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THURSDAY, JULY 14, 1859.

PROCLAMATION.

By His Excellency Colonel THOMAS GORE BROWNE, Companion of the Most Honorable Order of the Bath, Governor and Commander-in-Chief in and over Her Majesty's Colony of New Zealand, and Vice-Admiral of the same, &c., &c.

WHEREAS the Land hereinafter mentioned has been acquired by purchase from the aboriginal inhabitants of New Zealand, and it is expedient that the acquisition thereof should be notified by Proclamation accordingly:

Now, therefore, I, the Governor, do hereby proclaim and notify that the Native Title has been extinguished over the Blocks of Land whereof the boundaries are mentioned or described in the Schedule hereunto annexed.

Given under my hand, and issued under the Public Seal of the Colony, at Government House, at Auckland, this twelfth day of July, in the year of our Lord one thousand eight hundred and fifty-nine.

THOMAS GORE BROWNE.

By His Excellency's command,

HENRY JOHN TANCRED

GOD SAVE THE QUEEN!

SCHEDULE.

PROVINCE OF HAWKE'S BAY.

North Porangahau Block, estimated area 130,000 acres.

BOUNDARIES.

Commencing at Parimahu and following up the boundary of the block first sold (Te Hapuku's Block) to the Pa o Te Rangitakia, thence it runs to Otakoha and follows the stream to the Pou-a-Tapatu, thence it runs to the Ngutumara as far as Tutea-o-Kahutia, thence to the Manga-a-te-Waiora, thence to the Roupi and follows the course of the Waikopiro to the Manga-a-Purakau, and down that stream to Pukanohi where it runs into the Whangai, and so on to Manga Puaka, and following that stream to Poutini, thence to Mangawhero, and following that stream to Taurekaitai, and down the Taurekaitai to Porangahau to the mouth of the river, and thence by the sea beach round to Parimahu.

Saving and excepting the reserves at Eparaima, at Pakowhai, at the Makahua, at Oreorewaia, and at Manukaroa, as the said reserves have been finally settled and surveyed by Mr. Bousfield in conjunction with the Native Chiefs, and which reserves are mentioned in the Deed of Sale and particularly delineated on the original Maps in the Land Office at Napier.

Karanemas Reserve.

Mata Block, estimated area 4,000 acres.

BOUNDARIES.

Commencing at Karituwhenua, and running thence to te Hau, following thence the summit of the hill (Te Mata), to Kahurangi, turning there and running straight down to the source of the Ngakau o Hape, and down the stream to Ototara, and so to the Ngaruroro river, which forms the boundary back to Karituwhenua.

Tautane Block, estimated area 140,000 acres.

BOUNDARIES.

Commencing at the Arataura, and running inland to the Kohi-o-tu, thence to Tawaputahi, thence to Te Ahititi, thence to Te Iringa-o-Rahunga where it turns to the Southward and runs to Rakautuhaha, thence to Oporae, and thence still in a Southerly direction to Wahatuara when it strikes the boundary of the land already sold to the Queen of England, and follows the said boundary to Waimata, and from the mouth of that stream round the coast to Te Arataura.

Saving and excepting a reserve of one thousand acres, more or less, between the Wainui and Tautane rivers surveyed by Mr. Bousfield in conjunction with the Native Chiefs, and a reserve of fifty acres, more or less, including certain Native Cultivations and Graves on the left bank of the Tautane stream, also surveyed by Mr. Bousfield, in conjunction with the Native Chiefs, and which reserves are mentioned in the Deed of Sale, and particularly delineated on the original Map in the Land Office at Napier.

Colonial Secretary's Office,
Auckland, 13th July, 1859.

HIS Excellency the Governor, directs the publication of the following communication with its enclosure on the Geology of the Province of Auckland, by Dr. F. Hochstetter, for general information.

HENRY JOHN TANCRED,
(For the Colonial Secretary).

Auckland, June 30, 1859.

SIR,—In accordance with the tenor of my former letter, I now have the pleasure of forwarding to you my Report on the Geology of the Province of Auckland, in the form of the Lecture which I delivered the other evening to the Members of the Auckland Mechanics' Institute. In this Lecture, enlarged by some additions and notes, I have embodied all the information I at present have time to communicate.

I have also the pleasure to inform you that I have arranged a duplicate collection of geological specimens and fossils which I have obtained during my exploration of the Province of Auckland, and which I shall hand over to His Honor the Superintendent for the Auckland Museum. Allow me further to state that it will give me great pleasure to forward for the acceptance of the Government of New Zealand copies of the publications respecting this Colony, as they will appear from time to time prior to the completion of the volumes and atlases, embodying the whole results of the F. Austrian Novara Expedition.

As my further stay in Auckland draws rapidly to a close, and as my stay in Nelson before my departure for Europe will be very short—so leaving me no time for further correspondence, I now beg to return through you my sincere thanks to His Excellency the Governor, Colonel Gore Browne and the General Government, for the kind co-operation I have experienced from them in the prosecution of my geological researches during my stay here.

I am sure that Commodore Bernhard v. Wüllerstorf Urbair, the Commander of the Austrian Scientific Novara Expedition, and the Austrian Government will have great pleasure in learning that one of the members of that Expedition has received so much kindness and assistance on English soil in the antipodes.

I have, &c., &c.,
FERDINAND HOCHSTETTER,
Geologist on board the Austrian frigate "Novara."

To the Honorable
The Colonial Secretary,
Auckland.

LECTURE ON THE GEOLOGY OF THE PROVINCE OF AUCKLAND, NEW ZEALAND.

[Delivered to the Members of the Auckland Mechanics' Institute, June 24, 1859.]

Mr. President, Ladies and Gentlemen,—The members of the Auckland Mechanics' Institute having done me the honour to elect me as honorary member of their institution, and the Committee having invited me to give a Lecture upon the Geology of this Province, I have much pleasure in complying with their request. It is, however, with some hesitation that I undertake this task, fearing that my imperfect knowledge of the English language will prevent my making the short sketch I wish to lay before you as interesting as it might otherwise have been. Notwithstanding this drawback, I am glad to have this opportunity of giving the inhabitants of this Province, through the members of this Institute, such a *résumé* as I can of the chief results of the Geological Survey I have made of those parts of the country I have visited.

I feel this, indeed, to be a duty I owe to the community at large, in return for the very kind reception that has everywhere been given me—for the ready help that has always been afforded by all whom I have met with—and for the interest that has been shown by all in the proceedings of the Imperial Austrian "Novara" Expedition.

Having, in the months of January and February, completed my Survey, and finished a Geological Map, of the Auckland District,—which I now have the pleasure of showing you,—the necessity arose for my choosing either the *Northern* or the *Southern* portion of the Province for my farther researches, my limited stay in New Zealand rendering it impossible for me to make a sufficient examination in both directions.

I did not hesitate to choose the Southern districts—for these reasons: that the country over which I should there proceed, is inhabited almost exclusively by Maories, and has hitherto been almost unknown and totally unsurveyed, both topographically and geologically. The Northern districts, on the contrary, are for the most part better known, and from the number of European settlers in them, I was led to hope I should be enabled to collect some information through specimens forwarded to me for examination, and from the verbal descriptions of those who are well acquainted with the various localities.

My hope was not unfounded in either respect.

I have received many specimens of interest from various localities; also some valuable information from different settlers, and especially from my friends, the Rev. A. G. Purchas and Mr. C. Heaphy, who in the last few months have had opportunities of visiting several parts of the Northern portion of this Province, and of collecting very valuable specimens. In addition to this must be remembered the fact, that other scientific men, especially MM. Dieffenbach and Dana, had already visited and described at length some parts of the Northern country.

Through the liberality and excellent arrangements of the General and Provincial Governments I have been enabled in a comparatively short time to travel over and to examine the larger portion of the Province South of Auckland, extending as far as Lake Taupo and Tongariro Volcano, the boundaries between this Province and those of Wellington and

Hawke's Bay. I have thus obtained materials which will enable me, on my return to Europe, to construct a Topographical and Geological Map of the central part of the Northern Island.

My observations have, with the able assistance of Mr. Drummond Hay, extended from the East- to the West-Coast; and the numerous peaks and ranges have afforded facilities for fixing with satisfactory accuracy, by means of *magnetic bearings*, on the basis of points previously fixed by the nautical survey of Capt. Drury on the coast line, all the great natural features of this portion of the country. A great number of *barometrical observations* have afforded me the means of ascertaining the heights of mountains and plains in the interior, which I shall be able to calculate with accuracy by the aid of corresponding daily observations, taken in Auckland by Colonel Mould, who has kindly forwarded me a copy of his tables.

I have also obtained *photographic* and other *views* of great interest, many of which were taken by the gentlemen who accompanied me on the expedition for this purpose; and a large number of exceedingly valuable sketches have been contributed by the talented pencil of our president, Mr. C. Heaphy, for future publication in a geological atlas. Many of these are decorating the walls and others are lying on the table, and I shall be happy to show them to any ladies and gentlemen who may feel an interest in seeing them, at the conclusion of the lecture.

My *collections* have been growing from day to day, and include specimens of great interest in most branches of Natural History. I owe a great deal to the indefatigable zeal of my friend and fellow-traveller, Mr. J. Haast, who assisted me in collecting during our expedition. I am also much indebted to Mr. J. Crawford at Wellington, Mr. A. S. Atkinson of Taranaki, Mr. Triphook of Hawke's Bay, Mr. H. T. Kemp of the Bay of Islands, to the Missionaries, and to almost innumerable friends in Auckland.

Preliminary Remarks.

I cannot suppose that all my audience are acquainted with the first principles of Geology. I shall therefore be under the necessity, in order to make my report intelligible, of prefacing a few remarks upon the chief divisions of the Geological formations.

The various rocks, soils, and minerals, which occur upon the surface of the earth, or at various depths beneath it—in one word, the materials of the "*earth's crust*"—are classified, in the first place, with reference to their different *origin*, or, in other words, with reference to the different circumstances and causes by which they have been produced. They are divided into *four* great classes—*Plutonic, Metamorphic, Aqueous*, and *Volcanic* rocks. Another mode of classification is with reference to their *age*—that is, to the comparative periods of their formation. Those divisions will be easily understood.

The *Plutonic* rocks comprehend all the *granites, syenites, porphyries, diorites*—rocks which agree in being highly crystalline, unstratified, and destitute of organic remains—which are considered as of igneous origin, formed in the earliest periods of the earth, in great depths, and cooled and crystalized slowly under great pressure.

The *Metamorphic* rocks are the crystalline strata, or schists, called *gneiss, mica-schist* or *mica-slate, chlorite-schist, hornblende-schist*—also destitute of organic remains. According to the most probable theory, these strata were originally deposited from water in the usual form of sediment, but were subsequently altered by subterranean heat, so as to assume a new texture.

The two first classes of rocks are usually found in such a position that they form the foundation on which the aqueous rocks were afterwards superimposed. For instance, they compose the central line of a range of mountains, on both sides of which sedimentary rocks are deposited. Thus, in reference to their *age*, they are considered as the oldest, and are therefore called also *Primitive*.

There are exceptions to this rule in reference to the age of certain plutonic rocks of *eruptive* character. But I am now stating only general principles, and therefore avoid all questions leading to scientific discussions.

The next in order are the *aqueous* rocks—the production of watery action. They are also called *sedimentary* rocks, from the fact that they are the hardened sediments accumulated at the bottom of the sea or of fresh-water lakes. They are stratified, or divided into distinct layers or strata: as, for example, clay-slate, marl, sandstone, limestone, and are divided into three kinds, called *arenaceous* or *siliceous, argillaceous* or *clayey*, and *calcareous* or *chalky*—according to the respective predominance of Silica, Alumina, or Lime. Rocks of this class cover a larger part of the earth's surface than any others, and are of the greatest interest on account of the *organic* remains which are found imbedded in the different strata.

There are two principal means of ascertaining the relative age of aqueous rocks—derived, the one from their *position*, the other from the *fossil remains* they contain.

With reference to *position*—the bed which lies uppermost, is of course the newest of all, and that which lies at the bottom, the most ancient.

With reference to the *fossils* it is not so easy to give an explanation in few words; but some idea may be formed from the well-ascertained fact, that certain animals have existed for a certain period, and then wholly disappeared and been succeeded by other animals of different species, which, in turn, have again given place to others.

So, as Sir Charles Lyell truly says, "a series of sedimentary formations is like volumes of history, in which each writer has recorded the annals of his own times, and then laid down the book with the last written page

uppermost." And the organic remains are, as Dr. Mantell beautifully expresses it, the "coins of Creation," which give us the means of tracing the history of the development of the organic kingdoms.

Thus, by superposition and by their organic remains, the aqueous rocks are divided into groups forming, in reference to their age, what is termed an "ascending series," or beginning with the oldest, in the following manner:—

1. Primary formations or periods.
2. Secondary „ „
3. Tertiary „ „
4. Quartary „ „

In reference to the word "quartary" I may explain that, although it is not an English word, I take the liberty to use it in the sense of "post tertiary," as following the analogy of the other terms.

Each of those formations is again divided into numerous minor systems, on which I have no time to enter.

The fourth and last great division of rocks are the *volcanic*—as Trachyte, Basalt, Breccia, and Tuff—all produced by supramarine or submarine volcanic eruption. It is ascertained that the earliest true volcanic eruptions have occurred subsequently to the Secondary period, commencing in the Tertiary, and continuing to the present time; and it is a marked difference between the older and the more recent eruptions.

I have prepared a diagram which will serve to impress these first principles upon your memory, and so enable you to follow me in the account I have to give:—

DIAGRAM.

Origin.	Age.	Organic Remains.
Plutonic and Metamorphic rocks	Primitive formation.	no fossils.
Aqueous	Primary. Secondary. Tertiary. Quartary.	Fossiliferous.
Volcanic	Trachytic. Basaltic.	no fossils.

With these preliminary remarks, I now proceed to the main subject of my lecture.

GEOLOGY OF THE PROVINCE OF AUCKLAND.

The first striking characteristic of the Geology of this Province—and probably of the whole of the Northern Island of New Zealand—is *the absence of the primitive, plutonic, and metamorphic* formations, as granite, gneiss, mica-slate, and the like. I have been informed by Mr. Heaphy, that these rocks are of wide-spread extent in the Middle Island, forming mountain ranges of great altitude, covered with perpetual snow, and reaching in Mount Cook probably to 13,000 feet. The rocks of these formations contain the principal metallic riches of the earth. Therefore we cannot hope to find these riches developed in the highest degree in the Northern Island; but as other formations also contain metalliferous veins, there may be found many mines worth working, in the rocks I am about to describe.

I.—PRIMARY FORMATION.

The oldest rock I have met with in the Province of Auckland belongs to the *primary formation*. It is of very variable character—sometimes being more argillaceous, of a dark blue colour, (when decomposed, yellowish brown, the colour generally presented on the surface,) and more or less distinctly stratified like *clay-slate*—(at Maraitai on the Waitemata); at other times the siliceous element preponderates, and, from the admixture of oxide of iron, the rock has a red, jasper-like appearance—(at Waiheki, Manganese Point.) In other localities it is more distinctly arenaceous, resembling the Old Sandstones of the Silurian and Devonian Systems, called Grauwacke—(at Taupo, on the Hauraki Gulf).

As no fossils have yet been found in this formation in New Zealand, it is impossible to state the exact age: I am, however, of opinion, that these argillaceous siliceous rocks will be found to correspond to the oldest Silurian strata of Europe.

The existence and great extent of *this* formation are of considerable importance to this Province, as *all the metalliferous veins* hitherto discovered, or likely to be hereafter found, occur in rocks of this formation.

To these rocks belong the *Copper-pyrites*, which has been worked for some years at the *Kawau* and *Great Barrier*—the *Manganese* (Psilomelan) at *Waiheki*—and the *Gold-bearing quartz* at *Coromandel*.

The *gold* which is washed out from beds of quartz-gravel in the rivers and creeks flowing down from both sides of Coromandel range, is derived from quartz veins, of crystalline character and considerable thickness, running, in a general direction from North to South, through the old primary rocks which form the foundation of the Coromandel range. In some places these veins stand up like a wall on the summit of the range to a height of eight or ten feet. The clay-slate rock itself is exposed only at the bottom of deep gorges which form the channels of the principal streams. In almost all places it is covered by large masses of trachytic tuff and breccia, of which the hills surrounding the Harbour of Coromandel are composed. The well-known "Castle Hill"—which can be seen from Auckland—is a characteristic example of the Trachytic Breccia formation. The magnetic iron-sand which, in washing, is found with the gold, is derived from the same source as all the magnetic iron-sand of New Zealand, namely, from the decomposition of trachytic rocks. Small veins of quartz of amorphous character—that is, not crystalline, but in the shape of chalcedony, cornelian, agate, and jasper—are found in numerous places on the shores of Coromandel. These veins occurring in trachytic rocks, are quite different from the auriferous quartz veins in the primary formation,—a fact, I think, of much practical importance to state, to prevent

the fruitless search for gold where gold does not exist. All the gold-bearing gravel in the creeks is derived, as I have already said, not from the veins in the trachytic breccia, but from the much thicker and crystalline veins in the primary rocks. The surface-deposit in those creeks is very rich, but, as compared with Australian and Californian gold-fields, of limited extent and depth. (*I washed a few bucketsful of surface earth, and gravel, at a creek pointed out to me by Mr. Charles Heaphy, near Ring's Mill, at the Kapanga. Every panful showed scales of thin gold, with small fragments of quartz streaked and studded with veins and spangles of gold. These "specimens," as they are called by diggers, show no—or very little—sign of being water-worn, but are sharp and crisp fragments, as if they had been broken up on the spot, or in the immediate vicinity. I think the quartz veins in the mountains should be thoroughly examined, and that, when once the day has come that the Coromandel gold-fields are worked, the attention of the "digger" should be directed as well to the hills immediately above any rich deposits as to the alluvial workings below.*)

The Coal Beds at Coromandel occurring between strata of trachytic breccia are too thin to be of any value, and as the coal formation is absent, there is no ground for hoping that a workable seam may be found.

The primary formation occurs, to a more considerable extent, to the Eastward of Auckland, in ranges on both sides of the *Wairoa river* attaining an altitude of 1500 feet above the sea,—and striking from thence Northwards, over Waiheki and Kawau, to the Bay of Islands. In a Southerly direction, they extend, through the *Hangawera* and *Taupiri* ranges, across the Waikato, through the *Hakari-mata* and *Hauturu* range—parallel with the West Coast—to the Mokau district, where, at Wairere, the Mokau river falls in a magnificent cascade over a lofty precipice of that rock.

The same formation occurs again in the *Rangitoto mountain* on the Upper Waipa, and West of Taupo lake in the *Tuhua* mountains. But the most extensive range of primary rocks is that which commences near Wellington under the name of *Tararua* and *Ruawahine*, and runs in a North-easterly direction to the East shore of Taupo lake, under the name of *Kaimanawa*, in which rises the principal source of the Waikato—there called Tongariro river. The range continues from the shores of Taupo ake, in a North-easterly direction, to the East Cape, under the principal name of *Tewhaiti*. This lofty and extensive mountain range—the true backbone of the Northern Island—with peaks from 6000 to 7000 feet, is entirely unknown. (*In this range the *Plutonic* and *Metamorphic* rocks, yet unknown in the Northern Island, may perhaps be found.*)

Nearly all the primary ranges are covered with dense virgin forests, which render them extremely difficult of access. It must be left to the labour and enterprise of future years to discover and develope the mineral riches, the existence of which appears to be probable, not only from the geological characteristics of the country, but also from some few specimens of Lead and Copper ore that have from time to time been picked up by the Natives.

It is remarkable that, while one of the oldest members of the Primary formation is found so extensively in New Zealand, the later strata, as the Devonian, Carboniferous, and Permian system, appear to be altogether wanting;—while, on the other hand, in the neighbouring Continent of Australia these members of the Primary period, together with plutonic and metamorphic rocks, constitute, so far as we know, almost the principal part of the continent.

II.—Secondary Formation.

A very wide interval occurs between the primary rocks of the Northern Island and the next sedimentary strata that I met with. Not only the upper members of the primary series are absent, but also nearly the whole of the Secondary formations. The only instance of secondary strata that I have met with, consists of very regular and highly-inclined beds of marl alternating with micaceous sandstone, extending to a thickness of more than 1000 feet—which I first saw on the South head of the Waikato, and afterwards met with on the Western shore of Kawhia harbour.

These rocks possess great interest from the fact that they contain remarkable specimens of marine fossils, which belong exclusively to the secondary period, especially Cephalopods of the genera *Ammonite* and *Belemnite*, several species of *Belemnite*, all belonging to the family of the *Canaticulati*. These are the first specimens of those genera which have been discovered in the regions of Australasia. Both fossils have been known for centuries by our ancestors in the Old World—the Ammonite as the horn of Jupiter Ammon, and the Belemnite as the bolts of the God of Thunder. The latter, though now first seen in the Antipodes by Europeans, have long been known to the Natives of Kawhia by a much less dignified name,—the old warrior-chief, *Nuitone te Pakaru*, having told me that the stones I prized so much and collected so greedily, are nothing more than '*roke-kanae*,' which means the excrement of the fish commonly known amongst the settlers by the name of 'mullot.' In reality, the Belemnite belongs to a creature, long since extinct, which was allied to the now living cuttle-fish.

Secondary rocks may probably be found in some other parts of the West Coast, and occur, as I have been kindly informed by the Rev. A. G. Purchas, in the Harbour of Hokianga—but everywhere of limited superficial extent.

III.—Tertiary Formations.

I proceed now to speak of the Tertiary

period, strata of which, of very various characters, occupy a large portion of the Northern Island. The various tertiary strata are found for the most part in a horizontal position—a remarkable fact, from which we may conclude that even the numerous volcanic eruptions which took place during and after the period of their deposition, had not power enough to dislocate the whole system, but merely to produce local disturbances.

The tertiary period must be divided into two distinct formations, which may perhaps correspond to the European *Eocene* and *Miocene*. There is an older formation which is found principally on the West Coast, and in the interior, on both sides of the primary ranges, and a newer one which may be called the *Auckland Tertiary Formation*.

You will probably be interested to have some more minute description of the different strata of the older of these formations, as to this belong the *Brown-Coal* seams, to the discovery of which I am indebted for the opportunity of investigating the Geology of this Province, and on the intelligent working of which I believe very much of the future welfare of this Province depends.

The *Brown-Coal Formation* is of very considerable extent both in the Northern and Middle Islands of New Zealand, and is of similar character everywhere.

Some months ago I furnished a Report on the Coalfield in the neighbourhood of Auckland, in the Drury and Hunua districts, (*of which I will repeat here the principal points. The Drury coal belongs to a very good sort of brown coal—to the so-called *Glanzkohle*, with conchoidal fracture. I was not able to convince myself of the existence of different series of seams, one above the other, on different levels. I am much rather of opinion that the same seam, disturbed in its level, occurs at the different localities in the Drury and Hunua district, where coal is found. The average thickness of that coal seam may be estimated to amount to six feet. The section of the seam at Mr. Fallwell's farm can be taken as a fair average.

The seam consists there of three portions; the upper part a laminated coal of inferior quality, one foot; then a band of shale, two inches; the middle part coal of a good quality, one and a half feet; then a band of bituminous shale, six inches; the lowest part coal of the best quality I have seen, two and a half feet. Thus the whole thickness of the coal itself may be considered to amount to about five feet. The bituminous shale accompanying the coal contains fossil plants, principally leaves of *Dicotyledones*. It is remarkable that no fossil ferns are found in connection with the Drury coalbeds; it is the more so, as at the other locality which I must mention—on the West Coast, seven miles from Waikato Heads, —*only* fossil ferns, in a most beautiful state of preservation, are imbedded in gray argillaceous strata, alternating with sandstone and small coal seams, of, probably, the same geological age as the Drury coal. A considerable number of specimens from both localities will, by a future examination, furnish the opportunity for determining the principal features of the Flora of the *Brown Coal Period in New Zealand*.

The fossil gum found in the coal is a kind of "Retinite," derived from a coniferous tree, perhaps related to the Kauri, but it is by no means identical with the Kauri Gum, which is only found in the surface soil in those localities where there have been kauri forests. The fossil gum and kauri gum are very different in their qualities, as the most simple experiments in their ignition will show.

The thickness of the forest and the inaccessibility of the country prevent our now ascertaining, in an exact manner, the extent of the Drury coal-field. Still the existing openings show an extent of the coal-field quite large enough to encourage any Company to work the coal in an extensive manner.

I am glad to hear that a company, under the name of "The Waihoihoi Mining and Coal Company," is formed, to begin the working of this coal.*)

The same kind of coal I saw again on the northern slope of *Taupiri* and *Hakarimata range*. At *Kupakupa*, on the left bank of the Waikato, I examined a beautiful seam about 150 feet above the level of the river. The thickness of the seam then exposed was about 15 feet; how much greater the thickness may be it is impossible to say, as the floor has never been uncovered.

This is the seam to which the attention of the inhabitants of Auckland was directed several years ago by my friend the Rev. A. G. Purchas. I believe several tons were at that time brought to Auckland; but, owing to various circumstances—the chief of which was the Native ownership,—the hope of obtaining a supply from thence for Auckland was abandoned. No better position could, however, be found for mining purposes; and the day cannot be far distant when it will be worked to supply fuel for the *steam navigation of the Waikato*—the *main artery of the Province of Auckland*.

I have reason to believe that a Coal Field of considerable extent exists on the borders of the wide plains on both sides of the Waikato, between Taupiri and Mangatawhiri—for which district, shut in on all sides by ranges, I propose the general geographical name of "*The Lower Waikato Basin*."

A third coal-field exists on the Western and Southern boundaries of the very fertile alluvial plains above the junction of the Waipa and Waikato, which may be distinguished as "*The Middle Waikato Basin*"—the *future granary* of the Northern portion of this Island.

The localities in which coal has been discovered are the following:—in the Hohinipanga range, West of Karakariki on the Waipa; near Mohoanui and Waitaiheke, in the Hauturu range on the upper branches of the Waipa; and again in the Whawharua and Parepare

ranges on the Northern side of Rangitoto-mountains.

THE NEW ZEALAND BROWN COAL.

(*The following are the results of several analyses of specimens of the *Drury Brown Coal*, sent to England some months ago by Mr. Turnbull. The analyses have been forwarded to me by Mr. Farmer.

Laboratory, Museum of Practical Geology,
Jermyn-st., London, April 13, 1859.

Sir,—I have completed the analysis of the coal (lignite) which you left at the Museum, and herewith furnish you with the results of the examination.

I am, Sir,
Yours obediently,
CHAS. TOOKEY.

Brown, Esq.

Per centage composition of Lignite, from Auckland.

Carbon	55.57
Hydrogen	4.13
Oxygen	15.67
Nitrogen	1.15
Sulphur	0 36
Ash	9.00
Water	14.12
	100.00
Coke	50.78 per cent.

The amount of sulphur is small, and this will be a point for favourable consideration in the application of the coal for smelting purposes. The whole of the water is expelled at a temperature of 120° centigrade.

Dundee Gas Works,
March 17, 1859.

Analysis of Auckland Coal.

Produce of gas per ton of coal carbonized, 9.632 cubic feet.

Illuminating power of gas, 1.75.

Durability. the length of time that a 4-inch jet requires to consume a cubic foot of gas, 53 minutes.

Specific gravity, 495.

Produce of coke per ton, carbonized, 9¼ cwt.

(Signed) JOHN Z. KAY,
Engineer Gas Company.

Gas Works, Berwick,
March 12, 1859.

NEW ZEALAND COAL.

Gas, in cubic feet, per ton of coal, 7617.

Coke, per ton of coal, in lbs., 1155.

Tar and ammoniacal liquor, per ton of coal, in lbs., 571.

Value of gas, per ton of coal, in lbs. of sperm, 384.

One cubic foot of gas, burned in a No. 2 fishtail burner (or union set), equal sperm candles, 3.12.

Value of one cubic foot of gas, in grains of sperm, 374.40.

Coke, trable, retains the granular structure of the coal; disintegrates when exposed to air; during combustion gives out little heat; and leaves a large mass of stone coloured ash; specific gravity, 1.471.

Composition	Combustible matter...	39.25
	Silica and alumina ...	54.44
	Protoxide of iron	6.31
		100.

This coal is well adapted for the purpose of gas manufacture: the quantity produced is not large, but you will observe of a high quality, approaching several of the Scotch cannels in illuminating power.

The coke is of very inferior quality for heating purposes; but the quantity of iron share found in it is so great that it may possibly turn out to be a product of value.

JAMES PATTERSON,
Civil Engineer.

I subjoin comparative average analyses of the three principal kinds of fuel, from which it may be seen that the Drury Coal is precisely similar to the European brown coals in the proportion of its three principal constituents:

	Wood.	Brown Coal.	Black Coal and Anthracite.
Carbon...	51.4 to 52.6	55 to 76	73 to 96.51
Oxygen .	43 42	26 19	23 3
Hydrogen	6 5.5	4.3 . 2.5	5.5 0.5*)

I embrace here the opportunity of saying a few words on the *commercial value and applicability of the New Zealand Brown Coal.*

Although of entirely different character, and, generally speaking, of inferior value, to the older coals of the Primary formations, I cannot see any reason why this kind of coal should not be used in New Zealand for the same purposes as a similar brown-coal is extensively applied to in various parts of Europe, and particularly in Germany, where it supplies the fuel for manufactures of all kinds, for locomotives and steamers, and for domestic purposes. I am perfectly familiar with this kind of coal, and can assure the people of Auckland, that the Brown Coal of this country is quite as good as that which is used in Germany for the purposes I have just mentioned. I would strongly recommend that any Company which may be formed for the purpose of working the coal should also at the same time establish *Potteries* for the manufacture of earthenware. Remarkably suitable *Clays* of every necessary variety have been shown to exist in the immediate neighbourhood of the coal-fields, by the borings which have been made by the Provincial Government at my request.* By the establishment of such works,

(*The following are the results of two borings made in the flats between Drury Hotel and the Drury Ranges, under the direction of Mr. Ninnis, to whom I am indebted for the tables subjoined:—

BORING No. I.

	Feet.	Inch.	
1)	2.	0	Dark soil.
2)	9.	6	Plastic clay, yellow and blue.
3)	1.	6	Gravel and pebbles.
4)	1.	0	Yellow clay.
5)	3.	0	Grey clay.
6)	6.	0	Blue clay.
7)	11.	0	Arenaceous clay.
8)	15.	0	Grey clay.
9)	2.	0	Greenish clay.
10)	1.	0	Dark grey clay.
11)	5.	0	Bluish grey clay.
12)	2.	0	Sandy clay.
13)	5.	2	Volcanic ashes and gravel.
14)	5.	6	Hard basaltic rock.
	69.	8	

BORING No. II.

1)	1.	0	Dark soil.
2)	7.	0	Yellow clay.
3)	6.	6	White clay.
4)	7.	0	Yellow and red clay.
5)	1.	4	Brown clay.
6)	8.	0	Yellow clay.
7)	5.	0	Brown.
8)	4.	0	Redish.
9)	10.	0	Brown.
10)	4.	6	Gravel and Volcanic ashes
11)	9.	6	Hard basaltic rocks.
	63.	10.	

the value of the coal would be made apparent to everybody, and the manufacture itself, if properly conducted, cannot fail to be remunerative. It may be interesting to you to know that the far-famed "Bohemian Porcelain" is burnt by means of brown-coal, from a seam of, in some places of 90 feet thickness. While stating the uses to which brown-coal may be applied, I must warn you against thinking that it is suitable for steamers having to make long sea voyages. The bulky nature of the "brown-coal" will always prevent such steamers taking it on board when they can procure "black-coal." (*But, on the other hand, its qualities as a gas-producing coal, as the above analyses show, will render it valuable as an article of export.*)

I now come to another series of the older Tertiary strata, examples of which are found occurring in great regularity on the West Coast from Waikato to Kawhia. The lowest are argillaceous—the middle, calcareous—the upper, arenaceous.

The characteristics of the first *clayey strata* are, a light grey colour, very few fossils, small crystals of iron pyrites and glauconitic grains, which give these clay marls a similarity to the Gault and Green sands of the Cretaceous formation in Europe. They are found on the Eastern branches of Whaingaroa, Aotea, and Kawhia harbours.

Of greater interest and importance are the calcareous strata, consisting of tabular *limestone*, sometimes of a conglomerate nature, sometimes more crystalline, the whole mass of which is formed of fragments of shells, corals, and *foramini-feræ*, interspersed with perfect specimens of terebratulæ, oysters and pectens, and other shells. This limestone, when burnt, makes excellent lime, and may be wrought and polished for architectural purposes.

The Beds of Limestone worked by Messrs. Smith and Cooper, in the Wairoa district, belong to this formation, as do also the rich fossiliferous strata from the Waikato Heads towards Kawhia Harbour.

Picturesque columnar rocks of the same nature, looking almost as if they were artificially built of tabular blocks, adorn the entrance to Whaingaroa Harbour; and the romantic limestone scenery, and the fine Caves of the Rakaunui river—a branch of Kawhia Harbour—are deservedly prized by the settlers of Kawhia Harbour.

The Limestone Formation attains its greatest thickness (from 400 to 500 feet) in the Upper *Waipa* and *Mokau* district, between the Rangitoto range and the West Coast. It has in this country many remarkable features.

No one can enter without admiration the Stalactite Caves of *Tana-uri-uri* at Hangatiki, and of *Parianewanewa* near the sources of the Waipa—the former haunts of the gigantic *Moa*.

I went into those caves in the hope of meeting with a rich harvest of Moa skeletons, but I was sadly disappointed. Those who had been before me in the days of Moa enthusiasm having carried off every vestige of a bone. Great, however, was my labour, and not little my satisfaction, in dragging out the head-less and leg-less skeleton of a Moa from beneath the dust and filth of an old raupo hut!—The Maories, seeing the greediness with which the "pakehas" hunted after old Moa bones, have long since carefully collected all they could find, and deposited them in some safe hiding-place—waiting for the opportunity of exchanging them for pieces of gold and silver, showing thus how well they have learnt the lesson taught them by the example of the "pakeha."

The subterranean passages of the rivers in the *Pehiope* and *Mairoa* district are highly characteristic of the limestone formation. The limestone rocks, fissured and channeled, are penetrated by the water, and the streams run below the limestone upon the surface of the argillaceous strata, which I have before mentioned as underlying the limestone. This also explains the scarcity of water on the limestone plateau which divides the sources of the Waipa and Mokau rivers. The plateau is covered with a splendid growth of grass, and would form an excellent cattle run but for the deep funnel-shaped holes which everywhere abound. The Natives call them "*tomo*." They are similar to the holes which occur in the limestone downs in England, and on the Karst mountain on the shore of the Adriatic Gulf, where they are called "*dolines*."

The third and uppermost stratum of the older tertiary formation consists of beds of fine fossiliferous *sandstone*, in which quarries of good building stone may be found. There are whole ranges parallel to the primary mountains which seem to consist of this sandstone. I will mention only the *Tapui-wahine* range, about 2000 feet above the level of the sea, in which is the pass from the Mokau to the Whanga nui country.

Without a map on a large scale, which I have had no time to prepare, it would be useless to enter more minutely now into a description of the various localities in which the different formations occur. I may, however, mention that limestone and brown-coal have been found in places to the North of Auckland, in the districts from Cape Rodney to the North Cape.

The horizontal beds of sandstone and marls which form the cliffs of the Waitemata, and extend in a Northerly direction towards Kawau, belong to a newer tertiary formation, and, instead of coal, have only thin layers of lignite. A characteristic feature of this *Auckland tertiary formation* is the existence of beds of volcanic ashes, which are here and there interstratified with the ordinary tertiary layers.

I must say no more on the tertiary sedimentary formations, in order that I may leave some

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Of these I would draw attention, to No. 1., 2 for common pottery, No. I., 6 and 8, for finer stoneware, No. I., 7, for fire bricks. The various coloured clays, No. II., 2 to 9, will be applicable to every kind of pottery. No. II., 8, may be used as a colour or pigment in the same way as ochre and umber are generally used.*)

time to devote to the *volcanic* formations which, from their great extent and the remarkable and beautiful phænomena connected with them, render the Northern Island of New Zealand, and especially the Province of Auckland, one of the most interesting parts of the world.

VOLCANIC FORMATIONS AND PHÆNOMENA.

Lofty trachytic peaks covered with perpetual snow, a vast number of smaller volcanic cones presenting all the varied characteristics of volcanic systems, and a long line of boiling springs, fumaroles, and solfataras, present an almost unbounded field of interest and, at the same time, a succession of magnificent scenery.

It is only through a long series of volcanic eruptions, extending over the tertiary and post-tertiary periods, that the Northern Island has attained its present form. It would be a difficult task to point out the ancient form of the antipodean Archipelago the site of which is now occupied by the Islands of New Zealand. I must confine myself to a simple indication of the events which have given this country the form it was found to have by the South-Sea Islanders on their arrival, many centuries ago, from the Samoan group,—a form in all main respects the same as is now before our eyes.

The first volcanic eruptions were *submarine*, consisting of vast quantities of trachytic lava, breccia, tuff, obsidian, and pumice-stone, which, flowing over the bottom of the sea, formed an extensive submarine volcanic plateau. The volcanic action continuing, the whole mass was upheaved above the level of the sea, and new phænomena were developed. The eruptions going on in the air instead of under the sea, lofty cones of trachytic and phonolithic lava, of ashes and cinders, were gradually formed. These eruptions, breaking through the original submarine layers of trachytic lava, breccia and tuff, raised them, and left them, as we now find them, forming a more or less regular belt round the central cones, and having a slight inclination from the centre outwards. These belts I shall have occasion to refer to under the name of "*tuff-craters*," or "*cones of tuffs*," or "*craters of elevation*." In the course of time the volcanic action decreased, and we must now imagine that tremendous earthquakes occurred—that parts of the newly-formed crust gave way and fell in, forming vast chasms and fissures, which are now occupied by the Lakes, Hot Springs, and Solfataras.

Thus we now find in the central part of the Northern Island an extensive volcanic plateau of an elevation of 2000 feet, from which rise two gigantic mountains, *Tongariro* and *Ruapahu*. They are surrounded by many smaller cones, as Pihanga, Kakaramea, Kaharua, Rangitukua, Puke Onake, Hauhanga. The natives have well named these latter, "the wives and children of the two giants Tongariro and Ruapahu;" and they have a legend to the effect, that a third giant, named *Taranaki*, formerly stood near these two—but quarrelling with his companions about their wives, was worsted in combat, and forced to fly to the West coast, where he now stands in solitary grandeur, the magnificent snow-capped beacon of Mount Egmont (8270 feet). These are the three principal trachytic cones of the Northern Island.

By far the grandest and loftiest of the three is *Ruapahu*, whose truncated cone, standing on a basis of about 25 miles in diameter, attains a height of 9 to 10,000 feet above the level of the sea—about 3000 feet of which is covered with glaciers and perpetual snow. Ruapahu, like Taranaki, is extinct. *Tongariro* alone can be said to be active. I was enabled to distinguish five craters on Tongariro, three of which are to a certain extent active. Steam is always issuing from them, and the natives state that from the principal crater, called *Ngauruhoe*, on the top of the highest cone of eruption (7500 feet), occasional eruptions of black ashes and dust take place, accompanied with loud subterranean noises. I may remark, that the shape of the cone is changing, the western side, for instance, having, during the great earthquake at Wellington, in 1854, fallen in, so that the interior of the crater is now visible from the higher points in the Tuhua district on the Upper Whanganui. The remarkable fact, that snow does not rest upon some of the upper points of the Tongariro system, while the lower ones are covered all the winter through, shows that those parts are of a high temperature.

(*I had no opportunity myself of ascending Tongariro, but I have met with the following interesting account of an ascent of the highest cone of eruption by Mr. H. Dyson, which was communicated to the *New Zealander* by A. S. Thomson, M.D.:—

Mr. Dyson's Account of his Ascent of Tongariro,

In the month of March, 1851, a little before sunrise I commenced my ascent alone, from the north-western side of the Rotoaire lake. I crossed the plain and ascended the space to the northward of the Whanganui river. Here I got into a valley covered with large blocks of scoriæ, which made my progress very difficult. At the bottom of the valley runs the Whanganui river. After crossing the river, which at this place was then not more than a yard broad, I had to ascend the other side of the valley, which, from the unequal nature of the ground, was very tedious, and I kept onwards as straight as I could for the top of the mountain. At last I came to the base of the cone, around which there were large blocks of scoria which had evidently been vomited out of the crater, and had rolled down the cone. The most formidable part of my journey lay yet before me, namely the ascent of the cone, and it appeared to me from the position where I stood that it composed nearly one-fourth of the total height of the mountain. I cannot say at what angle the cone lies, but I had to crawl up a considerable portion of it on my hands and feet, and as it is covered with loose cinders and ashes, I often slid down again several feet. There was no snow on the cone or the mountain, unless in some crevices to which the sun's rays did not penetrate. There was not on the cone any vegetation, not even the long wiry grass which grows in scanty patches up to the very base of the cone. The ascent of the cone took me, I should think, four hours at least; but as I had no watch, it is possible from the laborious occupation I was at, that the ascent of the cone looked longer than it was.

But whether it was three hours or four that I was clambering up the cone I recollect I hailed with delight the mouth of the great chimney up which I had been toiling. The sun had just begun to dip, and I thought it might be about 1 p.m., so that I had ascended the mountain from the Rotoaire lake in about eight hours. I must confess as I had scarcely any food with me that I kept pushing on at a good pace. On the top of Tongariro I expected to behold a magnificent prospect, but the day was now cloudy and I could see no distance. The crater is nearly circular, and from afterwards measuring with the eye a piece of ground about the same size, I should think it was six hundred yards in diameter. The lip of the crater was sharp: outside there was almost nothing but loose cinders and ashes; inside of the crater there were large overhanging rocks of a pale yellow colour, evidently produced by the sublimation of sulphur. The lip of the crater is not of equal height all round, but I think I could have walked round it. The southern side is the highest, and the northern, where I stood, the lowest. There was no possible way of descending the crater. I stretched out my neck and looked down the fearful abyss which lay gaping before me, but my sight was obstructed by large clouds of steam or vapour, and I don't think I saw thirty feet down. I dropped into the crater several large stones, and it made me shudder to hear some of them rebounding as I supposed from rock to rock,—of some of the stones thrown in I heard nothing. There was a low murmuring sound during the whole time I was at the top, such as you hear at the boiling springs at Rotomahana and Taupo, and which is not unlike the noise heard in a steam engine room when the engine is at work. There was no eruption of water or ashes during the time I was there, nor was there any appearance that there had been one lately. I saw no lava which had a recent appearance; notwithstanding all this, I did not feel comfortable where I stood in case of an eruption. The air was not cold—the ascent had made me hot—but I had time to cool, for I remained at the crater nearly an hour. At about 2 p.m., I commenced my descent by the same way that I ascended. A fog or cloud passed over where I was, and caused me to lose my way for a short time. When descending I saw between Tongariro and Ruapahu a lake about a mile in diameter. I could see no stream flowing out of it on its western side. An extinct crater may also be seen near the base of Tongariro. It was almost dark before I reached the Whanganui river, and, although in strong condition and a good walker, I felt completely done up, and I fell asleep in a dry water-course. The night was cold, but I slept soundly until daylight, when I immediately rose and continued my descent, and at 10, a.m., I reached my residence at Rotoaire, with the shoes almost torn off my feet.

As far as I can learn, Mr. Dyson, in 1851, and Mr. Bidwell, in 1839, are the only Europeans who have ascended the highest cone of Tongariro.

The difficulty of ascending Tongariro is still the same as when Dr. Thomson published the foregoing account. "It does," as he says,

Not entirely arise from its height, or the roughness of the scoriæ, but from the hostility of the natives, who have made the mountain "tapu," or sacred, by calling it the backbone and head of their great ancestor. All travellers who have asked permission of the natives to ascend Tongariro, have met with indirect refusals. The only way to get over this difficulty is, to ascend the mountain unknown to the natives of the place, or even your own natives. Mr. Dyson did this, but his ascent was discovered by a curious accident. During his progress up the mountain he took for a time the little frequented path which leads along the base of Tongariro to Whanganui. A native returning from that place observed his foot-marks, and knew them to be those of a European. As he saw where the footsteps left the path, he, on his arrival at Rotoaire, proclaimed that a European was now wandering about alone on the sacred mountain of Tongariro. The natives immediately suspected it was Mr. Dyson, and they went to his house, waited his return, and took several things from him. He was now a suspected man, and his conduct was watched.

The second active crater of the Tongariro system, at the top of a lower cone North of Ngauruhoe, is called *Ketetahi*. According to the Natives the first eruption of this crater took place simultaneously with the Wellington earthquake of 1854. From Taupo lake I saw large and dense volumes of steam, larger than those from Ngauruhoe, emerging from the Ketetahi crater. The third active point on the Tongariro system is a great Solfatara on the north-western slope of the range. The hot sulphurous springs of that solfatara are often visited by the natives on account of the relief they experience in respect to their cutaneous diseases.*)

A grand impression is made upon the traveller by those two magnificent volcanic cones,—Ruapahu, shining with the brilliancy of perpetual snow,—Tongariro, with its black cinder-cone capped with a rising cloud of white steam;—the two majestic mountains standing side by side upon a barren desert of pumice (called by the natives, *One-tapu*,) and the whole reflected, as by a mirror, by the waters of Lake Taupo.

Lake Taupo is 22 English miles long in the direction from te Terepa to Tapuaeha ruru, and 16 broad. This lake is surrounded by elevated pumice stone plateaus, about 2000 feet above the sea, and 700 feet above the lake. The Waikato river, taking its rise from Tongariro, flows through the lake, traversing the pumice-stone plateaus on either side. In accordance with the names I have already proposed for the Middle and Lower Waikato Plains, the Taupo Country will form the "*Upper Waikato Basin*"*

It is one of the most characteristic features in the structure of the Northern Island, that, from the shores of Taupo lake, an almost level pumice-stone plain—called *Kuingaroa Plain*—stretches at the foot of the East Cape range, with a very gradual descent to the coast between Whakatane and Matata. A plain which, though now presenting a sterile appearance, will, I hope, at no distant day, be converted into fine grassy plains, capable of supporting large flocks of sheep.

In a similar way, a higher volcanic plateau, consisting of trachytic tuff and breccia, and various other volcanic rocks, stretches in a more northerly direction to the East Coast, between *Maketu* and *Tauranga*, the farthest extremities of which reach even to the Auckland District. On one side of Hauraki Gulf,

* The following positions of some of the principal points in the Upper Waikato Basin, as they result from my observations, may be of interest:—

	Lat. S.	Lon. E. of Gr.
Ruapahu Centre	39° 1'	175° 38'
Tongariro, Ngauruhoe Crater	38° 54'	175° 41'
Waikato, entrance into Taupotaki	48° 42'	175° 48'
" outlet from Taupotaki	38° 31'	176° 2'
Tukawa, Te Heu Heu's Pa on the shore of Taupo	38° 41'	175° 48'

the Coromandel range is covered with trachytic breccia, and again, on the West Coast, the same rock forms the coast-range from *Manukau* to *Kaipara*. This extensive plateau is intersected by many deep valleys, the sides of which are characterised by a succession of remarkable terraces. The same plateau is also broken in many places by more or less regular trachytic cones from 1000 to 3000 feet high. That you may become acquainted with the geological character of such mountains, I will mention several examples, the names of which are well known amongst European settlers. To this class of mountains belong *Karioi* on the West Coast, near Whaingaroa, *Pirongia* on the Waipa, the regular cone of *Kakepuku* between the Waipa and Waikato, *Maungatautari* on the Waikato, *Aroha* on the Waihou, *Putauaki* or Mount Edgecombe on the East Coast, and many others. The only active mountain which belongs to this class is *Whakari* or White Island, in the Bay of Plenty, a solfatara like the active crater of Tongariro.

(*Mr. David Burn, in his account of "A Trip to the East Cape," says:—

In about an hour after passing Flat Island, the snowy vapour upon White Island began to be discernible. By 1 p.m. we were in immediate contiguity with this remarkable island, passing quite close to its southern extremity. As we made our gradual approach, its aspect was of the most singular description. Except on its northern point, to which the sulphurous vapour does not seem to reach, it is utterly destitute of vegetation; there are patches of growing underwood; but in every other direction, the island is bald, bleak, and furrowed into countless deep-worn ravines. After we had passed it a short distance to the eastward, the capacious basin of the crater, with its numerous geysers roaring and raging, exposed its sulphurous bosom to our eyes and nostrils. If the outer and western sides of White Island be blank and furrowed, its inner circle is chased, as it were, in a rare and picturesque manner,—the sides of the hills, from their lofty mountain summits to the base, being *combed* into innumerable longitudinal ridges of a florescent bronze of brilliant and variegated hue.

Of this island, Captain Drury, of H.M.S. Pandora, gives the following description in the "New Zealand Pilot":—

"White Island, or Whakari, is about three miles in circumference, and 860 feet high. The base of the crater is one and a half miles in circuit, and level with the sea. In the centre is a boiling spring about 100 yards in circumference, sending volumes of steam full 2000 feet high in calm weather. Around the edges of the crater are numberless smaller geysers sounding like so many high pressure engines, and emitting steam with such velocity, that a stone thrown into the vortex would immediately be shot in the air.

"Here and there are lakes of sulphurous water, dormant; but the whole island is so heated as to make it difficult to walk. From the edges of the crater the scene below is only to be compared to a well dressed meadow of gorgeous green, with meandering streams feeding the boiling cauldron; but on approaching, we find this green to be the purest crystallised sulphur.

"No animal or insect breathes on this island, scarcely a limpet on the stones, and 200 fathoms will hardly reach the bottom within half a mile of its shores."

Being under the lee of the island and in smooth water, Captain Bowden, in the most obliging manner, hove the steamer to, and, lowering one of the quarter boats, conveyed us on shore to enjoy a personal inspection of this grand natural curiosity. There are two spots at which a landing may be effected, at the openings of the outer base of the crater; by a very little exertion in clearing away some of the boulders, the landing may be rendered perfectly easy; but although, this day, the water was smooth, still there was such a swell that judgment and caution were requisite to pick out a spot where best to escape the rollers that tumbled on the rough and broken beach.

Never shall we forget the grand displays which we beheld in this sulphurous cauldron. Its paintings fresh from Nature's hand—its lake of gorgeous green—its roaring jets of stormy vapour—are things to be witnessed, difficult to be described; but surpassing all these, and as if their central attraction, there was a fountain, seemingly of molten sulphur, in active play, which shot a column of wide spreading green and gold into the scorching atmosphere. The beauty of this fountain was surpassing, and we were under the impression, that from its energy, the volcano was more than commonly active in its workings. We were very circumspect in our approaches, as the surface in places was soft and yielding, and we knew not to what brimstone depths an unwary step might sink us. Our difficulty in walking, therefore, arose less from the heat, though that in places was great, than from the apprehension of sinking too far in the soft crustaceous surface, from which diminutive spouts of vapour would spit forth as if to resent our intrusion. Whenever we thought the ground at all doubtful, we sounded our way by hurling large stones to see what impression they would make, and we adventured or avoided proceeding accordingly.

Time, to our great regret, would not admit of a minute exploration, but all the grand features of the island had passed under view. We looked in vain for the gorgeous meadow described by Captain Drury; but we had only to enlarge any of the numberless miniature vapour holes to obtain pure crystallised sulphur *hot from the bakery*, and at the same time to convert these holes into more active vapour jets. The streams that issued in various directions were of boiling heat, limpid and tasteless; but, though sulphur was everywhere strewn around, it did not appear to be in quantities sufficient for shipment. After an hour's stop, we returned to our ship greatly delighted with the visit, and much indebted to our obliging Captain for having put it in our power to enjoy it.

Mr. Heaphy has kindly furnished me with a map and views of this singularly interesting island.*)

If we take a wider view of the geological features and the physical outline of these just described high plains and plateaus consisting of regular layers of trachytic rocks, breccia, and tuff, we shall find that the steep cones of Ruapahu and Tongariro rise from the centre of a vast tuff cone of extremely gradual inclination, the basis of which occupies the whole country from shore to shore—from East to West—having a diameter of 100 sea miles, and forming the largest cone of *tuffs*, or in other words, the largest *crater of elevation* in the whole world.

The Hot Springs.

Intimately connected with the described volcanic phænomena of the active and extinct volcanic mountains, are the *Solfataras*, *Fumaroles*, and *Hot Springs*. They are found in a long series, stretching across the country in a N. N. E. direction, from the active crater Ngauruhoe in the Tongariro system, to the active crater of White Island (Whakari). They occupy the chasms and fissures to which I have already referred.

There is only one other place in the world in which such a number of hot springs are found that have periodical outbursts of boiling water—that is in *Iceland*, the well-known *geysirs* of which are of precisely similar

character to those in New Zealand. The geysirs or boiling fountains of Iceland, long celebrated for possessing this property in an extraordinary degree, have, indeed, strong rivals in the *puias* and *ngawhas* of New Zealand Although there may be no single intermittent spring in New Zealand of equal magnitude with the great geysir in Iceland, yet in the extent of country in which such springs occur, in the immense number of them, and in the beauty and extent of the siliceous incrustations and deposits, New Zealand far exceeds Iceland.

In enumerating the principal of these phænomena, we may begin with—

1. The active craters of *Tongariro*, which are at present in the condition of solfataras that may be called the state of repose of active craters, and with the hot springs rising on the slope and at the base of that mountain.

2. We then pass on to the *Tokanu* and *Terapa* springs, on the Southern extremity of Taupo lake. The principal 'puia' at Tokanu is called *Pirori*, an intermittent fountain whose column of boiling water, of two feet in diameter, sometimes reaches a height of more than 40 feet.

3. On the opposite side of Taupo, at the Northern extremity of the lake, we again meet with hot springs, and with a river of warm water called *Waipahihi*, which, rising in the extinct volcanic cone of Tauhara, falls, in a vapour-crowned cascade, into Taupo.

4. Descending from Taupo by the outlet of the Waikato, we find, on the left bank, in the midst of a great number of pools of boiling mud, a fumarole called *Karapiti*, an enormous jet of high-pressure steam, escaping with such force as to produce a sound like letting-off the steam from huge boilers and as to eject to a great height sticks, or the like, thrown in by the curious traveller. On the right bank is another fumarole of similar character, called *Parakiri*.

5. About twenty-five miles below the outlet of the Waikato from Taupo, at the 'pa' *Orakei-korako*, both banks of the rapidly-flowing river are perforated, in more than a hundred different places, by fumaroles and boiling springs, most of which are of the intermittent kind; and siliceous incrustations of beautiful colours decorate the banks of the river. *Temimi-a-Homaiterangi*—the principal geysir—throws up its large column of boiling water at intervals of about two hours to a height from 20 to 30 feet. An immense volume of steam succeeds the jet, and the water then suddenly sinks into the basin.

6. At Orakei-korako the line of hot springs crosses the Waikato, and continues along the foot of the very remarkable *Pairoa range* on the Easterly side of the Waikato. The almost perpendicular Western side of this range is caused by an immense 'fault' in the volcanic plateau, corresponding to a deep fissure in the earth-crust, from which sulphureous acid, sulphuretted hydrogen, sulphur and steam, are continually escaping, while huge bubbles of boiling ash-coloured mud are rising on the surface.

7. From the same range, the warm-water river *Waikite* takes its origin. On both sides are deep pools of boiling water, on the margins of which we discovered most beautiful ferns, hitherto unknown, one species belonging to the genus *Nephrolepis*, the other to the genus *Gonecopteris* These ferns are remarkable not only for their elegance, but also from the peculiar circumstances under which they exist, as they are always surrounded by an atmosphere of steam.

8. We now come to the well-known ROTOMAHANA, the most wonderful of all the wonders of the Hot Springs district of New Zealand. I will not attempt to describe in a hasty lecture like this the beauties of this Faëry-land. Whoever has once had the happiness to look into the blue eyes of *Otukapuarangi* and *Te Tarata* can never forget their charms; and whoever has stood beside the boiling surf of the *Ngahapu* basin will always retain a vivid impression of its terrors. The terraces of siliceous deposit on the shores of Rotomahana are unequalled in the world, nor is there any thing that even bears any resemblance to them.

9. On the *Rotorua* lake the intermittent boiling springs of *Whaka-rewarewa* are the most interesting. *Waikite*, the principal "ngawha," issues from the top of a siliceous cone some 20 feet high, and is surrounded by several smaller geysirs, boiling mud-pools, and solfataras. At intervals of considerable length, sometimes extending to many months, all these '*ngawhas*' begin to play together and form a scene which must be most wonderful and beautiful.

The hot springs of *Ohinemutu* form agreeable bathing-places, the fame of which is already established.

10. The last in the line are the great solfataras on the pumice-stone plateau between Rotorua and Rotoiti — such as *Tikitere* and *Ruahine*.

I will now say a few words in explanation of these phænomena.

All the waters of the Springs are derived from atmospheric moisture, which, falling on the high volcanic plateau, permeates the surface and sinks into fissures. Taupo—the axis of which corresponds with the line of the Hot Springs—may also be considered as a vast reservoir, from which the lower springs are supplied. The water, sinking into the fissures, becomes heated by the still-existing volcanic fires. High-pressure steam is thus generated, which, together with the volcanic gases, decompose the trachytic rocks. The soluble substances are thus removed by the water, which is forced up, by the expansive force of the steam and by hydrostatic pressure, in the shape of boiling springs. The insoluble substances form a residuum of white or red fumarole clay, of which the hills at Terapa round Rotomahana and the Pairoa consist.

All the New Zealand hot springs, like those of Iceland, abound in Silica, and are to be divided into two distinct classes—the one *alkaline*, and the other *acid*. To the later belong the solfataras characterised by deposits of sulphur, and never forming intermittent fountains. All the

intermittent springs belong to the alkaline class, in which are also included the most of the ordinary boiling springs. Sulphurets of Sodium and Potassium, and Carbonates of Potash and Soda, are the solvents of the Silica, which, on the cooling and evaporation of the water, is deposited in such quantities as to form a striking characteristic in the appearance of these springs.

Here I must leave this interesting subject. To enter more deeply into the theory of these phænomena would be out of place here. It may be, however, well to mention that numerous facts prove that the action which gives rise to the hot springs is slowly diminishing.

I must also state my conviction that ere long these hot springs will be visited by many travellers, not only for the sake of their beauty and interest, but also for the medicinal virtues they have been proved to possess. Already many Europeans have bathed in, and derived benefit from, the warm waters at Orakeikorako and Rotomahana.

I am unwilling to omit the interesting legend current among the Natives in reference to the origin of these hot springs. The legend, as told by Te Heuheu, the great chief on the Taupo lake, is the following :—

The great Chief *Ngatiroirangi*, after his arrival at Maketu at the time of the immigration of the Maories from Hawaiki, set off with his slave Ngauruhoe to visit the interior, and, in order to obtain a better view of the country, they ascended the highest peak of Tongariro. Here they suffered severely from cold, and the Chief shouted to his sisters on Whakari (White Island) to send him some fire. This they did. They sent on the sacred fire they brought from Hawaiki, by the taniwhas *Pupu* and *Te Haeata*, through a subterranean passage to the top of Tongariro. The fire arrived just in time to save the life of the Chief, but poor Ngauruhoe was dead when the Chief turned to give him the fire. On this account the hole through which the fire made its appearance—the active crater of Tongariro—is called to this day by the name of the slave *Ngauruhoe ;* and the sacred fire still burns within the whole underground passage along which it was carried from Whakari to Tongariro.

This legend affords a remarkable instance of the accurate observation of the Natives, who have thus indicated the true line of the chief volcanic action in this island.

Having now described the older and more extensive volcanic phænomena of *the interior*, I proceed to notice the later phænomena of volcanic action in the *immediate neighbourhood of Auckland.*

The Auckland Volcanic District.

The Isthmus of Auckland is completely perforated by volcanic action, and presents a large number of true volcanic hills, which, although extinct and of small size, are perfect models of volcanic mountains. These hills —once the funnels out of which torrents of burning lava were vomited forth, and afterwards the strongholds of savage cannibals—are now the ornaments of a happy land the home of peaceful settlers, whose fruitful gardens and smiling fields derive their fertility from the substances long ago thrown up from the fiery bowels of the earth.

My Geological Map of the Auckland District contains no less than *sixty* points of volcanic eruption within a radius of *ten miles*—the variety of which, together with the regularity of their formations, gives very great interest to this neighbourhood. The newer volcanic hills round Auckland are distinguished from the older ones in the interior, not only by their age, but by the different character of their lava—the older being *trachytic*, while the Auckland are all *basaltic*.—I have not yet mentioned the difference between Trachyte and Basalt. I will therefore say a few words in explanation. The difference consists in the minerals of which the rocks are composed. Trachyte is composed of a mixture of glassy feldspar *(Sanidin)* and hornblende : obsidian and pumice-stone are the usual concomitants of trachytic lava. Basalt consists of a minutely-crystalline mass of feldspar mixed with augit : an admixture of greenish grains of Olivin is characteristic of basalt.

In order to gain a clear idea of the history of the Auckland Volcanoes, we must suppose that before the period in which the Auckland Isthmus was slowly raised above the level of the sea, a submarine volcanic action was already going on. The products of this submarine action are regular beds of volcanic ashes, which form highly interesting circular basins with strata always inclining from within, outwards. You will at once remember several striking examples which I can mention—as the Pupuki Lake on the North Shore ; Orakei Bay in the Waitemata ; Geddes's Basin *(Hopua)* at Onehunga ; and the tidal basin *(Waimagoia)* at Panmure;—Pupuki Lake, believed to be bottomless, has been ascertained by Captain Burgess (who kindly sounded it at my request) to be only 28 fathoms. I call those basins and similar formations, *tuff craters* or *tuff-cones*. The excellence of the soil of Onehunga and Otahuhu is owing to the abundance of such formations, decomposed strata of which form the richest soil that can be met with. It is curious to observe how the shrewder amongst the settlers, without any geological knowledge, have picked out these tuff-craters for themselves, while those with less acute powers of observation have quietly sat down upon the cold tertiary clays.

After the submarine formation of the tuff-craters, the volcanic action continuing, the Isthmus of Auckland was slowly raised above the sea, and then the more recent eruptions took place by which the cones of scoria, like Mount Eden, Mount Wellington, One Tree Hill, Mount Smart, Mount Albert, and Rangitoto, were formed, (*and great out-flowings of lava took place. Many peculiar circumstances, however, prove that those mountains have not been burning all simultaneously. It can easily be observed that some lava streams are of an older date than others.*) In general the scoria cones rise from the centre of the tuff-craters, (Three Kings, Waitomokia, Pigeon Hill near Howick.) Occasionally, as in the instance of Mount Wellington, they break through the margin of the tuff-crater.

The Crater System of Mount Wellington is one of the most interesting in this neighbourhood, as beautifully shown by the large map, which Mr. Heaphy has kindly prepared for me from actual survey. (*There are craters and cones of evidently different ages. The result of the earliest submarine eruptions is a tuff-crater. The Panmure road passes through the tuff-crater, and the cutting through

its brim exhibits beautifully the characteristic outward-inclination of the beds of ashes, elevated from their former horizontal levels by the eruptions, which threw up the two minor crater cones south of the road—one of which is now cut into by a scoria quarry. After a comparatively long period of quiescence, arose from the margin of the first crater system the great scoria-cone of Mount Wellington, from whose three craters large streams of basaltic lava flowed out in a Westerly direction, extending North and South along the existing valleys of the country, one stream flowing into the old tuff-crater, and spreading round the bases of the smaller crater cones. The larger masses of these streams flowed in a South-westerly direction towards the Manukau, coming into contact with the older and long-before hardened lava streams of "One Tree Hill." The traveller on the Great South Road will observe about one mile east of the "Harp Inn" the peculiar difference in the colour on the road, suddenly changing from red to black, where the road leaves the older and more decomposed lava streams of One-tree Hill and passes on to the new and undecomposed lava streams of Mount Wellington. The farmers have been able to avail themselves of the decomposed lava surface, which is now beautifully grass-covered, but not of the stonefield of the newer Mount Wellington and Mount Smart streams.

The *Caves* at the "Three Kings," Pukaki, Mount Smart, Mount Wellington, &c., are the result of great bubbles in the lava streams—occasioned probably by the generation of gases and vapour as the hot mass rolled onward over marshy plains. These bubbles broke down on their thinnest part—the roof—and the way into the caves is always directly downward.*)

Examples of every gradation may be seen—from the simple tuff-crater without any cone, to those which are entirely filled up by the scoria cones. Especially interesting are those which may be said to represent the middle state, in which there is a small cone standing like an island in a large tuff-crater, and surrounded by either water or swamp. Perhaps the most perfect specimens of this kind occur at Otahuhu and near Captain Haultain's, a map of which, from actual measurement, has been prepared by Mr. W. Boulton. You need not be alarmed when I tell you, that even the very spot on which we are assembled is the centre of an old tuff-crater, from which fiery streams once issued, and which has thrown out its ashes towards the hill on which the barracks stand.—In order to account for these various shapes, it must be borne in mind that the cones of scoria were once higher, but on the cessation of volcanic action they sunk down in cooling, and some entirely disappeared.

That the Auckland volcanoes were, in the true sense of the word, "burning mountains," is proved not only by the lava-streams, which are immense in comparison to the size of the cones, but also from the pear-shaped volcanic bombs which, ejected from the mountain in a fluid state, have received their shape from their rotatory motion through the air. That the eruptions of the Auckland volcanoes have been of comparatively recent date, is shown by the fact that the ashes everywhere occupy the surface, and that the lava-streams have taken the course of the existing valleys. (*This is beautifully exemplified by the probably simultaneous lava streams of Mount Eden, the Three Kings, and Mount Albert, which, flowing through a contracted valley, meet altogether—on the Great North Road—and form *one* large stream to the shore of the Waitemata, terminating on the well-known long reef West of the Sentinel Rock.*) But many thousand years may have passed since Rangitoto, which is probably the most recent of the Auckland volcanoes, was in an active state.

I have been frequently asked whether it is true, as a countryman of mine who some years ago travelled in New Zealand is said to have told the European settlers, that New Zealand is a pleasant country, but that they had come a thousand years too soon. In answer to this I have to remark that any one who knows anything of geological science must be aware, that "a thousand years" is an almost inappreciable space of time in reference to geological changes. And I would rather say, that it would have been better for New Zealand if it had been colonized a thousand years ago, as there would then have been no cause for the discussion of the "Land Question."

I should have much pleasure in saying a great deal more on the Geology of New Zealand, but time will not permit me. Many subjects I have been compelled to omit altogether—such as the Quartary formation in the Drury, Papakura, and Waiuku flats; the Basaltic Boulder formation; the Alluvial formations in the Middle and Lower Waikato Basin, and other places; and I have said nothing of the changes which are now going on.

The materials which I have accumulated during my six months' sojourn in New Zealand will, I expect, require several years of labour to prepare for publication; and, unless the war which now threatens my own country should unhappily interfere to prevent the completion of the peaceful scientific undertaking of the Expedition to which I belong, it will give me great pleasure to forward to Auckland copies of our publications respecting New Zealand, accompanied by an atlas, containing the maps and other illustrations.

In concluding this lecture, I cannot omit the opportunity of saying a few words of farewell to the inhabitants of this Province.

Now that I am on the point of leaving Auckland, I turn in memory to the hour in which I made up my mind to leave my friends on board the Frigate "Novara" and to remain for awhile in New Zealand. I can assure you it was an hour of great anxiety, but I am glad to say I have never regretted the decision to which I with so much difficulty brought myself. Having received assistance in my labours from all sides, I have arrived at results which have afforded me much satisfaction, and which I hope will not be without good fruit to the present and future inhabitants of this Province. Having at first felt some difficulty in making up my mind to remain, I now feel a similar difficulty in leaving. Home-ties, however, are drawing me homewards, and I must quit the country in which I have spent so many happy days. In parting, I have one request to make,—that you will remember me as kindly as I will remember you; and I have one wish—which is for the prosperity of the Colony of New Zealand, and the advancement of the Province of Auckland.

Dr. FERDINAND HOCHSTETTER.

[NOTE.—The chief additions made since the delivery of the Lecture are thus distinguished—(* *).]

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