1886.

NEW ZEALAND.

VOLCANIC ERUPTION AT TARAWERA

(PRELIMINARY REPORT ON THE), BY S. PERCY SMITH, ASSISTANT SURVEYOR-GENERAL, AUCKLAND.

Presented to both Houses of the General Assembly by Command of His Excellency.

PRELIMINARY REPORT ON THE VOLCANIC ERUPTION AT TARAWERA, 10TH JUNE, 1886: BY S. PERCY SMITH, ASSISTANT SURVEYOR-GENERAL, AUCKLAND.

Survey Office, Auckland, 19th June, 1886.

IN this preliminary report on the eruption that took place at Tarawera and Rotomahana early in the morning of the 10th June, 1886, I do not propose to enter into a full detail as to the occurrence of the phenomena observed at the time, for which purpose, indeed, the necessary data is not yet to hand, but rather to describe the state of the various points of eruption and the alterations that have been made in the surrounding country.

I must preface these remarks by stating that at the present time, so shortly after the deposit of vast amounts of mud and ashes, it is very difficult to get about the country beyond the one or two routes which are now commonly used by visitors to the scene of activity. Covered as the country is by ashes and mud of great depth, the physical exertion of travelling across it prevents extended journeys, and, as no water can be obtained near the ash-fields, camps cannot be fixed in positions suitable for exploration. It is hoped, however, that after the first heavy rains the ashes will have become consolidated and to a large extent have slipped off the ridges into the valleys, and thus allow of more progress being made, and that without the fatigue now experienced.

If a line be drawn very nearly south-west (true) from the top of Ruawahia, it will be found to indicate very closely a line of thermal action extending from the base of that mountain to Orakeikorako, along which from time immemorial have existed hot springs, geysers, and fumaroles in immense numbers. Such a line will also pass along the wall-like western face of the Paeroa Mountain, at the base of which, in several places, hot springs and fumaroles have always existed. A little to the north of Paeroa is the Maungaongaonga Hill, on which no sign of recent action is apparent; but immediately to the east of it is a country with innumerable hot springs, boiling-mud holes, and lakelets, having on the east side the Kakaramea Mountain, where thermal action is very active, the greater part of the mountain having been steamed and boiled and coloured by the subterranean vapours from top to bottom. In many places it is only necessary to make a hole in the surface to see the steam come forth. Further to the north-east the same line strikes through Rotomahana. It is thus obvious that this line indicates an old line of activity and consequent weakness of the crust of the earth; and it is easy to show, by varying its direction very slightly, or by treating it as a band of moderate width, that its production northward would strike White Island, whilst in the opposite direction Tongariro and Ruapehu form the terminal points of activity southwards.

A reference to the four-mile map attached to this report shows that the recent eruptions have followed very closely this same line. Taking Wahanga as the most northerly point of activity and Okaro Lake as the most southerly, it will be found to have extended a distance of nine and a half miles; or, if we take the so-called "Southern Crater" as the southerly point, a distance of eight and a half miles. (The eruption on the south side of Okaro Lake which was reported requires confirmation; as yet no one has visited the ground.) Along this line there may be said to be eight craters or points and groups of eruption (using the term "crater" in a somewhat extended sense, to include eruptions of a dissimilar character).

Wahanga.—The most northerly is Wahanga, a mountain about 3,500ft. high, and of very similar appearance and structure to Ruawahia, from which it is separated by a neck some 500ft. lower than the general level of the two mountains, and the northern end of which slopes down to the outlet of the Tarawera Lake, near the Native village of Tapahoro. Whatever may have been the state of activity of Wahanga at the first outbreak, it is now merely sending forth occasional clouds of smoke, with a few minor points from which smoke and steam arise in small quantities. It is impossible at present to say whether a crater has been formed.

Ruawahia.—The next point to the south is Ruawahia, which, by many of those who saw the first sign of eruption on the 10th, is believed to have been the earliest to emit fire and smoke and

the other usual accompaniments of eruption. A reference to sketch No. 2, accompanying this report, shows that the activity is principally on the north-east side of the mountain and on the top. It is, I think, clear, from careful watching with the glass, that a crater has here been formed—probably a true one, and that the little peaks seen in the sketch have been formed by, or rather increased in height by, matter ejected from the crater. There is at present no sign of lava to be seen through the glass, though the testimony of those who saw the eruption first seems to indicate that some was ejected. As the top of the mountain is now covered deep in ashes, the lava may be hidden. The smoke from the crater is often of an inky blackness, though more frequently brown or even dark grey in colour, but its volume is not great. On the slopes of the central peak, and to a lesser degree on the right-hand one, the ground appears to be covered thickly with some yellowish-green matter—most probably sulphur: it covers many acres. There appears to be a deep deposit of ashes and sand on top of the mountain and down the slopes, filling up and smoothing over the innumerable crevices and heaps of broken stone which formerly made walking so difficult there. Frequent reference has been made in newspaper paragraphs to the previous existence of a crater on Ruawahia or Tarawera, but I am able to say that, on my three ascents of the mountain in 1874, no sign of a crater was visible. Prior to the eruption the two mountains of Wahanga and Ruawahia (for Tarawera is only a local name on the south end of Ruawahia) formed two high table-lands of about three miles in total length by about half a mile in width, divided by the saddle before referred to, the top of which was covered with large angular fragments of trachyte, which had the appearance of having been shivered into pieces by frost; and the top was further divided into hillocks by deep crevices running irregularly in all directions. The edge of this table-land has steep, precipitous, rocky sides, falling off into gentle slopes all round, on which were several forests of considerable size—now, alas, all destroyed!

Tarawera.—At the south end of Ruawahia, on the portion called Tarawera, is found the third crater or point of eruption. Sketch No. 2 shows this to take the form of an immense rift or gorge, extending from the top of the plateau right down the side of the mountain in a south-west direction towards where the White Terraces formerly where. It is at least 500ft. wide, by the same depth—and, indeed, may be much deeper, for at present it is impossible to obtain a sight right into it. The chasm emits frequent columns of black and brown smoke, with some steam, for its whole length; but no ejection of stone or other matter was noticed. On both sides of it, extending for a considerable distance right and left, the rocks and ashes are coloured a bright yellowish-green by the sulphurous vapours emanating from it. The forest which stood on the south-east spurs of Tarawera has disappeared, leaving only a comparatively few burnt and charred stumps to indicate its locality. The mass of matter which has been ejected from the chasm must be enormous, and has doubtless aided in heaping up the sandhills which now lie between it and the Terraces, and which have completely filled up the valley formerly existing near Rotomakariri. So much has the appearance of the country altered in this neighbourhood that it is almost impossible to recognize the former landmarks. The Kaiwhaka Valley, down which ran the stream of warm water connecting Rotomahana with Lake Tarawera, has disappeared in its upper part entirely, being filled by rocks, sand, and ashes. This being so, it is no wonder that the Maori village of Te Ariki, which was situated near the outlet of the stream into Tarawera Lake, and where some forty unfortunate Maoris were living, should be entirely buried; and, as reported, the land has formed a projection into the lake of some hundreds of feet. Between the foot of the chasm and the Terraces the country is cut up by cracks and gullies formed by the escaping waters ejected from the craters; and as the frequent earthquakes shake the ground jets of steam appear in quick succession as the cracks open.

Rotomakariri.—Rotomakariri, or its immediate vicinity—for the exact locality cannot be identified at present—seems to be the site of a very active crater, from which a high column of steam, with occasional smoke, is sent high up into the air, and from near which Mr. Morgan reports that he saw, on the evening of the 12th, a great deal of flame, or possibly the reflection on the clouds of vapour of the lava or heated stones below.

Rotomahana and Terraces.—The next point of eruption on the line is Rotomahana itself. Here the most wonderful alterations have taken place, changing a placid lake into a roaring crater, from which rises a column of steam nearly a mile and a quarter in its longest diameter and, as far as at present can be ascertained, nearly a mile in width. This grand column of steam, like a mass of cumulous cloud, ascends to over 15,000ft.—15,480ft. measured by clinometer, but the top of the column could not be seen. The western side of the crater at present can alone be studied, as the ashes and sand are too deep to admit of a journey to the eastern side. It has, as it were, eaten back southwards and westwards from the shore of the former lake a distance of over half a mile, the southern side being immediately at the foot of the high hill called Te Hape-o-Toroa, which will be remembered as standing behind the Pink Terrace. The spot where once was situated the most beautiful object of its kind in the world, the White Terrace, is now, I believe, occupied by a crater forming a sort of horse-shoe bay in the side of the greater crater of Rotomahana, and from which a vast column of steam arises and joins the general mass above. I wish that I could write positively on this point, but, as already pointed out, the shape and contour of the ground is so altered by the mass of ejected matter that exact localities cannot at present be identified. Should this horse-shoe crater hereafter prove to be not exactly where the White Terraces stood, it is, at any rate, quite close to it, and its exact position does not affect the question as to whether the Terraces are in existence or not. If not there, then they are either buried deep under the stones and sand, or have sunk into the main crater. The Pink Terraces were in such a situation as to be at least a quarter of a mile within the margin of the present crater, and no eye can penetrate through the dense steam to ascertain their fate. Occasional breaks in this dense veil allow of momentary glances into the crater, but for no great distance, and the sight disclosed is one of horror. A dim brownish twilight, making everything of a hideous hue, enables one to see a dreadful mass of

boiling or boiled mud, black and brown in colour, with seething pools of steaming water or liquid mud, sometimes cast up into fumaroles ejecting steam, at others vomiting forth stones and mud with a noise like the roar of innumerable steam-engines. From time to time the more active vents along the margin, after a prolonged roar or a sharper detonation like that of a cannon, shoot forth high into the air large bodies of stone, sand, and mud, which generally fall back from whence they came. This is not always so, however, for the surface of the sand- and ash-covered hills around the margin are dotted over with fragments of stone ejected from the crater, whilst other and larger pieces have sunk in, leaving shallow round depressions to mark their sites. The outer edge of the crater differs in height above the bottom according to position, and no general statement could be given as to an average height, but at the west side it is probably about 300ft., the upper part being formed of *débris* thrown out from the crater. To the margin of this ejected matter it is dangerous to approach—it is constantly falling in, and is full of cracks for many yards back. To the east of Te Hape-o-Toroa Hill, in the valley which was formerly occupied by a stream running into Rotomahana, are several points of eruption, some of them throwing up stones and mud at intervals, generally preceded by a loud detonation. The top of this hill, being about two hundred and fifty yards from the margin of the crater, affords an excellent view of the whole series of eruptions (exclusive of the Ruawahia group), and it is easily reached by any one from Rotorua in a ride of eighteen miles, with a walk across the ash-field of about three and a half miles: but, at the same time, the frequent earthquakes tend to engender a feeling of insecurity, and a fear that the steep hill-side might easily fall into the crater. The hill itself is covered deeply with coarse sand, as is the country to the west of Rotomahana, with occasional large stones, which have been ejected. This sand, excepting on the hill itself, is in places very deep, and trying to walk through. As I happened to ride over part of this country about three months ago, I am in a position to judge of the depth to which it has been covered, and can say that in one little valley the sand is certainly 25ft. deep, though doubtless this is too great for an average depth.

The Black Crater.—A short distance to the south of Te Hape-o-Toroa is situated the most northerly of the southern group of eruptions. A large body of steam escapes from it, but, as I had not time to inspect it closely, I am only able to say that it is of similar character to the most southerly crater. Next to it on a low hill is a crater which has been named the Black Crater, from the colour of the ejecta, consisting of volumes of steam, sand, and stones. Sketch No. 1 shows this as it constantly appears, in full eruption, vomiting forth large quantities of stones, sand, and mud, the ejecta rising frequently to between 400ft. and 500ft. in the air. Most of the stones, &c., fall back again into the crater, though every now and then a column shoots up in an oblique direction, discharging large quantities of stone on the outside of the cone it is gradually building up with a noise like the rattle of musketry, and leaves them smoking on the surface. The shape of the columns when charged with stones and sand is most elegant, and looks like grand pyramidal geysers, darkened by the sand and mud so as to stand out in relief against the accompanying masses of rising steam. This crater is perhaps more entitled to the name of volcano than the others, for it is building up for itself a true cone with the outward inclined strata of stone, mud, and sand.

The Southern Crater.—The next crater is on lower ground, and occupies the site of a former valley; it is very active, but only occasionally discharges stones and sand. The southernmost point of eruption is a crater which has burst through a ridge and built up a small uneven cone for itself; it is about 250 yards long by 100 yards wide at the lip, and about 350ft. deep. There is a smaller crater inside it, now extinct. The bottom is filled with brown water and mud, steaming in places, with a very active boiling spring in the northern corner, from which a large column of steam was rising when we were there. The sides were fast falling in, and great cracks around the margin lead to the belief that it will soon be partially filled up as the activity of the forces decrease. The day following our visit it had become intermittent in its action. Evidently the action in this part is fast decreasing, a fact which is proved not only by its lesser activity, but from the signs of former (recent) activity, as shown by the heaps of stones, some as large as a man's body, which had been thrown out on all sides for a radius of a quarter of a mile or more.

Lake Okaro is unchanged, except that the vegetation is all covered by the ejected ashes. It is stated that on the night of the 11th June a high column of black smoke was seen rising from the southern end of this lake, but the fact requires confirmation: no sign of any eruption was seen by our party two days following that on which the smoke was reported. In the meantime I must assume that the Southern Crater is the most southerly point of eruption.

Extent of Country covered by Ejecta.—The extent of country which has been covered by the matter ejected from the different points is very extensive, but complete information on this point is not as yet to hand. The four-mile map accompanying this report shows generally its boundaries. Of course the depth of deposit varies very greatly, being generally deepest nearest the points of eruption, whilst on the extreme edges of the portion coloured on the map it is very slight. The area shown on the map is about 1,850 square miles. A remarkable feature in the ash-deposit around Okaro is the sharp line of demarkation, where the ashes end and the vegetation still remains.

Nature of Deposit.—The nature of the deposit also varies in different localities. Immediately round Rotomahana it seems to be composed of coarse and fine sand, mixed with fragments of stone generally of a trachytic nature, and with a large amount of sinter broken up very fine. Close to each point of eruption the stones ejected are of a large size, frequently being as large as a man's body. I looked carefully for any sign of fused rock, but, with one or two doubtful exceptions, the stones appear to be those of the rock of the country broken into fragments, and showing no sign of fusion of recent date. These rocks are the various forms of trachytes common to the country. Immediately to the south of Hape-o-Toroa, and covering about forty-five square miles of country, the deposit is a dirty-white ash, very fine and soft, having the appearance of and feeling in the

fingers like dirty flour. Looking eastward from Pareheru the country presents the appearance of a series of sandhills such as is frequently seen on the coast—indeed in travelling over it it is difficult to believe that one is not on the sea-shore, the rounded shapes of the hills adding much to the delusion. Everywhere within 2ft. of the surface the sand and ashes are warm, and 4ft. down quite hot. These ashes seem to have been ejected in a dry state. Nearer Rotomahana large quantities of water have been thrown out, some of which remains in pools and ponds on the surface; and, though there is mud occasionally, no great quantity exists in this locality. It is not until the crater is left some two or three miles in a north-westerly direction toward the Wairoa Village that the great deposit of mud is found. It extends thence north-west and north, covering the whole country up to the edge of Rotorua and Rotoiti, being apparently deepest in the vicinity of Wairoa, Okareka, Okataina, and Tarawera. Its depth varies from 4in. at Te Ngae to probably an average of 4ft. at the Wairoa, though in many places it is much deeper, having been drifted by the violent wind which accompanied the outburst against any obstruction and into the hollows, these forming drift. Seven days after the eruption this mud was quite wet, with no sign of becoming at all dryer, and was extraordinarily cold to the feeling, quite as much so as snow. It is not in the least plastic. Further from the centre of eruption, the deposit appears to consist more of fine wet sand of a dark grey colour, mixed with mud: whilst at Te Teko and Galatea it is said to be formed of small stones (scoriæ is the term used, but, as far as can yet be learned, the stones are not fused). The ash appears to me to be the last ejected. Messrs. Harrow and Edwards, who accompanied the boat expedition across Lake Tarawera to search for the Ariki Village, describes the deposit near that place, as seen in a torrent-bed, to be as follows: On the bottom, large stones; next, 3ft. of mud and ashes; then 1ft. of small stones (or scoriæ), still hot; then 15ft. or 16ft. of ashes, covered by about 4ft. of mud.

The Forest.—The forest around the seat of eruption presents the most deplorable and desolate aspect. Wherever the mud has fallen it has completely stripped off the leaves, and in the deeper parts the weight of mud has broken off branches, leaving jagged stumps and stems, thickly bespattered with mud. On the north side of Tarawera the forest is on fire in several places; but, on account of the mud, this cannot extend far. The violent wind which accompanied the outburst, especially near the Wairoa, has prostrated considerable areas of forest, leaving a tangled mass of mud-covered logs. The beautiful forest on the road from Rotorua to Wairoa, near Tikitapu Lake, is a complete ruin, and, together with the village of Wairoa, presents a scene of utter desolation beyond all description. The beautiful clear waters of the lakes are now turbid with mud, and must continue so for a long time to come, as the first heavy rains will bring down vast quantities of fresh mud to add to them. Even Rotorua is discoloured over its whole area.

Wairoa Village.—At the Wairoa Village the stream of that name, which forms the outlet of Rotokakahi, is obliterated, its bed being filled with mud. The falls, so much admired by all visitors, have ceased to exist; whilst the village itself is buried in deep mud, the ruins of the houses appearing as heaps projecting above the general surface. Some three or four houses, however, are still partially standing, and serve by their appearances to make the general desolation more marked. Tarawera Lake appears to be about 3ft. to 4ft. higher than its ordinary level, Rotokakahi about the same level as usual; Rotorua is higher than it has been for some time, and is slowly rising.

Earthquake Cracks.—The heavy earthquake at 2 a.m on the morning of the 10th June, and the constant and frequent shakes and tremors since, have caused cracks in several places. In the Waikorua Basin, on the Rotorua–Galatea Road—a place where several cracks, one of about half a mile long and twenty yards wide, have been known from the earliest times—several new cracks have appeared, but of no great extent. We counted five across the path, but only one was as much as a foot in width. They invariably take the line of the older cracks, running north-east and south-west. Mr. Morgan describes the cracks on the south side of Kakaramea to be very numerous, and in one place a spur from that mountain is cracked and broken-up to an extent to make crossing it very difficult. The north end of Maungaongaonga is also much cracked.

Looking over the country south of Kakaramea, where a very large number of hot springs exist, it appeared as if some of the springs were more active than usual, the columns of steam rising were of greater height and volume than I remember to have seen before.

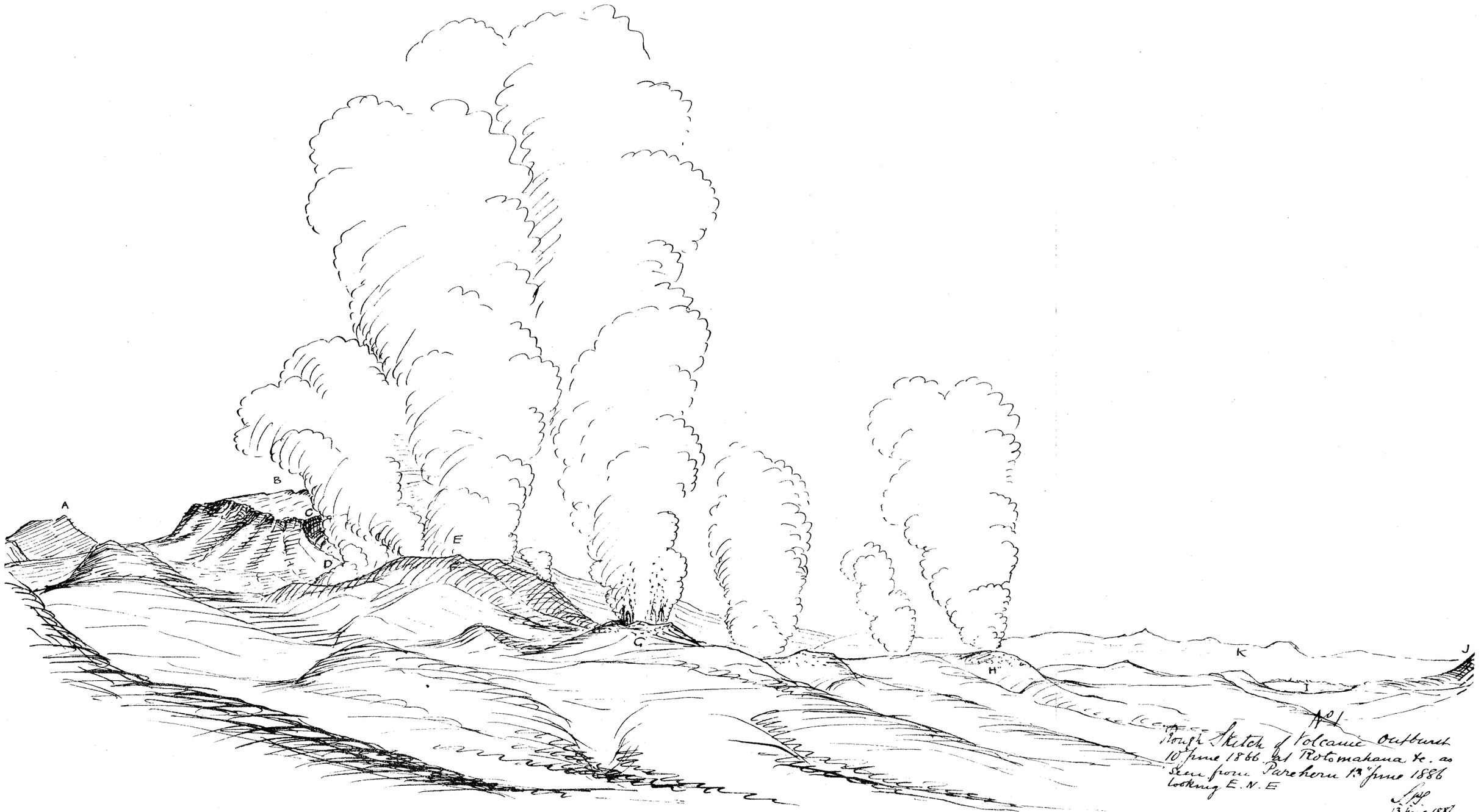
Rotorua.—In the immediate neighbourhood of Rotorua there are signs of increased activity in the springs. On the night of the 10th June several small hot springs burst forth along the north-east foot of the Pukeroa Hill, notably one about fifty yards from the Government Agent's house, that is 10ft. in diameter, and is constantly boiling. Northwards from this steam escapes from the ground in numbers of places, sometimes accompanied by water, round as far as the Maori pa, where several small hot springs have appeared; indeed, one has broken out in the Tamate Kapua meeting-house. The locality of these new springs is in that part which is covered with blocks of sinter formed by deposits from springs long since quiescent, and, as far as I know, none have occurred in places which were not formerly active. It was noticed that, although the earthquakes at Rotorua are spoken of as very severe, no chimneys have fallen or been cracked, nor do articles such as bottles on shelves appear to have been thrown down. When we take into consideration the position of the houses where most of the people live at Rotorua, surrounded as they are on all sides by boiling springs and steam vents, it is not surprising that each earthquake as it occurs causes considerable alarm.

S. P. Smith,
Assistant Surveyor-General.

The Surveyor-General, Wellington.

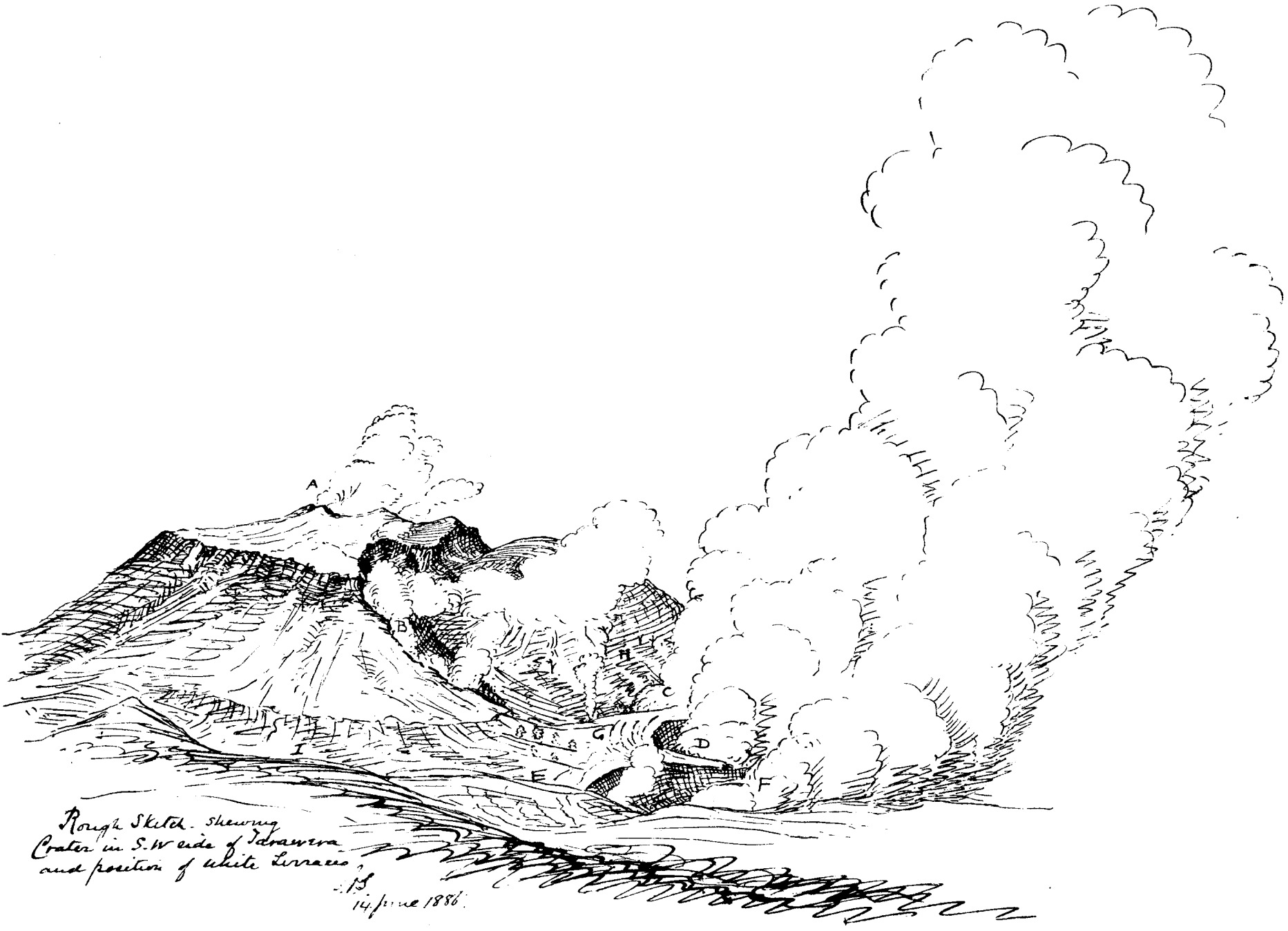
By Authority: George Didsbury, Government Printer, Wellington.—1886.

A Maungawhakamana
B Ruanahia & Tarawera Mounts
C Crater in S.W. side of Tarawera
D. Position of White Terrace
E Steam rising from Rotomahana
F Hape o Toroa Hill.
G The Black Volcano (in eruption)
H. Southern Volcano
I Okaro Lake
J Slopes of Kakaramea
K Edge of Kaingaroa Plain



No 1
Rough Sketch of Volcanic Outburst
10th June 1886 at Rotomahana &c. as
Seen from Parekeru 13th June 1886
looking E.N.E

J.P.G
13 June 1886



Rough Sketch shewing
Crater in S.W side of Tarawera
and position of white Terraces

J.S
14 June 1886

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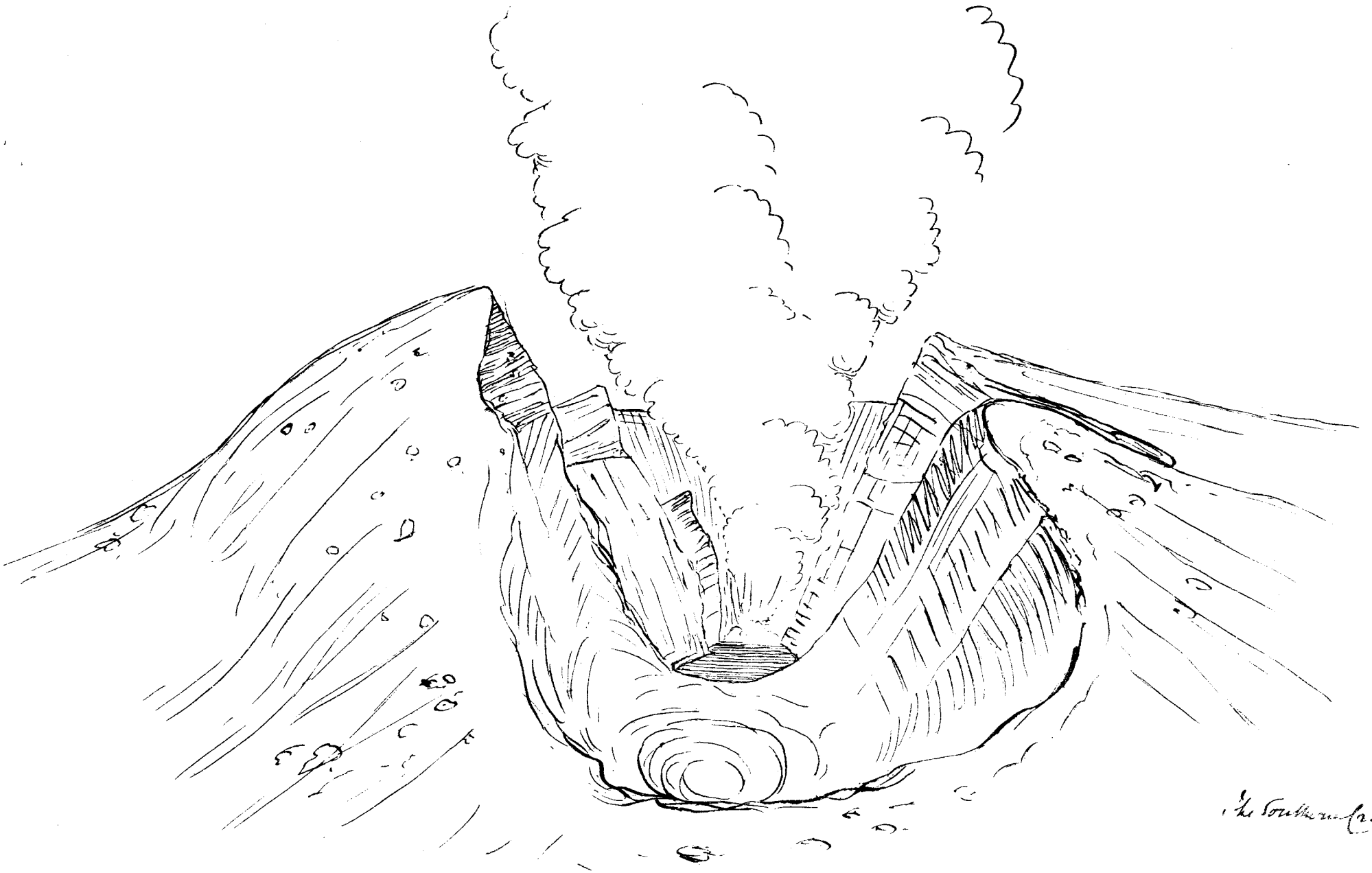
A Crater on top of Ruawahia
B " in S.W. Side of Tarawe
C Approximate position of Roto-makariki
D Former position of white Terr
E " outlet to Rotomahana
F Great Crater of Rotomahana
G Earthquake cracks, Steam
Vents and torrent beds
H Burnt Forest
GI Pound above Te ariki



The Southern Crater looking north
June 13. 86

MAP OF THE COUNTRY AROUND TARAWERA VOLCANO.

Eruption of 10th June 1886.

Scale

BAY OF PLENTY

TAURANGA HARBOR

TE PUKE SETTLEMENT

ROTO IT

ROTO MA

ROTO EHU

ROTO ROA

ROTO ITI PAKU

TAMURENUI

ROTO

RUA

TARAWERA LAKE

OKATAINA LAKE

REREWHAKAITU L.

ROTOMAHANA

ROTOKAKAHI

OKAREKA L.

TIKITAPU L.

LAKE TAUPO

WAIKATO RIVER

Road to Tauranga

Proposed Rl.

Road to Cambridge

Road to Taupo

Mt Tarawera before the Eruption. *From a sketch by* H.E. Sir Wm. Jervois

NOTE

Area covered by mud and ashes

Places of activity

Altitudes ... 3606 ft

Roads

Tracks

Bush

NORTH ISLAND N.Z.

0 50 100

MILES.

JAMES McKERROW
Surveyor General

TARAWERA VOLCANO.

Plan of
THE SEAT OF ERUPTION
10th June 1886.

SCALE OF CHAINS.
80 40 0 80 160 240

MOKOIA
TE NGAE
ROTO RUA
ROTOKAWA
OKATAINA LAKE
OHINEMUTU
PUKEROA
MUD
OKAREKA LAKE
DEEP
Waiteruga
Tarawera R.
TE TAPAHORO
LAKE TARAWERA
APPROXIMATE BOUNDARY LINE OF EARTHQUAKE CRACKS AND WATERSHED
Moerangi
TIKITAPU L.
WITH
Kaurehapa
Kaiiri
Punarania
TE WAIROA
Tutuhihau
ROTO KAKAHI
Te Kumiti
MOURA
Wahanga
Epiha
KAITERIRIA
COVERED
Ruawahia 4' 3609 ft.
Kanakana
TE ARIKI
Tarawera
Pakaraka
Taumatamanuka
TE TARATA OR WHITE TERRACE ROTOMAKARIKI
PINK TERRACE (OTUKAPUARANGI)
HOT SPRINGS
ROTOMAHANA
ROTOMAKARIKI CRATER
Te Hape o Toroa
Tumutumu
Parcharu
ROTOMAHANA CRATER
KAUAE
COVERED WITH ASHES
THE BLACK CRATER
SOUTHERN CRATER
OKARO LAKE
REREWHAKAITU
Ngapuketurua
NGAHEWA L.
HOT SPRINGS
Kakaramea
GREEN LAKE (ROTOWHERO)
Maungaongaonga
BLUE LAKE (ANGA-I-KAKAHO)
CRACKS
NGAPOURA L.
PAEROA RANGE
TE MANANIATAEU HOT

Lithographed at the General Survey Office Wellington N Z July 1886