, who says that there is limestone on the island, and that garnets have been found there.

I am indebted to Mr. Fred. Hildreth, of Gowgonda Lake, Ontario, Canada, for specimens of rock from this island, and for much information in regard to it. On the eastern side of the island there is a good deal of calcareous conglomerate with much included volcanic rock. This formation rises to a level of 300 ft., and has a highly irregular surface. Above this level the surface of the ground consists of highly coloured clays, obviously derived from the decomposition of basic volcanic rock. This is apparently a coarse-grained doleritic rock, which in hand-specimens appears

* Marshall: "Alkaline Rocks of the Cook and Society Islands," *Trans. Aust. Assoc. Adv. Sci.*, vol. 13, 1912, p. 198.

to closely resemble the coarse dolerite that is so common in Rarotonga, Tahiti, Huahine, and Raiatea. Unfortunately, I could not obtain a specimen of this rock for microscopic examination. On the west side of the island the material at the sea-level is a fine-grained igneous rock similar to the fragments contained in the calcareous agglomerate on the eastern side. This rock contains enough magnetite to deflect the compass-needle in the most marked manner. Under the microscope it is found to contain relatively large crystals of magnetite embedded in a very fine-grained ground-mass consisting largely of minute microlites of labradorite feldspar, some very small crystals of olivine, minute granules of augite and of magnetite. Though extremely fine-grained, there is no glass whatever in the rock, which has evidently been formed from the very rapid cooling of basaltic lava.

From the statements made to me by Mr. Hildreth, combined with the results of my examination of the rock-specimens, the following appears to be the geological history of the island: Submarine volcanic action first formed the agglomerate on a sea-floor that was covered with calcareous ooze. The eruptions continued, and formed a volcano of moderate size. The old sea-floor was afterwards raised until it attained an elevation of 300 ft. above sea-level. There is apparently a well-marked terrace at an elevation of about 300 ft. on the east side, which probably marks a sea-level that remained unchanged for a considerable period.

ART. XXXIX.—*The Geology of the Cape Runaway District.*

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THE strip of country running due east and west from Cape Runaway to Matakaoa Point has not yet received much attention from the geological standpoint. Throughout this twenty miles of coast-line the country rises steeply, and soon reaches to an elevation of 1,300 ft. The country slopes down nearly as steeply on the southern side of the ridge into the valleys of the Wharekahika and Ngarue Streams, running east and west respectively. Thus this narrow bar of country is marked off from all that lying to the south, and constitutes a geographical unit. In a north-north-east direction the ocean-floor dips down steeply, and within fifty miles there is a depth of 1,000 fathoms, and within two hundred miles the ocean is 4,380 fathoms deep. This profound abyssal depth marks the farthest known extension of that great earth-feature the Kermadec-Tonga trench; but, since soundings are relatively few in this part of the Pacific Ocean, it is quite possible that future work will show that this trench actually extends still farther to the south. This is the nearest known approach of abyssal depths to the coast-line of New Zealand. The average slope throughout this distance of two hundred miles is about 137 ft. per mile—that is, 1 in 40.