D.—No. 3.

PAPERS

RELATING TO

THE DEVELOPMENT OF COAL MINES, ETC.

AS PROVIDED IN PART VIII. OF THE IMMIGRATION AND PUBLIC WORKS ACT AMENDMENT ACT, 1871.

PRESENTED TO BOTH HOUSES OF THE GENERAL ASSEMBLY, BY COMMAND OF HIS EXCELLENCY.

WELLINGTON.

1872.

SCHEDULE OF CORRESPONDENCE, &c.

No.	Date.	From.	To.	Subject.
1	12 Dec., 1871	Dr. Hector. ...	Hon. Minister, Public Works.	Remarks as to the best application of fund voted under "The Immigration and Public Works Act, 1871," for Coal explorations in the Colony.
		AUCKLAND.		
2	15 Mar., 1872	Dr. Hector ...	Under Colonial Secretary.	Requesting authority for Captain Hutton to report on Kawa Kawa, Wangarei, Waikato, and Hauraki Gulf Coal Mines.
3	8 May, 1872	Ditto ...	Under Secretary, Public Works.	Forwarding reports by Captain Hutton on present condition of Northern Coal Fields; also copy of instructions to Captain Hutton, and copy of Mr. Moodie's report in November, 1865.
		NELSON.		
4	9 Oct., 1871	Hon. J. Vogel ...	Dr. Hector ...	Asking opinion as to mineral resources of Nelson South-West District.
5	18 Oct., 1871	Dr. Hector ...	Hon. J. Vogel. ...	Opinion as requested.
6	22 June, 1872	Ditto ...	Under Secretary, Public Works	Preliminary report on the Coal Mines in the Western District of Nelson Province.
		WESTLAND.		
7	6 Jan., 1872	Dr. Haast ...	Hon. Mr. Reeves ...	As to discovery of Coal on West Coast by Mr. William Docherty.
8	5 April, 1872	Mr. Maude ...	Dr. Haast ...	Before public money is expended, existence of coal seam discovered by Mr. William Docherty must be proved to satisfaction of officer of Geological Department.
		CANTERBURY.		
9	10 May, 1872	Dr. Hector ...	Under Secretary, Public Works	Forwarding extract from report by Dr. Haast, which refers to opening of Coal Mines at Malvern Hills and construction of Branch Railways to them.
10	17 June, 1872	Ditto ...	Ditto ...	Forwarding report by Dr. Haast on coal seams in Ashburton District and Clent Hills.
		OTAGO.		
11	15 Mar., 1872	Dr. Hector ...	Under Colonial Secretary	Forwarding instructions to, and report from, Captain Hutton relative to Coal explorations in Southern District of Otago.
12	6 April, 1872	Ditto ...	Ditto ...	Further with reference to above.
13	10 May, 1872	Hon. W. Gisborne ...	His Honor the Superintendent of Otago	Forwarding copies of above, and asking His Honor's opinion as to further explorations.
14	19 Jan., 1872	Mr. W. O. Ball ...	Hon. W. Reeves ...	Applying for money to erect a wharf and tramway for Preservation Inlet Coal Company.
15	22 Jan., 1872	Mr. Maude ...	Mr. W. O. Ball ...	Further information requested before grant of money is authorized.
16	19 June, 1872	Dr. Hector ...	Under Secretary, Public Works	Forwarding report by Dr. Haast on Shag Point Coal Mine, and generally on coal-bearing formation in North-east District of Otago.

APPENDIX.

AUCKLAND.

Date.	From.	To.	Subject.	Page.
1872. 4 July	Dr. Hector ...	Under Secretary, Public Works	Report respecting coal seams in the Wangaroa and Mongonui Districts.	25

NELSON.

Date.	From.	To.	Subject.	Page.
29 June	Dr. Hector ...	Under Secretary, Public Works	Report on the Collingwood Coal Mine.	27

CANTERBURY.

6 July	Ditto ...	Under Secretary, Public Works	Further with reference to Malvern Hills Coal Mine. Mr. Hill has succeeded in reaching a 7-foot seam of coal.	34

WESTLAND.

20 June	Ditto ...	Under Secretary, Public Works	Forwarding correspondence relative to coal seam at Kanieri River.	35

OTAGO.

9 July	Ditto ...	Under Secretary, Public Works	A short account of the Coal Fields which will be rendered available by the Southern Trunk Railway from Dunedin to Clutha.	37

Schedule of the New Zealand Coals reported on by the Geological Survey Department.

LIST OF PLANS.

PAPERS RELATING TO DEVELOPMENT OF COAL MINES, ETC.,

AS PROVIDED IN PART VIII. OF THE IMMIGRATION AND PUBLIC WORKS ACT AMENDMENT ACT, 1871.

No. 1.

Dr. Hector to the Hon. J. D. Ormond.

Memorandum by Dr. Hector as to Explorations for Coal in different parts of the Colony.

At the desire of the Hon. Mr. Gisborne, I beg to make the following remarks on the best application of the fund voted under the Public Works and Railways Acts, for the purpose of exploring for coal in the different parts of the Colony.

The geological survey of the Colony has hitherto, with few exceptions, been of a general character, more with the view of ascertaining the order and distribution of the various formations than for the purpose of accurately defining their boundaries, or of determining exactly the available quantities of coal seams and other contents of the rock masses which have an economic value. It has, in fact, been of the nature of a "reconnaissance survey," and as such has been extended as rapidly as possible to nearly every part of the Islands. This preliminary survey has had the effect of narrowing the field in which a detailed and much more expensive kind of examination is necessary. With reference to the special question of coal seams, we now know pretty accurately the areas in which they can and cannot exist. We also know the thickness and value of many known seams, but their extent only imperfectly. I would therefore suggest that the fund under consideration should be devoted to the more definite search for coal seams in favourable localities, and also to proving the extent of the seams already known. This work can be carried on under my direction and superintendence, without interfering with the regular progress of the more general geological survey. It will be necessary that the search should be conducted in some cases by geological surveying, and in others by boring. The first method will require, in each locality where the work is in progress, a field party consisting of a qualified geological surveyor, two or three men, pack-horses and camp equipage; cost about £70 per month.

Boring is much more expensive, and must be done by contract. The first step is to ascertain what boring tools are available; the second to choose the most advantageous localities.

Boring rods have been purchased by some of the Provincial Governments, Otago, Nelson, &c.; but definite inquiries will have to be made on the subject. If boring is determined on, it will be well to advertise early for the services of skilled persons, as boring is a special business, and on several occasions skilled borers have applied to me for employment.

The selection of the site on which the boring should be commenced, will require to some extent to follow the survey. At the same time, there are some localities that could be decided on without much difficulty. It would be very advantageous that boring should be only attempted in a district near where an assistant is at work in the field, so that he may examine the results from time to time as they are obtained, and see that the record is faithful.

Localities.

The most valuable seams of coal are, as is well known, on the west coast of Nelson; but there is also a large area in the south-east of the Province of Otago, where, although no large coal seams have been discovered, yet there is reason to expect their existence. These two districts should be placed under District Surveyors, who would gradually overtake the whole of them, each with a boring party, as well as a field party, when necessary. If the above mode of procedure meets with approval, for the present season I would make the following suggestions:—

The examination of the West Coast coal fields has been already considerably advanced; and as I am personally well acquainted with the details, I think it will be advisable that the survey of that district should in the meantime be continued under my immediate supervision, with such assistance as I can obtain locally.

For the south-east district of Otago, I can arrange that Captain Hutton should at once proceed with the examination, and devote to it the remainder of this season.

In addition to the above districts in the South Island, I would also suggest that Dr. Haast, who has just completed the survey of the coal fields of the Malvern Hills, should be employed also to examine the Clent Hills and a few other localities in Canterbury, and north-east of Otago, where there are coal seams concerning which our information is very imperfect.

In the North Island, there is the coal field in the northern district of Auckland which was examined and reported on in 1866. Since that date, the Kawa Kawa Mines have been extensively worked, and it would be desirable that they should be re-examined, in order to obtain any further information that has been rendered available by the workings.

From the Mokau River, southwards to the Wanganui, there is known to be a considerable area of coal-bearing country which has not been examined owing to the Native difficulty, but which, I understand, it might be possible to visit this season. It would, however, be impracticable to attempt more than a rapid inspection of this district, which it would be necessary that I should myself undertake.

A map is attached showing the different coal-bearing areas above referred to.

James Hector.

12th December, 1871.

AUCKLAND.

No. 2.

Dr. HECTOR to Mr. COOPER.

SIR,— Geological Survey Office, Wellington, 15th March, 1872.

I have the honor to request authority to obtain a report by Captain Hutton on the present state of the following coal mines:—

1. Kawa Kawa—Bay of Islands.
2. Wangarei.
3. Waikato.
4. A newly-opened mine on the opposite side of the Hauraki Gulf from Shortland.

* * * * * * *

I have, &c.,

The Under Colonial Secretary. JAMES HECTOR.

No. 3.

Dr. HECTOR to the UNDER SECRETARY, Public Works.

SIR,— Geological Survey Office, Wellington, 8th May, 1872.

I have the honor to forward, for the information of the Minister for Public Works, a report by Captain Hutton on the present condition of the Northern Coal Fields.

I also enclose my letter of instructions and the report by Mr. R. W. Moody, dated 30th November, 1865, to which Captain Hutton alludes in his report, as they give further information respecting the Kawa Kawa Coal Fields.

I have, &c.,

The Under Secretary for Public Works. JAMES HECTOR.

Enclosure 1 in No. 3.

Dr. HECTOR to Captain HUTTON.

Colonial Museum, Geological Survey Department,

SIR,— 16th March, 1872.

I am directed to employ you in obtaining a report on the present state and prospects of the following coal mines:—1. Kawa Kawa; 2. Wangarei; 3. Waikato; 4. Hauraki.

1. At the Kawa Kawa Mine you will be good enough to ascertain and report the (*a*) amount of excavation that has been done; (*b*) the quality and thickness of the seam in different parts; (*c*) estimated quantity still available "level free," or within 600 feet of the surface; (*d*) whether any steps could be taken to ascertain the existence of coal seams in other and more accessible positions.

You can refer to sheet 1 of the sketch-map of the geology of the district which I furnished to the Superintendent of Auckland in 1866, on which an attempt was made to show the above areas. This map shows that the steep hills that surround the Bay of Islands south of Waitangi are composed of slate rocks. The Kawa Kawa River cuts through this range, and affords easy access to the later stratified and volcanic rocks that lie along the west side of the range. The formation of the valley of the river appears to have been formed by the existence of a fault, as on the north side there is a steep scarp of slate rock rising 500 feet above the river, while the south side of the valley is a gentle slope formed by stratified deposits resting at a low level on the denuded surface of the slates.

The high slate ridge on the north, forming the Kawa Kawa Block, is a plateau with steep sides, except to the north-west, in which direction it slopes gently to the Waimate basin; sandstone beds (with coal?) occur on the top of the plateau at a higher level than they should do if the strike observed on the south were continued across the valley.

Sheet 2 was a plan from actual compass survey of the coal fields from the data which was available in 1866, showing the line of outcrop and relative position of shafts and bore-holes.

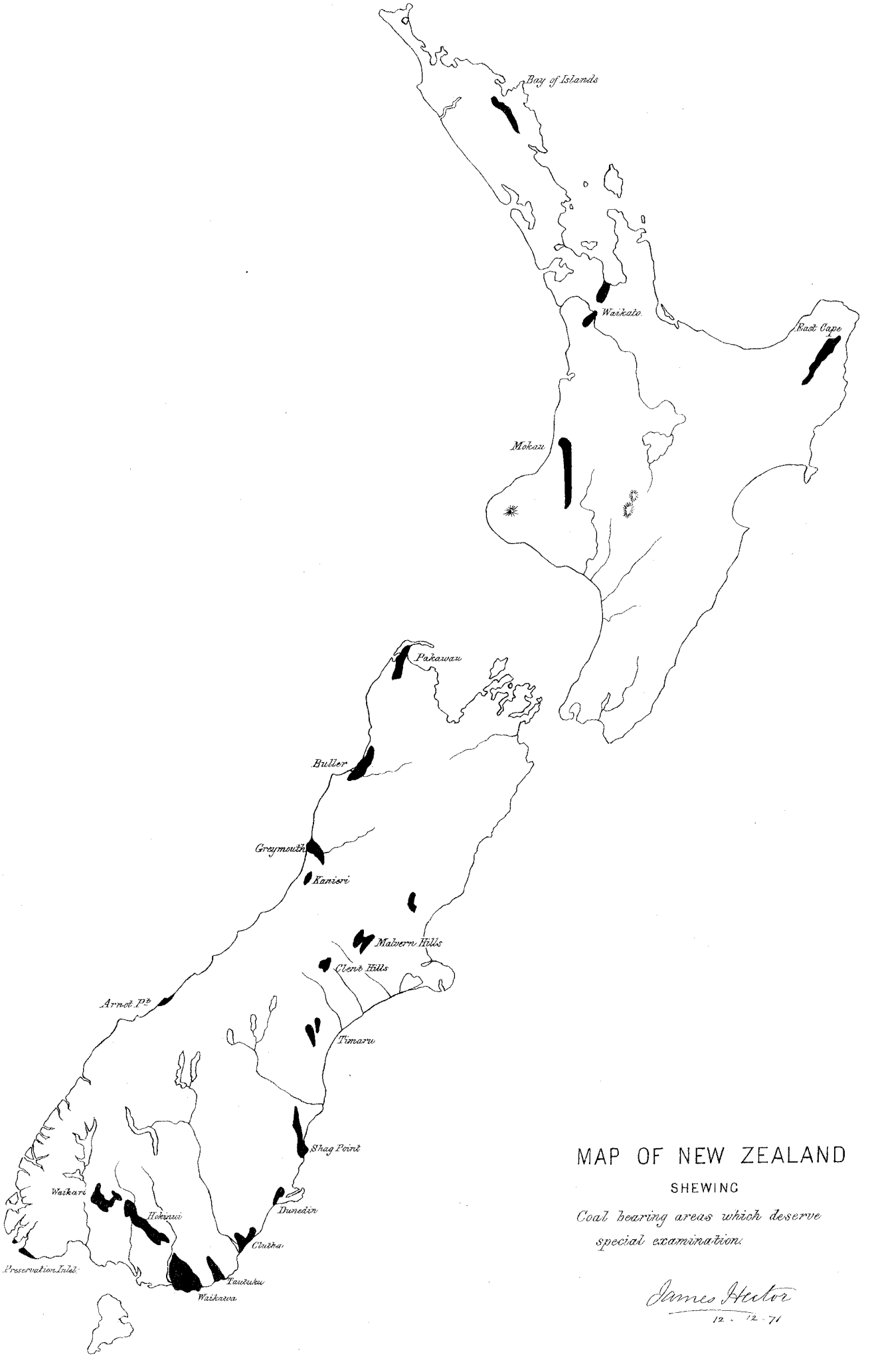
It is desirable that this map should be brought up to date by the addition of any further information, and plans of the late workings.

The line of outcrop is pretty clearly indicated by the form of the ground.

The underlying green slates and sandstones are well seen in the tram cutting and valley of the Waiomio Creek, and I saw no reason to suspect any local disturbance or "dyke" influence near the outcrop which could account for the dehydration of the coal.

Up the Waiomio, heavy conglomerates appear to rest on the slates or replace the coal? or has the coal been denuded off before this deposit?

Sheet 3 shows the position of the various borings that were made, and may be useful for comparing with the underground workings.



MAP OF NEW ZEALAND

SHEWING

Coal bearing areas which deserve special examination.

James Hector

12 . 12 . 71

In 1866, I reported that the works necessary for opening up the mine would be of a very expensive character, even if the most favourable anticipations of the extent and purity of the seam were realized.

For a short time the coal might be extracted by a level drive from the edge of the swamp, and during that time the mine would drain itself, and the haulage would be cheap; but it would soon be necessary to put down a well-lined shaft 40 to 60 fathoms deep, and powerful pumping machinery would be required in order to produce a sufficient quantity of coal to cover the heavy outlay necessary to convey the coal to the shipping place.

Considering these difficulties, I stated that it would not be advisable in my opinion to commence any imperfect system of mining; but until there is a prospect of being able to raise and dispose of at least 500 tons per month, to defer opening the field and wait for the future settlement of the country, when such works will be less expensive and a local market will exist.

2. *Wangarei.*—Mr. Bedlington is engaged in boring for coal seams at that place; and if you consider that his work is likely to assist in the discovery of useful coal, if properly carried out, I will be prepared to recommend that Government should assist his efforts.

You will endeavour to get a plan of Walton's Mine, and any statistics of the output, &c., that are available.

If you pass overland from the Bay to Wangarei, you will have an opportunity of seeing the coal seams at Hikurangi, of which there are four or five; but unless some sinking or driving has been done since I was there, it will not be worth while your making a special visit to that place.

3. *Waikato and Drury.*—You will gather any information respecting these mines that is not embodied in your previous reports, and make any practical suggestions that occur to you respecting the application of the Drury and Waikato coal for the railway service.

4. *Hauraki.*—A full report on the coal seams at this locality, with a sketch plan showing those favourable for access, extent, &c., is required.

I anticipate the foregoing work will occupy you for six weeks . . . . . .

I have, &c.,

Captain Hutton, F.G.S. JAMES HECTOR.

Enclosure 2 in No. 3.

REPORT on the Coal Mines in the Province of Auckland, by Captain F. W. HUTTON.

Kawa Kawa, Bay of Islands.

SINCE the present company took over this mine, they have opened it at the outcrop of the coal on the Waiomio Swamp, as recommended by Dr. Hector, and have been working it by a gallery from this point along the strike of the seam, in a N. by E. (true) direction. After driving for about 27 chains the coal got thinner, and was found ultimately to be cut off by a fault. At the same time the coal was also being worked below the adit level, near the entrance to the mine, where the seam is 12½ feet thick, and the coal of superior quality; but ultimately water broke in in such large quantities that their small pump could not keep it under, and this part of the mine has had to be abandoned until large pumps are erected.

The occurrence of the fault just mentioned was first pointed out by Mr. R. W. Moody, C.E., (copy of correspondence relative to Kawa Kawa Mines, A. No. 11—Report to Mr. Weaver, Engineer-in-Chief, 30th November, 1865), who was employed by the Provincial Government of Auckland to report on the coal seam. It appears to run in an east and west direction, passing at a short distance south of Moody's bore-hole, No. $\frac{1s}{1}$, and north of his bore-hole No. 3, and to have its downthrow to the south.

In order to prove the position and throw of this fault, a bore has been put down about half-way between Moody's bore-holes Nos. $\frac{1s}{1}$ and 3, on the line of strike of the coal from the level of the Waiomio Swamp, and at about 100 feet above this level.

The bore went through—

Gray sandy clay	45 feet
Hard gray calcareous sandstone	52 „
Green sandstone	71 „
Coal	7 „
Total	175 feet

This boring must therefore be on the south side of the fault, and the throw of the fault must here be about 68 feet.

As the outcrop of the coal known as Moody's outcrop was found by Dr. Hector to be about 70 feet below the level of the first seam, it is probable that this difference of level is also to be accounted for by the same fault, and that therefore there is no evidence of a second seam underlying the one at present worked.

The bore is now being commenced at a spot near Moody's No. 5 bore-hole, which is expected to be on the north side of the fault, and which will therefore prove, within certain limits, the direction in which it crosses the field. The altitude of this bore-hole has not yet been ascertained; but, should it prove to be on the north side of the fault, it will probably reach the coal at about 200 feet.

It is then intended to bore at the place recommended by Dr. Hector in 1866, near the Waimaheke Creek, where the coal should be reached at a depth of about 300 feet, and also at the place proposed by Mr. Moody, higher up the creek, where the coal should be reached at about 600 feet. These bores will prove an area of 75 or 80 acres, and will give confidence to the Company to undertake the outlay which will be necessary before the mine can be put in proper working order.

As no survey has been made of the mine, and as a large part of it is at present flooded, it is impossible to estimate with accuracy the amount of excavation that has been done, but the manager informed me that about 90,000 tons had been taken out, and that he estimated that about 40,000 tons

more remained above adit, and to the north of the fault. The seam varies from 16 to 7 feet, the average being about 12½ feet in thickness. The average dip is W. 5° N. 1 in 6.

I do not think that any more accessible position than the present one could be found for working this field, especially as three miles of railway have been already made from the mine to water carriage. I am also of opinion that the existence of the fault crossing the field will not deteriorate the value of the mine; for although on the one hand a certain amount of driving through the overlying sandstone will have to be done in order to connect the two sides of the fault, on the other the downthrow of 70 feet will extend the area of the field; and as this portion will be at a lower level, it will probably have a more solid roof than that portion above adit—and the badness of the roof has been, up to the present, a cause of great expense in working the mine.

Whangarei.

The mines at Whangarei have been abandoned for about six years, and there is, I believe, no intention of reopening them.

Superior coal was found some time ago on land belonging to Mr. Frater, on the east side of the range towards Ngunguru; and Mr. Bedlington, C.E., has traced the formation westward, towards Whangarei Harbour, and he is now boring on land belonging to Mr. Dent, on the banks of the Awaroa, a small stream running into Whangarei Harbour, about three miles north of Grahamstown. The position of the bore-hole is about a mile and a half up the stream. At the time of my visit the bore was down 209 feet through brown sandstone, with numerous casts of marine shells, and Mr. Bedlington expected to reach the coal at a depth of 240 or 250 feet.

Waikato.

No material alteration has taken place in this mine since I surveyed it and reported upon it in 1867. Two bore-holes have been put down, which prove the coal to be horizontal. The principal defect of this mine was the height of the shoot, which broke up the coal unnecessarily when loading barges. This is now being rectified by making a new tramway on the southern side of the spur, and by opening up the seam in that direction.

For further information on this and on the Drury Coal Fields, see Transactions, New Zealand Institute, iii. p. 244.

Drury.

The coal mines at this place have been abandoned for about eight years, and the works have all fallen in. The Hon. H. Chamberlin, M.L.C., the owner of the property, has been making further exploration by boring, but nothing has as yet been discovered that would, in my opinion, warrant the reopening of the mine. I have been informed by the former manager that the uneven surface of the under clay, the badness of the roof, and the high freight to Auckland, were the principal causes of this mine being abandoned.

29th April, 1872. F. W. Hutton.

Enclosure 3 in No. 3.

Mr. R. W. Moody to Mr. W. Weaver, Engineer-in-Chief.

Sir,— Auckland, 30th November, 1865.

In accordance with your instructions, I beg to submit the following report, for the information of His Honor the Superintendent, touching that portion of the Kawa Kawa Coal Fields in which I have been boring for coal on behalf of the Provincial Government.

My instructions were, on leaving Auckland for this coal field, to prove in the first place an area of about 500 acres, which would enable the Government to lease that portion to a company, leaving the remainder of the field for further consideration.

On my arrival on the ground in the latter part of June, I marked out a portion of the field for boring operations, about 200 acres in extent, and commenced the No. $\frac{1}{1}^{s}$ hole, situated 200 yards south-east from the shaft sunk by Mr. Henry Graham; the coal was reached in $\frac{1}{1}^{s}$ at the depth of 59 feet 6 inches from the surface, the seam being 13 feet 3 inches in thickness, of fine "hard coal," with a good sound roof, composed of hard brown sandstone.

After proving the coal in No. $\frac{1}{1}^{s}$, I commenced a bore-hole marked on the plan No. 2, and situate about 300 yards further up the creek on the opposite bank, and about 500 yards south of Graham's shaft, but had not gone down many feet in this hole before I found that we had got into measures quite different from those met with in No. $\frac{1}{1}^{s}$ B H, inasmuch as there was a total absence of the "green sandstones" which are so abundant, and which act as a very good guide in the Kawa Kawa Coal Field especially, and coming at a depth of nearly 40 feet into contact with felspar which is very rarely interstratified with the sandstone, and never with the carboniferous measures except in very extraordinary cases. I considered it prudent to abandon this hole, at least for a time, and to try one on each side, with a view, if possible, to determine the course and size of the disturbed ground, as there does not appear at the surface the slightest indication of any irregularity in the stratification. I therefore put down a bore marked No. 3 on the plan, and situate about 70 yards north-east from the No. 2 hole; although the measures in this hole were much more favourable than those of the last, I was obliged to abandon it at 56 feet deep, solely on account of not having "casing pipes" to secure the soft sandstones.

After leaving No. 3, I commenced one on the opposite side of No. 2, marked on plan No. 4, situate about 100 yards from No. 2, in a line bearing S.W. This is the only hole where anything like the English carboniferous measures have been met with in this ground, in which we have 17 feet of blue "argillaceous shale." The measures seem so mixed with claystone, and sandstones, that I am of the opinion that we were here in close proximity to the coal on one side, and faulty or disturbed ground

on the other; but whether the coal is actually absent at this particular spot, I was not able to ascertain, solely from want of proper casing-pipes to allow of my going deeper. The irregularity may only prove, after all, to be an ordinary fault or dyke. Owing, as I said before, to my not having tubes, I was obliged to abandon this hole also. The top measures were so soft, and the lower ones so hard, that the hole could not be kept open to allow of further progress without being secured.

At this juncture (the end of July), after placing the work in the hands of my nephew, giving him sufficient instructions and work to go on with during my absence, I resolved to proceed to Auckland, with a view of suggesting to the Engineer-in-Chief the propriety of at once getting some pipes. It was ultimately, in order to save expense, agreed upon to get some tin pipes made, having used such very successfully on different occasions in England; but the measures there were more favourable than those at Kawa Kawa; the soft sandstones at the latter place are much softer, and besides contain larger feeders of water than do the English measures. The hard sandstones here are similar to those of England, being compact and possessing an equal amount of resisting power; hence the difficulty in keeping back the soft sandstones of the top measures during the process of boring in the hard measures below, the vibrations of the rods assisting to loosen the soft beds above.

On my return to the coal field in September, my instructions then were altered as to the extent of future operations, viz., that instead of 500 acres I was requested to prove only 250 acres, and that with as little delay as possible, and with the least possible expense, as the funds voted for the exploration of the field were getting low, which of course necessarily altered my original plan of operations, inasmuch as I was obliged to reduce the intended number of holes, the result of which would tend to increase the difficulty in proving the coal at the required points. On my arrival at Kawa Kawa, after an absence of about five weeks, I found that the instructions which I had given my nephew had been practically carried out, and that Nos. 5, 6, 7, and 8 holes, as marked on the plan, had been commenced, and carried down 113 feet, 85 feet, 22 feet, and 28 feet respectively, and then abandoned; the two first for want of casing-pipes, and the two latter for want of proper tools to clear the holes of projections of hard rock.

The hole marked No. 9 on the plan was in operation on my arrival, but the position being so low, and in consequence of there being so much wet weather at the time rendered the measures so "quick" and dangerous, that I was obliged at a depth of 70 feet from the surface, to abandon it, being afraid of losing both pipes and boring rods. I then removed about 65 yards from the swamp to higher ground, and started No. 10 hole, where the indications for coal continued to be most favourable up to the time of my leaving the work.

I may here mention that, at the commencement of the work, the tools and materials put into my hands were not at all fitted for the requirements of the work we had to perform; the set was not at all complete, being an odd lot, consisting of a few of one kind and a few of another. We had the greatest difficulty, and much unnecessary labour and time was expended over them in making alterations and repairs from time to time, to make them in any way fit for the purpose, which of course added very materially to the boring expenses, and more especially as we were in such an isolated place. The only drawback to complete success in proving the field was the want of proper boring apparatus; and although the sum already expended may appear to a casual observer large, yet, taking everything into consideration, it is not quite double that of the cost in England for work of the same kind, and for a like amount of work done.

If I had been at first supplied with a proper set of boring tools, the cost would not have much exceeded the prices paid in England. I may further add that the Kawa Kawa Coal Field has not yet been sufficiently examined to warrant my giving a decided opinion as to its value or capabilities, and to illustrate or report fully upon the peculiar structure of the country, the internal arrangements and superposition—viz., to ascertain the "dip" and "strike" of the strata, the size and course of "faults" and dislocations—all of which are absolutely necessary before any attempt at sinking shafts can be made; therefore careful and accurate plans and sections are essential and important to show the position and inclination of the coal.

It is, in fact, necessary to have a comprehensive picture before the eye of all prominent natural features of the property, both above and under ground, as far as they can be possibly ascertained, before anything of a permanent nature can be safely attempted.

It must therefore be evident to all having the slightest knowledge of the mineral structure of the earth, that, in places where exploration has never before been attempted, and more especially where volcanic action has previously existed, great difficulties sometimes present themselves in conducting the necessary operations in such exploring expeditions. Hence the necessity of a very careful examination of the stratification by borings or sinkings. And although I have not succeeded in proving a sufficient area of coal to enable the Government to lease any portion of the Kawa Kawa Coal Fields, the cause being simply a want of proper tools to carry out effectually the necessary operations, nevertheless I am of opinion that coal exists in sufficient quantities and of a very superior description, and of an unusual thickness, to justify the Government to make further trial.

The coal is, in my opinion, suitable for steam, house, gas, and smiths' purposes, and besides it is a good coking coal. I am also of opinion that this coal field contains more than one seam of coal, and that it extends a considerable distance, especially in the direction of Whangarei. It may not be continuous or unbroken, as there is every appearance of the whole district having been more or less disturbed by volcanic agency.

I have, &c.,
R. W. Moody,
Mining Engineer.

W. Weaver, Esq., Provincial Engineer.

NELSON.

No. 4.

MEMORANDUM by the Hon. J. VOGEL to Dr. HECTOR.

IN an agreement for the construction of the Nelson and Cobden Railway which it was proposed to make with the firm of Messrs. Brogden, those gentlemen were to have three years to decide upon whether they would proceed with the work. In the meanwhile they were to make the survey, and there is no doubt they also proposed to investigate the capabilities of the country. The agreement subsequently fell through, and the Government now propose to have the capabilities of the country investigated before opening up any further negotiations for the construction of a railway through it.

Your advice is asked on the subject. Something more definite than a merely scientific opinion would be desirable. Can you suggest any practical course for investigating the mineral wealth of the district, and in what shape and at what cost?

9th October, 1871. JULIUS VOGEL.

No. 5.

MEMORANDUM by Dr. HECTOR to the Hon. J. VOGEL.

THE only possible way of determining the mineral value of the Western District of Nelson is to make a geological survey of it, and from the analogy between the structure of the country so discovered to other regions where the same formations prevail, infer the minerals that will probably occur in sufficient quantity to be of economic importance.

Much preliminary work has already been done towards the accomplishment of such a survey, and the accompanying plans show the general results in two forms:—

A Coloured Geological map. Not printed.

Plan I. shows the general distribution of the formations.

Plan II. shows the localities in which minerals of value have been found.

The depression through which it has been proposed to take the Nelson and Cobden Railway lies between the main range of the Island on the east, and a group of isolated mountain masses that extend from the mouth of the River Grey to Cape Farewell. The mountains on the east are slate and sandstone formations, and along their western base greenstone and serpentine have reached the surface, and carry copper, chrome, and several other ores in varying quantity. There is also a well-founded expectation that gold may yet be found in this formation in reefs.

The western mountains have a much more complex structure. They may be looked on as originally formed of slate, mica-schist, and granite, and to have been covered with upper secondary strata, with coal seams.

Coal.—Large areas of these coal formations have been denuded, and only detached patches are left, generally in positions that are not easily accessible. The areas so left are approximately marked on Plan II. In some of these areas workable coal seams have been discovered, as described in various published reports. The coal varies in quality, but is on the whole of better quality than that found in other parts of New Zealand. As a rule it is "level free," or in other words, elevated above the average water-level of the country.

Gold.—Every river in the western district is auriferous, to a greater or less degree; and from the enormous deposits of fine gold dust which occur on the present and ancient coast-lines, back as far in time as the later tertiary period, there must be a large proportionate quantity of heavy gold yet to be found in the mountain valleys. From the rarity of gold in the rock-bound valleys of the eastern or main range, and the occurrence of very heavy gold (nuggets upwards of 30 to 40 oz. weight) in some of the valleys of the western range, it would appear that the latter are the chief source from which the gold has been distributed.

Prospecting between the two ranges has been very imperfectly carried on, owing to the superior attractions and easy mode of life offered by the beach diggings.

Auriferous Reefs.—Auriferous reefs have been discovered and partly explored in at least seven distinct localities in the western ranges, some of them being of a very promising character, and they will no doubt be worked as soon as the alluvial diggings decline.

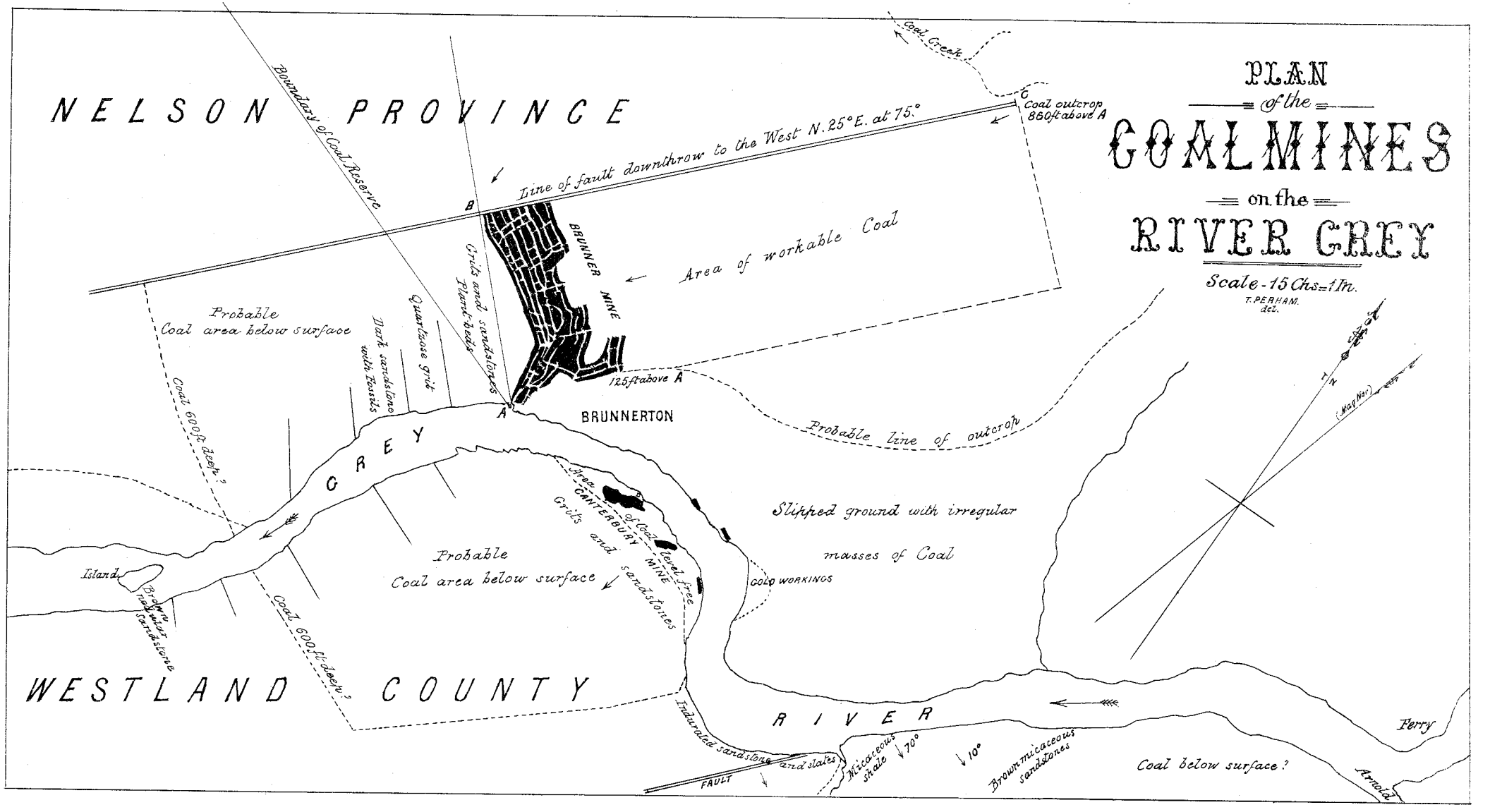
Other Metals.—Ores of silver, lead, chrome, copper, zinc, massive magnetite, and specular iron ore have been found in the district; also graphite, marble, limestone, and other minerals.

In the meantime, the circumstances under which the above-mentioned minerals have been found could be collected together from various reports, so that their prospective importance might be judged of.

The very imperfect state of topographical survey of the district, and the broken nature of the country, will render a detailed geological survey a tedious and expensive matter; but a geological surveyor and party might collect a great deal of accurate information about that particular line of section which has been chosen for the railway in the course of the ensuing summer. The expense of such an examination would not be less than £600.

JAMES HECTOR.

Geological Survey Office,
Wellington, 18th October, 1871.


PLAN
of the
COAL MINES
on the
RIVER GREY
Scale - 15 Chs = 1 In.
T. PERHAM. del.
NELSON PROVINCE
WESTLAND COUNTY
Boundary of Coal Reserve
Coal Creek
Coal outcrop 860ft above A
Line of fault downthrow to the West N. 25° E. at 75°
B
C
A
BRUNNER MINE
Area of workable Coal
Grits and sandstones
Plant-beds
Quartzose grit
Dark sandstone with fossils
Probable Coal area below surface
Coal 600ft deep?
125ft above A
BRUNNERTON
Probable line of outcrop
GREY
Area of Coal CANTERBURY MINE level free
Grits and sandstones
Slipped ground with irregular masses of Coal
COLD WORKINGS
Probable Coal area below surface
Island
Brown micaceous sandstone
Coal 600ft deep?
Indurated sandstone and slates
FAULT
RIVER
Micaceous shale
70°
10°
Brown micaceous sandstones
Coal below surface?
Ferry
Arnold
N
(Mag. North)

No. 6.

Dr. HECTOR to the UNDER SECRETARY, Public Works.

SIR,—

I have the honor to make the following preliminary report on the coal mines in the western district of the Province of Nelson.

In a former report (Geological Reports, 1867, p. 18) I divided the upper secondary coal fields in that part of the Colony into—

1. The Pakawau field, which extends from near Cape Farewell southwards for about fifteen miles, occupying a great part of the surface of the mountains between the valley of the Aorere River and West Wanganui Inlet.

2. The Buller, or Mount Rochfort, field, which occupies a narrow strip of mountainous country that extends southwards from the Karamea River to the Buller, a distance of forty miles, with a greatest width of seven miles.

3. The Grey River and Mount Davy field, which forms a range of mountains lying to the north of the Grey River, in which direction the formation extends for seven miles to where it is intersected by the coast.

The coal formation in each of these areas has the same general character, comprising conglomerates, and sometimes an angular breccia towards the base, followed by micaceous sandstones, grits, and shales, with seams of black coal (caking anhydrous coal). The thickness of this lower part of the formation is from 200 to 800 feet. In some localities, a thick bed of well-rounded conglomerate follows the above; but where this is wanting, the micaceous sands pass gradually into sandy clay marls of a dark brown colour, containing nodules of ironstone and marine fossils (limonite sandstones). Immediately beneath this marine formation, sometimes in the sandstone and at others resting on the surface of the conglomerate, is frequently a seam of coal of an inferior description, which will be spoken of as the upper coal. Its most common form in the district is a pitch coal, which is a variety of brown coal, containing a large admixture of resinous matter and a comparatively small proportion of constitutional water.

Marine formations to the thickness of at least 1,500 feet follow, consisting in ascending order of argillaceous sandstones, finely laminated marly shales, compact chalk marl, and calcareous sandstone.

In some localities the lower members of this series of marine formations are wanting, and the upper calcareous beds overlap on the basement rocks of the country, but generally having the coal formation represented by a thin intervening band of sandstones, shales, and pitch or common brown coal seams. From this I infer that the upper coal and its associated sandstones are the horizontal equivalents of the limonite sandstones, which I have referred to as immediately following the lower coal-bearing strata in some parts of the district.

Grey River District.

The only mine of importance which has been opened in this district is the well-known Brunner mine, six miles from the mouth of the Grey River. There is nothing to report as to this mine in addition to what has been stated in former reports, except that the workings are still quite inadequate to supply even the local demand.

The coal seam is 16 feet thick, and has been proved, by underground workings, to be of uniform quality, without admixture with slack or other foreign matter, throughout an area of 30 acres; in addition to which, the surface indications lead me to estimate the quantity of coal which is available without sinking as at least 4,000,000 tons, the area of undisturbed coal above the water-level being more than half a square mile. In addition to this a much larger quantity of coal can be obtained by sinking.

The extension of the coal to the north is interrupted by a fault, which cuts it off; but there is no reason to doubt that the seam will be again found at a deeper level, the downthrow being in that direction.

Up to the present time the extent of this downthrow has not been determined, but, from examination of the strata, and comparison with parallel faults which can be observed in the same formation on the sea coast farther to the north, I expect it to be less than 100 feet. On the south side of the Grey River the coal appears to be also cut off by a fault, but this has not yet been proved by underground working.

The Brunner mine can never be worked to advantage, nor afford any supply of coal to other parts of the Colony, until the railway connecting the mine with the mouth of the river has been constructed; and the amount of coal already ascertained to exist is, in my opinion, sufficient to warrant the expenditure authorized for this purpose; and, from the great facilities which exist for working the mine, the coal should be delivered to vessels at 8s. per ton.

After the construction of the railway, and the preliminary harbour improvements which have been recommended as part of the railway works, I believe that a good steam-tug for the bar service would be sufficient to enable small sailing vessels, in the first instance, to carry on a profitable coal trade with other ports of the Colony, and that, if the trade expands, and the coal proves, on working, to extend over larger areas, the depth of water on the bar can be hereafter materially increased by proper engineering works.

The accompanying plan shows the relative areas of coal which are above and below the water-level, and the position of the faults.

A sample from the 6-foot seam of coal that crops out on the coast six miles north of the Grey River has been analyzed by Mr. Skey, and found to be a very superior variety of pitch brown coal, resembling very much the best kind found at Shag Point, in Otago, and, like it, well adapted for gas-making, but without furnishing any true coke. It contains—

Gas and oil	55·40
Fixed carbon	34·80
Water	6·20
Ash	3·60
	100·00

It will be observed that the composition of this coal is very different from that found towards the base of the formation at the Brunner mine, which contains 64 to 68 per cent. of fixed carbon. I mention this fact as it has been supposed by some persons that the seam on the coast is a continuation of that which is worked at the mine.

Mount Rochfort Coal Field.

During the past summer my attention has been mainly directed to the discovery of coal mines within easy reach of Westport.

The coal formation of this area was, previously to my former examination of it in 1867, surveyed and reported on by the late Mr. James Burnett, whose excellent plans were placed at my disposal by his Honor the Superintendent of Nelson.

This coal field may be described, in general terms, as occupying an undulating plateau, or flat upland valley, the western termination of which overhangs the coast, having an elevation of from 1,500 to 2,500 feet near the Buller, while in the other direction it slopes to the north-east, and descends to the sea-level at the Mokihinui.

Viewed from the sea coast the coal formation is seen to commence at Mount Rochfort, which presents a cliff of conglomerate, 700 feet high, three miles inland, facing the south. From this point northward there is a dip in the level, in the centre of which is the deeply cut gorge of the Waimungaroa, but the plateau surface does not reach lower than 1,500 feet above the sea. The formation again rises, behind and to the eastward of Mount Frederic, to 2,800 feet, and dips again to the Ngakawau, when the plateau surface is only 1,000 feet above the sea. A long ridge of granite then extends to the Mokihinui, beyond which the coast is formed by the upper marine formations. The general features of this district are shown in the attached plan and sections.

Many outcrops of a seam of hard, pure coal, from 8 feet to 16 feet in thickness, have been discovered on this plateau, but all at such an elevation as to require engineering works of a costly nature to reach them. A search has therefore been made, with a view of finding a seam in a more accessible position, and with this object the lower gorge of the Buller River, where it cuts its way round the south end of the plateau, was examined, as it has very naturally been supposed that the coal seams might be there found at a lower level and in an available position.

Lower Buller Gorge.

This gorge commences nine miles from the mouth of the river, and for five miles the hills on both sides are formed of granite.

Towards the south, in the direction of Mount Rochfort, the granite spurs rise to the height of at least 1,500 feet above the river; the coal formation lying on the top of this range and five miles back from the river.

The valleys in that direction are extremely narrow and rugged, and offer no favourable line of access to the plateau.

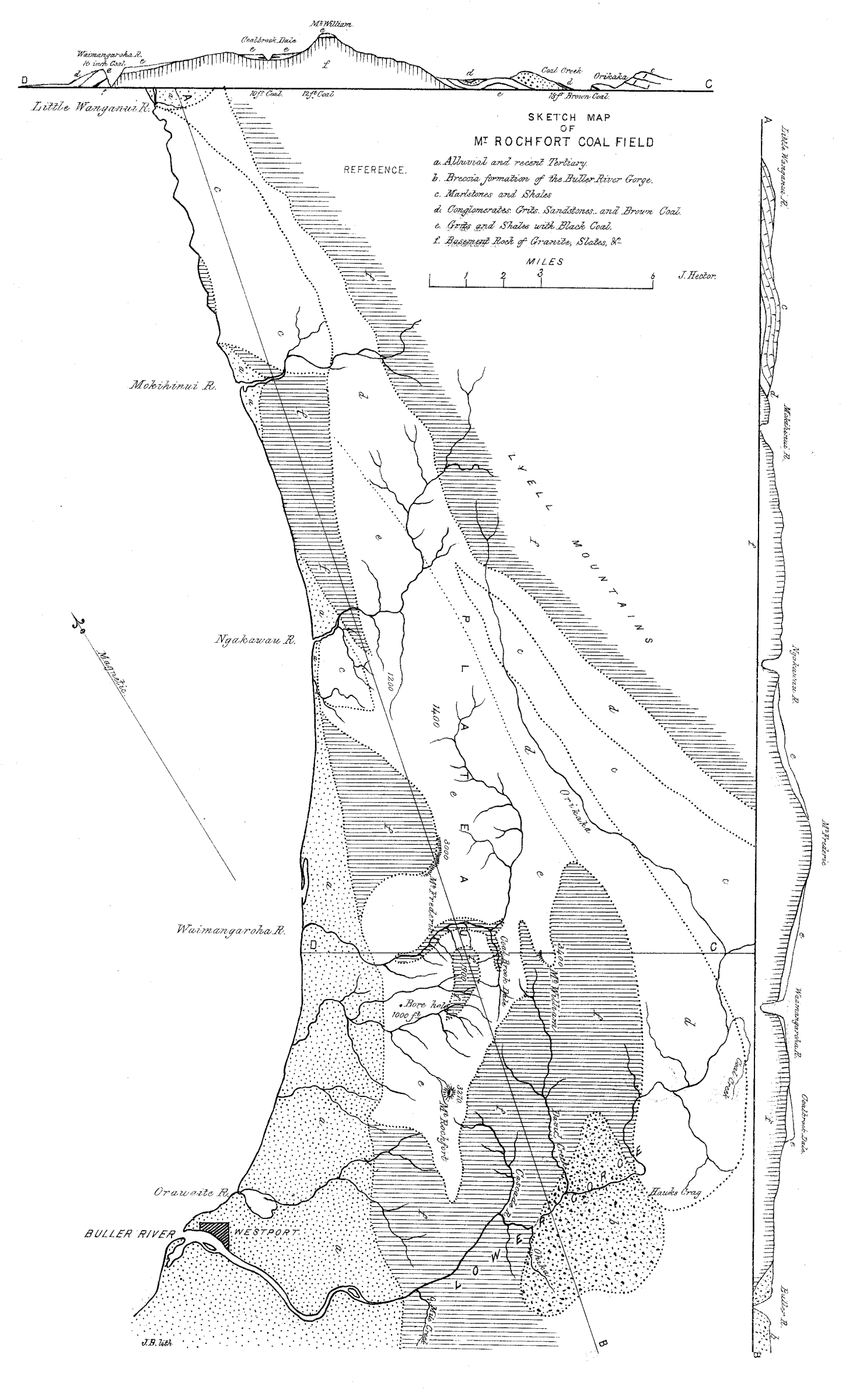
In ascending the river, the granite is succeeded, after a narrow band of mica schist, by a massive conglomerate and breccia formation, forming hills 1,400 feet high, the spurs of which are equally inaccessible with those of the granite formation, and terminating frequently perpendicularly towards the river, so that at one place, called the Hawk Crag, it has been necessary to cut the horse track like a half section of a tunnel, along the face of the precipice. This great conglomerate, which is quite a local formation, without parallel in any other part of the district, crosses the valley from north to south, and rests unconformably on the coal-bearing strata, which commence just before reaching the Blackwater and continue to Granger Point, where the valley opens out for some distance; and the overlying marine formations, which run in a north line from the Inangahua Junction to the coast at the White Bluff, north of the Mokihinui River, commence to form lofty mural bluffs of chalk, marl, and tabular limestone.

In the lower part of the coal formation at this place, only obscure fossil plants and thin seams of coal were found; but in the higher part of the section, and overlying the conglomerates, the seam of coal occurs that was referred to by Mr. E. J. O'Conor, M.H.R., in his evidence before the Select Committee on Colonial Industries (Parliamentary Paper, H. 7, 1871, p. 17). This seam is exposed in several places in Coal Creek, a tributary of the Buller from the south. The coal, which is compact brown coal, containing masses of fossil resin, is at least 16 feet thick, and dips to the south-east at 10°, under a compact brown micaceous sandstone that contains leaf impressions. Its composition, from several analyses that have been made in the laboratory, is as follows:—

Fixed carbon	41·94	50·80
Gaseous matter	36·97	25·54
Water	13·93	16·46
Ash	7·16	7·20
	100·00	100·00

It is compact, hard, with a dull lustre, and is very different in appearance from that found in the plateau, being, in fact, a brown coal, containing an unusually high percentage of fixed carbon, but still containing too much water to be employed for sea-going steamers. This coal will not, therefore, justify any large expenditure for the purpose of taking it to Westport, and even were it equal in quality to that found on Mount Rochfort, I doubt if it would pay, at the present time, to construct a railway line through the gorge for such a purpose; while, on the other hand, the great risk of running the rapids with heavily laden boats will prevent any large quantity being conveyed by water carriage even as a return cargo by the barges that at present take the goods up country.

In the valley of the Inangahua, coal occurs at several places, the sandstone formation crossing the river seven miles from its junction with the Buller. At this point there is a seam of pitch coal the thickness of which was not ascertained, and the same seam appears again to rise towards the east from beneath the marl stones on the creek. The coal seam on Murray Creek deserves mention, although the locality is too far inland to allow of the coal being available for other than local use at the present


Mt. William
Coalbrook Dale
Waimangaroha R.
16 inch Coal.
Coal Creek
Orikaka
C
D
10ft Coal.
12ft Coal.
15ft Brown Coal.
Little Wanganui R.
SKETCH MAP
OF
Mt ROCHFORT COAL FIELD
REFERENCE.
a. Alluvial and recent Tertiary.
b. Breccia formation of the Buller River Gorge.
c. Marlstones and Shales
d. Conglomerates. Grits. Sandstones.. and Brown Coal.
e. Grits and Shales with Black Coal.
f. Basement Rock of Granite, Slates, &c.
MILES
1 2 3 6
J. Hector.
Mokihinui R.
Ngakawau R.
Magnetic
Waimangaroha R.
LYELL MOUNTAINS
PLATEAU
1200
1400
3000
Mt Frederick
3400
Mt William
Bore hole
1000 ft.
3270
Mt Rochfort
Orawaite R.
BULLER RIVER
WESTPORT
Hawks Crag
Cascade Creek
Mile Creek
J.B. lith
A
B
Mt Frederic
Coalbrook Dale
Buller R.

time. This stream is a branch of the Inangahua River, on which the alluvial diggings were first worked which led to the discovery of the reefs in this vicinity. The creek has a short course of about three miles, and at its upper third cuts through a bed of fine coal, not less than 20 feet thick, and perhaps more. The seam dips to south-east at 10°, and rests on a floor of brown sandy shales and tough sandstone, which again rest unconformably on the green and grey slatey sandstones which form the matrix of the quartz reefs. The coal seam is covered with thick beds of grit and sharp quartz sandstone, like that on Mount Rochfort. This coal is now excavated for supplying the steam quartz mills. Its quality is excellent, as shown by Mr. Skey's analysis of two different specimens:—

Fixed carbon	(*a*)54·52	(*b*)54·94
Hydro-carbon	39·31	33·70
Water	4·98	10·38
Ash	1·19	·98
	100·00	100·00

(*a.*) Is a compact coal, with a bright lustre and splintery fractures, resembling some of the Mount Rochfort coal, but to which it is inferior in the smaller proportion of carbon, and not forming so coherent a coke.

(*b.*) Has more the fracture of a brown coal, and looks like jet.

The Murray Creek coal must be considered as intermediate in value between the pitch coal and the bituminous coal of the Brunner mine.

Mount Rochfort Plateau.

This is a basin-shaped area, having an extent of about fifteen square miles, and included between Mount Rochfort (3,270 feet altitude) on the south, Mount William (3,400 altitude) on the east, and Mount Frederic (3,000 feet altitude) on the north-west.

To the north-east it slopes gradually to a low saddle between the Orikaka and Mokihinui Rivers. It also slopes, but very abruptly, towards the west through the depression between Mount Rochfort and Mount Frederic, and also towards the south-west to Ngakawau.*

The arrangement of the coal formation is very irregular on this plateau, but, disregarding minor inequalities, it appears to be as follows:—A syncline, or rather a trough-like valley, the axis of which is inclined to the north, commences at the saddle between the heads of the south branch of the Waimangaroha and the streams flowing south to the Buller, and between Mount Rochfort and Mount William, and, passing to the east of Mount Frederic, reaches the coast above the Ngakawau. This trough appears to carry the heaviest seam of coal, but its dimensions and extent are not yet ascertained.

Lying to the west, and somewhat parallel to the above, the remains of a second synclinal exist, the eastern side of which is represented by a patch of the formation which dips south-west from Mount Frederic, and the western side by the strata towards the base of the seaward slope of Mount Rochfort, which dip to the eastward. The summit of Mount Rochfort itself, which is a barren mass of conglomerate without coal seams, may be looked on as the anticlinal ridge between these troughs; but north towards the Waimangaroha Gorge the coal formation has been denuded, and granite and slate appear at the surface, completely cutting off the extension of the coal seam across the plateau.

To the west of this outcrop of the underlying rock only a 16-inch seam of coal has yet been found. In using the above terms to describe the above arrangement of the strata, it must be understood that these troughs have arisen in a great measure from original inequalities of the surface on which the coal formation was deposited, probably as a great lacustrine drift, so that a coal seam found in one depression will not necessarily extend into an adjacent one, and this is shown by the manner in which the upper grit beds, which overlie the coal, thin out against the slate patch in the centre of the plateau.

The disturbances that have affected the formation since its deposit are so abrupt as to have more of the nature of faults than plications, a point of great importance in the practical working of the coal field. A most remarkable instance of this is offered by Mount William, on the top of which (of 3,400 feet altitude) the coal and accompanying strata, 200 feet thick, are found dipping at 15° to the north, while due west, at a distance of 60 chains, and 1,800 feet less elevation, the same strata again occur dipping 10° to the north, resting on vertical slates that strike east and west, which form also the intervening mountain slope.

The nearest seam of coal on the plateau to Westport, of sufficient thickness to be worked, is at an altitude of 1,800 feet, and twelve miles distant in a direct line, and is that which was discovered, in 1861, by Dr. Haast, at Coalbrookdale, one of the sources of the Waimangaroha. The coal appears on both sides of a shallow upland valley as a 10-foot seam that crops out in some of the perpendicular cliffs in a very conspicuous manner. The quantity of coal available for mining at this place was carefully ascertained by the late Mr. Burnett to be about 750,000 tons (Nelson Provincial Government *Gazette*, 1862, p. 77). He proposed a railway by which this coal might be taken to Westport, the dip, at 1,400 feet from the edge of the plateau, to be overcome by an incline with a stationary engine. The cost of this line, which was to be fourteen miles in length, together with other preliminary expenses, he estimated at £100,000. The proposed line was again surveyed and reported upon by Henry Wrigg, Esq., C.E., (Nelson *Gazette*, 1868, p. 159,) and his estimate for a locomotive line, without an incline, to reach Westport in nineteen and three-quarter miles, together with other works which he recommended, was £133,336. Such a large expenditure would be obviously quite out of proportion to the amount of coal that has been proved actually to exist at Coalbrookdale, and within reach of the proposed line; but it was anticipated that the coal would be found distributed more generally throughout the plateau, and especially towards the west, and that five different seams existed in some places, having a total thickness of 38 feet of coal.

I have not, however, been able to satisfy myself of the existence of more than one important seam in the different parts of the plateau; and, moreover, have ascertained that the coal at Coalbrookdale

* Ngakuwaho on the map; but according to the Maoris Whaugakawau, or shortly, as above.

is confined to a narrow area, not exceeding 40 chains in width, the extension through the plateau to the westward, as I have already stated, being interrupted by the basement rocks reaching the surface.

Towards the brink of the plateau, on the west side of the basement rock, the coal grits again appear, with a dip of 15° to the west; but they only contain, so far as yet ascertained, a thin band of shales, with one 16-inch seam of coal. To ascertain if any coal seam crops out on the seaward face of the plateau, which is exceedingly deep and covered with débris, a search was made from the outcrop of this seam, at 1,700 feet altitude, down to the base of the mountain. Four men were employed for a month in making this exploration, by excavating among the débris and in the creek beds.

No fresh seam of coal was discovered by this work; but a trench cut in the face of the hill, for 500 feet above the old Bore-hole camp, proved that the 16-inch seam found there is only a repetition of the thin seam exposed on the surface of the plateau.

The result of my examination, up to the present time, does not, therefore, enable me to recommend any place where boring should be undertaken on the low ground between the base of Mount Rochfort and Westport.

Ngakawau River.

This river is eighteen miles north of Westport, and is a comparatively small stream, taking its rise in the plateau to the north-west of Mount Frederic. It is the only locality where any mining for coal has been carried on in the district, except in the trial workings at Coalbrookdale, and those at the Mokihinui, to which I shall afterwards refer.

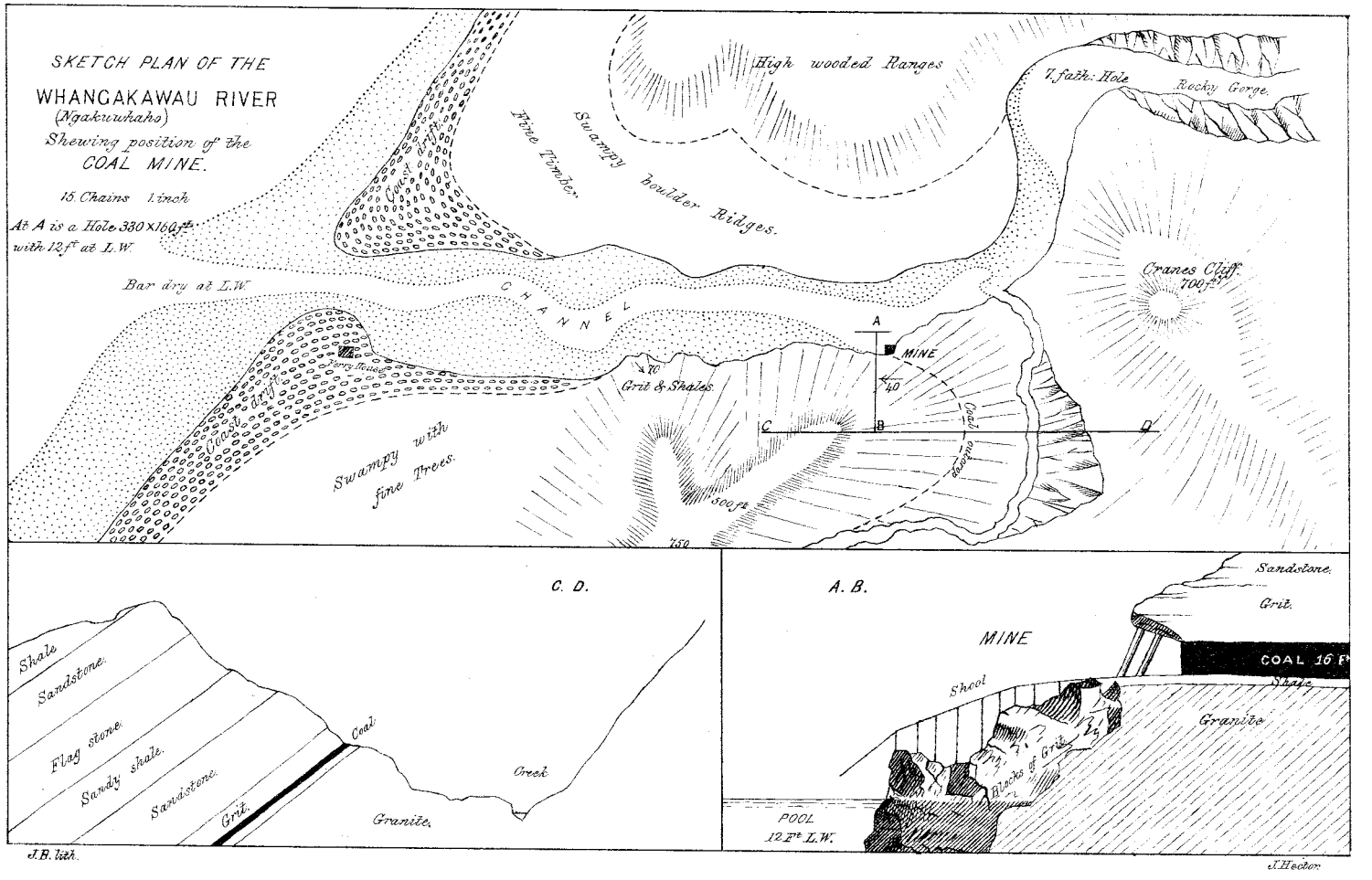
The coal at this place was discovered many years ago, but, until four months since, was neglected on account of the soft friable nature of the seam at the outcrop. The coal mine is 60 chains from the mouth of the river on the south side, at the head of a straight reach which runs east and west from the bar, with an extreme width of 5 chains, but narrowing very much at the outlet, as shown on the attached plan.

At low water the river is a succession of pools and rapids, from the coal mine to where it runs over the beach; but at high water it is a wide basin, with 8 to 10 feet of water on the entrance. The coal is within a few feet of the granite, with a sandy shale between. It dips 40° to the west, the strike varying a little from south to south 10° west, as far as can be judged of from the outcrop. The roof is a tough sandy grit, with mica and carbonaceous markings (20 feet), covered with micaceous flags and thin beds of brown sandstone (60 feet). These beds are followed by gritty sandstones and indurated sandy shales, the above formations forming a ridge that runs parallel with the coast to he south, rising from 300 to 1,000 feet in that direction. About halfway down to the mouth of the river the grits dip for a short distance at 70° to the south-east, but this is probably a local disturbance, perhaps due to the under-cutting of the river.

The excavation that had been made in the coal was only 4 fathoms in length, at the time of my visit (20th May, 1872), on a steep hill side, 30 feet above the water-level, and 40 feet back from the brink, as shown in section AB. A stage and shoot has been erected, with a slope of 1 in 3, and a breastwork in front that will enable it to carry 100 tons of coal in such a manner that it can be discharged at once into a vessel from a height of 20 feet, above a pool 170 feet wide by 5 chains long, in which there is 12 feet depth at low water. There is a pinnacled rock in this pool, which will have to be removed, after doing which, any vessel of a size that can cross the bar, will not only have room to swing, but may lie alongside and load during the ebb without taking the ground.

The seam is 16 feet thick, and though very friable and irregularly jointed, with a sooty and rather shaly fracture, it stands well in the face of the drive. There is a "brow" fault about 15 feet from the entrance, through which the surface water leaks, but otherwise the coal is quite dry. Its quality is excellent, and I saw it tested both in a forge and on the open hearth, and nothing better could be desired. It burns freely, with a bright flame and no unpleasant smell. If allowed to remain undisturbed it forms a compact coke, which, with the addition of a little fresh coal, can be entirely consumed, leaving only a small proportion of dull grey ash. The coal can be traced round the point of the spur to the south, the highest point of the outcrop being 100 feet above the water level, and there the coal is a good deal harder than in the mine. The outcrop then descends to a branch stream (Mine Creek), which it crosses about 13 chains (estimated) in a direct line from the mine. The coal has not actually been found where it crosses Mine Creek, as the grits and sandstones there form a very bold but short gorge, which is occupied by a deep pool, so that the bed of the stream cannot be examined. Below this point, Mine Creek flows over granite to where it joins the Ngakawau, about 100 yards above the mine. Following up this creek, the sandstones are seen gradually to pass into sandy clay shale and compact marl of a dark colour, still preserving the same dip as the beds at the mine, namely, 40° to the westward. Half a mile up the creek, in a south-south-west direction, marine fossils, like those in the Cobden limestone, occur in a brown marl-stone. About three-quarters of a mile up, the creek divides into two branches, and in the east branch nothing but the marl-stone is found, but the bed of the west branch is full of large blocks of sandstone and grit, with fragments of coal. On the hill face, east of Mine Creek, the grits are found to rise, still preserving their steep westerly dip, to a height of 800 feet; the outcrop rising at an angle of 15° to 20° to the south-east, as far as could be ascertained in the heavy timber and dense scrub which covers every part of this valley. At 960 feet above the creek, the open surface of the plateau is reached, and there the grits and sandstones are found lying flat, but with a general dip to the north and east. No coal has actually been found on this part of the plateau, nor in the outcrop on the face of the hill above described, but, on following the plateau to the south, towards Mount Frederic, there is a 16-foot seam of coal, of equal quality to that at Coalbrookdale, at an altitude of about 1,300 feet. Across the plateau to Coalbrooksale, a distance of about ten miles, the surface is tolerably level, and many outcrops of coal were discovered by Mr. Burnett in this line.

From the level at which the present mine has been opened, up to the outcrop of the seam, I do not estimate more than 80,000 tons will be available, even if no break occurs between the mine and the creek at the back, and about twice as much may be available in the block between the mine level and the water-level, so that for shipping this small quantity of coal the river in its present state is quite


SKETCH PLAN OF THE
WHANGAKAWAU RIVER
(Ngakuruhaho)
Shewing position of the
COAL MINE.
15 Chains 1 inch
At A is a Hole 330 x 160 ft
with 12 ft at L.W.
High wooded Ranges
7 fath. Hole
Rocky Gorge.
Fine Timber.
Swampy boulder Ridges.
Bar dry at L.W.
CHANNEL
Cranes Cliff
700 ft
Ferry House
Grit & Shales
MINE
A
B
C
D
40
70
Coal
Swampy with fine Trees.
500 ft
750
C. D.
Shale
Sandstone.
Flag stone.
Sandy shale.
Sandstone.
Grit.
Coal
Creek
Granite.
A. B.
Sandstone.
Grit.
MINE
COAL 16 F
Shale
Shool
Granite
Blocks of Grit
POOL
12 Ft L.W.
J.B. lith.
J. Hector

sufficient. It is easily available, in average weather, for vessels drawing 8 feet, and not over 120 feet in length. By clearing the channel of boulders, and using them for the construction of a pier-head to prevent the surf washing the beach shingle into the river, the bar could no doubt be improved. The existence of granite and good freestone in any quantity and size of blocks required for constructive works, and the circumstance that the only protection required to be provided is against the coastal drift, renders this place particularly favourable for harbour works. The river brings down no silt or shingle, although liable to good scouring freshets, which is proved by the existence of a 7-fathom hole below the granite gorge, 30 chains above the coal mine. If the coal can be traced from the present mine into the plateau, some harbour works should be undertaken, but even if this extension of coal is not proved, I am inclined to think that this would be a better place from which to work the high-level coal on the plateau than any other which has been suggested. A granite spur from the plateau extends from the east to the head of the reach above the coal mine, and there forms a conical bluff, about 600 feet high (Crane's Cliff), which is steep towards the water, and might be turned to account for lowering the coal to the vessels, from a level that could be reached by an easy tramway from the plateau above.

The arguments in favour of using this river to export the coal from the field under consideration, are,—

1. The low altitude of the plateau at this point—900 feet.
2. The strong probability that the coal will continue and may be worked from the sea level to that of the plateau, by an incline on the east side of Mine Creek.
3. That the coal can be brought along an easy spur from part of the plateau where the best seams exist, to the top of Crane's Cliff, and from there lowered with a self-acting apparatus.

The question then remains whether it would be better to improve the harbour at this place, or to construct a railway to Westport; which is a matter upon which an engineer's opinion should be obtained. It may be pointed out that the facilities for harbour improvements are such that they would probably not exceed the first cost of such a railway, and that, after reaching the Buller, to supply anything like a good large coal trade, very extensive wharfage works would still be required, for which there is no material readily available, the Buller being a large, erratic river, delivering its waters in a low sandy delta, intersected by lagoons and water channels, and liable to sudden and extensive changes at its mouth. The country is, however, very favourable for the construction of a line, if required, north of Westport, as, for most of the distance, it could follow along the foot of the hills to the Waimungaroa, and from there be constructed upon a very perfect shingle terrace, covered with light timber, that runs parallel with the beach. Four or five rivers will have to be crossed, but only one—the Waimungaroa, is of any importance.

The present lessees of the Ngakawau mine will, no doubt, for their own interest, ascertain if the coal can be traced across Mine Creek; and I recommend that, as soon as the season permits, this exploration should be continued for the purpose of tracing the coal into the plateau.

Mokihinui River.

A 6-foot seam of coal, together with some small subordinate seams, occurs about three miles up this river, associated with grits, shales, and sandstones, and dipping conformably under clay marles at a high angle in the same way as at the Ngakawau. At the time of my visit, the river was too much flooded to admit of my examining the section clearly, but Mr. Burnett reported that only a very small portion of this seam is available without sinking and pumping, and that, from its relative position to the bed of the river, very powerful machinery would be required for the latter purpose. The samples of coal I obtained from this place appeared to me of rather inferior quality, but Mr. Burnett states, from an inspection of several tons that were sent to Nelson in 1863, that it burns freely and is very bituminous.

The Mokihinui is a river of considerable size, generally with 10 or 12 feet on the bar, but is liable to excessive floods, which come down with great suddenness, while there is no sheltered place where even a small vessel can bring up within the river so as to be out of the full force of the current.

I have, &c.,

Wellington, 22nd June, 1872. JAMES HECTOR.

WESTLAND.

No. 7.

Dr. HAAST to the Hon. Mr. REEVES.

SIR,— Canterbury Museum, Christchurch, 6th January, 1872.

When I explored the southern portion of Westland four years ago, I found on both sides of the mouth of the Piringa River, which has a good entrance, extensive beds belonging to the Grey and Buller coal formation; but owing to the want of provisions, to the almost impenetrable forest vegetation, and the very rugged nature of the coast, I was unable to find any coal seams. However, one of my companions, Mr. William Docherty, an intelligent miner and reliable man, living at Okarito, and who, ever since then has been collecting specimens of natural history for the Canterbury Museum, has informed me, a few weeks ago, that in cutting a track in that district for the Westland Government, he has come across what he thinks a large seam of excellent coal.

When Mr. Docherty was lately in Christchurch, I explained to him how to measure the seams, and to collect all necessary details, and he is quite willing to return to the locality to furnish us with all the necessary information, and send large specimens of coal, if he would receive on return a bonus for his trouble and loss of time.

I would therefore recommend that a bonus of say £30 be offered to him in case the seam he speaks of is sufficient thickness to be workable, and in such an accessible position that the coal in due time could be shipped at the Piringa Harbour.

I have, &c.,
JULIUS HAAST.

The Hon. W. Reeves, Resident Minister for South Island, Christchurch.

No. 8.

Mr. MAUDE to Dr. HAAST.

SIR,— 5th April, 1872.

I am directed by Mr. Reeves to acknowledge the receipt of your letter of the 6th January, 1872, and to state that the expenditure of £30 for further investigation of the coal seam discovered by Mr. Docherty in Westland is authorized; but it is to be distinctly understood that, before any money can be paid, the existence of the coal seam must be proved to the satisfaction of a surveyor from the department under the control of Dr. Hector.

I have, &c.,
THOMAS W. MAUDE,
Secretary.

Dr. Haast, &c., &c., Christchurch.

CANTERBURY.

No. 9.

Dr. HECTOR to the UNDER SECRETARY for PUBLIC WORKS.

SIR,— Geological Survey Office, Wellington, 10th May, 1872.

As forming part of the information respecting the practical opening up of the Coal Fields in this Colony, I have the honor to enclose an extract from a report to this Department by Dr. Haast, on the geology of the Malvern Hills, which refers to the opening of coal mines, and the construction of branch railways to them. Dr. Haast's further reports on the subject relate only to geology, and appear in the publications of this Department.

I have, &c.,
JAMES HECTOR.

The Under Secretary, Public Works.

Enclosure in No. 9.

EXTRACT from REPORT by Dr. HAAST, F.R.S.

Practical Suggestions.

The geological examination of the Malvern Hills was undertaken principally with the object of deciding the question whether there was sufficient coal to warrant its extraction on a large scale, and procure the means of supplying part of the New Zealand, or at least the Canterbury market with the produce of our own mines.

In my report I have shown that in the district under review, there exists two principal series of coal, which, generally, may be described as containing *unaltered* and *altered* brown coals. The former strata begin on the southern banks of the Hawkins, where Mr. Jebson's Coal Mine is situated, and continue without interruption, except where broken through by the Selwyn and its tributaries, to the left bank of the Hororata River.

In many localities the brown-coal beds have suffered considerable denudation, so that only a small portion of the coal seams is situated above the principal drainage line of the country; in others the beds have been preserved by more favourable circumstances, and rise several hundred feet above the watercourses near which they are situated.

There are three principal considerations, of which, in judging of the practical value of these coal-bearing strata, we ought not to lose sight, viz.: (1.) Quality of coal; (2.) Thickness of seams; and (3.) Extent of beds from which the coal can be obtained level free.

Quality of Coal.

Of the three main localities where the coal seams are easily accessible, we must at once put the Hororata aside, as there the beds are only of small extent, and contain coal of inferior quality. Of the two remaining localities, the Hawkins and the Selwyn, the brown-coal beds on the right bank of the first-named river have been worked for years to a limited extent, through which we have become well acquainted with the character of the ground. Of the three sets of seams occurring there, those at present worked by Mr. John Jebson are the thickest, consisting of two seams of about two feet each, with the same thickness of shale between them. They consist of a brown coal of very fair quality, which is at least equal to that obtained from the principal beds of brown coal of Bohemia, which is so extensively worked and used all over that country, not only for household purposes, but also for stationary and locomotive engines. I may here observe that although coal of the carboniferous period is largely imported to Berlin from Silesia, Bohemian brown coal is nevertheless extensively used there also, as proved by German statistics.

Quantity Available.

The second consideration—viz., extent of beds above water line of drainage channels—judging only from our present experience, is not so favourable near the Hawkins as in some other localities.

The hill sides, rising about 200 feet above the Hawkins, consist mostly of post-pliocene alluvium, so as to leave only a small portion of the coal beds level free. Of course, I only speak of the indications the former and present workings have afforded me; and it may be possible that if the drives are continued further into the hill the coal beds may rise so as nearly to reach the surface, and thus give us an altitude of nearly 200 feet, throughout which, of course, a larger quantity of coal for extraction would be available than we can expect at present, reasoning from the data before us.

The last locality under consideration is the Selwyn, where, in the Surveyor's Gully, one of its small tributaries, and close to the Canterbury Plains, seams of very good brown coal, about three yards in thickness, can be easily worked, and appear to be of quality superior to any other of the same beds, both north and south. Moreover, the quantity that can be obtained level free, according to my calculations, is about 3,000,000 tons in that neighbourhood. Thus, if no other considerations were to be taken into account, the Selwyn brown-coal beds would, taken by themselves, offer the greatest advantage, both to the coal miner and to the public; but the existence of the second series (altered coal in isolated outliers, owing their preservation to the action of igneous rocks near them) must not be overlooked, as they will also afford coal of a superior quality, in more or less quantity, according to the size of the outliers.

The alteration of the brown coal, as shown in my report, has been of various degrees of intensity, according to the thickness, number, and size of the dolerite dykes and streams which are associated with it.

The coal beds in the Big Ben outlier are the least affected, still possessing the character of a true but excellent brown coal, whilst the seams in the Acheron assume quite an anthracitic nature.

The beds in the Kowai and the Upper Selwyn assume an intermediate structure resembling European and Australian coal of carboniferous age. Of the isolated patches, the easiest of access, that of the Selwyn above Mount Misery, first claims our attention. It is the largest in size, has in its north-east corner been worked by Mr. M. B. Hart for the last few years, and now towards the centre Mr. H. P. Hill is just sinking a shaft for mining purposes on a large scale. From a calculation of the approximate area over which mining could be carried on with advantage in that locality, it appears that at least 1,500,000 tons of altered coal for household and steam purposes would be available, always assuming that the disturbance in the beds is not greater than the result of previous exminations would suggest to have taken place.

Line of Communication.

Considering, therefore, that the most valuable portion of the unaltered and altered brown-coal beds occur on and near the banks of the Selwyn, a railway constructed from the Rolleston Station on the Southern Railway line to the junction of the Surveyor's Gully with the Selwyn, would bring us to a central spot, whence the brown-coal seams of the Surveyor's Gully, and on the banks of the Selwyn, as well as the altered beds on which Mr. Hart's and Mr. Hill's mines are situated, could be reached by a tramway. This line would have many advantages, as it would pass over the waste lands of the Crown all the way, and thus could be cheaply constructed, whilst, at the same time, excellent land would become opened for selection all along the line and its neighbourhood. Moreover, a still larger amount of land could be made available by means of improving it by irrigation, for which the levels of the country and the existence of the debouchures of such rivers as the Hawkins, Wai-ani-ani-wha, and Selwyn into the plains, would offer peculiar facilities.

I wish also to draw attention to the central position of the terminus of such a line being easily accessible to the inhabitants of the Hororata and Upper Rakaia, as well as to those of the Hawkins and the Upper Waimakariri; and, if necessary, branch lines could be constructed in both directions in years to come from such a central locality.

There would be also another way by which Russell's Flat and the Kowhai (West Coast Road) could be reached—viz., by continuing the line up the Selwyn as far as Hart's Flat, then across the low saddle to Russell's Flat, and so on to the Kowhai, by which all the level country in that direction would have direct communication with Lyttelton and the other centres of population along the line, and by which also the timbered country of the Kowhai could be brought within reach. Another way for continuing the line would be to skirt the Malvern Hills from the central station, near the Selwyn, below the junction of the Surveyor's Gully, so as to reach Mr. Jebson's Coal Mines, and so on to the Kowhai. By these proposed lines, an easy market might be gained for the coal deposits and other natural products of the Malvern Hills for the benefit of the country.

JULIUS HAAST.

No. 10.

Dr. HECTOR to the UNDER SECRETARY, Public Works.

(No. 61–71.)

SIR,— Geological Survey Office, Wellington, 17th June, 1872.

I have the honor to forward a preliminary report by Dr. Haast on the Survey of the Coal Deposits in the Ashburton District and Clent Hills of the Province of Canterbury, which has been made in accordance with a suggestion in my Memorandum of the 12th December last.

I have, &c.

The Under Secretary for Public Works. JAMES HECTOR.

Enclosure in No. 10.

PRELIMINARY REPORT on the Coal Deposits of the Ashburton District, Province of Canterbury, by JULIUS HAAST, Ph.D., F.R.S.

DURING the course of last summer, I was instructed to examine the Ashburton District, in continuation of my researches into the existence and extent of coal fields in this Province, and in the following pages I beg to offer a *résumé* of the main results of that examination, leaving its scientific portion to my more extended geological report.

Although the geological features of the country resemble in many respects those of the Malvern Hills, this resemblance is principally confined to the existence of older rocks, palæozoic sedimentary beds, and melaphyres and quartzitic porphyries,—the absence of the whole series beginning with the porphyry conglomerates and including the seams of brown coal, saurian and other fossiliferous beds, up to the greensands, being very striking.

This non-occurrence of beds so well developed at no great distance is very important in more than one respect, notwithstanding that their place is being taken by younger beds of a somewhat similar nature, with seams of brown coal at their base. This difference would not be so remarkable if a greater distance were to separate both localities from each other, or if a mountain chain of great height between them would have offered an opportunity for the formation of different beds in character or age on both sides; however, both series of beds are situated along the eastern side of the great longitudinal chain, and there are at least at first sight no sufficient reasons to account for this dissimilarity.

Beginning with the oldest beds in the district, the palæozoic sedimentary strata, of which the higher ranges are exclusively composed, we observe also here, that their lowest visible portion consists principally of conglomerates, shales and coarse sandstones, and of which, in my Report on the Geology of the Malvern Hills, I have given the principal features. These beds are in some localities replete with the impressions of ferns, of which some are identical with those accompanying the numerous seams of coal opened up in the Colony of New South Wales.

I have been able to follow these beds all the way from the Malvern Hills to the banks of the Rangitata, but unfortunately found them devoid of regular coal seams; the existence in many localities of small seams of black carbonaceous shales, or the bark of trees converted into a fine glance coal, making this search after workable coal still more tantalizing.

We therefore are compelled to assume, that during the formation of these very extensive strata, covering the greatest portion of this part of New Zealand, and which have been folded up and denuded in a remarkable manner, the necessary conditions favourable for the formation of seams of coal did not exist.

In another locality, in Mount Potts, on the banks of the Upper Rangitata, these lower beds also appear well exposed in deep gorges, cut by mountain torrents, overlaid by the same sequence of rocks as the fern beds of the Clent Hills; but they contain numerous marine exuviæ, identical or closely allied to Australian forms of older Carboniferous or younger Devonian age, thus offering additional evidence of the age of the Clent Hill series, as both beds, the fern and shell beds, alternate with each other in New South Wales.

This whole series of older sedimentary strata is, as in the Malvern Hills, overlaid in the district under review by igneous rocks, having been deposited in a semicircular form stretching from the south-eastern corner of Mount Winterslow, across the valley of the Stour, and after forming the very summit of the Clent Hills across the valleys of the Southern or main Ashburton and of the Northern Hinds to the isolated little range between the latter and the Southern Hinds, called the Gawlor Downs.

The relations of these melaphyres, the oldest basic rocks, as well as those of the next series, the acitic or quartzitic porphyries, which in many localities, principally in the north-eastern corner, overlie them, are well exposed in a considerable number of sections. In several localities, however, the latter repose directly upon the older sedimentary rocks, and offer us at the same time sufficient evidence from which we can judge of their age and mode of deposition. One of these localities is on the flanks of Mount Somers, which is principally composed of quartzitic porphyries, and the pitch stones associated with them, and where a small range called Cox Hills runs from its south-eastern end in a southerly direction towards the Southern Ashburton. In the deep gullies of these hills, and principally in Petrefying Gully, splendid sections are opened to our examination; here, above green sands and quartzose sands which overlie directly the sedimentary palæozoic rocks, follow shales with dicotyledonous leaves, and a seam of coal about 3 feet thick with a dip of 46°, and consisting at the outcrop of an inferior brown coal showing woody structure.

The overlying shales and clays gradually change into porcelain jasper, and are covered by a great thickness of pitchstone-agglomerates, containing pieces from 1 inch to 10 feet in diameter, and which in its turn is again overlaid by pitchstones and quartzitic porphyries, which latter form the great mass of Mount Somers, rising about 3,000 feet above the brown-coal series below them.

A similar seam of inferior brown coal exists in Woolshed Creek, which latter has cut a deep and magnificent gorge on the western slopes of Mount Somers, exposing the porphyritic streams for a thickness of more than 1,000 feet, the whole confirming the observations made in the gorge of the Rakaia as to the character of the beds underlying the quartzitic porphyries. (See Malvern Hills Report, page 79, Geological Report, 1871.)

I pointed out already that the porphyry conglomerates, the brown-coal bearing and saurian beds of the Malvern Hills, were missing; their place being taken by a younger formation and of the age of the Curiosity-shop beds, and with which, as far as I could observe, no seams of brown coal of any consequence are associated.

There are however several other localities where we meet with workable seams, being associated with shales, ironstones, and quartzose sands, but in which I failed to obtain any fossils from which their age might be ascertained. This series might possibly be of the age of some of the coal seams of the Malvern Hills. Several of these seams are situated in such positions that it would be difficult to work them at present with advantage, whilst others are easily accessible and are already worked.

The fact that there is a great deal of timber in the district under review has hitherto prevented the

general use of coal in the neighbourhood for household and other technical purposes, but I have no doubt that in years to come some of these seams will offer a good field for industrial enterprise.

The principal locality is situated near the junction of the River Stour with the Ashburton, where in Coal Gully a seam of 14 feet thickness, dipping 8° towards E.S.E., and of which the lower portion of 8 feet is extracted in an adit of proper construction, has been worked for the last eight years. The lessee of the mine is selling only about 150 tons in the year, which is sold at £1 per ton at the pit's mouth. It is a fine pitch coal with smaller layers of glance coal interstratified, possesses considerable hardness with conchoidal fracture, and is of the same quality as the average brown coals of the Malvern Hills.

The principal seam reposes upon porphyry tufas, is covered by shales with smaller seams of brown coal and sandy clay marls, the whole overlaid by post-pliocene alluvium. On the opposite side, and on the southern bank of the River Ashburton, I observed in the banks of a small creek two other seams about 4 and 5 feet thick, which I partially opened up, belonging to the same formation; and near the banks of the River Stour in Alexander Creek, shales and irregular deposits of coal are also met with; without doubt a portion of the same field, although the seams of coal are there irregular and of inconsiderable thickness.

Extent.

It appears from the geological configuration of this country that a range consisting of quartziferous porphyries stretched before the deposition of the coal seams across the present valley of the Ashburton about a mile below the present junction of the Stour, and that thus behind this barrier a somewhat triangular basin existed, about two miles long, and in its largest diameter one mile and a half broad, in which the coal-bearing strata were formed.

Only in a few localities on the sides of the hills these beds have been preserved from the destructive agency of the post-pliocene glaciers, so that they can be worked level free; however, they may nevertheless exist in other spots which are at present covered by post pliocene-alluvium.

The seam in Coal Gully is worked level free, and will be found to extend over 20 acres, so that there are at least 100,000 tons of coal available. The beds on the opposite side of the River Ashburton, from which coal can be obtained also level free, are of smaller extent, but still of sufficient size to be opened and worked with profit.

We have as yet no data from which we could ascertain if the seams in this basin extend to the centre of the valley—if they gradually thicken or diminish—or even if they are confined to the edges of the basin only; but, judging from other localities in this Province which present similar features, we may assume with some degree of confidence that they will be found to stretch across the valley covered by post-pliocene alluvium, and to be reached only by pits.

A second locality where brown coal of excellent quality is exposed is situated on the western slopes of the Clent Hills, where a seam of 28 feet 6 inches in thickness, divided only by small shaly bands, stands at an angle of 63° dipping towards E.S.E., or towards the range.

Except the cast of a cyrene in some clay marls, I did not observe any fossils associated with these beds, so that also in this case we have no data to compare their age with that of other brown-coal measures in New Zealand.

These beds appear to be only portions of a larger formation, which has generally been destroyed by the enormous ice-plough, in post-pliocene times so effectually at work in the outrunning ranges of the Southern Alps. However, as on the other side of the broad valley on the banks of the River Cameron small seams of brown coal also appear below the morainic accumulations, we may not hope in vain that also in this large opening in the ranges round Lake Heron extensive deposits of brown coal may lie hidden which will be of considerable use in years to come.

Finally, in the bight which is formed by the junction of the Cox range with Mount Somers, a series of seams of lignite occurs, probably being portions of beds of larger dimensions, which in other localities in that district are either hidden below post-pliocene and recent alluvium, or removed by glacier or fluviatile action. This series, which has an average dip of 14° towards N.N.W., reposes here upon quartziferous porphyries, and begins with beds of porphyry, tufa, and fireclays, covered by a succession of shales alternating with seams of coal 2 to 5 feet thick, the coal consisting of distinct layers of earthy brown coal and lignite, the latter exhibiting quite clearly the woody structure.

As all these beds do not apparently enclose any fossils, it will be difficult to fix at present their exact age, although I have no doubt that they belong to the lowest portion of our tertiary series, called the Curiosity-shop beds.

The next beds under review, which by their hardness have resisted well the action of glacier agency, or of the huge torrents issuing from the enormous ice-masses once filling the upper portion of the country, consist of a series of sands, shell-sandstone, palagonite tufa, calcareous and tufaceous sandstones and limestones, forming often bold and picturesque cliffs. They contain a great variety of shells and other exuviæ, all indicating that they belong to the above-mentioned tertiary Curiosity-shop series, the principal fossils being *Pecten Hochstetteri, Turitella Gigantea, Pectunculus laticostatus*, and *Waldheimia*. They do not contain any workable seams of brown coal, but abound in fine quartzose sands, building stones, and limestones.

Summing up the results obtained, the examination of the Clent Hills district has proved the existence of workable seams of good brown coal, and of which those in the Ashburton-Stour Basin are easily accessible, of fireclays, white quartzose sands, limestones, and building stones, and which will in years to come be of considerable value to the adjoining districts.

Christchurch, 12th June, 1872. JULIUS HAAST.

OTAGO.

No. 11.

Dr. HECTOR to Mr. COOPER.

SIR,— Geological Survey Office, Wellington, 15th March, 1872.

I have the honor to forward, for the Hon. Mr. Gisborne's information, a preliminary report by Captain Hutton on the Coal Fields of the Southern District of the Otago Province, together with my letter of instructions to him.

Captain Hutton has not completed the examination of the whole district, but I consider I have sufficient information to warrant practical recommendations as to the best method of opening up a mine for the supply of the railway, and Captain Hutton can resume his examination at a future date.

I am making inquiries as to the best way of getting the exploratory drive at Nightcap Hill executed, and will report the result. In the meantime I would particularly beg Mr. Gisborne's attention to the suggestion that rewards should be offered for the discovery of coal seams, in which I concur.

I have, &c.,

The Under Colonial Secretary. JAMES HECTOR.

Enclosure 1 in No. 11.

Dr. HECTOR to Captain HUTTON.

SIR,— Geological Survey Office, Wellington, 22nd December, 1872.

I have the honor to request that you will devote the next four months to the geological survey of that portion of the southern district of the Otago Province which extends from the Takitimu Mountains in the west to the coast between the Mataura and Molyneux Rivers, and including the Wairaki and Taungatura Downs, the Hokanui Hills, and the Kaituka Ranges.

The special object of your survey will be to ascertain the extent and value of the coal seams which occur in the district, but for this purpose it will be necessary for you to examine the general structure of the district on several lines of section. The lines which I recommend from my own knowledge of the district are marked on the attached plan.

Section I., in a north and south direction up the valley of the Otapiri Creek, is the first to which you should direct your attention, as there you will find the lower formations well displayed.

Section II., north-east from the Takitimu, the Mount Hamilton District, will give you a greater expansion of the middle part of the series.

Section III. is the section from the Takitimu south to the Morely Creek District, and on to the Yellow Bluff, on which line you will find the older and newer formations best developed.

Section IV. will intersect or approach several valuable seams of brown coal at the eastern extremity of the Hokanui. In the district east of the Mataura you will find very good sections on the lines marked, avoiding the heavy bush.

The coast section can only be reached by land as far north as Waikawa, and again at Catlin River and the Nuggets.

The following is a list of the localities where fossils have been gathered:—

Section I., Forest Hill limestone, with marine fossils. In this limestone are caves with fine moa-bone deposits, which I should like you to examine if you have an opportunity.

Otapiri River at *a*. Astarte sandstone above the *pecopteris* beds at *a*, which have been explored by a drive from a bush gully; *b*, a low cliff of dark sandstone, in which I got *glossopteris*; *c*, *d*, *e*, are the calciferous shales (Kahiku series), with wide-winged *spirifer*, &c., under the conglomerates, which form the base of the Mataura series.

Section II. Fossil plants occur in the Mount Hamilton sandstones, followed by *septaria* clays, also with fossils. I think the supposed coal at Coal Hill must be serpentine, but I have never been there.

Section III. Older part of the Mataura series with fossils *a*, *b*, *c*, also the brown coal with fossils at *d*, followed by greensands, marls, and limestones, all fossiliferous.

Mataura Falls.—Sandstones and shales with fossil plants.

Waikawa.—Fossil plants at the localities marked on plan.

Tautuku.—On the coast, green sandstone with plants and *ammonites*.

Catlin River.—Fossils at places marked on plan.

Shaw's or Roaring Bay, and the Nuggets.—Fossils in limestone, and indurated sandstone.

Kahiku Gorge.—Fossil shells.

Popotuna Gorge.—Fossil shells and plants.

Waipahi Creek.—Fossil shells.

The localities where coal seams are worked or have been looked for are Mount Hamilton, irregular seams of good quality; Otapiri Creek, irregular seams; also brown coal nearer Forest Hill. The neighbourhood of this coal to the Winton Railway Station makes it desirable that you should report on the best place where a supply could be obtained for the use of the locomotives. Morely Creek, a good seam of brown coal, much of it burnt out, however.

The Mataura River.—From the Falls up to McNab's there are several seams of brown coal exposed, also at Hill's Station and the Hokanuis. Below the Falls, a thick bed of lignite is worked.

Waikawa Harbour.—Several thin seams as marked on the plan. The coal is good, but the seams are thin and irregular as far as yet explored.

If you should think it necessary to assist your investigation by "boring" in any part of the above district, you will inform me on the subject at as early a date as possible.

I have, &c.,

Captain Hutton, F.G.S., Assistant Geologist. JAMES HECTOR.

Enclosure 2 in No. 11.

REPORT on the COAL FIELDS of the Southern District of OTAGO by Captain HUTTON, F.G.S.

I HAVE the honor to report that I was engaged from the 4th January until the 21st February last in examining the coal deposits of the Southland District, between the Mataura and Waiau Rivers, and the following is the result of my examination. The geology of the district will form the subject of a separate memoir.

The coal fields of this district may be divided into four areas, viz. :—

1. The Hokanui District.
2. The Mount Hamilton District.
3. The Wairaki District.
4. The Oropuki District.

The two first contain seams of black bituminous coal, the two latter brown cannel, or pitch coal. Extensive deposits of lignite, sometimes of very good quality, are also found in the valley of the Mataura, at Oropuki, and near Invercargill; but as these can never have more than a local value, I shall make no further mention of them in this report.

1. *The Hokanui District.*—This district includes the whole of the Hokanui Hills, with the exception of the northern corner. The rocks are green sandstone, shales, grits, and conglomerates, which dip at angles never exceeding 20° in various directions. The same formation extends under the plain between the Hokanui and the sea, but it is here covered by a thick deposit of alluvial gravels containing beds of lignite.

At present coal has only been found iu a few localities on the seaward slope of the Hokanui, and even here only in seams too thin to be worked with advantage.

Up a small creek flowing into the Otapiri, three thin seams of coal have been discovered, none of them however exceeding six inches in thickness. Higher up, I am informed by Mr. J. R. Thompson, a seam of carbonaceous shale about four feet thick exists, but without any good coal in it. This, probably, is the carbonaceous shale referred to in the Colonial Museum and Laboratory Report, 1868, p. 18.

West of the Makarewa, coal has been found in several localities near Mr. Anderson's farm, but were also it does not exceed a foot in thickness. This coal is black, and does not fall to pieces on exposure to the weather. It has not yet been analyzed, but will no doubt prove of superior quality, and if it can be obtained in a seam of not less than three feet in thickness, would be of considerable value.

It is, I find, a commonly received opinion, that those portions of the formation that occupy the flat land below the gravels forming the plains between the Hokanui and the sea would not be so much disturbed as those portions that form the hills, and therefore, that if coal could be found in the flats, by boring through the gravels, it would be much more advantageously placed for working; the supposition being that the hills are owing to an uplifting of the strata in those localities, while in the plains they have remained undisturbed. This, however, is quite a mistake, as the whole of the formation has undergone the same amount of disturbance, and the hills are of that class sometimes called "hills of denudation;" that is to say, that they are higher than the plains simply because, where the plains now exist, the rocks have all been washed away down to that level. If, therefore, a seam of coal was found below the plains, there is no reason to suppose that it would be less disturbed than if it was in the hills; and a mine situated in the plains would entail great expense in pumping and lifting machinery, while one situated in the hills could probably be worked level free. The plains also could only be explored by boring, which would be a very expensive operation, especially as the bore would have first to penetrate through a considerable thickness of loose gravel in which the rods would be liable to stick fast, and would then have to be continued down through hard sandstone. The hills, on the contrary, can be easily explored in the gullies, and a much greater extent of the formation, both horizontally and vertically, can be examined than by boring. As, therefore, there is as yet no evidence for the supposition that a coal seam thick enough to work underlies the plains, it would in my opinion be only throwing money away to attempt exploration by boring; and instead, in order to encourage the the prospecting of the hills, I should recommend that a reward be offered for the discovery in the Hokanui Hills, of a coal seam sufficiently thick to pay for working. This might, perhaps, be defined as a seam having a total thickness of not less than four feet of good coal within a vertical depth of not more than six feet.

The same formation as that in which the coal is found in the Hokanui extends also across the Mataura River nearly as far as the Clutha, and from the sea nearly as far as the Kahiku Mountains. Thin seams of coal have also been found in several places in this district, as Waikawa, Toi-tois, Islay, Wyndham, &c. At Toi-tois, near the mouth of the Mataura, Mr. Brunton has explored some outcrops of coal by drives, and a shaft. The following is the section at this locality :—

Conglomerate, green sandstone	200 +
Fireclay	6·0 about.
Coal, with shale partings	1·6
Dark gray shale	40·0 about.
Coal (seven thin seams with shale)	6·0
Green sandstone	20·0 about.
Conglomerate	15 +

The whole dip, 6° N.N.E.

The coal from Waikawa has been analysed, and the analyses are published in the Appendix to the Jurors' Reports and Awards of the New Zealand Exhibition, 1865, p. 441; and in Dr. Hector's first General Report on the Coal Deposits of New Zealand, p. 33; and the Third Annual Report on the Colonial Museum and Laboratory, p. 20. Other information can also be obtained from these publications.

The remarks that I have already made about prospecting the Hokanui Hills for coal are equally applicable to the country about Waikawa; and I would therefore recommend that a reward be offered for the discovery of a payable seam in this district also.

2. *Mount Hamilton District.*—This district is confined to a small portion of Mount Hamilton, which forms the north-east end of the Takitimu Mountains. The coal seams are thin, and of very limited extent. The thickest seam that I could find was only 10 inches of good coal, with shales above and below it, the whole overlaid by yellow sandstone, dipping 30° W.N.W. More to the west, a few very thin seams of coal are seen interbedded with the yellow sandstones, which dip in this place 25° S.E.

The height of this coal field is 2,500 feet above the level of the flats at the base of the mountain, or about 3,300 feet above the sea. The position, therefore, as well as the thinness of the seams, and the limited area of the field, put the practicability of working it quite out of the question; the coal however is black, bituminous, and of excellent quality.

3. *Wairaki District.*—This district skirts along the southern base of the Takitimu Mountains and Wairaki Hills, from Taylor's Creek on the west as far as the alluvial plain of the Jacob's River on the east, a distance of about eighteen miles. Near the Jacob's River it has a breadth north and south of about three miles, which gradually diminishes westward; thus forming a triangle, the apex of which is at Taylor's Creek, and the base at the southern spur from Mount Beaumont, called the Nightcap. This will give an area of about twenty-one square miles.

The coal in this district is quite similar in appearance to that worked in the Waikato, and is what is generally called a "brown coal." As, however, this name has been often employed for compact varieties of lignite, it would, I think, be preferable to use the name "pitch coal" for this class of coal, which may be distinguished from the lignites by never containing any trace of wood-like structure, by its pitch-black colour, and by its waxy lustre. This is the name used by Dr. Percy (*Metallurgy*, p. 85), who considers it as the best variety of brown coal or lignite. This coal, although inferior in heating power to the true black coals, will be found very useful for all household purposes, as well as for stationary engines. It is largely used by the steamers on the Waikato River, with satisfactory results, and I have no doubt but that it would answer for locomotives also.

Analyses of this coal from Morely Creek will be found in the Appendix to the Jurors' Reports and Awards, New Zealand Exhibition, 1865, p. 441, No. 11; and also in the Third Annual Report of the Colonial Museum and Laboratory, p. 20, where the analyses from Taylor's Creek, Reinecker's Run, Howell and Steven's Run, Holt's Run, and probably from Aparima, are all from this district.

At Taylor's Creek a section is opened just on the edge of the basin, and a seam of coal 5 feet thick is seen to rest on the edges of slates and sandstones. The coal is here covered with shales and micaceous sandstone, the whole dipping 20° south-west. Following down the creek, more black shales are seen to overlie the micaceous sandstone. These probably indicate the presence of a second seam of coal, but the section stops suddenly. As the section here is evidently quite on the edge of the basin, the seam of coal may get thicker in a south-westerly direction. At Linton, two seams are distinctly seen dipping 25° S.S.W., but the thickness of neither of these has been ascertained.

In a cliff on the right bank of the Morely Creek, the following section is displayed:—

Yellow sandstone	20+
Blue marl	20
Coal	3
Shale	1
Coal	2
Shale	12
Coal	2
Shale	10+
	70+

The whole dipping 25° W. by S.

Higher up the Morely Creek, at Messrs. Reinecker's and Hunter's Station, the coal has been opened up in several places. The thickness, as ascertained close to the home station, was 10 feet, and the dip 25° S.W.

The nearest place to the railway at which the coal has been found as yet is on the west side of the Nightcap Hills; it has not, however, been opened up sufficiently to ascertain either its dip or thickness.

A tolerably approximate estimate of the quantity of coal in this field cannot be given without a great deal more data to go upon, on account of the variation in the dip and thickness of the seams; and the expense attending the obtaining of such data would be far more than it would be worth, for it can already be safely stated that the coal exists in sufficient quantity to justify a large mine being opened in it.

The nearest place to Winton at which this coal is likely to be found is on the eastern slopes of the Nightcap Hills, from which point a railway of eighteen miles in length would reach Winton over quite level ground.

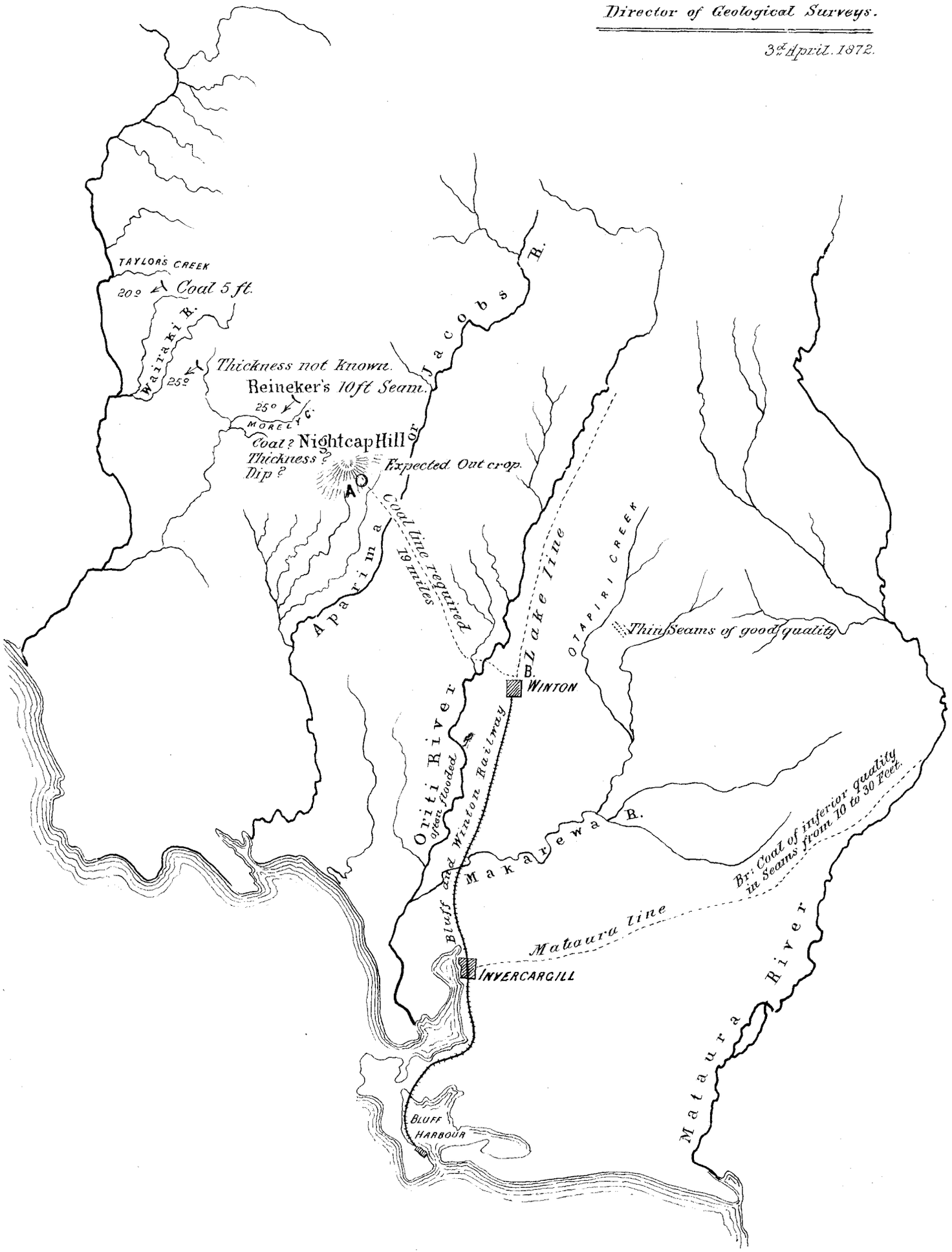
The way to proceed in order to find the coal on the eastern slopes of these hills is, first to open out the known outcrop on the western side, and obtain as accurately as possible the direction of the strike of the seam; this is of course at right angles to the dip. A line should then be run with a level over the hills in the direction of the strike, until the same level is reached on the eastern side as the known outcrop on the western side; a few feet above this point a bore should be put down, and if it

Plan of Southland

Shewing the position of the Coal outcrop at Nightcap Hill and the line required to connect it with the Railway to Winton.

Signed J. Hector.
Director of Geological Surveys.

3rd April. 1872.



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is successful in striking the coal, the seam may be either opened up at that place, or two other bores be put down in order to get the dip of the seam. When the dip of the seam is ascertained at that point, but little difficulty will be experienced in hitting off the position of the seam at the level of the plains at the Jacob's River, and a drive put in there will be the best position for opening a mine.

4. *Oropuki District.*—In this district the coal is situated at about a height of from 150 to 200 feet above the sea, and about five miles from the beach. It occupies a portion of the valley of the Waimeamea River, and it is about three miles in length and one in breadth.

The coal is exactly similar in appearance and quality to that of the Wairaki District, just described. At present it is only exposed in water races, some of which have fallen in, and in no place was I able to measure its thickness. It is however evident that this is considerable, and, according to the miners, from 10 to 15 feet. It is covered with dark very tough shales, and the floor is composed of chocolate-coloured shales. The upper part of the formation is soft green sandstone. The dip is about 12° S.S.W.

This coal is of good quality, but not superior to that from the Wairaki District, while it is neither so accessible in position, nor so extensive in quantity. As the country in which it occurs is well covered with bush, it is not likely that this coal will be used, even for local purposes, for some time.

It appears to me, therefore, that the only coal field of any commercial value at present known in Southland is in the Wairaki district; and I think that this could be at once opened up with great advantage to the country.

F. W. Hutton,
Assistant Geologist.

Wellington, 6th March, 1872.

No. 12.

Dr. Hector to the Under Colonial Secretary.

Sir,— Geological Survey Office, Wellington, 6th April, 1872.

With reference to my letter of the 15th ultimo, I have the honor to attach a map to accompany Captain Hutton's report on the Southland Coal Fields, explaining for the information of the Minister for Public Works the position of the Nightcap Hill (where it is proposed to make further exploration for coal), with reference to the existing and proposed railway lines.

The line A B on the map is that which will require to be constructed if the existence of a mine is proved, and no coal of sufficiently good quality is found in any more accessible position.

I am inclined to think that Captain Hutton does not sufficiently estimate the difficulty and expense of this proposed line; for though the country it passes through is level, it is very swampy for a great part of the year, and one very bad shingle river (the Oriti), which is subject to heavy floods, will have to be bridged.

After my examination of the district in 1869, I had some hope that coal might be found in a position more accessible to the railway than that at Nightcap Hills. Captain Hutton's report does not, however, favour the prospect of getting the coal at any nearer locality; but before taking any steps to survey a line connecting that place with Winton, it will be necessary to ascertain definitely that the coal at the Nightcap Hill, which is at present only seen from a superficial outcrop in a drain, really occurs in as valuable a seam as it does at Morley Creek.

The work required to prove the coal at this place, as suggested by Captain Hutton, can be executed by a coal-viewer or practical mining surveyor.

I have ascertained from Mr. Pearson, Commissioner of Crown Lands, that arrangements can be made locally for having the necessary excavations made; and I beg to recommend that I be authorized to commence them at once, on the following terms:—

The required levelling and excavation, as described in Captain Hutton's report, to be contracted for at a definite and moderate rate of payment, the amount to be doubled in the event of a sufficiently valuable seam for the supply of the railways being discovered.

The total expense of this should not, in my opinion, exceed £200.

I have, &c.,
James Hector.

The Under Colonial Secretary, Wellington.

No. 13.

The Hon. W. Gisborne to His Honor J. Macandrew.

Sir,— Colonial Secretary's Office, Wellington, 10th May, 1872.

I have the honor to forward to your Honor copies of the instructions given to Captain Hutton on the 22nd of December last, and of the reports which have, in accordance therewith, been forwarded to the Government.

As a large portion of the land around Nightcap Hill (where it is proposed to make further exploration for coal) is freehold, the Government will be glad to be favoured with your Honor's views before directing the proposed further exploration to be commenced.

I have, &c.,
W. Gisborne.

His Honor the Superintendent, Otago.

No. 14.

Mr. W. O. Ball to the Hon. W. Reeves.

Sir,— Dunedin, 19th January, 1872.

I have the honor to submit to you, on behalf of the Preservation Inlet Coal Company, a request that you will grant a sum of money, as provided for in Part VIII. of the Immigration and Public Works

Act Amendment Act, for the purpose of erecting a wharf and tramway at Preservation Inlet, which is required for the working and further development of the coal seam there, on which the Company have already spent between £2,500 and £3,000 in prospecting, and which they have ascertained to be of very large extent. I need scarcely point out the advantages the Inlet possesses as a coaling station, being in a direct line of the Australian steamers to and from New Zealand; and the water being of sufficient depth to admit the largest vessel, the cost of coal put on board ship would be about one-third the price paid for Newcastle here.

As Captain Hutton is at present in Invercargill, I would respectfully suggest the advisability of his proceeding with his staff and boring instruments to the Inlet, and report the fact as stated to your Honor.

The survey and sketch maps, showing the position of the coal deposits, are at your service; and any other information you may require I shall be glad to afford.

I am, &c.,
W. Oram Ball,
Hon. Secretary.

The Hon. W. Reeves, Resident Minister for Middle Island.

No. 15.

Mr. Maude to Mr. W. O. Ball.

Office of Resident Minister for the Middle Island,
Dunedin, 22nd January, 1872.

Sir,—

I have the honor, by the direction of Mr. Reeves, to acknowledge the receipt of your letter of the 19th inst., requesting, on behalf of the Preservation Inlet Coal Company, that money may be granted under the provisions of "The Immigration and Public Works Amendment Act, 1871," for the purpose of erecting a wharf and tramway at Preservation Inlet.

In view of considering the application, I have to request that you will be good enough to supply the Government with information on the following points:—

1. Is the Preservation Inlet Coal Company registered?
2. If so, what is its nominal capital and proposed number of shares, and how much has been paid up?
3. If not, of whom does the Company consist?
4. What amount has been already expended, and what work has been done to represent such expenditure?
5. A statement as to what the property consists of, its tenure, extent, and to whom and by whom a lease, if any, has been granted, and for what term.
6. Whether it is a public reserve under the Act of 1854; and if so, whether it has been Crown granted to the Superintendent, and whether any special conditions are attached to the grant.
7. How far the coal mine has been surveyed, and what is its supposed extent.
8. What length of tramway is projected, and whether any reliable estimate of probable cost of tramway and wharf has been made, and how much of such sum it is intended to ask Government to advance; and any other information of a special character which will enable the Government to arrive at a conclusion, so soon as full particulars may be to hand.

I have, &c.,
Thomas Wm. Maude,
Secretary.

W. O. Ball, Esq.

No. 16.

Dr. Hector to the Under Secretary, Public Works.

Sir,—

Geological Survey Office, Wellington, 19th June, 1872.

I have the honor to enclose Dr. Haast's report on the present condition of the coal mine at Shag Point, and generally on the coal-bearing formation in the N.E. District of the Province of Otago.

I have, &c.,
James Hector.

The Under Secretary for Public Works.

Enclosure in No. 16.

Preliminary Report on the Shag Point Coal Fields, Otago, by Julius Haast, Ph.D., F.R.S.

During the past autumn, at the request of the Director of the Geological Survey, I paid a visit to the Shag Point district, in order to report on the present state of the coal mine which is worked there, and give my opinion on the value of the coal measures, their relations to the limonitic sandstones overlying them unconformably, and with which, in other localities, brown-coal seams are associated; also to institute a comparison between them and beds of similar character in other parts of the Colony with which I am acquainted. I found the beds in question not only of great scientific interest to the geologist, but also of considerable practical value to the Colony, as the following notes, containing some of the principal results of that examination, will readily show.

The Shag Point coal measures are the upper portion of a littoral formation of great thickness, consisting mostly of conglomerates, gritty sandstones, and shales, with seams of pitch coal, deposited on the slopes of the Horse Ranges, running at a distance of about three miles inland, parallel with the coast. This series has a thickness of several thousand feet, and is divided into two portions, of which

the largest one is situated inland, being about seven miles long and on the average two miles broad, containing the older portions of the beds, and not reaching anywhere the sea coast.

The other and smaller portion, containing the uppermost beds of the whole series, is separated from the lower portions by tertiary rocks of younger age, which run for a distance of about one mile from the eastern flanks of Mount Ivitai, along the northern banks of the Shag River to the western flanks of Mount Vulcan, capping that hill on its northern portion to the sea coast. This second portion is about one mile and a half long, and a quarter of a mile broad, and contains the principal coal seams of the whole series.

The lowest beds of the whole formation consist of subangular pieces of micaceous schists, often much decomposed, with occasional beds of small seams of coal 6 to 15 inches thick, of ironstones and ferruginous sandstones. Ascending higher in the series, the conglomerate which in its lowest portion had more the character of local *debris* cemented together, becomes gradually more rounded, and consists now, often almost entirely, of well-rolled pebbles of quartz.

After a thickness of several hundred feet, this conglomerate, which hitherto had almost exclusively formed the ranges, is overlaid by a series of thick-bedded sandstones and shales of a total thickness of about 150 feet, the latter containing a great number of small seams of excellent brown coal, but unfortunately too thin for any practical purpose, the largest one being only about 12 inches thick.

This portion of the formation is well visible, as the strata where they are cut through by the deep ravines descending from the Horse Ranges have given rise to enormous slips, so that the character of the beds is well exposed. I was enabled to follow these strata from the valley of the Shag River to the ranges above Trotter's Creek, where they are hidden below tertiary rocks.

Still advancing higher in the series, the beds of Mount Ivitai are reached, where we meet, between thick beds of conglomerate, layers of white quartzose sands, often very incoherent ,and shales, and amongst the latter a seam of fine pitch coal, with smaller layers of glance coal interstratified, and of a thickness of 3 feet 9 inches; however, as the dip of these beds, which in the lower portion is only inconsiderable, gradually becoming steeper, has now already reached 64 degrees, this seam will therefore be of little use for the extraction of fuel.

The smaller portion of the series, separated from the larger one by a belt of tertiary rocks, consists first of thick beds of conglomerates, mostly well-rounded pebbles of quartz, overlaid by shales and thick-bedded coarse sandstones, still standing at a high angle (62°); continuing to follow them down the Shag River for half a mile, the strata which hitherto had principally again been conglomerates becomes gradually less steep, dipping 49°, and consists now of shales with small seams of coal and bands of clay-ironstone, containing the same fossil plants as the shales in the coal mine at the Boat Harbour.

Before reaching the mouth of the river, the dip of the strata has diminished to 31°, and we meet here, between the conglomerates, quite a series of coal seams, often interstratified with them, and of which five workable seams of a thickness of at least 20 feet are exposed. These latter beds are covered by sandstones and conglomerates, by which the precipitous sea coast near the mouth of the river is formed.

In following the Coast in a northerly direction, we observe that the strata have an anticlinal arrangement, the coal seams having been greatly destroyed by slips and denudations, the beds immediately below them forming the coast line until we reach the so-called Boat Harbour, where the larger seams appear again just above high watermark, covered uncomformably by tertiary beds. It is here where years ago a coal mine for the extraction of an excellent brown coal (pitch coal) has been opened, which at present is worked by Mr. J. C. Rowley, of Heathfields, who raises about 250 tons per month, sold at 15s. per ton at the pit's mouth.

The following beds have been exposed in the coal mine in a descending order:—

Shales.	Feet.	in.	
Pitch Coal	3	10	Dip, 16° towards N.E.
Shales	4	4	
Pitch Coal	1	4	
Fireclay	0	6	
Main Seam Pitch Coal at present only works	8	0	
Shale	0	0	

It will be seen from this list that there is at least one more workable seam which hitherto has not been worked, and which is situated above the seam at present mined.

The coal mine is situated mostly below high watermark, and is worked on the Scotch Pillar and Stall system, 8 feet being left and 14 feet taken. It is approached by a main drive (horse road) 7 feet high and 6 feet wide, dipping about 3°; the water being collected at the end in a well, and brought out in an iron chest containing about half a ton, on the average, eleven times a day. This new or main drive runs 7 chains 12 links to this well, whilst some of the older or high-level drives which are connected with the former by well-secured cross drives have been advanced nearly 9 chains.

The whole portion of the new mine is all in good working order, well secured, and ventilated by an air shaft 5 chains from the entrance of the mine. In the present mine there are thus two seams available of 4 and 8 feet, together 12 feet; whilst it appears, from my examinations in other localities, that besides minor ones, another seam of about 7 feet will be found below these two seams; thus offering about 19 feet of coal in three workable seams; but taking only 15 feet of coal as available, and over an area of seventy acres, which, as I shall show in my final report, is only a moderate estimate, this would give us about 1,600,000 tons of coal, which, in order to allow for possible disturbances or other causes by which this quantity of coal might be diminished, reduced by more than one-third, would still leave us at least one million of tons of workable coal.

The Age.

This formation, which in its characteristic feature resembles greatly the conglomerate beds of the Malvern Hills, seems to be, if not altogether devoid of the remains of animal life, exceedingly poor in

them, as I could not find the least traces, notwithstanding the most careful search; but the shales, ironstones, and sandstones, principally those in the uppermost portions of the whole series, are sometimes full of the exuviæ of plants, consisting mostly of dicotyledonous leaves of ferns and coniferæ. Of the latter, the principal specimens consisting of leaves and twigs belong to a pine, without doubt closely allied to Dammara, and which has also been found in the septaria of the Waipara, thus indicating that both formations, in other respects so dissimilar, belong to the same geological horizon.

This formation is overlaid unconformably by a series of conglomerates and ferruginous (limonitic) sandstones, which in this part of the country do (as far as I could ascertain) not contain any workable coal seams; whilst more to the north, in the Otepopo district, and lying directly upon the micaceous schists, a seam of brown coal of fair quality occurs, about 5 feet thick, and which is at present worked. Owing to the fact that this coal mine lies about 800 feet above the level of the sea, only accessible by a steep road, and the beds of limited extent only, these deposits are not of practical value at present, except for local purposes.

I may also here observe that in several localities the lowest beds of this younger or limonitic sandstone formation, upon which the Moeraki Septaria bed reposes, the former consisting of a quartz conglomerate, with a very ferruginous matrix, is so auriferous near the contact with the underlying beds, that in some places adits have been driven into the hill side for the extraction of the rock; the stuff thus gained, being broken up with hammers and washed, giving fair wages to the miner.

Practical Suggestions.

The great drawback to the development of the Shag Point Mine, to take the coal seawards, is the existence of a rock midway in the entrance of the small cove adjoining the mine, generally called the Boat Harbour. If it were found to be practicable to have this rock removed, coasting vessels of fair size could come close alongside the mine, and be loaded from the coal trucks. Hitherto vessels loading here have to stand outside, and a boat, carrying several tons of coal in bags has to go backwards and forwards in order to load them, by which process, besides the loss of time, the price of the coal is materially raised.

Moreover, the present possessor of the mine—Mr. J. C. Rowley—has the intention, if the rock in question were removed, to run a steamer of about 50 tons burthen to and from Dunedin, and sell the coal for about 15s. per ton in that city, by which a great boon would be conferred on the inhabitants of that portion of New Zealand, and at the same time make the establishment of many industries possible which hitherto, owing to the high price of coal, could not be begun. Such a steamer, trading regularly between Shag Point, Boat Harbour, and Dunedin, would also transport passengers and goods in both directions, and thus foster commerce and agriculture.

If, therefore, the locality were examined by a Marine Engineer, in order to see if the rock could easily be removed without destroying the value of that small harbour, a great boon would be conferred upon the district.

However, there is still another way of bringing the Shag Point coal into more universal use, by constructing a tramway or light railway to the Moeraki Harbour, and shipping the coal from thence; and by connecting that rail or tramway with another line running through the saddle between Mount Ivitai and Mount Vulcan as far as Palmerston, the fertile and rising district surrounding that township would be brought into easy and regular communication with Moeraki, a harbour which presents so many facilities for shipping.

JULIUS HAAST.

Christchurch, 12th June, 1872.

APPENDIX.

AUCKLAND.

Dr. Hector to the Under Secretary, Public Works.

(No. 74-72.)

Sir,— Geological Survey Office, Wellington, 4th July, 1872.

I have the honor, in reply to your reference made during my absence, to afford the following information respecting the occurrence of coal seams in the Wangaroa and Mongonui districts.

Having examined the district in 1866, I am able to speak from personal knowledge on the subject, and perhaps the notes I made will be sufficient to guide the local explorers for coal until a more definite survey of the district has been made, which will be at as early a date as the other calls on the Department will permit.

Wangaroa Harbour.

This is a deep, land-locked harbour, surrounded by bold, almost precipitous, cliffs of volcanic rock, trachytes, and trachytic agglomerate. These rocks rest on tufaceous sandstones and conglomerates, with beds of fine smooth-grained mudstone, containing fossil leaves of very recent-looking character, comprising dicotyledonous plants and ferns, among the latter being a *Pteris* that closely resembles the common bracken, still growing on the hills. These plant-beds are well displayed in the cliffs, at the base of St. Peter's, a dome-shaped hill 500 feet high, on the north side of the harbour, and opposite to which is a similarly-formed hill called St. Paul's. The above strata have a general dip at a low angle E. and N.E.

At the head of the harbour the cliffs recede, and there is a large extent of low land, with mud flats covered with mangroves. In the low promontory round this part of the harbour a totally different formation is exposed, consisting of green sandstones, grit, and sandy shales, containing mica, vegetable remains, and small irregular seams of coal of fair quality. The thickest seam is only 2 ft., and cannot be traced far. It is exposed in a mud flat beneath the high watermark, and dips to N.W. at 27°. On the adjacent shore, a hole was sunk 12 ft. from the line of the outcrop, and cut the coal again at a depth of 6 ft.; but three other shafts 9 ft., 15 ft., and 27 ft., in good situations, failed to strike the coal, only alum shales, with carbonaceons markings, being found. Over these beds are sandy clays, with nodules of calcareous ironstone, containing a few casts of fossil shells. In the Kaiou Creek, which enters the harbour from the south, a tough gray clay marl, with irregular ferruginous partings, is to be seen in the road cuttings for several miles, and is probably an upper member of this older series of rocks, which I suppose to be the equivalent of the coal formation at Kawa Kawa and Whangarei.

Subsequently to my visit, a thick coal seam was found, associated with green sandstone, in the upper part of this valley, but I am not aware of the precise locality. Specimens were however forwarded for analysis by Mr. H. Williams. The external appearance of this coal, and especially its bright, lustrous fracture, resembles that of the Grey River coal, but from its composition it is much inferior to either that coal or the Kawa Kawa coal in useful qualities. It is hydrous pitch coal, compact, with very irregular cleavage, and a dark brown powder and glistening streak. It burns freely, containing 84·60 per cent. of combustible matter, the rest being water and a very small quantity of ash. It has not been received in sufficient quantity to test practically its efficiency as a steam generator, but its theoretical evaporating power is 6·5, that of the Kawa Kawa coal being 6·8, while that of the Newcastle coal and the Grey River coal is about 8·0. Its specific gravity, upon which depends the comparative space it will occupy in bunkers of a steamer, is quite as good as that of the Kawa Kawa coal, one ton occupying 1·018 cubic yards. It is a non-caking coal, and in this respect, and in the rather large percentage of water it contains, it resembles common brown coals. It yields half its weight of bright, glistening coke, with a fair amount of gas, but rather less in quantity and of feebler illuminating power than the Kawa Kawa coal, to which it is however superior in respect to the small quantity of sulphur it contains.

Excepting in the low ground at the head of the Wangaroa Harbour and in the tributary valleys, the coal series was not observed, the rest of the district consisting of broken ridges, and shallow swampy valleys in the upper volcanic rocks; and no formation was detected between this place and Mongonui except the volcanic rocks and the Palæozoic, which form the framework of the district, and on the hills give rise to a stiff clay soil, generally known as Kauri land.

Mongonui.

The rocks round Mongonui Harbour belong partly to this formation and in part to the volcanic series; but on crossing to the west several interesting formations are exposed along the coast, some containing carbonaceous beds.

Greenstone slates extend for one-third of a mile in this direction, and are succeeded by a tertiary deposit of brown, yellow, and dark blue clays covered with sandstone, passing in places into a pebble conglomerate. In Cooper's Bay, at the level of the beach, the lower beds of the formation, which is 200 feet thick, were found to contain fossil leaves similar to those now existing, and fruits like that of the mangrove; also masses of lignite, but no defined beds.

In one place, the lignite has at some time or other been on fire, and parts of it converted into a bituminous mineral resembling very much a mineral obtained on the Chatham Islands, that has been formed under similar circumstances.

The section of the formation which extends across Cooper's Bay and for a few miles inland on the tops of the hills is as follows:—

	Feet.
White indurated clay	30
Sandstone	20
Conglomerate	20
Sandy clay	40
Blue clay with ironstone bands	30
Sandy clay with carbonaceous markings and lignite layers	20
Lignite	4 to 6
Gray laminated clay	8
Conglomerate	20
Slates	

This formation is of comparatively recent origin, and cannot be expected to yield any valuable mineral fuel; but five miles to the westward an older series is exposed, which appears to belong to the coal-bearing formation of the Northern District. On the west side of the Autere River, gray micaceous sandstones in thin flaggy beds occur, with plant-remains overlaid by pebble conglomerate and clay shales, which inland pass into impure limestones.

No coal seams were observed in the lower part of the series, where they might be expected; but in 1865 I received a specimen of bituminous or oil shale from the Rev. Richard Taylor, which he stated was found at the place. This shale was fully described in a previous report (New Zealand Coal Reports, 1865, p. 45), from which the following is an extract:—

From the composition of this mineral it will be seen that it approaches closely to the famous Torbanehill oil-shale in character, to which it also bears a considerable external resemblance, with the exception of being rather darker and more resinous in lustre. Its properties are as follows: Very coherent, close grained, hard and tough, almost elastic; does not show the slightest indication of laminæ or cleavage planes, having a smooth semi-conchoidal fracture in every direction.

What appears to be the exterior portion of the stratum is of a yellow colour, while the rest is of a dull black colour, and perfectly homogeneous in every part. It is exceedingly difficult to pulverize this mineral; but when a moderately-fine powder is obtained, it has a very decided brown or chocolate colour. Its specific gravity is 1·112. It ignites with ease, and bursts into a flame which is sustained for a long time with great vigour. The flame is at first very luminous and bright, but soon becomes long and smoky, and during combustion small oil-bubbles may be seen escaping.

The presence of oil to a large extent among the volatile matters, escaping at comparatively low temperatures, is best observed by heating the substance in a partially-closed test-tube to a temperature of 400° Fahr., after previously drying it at 212°. The oil is then seen to condense upon the cooler portion of the tube in considerable quantity; and when finally removed to a cold place, a large portion of the oily matters solidify to a white substance, probably paraffine.

When heated to a dull red heat in a closed crucible till no more gaseous matters are evolved, there remains about 23·00 per cent. of light, non-coherent, cellular, and slightly lustrous coke, and this in the open fire was found to burn readily to a perfectly white ash.

The chemical composition of this coal is as follows:—

Volatile matter	75·20
Carbon in coke	9·30
Hygroscopic water	1·80
Ash	13·70
Sulphur	Traces.
	100·00
Relative percentage of volatile matter	88·99
Relative percentage of fixed carbon	11·01
	100·00

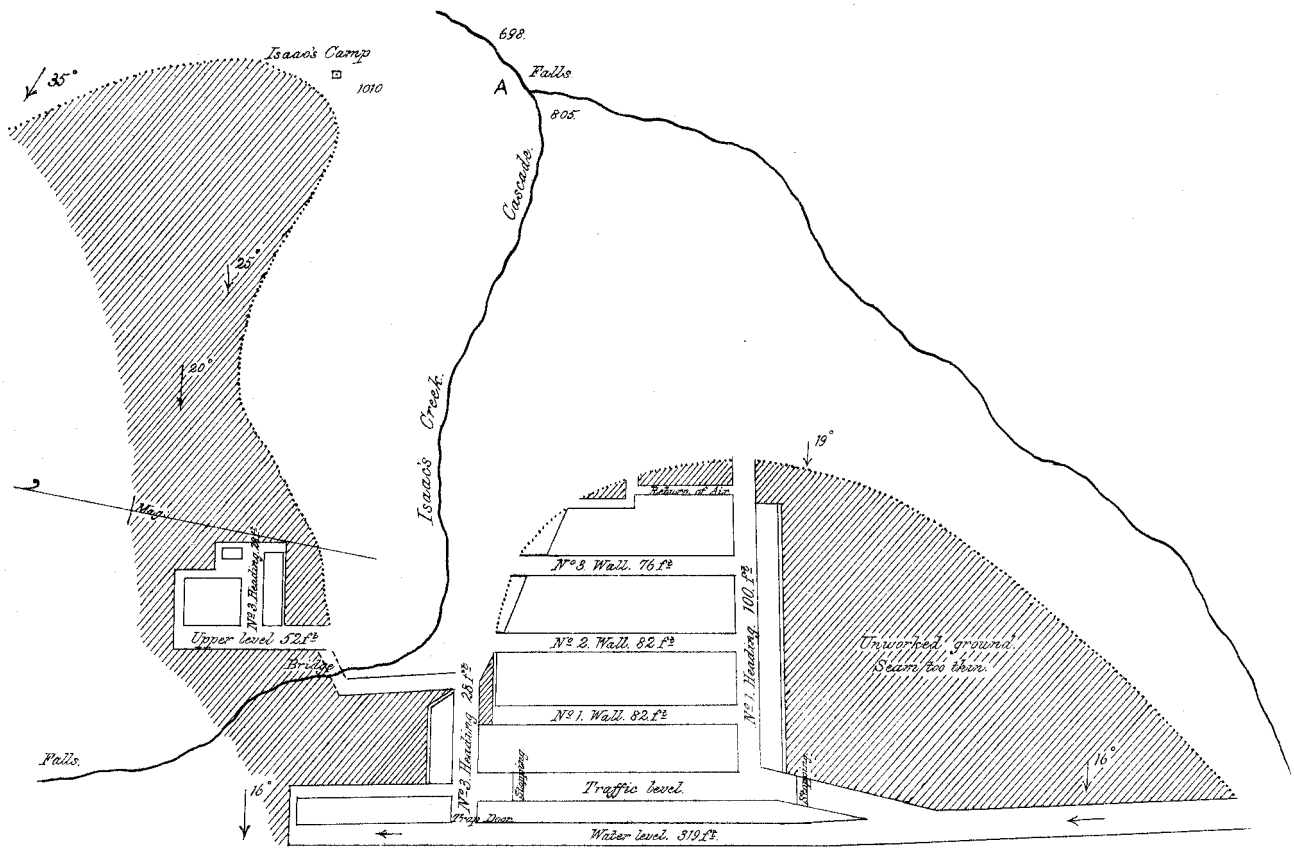
I have never heard of any other samples of this interesting form of coal being found either in the Mongonui district or in other parts of New Zealand.

At Ohora Harbour, which is twenty miles to the north of Mongonui, the western side of the bluff hill known as Mount Camel is also composed of gray sandstone and shales, in which no carbonaceous layers were observed, though silicified wood occurs on the surface of the ground.

At Parengarenga and near the North Cape there is another exposure of the same sandstone, shales, and conglomerates, covering an area of several square miles. At the point on the north side of the entrance to the harbour, the formation is seen to dip to the S.S.W. The base of the formation is not seen, the lowest beds being green sandstone, containing seams of semi-bituminous coal of limited extent. From one of these about two tons of coal had been extracted, but there was no deposit of any importance to be found at the place. The greensands are covered by conglomerates, which form the sea-cliffs, in which are blocks of silicified wood of a black colour, and also particles of coal.

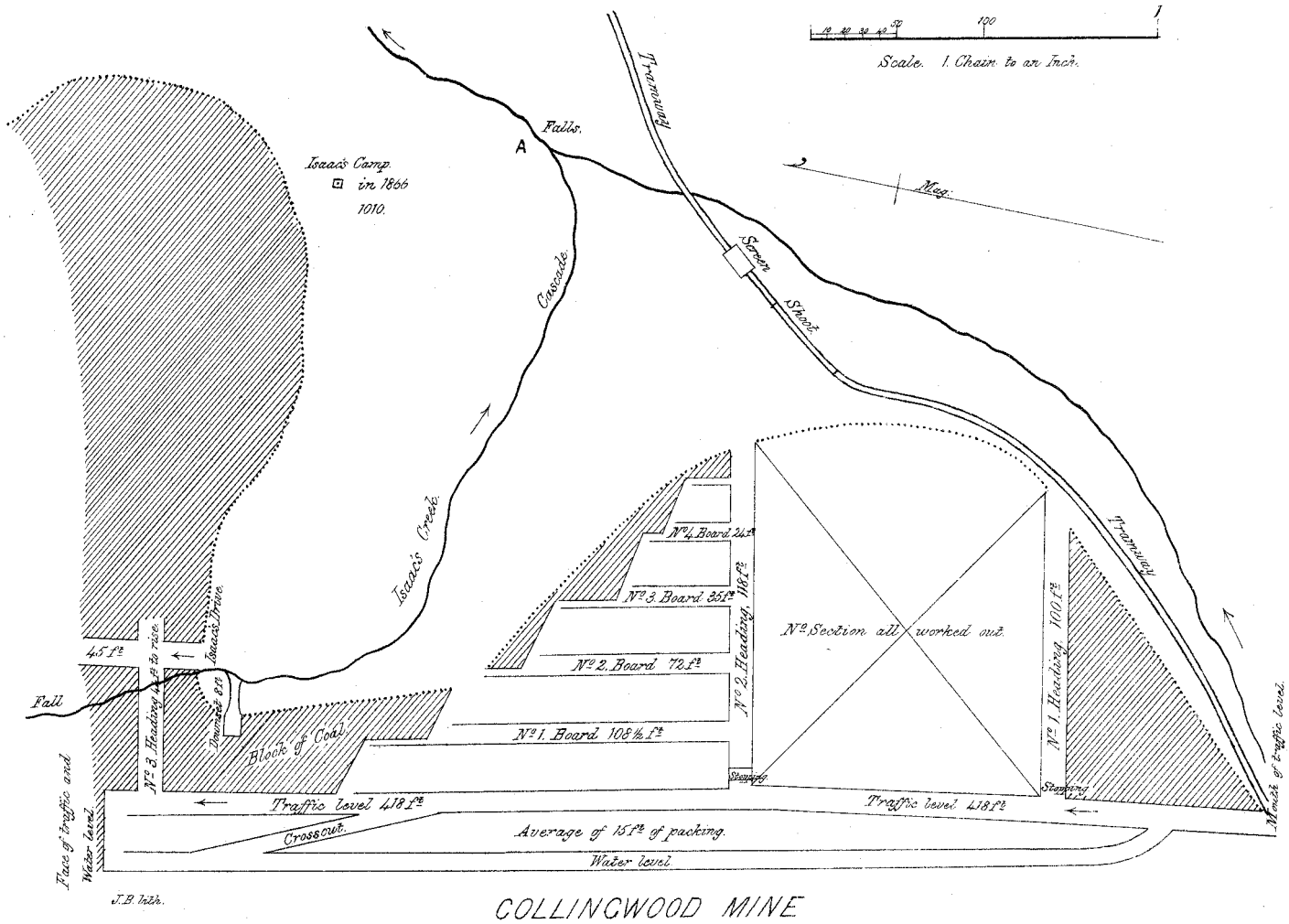
The harbour is bounded by terrace flats and low hills, in which, and in the sea-cliffs to the north, the following section was observed:—

1. At base, greensands with ferruginous bands, showing in the summit of an anticline that runs W.N.W.
2. On this, towards the west, rest greensands, dip 12° to S.W.—20 ft.
3. Fine-grained conglomerate—20 ft.
4. Green sandstone, with a foot of coal—40 ft.
5. Red sandstone, with pebble beds—40 ft.
6. Greensands, with ironstone nodules, containing kernels of white clay—50 ft.
7. Shale, with masses of coal and conglomerate bands—50 ft.
8. Finely laminated greensand—40 ft.



COLLINGWOOD MINE

Workings in lower Seam.



COLLINGWOOD MINE

Workings in upper Seam.

9. Green sandy shale with flat cement stones, containing plant impressions; bedding very regular, but the strata are cut by joints lined with calcareous spar and ironstone—80 ft.

10. Conglomerate—10 ft.

11. Nodular sandstone.

Resting unconformably on the above are calcareous shales and marlstones.

Parengarenga Harbour is only suitable for vessels of small size, the depth of water on the bar being only a few feet.

The foregoing notes were made in the course of a general and cursory examination of the district for a few days in January 1866, and sufficiently prove that there is a considerable development of coal in the district north of the Bay of Islands. I was not successful in getting perfect fossils, and therefore cannot express a decided opinion as to the age of the formation in question; but in the geological map of the district I have placed it provisionally in the same group with the Kawa Kawa coal.

The only recommendation I at present feel able to make is, that the coal up the Kaiou Creek should be opened out and traced on the surface if possible, so that, its true direction being ascertained, it may be sought for at the most convenient place to the deep water. Boring should not be resorted to until it is very clearly established that the coal may be expected to occur in the particular locality selected. This course was previously recommended to the persons locally interested, but I have never heard of the result.

The existence of valuable coal near Mongonui at present rests on the evidence afforded by the occurrence of carbonaceous sandstone near the Autere River, and the single specimen obtained by the Rev. Richard Taylor, as I do not consider that the lignite deposit at Cooper's Beach and close to Mongonui would answer for steamers.

A rough sketch of the district is enclosed, showing the position of the localities alluded to, excepting Parengarenga, and representing approximately the general distribution of the geological formations.*

I have, &c.,

The Under Secretary for Public Works, Wellington. JAMES HECTOR.

NEL ON.

Dr. HECTOR to the UNDER COLONIAL SECRETARY.

SIR,— Geological Survey Office, Wellington, 29th June, 1872.

I have the honor, in reply to your reference of 12th January,† to make the following report on the Collingwood Mine, in the Province of Nelson, which I had no opportunity of examining till 30th May last.

This mine is situated in the Pakawau Coal Field, the general characters of which are described in a previous report (Geological Report, 1867, p. 19), made when the coal seam had been only recently discovered, and no mine had been opened. A description of the state of the mine last year was given by Captain Hutton (Geological Reports, 1871, p. 157).

To reach the mine, the river is ascended in a boat for half a mile to a point where wharves have been built, and where vessels of small size can load. From this point to the foot of the hills, a distance of one mile and a quarter, a wooden tramway has been laid through a bush flat, a good deal of iron rail being used near the river. The hill is then ascended by an incline at an average angle of 33°, but in parts even steeper, the length of the incline being 1,300 feet, and the vertical rise 600 feet. The rails on the incline are made of wood, the line being double, and there being also a double length of wire rope, which appears rather unnecessary, as the incline is worked with a single drum and powerful break.

From the top of the incline, a side-hill cutting leads up a valley for about a mile to where it strikes the creek at the top of a vertical fall of 107 feet. The coal is here received into the waggons from screens, to which it is sent down from the mine by a steeply-set box-shoot, the difference in level between the mine and the screens being 80 feet. Narrow iron tramways are laid down from the different levels in the mine to the shoot.

The mine consists of workings in two seams of coal, which have been opened out at the lowest level at which they can be cut in the bed of the creek, and from there excavated to the outcrop on the brow of the spur for a distance of two chains. The workings extend on the strike of the seams for about five chains, and are then cut off by another branch called Isaac's Creek. The whole of the available coal in the block between the two creeks has now been worked out, as shown on the attached plan of the workings, which is from a rough sketch by the manager, Mr. Marshall.

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* Enlarged geological map of the Northern District of the Auckland Province.—J. HECTOR, 1867.

† NOTE.—The reference alluded to was made on the following Report of the Public Petitions Committee of the House of Representatives, Session 1871.

Report on the Petition of Henry Halcombe.

Petitioner is Henry Halcombe, an elector of Collingwood.

Petitioner states that a certain coal mine at Collingwood has been leased from the Crown by a company, who have expended nearly £4,000 in opening up a tramway and approach to the said mine.

Petitioner prays that the House will reimburse the lessees of the coal mine their aforesaid expenditure, and will give them aid by providing a sufficient supply of skilled miners under the Immigration Act of 1870.

I am directed to report that the Committee are favourably inclined to the proper development of the coal fields of the Colony, but are unable to make any recommendation on petitioner's case, as it involves a question of policy which the Government ought to consider and deal with on some well-defined principles which could be generally applied wherever coal fields can be profitably worked.

THOMAS KELLY,

10th October, 1871. Chairman, Public Petitions Committee.

REFERRED to Dr. Hector for inquiry, to report on capabilities of this mine (at Westport, or elsewhere).—W. GISBORNE, January 12, 1872.

To the north of the present workings there is still a block of untouched coal, from the traffic level, for 4 chains on the rise to the point on the plan marked Isaac's Camp, which is 1,060 feet above the sea level, and at the top of a vertical precipice that rises 316 feet above the foot of the fall. To get at this coal from the present mine, will require the putting in of a drive at a cost of about £150, to pass under the level of the north branch of the creek, at a safe distance to avoid tapping it.

The above-mentioned works have been constructed by a company chiefly consisting of working shareholders; and the accompanying statement, supplied at my request by the legal manager, shows the manner in which the funds have been applied; and I have no hesitation in stating that all the works have hitherto been carried out in a most substantial and yet economical manner, and that they display a very great amount of enterprise. From the account of the receipts and expenditure, it however appears, that no return has hitherto been made on the capital employed, and that the sale of the coal has merely paid working expenses. It is therefore important that in any fresh extension of the mine a more economical system of working it should be adopted.

The supply of coal available by the present method of working being almost exhausted, the first step will be to lay open a fresh area of the seams; and the consideration of how this can be most advantageously effected, requires a statement of the geological conditions under which the coal occurs.

In following up the bed of the stream to the foot of the fall, and also along the incline and tramway cutting up the side of the valley, a section of the rocks which underlie the coal measures is obtained. They consist first of clay schist containing mica and a little quartz, the apparent bedding of which dips at 40° to W.S.W., or into the body of the hill. This is probably not the original stratification of the rock, but rather a foliated structure which has been superinduced; for both in the bed of the creek at 300 feet altitude, and in the tramway cutting about 5 chains from the top of the incline, a bed of blue, red, and white crystalline limestone about 80 feet thick occurs, that appears to be more nearly vertical, but is at the same time traversed by thin layers of mica that have a moderate dip to the west. These mica layers are hardly perceptible in fresh fractured surfaces, but, when the limestone has been weathered, they stand out in high relief, and have complicated contortions like those usual in mica schist.

This limestone is an important feature in the geology of the district, as it can be traced along the eastern face of the hills towards Pakawau, and in several places is associated with graphite shale and talcose slate. Red and blue clay schists, containing mica and quartz, then follow, in the bed of the stream, the section along the tramway being obscured by slipped ground.

The coal measures commence in the tram-cutting 5 chains before reaching the shoots, and the junction is also very well marked by a rock parting stained with iron, which crosses the precipice at the vertical fall, about 40 feet from its base, the lower part consisting of brown mica schist, with an apparent dip of 40° to N.W.

1. The lowest bed of the coal measures, resting on the above, is a blue-gray breccia of angular fragments of schist and slate, together with angular and rounded masses of quartz, the surface on which this breccia rests dipping 30° to W. 10° N.—thickness, 35 ft.

2. Conglomerate of well-rolled quartz, quartzite, and crystalline sandstone, cemented with gray sand—20 ft.

3. Grey sandstone that weathers red and contains patches of fine-grained breccia, of flakes of slate and quartz—50 ft.

4. Tough brown and green argillaceous sandstone and carbonaceous shales, in thick beds, with layers of grits and coal seams, of which six are known. Average strike, N. 15° W., dip from 25° to W., but getting flatter into the hill—250 ft.

The coal seams already discovered in this part of the formation are as follows, in descending order:—

No. 1. Exposed in face of fall on the north branch above Isaac's Drive—coal, 1 ft.

No. 2. Upper seam, which is worked—coal, 2 ft. 5 in. This seam contains a stone band, of variable thickness, the coal below the band being generally the most regular. About one-third of the stuff excavated from the seam has to be rejected.

No. 3. Lower seam worked—coal, 3 ft. Contains a single stone band, which has shown a tendency to thin out towards the S.W. corner of the workings, being from 6 to 16 inches thick.

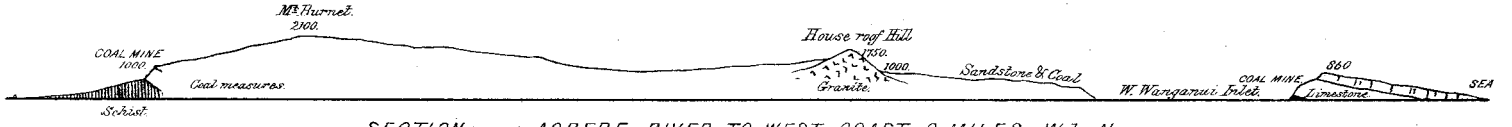
No. 4. Cut in the first drive made in Isaac's Creek—coal, 2 ft. Has a 2-inch stone band. In the first creek, north of Isaac's Camp this seam has 2 ft. 8 in. of clear coal.

No. 5. In the creek below the old workings, but so mixed with stone as to make 2½ ft.—coal, 1 ft.

No. 6. In the waterfall on Isaac's Creek, beside the shoot, 4 ft. thick, but very inferior, not showing more than 6 inches of pure coal. This is the lowest seam, and is about sixty feet from the base of the brown sandstone group.

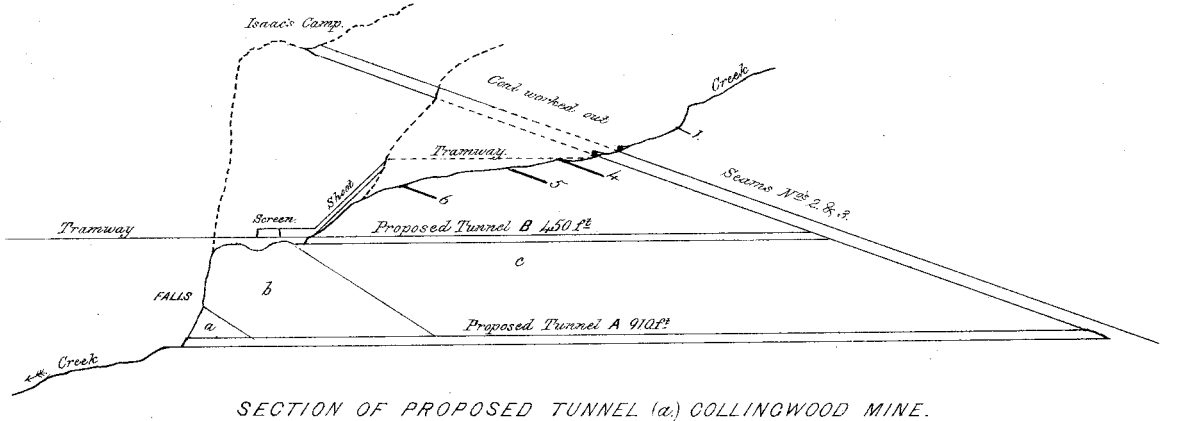
The remainder of the section to the top of the hill has been very imperfectly observed, on account of the thick bush. At 200 feet above the highest coal seam known, I found a light-brown micaceous shale, full of the same fossil leaves which are abundant at Pakawau (dicotyledonous leaves, ferns, &c.); and at a still greater altitude, the bearing being S. 20° E., hard brown carbonaceous sandstone, also with fossil leaves, N. 10° W., dip 35° to W.

It is thus pretty certain that the greater part of the hill above the mine is composed of the sandstones belonging to the coal measures; but Mr. Marshall informed me that on the top of the range, about two miles back, there are blocks of sandy limestone of quite a different kind from that cut in the lower part of the hill, and resembling the fossiliferous limestone on the coast at Wanganui Inlet. Four miles W. by N. from the top of the range above the mine, is the House-roof Hill, a sharp-topped cone which I ascended from West Wanganui Inlet in 1866, and found to be an isolated boss of granite 1,750 feet high, and surrounded to the height of 1,000 feet by sandstones containing thin coal seams, like the uppermost beds above described. The country between House-roof Hill and the top of the range is a slightly depressed plateau (as shown in section), so that the coal measures must either lie tolerably flat, or have small undulations. This has an important bearing on the future works for developing the coal, which I shall have to discuss, as it affords strong evidence that the coal seams will not continue with the high dip which they have at the outcrop. This is also confirmed by the actual workings in the coal, in which both seams at the outcrop dip at 1 in 3 (or 19°), and in the



SECTION —— AORERE RIVER TO WEST COAST 8. MILES, W. by N.

Section, Vert. & Hor. 3000 ft. to the inch.



SECTION OF PROPOSED TUNNEL (a.) COLLINGWOOD MINE.

a. Schist b. Breccia & Conglomerate. c. Sandstones with Coal.

J.B. lith. J. HECTOR.

lowest level at 1 in 3½ (or 16°). The dip is also much steeper where the coal is exposed in the creek north of Isaac's Camp, which is still further to the eastward, for there the same seam dips at 35°, and the strike is changed from N. 10° W. as it is in the mine, to N. 12° E.

Two tunnels were suggested by the late Mr. Burnett (who originally planned out the works for the Company), for the purpose of cutting the coal seam at a lower level than the present workings:

A—From the bottom of the perpendicular fall.

B—From the top of the fall, or nearly the head of the present tramway.

The tunnel selected should be driven at right angles to the strata, and according to the angle of dip would be the length of tunnel required, and their position is shown on section , which is from rough measurements I made with an aneroid in 1866, and therefore only an approximation.

In the case of the lower tunnel A, by taking the dip of the coal at 16°, as observed in the mine, the length to cut seam No. 3, or the lower seam that is worked, would be 970 feet, but if the steeper dip at 25° were taken, about 720 feet. Of this about 100 feet is schist, and 300 feet would be in the breccia, conglomerate, and gray sandstone; after which the lower sandstone with shale partings would be reached, and in this the work would be comparatively easy.

Tunnel B, allowing for the positional advantage it gains by the erosion of the gulley, and calculated on the least dip observed, would have a length of 450 feet, and at the greatest dip a length of 350 feet. In this case the whole of the lower beds would be avoided, and the drives would all be in the upper brown sandstones, or proper coal-bearing beds, and the lowest or No. 6 seam should be cut after driving about 130 feet.

The calculation of the quantity of coal that would be "won" by these drives respectively, may be founded on the experience in the present mine. The total area of the mine is about one acre in extent, from which some 5,000 tons of coal have been obtained, 3,200 tons being the quantity sold by the existing Company, the rest being allowed for former working, waste, and consumption at the works. Rejecting the ground that has been considered unworkable, and taking each seam respectively, we find—

	Tons.
In upper or 2½ feet seam, ground worked ¼ acre	1,050
In lower or 3 feet seam, ground worked ¾ acre	4,440
This gives per acre for upper seam	5,000
„ for lower seam	5,550
Total per acre for both seams	10,550
But as more than half of the ground hitherto opened has been too thin to work, deduct say	5,550
Available per acre	5,000

Taking the dip at 20°, the distance, following the seam from the end of tunnel A to the level of the present working, would be 8 chains, and for tunnel B 3½ chains; so that by excavating the coal by levels for a distance of 5 chains each way from the tunnel, the amount of coal obtained would be—

	Tons.
By tunnel A	40,000
„ B	17,500

To this must be added all the coal that can be extracted from the hill spurs between the creeks, which must be a very considerable amount. I have taken five chains as the length of drives each way merely as an illustration, as, if the mine was found to pay, with a proper system of ventilation, the galleries might be extended to a very great distance.

The only data I could obtain for estimating the probable cost of the tunnels are from the cost of a heading in the lower level that was driven for 90 feet in "dead rock,"—*i.e.*, not in coal. This cost 30s. per foot, and was in the brown gritty sandstone that forms the roof. A main tunnel for carrying the whole traffic of the mine would, however, require to be of much larger size. The excavation of the upper tunnel I should expect to cost less per foot, as it is a shorter distance, and is in better ground.

In order to compare the cost of the two tunnels, I will assume that the upper will cost 50s. and the lower 70s. per foot, in which case the former will require £1,125 and the latter £3,395, or in the proportion of 3 to 1, while the amount of coal won is in the proportion of 2¼ to 1. Or, if the advantage gained by the drive be valued at about 1s. per ton on the coal, it will take 22,000 tons to pay off the cost of the upper tunnel, and 68,000 to pay off the lower.

It is necessary to point out, in the case of the lower tunnel being adopted, an additional expense would be incurred for the remaking of the tramway from the mouth of the tunnel to the incline. How much that would amount to I am unable to say; but as the valley at the level of the fall is narrow and rough, I believe it would be very considerable.

On the other hand, the present tramway and incline, as they stand, will serve for working the mine from the upper tunnel, the only part of the plant now in use which would be rendered useless being the shoot, which is a most objectionable feature in the existing arrangements. But the greatest objection I have to recommending the lower tunnel is founded on the clear indication that the strata dip at a less steep angle as they pass into the hill, and that the distance required to be driven may in that case not only be greatly in excess of the foregoing estimate, but even that the coal may not reach so low as to be cut in the tunnel A.

From the foregoing considerations, I have therefore no doubt that if either tunnel is made, it should be the upper one; and that if mining operations are to be resumed, there is no better plan to be suggested. It may be thought that a good deal of coal should be won by pumping and hauling by an incline from the present workings; but that would add more per ton to the cost of getting the coal out

than the expense of the drive, and would not get rid of the shoot, the use of which, by breaking the coal into dross, greatly reduces its value in the market.

The question of whether thin and irregular seams like those in the mine are worth working, should however be considered before this large additional expenditure is entered on. Seams of pure coal under 2½ feet are worked in many countries, and particularly in Belgium, where few thicker seams occur; but they are free from the stone bands which give so much trouble in the Collingwood Mine. The manager, Mr. Marshall, is inclined to think that there is on the whole an improvement in the purity and thickness of the seams as they dip into the hill, and he is very sanguine that if they were cut at a lower level this would be clearly established, and that it would even pay to work with the present seams if the shoot were done away with, and a greater extent of ground opened, so that more miners could be at work, and thus keep the brakesmen, tramway drivers, and other hands above ground, fully employed.

It is not necessary to allude to the very favourable analyses that have been made of the coal, as there is no doubt of its value for steam, gas, and household purposes; and that it would compete successfully with Newcastle coal on its own merits may be judged from the attached letters furnished, at my request, from persons who have actually tested the coal. I also beg to enclose an abstract of experiments that were made on the comparative value of this coal for steam and gas purposes, which show most satisfactory results. It is not quite so free from ash as the Grey and Buller coal; on the other hand, not being so tender, it bears carriage better. The area of the coal field, the capabilities of which the successful working of the mine will test and direct practical attention to, is about thirty square miles. The position of Collingwood is most favourable, as it is very little out of the track of the steamers, and at very slight expense wharves might be built into deep water, Cape Farewell Spit affording perfect shelter from all heavy seas.

On the ground, therefore, that it may lead to the opening of more extensive mines in the district, I am able to recommend that the present Company should, under proper restrictions, have assistance towards putting in the upper tunnel B.

I have, &c.,
James Hector.

Enclosure No. 1.

Memorandum *re* Collingwood Coal Company for Dr. Hector.

Nelson, New Zealand, 30th May, 1872.

The original capital of the Company was thirty shares of £120 each	£3,600	0	0
Advance made by shareholders (since capital was paid up)	350	0	0
Bonus received from Provincial Government on 3,000 tons at 5s.	750	0	0
	£4,700	0	0

The whole of this sum has been expended in making a road from the river bank to the mine, a distance of three and a half miles through heavy bush, and rising to an elevation of nearly 1,000 feet above the sea-level; laying a substantial wooden tramway; erecting a shoot about 140 feet long; a self-acting brake, to work an incline a quarter of a mile long, and rising 1 in 2; huts for the accommodation of miners; blacksmith's shop, with tools and all appurtenances; trucks for conveyance of coal from mine to wharf; wharf for shipping coal; together with about 20 tons iron, used as rails for underground roads; underground trucks, &c., &c.

The wages paid by the Company, while it was in full work—viz., from March, 1871, to January, 1872, a period of nearly ten months—amounted to £1,940; and cash received for coal sold during the same period, £1,946. The number of men employed during that time, from 15 to 20. Total quantity of coal raised, 3,200 tons.

Early last January the Company received notice from the Provincial Executive that they would not be prepared to pay any further bonus without a special vote from the Council; and just at that time the Company was engaged in carrying through their level in the lower seam, an undertaking calculated to cost from £100 to £150; and the Company, being entirely without funds, was obliged to suspend operations, as the coal was costing every penny that was received for it, leaving no margin for drives, plant, or any contingency whatever.

The directors then thought of increasing their capital by an appeal to the public, for the purpose of putting in a drive at the bottom of the shoot—that is, 140 feet below the present workings—with the double view of getting rid of a shoot that smashed the coal to such a degree that for household purposes militated against its marketable value, and to lay open a larger field of coal; but the almost universal failure of mining speculations in this part of the Province rendered the attempt abortive.

The underground manager, Mr. Marshall, an intelligent, painstaking, and practical man, is satisfied that, if the coal was cut at a lower level, the undertaking could be made to yield a large profit on the outlay.

In what has been done, the Company has achieved one great object—viz., proving the quality of the coal, which, for steam, gas, and household purposes, is unsurpassed by any coal hitherto discovered in New Zealand.

Edward Everett, James Henry, } Directors.
Thomas Webster,
Legal Manager.

Enclosure No. 2.

Mr. Webster to Dr. Hector.

Sir,— Nelson, 17th June, 1872.

In compliance with your request, I beg to enclose a few certificates relative to the quality of the Collingwood coal for steam, gas, and household purposes; also a memorandum from Mr. James Cross, junior, showing the quantity he has shipped to other places. But in addition to that, Messrs. N. Edwards and Co. have sent about 100 tons to the Wairau, and the Wellington Gas Company sent a vessel on their own account, carrying about 40 tons.

It must be remembered that, owing to the Company being entirely without funds, and the difficulty experienced in procuring skilled labour, the output of coal has always been limited, and while the mine was in work the Company could have sold four times the quantity of coal raised.

The Provincial Council has just authorized the Superintendent to advance a sum not exceeding £250, which, with the great advance in the price of Newcastle coal, will enable us to recommence operations in our present level so soon as we can get miners.

I have, &c.,
W. M. Webster,
Legal Manager.

James Hector, Esq., Wellington.

Abstract of Letters furnished by the Legal Manager of the Collingwood Coal Company.

(1.)

Nelson, 17th June, 1872.

Out of the 2,000 tons coal purchased from the Company, I have shipped to Wanganui 350 tons, to Wellington 70 tons, and Wairau 100 tons; and since mining operations have been suspended, I have received from these places orders for at least 600 tons more.

James Cross, junr.

(2.)

Nelson, 17th June, 1872.

According to your request, I beg to state that I have used the Collingwood coal for both household and steam purposes ever since the mine was opened, and consider it far superior to Newcastle or any other coal I have used, more particularly for steam purposes.

W. T. Good.

(3.)

Nelson, 15th June, 1871.

I have used the Collingwood coal for the last eighteen months on board the paddle steamer "Lady Barkly," and, with proper care taken at the pit to free the coals from shale, they generate steam more readily than any coal I have used, and I would prefer them to either Welsh, English, Newcastle, or Grey coal for steam purposes.

Donald Ross,
Engineer, "Lady Barkly" p.s.

(4.)

Lyttelton, 8th December, 1871.

We got seventeen tons of the Collingwood coal, and gave them a fair trial between Nelson and Wellington. They are good steam coal, raise steam very fast, but they are too small for our bars. If they were larger, I would prefer them to most of the Newcastle coal we get.

R. Brock,
Chief Engineer, s.s. "Rangitoto."

(5.)

Wellington, 29th June, 1871.

The "Waihopai" arrived and discharged the coal from your pit. They cost us 3s. 6d. per ton more than New South Wales coals, so I hope they will prove equally superior.

I am now trying them on a large scale, and will inform you of the result. The gas made is no doubt superior in illuminating quality to any coal I have had from New South Wales.

J. Rees George,
Manager, Wellington Gas Company, Limited.

(6.)

Wellington, 10th August, 1871.

The result of the trial of the coal received in "Waihopai" is very satisfactory; the gas made from it is very good, and the quantity given from an average of eight tons was equal to 9,300 feet of gas to the ton. I have used about half the cargo, and shall be prepared to receive another cargo in a week or two. At the previous rate, it costs 4s. per ton more than New South Wales coal; the quantity and quality of the gas is however superior. Mr. Kebbell is trying some experiments in its steaming qualities, which he tells me are satisfactory.

If you could land the coal here at 25s. 6d. or 26s. per ton, I could arrange to receive a regular shipment of at least fifty tons per month, and coal merchants would also be prepared to take a supply at that price.

J. Rees George,
Manager, Wellington Gas Company, Limited.

(7.)

Wellington, 16th August, 1871.

Will you be kind enough to telegraph to me in reply to this, as to when you would be likely to be able to send another cargo.

Your coal is certainly the best I have had for gas purposes, and I am anxious to obtain a regular supply if possible.

J. Rees George,
Manager, Wellington Gas Company, Limited.

(8.)

Nelson Brewery, 17th June, 1872.

With reference to our opinion of the Collingwood coal,—In January, 1871, we wrote to Mr. Cross stating that we preferred it to Newcastle or Grey. Since then till the mine was stopped working, we used no other. We find it answer our purpose better than any coal we have used, and shall be glad to hear of the mine being worked again.

Hooper and Dodson.

(9.)

Nelson Brewery, 16th January, 1871.

In order to give the Collingwood coal a fair test as to its capabilities for our purposes, we tried it last month against our consumption in November of the Grey coals, which we have hitherto found suit us better than the Newcastle, New South Wales.

We find the quantity consumed for a given amount of work is slightly more of the Collingwood than of the Grey coal; being in the proportion of 155 to 147. There is, however, a saving in the cost for a similar amount of work of about 10½ per cent.

We should remark that the Collingwood coals used last month were very inferior to what are now being sent over, and we have therefore every reason to anticipate that the saving will in future be still larger.

Hooper and Dodson.

Abstract Result of Experiments to determine the Comparative Value of Collingwood Coal for Steam and Gas Purposes, made by Messrs. J. Rees George and John Kebbell.

(From "Transactions, New Zealand Institute," vol. iv. pp. 146–152.)

A.—As a Gas Generator.

The results given in the table were ascertained by comparing the illuminating power of the gas burning in a standard Argand burner of fifteen holes, consuming nearly 6 cubic feet per hour, against a standard sperm candle, burning 120 to 125 grains per hour, the power being measured on the graduated scale of a photometer as in use by the Government examiners in London. The pressure of gas, in cases where samples of 112 lbs weight. were tested, was 2·5 inches, or about the same pressure at which the gas is delivered to consumers from the mains; in cases where samples of only 7 lbs. or 10 lbs. were tried, the pressure was 1·4 inch, and this difference of pressure accounts largely for the decreased power of illumination shown in the smaller samples. In the case of the larger samples the illuminating power was ascertained immediately after the gas had passed through the purifiers, before being stored, or subjected to the friction of a long length of pipe; while in the case of the smaller samples it could not be tried until some two or three hours after storage, and passing through a length of, perhaps, 100 feet or more of a small tube. These circumstances combine to make the small samples show a worse result than the larger quantities, as storage and friction rapidly reduce the illuminating power of coal gas.

TABLE SHOWING GAS-PRODUCING QUALITIES OF VARIOUS COALS.

New South Wales Coal.

Date of Test.	Name of Mine.	Weight of Sample tested.	Quantity of Gas produced from sample, in cubic feet.	Quantity of Gas per Ton of Coal, in cubic feet.	Illuminating Power of Gas in standard Candles.	Weight of Coke per Ton of Coal, in lbs.	Remarks.
1871.							
Jan. 30	Australian Agricultural Co.	7 lbs.	27	8,640	13	1,600	
Mar. 17	„ „ „	14 lbs., mixed with ¾ oz. Kauri Gum Dust.	...	...	17	...	
July 26	„ „ „	112 lbs.	505	10,100	17	1,580	Obtained at high temperature, 1,700° or 1,800° Fahr.
Feb. 23	Co-operative Co.	10 lbs.	40·85	9,150	11½	1,680	
July 28	„ „	112 lbs.	500	10,100	16½	1,600	Obtained at high temperature, 1,700° or 1,800° Fahr.
Feb. 23	Old Lambton Co.... ...	7 lbs.	33·4	10,700	6 to 7	1,760	This gas had been stored several days before testing, and in consequence lost largely in illuminating power.

New Zealand Coal.

Date of Test.	Name of Mine.	Weight of Sample tested.	Quantity of Gas produced from sample, in cubic feet.	Quantity of Gas per Ton of Coal, in cubic feet.	Illuminating Power of Gas in standard Candles.	Weight of Coke per Ton of Coal, in lbs.	Remarks.
1871.							
Apr. 30	Grey Coal, Test No. 1 ...	7 lbs.	35·5	11,360	14½	1,590	This is not a guaranteed sample; it was obtained from the s.s. "Luna," and may possibly have other coal mixed.
"	" " Test No. 2 ...	7 lbs.	31·3	10,016			
July 10	Grey Coal (Sample obtained from Brunner Mine by Dr. Hector.)	112 lbs.	550	11,000	20 to 24	1,820	
July 17	Grey Coal, Slack (Sample obtained from Brunner Mine by Dr. Hector.)	112 lbs.	430	...	21 to 25	...	The quantity registered is doubtful.
July 18	" " " (Sample obtained from Brunner Mine by Dr. Hector.)	112 lbs.	510	10,200	Average 22½	2,020	
July 20	" " " (Sample obtained from Brunner Mine by Dr. Hector.)	112 lbs.	550	11,000	Average 22½	1,880	Retorts were at a much greater heat than in the preceding and following examples.
July 24	" " " (Sample obtained from Brunner Mine by Dr. Hector.)	112 lbs.	530	10,600	Average 20	1,800	
Mar. 23	Collingwood Coal (Nelson)	7 lbs.	...	About 5,000	18½ to 19	...	Retort at only a dull red, about 1,000°.
Mar. 31	" " " (3 tests about equal)	7 lbs. each	28·27	9,811	18 to 19	1,280	Illuminating power ascertained after gas had been stored some time, perhaps two or three days.
June 30	Collingwood Coal (Nelson)	tons cwt. 8 4	76,960	9,300 nearly	19	1,780	This gives illuminating power after storage, and as was supplied to consumers.
July 25	" " "	112 lbs.	500	10,000	25 and above	1,500	
July 8	Bay of Islands Coal (Kawa Kawa)	112 lbs.	530	10,600	18 to 19	1,328	
July 17	Mount Somers, Ashburton River, Canterbury	84 lbs.	200	5,300	None	A small quantity of light breeze only left after working off the gas.	

B.—For Steam Purposes.

Mr. Kebbell's trials were made by burning half a ton of coal, and ascertaining the time a stationary engine was kept at work with the consumption of this weight of coal. Care was taken in each case that the height of water in the boiler, the pressure of steam, the work being performed by the engine, and all other circumstances, should in each case present exactly the same conditions when the trials were commenced and completed.

		h.	m.
No. 1.—English steam coal	worked engine	4	25
No. 2.—Newcastle, N.S.W.*	" "	4	39
No. 3.—Collingwood coal, No. 1 trial	" "	4	55
No. 4.—Collingwood coal, No. 2 trial	" "	5	0
No. 5.—Grey River coal	" "	5	5
No. 6.—Bay of Islands, Kawa Kawa Mine*	" "	5	11

No. 1 gave about the same quantity and description of coke as the New South Wales coal.

No. 2 made 114 lbs. of waste on the half-ton.

Nos. 3 and 4. This coal cokes sufficiently to prevent it running through the bars. If the fires are fed regularly, they require no stoking, and the least attention of any coal ever used by Mr. Kebbell. The clinker is similar in quantity and quality to the New South Wales coal.

No. 5, Grey River coal, is a good coking material, and cakes very much in furnaces with a moderate draught, requiring a good deal of attention. The quantity of clinker and waste was so small as not to be worth mentioning.

No. 6, Bay of Islands. This coal made 28 lbs. of clinker, which is injurious to the furnace bars, adhering to them very strongly, and can only be removed by allowing the bars to cool down. If it were not for this fault it would be a good steam coal.

In these trials all the New Zealand coals give a better result than either English or New South Wales coal, in work performed with an equal weight.

For household purposes, all who have tried the Grey River and Collingwood coal prefer them to any coal imported into the Colony, as being cleaner and burning more freely and pleasantly.

All the expirements made and information that I have been able to obtain tend to show that New Zealand possesses superior coal for steam purposes, when worked with stationary engines, at a moderate draught, and for household and gas purposes, to that of New South Wales; but that for steamers' boilers, working at a strong draught, the heavier coals of England and New South Wales have the advantage. It is to be hoped that the further development of the mines will ultimately remove the last named defect.

* Computed from a previous series of experiments, the value of the English coal being taken as the same in both.

CANTERBURY.

Dr. HECTOR to the UNDER SECRETARY, Public Works.

SIR,— Geological Survey Office, Wellington, 6th July, 1872.

I have the honor to enclose a letter from Dr. Haast, informing me that Mr. Hill has succeeded in reaching a 7-foot seam of coal, at a depth of 106 feet, in the shaft which he has sunk on his property in the Malvern Hills. He has also forwarded a sample for analysis, the result of which I now furnish, as it has an important bearing on a report which I furnished on 13th May. The sample proves to be a common brown coal, not a pitch coal, and is exactly similar to that which exists in the church reserve farther down the Selwyn River, and to the coal which has been for many years mined on the Hawkins River by Mr. Jebson. The chief interest in this discovery is the change in the quality of the coal which it discloses, from that previously found in the same close vicinity, which was of very superior quality.

I append for comparison, along with the analysis of the last specimen sent, the composition of the coal from two seams cut in a drive two chains distant, and which I suppose to correspond with the seams marked A and B in Dr. Haast's section. This comparison clearly shows that no rule can be applied in this district as an indication of the value of the coal founded on the age of the formation in which it occurs, or on the depth at which the seam is struck; and that the improvement in quality observed in some seams, is entirely due to the manner in which they have been affected by volcanic rocks subsequent to their deposition.

	A.	B.	C.
Fixed carbon	67·49	53·30	41·22
Gas and oil	17·89	33·97	31·69
Water	2·12	9.98	20·74
Ash	12·50	2·75	6·35
	100·00	100·00	100·00

A is a compact, lustrous coal, quite black, and approaching an anthracite in appearance, and is in contact with volcanic rock.

B is a massive and less friable coal, and of rather duller lustre, except where traversed by laminæ of jet, and was separated by about 8 feet of shales from the overlying volcanic rock.

C, the coal now sent from the newly discovered 7-foot seam, is a dull brown coal, without lustre, and cracks into fragments on exposure to dry air.

The comparative value, for steam purposes, of these coals is as follows:—

A. 8·77 ... B. 6·92 ... C. 4·83

These figures representing the pounds of water which a pound of each coal will evaporate.

The upper seams have, therefore, undergone a process like that of coking; the lowest seam, which is 23 feet below the lava, not having been influenced by it. I therefore anticipate that only portions of the coal in the Upper Selwyn Valley will be found to be of the superior quality, and that a large extent of the seams still remain unaltered; so that the result of Mr. Hill's exploration requires a material diminution of the estimated amount of steam coal in this area, which was stated in the previous report by Dr. Haast, although it is at the same satisfactory to find that the brown coal has considerable extent.

I have, &c.,

The Under Secretary, Public Works, Wellington. JAMES HECTOR.

Enclosure.

Dr. HAAST to Dr. HECTOR.

SIR,— Canterbury Museum, 20th March, 1872.

I have the honor to inform you that Mr. Hill has at last succeeded to master the water in his pit, and has now laid open a fine seam containing 7 feet of coal, of which I have sent you a specimen by the book-post. You will observe that this seam contains a fine pitch coal, in which the altering agency of the dolerite stream has had much less influence than in the seams opened up in the drive. Will you be good enough to have this coal analyzed at your earliest convenience, as Mr. Hill is very anxious to know the result. That gentleman tells me that this coal welds iron very well.

Here are some of the details of his shaft:—

Depth to lava stream,—	Ft.	In.
Clay and shales	58	0
Dolerite stream	26	0
Shales	8	0
Coal, very much altered	0	8
Shale	6	0
A. Coal, less altered	1	6
Shales	3	0
B. Coal, fine pitchstone	1	0
Shale	2	6
C. Seam of pitch coal	7	0
	113	8

I need scarcely say that the results of Mr. Hill's trial-shaft are highly gratifying, and that there is now no doubt that great quantities of coal will be soon available for sale.

I have, &c.,
JULIUS HAAST.

Dr. Hector, F.R.S., Director,
Geological Survey, Wellington.

WESTLAND.

Dr. HECTOR to the UNDER SECRETARY, Public Works.

SIR,— Geological Survey Office, Wellington, 20th June, 1872.

I have the honor to forward correspondence relative to a coal seam which was discovered on the Kanieri River, about miles from Hokitika, in July, 1870.

I have, &c.,
JAMES HECTOR.

Under Secretary, Public Works.

Enclosure No. 1.

Dr. HECTOR to the UNDER COLONIAL SECRETARY.

SIR,— Geological Survey Office, Wellington, 13th December, 1870.

I have the honor to report as follows on the analysis of the specimens of coal from Kanieri, Westland, submitted, together with a plan, sections, and report, by the County Engineer, on the 28th October last, a reply to which has been unavoidably delayed until this date owing to pressure of work.

The information supplied in Mr. O'Connor's report, together with the inspection of the accompanying rock specimens, only enables me to speak with confidence on the following points:—

1. The coal seam undoubtedly belongs to the same formation as that in which the Brunner mine on the Grey River occurs, the associated rocks, which are very characteristic of the formation, being identical.

2. From the direction in which the coal is dipping, viz., S.E., or towards the slate and granite ranges which, I believe, bound the Kanieri Lake, and also from the friable texture of the coal, the seam which has been discovered appears to be in a faulted or locally dislocated portion of the formation, in which case it probably has no great extent.

A very similar dislocated mass of the coal formation is found at the northern limit of the Buller Coal Fields on the Ngakuwau River, and I have not much hope of the new discovery unless the coal is found dipping at a lower angle and in a westerly direction.

It is, however, extremely encouraging to find that the coal formation extends so far to the South of its hitherto known limits, as it affords good ground for believing in the continuation of the coal field under the fossiliferous blue clay formation that forms the base of the terraced country lying between the mountains and the sea coast.

The sample sent shows the coal to be massive, with irregular laminated cleavage, exceeding friable, colour black in mass but brown in powder.

Notwithstanding the large percentage of ash which it contains, it cokes well and cakes strongly in the crucible. The colour of the ash is white.

Three separate specimens were analyzed, the first having been sent by Mr. Bloxham in July last, on the first discovery of the seam.

The following is their composition as determined:—

	I.	II.	III.
Water	·86	·29	·40
Fixed carbon	58·69	48·97	44·80
Hydro-carbon	19·34	39·92	36·40
Ash	21·11	10·82	18·40
	100·00	100·00	100·00

No. I. is described as being from the original outcrop of the seam, where it was three feet thick, and is rather a highly carbonaceous shale than a true coal; it is therefore a good sign to find that the seam has so improved in quality on being followed under ground for a distance of 116 feet.

The seam is, however, too thin to admit of being profitably worked unless under very favourable circumstances.

I hope to be able to have the locality geologically examined this season, after which I will be able to advise whether steps should be taken to test the field at other points.

I have, &c.,
JAMES HECTOR.

The Under Colonial Secretary.

Enclosure in No. 2.

Mr. G. MUELLER to the Hon. W. REEVES.

(No. 407.)

SIR,— Chief Surveyor's Office, Hokitika, 21st June, 1872.

I have the honor to report that, in accordance with instruction received from the County Chairman, I have examined the locality of the recent coal discoveries in the Kanieri district, and I beg now to submit a plan of the coal field and the result of my observations.

Coal in that district was first discovered in Coal Creek, and after the two tunnels marked on the plan "Old Drive" and "Tunnel" respectively were constructed, Mr. C. Y. O'Connor, the then County Engineer, examined and reported upon the discovery. Copies of his report and plan and a number of geological specimens were forwarded to the General Government, and submitted to Dr. Hector for analysis and report. Since that time, prospecting for coal in Coal Creek has been abandoned, and I can therefore present no fresh data concerning the several seams cropping out near that creek. All the information regarding these will be found in Mr. C. Y. O'Connor's report dated 29th September, 1870, and Dr. Hector's report dated 13th December, 1870.

The first indications of coal (detached pieces imbedded in a yellow clay) in Purnell's Creek were found near peg No. 8, and an examination of the upper portion of the creek bed disclosed the existence of several seams running N.E. by N. The Prospecting Company then, for the purpose of thoroughly examining the same, cut a cross trench (A.B.) on the east side of the creek, which resulted in exposing to view eight coal seams, varying in thickness from 6 in. to 6 ft., the three largest being 4 ft., 4 ft. 6 in., and 6 ft. respectively (see section of Prospector's trench).

They next sank a shaft on the top seam (marked "upper shaft") to a depth of 44 ft., descending in the coal seam the whole depth, and proving satisfactorily thereby—what could not be fully ascertained by examination of strata in trench—that the seam descends vertically. Referring to the section of the "upper shaft" you will perceive that the thickness of the coal for the first 37 ft. varies from 4 ft. to 5 ft. 6 in., and that thereafter it increases to a thickness of 8 ft. 6 in. The underlying and covering strata (sandy clay and shale) is cut at east or west side alternately by the perpendicular sides of shaft, showing that, in addition to the upheaval or depression of the whole mass, the coal seams and surrounding strata have been exposed to a very considerable shaking.

The Company next sank the "lower shaft," a section of which is shown on the accompanying map. At the out-crop, the coal seam was found 6 ft. wide, and at a depth of 4 ft. from the surface, the wedge-end of a sandstone reef (?) was struck, which divided the coal seam in two parts, of a thickness of respectively 4 ft. 6 in. and 2 ft. 10 in. As they descended in sinking this shaft, the sandstone formation expanded, until at a depth of 11 ft. it reached a thickness of 2 ft. 6 in. The coal seam of the "lower shaft" has been traced to a considerable distance, and it measures in the bed of Purnell's Creek fully 7 ft. in width.

In Butcher's Creek also, a small seam of coal has been discovered at an elevation of about 1,167 feet above sea-level. It is only 3 inches in thickness, runs in the direction of S. ½ W., and dips towards the east at an angle of 70°.

These are the various seams known up to the present time in the Kanieri District, considering their position, strike, and dip, viz.:—

Seams near Coal Creek	...	Strike, N. by E.	...	Dip, 18° and 33° S.E.
Seams near Purnell's Creek	...	„ N.E. by N.	...	„ 90°, or vertical.
Seams near Butcher's Creek	...	„ N. ½ E.	...	„ 70° E.

and, considering the short distance from one batch of seams to the other,—namely, from Coal Creek seams to Purnell's Creek seams, 27 chains; from Purnell's Creek seams to Butcher's Creek seams, 16 chains,—it must be evident that very considerable local disturbances in that portion of the Kanieri coal measures must have taken place, and the correctness of Dr. Hector's opinion, as noted in his report of 13th December, 1870, that the coal appears to be "in a faulted or locally-dislocated portion of the formation," is fully borne out.

The underlay or floor of the coal seams exposed at Purnell's Creek being on the east side of said seams, proves that the upheaval has taken place from the east towards the west. The undisturbed coal bed should, therefore, be sought between the present workings and the Kanieri Lake, unless it is taken for granted that the eastern boundary of the coal measure is somewhere near Butcher's Creek. The wedge-shaped sandstone dividing the coal in "lower shaft" seems certainly to favour the latter idea; but unless it is proved, by sinking the "lower shaft" to a much greater depth, that the width of this sandstone formation continues to increase considerably, it may fairly be put down as one of those not unfrequent cases met with in known coal measures, where thin layers of such formation are found enclosed in coal seams of considerable thickness.

The Company, in the belief that the undisturbed coal bed is to be found to the west of the shafts, commenced boring in the bed of Purnell's Creek. They went to a depth of 95 feet, and during the entire depth passed through the same sandstone formation which showed at the surface, proving thereby that the strata from the bottom of the prospectors' trench to the bore (near peg No. 8, Purnell's Creek) are in a vertical position, like those about the shafts. It also seems to indicate that the coal seams descend to a very considerable depth—to about 280 feet (if they reach the level of the bottom of bore)—and if so, there is coal in abundance, provided the working of vertical seams of from 6½ feet to 8½ feet can be profitably carried on.

Highly inclined seams of coal (edge coal) are profitably worked elsewhere, and I think means might be devised for profitably working vertical seams of so great a thickness.* This however is a question for engineers to consider, and I shall therefore content myself with simply pointing out the facilities of approaching the coal seams at a great depth by way of a tunnel. Peg No. 8, near the bore in Purnell's Creek, is 160 feet lower than the mouth of the "upper shaft," and about 220 feet lower than the top of the hill. Provided the coal seam of the "lower shaft" continues in the same direction, and this can be easily ascertained by tracing the same on the surface, a tunnel run from peg No. 8, at a bearing of 118° magnetic, should intersect the vertical coal seams of the Prospectors' trench at a depth of at least 200 feet below the surface, that of the lower shaft at a distance of about 425 feet from the mouth of tunnel, and the seam of the upper shaft at about 510 feet. The latter seam, as already stated, reaches the width of 8½ feet, at a depth of 37 feet from the surface.

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* An unlimited supply of the most suitable timber for mining purposes, for props, &c., can be had on the spot. Pine trees of 3 feet diameter and above, abound in that locality.

There would be no difficulty in constructing a tramway from the mouth of the tunnel to the Kanieri Township. Its length would be about nine miles, and the cost of construction £300 per mile, according to Mr. O'Connor's estimate.

Together with report and plans, a box containing specimens of various strata will be forwarded to you. The numbers I have given these specimens correspond with the numbers on the plan, indicating the localities from whence they were taken. To facilitate classification I affix the following list:—

Specimens marked 1, 1*a*, 2, to 41, came out of prospectors' trench,
Specimens marked 42 to 46 came out of lower shaft.
Specimens marked 47 and 48 came out of upper shaft.
Specimens marked 49 came out of bore in Purnell's Creek.
Specimens marked 50 came out of upper shaft.
Specimens marked A and B came out of Butcher's Creek coal seam.
Specimens marked C came out of upper shaft.
Specimens marked D came out of lower shaft.

Many of the specimens have suffered during carriage, more especially the coals, which are all of a very friable nature.

I have &c.,
GERHARD MUELLER,
Chief Surveyor, Westland.

The Hon. the Minister for Public Works,
Middle Island, N.Z.

OTAGO.

Dr. HECTOR to the UNDER SECRETARY, Public Works.

(No. 72.)

SIR,— Geological Survey Office, Wellington, 9th July, 1872.

In order to render more complete the reports on the coal mines of the Colony, which have been prepared for the information of the Minister for Public Works, I have the honor to forward a short account of coal fields which will be rendered available by the Otago South Trunk Railway from Dunedin to the Clutha River.

I should explain that much of this information has already been published in papers presented to the Provincial Government of Otago, 1864, and in other official reports.

The coal deposits referred to may be described as in two distinct areas,—

1. The Clutha and Tokomairiro Field.
2. The Green Island and Saddle Hill Field.

The first of these occupies an area of twenty square miles on the East Coast, north of the Clutha River. The formation consists of conglomerates, sandstones, and clay shales, with several seams of coal. These strata form a range of hills, 700 feet high, between the Kaitangata Lake and the sea coast, and dropping in altitude to the north, again rise and flank the south-east side of the Mount Misery range, which is composed of the upper schistose rocks. The chief coal seams are at the south end of the above area, and a very clear section of this part of the formation is exposed in the sea cliff between the north end of the sand spit of the Clutha River and Coal Point, a distance of nearly three miles.

This cliff bounds a terrace 70 feet above the sea level, and extending for half a mile back to the base of the hills. The coal measures are exposed in the lower 10 to 20 feet of this cliff, and also in the bottom of ravines that intersect the terrace, the upper part of which is composed of horizontally stratified ferruginous sands, clays, and gravel beds, finely laminated and false bedded. No fossils were seen in this deposit, but it contained nodules of impure siliceous ironstone, that yield traces of phosphoric acid. These sand beds, which are probably of the same age as the gold drifts of the interior, rest on a very uneven surface of the coal measures which form the lower part of the cliff, consisting of alternating beds of conglomerate, sandstone, shale, and fire-clay, all containing more or less carbonaceous matter, and having a general dip of 7° to 12° to the east, but at several places faulted, so that for a short distance the dip is in the opposite direction.

Section I. shows the manner in which the strata are exposed in the cliff, the following being an estimate of the thickness of the various beds:—

A. Ferruginous sands and clays in horizontal beds, 40 feet to 50 feet thick.
B. Coal measures, dip, E.N.E.

	Feet.
1. Gravel grit	6
2. Sandstone	30
3. Laminated clay, with dicotyledonous leaves	30
4. Double fault, filled with clay of a bright blue colour (1 foot wide)	
5. False-bedded sandstones	10
6. Quartzose gravel	23
7. COAL (A) (Coal Point seam)	20
8. Carbonaceous shale	?
9. Grit	?
(Here the dip changes to S.W., with an obscure fault.)	
10. Clay slate	15
11. Quartz grit	2
12. Brown sandstone	10
13. Impure coal and fine clay	10
14. Soft blue clay, with ironstone septaria	6
15. Quartzose grit	
(The dip changes to E.S.E.)	
16. Gravel grit	10
17. Mullock	4
18. Fire-clay	4
19. Shale	6
20. COAL	6
21. Fire-clay	3
22. Gravel, with carbonaceous streaks	6
23. Impure fire-clay	4
24. Finely-laminated sandy clays, with carbonaceous streaks	16

25. Patch of quartzose gravel, with iron pyrites resting on coal (thins to 3 feet against dip) 4
26. Carbonaceous clay 10
27. Sandy clay, with pebbles interspersed ... 30
28. Conglomerate of slate pebbles, irregularly stratified 6
29. Grit, coloured bright yellow, with efflorescence 12
30. Carbonaceous shale 6
31. Coal 5
32. Carbonaceous clay 15
33. Yellow and gray clay, with gravel beds and carbonaceous shale 15
34. Grit and pebbly conglomerate ... 30
(A few chains are here obscured by a more recent formation than even the upper sands, consisting of sand and drifted wood passing into lignite.)
35. Red clay 4
36. Coal and fire-clay 5
37. Fine pipeclay 4
38. False roof of gravel stone 1
39. Coal (M) (Coal Mine seam) 18
40. Carbonaceous shale 3
41. Pipeclay 1
42. Gravel stone, with grit and stems of trees 60
43. Coal 2
44. Fire-clay 1
45. This rests on a conglomerate of green schist, pebbles, smooth and oval, of various sizes, to 6 inches in diameter, cemented by green and gray sand, containing magnetic iron sand and glauconite, which continues to the Spit. Bedding decided to E.S.E., 15 deg. This conglomerate is cut by veins of calc spar, a few lines in thickness, that pass N. and S. right through pebbles and cement.

There are, therefore, in the above distance, four seams of clean, workable coal exposed in the section, giving a total thickness of 38 feet; but in some cases the same seams are probably repeated by faults.

The coal seams are apparently very regular, and generally have a roof of tough shale. In only a few cases, however, they rest on fire-clay, as more frequently the floor is of fine-grained conglomerate.

The principal seam, marked M, is 18 feet in thickness, resting on a white pipeclay and roofed by a dull, carbonaceous clay shale. The lower part of this seam is very black and compact, and contains the largest percentage of water and ash. Towards the top of the seam the coal acquires a more laminated character, and the brown, amorphous coal alternates with thin laminæ of jet. No fragments of wood or traces of unaltered tissue can be observed in this coal; but in the shales above, leaves and stems of plants are of frequent occurrence, perfectly fossilized, but in a fragmentary condition.

The seam marked A is that which forms Coal Point. Only the upper part is exposed in the cliff, but it is probably 20 feet thick, as it forms a reef which extends to the seaward, and is exposed for several hundred yards at low water. The coal is variable in quality, but, on the whole, is similar to that in the seam at the mine, and might possibly be the same seam repeated.

Beyond Coal Point there is a change in the formation, on the coast, for a few chains, to blue, laminated clay, with fossil leaves, which are overlaid by gray sandstone. Northward of this only more recent formations are seen; a sandy limestone, with upper tertiary marine shells, occurring at one place five miles from Coal Point.

The first mine in this district was opened in 1858, in the 18-ft. seam marked M, and for some years was vigorously worked, a large quantity of coal being extracted at first by a wide irregular drive from the sea beach, but afterwards by an incline from the bottom of a gully, up which the coal was hauled to the level of the terrace, along which an iron tramway was laid for three-fourths of a mile to the Clutha River, to the level of which the coal was again lowered by an incline to the shipping wharf.

In 1864 a seam was opened in a more convenient position close to the river, and two miles north in a straight line from the old mine, and on the west side of the Kaitangata Range. The seams found here appear to correspond with those in the coast section, but the strata dip to the N.W. at 5° to 7°, which indicates that the intervening hill is an anticlinal arch. From the Kaitangata Range the hills drop in altitude to the north, and are less rugged for about six miles to where the conglomerates flank the east side of Mount Misery, and again rise to about 750 feet, resting on the schist rocks. The coal crops out in several gullies in this part of the range, and in the valley of the Tokomairiro an 8-ft. seam dipping to the N.E. was worked at an elevation of 600 feet above the sea level. The upper part of this seam, of which about 3,000 tons had been excavated as early as 1862, is soft and of dull brown colour; the lower half of the seam has a resinous lustre, and burns freely. The coal measures can be traced for nine miles north of the Tokomairiro Valley to the mouth of the Akeritu stream, north of which the schist rocks come down to the sea coast.

The Kaitangata hills will be the most convenient place to the railway from which to work this coal field; and with some modification of the furnace bars, I have no doubt that the coal will answer for the use of locomotives.

Fifteen analyses have been made of this coal from various seams, and the theoretical evaporative power obtained from the average of these is 5·34 lbs of water for each pound of coal used, the highest being the lower part of the Tokomairiro seam, which is 6·09. This coal is of the same value as fuel as the Southland brown coal, although I have seen no specimen that contains so much resin and burns so freely as the coal from the particular seam at Morley Creek. This is, however, an accidental and local peculiarity, that may be absent in one part of the seam and present in another. On the rise cut through by the road and railway south of Tokomairiro, there is a thick seam of inferior brown coal or lignite. This seam was very imperfectly exposed when I last saw it, but appears to be at least 12 feet thick, and to dip at a low angle to the S.W., being covered by pipeclay and gravel. Although of very great thickness, it is of inferior value as fuel.

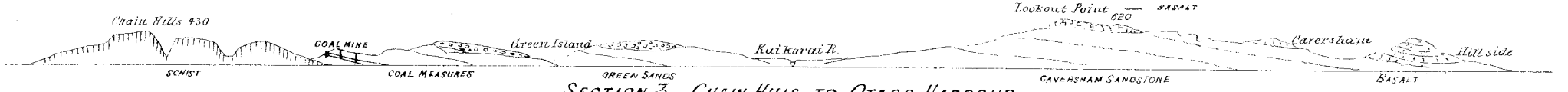
Green Island and Saddle Hill Coal Field.

This occupies a large area in the vicinity of Dunedin, in which the coal seams appear along the western boundary, in a line extending from the mouth of the Otokaia Creek for about nine miles, to the valley of the Water of Leith.

The strata, with the coal, probably have a trough shaped arrangement parallel with the coast, and the lowest beds that can be observed have a prevailing south-easterly dip, and, resting on schist rock,

— OTAGO —

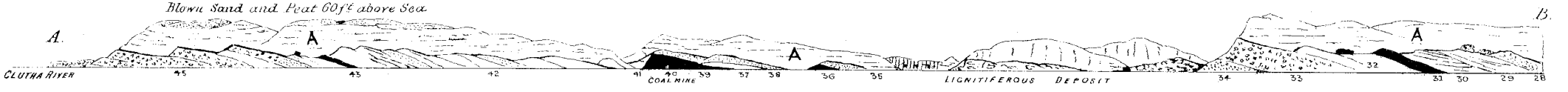
— GREEN ISLAND COAL FIELD —

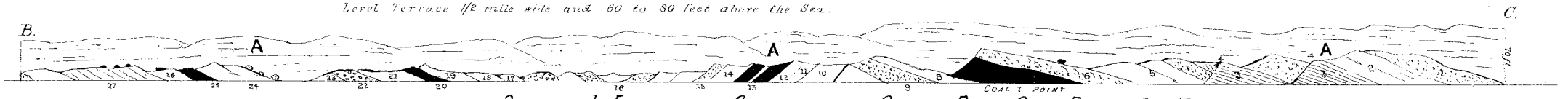


SECTION 3, CHAIN HILLS TO OTAGO HARBOUR.

SECTION 2, THROUGH SADDLE HILL TO MOUTH OF KAIKORAI RIVER

—— CLUTHA COAL FIELDS ——





SECTION 1, EXPOSED ON COAST BETWEEN CLUTHA R. AND COAL POINT 3 miles.

J. Hector.

pass beneath the Caversham sandstone, which is a tertiary marine formation, which is again overlaid by the volcanic rocks of the Dunedin basin, as shown in sections 2 and 3.

The lowest stratum of the coal measures, as seen on the west side of Saddle Hill, appears to be a thick conglomerate, on which the coal rests, and is worked by drives into the face of the hill at 400 feet above the sea level. There have been extensive landslips in the face of the hill, so that the exact sequence of the strata is not clear; but there are three distinct seams of 8, 4, and 3 feet thickness respectively, contained in clay shale, and covered by laminated sands with carbonaceous markings. The upper part of the hill, which is 1,560 feet altitude, is dolerite and basalt, the Caversham sandstone either being very thin, or not represented in the section on the west side. On the eastern slope, towards the sea, however, fossiliferous sandstone occurs over the coal.

From the north end of Saddle Hill the ridge of schist rock increases in altitude to form the Chain Hills, which are crossed by the main south road, and are to be tunnelled for the railway. Several collieries have been in operation since 1862 in this part of the field, close to the eastern boundary of the schist rocks, being the only place in New Zealand where coal mining has been carried on by deep shafts, as in England, all the other mines in the Colony being worked either by "free levels" or by "inclines." As at Saddle Hill, there are three principal seams, as shown in the following sections of two of the principal shafts:—

At Walton Park Colliery, where the shaft is 130 feet deep, the following strata were passed through:—

	Feet.
Sands, clays, and ferruginous gravels, of which no record was kept, and which belong to a recent tertiary formation	65
Bituminous shale and clay, with thin bands of coal	35
Upper Coal	7
Sandy clay and blind coal	12
Lower Coal	9
Bituminous shale...	1
Quartzose sand	2
Gray sandy clay	1½
Coal	2
Micaceous fire-clay	4
Sandy clay	15
At Doig's mine, which is situated more to the north, the section is as follows:—	
Surface clay, with boulders of volcanic rock, sand, gravel, and other recent formations	80
Resting unconformably on	
Coal	6
Mica shale	3
Coal	2
Grit	3
Coal	2
Mica shale	3
Coal	14

The Green Island coal varies a good deal in quality, but most of it is a lustrous brown coal when first extracted. From the depth of the mines, and the porous nature of the strata, it generally contains a much larger percentage of accidental water than the coal from the Clutha field, so that it cracks and breaks up into small fragments on exposure.

Following the line above indicated to the northward, the next outcrop known is in the Halfway Bush, but the coal there has the character of a bituminous shale, containing a large proportion of ash.

In the Water of Leith fragments of coal have been found which indicate that the seams in that direction has been altered by the igneous rocks. One specimen, stated to have been obtained in the Botanic Garden reserve, has the property of caking, which is quite exceptional even among the altered brown coals. (Laby. Rept., 1871, p. 14).

No seam has yet been found up the valley of the Water of Leith, so far as I am aware, but several have been recently reported at various points round the harbour. From information furnished me by Mr. Richard Evans, it appears that thin seams have been found, by explorations made under his direction, near Arden's Bay, and more recently coal has been found nearer to Port Chalmers.

The discovery of coal seams in this situation is extremely interesting, and might be of great economic importance, as, if they prove to have been altered by the overlying basaltic rocks in the same way that the brown coals have been altered under similar circumstances at the Malvern Hills in Canterbury, the coal might prove a valuable steam generator.

The average evaporative power of the Green Island and Saddle Hill coal is 5·02 lbs. of steam to each pound of coal, which agrees with the unaltered brown coals of the Malvern Hills; but the altered portion of the same seams at that place have an evaporative power as high as 8 to 9lbs, or equal to the best English coal.

In an early report on the brown coals, I pointed out that this improvement in the value of the coal by the expulsion of the water and the addition of a small percentage of bitumen, might be effected artificially.

If this process,—a modification of which has recently been brought into use for the supply of locomotives on the Italian railways,—were economically successful, it would render available, for the use of steamers and locomotives, the large deposits of brown coal which are found in nearly every part of New Zealand, and which, in the natural state, are only fit to generate steam for stationary engines.

I have, &c.,

The Under Secretary for Public Works, Wellington. James Hector.

GENERAL REPORT, BY DR. HECTOR.

SIR,— Geological Survey Office, Wellington, 13th July, 1871.

With the view of facilitating reference to the different coal seams in the Colony, which have been reported on by this department, I have the honor to enclose a schedule arranged according to the Province in which they occur, but from which schedule all analyses of coals not of practical importance have been omitted.

Where several analyses have been made of coals from the same district or locality, they are arranged according to their relative value, obtained by calculating their evaporative power, or the number of lbs. of boiling water which should be evaporated by one lb. of each kind of coal. In making this calculation, the same method has been adopted as that employed in similar investigations in other countries; and in the case of those coals that contain a large percentage of water, a due allowance has been made for the consumption of heat in the conversion of that water into steam.

The terms applied in the schedule to the different varieties of coal in New Zealand are to be used with the following definite meanings:—

I. *Hydrous.* (Coal containing 10 to 20 per cent. of permanent water.)

a. Lignite. Shows distinct woody structure, laminated, or shows that structure on desiccation; very absorbent of water.

b. Brown Coal.—Rarely shows vegetable structure. Fracture irregular, conchoidal, with incipient lamination; colour, dark brown; lustre, feeble; cracks readily on exposure to the atmosphere, loosing 5 to 10 per cent. of water which is not reabsorbed; burns slowly; contains resin in large masses.

c. Pitch Coal.—Structure compact; fracture smooth, conchoidal; jointed in large angular pieces; colour brown or black; lustre waxy; does not desiccate on exposure, nor is it absorbent of water; burns freely, and contains resin disseminated throughout its mass.

II. *Anhydrous.* (Coal containing less than 6 per cent. of water.)

a. Glance Coal.—Non-caking, massive, compact or friable; fracture, cuboidal, splintery; lustre glistening or metallic; structure obviously laminated; colour black; does not form a caking coke, but slightly adheres. This variety is brown coal altered by igneous rocks, and presents every intermediate stage from brown coal to an anthracite.

b. Semi-Bituminous Coal—Compact, with laminæ of bright and dull coal alternately; fracture irregular; lustre moderate; cakes moderately, or is non-caking.

c. Bituminous Coal.—Much jointed, homogeneous, tender, and friable, lustre pitch-like, glistening, often irridescent; colour black, with a purple hue; powder brownish; cakes strongly, the best varieties forming a vitreous coke, with brilliant metallic lustre.

I have, &c.,

The Under Secretary for Public Works, Wellington. JAMES HECTOR.

SCHEDULE of the NEW ZEALAND COALS which have been reported on by the GEOLOGICAL SURVEY DEPARTMENT.

AUCKLAND.

Kaiou River, Whangaroa Harbour:— A thick seam, in green sands; collected by H. Williams, Esq., no mine being yet opened.	Pitch Coal	6·29	49·60	14·40	1·00	Non-caking	48
Kawakawa Mine, Bay of Islands:— Seam 13 feet thick, in green sands; has been worked since 1865; contains much sulphur.	Glance Coal	7·44	57·20	4·60	2·20	Non-caking, but occasionally adherent.	25
		7·20	55·40	4·40	1·70		27
		7·12	54·80	4·00	3·80		46
		6·14	47·30	3·20	...		...
		5·81	44·66	3·20	9·00		45b
		5·33	41·53	5·70	1·54		211
Average composition	...	6·51	50·15	4·18	3·04	...	...
Walton's Mine, Whangarei Harbour:— A 5-foot seam, in green sands; mined during 1865–7; contains sulphur and much ash.	Glance Coal	5·11	47·90	9·20	7·00	Non-caking	51
		4·96	38·80	7·20	12·80	„	50
		4·71	36·80	6·10	11·90	„	19
Average composition	...	4·93	41·17	7·50	10·57	...	...
Matakana:— Thin, irregular seam, in sandstone.	Brown Coal	6·20	48·96	14·15	·64	Non-caking	10
Drury:— A 6-foot seam; mined, 1862–5.	Brown Coal	5·18	41·10	13·90	3·30	Non-caking	9
Waikato River, Kupakupa Mine:— A 6 to 18-foot seam, in blue and yellow clays; largely mined.	...	6·28	49·50	12·80	3·30	Non-caking	15
		5·70	45·40	17·20	1·60		47
Average composition	...	5·99	47·45	15·00	2·45	...	...

AUCKLAND—*Continued.*

——	Variety.	Evaporative Power.	Fixed Carbon.	Water.	Ash.	Nature of Coke.	Laboratory Number.
Coromandel :— Thin seam, underneath the trachyte breccias.	Altered Pitch Coal ...	6·15	47·90	7·80	11·80	Cakes slightly	1,198
Waiapu, East Cape :— Thin seam ; contains much ash, being almost a shale.	Pitch Coal	4·82	37·10	2·70	35·80	Cakes slightly	88*a*
		4·68	36·02	2·98	27·37	,,	88*b*
Average composition	...	4·75	36·56	2·84	36·58	...	...
Mokau Harbour :— Reported to be a 7-foot seam, in an accessible position.	Brown Coal	5·04	40·00	14·00	7·80	Non-caking	49

WELLINGTON.

Upper Wanganui River :— A thick seam reported.	Pitch Coal	6·42	51·00	8·60	4·20	Non-caking	74

NELSON.

Brunner Coal Mine, Grey River :— An 18-foot seam, in micaceous sandstones and grits. Half square mile has been proved, but it extends over a large area, though much faulted. Mine worked since 1865.	Bituminous Coal ...	8·10	62·37	1·99	6·20	Cakes strongly, and forms valuable coke	331
	,,	7·93	61·00	1·90	3·20		...
	,,	7·39	56·86	1·16	5·49		1,240
	,,	7·20	55·40	1·60	5·20		...
	,,	7·03	54·11	1·40	11·30		...
	,,	6·49	49·98	1·52	5·26		332
Average composition	...	7·36	56·62	1·59	6·11	...	...
Mount Rochfort :— Seams on high plateau 10 to 18 feet thick, from 900 to 3,000 feet above sea level. Largest continuous area at Coalbrookdale, has a 10 feet seam, interbedded with quartzose and micaceous grits.	Bituminous Coal ...	8·50	65·45	2·60	4.00	Cakes strongly and forms valuable coke	37
	,, ...	8·15	62·70	1·05	4·70		329
	,, ...	8·09	62·29	4·99	·74		95
	,, ...	7·81	60·10	1·70	·40		93
	,, ...	7·63	58·74	·70	4·55		330
	,, ...	7·43	57·20	1·80	·80		...
	,, ...	7·36	56·63	3·01	1·29		94
Average composition	...	7·85	60·44	2·26	2·35	...	...
Inangahua, Murray Creek :— An 18-foot seam, associated with quartzone grits.	...	7·03	54·52	4·98	1·19	Cakes slightly	1,165
		7·02	54·94	10·38	·98		235
Average composition	...	7·02	54·73	7·68	1·08	...	...
Upper Buller, Coal Creek :— Seam 16 feet, with brown micaceous sandstones, found on both sides the Buller River.	...	6·38	50·80	19·40	7·20	Non-caking	1,096
		4·63	38·63	11·45	5·65		181
Average composition	...	5·50	44·71	15·42	6·42	...	...
Brighton :— A 6-foot seam, in brown sandstone under marl.	Brown Coal	5·09	41·08	21·54	10·46	,,	101
Mohikanui :— Brown sandstones under marls.	...	5·98	46·61	7·28	2·75	Cakes slightly	1,221
Sea Coast North of Point Elizabeth :— A 6-foot seam underneath ferruginous sandstone ; good illuminating properties.	Pitch Coal	4·45	34·80	6·20	3·60	Adherent	1,220
Collingwood Mine :— Several thin seams, in brown sandstones. Mine worked since 1868.	Bituminous Coal ...	7·69	59·20	2·40	5·80	Cakes moderately	62*b*
		7·55	58·12	1·26	5·11		1,221*a*
		7·09	54·60	2·20	3·80		62*a*
Average composition	...	7·44	57·31	1·95	4·90		
Pakawau :— Same formation as the previous. Seams yet found very irregular and very variable in quality, many of them being carbonaceous shales, which are not included in the general average —no regular mining.	Bituminous Coal ...	8·71	67·00	4·90	1·40	Cakes	2
		6·54	50·34	3·33	10·16	Cakes strongly	522
		6·51	50·10	3·56	8·26	,,	328
		6·03	46·44	2·57	6·92	Slightly adherent	1,026
Average composition	...	6·95	53·47	3·59	6·68	...	...

NELSON—*continued.*

——	Variety.	Evaporative Power.	Fixed Carbon.	Water.	Ash.	Nature of Coke.	Laboratory Number.
Pakawau—continued.	Carbonaceous Shales ...	5·69	43·80	2·75	24·83	Cakes strongly	320
		5·35	41·20	2·20	18·90	Slightly adherent	83
		4·99	38·41	2·77	14·86	„	102*d*
		4·94	38·00	1·60	25·20	„	40
		4·47	34·40	3·20	40·80	„	521
Average composition		3·85	45·00	4·80	11·30	Non-caking	70*a*
West Wanganui :— Upper part of same formation; mined since 1867.	Pitch Coal	4·20	50·10	8.60	4·20		
Average composition	...	4·02	47·55	6·70	7·75	...	...
Jenkins' Mine :— Irregular seam, probably in a landslip; worked in 1860; three miles from Nelson.	Jet Coal	7·94	62·40	14·40	1·80	„	229

CANTERBURY.

Malvern Hill District :— Extensive, but detached, areas of Brown Coal, which, in many cases, have been altered to a valuable Steam Coal by the influence of igneous rocks, and are distinguished as Glance Coals; seams from 2 to 8 feet thick, in micaceous and argillaceous shales. Mines have been opened in Brown Coal on the Hawkins River, and in the Glance Coal on the Selwyn River and the Kowhai River; worked irregularly since 1862. The composition of the Glance Coal varies according to the proximity of the igneous rock which has affected it; seams of unaltered Brown Coal occurring 25 feet under dolerite rocks.	*a* Anthracite Glance Coal	11·55	89·91	3·17	7·92	Non-caking	609
	b Hard Glance Coal ...	10·33	80·01	6·50	2·54	„	607
	c „ ...	9·61	73·94	3·60	5·86	„	224
	c „ ...	9·05	69·62	2·77	12·69	„	608
	c „ ...	8·77	67·49	1·12	12·50	„	1,016*c*
	b „ ...	8·59	66·10	2·20	17·60	„	...
	e „ ...	8·30	64.51	6·76	7·46	„	228
	d „ ...	7·94	61·10	1·60	1·90	„	...
	d „ ...	7·72	59·39	3·84	2·94	„	853
	d Soft Glance Coal ...	6·81	53·30	9·98	2·75	„	1,016*d*
Average composition	...	8·87	68·54	4·15	7·42	...	...
a Acheron Valley, *b* Kowhai, *c* Hart's Mine, *d* Hill's Mine, *e* Rakaia, *f* Jebson's Mine, *g* Big Ben, *h* Craigie Burn, *i* Mount Sommers, *k* Church Reserve, Selwyn.	*f* Brown Coal	5·73	46·02	21·66	5·33	„	617
	g „	5·71	45·00	12·00	1·90	„	...
	h „	5·62	44·62	15·54	4·58	„	98
	f „	5·58	44·50	17·50	6·78	„	1,016*a*
	d „	5·22	41·22	20·74	6·35	„	1,233
	i „	5·05	39·60	8·80	12·40	„	...
	k „	4·99	40·12	19·50	6·15	„	618*b*
	k „	4·98	40·01	18·88	3·50	„	1,016*b*
	k „	4·65	36·06	11·40	3·20	„	...
Motanau, Amuri :— 4 feet seam.	„	5·03	40·37	18·15	5·37	„	107
Average composition	...	5·26	41·75	16·42	5·55	...	...

WESTLAND.

Kanieri River :— Thin seams in micaceous sandstone, not thoroughly explored; contains much ash.	...	7·42	58·69	·86	21·11	Cakes strongly	970
		6·28	48·97	·29	10·82	„	970*b*
		5·80	44·80	·40	18·40	„	970*c*
Ross (exact locality unknown) :—	...	4·01	31·43	6·58	19·46	Non-caking	1,234
Average composition	...	5·88	45·97	2·03	17·45	...	...

OTAGO.

North-east District, Shag Point :— Seams of Brown and Pitch Coal, with grits and sandstones. Mines open since 1862.	Brown Coal	5·66	45·30	19·20	5·40	Non-caking	87
	Pitch Coal	5·36	42·16	10·90	9·33	„	301
	Brown Coal	5·23	41·99	19·60	5·01	„	535
Average composition	...	5·42	43·15	16·57	6·58	...	...
North-east District, Oamaru :— Thick seam, with conglomerates and pipeclays at Big Hill. (?)	Brown Coal	5·36	43·16	21·33	10·34	Non-caking	259*a*
	„	4·82	39·10	13·40	2·80	„	12
Average composition	...	5·09	41·13	17·36	6·57	...	...

OTAGO—*continued.*

——	Variety.	Evaporative Power.	Fixed Carbon.	Water.	Ash.	Nature of Coke.	Laboratory Number.
Green Island and Saddle Hill:— Thick seams of Brown Coal in grits and clay shale, mined extensively since 1861. Four mines at present in operation, worked by deep shafts.	Common Brown Coal ...	5·37	43·12	20·26	2·25	Non-caking	304
	,, ,, ...	5·35	42·39	14·22	2·29		305
	,, ,, ...	5·13	41·15	19·34	3·64		306
	,, ,, ...	4·86	39·28	21·01	5·65		1,146
	,, ,, ...	4·76	38·24	18·45	5·78		303
Botanic Reserve:—	Altered Pitch Coal ..	4·63	37·60	14·40	4·20	Cakes	1,085
Average composition	...	5·02	40·30	17·95	3·97	...	...
Clutha and Tokomairiro District:— Seams 5 feet to 20 feet, with conglomerates and sandstones. Mines worked since 1859.	Brown Coal	6·09	48·70	20·20	3·30	Non-caking	1,114
	Pitch Coal	5·99	46·67	7·27	10·70	,,	322
	Brown Coal	5·92	46·74	12·94	3·64	,,	309
	Pitch Coal	5·76	46·84	9·20	3·44	,,	1,144*a*
	Brown Coal	5·34	42·10	11·80	5·93	,,	313
	,, ...	5·27	41·57	11·60	5·90	,,	312
		5·26	42·15	18·69	4·58	,,	1,144*b*
		5·24	41·83	16·43	12·30	,,	307
		5·18	41·38	17·50	5·20	,,	309*c*
		5·16	41·32	16·35	4·66	,,	309*b*
		5·07	40·29	13·72	6·61	,,	313*b*
		5·01	40·02	16·10	5·61	,,	309*d*
		4·96	39·66	16·31	5·43	,,	302
		4·47	36·57	20·91	7·32	,,	1,145*b*
Average composition	...	5·34	42·56	14·93	6·04	...	...

SOUTHLAND.

Imaka, Catlin's River:— Thin, irregular seam, in sandstone.	Semi-bituminous ...	7·72	59·40	4·20	1·40	Cakes	1,000
Waikawa:—	,,	5·69	44·34	6·60	16·11	Slightly coherent	326
Irregular seams, in coarse sandstone.	,,	4·94	38·91	10·32	10·00	,,	230*a*
Mount Hamilton:— Irregular seams, in sandstone.	Bituminous ...	6·38	49·08	1·68	9·50	Cakes strongly	1,105*a*
Average composition	...	6·18	47·93	5·70	9·25	...	...
Wairaki District:— Seams 4 to 10 feet of Brown and Pitch Coal, in micaceous sandstones and clays. No regular mines opened.	Brown Coal	6·10	48·30	15·60	5·10	...	71
	,,	5·24	41·78	16·67	4·88	...	197
	Pitch Coal	4·79	37·81	10·94	2·97	...	235
	,,	4·55	36·01	11·33	12·45	...	200
	Brown Coal	3·51	28·44	15·33	6·22	...	200*b*
Orepuki:— Same formation as above.	,,	5·44	43·20	14·90	2·80	...	77
Average composition	...	4·94	39·26	14·13	5·74	...	...
Preservation Inlet:— Thin, irregular seams, in sandstone, on Coal Island, much faulted and altered.	Glance Coal	8·63	66·43	4·40	2·24	Dull, non-caking	324
	,,	8·03	61·83	4·40	5·14	...	323
	,,	7·07	54·38	4·20	11·20	...	325
Average composition	...	7·91	60·88	4·33	6·19	...	...
Preservation Inlet:— Thick seams of Brown and Pitch Coal on the main land, south of Coal Island.	Pitch Coal	5·62	43·83	6·58	6·67	Non-caking	176
	Brown Coal	5·17	41·23	16·20	7·24	...	148
	,,	4·85	38·87	17·77	3·87	...	234
Average composition	...	5·21	41·31	13·52	5·93	...	...
Tuapeka:— Thick seam of lignite under the oldest gold-drift; shows vegetable tissue.	...	4·28	34·40	16·80	4·40	...	243
Waitahuna:— Similar formation.	...	4·71	37·25	11·06	11·81	...	308