

Plains east of Waiotapu. This material probably diverted the Waikato River from its northerly course to the Bay of Plenty to a westerly course through the Atiamuri Gorge. The next series of eruptions built up the vesicular hornblende rhyolite mountains of Tarawera and Haparangi. Smaller eruptions of this rock formed conical hills similar to those near Mount Egmont in Taranaki.

Succeeding outbreaks have been on a somewhat smaller scale, and only fragmentary material was emitted. The tuffs follow roughly the present contour of the land, and are therefore clearly of Recent age. The earliest of the Recent eruptions were the rhyolitic pumice showers, of which as many as seven can be counted in some sections. In general they average about 4 ft. in thickness, the coarse material of the bottom layers being about 9 in. thick. The fine material has weathered to a brown loam. Most of the showers have come from the Rotorua district; on the western and southern edges there is an overlapping of ash from the Taupo district. Explosion craters now occupied by lakes are the source of some of the showers, a good example being Tikitapu, which was probably the origin of the oldest of the Recent tuffs that occur around Rotorua Township. Preceding the youngest shower of pumice were eruptions of andesitic ash from the explosion craters of Rotokawau and Rotoatua, south of Rotoiti. These were the forerunners of the Tarawera eruption of 1886. On the night of the 10th June of that year ten craters extending the length of Tarawera Mountain were formed, from which a great quantity of andesitic ash similar to that from Rotokawau was blown. A few hours later fourteen vents, prolonging the line of the craters on Tarawera, opened in Rotomahana and at several other points (Fairy, Black, Inferno, Echo, and Southern craters). These, however, with the exception of one crater, probably Echo Crater*, which ejected some andesitic material, erupted only the shattered surface rock—thermally altered rhyolitic tuffs and lavas. After about five hours the violence of the outburst lessened considerably, but for two months there were small shots and much steam from the craters. Black Terrace Crater broke out early in August. Small outbreaks—Waimangu in January, 1900, and Frying-pan Flat in April, 1917—on this chasm indicate that this part is yet to be regarded as a menace.

HOT SPRINGS.

The Rotorua district contains a great number of hot springs. They may be divided into five groups—Whakarewarewa-Ohinemutu, Tikitere, Rotomahana-Waimangu, Waiotapu, and Paeroa Range. Alkaline, acid, and neutral springs may occur within a few feet of one another. In general the alkaline pools are boiling or hot and clear, and have an outflow, whereas the acid seldom reach boiling-point, and are discoloured or muddy. The waters of the alkaline springs deposit silica freely, building up sinter cones round their vents and coating the ground over which they flow. Only five fumaroles of any size occur in the district. Their temperature is 99° C., the boiling-point of water for the altitude, and they form no sublimates. There are in addition many small steam-vents, around which acicular crystals of sulphur are deposited. At Ohinemutu most of the springs are at or close to boiling-point and have an alkaline reaction. On the eastern side of Rotorua Township and at Whakarewarewa there are alkaline, acid, and neutral springs. At the former locality the sulphury slime on the edge of some of the alkaline pools has an acid reaction, probably due to the oxidation of sulphur. Pohutu Geyser, at Whakarewarewa, which was in action during Hochstetter's visit in 1859,† still plays to a height of 50 ft. or 60 ft. for about twenty-five minutes, as a rule, once or twice every twenty-four hours. It is preceded one to four hours by the adjoining Prince of Wales Feathers, which plays almost continuously until Pohutu has finished erupting. It is said that after heavy rain Pohutu is inactive for a day or so. At Tikitere the springs, with only one or two exceptions, are acid, are discoloured by mud, and boil vigorously. The springs at Rotomahana and Waimangu were found to be alkaline or neutral, with the exception of the small hot lakes in Echo (Frying-pan Flat) and Inferno craters. The waters of these lakes are clear. Echo Crater and occasionally Inferno Crater have an overflow of about 18 gallons per second, making notable exceptions to the general character of acid springs. The hot springs along the fault on the Paeroa Range are weakly mineralized, and are alkaline. At Waiotapu are seen acid, alkaline, and neutral springs.

Extensive decomposition of andesites and rhyolites by steam and hot water to kaolin has taken place on Maungakakamea (Rainbow Mountain), near Waiotapu, and on the scarp of Paeroa Range. At Whakarewarewa, besides alteration to kaolin, there is seen in small areas of collapse a further stage where only silica remains.

Gas rises freely from many of the springs. Samples from Rotorua, Whakarewarewa, and Waiotapu, analysed by the Dominion Analyst, consisted mainly of carbon dioxide with smaller amounts of hydrogen, carburetted hydrogen, sulphuretted hydrogen, nitrogen, and oxygen. The gases from all localities are remarkably alike in composition, and resemble gases from hot springs in volcanic regions in other parts of the world.

ECONOMIC GEOLOGY.

Although the district abounds in igneous rocks, good roadmaking-material is scarce. The present sources are the Ngongotaha rhyolite, the silicified lake-beds on the eastern side of Rotorua, the vesicular hornblende rhyolite on the Rotorua-Waiotapu Road, and pumiceous deposits. The best deposits of roadmaking-material observed during the field season were the andesite of Maungaongaonga and the rhyolite of Matawhaura, between Rotoiti and Rotoehu, both less than a mile from arterial roads.

A deposit of high-grade white diatomite (kieselguhr), 6 ft. thick, occurs in the Ngongotaha Valley on Mr. Brake's farm, and is quarried for export. Other deposits were found at Ngongotaha Village, Pohirua, on the north shore of Rotorua, and on the western side of Lake Tarawera, but they are not as high grade as that on Mr. Brake's property.

* Locally this name is given to Inferno Crater.

† F. von Hochstetter: "New Zealand," pp. 427-28; 1867. Waikite Geyser, described by Hochstetter, has erupted only for short periods during recent years.