

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, F.G.S., DIRECTOR.

REPORT OF PROGRESS

FOR

1871-72.



Montreal:
DAWSON BROTHERS.
1872.

Presented to

Prof I. I. Whitney

By the Director of the

GEOLOGICAL SURVEY,

On behalf of the Government of the Dominion of Canada.

J. D. WHITNEY.

HARVARD UNIVERSITY.



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• MAPS AND DRAWING OF FURNACE.

A map accompanies the Report of Mr. Richardson, illustrating the distribution of the coal-fields of the east coast of Vancouver Island. Mr. Vennor's Report also contains a map showing the course of the auriferous zone in Marmora, and a drawing of the Dunstan revolving cylinder furnace.

GEOLOGICAL SURVEY OF CANADA.

REPORTS

OF

EXPLORATION AND SURVEYS.

1871-72.

SUMMARY REPORT
OF
GEOLOGICAL INVESTIGATIONS,

BY
MR. ALFRED R. C. SELWYN;

ADDRESSED TO
THE HONORABLE JOSEPH HOWE, M.P.,
SECRETARY OF STATE FOR THE PROVINCES.

MONTREAL, 20TH MAY, 1872.

SIR,—I have the honor to transmit to you herewith, for the information Reports 1871. of His Excellency the Governor in Council, the undermentioned Reports relating to the investigations made by the Geological Survey during the past year.

1. Journal and Report of preliminary Explorations in British Columbia, by Mr. Alfred R. C. Selwyn.
2. Report on the Coal-fields of the East Coast of Vancouver Island, with a map of their distribution, by Mr. James Richardson.
3. Report of progress in Exploration and Surveys of country between Lake Superior and the Albany River, by Mr. Robert Bell.
4. Preliminary Report of Exploration and Surveys in the country between Lake St. John and Lake Mistassini, by Mr. Walter McOuat.
5. Progress Report of Exploration and Surveys in the Counties of Leeds, Frontenac and Lanark, in the province of Ontario, with a plan of the Township of Marmora, showing the position of the worked Gold Mines, and the course of the Auriferous Zone, by Mr. H. G. Vennor.
6. Report of progress in Geological Investigations in New Brunswick, by Professor L. W. Bailey.
7. Summary of Statistics of Mines and Mineral Produce] of the Dominion, prepared from Official Returns and other sources, by Mr. Charles Robb.

Progress of Geological Explorations.

GEOLOGICAL EXPLORATIONS.—The general progress of the Geological Survey during the past year has been satisfactory, and besides the investigations and surveys, of which the particulars are given in the above named Reports, exploration has been continued in Nova Scotia by Mr. Scott Barlow.

Survey of Springhill Coal-field.

In my Summary Report dated May, 1871, I stated that the survey of the Springhill Coal-field, Cumberland County, Nova Scotia, commenced by Mr. Scott Barlow on the 6th September, had progressed satisfactorily, and the facts then ascertained were briefly stated.

Last spring, Mr. Barlow was directed to continue this survey, and to extend it as far as possible over the whole space embracing the productive deposits. With this view, he directed his operations so as to include the northern outcrop, and to acquire a knowledge of the general structure of the whole field; but having no map on a scale sufficiently large for practical purposes, it was considered essential that the roads, rivers and streams running through the district should be carefully measured and all the details of the rock exposures faithfully recorded.

He commenced his operations by surveying the roads running south to the Maccan River, then those running in an easterly direction to the post-road between Truro and Amherst; and afterwards followed the post-road in a north-westerly direction, to Styles' mine on the north outcrop, thence in a westerly direction to the Little Forks (now called Athol), and from that to the Scotia mine at Maccan River, on the road to the South Goggins.

Measurements by Mr. S. Barlow.

He measured in all about eighty miles of roads, rivers, streams and lines through the woods, and registered the strike, dip and mineral character of every rock exposure met with. Eight miles of the distance mentioned were measured by theodolite and chain, and the remainder by prismatic compass and chain. About one third of the measurements were made in the woods under great difficulties, in consequence of the unevenness of the ground, and a thick growth of underbush, which necessitated a great deal of chopping. The area included in the measurements may be about sixty square miles.

Pits and borings.

The positions of all pits and borings sunk by parties exploring for coal were accurately determined, the facts disclosed by these carefully recorded, and any plans, sections or documents, with other information that might be of value, were collected and copied; specimens of the rocks and fossils were procured, and these materials are now all in the Geological Survey Office in Montreal. The last month of the season was spent in proving the outcrops of some of the coal-seams by borings, and by sinking small pits in positions where the work of the proprietors appeared to be deficient, but where a small outlay of the funds of the Survey seemed likely to determine points of importance. A heavy fall of snow on the 25th

November, interrupted these operations before Mr. Barlow had satisfied himself with regard to several of them.

Of the extent and value of the coal-seams, it would be premature to say ^{Extent and value of the coal-seams.} more than is stated in my Summary Report of last year, until more facts are ascertained and put together, and a map is constructed to shew the relation of one part to another. Sir William Logan made a personal visit to the Cumberland coal-field in the middle of July, and informs me that Mr. Barlow was doing his work remarkably well; he considers that the proprietors of the area where the chief explorations of the district were in progress were fortunate in the employment of Mr. John Anderson, an intelligent practical miner, who has gained his experience in Scotland and in Nova Scotia; but that his skill is much interfered with by his destitution of proper instruments. He had been very obliging in giving Mr. Barlow all the information in his power.

In the area above referred to (one of the "Black" areas), under Mr. Anderson's superintendence, what appears to be a valuable group of coal ^{Outcrop of seams.} seams, has been traced on the south outcrop from a slope on the eleven-foot seam (which is one of the group) for about twenty-five chains to the north-eastward, where they are interrupted by some irregularity or disturbance. But, in a bearing N. 10°. E. from this point, and at a distance of about twenty-three chains, what is considered by Mr. Anderson to be the eleven-foot ^{Eleven-foot seam.} seam of the same group has been met with and traced for about forty-two chains on the strike; when, according to Mr. Anderson's view, there is another turn carrying the seam to the north-westward. In this bearing he has traced the outcrop for about a quarter of a mile. Beyond this, in about the same bearing, at a distance of about fourteen chains, he has met with two seams, but he is undecided whether either of them is the eleven-foot seam.

The position where his work has been suspended is about one and three-quarter miles from the Intercolonial railroad, across the measures; but where the seam would intersect the line of the railroad on the strike, were the search carried further, is a matter of great doubt. Two turns have already occurred in it, and there may be more. The object of the borings ^{Object of borings made by Mr. Barlow.} made by Mr. Barlow, which were on two transverse lines, one on each side of the first disturbance mentioned, and about thirty-two chains apart, was to determine whether the seams on the opposite sides of this disturbance were really the same. This he expected to do by probing down to each seam of each group in succession, and thus ascertaining that the thicknesses of the seams and the distances between them were the same in both localities; than which there could be no better proof. He was, however, not able to complete the necessary work last autumn, but it is proposed to do so this season, and likewise to prosecute the general exploration and survey of this important coal-field.

Laurentian
limestone bands
of the Lièvre,
Petite Nation
and Rouge
Rivers.

Mr. James Lowe has further advanced the work, which he has been engaged upon for several seasons, of tracing and mapping the distribution of the Laurentian limestone bands on the upper waters of the Lièvre, Petite Nation and Rouge Rivers.

Map of the East-
ern Townships.

Mr. Robert Barlow has made considerable progress during the year towards the completion of the map of the Eastern Townships, which is being engraved in London in four sheets, on a scale of four miles to one inch.

This map embraces a large region extending on both sides of the St. Lawrence from Montreal to Quebec, and, it is hoped, will be ready for publication next year. Mr. Arthur Webster made measurements last season of nearly seven hundred miles of roads, which were required for the map on the north side of the St. Lawrence between Montreal and Three Rivers.

Investigations
and labors of
Mr. Billings.

Mr. Billings, in addition to his ordinary labors connected with the arrangement of the collections in the Museum, has been occupied chiefly in the investigation of the fauna of the Lower Potsdam rocks; and also with the fossils of the Guelph formation. Some portion of his time has been devoted to the study of the collections made in British Columbia. Some of the results of his investigations have been published in the Canadian Naturalist, and others will shortly appear.

Palæontological
collections.

On the 22nd of August Mr. Billings left Montreal, accompanied by Mr. Weston, and proceeded to Bic for the purpose of collecting fossils. A number of localities between Bic and the Chaudière were examined, and 500 specimens have been secured which are available for the purpose of the Museum and for scientific investigation. Mr. Billings states that a further collection from the Straits of Belle Isle is required for comparison. As the Lower Potsdam group is there exposed on a large scale, and in an undisturbed condition, that locality is the best known for ascertaining the facts required to work out the palæontology of this formation.

At Hespeler, in the Guelph formation, Mr. Weston, during three visits to the locality, made a valuable collection of 280 specimens, among which is a new genus of great interest, which Mr. Billings has briefly described in the Canadian Naturalist of December last, under the name of *Monomerella*.

Another important collection was made for the Survey by Mr. DeCew in the Waterlime formation in the township of Bertie, county of Haldimand. This consists of sixteen specimens of *Eurypterus remipes*; some of them in a fine state of preservation.

A collection of 280 specimens of Trenton and Black River fossils from Blue Point, Lake St. John, was made by Mr. McOuat. And about 100 specimens were presented to the Museum by Major Grant, of Hamilton, chiefly from the Clinton group.

Saurian fossil
foot-prints.

A very fine series of Saurian fossil foot-prints, from the Carboniferous rocks of Cumberland County, Nova Scotia, was secured for the Geological Museum by Mr. Scott Barlow. They have been examined and described

by Dr. Dawson, who considers them to be of a new species, which he has named *Sauropus unguifer*. Dr. Dawson's description of these interesting fossils will appear in one of the scientific periodicals.* Altogether, there have been about 1,200 specimens added to the collection during the year.

A very valuable addition has likewise been made during the past year, through the kind and gratuitous labors of Dr. Dawson, to the palæontological publications of the Survey; being a Report illustrated with twenty plates, on the fossil Land Plants of the Devonian and Upper Silurian formations of Canada. Report by Dr. Dawson.

Dr. T. Sterry Hunt spent a part of last summer with Professor Bailey in further geological examinations in Southern New Brunswick. During the winter he has attended to the printing of the volume of Reports for 1870-71, just issued, and he has also devoted a part of his time to examining some of the specimens of rocks and minerals collected by the different exploring parties. By far the greater part of his time has, however, been occupied in correspondence and consultation with persons from all parts of the Dominion and elsewhere, who apply to him for information upon all subjects connected with economic geology, mineralogy and mining industry. Labors of Dr. Hunt.

This plan of giving gratuitous information and advice personally, to every one who applies for it, at any hour and on any day in the week, though doubtless advantageous to the public, is very unsatisfactory to the officer concerned, who has nothing to shew for his time, thus often uselessly consumed and taken away from what are more properly his official duties as chemist and mineralogist to the Survey.

As a rule all such applications should be made by letter; one day only in the week should be set apart to receive visitors and to attend to personal enquiries, such as cannot well be made or answered in writing, a register being kept of all consultations and enquiries, whether personal or by correspondence, which would be a record of the time which has thus been devoted to the public.

I have the honor to be,

Sir,

Your obedient servant,

ALFRED R. C. SELWYN.

* Geological Magazine for June 1872, Vol. IX, No. 6.

JOURNAL AND REPORT
OF
PRELIMINARY EXPLORATIONS

IN
BRITISH COLUMBIA,

BY
MR. ALFRED R. C. SELWYN;

ADDRESSED TO
THE HONORABLE JOSEPH HOWE, M.P.,
SECRETARY OF STATE FOR THE PROVINCES.

GEOLOGICAL SURVEY OFFICE,

MONTREAL, May, 1872.

Geological Ex-
ploration in
British Colum-
bia. Journal
and Reports.

Sir,—I have the honor to submit the accompanying Journal and Reports of the preliminary Geological Exploration which I made in British Columbia last summer, assisted by Mr. James Richardson of the Geological Staff, in pursuance of the authority conveyed to me by your letter of the 20th June, 1871, as follows :

OTTAWA, 20th June, 1871.

Cost of Explora-
tion.

Sir,—By my letter of the 9th inst. you were authorized to organize and equip a party for the purpose of making a preliminary Geological Exploration this summer in British Columbia, on the understanding that the cost of the said party should not exceed \$6,000 for the year. You were likewise authorized to accompany the party yourself, and you were informed that instructions as to the objects to which your attention should mainly be directed, and as to the portions of British Columbia which it is most desirable you should first examine, would be communicated to you in due course.

I now have the honor to acknowledge the receipt of your letter of the 10th inst. in reply, in which you point out the desirability of the second on the party being a competent geological observer, accustomed to travel in the woods, and, in an emergency, capable of carrying on the exploration, and taking charge of the party.

Having had this, and the other subjects above referred to, under consideration, the following further instructions are now transmitted for your guidance.

You are authorized to take with you to British Columbia, as assistant and second on the party, Mr. James Richardson, of the Geological Staff. You will yourself return to Montreal at the close of the season, but should you think it desirable that more extended observations should be made, more particularly of the Coal-fields on the coast, than your own time will admit of, you may make arrangements for Mr. Richardson to continue the investigation till the end of the year, or for such period beyond the date of your own departure as you may consider advisable.

As regards the portion of the country which it is most desirable that you should first examine, you must in a great measure be guided by your own judgment, and by information obtained on the spot. But it is of course desirable and important that as much as possible should be ascertained respecting the general geological features and the useful minerals which may be found on and in proximity to the several lines which will be explored by the engineering parties, and on one or other of which the future Pacific railroad will be located.

With a view to secure accurate illustrations of the physical features of the country and of other objects of interest which may be met with during the exploration, you are authorized to make arrangements with Mr. Notman, of Montreal, for a photographic artist to accompany the expedition, on the understanding that he is paid and equipped by Mr. Notman; his travelling expenses only being paid by the Government. Of these, one half will, in accordance with your arrangement with the Engineer-in-chief, Mr. Fleming, be made chargeable to the Pacific Railroad Exploration Fund, and the other to the appropriation for geological purposes in British Columbia. Considering the lengthened experience both of yourself and of Mr. Richardson in explorations of the kind you are now undertaking, it is not thought necessary to instruct you more particularly as to the various subjects in addition to those appertaining especially to geology, to which your attention should be directed, such as the nature of the soil, the vegetation, the quality and kind of timber, the distribution of plants and animals, the character of the climate, &c., &c., on all of which interesting and valuable information may no doubt be gathered.

You will proceed as early as possible, via San Francisco, to Victoria. There you will engage men and secure all necessary supplies and equipment. And you will place yourself in communication with the gentlemen named in the margin,* who have been instructed by Mr. Fleming to afford you all the assistance and information in their power, with a view to facilitate and promote the special object of your exploration, and from whom you will likewise ascertain all particulars respecting the routes on which operations will be conducted.

* Mr. John Trutch; Mr. Walter Moberly; Mr. R. McLennan; Mr. George Watt, Commissary and Paymaster.

Return route.

It is presumed that you will return to Canada via San Francisco ; but should you think it advisable with a view to scientific objects or from any other cause, that you should cross the Rocky Mountains and return by the valley of the Saskatchewan, you are at liberty to do so. In the event of your returning by the latter route, it is desirable that you should obtain as much information as time and circumstances will permit in reference to the Coal deposits on the Saskatchewan, and also to the Gold-fields supposed to exist on the eastern slope of the Rocky Mountains, and more particularly near the sources of the head waters of the North Saskatchewan.

I have the honor to be,

Sir,

Your obedient servant,

(Signed)

JOSEPH HOWE,

Secretary of State for the Provinces.

ALFRED R. C. SELWYN, Esq.,

Director Geological Survey,

Montreal.

Difficulty experienced in procuring men, supplies and equipment.

Our departure from Montreal was unfortunately deferred till too late in the season ; and the unexpected delays we were subjected to on the journey to Victoria, with the further unavoidable delay there, and at Kamloops, occasioned by the difficulty experienced in procuring men and the necessary supplies and equipment for the expedition, and likewise in making arrangements for their transport, together with the obstructions subsequently encountered in penetrating the dense and pathless forest and jungle which prevail almost unbroken, except by swamps and rivers, for more than 150 miles on the line of route travelled from Kamloops to the Leather Pass in the Rocky Mountains, are causes which, I regret to say, have combined with others to render the result of our exploration less than might reasonably be expected, and than I had myself anticipated. The general knowledge, however, which the season's operations have enabled us to acquire of the physical character of the country, the distribution in it of the various formations, the facilities for travel in the several districts, and of other minor matters, will prove valuable in prosecuting the more extended and detailed investigations which I hope the Geological Survey will be able to accomplish in future seasons in this interesting though little known Province of the Dominion.

Facts relating to the Geological structure and mineral resources of the country.

The facts which have been ascertained relating to the geological structure and mineral resources of the country, though comparatively few, and scattered over a region of between five hundred and six hundred miles in length,—therefore necessarily at present disconnected,—are some of them new and exceedingly interesting, and when followed out will, I believe,

throw much light on the age of the crystalline rocks, and on the geological distribution of gold in North-western America, as well as of the productive Coal-fields, and of the many other valuable minerals which are known to be widely distributed throughout the country, but which require to be located, and their actual extent and workable value accurately determined. The collections which were made during the expedition contain a number of interesting specimens of rocks and fossils from the different formations; but for the purpose of study, and for the accurate determination of their relations, larger and more complete collections will be required, some of which we shall be able to secure next season. To the zeal and perseverance, often under the most unfavorable circumstances, of Messrs. Baltzy and Hammond, of Mr. Notman's staff, are due the very beautiful and interesting photographic illustrations of the route from Yale to the Leather Pass, a complete set of which, comprising 36 views 8 x 10 and 84 stereoscopic views, is transmitted herewith.

Collections of
rocks and fossils.

Photographs.

Journal of Expedition.

We left Montreal on the afternoon of the 26th June, and reached San Francisco, without accident or delay, on the 3rd July. From information before leaving Canada, we supposed that the steamer for Victoria would not leave San Francisco till the 5th July; on our arrival there we found, however, much to our disappointment, that she had sailed a few hours before, and that fourteen or fifteen days would elapse before the departure of the next steamer for Victoria. Under these circumstances, I thought it advisable to proceed by a steamer which would leave on the 6th for Portland in Oregon, whence, I was informed, we would find no difficulty in reaching Victoria, either by steamer direct, or overland, via Olympia, and Puget Sound; the latter route involving a journey of about ninety miles by stage from Monticello on the Cowlitz River to Olympia, situated at the head of Puget Sound. We accordingly left San Francisco for Portland on the 6th July. On Sunday the 9th we reached Astoria, at the mouth of the Columbia River, and, on Monday evening the 10th, arrived at Portland, situated on the Willamette River, twelve miles above its junction with the Columbia, and one hundred miles above Astoria. Here we were destined to be again disappointed and delayed. There was no certainty when a steamer would leave for Victoria, and it therefore became necessary to arrange for proceeding via Olympia. The steamer thence to Victoria, calling at the various settlements on Puget Sound, leaves on Mondays and Thursdays only, at 4 a.m., and as the trip by river steamer from Portland to Monticello, and thence by stage, would occupy the greater part of three days, it was impossible to catch the following Thursday's steamer; we therefore remained at Portland till Thursday,

Departure from
Montreal.

San Francisco
to Portland in
Oregon.

Puget Sound.

and reached Olympia by the route above named on the afternoon of Sunday the 10th July; arriving in Victoria per steamer North Pacific on the following Monday at 8 p.m., having been three weeks on the journey from Montreal. The officers mentioned in your letter of instructions, connected with the Pacific Railroad Exploration Survey, who preceded us from Canada, had not left Victoria when we arrived there, and were still occupied perfecting their arrangements, purchasing supplies and hiring men. I immediately placed myself in communication with Mr. Walter Moberly and Mr. McLennan, and having carefully considered the several routes which they informed me were to be examined by the Engineering parties, I deemed it best to select for our operations the one which was to be followed by Mr. McLennan, from Kamloops up the North Branch of the Thompson River to Tête Jaune Cache on the Upper Fraser, and thence through the Leather Pass to Jasper House; hoping to be able to return by a route which was to be explored and opened from Richfield on the Cariboo gold-field to Tête Jaune Cache, by another of the railroad survey parties under Mr. Mahood. This route appeared to offer a much wider and more promising field for geological investigations than that which was to be followed by Mr. Walter Moberley, from Hope on the Fraser via Similkameen, Fort Colville, the Kootenay River and the Columbia to Howse Pass; as well as facilities for returning later in the season, afforded by the waggon-road, 378 miles in length, from Cariboo to Yale. I was further influenced in making this selection by the fact that a considerable part of the latter route had already been explored by the geologist attached to the British and North American Boundary Commission, as well as by Dr. James Hector, in connection with Capt. Palliser's exploration of the passes of the Rocky Mountains, and other portions of the British territory in North-west America, extending over four years, from 1857 to 1860; whereas the geological features on the former had never before been reported on or examined.

As we had brought no camp equipments with us from Canada, everything of this nature had to be purchased before leaving Victoria, as well as the provisions, which would be required from the time we left the waggon-road between Yale and Cariboo, until our return to it at the close of the season. Beyond the limits of the waggon-road the system of transport, except upon the lakes, where boats or canoes can sometimes be hired, is almost entirely confined to "packing;" either Indians, mules, or horses being used. An Indian load is about 100 lbs., that of a horse about 250 lbs., and for a mule from 250 lbs. to 400 lbs. Indians are therefore not often employed when the quantity of material exceeds a few hundred pounds, or the road to be travelled is passable for horses or mules. Our material amounted to about 3,600 lbs., and therefore fifteen horses were required to transport it.

Arrival at Victoria.

Selection of route.

Previous Explorations.

Outfit.

System of transport.

These we were informed we should find no difficulty in purchasing at Kamloops.

Our preparations in Victoria were completed on Monday, 24th July, and the next morning we embarked on board the steamer *Enterprise* for New Westminster, situated at the mouth of the Fraser River, and ninety-five miles from Victoria, and arrived there the same evening at 6 p.m., our party consisting of Mr. James Richardson of the Geological Staff, Mr. Baltzly, photographic artist, Mr. Hammond, assistant, and James Deans, hired in Victoria as general assistant. Early the following morning we started in the stern-wheel river steamer *Lillooet* for Yale, ninety miles above New Westminster, and at the head of navigation on the Fraser. For about fifty miles, or to the mouth of Harrison River, there is not much current, but thence to Yale the rise is very rapid, and the current so strong that the steamer frequently could not make more than from three to four miles an hour. At 9 p.m., we reached Hope, twelve miles below Yale. Here the party under Mr. Walter Moberly, with their supplies, were landed, to commence next morning, by the passage of the Hope Mountain, nearly 6,000 feet above the sea, their journey of 450 miles to Howse Pass in the Rocky Mountains.

The intricacy of the channel, and the strength of the current made it impossible for the steamer to proceed up the river with safety after dark, and we therefore lay moored to the bank till daylight, when a fresh start was made, and Yale reached at 8 a.m. on Thursday the 27th July. A dense fog had hung upon the hills since daybreak, and, shortly after our arrival, it commenced raining heavily. Towards the afternoon, the weather having partially cleared up, Mr. Baltzly availed himself of the opportunity to secure some photographic views. I spent the greater part of the day in endeavoring to find some means of transport. Barnard's stage waggon were already all engaged for the conveyance of the supplies for the railroad survey parties, and neither teams nor pack animals were to be had. I was therefore obliged to be satisfied with a promise from Mr. Barnard to forward our supplies and equipment as soon as he could secure teams. In the meantime, not wishing to remain in Yale, I engaged four Indian packers at one dollar *per diem* each, to carry the photographic apparatus, a couple of tents, and some blankets and provisions; and at seven a.m., on the 28th July, we started on foot for Lytton, fifty-seven miles above Yale.

For the purpose of fixing our geological observations, Mr. Richardson paced and took compass bearings along the road. At 4 p.m. we reached the suspension bridge, thirteen miles from Yale, by which the wagon-road crosses to the left bank of the Fraser; and here we made our first camp in British Columbia, on the only level space to be found by the roadside, about 100 yards from the east end of the bridge. The next morning we

Boston Bar.

started at seven. Toward mid-day it became intensely hot, and two of our Indians showed signs of distress; they had to halt frequently to rest, and did not make more than two miles an hour. Boston Bar, twenty-six miles from Yale, one of the road-side inns which occur at intervals of seven or eight miles, was reached at one p.m. The thermometer then stood at 80° in the shade and at 105° in the sun. The two Indians were now completely knocked up, and declined to proceed. The chief of the party, however, after a considerable time spent in discussion with his friends, at length informed us that he could procure a horse that would carry the packs, which would enable us to travel faster, and that we were not to pay him more than we had agreed upon at Yale. We gladly consented to this arrangement; the horse, or Indian pony, was brought out, the packs arranged and lashed on a very primitive kind of pack-saddle, and our march resumed. At 7 p.m. we camped at Butchers Flat, thirty-one and a half miles from Yale, on the edge of a dry, stony, gravel terrace, thinly clothed with pine trees, and sloping at an angle of thirty-two degrees down to the swift and turbid waters of the Fraser from about 100 feet above it.

Butchers Flat.

30th July.—To-day being Sunday we did not move camp. In the afternoon I ascended the hills to the east. At 3 p.m. at the camp the barometer registered 29.14 and the thermometer 99° in the shade. At the highest point to which I ascended the barometer reading was 26.87, the horizontal distance, east of the camp, being probably not more than two and a-half miles. On the opposite side of the river the hills rise even more abruptly to heights where snow lies in patches, apparently throughout the year being probably not less than 7,000 feet above the sea.

Jackass Mountain.

31st July.—4 a.m., barometer 29.27, thermometer 67°. Starting at 6.30 a.m. we reached the Mountain House (Boothroyd's) at 8.15., five miles from our camp on Butchers Flat. The road rises rapidly the greater part of the distance, the barometer reading at Boothroyd's being 28.82. Thence to the Forty-two Mile House, six miles further, is a descent nearly equal to the previous rise, the barometer at the latter registering 29.22. Two miles more brought us to the summit of Jackass Mountain, barometer, 28.64. This is the most elevated part of the road between Yale and Lytton, where we arrived at 6 p.m., tired and foot-sore, having walked 27 miles, over a very rough and dusty road, the temperature throughout the day being between 70° and 90° Fahrenheit.

1st August was passed in fruitless endeavors to hire fresh Indians or other means of transport. None could be procured, and it seemed uncertain when we should be able to continue our journey. The following morning, however, I learnt that one of Barnard's stage-waggons, which had taken up supplies for the railroad survey parties, had arrived at Lytton

during the night, on its return to Yale. I at once telegraphed a request to Mr. Barnard that he would instruct the driver, instead of continuing his journey to Yale, to take our party on to Cache Creek. This he consented to, and the same evening we reached Spence's Bridge, formerly Cook's Ferry, twenty-three miles from Lytton up the valley of the Thompson, having stopped at some interesting points to take photographs, and to examine the rocks.

The waggon-road between Lytton and Spence's Bridge has been laid out in such a manner as to make it apparently unnecessarily hilly and circuitous. It follows the left bank of the Thompson, in some places at a considerable distance removed, and several hundred feet above the water, while in others it is close on the margin of the river, and only a few feet above it. The old trail seems to be more direct, and to offer better gradients, though perhaps involving a greater amount of cutting and grading. This part of the valley is narrow, and very precipitous, especially on the west side, where the rocks rise in almost perpendicular cliffs from the edge of the water to a height of eight hundred or a thousand feet, presenting magnificent sections of the stratification. Approaching Spence's Bridge a marked change occurs in the character of the country. The hills are lower and less precipitous, better grassed, and less thickly timbered. The quality of the soil is greatly improved, and there are considerable areas of cultivable land. Along the valley of the Fraser and the Thompson to Spence's Bridge there is scarcely any land suitable for farms, and that which is capable of cultivation for gardens occurs only in very limited patches, either on the gravel terraces, or on the narrow alluvial flats which occasionally border the river. The largest, if not the only farm under cultivation between the points above named, is that of the Messrs. Boothroyd, at the Mountain House, where there are a few hundred acres of tolerably level land with a light sandy loam soil. From below Hope to Lytton, the character of the valley of the Fraser, and of that of its tributary, the Thompson, is little else than a deep gorge or cavity cut obliquely through the eastern flank of the Cascade Mountains, which rise on both sides in precipitous ridges almost from the water's edge to heights of from 2,000 to 7,000 feet. These ridges are for the most part pretty thickly clothed with varieties of pine and fir. Except an occasional birch, no hard wood timber trees were observed. Occasionally, for considerable distances, narrow gravel terraces border the river, and, where they occur, the level surface of the terrace has been taken advantage of in constructing the road. From its often passing from the level of one terrace, to that of a higher or lower one, many short steep pitches occur, and as numerous steep transverse gullies and ravines have been scooped in the terraces by the brooks and storm waters from the hills, the curves and windings in the road, to preserve a tolerably level course, are correspondingly numerous, and sometimes occur to such an

Waggon-road
between Lytton
and Spence's
Bridge.

Spence's Bridge.

Soil.

Valley of the
Fraser from
Hope to Lytton.

Timber.

Gravel terraces.

extent as nearly to double the direct distances. In some places, as at China Bluff, below Boston Bar, and at Jackass Mountain, the road has been cut for many miles out of the almost perpendicular walls of rock, or carried round them on strongly constructed timber scaffolding, supported on the projecting ledges; the river foaming and eddying along in its rocky bed, sometimes as much as 800 feet below. At Spence's Bridge, the Thompson is 213 yards wide, with a powerful and rapid current. The bridge is a not very substantial wooden structure, by which the waggon-road crosses to the west, or right bank, about one mile below the confluence of the Nicola River. The waters of Nicola Lake empty through this stream, and it likewise drains a large section of country, lying to the eastward of Lytton and southward from Kamloops, which is stated to be one of the finest grazing and farming districts in British Columbia. I had not an opportunity of visiting the Nicola valley, but a part of it, where a seam of coal has been discovered, was examined by Mr. Richardson. Country of a similar character borders the road for the greater part of the eighty-three miles between Spence's Bridge and Fort Kamloops. The soil is of the richest description, and there are already in this district quite a number of large and well cultivated farms.

Nicola River.

Coal.

Rich soil.

Cache Creek.

Savona's Ferry.

Kamloops.

Cache Creek, which we reached on the 3rd August, is thirty-three miles from Spence's Bridge, and 110 miles from Yale. The settlement consists of the ordinary road-side inn and store combined, a blacksmith's shop and some Indian huts. It is situated on the Bonaparte River, about five miles above its junction with the Thompson, which it reaches by an impassable wall-sided canon, cut, apparently by its own waters, through the gravel terrace deposits of the main valley. From Cache Creek a branch road has been constructed twenty-three miles to Savona's Ferry, where we arrived on the 5th August. This is the eastern terminus of the waggon-road, and is situated at the out-flow of the Thompson River from Kamloops Lake.

A few years ago the Hudson Bay Company built a fine and commodious stern-wheel steamboat at Kamloops, which ran for some time from the terminus of the road above mentioned, through Kamloops Lake and up the South Thompson River, to the eastern end of Great Shushwap Lake, a distance of 115 miles. This vessel is now lying idle opposite the Post at Kamloops, and the only means of transport eastward from Savona's, at present, is either by small open boats and canoes, or by pack-horses on the trails which run up the valley on either side of the lake.

Kamloops is a few miles up the river, at the east end of the lake, twenty-three miles distant from Savona's Ferry, and opposite the junction of the north and south branches of the Thompson. This was the final starting point for the parties which were to explore the Leather Pass in the Rocky Mountains, and the Eagle Pass through the Gold Range, from Shushwap Lake to the Columbia River. Here the pack trains had to be

organized, and the supplies concentrated. I arrived at Kamloops on the 6th of August, with Mr. Walter Moberly, having left Savona's Ferry the previous evening in a small canoe with two Indians. On the 9th of August the other members of our party reached Kamloops, but our supplies were still on the road, and did not arrive for several days; while from the difficulties met with in purchasing the required number of pack-animals and their equipments, and in hiring men, we were not able to complete our preparations until the 18th of August. On the 19th we commenced our journey to the Rocky Mountains.

During our stay at Kamloops, from the 9th to the 18th of August, the greater part of my own time was occupied in attending to the preparations above referred to. A few geological observations were, however, made in the neighborhood, both by Mr. Richardson and myself, and Mr. Baltzly secured a number of excellent and characteristic photographs of the scenery.

With a view to secure information over as large an extent of the country as possible, in the short time at our disposal, I considered it advisable to separate from Mr. Richardson at Kamloops, and while I turned my attention to the valley of the North Thompson and the Leather Pass, that he should make independent explorations, first of a part of the South Thompson Valley, and afterwards along the line of the waggon-road from Cache Creek to Cariboo; and, later in the season, devote whatever time remained at his disposal to investigations in the coal-fields of Vancouver Island.

Leaving Kamloops, as above stated, on the 19th August, the Geological Survey party consisted of eight persons, with fifteen horses carrying camp equipments, photographic instruments and material, and provisions for rather more than two months, together amounting to about 3,600 lbs.

The second division of the Railroad Survey parties had preceded us by a few days with a strong party of axe-men to clear the trail, and we therefore anticipated but little difficulty, and expected to be able to travel at an average speed of from eight to ten miles a day.

The valley of the North Thompson for seventy-five miles above Kamloops, or to Clearwater, though rarely reaching a width of two miles between the base of the hills on either side, and probably not averaging more than one mile, nevertheless presents some considerable areas of fine farming land, on flats either quite open, or lightly timbered with pine and fir, and elevated above the river from five to thirty or forty feet. The finest and most extensive of these, nearly a mile in width, is between fifty and fifty-seven miles above Kamloops, at and below the Red Pine Indian Reserve. On this area, and generally on these flats, the grass is most luxuriant, and in many parts would cut at the rate of from one to two tons of hay to the acre. The last farm up the valley is only fifteen miles above Kamloops, beyond which there are no white settlers.

Camp at The
Little Fort.

On Thursday, 24th August, we camped on a fine flat above The Little Fort, an old and now deserted Hudson Bay Company's trading post, fifty-five miles above Kamloops. At the head of this flat, the first considerable stream from the west joins the North Thompson, issuing from a wide valley trending to the north-west, and which at first appears to be the main valley.

Pass to Lake La
Hache.

It affords a pass from the valley of the Thompson to Lake La Hache on the waggon-road, about fifty-five miles distant. The Thompson makes here a sharp short bend to the eastward, and passes in its upward course round the foot of a rocky bluff rising into a high conical-shaped hill, which, seen from the south, appears almost to block up the valley; the hills on the east side also closing in upon the river, form a canon

Passage of Assi-
niboine Bluff.

or gorge for nearly five miles, terminated by the Assiniboine Bluff, described in *The North-west Passage by Land* (Milton and Cheadle) p. 310, and which here completely bars the further passage along the river bank. The railroad party had cleared and graded a zig-zag trail up this bluff, so steep and narrow, however, that the horses, even when relieved of their loads, traversed it with considerable difficulty and risk. The rise being, according to barometric observation, about 490 feet in 550 yards. Fortunately, some Indians, who were living on the flat where we camped the previous night, brought their canoes up the river to our aid, and transported our baggage round the base of the bluff, a distance of not more than four hundred yards. Having thus surmounted this obstruction without accident, we proceeded on our way, and at 6 p.m. camped about four miles higher up, on a small low flat on the edge of the river, covered with coarse grass, bushes and burnt timber, and which appear to have been flooded quite recently. A thunder storm had been approaching for some hours, and before we got our tents pitched heavy rain commenced falling; the barometer registering at 9 p.m., 28.63.

Overtake pack-
trains.

26th August.—Started at 6 a.m., closely following the bank of the river, the grass and bushes very wet from the rain which fell last night. On Thursday evening we overtook one of the pack-trains which had started from Kamloops several days in advance, and this morning, at three and a-half miles from our camp we passed another, already ten or eleven days on the road. Here the hills again closed on the river, and the trail became very bad, continuing so for the next eight miles. Steep pitches, rocky sidings, thick timber and boggy springs, and the path so narrow that the horses could not pass one another. At four p.m., eleven miles from our last night's camp, the three pack-trains, numbering some fifty or sixty animals, arrived at a spot where the precipitous character of the hills on the east bank, rising almost perpendicularly from the edge of the water, made it necessary to cross to the opposite side. At this point, one mile above the junction of Clearwater, the North Thompson is nearly three hundred yards wide, with a deep channel, and a powerful, rapid current. And now a busy

and exciting scene commenced. One by one the animals were led forward to a small space which had been cleared on the brink of the river, and divested of their loading and saddles. These were transferred, some into a small boat which had been sent up the river from Kamloops, and some into Indian canoes, and ferried, load after load, to the opposite shore. This work finished, the animals in three separate bands, with their respective bell-horses leading, were, after much yelling, pelting and vociferating by the packers and their Indian assistants, forced into the water, and at once struck out for the opposite bank. Some of them, apparently accustomed to the work, made a straight course, while others abandoned themselves to the current and were carried a long distance down the stream, narrowly escaping a watery grave. By dusk, animals and cargo were all safely landed, and our tents pitched about one hundred feet above the water on a narrow gravel and sand terrace, up the steep face of which a zig-zag path had been graded only a few hours before our arrival.

Crossing of the
North Thompson
at Clearwater.

Sunday, 27th August.—We did not move camp. Towards dusk rain commenced falling, and continued during the night.

Monday, 28th August.—To-day we travelled only six miles and a-half, and camped at mid-day on the left bank of Raft River, about one mile above its confluence with the Thompson, on a well-grassed flat, pretty thickly covered with willow and alder bushes. Raft River is a fine clear stream, from two to three feet deep, and about 150 yards wide; at about a mile above our camp it issues from a rocky gorge, making several picturesque cascades in its course towards the flat. The advance party under Mr. McClennan had left this camp in the morning. In the afternoon I rode ahead and overtook them at thirteen miles, within two miles of where the river resumes its north and south course. From Clearwater upwards, the general course of the river, for rather more than twenty miles, is a few degrees to the south of east. I returned to our camp at Raft River the same night, and on the following day, 29th August, we camped on the ground where I had left the advance party the previous evening.

Cascades.

30th August.—A little rain fell during the night, and at daybreak the hills were hidden in fog. Five of our horses were missing this morning. After hunting for them for some time through the wet scrub, I found four, and drove them into camp; leaving the men to find the one still missing, I went on to examine the trail, and, at nine and a half miles, overtook Mr. McClennan and the clearing party, grading and clearing the path up a steep gravel bench. In the last nine and a-half miles a great deal of similar work had been done, and a large amount of clearing of logs and brush had been necessary to make the road passable for the pack-trains.

Horses missing.

Overtake clearing party.

As far as our camp of the 29th August, the country had been tolerably open, and our progress satisfactory, but thenceforward obstructions and difficulties of all kinds increased rapidly. Including two Sundays, on which

Slow progress.

the geological party did not move camp, we had been twelve days on the road from Kamloops, and had travelled ninety-five miles. To-day we made nine and three-quarter miles, and camped on a gravel bench on the margin of the river, about one hundred feet above the water, and about three-quarters of a mile below the junction of Mad River; barometric observations making the height here about 1,550 feet above the sea.

Mad River.

The Little Paddock.

Thick forest and fallen timber.

Decide to retrace our steps to Mad River.

Commence the ascent of the Mountains.

31st August.—Started early, and after crossing Mad River, about five chains above its confluence with the Thompson, soon overtook the railroad party, all hands hard at work, clearing the track and grading the steep banks which had to be traversed. At about five miles and three-quarters above Mad River, after having crossed several small creeks, we came to a small stream, on the other side of which the obscure path we had been following through the forest apparently ended, or was lost in an open grassy flat, which our Indian guide told us was known as "The Little Paddock" and that on it was the last good feed for many miles up the valley. Having spent nearly an hour here, in searching in every direction for the *blazed* trees marking the continuation of the trail, we at length found them in the thick forest on the hill, on the far side of the flat. We then proceeded, clearing the road for a little less than two miles further, when we struck another strong shallow brook from the left. Beyond this the forest became so thick, and was so encumbered with fallen timber, that the task of cutting a road through it in any reasonable time seemed almost hopeless. Our Indian guide now informed us that there was a good trail over the mountains, starting from the right bank of Mad River, always used by the Indians when travelling with horses to Jasper House, in order to avoid the rocks and canons which he said were now immediately in front of us, and extended up the river for not less than twenty miles, and which it would be impossible for us to pass without crossing and re-crossing the river, at least three times; this it was impossible to do without canoes, and we therefore decided to retrace our steps to Mad River. Having come to this decision, we returned to the "Little Paddock" and encamped. The flat here is about 300 yards wide, and extends up the creek on a bearing N. 56° W. for a considerable distance. It is pretty thickly covered with bushes and clumps of willow, alder, hazel, and elder, with a few scattered poplar and pine trees. The soil is a rich, dark, sandy loam, and is well covered with grass between the bushes. The course up the main valley is N. 71° E, magnetic.

Tuesday, 1st September.—5.30 a.m., barometer 28.10. Started at seven a.m., and at 10 a.m., re-crossed Mad River, and commenced the ascent of the mountains. The only evidence of any trail or path except that which we made ourselves, was an occasional *blazed* tree; the ascent was very steep, the forest thick and as much as ever encumbered with fallen timber. At one and one-half miles up, the barometer reading

was 26.87, indicating a rise in that distance of about 1,150 feet. As there was a small spring and fair picking for the horses, we encamped here, the axe-men continuing to clear the trail ahead.

Saturday, 2nd September.—Started at 8 a.m., and paced 3,200 yards up trail, taking bearings; passed the clearing party, and went ahead with McClennan for about two and a-half miles, *blazing* the trail to guide the axe-men. Found the country getting worse, much clearing required, and often very boggy. The men had opened the trail for about three and a half miles from camp. Decided on working to-morrow to try and cut through to the good grass which was said to be ahead, and which the animals, already beginning to show the effects of hard work and bad feed, were much in need of. The risk of losing them in the thickly timbered and badly grassed country we were now in, and of the snow coming before all the supplies could be brought over this mountain road, made it absolutely necessary that no time should be lost. The barometer reading this evening at 3,200 yards up the trail was 25.72, and at camp below at 9 p.m., 26.80, indicating a rise of about 1,000 feet.

Difficult country.

Animals beginning to show the effects of hard work and bad feed.

Sunday, 3rd September.—6. A.M., barometer 26.93. At 7.30 I went ahead with the axe party, leaving instructions for our camp to follow on Monday morning. At five miles and 380 yards we emerged from the forest into a small alpine prairie, and camped at 3.30 p.m., beside a clear mountain brook, which we had crossed lower down and followed up for about 1,000 yards; barometer 24.17, shewing a rise from camp of about 2,610 feet. At 4 p.m., commenced raining and rained all night.

4th September.—6 a.m., barometer 24.05. Cold and foggy. I went ahead two miles with the axe party, clearing and marking the trail, then returned to last night's camp of second party, and paced forward two and three-quarter miles. Our train arrived at 4 o'clock. Several small mountain lakes were passed to day, and a large glacier was seen in the mountains to the east, on the other side of the Thompson valley; 9 p.m., barometer 23.75.

Glacier.

Tuesday, 5th September.—Started early, and at five hundred yards forward reached the water-shed to the north; barometer 23.72, indicating the highest elevation yet reached. Till about mid-day we travelled in a nearly north course over swampy and moss-covered meadows, along a rather flat water-shed crossing the heads of the eastern waters. We then turned more easterly, and descended a steep, thickly wooded hill, full of springs, which made the ground even more soft and boggy than it was in the meadows on the summit. At about four miles and three-quarters from our camp we overtook the clearing party, and owing to the numerous soft places, which had to be logged or covered with branches before the pack animals could cross them with safety, only about three and one-half miles of trail were cleared to-day, and this evening we were all camped within half a mile of each other.

Height of land reached.

Swampy meadows.

Indian winter
camp.

The following morning, Wednesday, the 6th September, I went ahead for about two miles through rather thick forest, when the country again opened into long meadows, bordered and separated from each other by woods and narrow belts of timber. An old Indian winter camp was passed here, the trees around it all chopped off at about eight to nine feet from the ground, indicating the depth of snow. The branches of the trees are very short and much bent downwards, the tops often little better than bare poles. The grass on the meadows, which all partake more or less of the character of swamps, was already brown from the effects of frost, and afforded poor nourishment for the horses, after working hard throughout the day. The nights are cold and generally frosty. To-day we travelled five miles, and camped about 4 p.m. on the border of a stream, running partly from a chain of small lakes, and partly from the low wooded hills and swamps to the westward. This, we imagined, was the source of Mad River. 9 p.m., barometer 24.06. (See photograph, No. 69,964).

Source of Mad
River.

Thursday, 7th September.—A sharp frost last night; ice on the pools, and the grass all frozen stiff. 7 a.m., barometer 24.17. Several horses missing, having strayed into the woods, where the frost is less severe than on the open meadows. Crossing the stream, a short distance above our camp, our course was nearly north, magnetic, along the east side of two lakes emptying into it, the first nine hundred yards, and the second one thousand and fifty yards in length, with an interval of five hundred and seventy yards, the average breadth being less than one-quarter of a mile. Seven hundred and eighty yards further a flat water-shed was reached, (barometer 24.07), falling towards another small lake, 1,050 yards beyond which, on a small brook, was the last night's camp of the clearing party. At 9 a.m., barometer 24.27. Following down the right bank of this brook, we came, at 900 yards, to a fine grassy meadow, trending E. 20° N. and W. 20° S., four hundred yards wide, sloping rather steeply from both sides down to a strong stream running through the centre of the meadow, on a course W. 25° S., and which we thought, from its course, must be one of the main sources of Raft River. We travelled nearly five miles further on a general northerly course, passing over undulating forest country, with occasional rocky ridges interspersed with small swampy meadows. At about one and a-half miles beyond the Raft River meadow, we passed a height of land, barometer 23.91, being a rise of more than two hundred feet from our last night's camp. Thence there was a gradual, though not constant, descent to our camp, nearly three miles and a half further. This evening the railroad and geological parties, and the three pack-trains, are all camped together in rather thick forest, as usual interspersed with open swampy meadows.

Source of Raft
River.

Sharp frost.

Friday, 8th September.—Barometer at camp 8 a.m., 25.06; cold and clear. Sharp frost last night, and the horses all looked very miserable. The axe-party

started early, clearing the trail on a north-north-westerly course. I followed at ten a.m., pacing and taking bearings. At 2,400 yards crossed a strong brook in a deep, narrow gully, falling to the N.E.; barometer in the bed 24.77, and on the bank 24.73. A steep, thickly-timbered range was now in front, and the trail was taken up it, the hill rising on the right, involving a course, as I thought, too much to the westward. In a distance of 2,700 yards we had ascended more than seven hundred feet, the barometer registering 23.93; and at 800 yards further we found ourselves on open, ^{Open grassy hills.} grassy hills, barometer 23.80, overlooking a large, deep valley to the north, while beyond were steep rocky ranges of snow-clad mountains. We were now nearly 1,000 feet above our camp of last night, and not less than 5,700 feet above sea level. The valley in front of us we supposed to be that of Blue River, the first large tributary of the Thompson, above the canons of Murchison's Rapids, to avoid which we had come over the mountains. As we had to cross Blue River at its junction with the Thompson, it was now necessary to seek the shortest and best route to that point. We accordingly turned east, descending about 150 feet on to a flat swampy saddle, from which the water ran north down a narrow gully towards Blue River valley, and on the other side into a small lake, and thence southerly ^{Valley of River.} towards a stream which we had crossed this morning. As there was no certainty of finding good feed further on, we considered it advisable to make our camp here. The clearing party, however, went ahead to clear the trail down the gully above-mentioned, returning to this camp in the evening. None of the pack-trains had yet arrived, and while looking round to find a dry camping ground, I discovered marks which had been put up ^{Find marks shewing the direction of the trail.} by an Indian hunter who had passed us several days before, and had promised our guide that he would blaze some trees and put up marks at this point, to indicate the direction we ought to follow. From these it appeared that our course lay altogether to the eastward of that taken down the gully by the clearing party. Ascending a small hill about three-quarters of a mile north-east of the camp, we obtained a magnificent view of the surround- ^{Fine view.} ing country from north-east to north, north-west and west. In the latter direction, at about fifteen miles distant, a large-sized lake was observed, lying apparently towards the head of the valley, which we supposed to be that of Blue River. The apparent distance and the direction of the lake ^{Large lake.} would, however, place it very close to the valley of Clearwater River, into which it may perhaps discharge. The beautiful views of the Selkirk Moun- ^{Views of the Selkirk Mountains.} tains, though they fail to do justice to the reality, still afford a good idea of the grandly picturesque character of the scenery, and the rugged outline of the ice and snow-covered peaks, as seen from this point.

9th September.—Barometer at camp, 6 a.m., 23.99. This morning the clearing party started in the direction indicated by the marks found last evening, the course lying about N.E. magnetic. After crossing the heads of sev-

Descent to the
Valley of the
Thompson.

eral small brooks, all running to the left, through grassy and boggy gullies, we soon entered the thick forest, the trail falling rapidly towards the valley of the Thompson. The scrub and the fallen timber were so thick, and the descent in places so steep, that after working hard all day, we only cleared 9,400 yards. We were now in a thick forest of large timber, hemlock spruce, fir, and cedar; no grass anywhere, the ground thickly covered with moss. The clearing party camped here, and some of the cargo was also brought on and deposited. I returned up the mountain, and the animals were all sent back for feed, as there was not a blade of grass in the forest below. On this account I sent back instructions in the morning for our party not to move. At the camp of the clearing party, the barometer stood at 26.27, and at our camp, at 9 p.m., 24.35; indicating a difference of about, 1,900 feet in a distance by the trail of 6,400 yards, and nearly half of this fall was in the last 1,400 yards, the barometer rising in that distance from 25.03 to 26.02.

Frosty weather.

Sunday, 10th September, 6 a.m.—Barometer 24.35. A sharp white frost last night. Fine bright day, cloudless sky. Did not move camp: the animals are enjoying themselves in the good feed and bright sunshine. We are now $143\frac{1}{2}$ miles from Kamloops, and have been twenty-two days on the road, thus averaging only six and a-half miles a day throughout, and since commencing the traverse of the mountain only three and five-eighths miles per day.

11th September.—6.30 a.m., barometer 24.32. Fine clear frosty morning; started at 8 a.m., with two men to repair bad places on the trail down the mountain. At noon reaching camp of clearing party; sent the men back, and went on till I overtook the axe party. Trail bearing too much to the eastward. At 3,774 yards crossed a small creek running eastward in a flat-bottomed gully, with steep banks of reddish sand. A short distance beyond this we came to the edge of another flat-bottomed gully, too wide to be bridged, and too boggy for the horses to traverse. As it was late in the day, we returned to the small creek we had just crossed, and camped. 9. p.m., barometer 27.32; probably about 2,400 feet above the sea, and about 2,700 feet below our last camp.

Swampy
ground.

12th September.—6. a.m., barometer 27.47. At 8.30 a.m., started to look for the best course to avoid the swampy ground which stopped our progress last evening. In about half a mile came upon a small creek, at its junction with the Thompson, with soft muddy banks, but with very little water. This creek issues from large swampy meadows, covered with coarse long grass, and bordered by thick willow scrub. These meadows extend a considerable distance up the valley, and the latter apparently branches in several directions, and must receive the waters of a number of the small brooks which we crossed yesterday on the descent from the mountain, much of their water being absorbed in the swampy flats. In order to get

the pack-trains safely over this creek, a substantial bridge had to be erected. This work, and clearing the trail to a suitable camping ground, about one-quarter of a mile beyond the bridge, occupied the whole afternoon. At dusk all the pack-trains arrived and camped. We named this Wild-goose Creek camp, from the circumstance of a number of wild-geese frequenting the swampy meadows above mentioned. 9 p.m., barometer 27.46, about ten feet above the river.

13th September.—The whole party occupied to-day clearing and grading the trail, partly through thick forest encumbered with huge fallen trees and dense under-growth, or along steep hill sides, on which the old forest had been burnt, and was replaced by a growth of sapling spruce, pine and cotton-wood from five to twenty feet high, so thick as to form, in some places, an almost impenetrable wall on either side of the narrow path which we cleared through it. At 4,125 yards from Wild-goose Creek camp, we came to the base of a steep rocky hill, descending abruptly to the water's edge, and extending for 474 yards to the crossing of Blue river, about 130 yards above its confluence with the Thompson.

Thursday, 14th September.—6 a.m., barometer at Wild-goose Creek ~~Blue River~~ ^{Blue River} camp 27.52; heavy rain. All hands at work to-day clearing and grading the trail round Blue River bluff.

15th September.—Trail round bluff finished, and cleared 3,078 yards beyond Blue River. Heavy rain in the afternoon; very wet in the scrub. Did not return to our camp on Wild-goose Creek this evening.

16th, Saturday.—Cleared 3,490 yards, crossing two small creeks, both of which had to be bridged, and passed a large tributary coming in on the opposite side from the east, and which, from the turbid character of its water, we named Muddy River. Heavy rain fell this evening, lasting from four to eight p.m., and making everything wet and uncomfortable. I had not moved our camp from Wild-goose creek, as there was better feed there for the horses than any we had met with beyond. 9 p.m., barometer at camp 27.32.

17th, Sunday.—Did not move camp. 6 a.m., barometer 27.50; 2 p.m., 27.52; 9 p.m. 27.57.

18th, Monday.—6 a.m., barometer 27.61. At 9 a.m. left Wild-goose creek, where our camp had been stationed since Tuesday 12th, and travelled a little more than four and one-quarter miles to the camping ground, from which the clearing party had started this morning. This camp is due west, magnetic, from the valley from which issues Muddy River. Our progress during the past week has been most unsatisfactory, it having taken five days to make only four and a-quarter miles of trail, the whole of it being through dense forests, alternating with boggy creeks and steep sideling hills. The country becomes more difficult as we proceed, and there is now no chance of our being able to reach Jasper House this season. We have short rations, only six weeks provisions left, on a much reduced scale.

Sunday, 24th September.—Canoe camp, 6 a.m., barometer 26.64 ; cold and clear. During the past week we have only made seven and a-half miles. The autumnal rains seem to have set in, and the leaves are falling rapidly. Wednesday, Thursday and Friday, it rained almost incessantly, and snowed on the hills ; every one wet and uncomfortable, and the animals suffering severely from cold, wet nights and want of food. Barometer, 9 p.m., 27.52. The snow on the hills has melted a good deal to-day, and there has been a light breeze from the north. The absence of wind along the valley, even enough to shake the wet off the bushes and trees, is very remarkable. Indeed, since leaving Kamloops, we have experienced nothing approaching a breeze, either in the valley or crossing the mountain.

Autumnal
rains.

Snow on the
hills.

Absence of
wind.

Limestone Ri-
ver.

25th September.—6 a.m., barometer 27.51. Started at 8.45 a.m. ; at 10.30 it commenced raining, and rained incessantly to 9 p.m. Moved camp to-day to end of trail, 12,030 yards, a little more than six and three quarter miles. This camp is about one-quarter of a mile from the river, and from fifty to sixty feet above it. At 7,593 yards above Canoe camp, we crossed a river from the left, which, when full, must be a powerful torrent. It has several channels and a wide stony bed. Now the water is only about twenty feet wide and eighteen inches deep. Many of the pebbles and boulders in its bed are of a white coarsely-crystalline limestone—we therefore named it Limestone River—with others of gneiss, mica schist and quartz. The banks are everywhere low and flat.

26th September.—6 a.m., barometer 27.26. Fine day. Did not move camp ; all hands clearing trail, made 3,624 yards. Forest thicker than ever. 9 p.m., barometer 27.00 ; at 9.15 commenced raining.

Fine waterfall.

27th September.—6 a.m., barometer 27.01. At 6,745 yards overtook clearing party, and cleared 916 yards further. At 4.30 p.m., camped in a thick willow scrub on river bank. Train arrived at 5 p.m. ; only a few light showers to-day ; passed a fine waterfall on the opposite side of the river ; weather too dull for photography.

28th September.—6 a.m., barometer 27.21 ; foggy and showery. Started at 8.30, and worked clearing trail till 4 p.m. Cleared 3,260 yards, and returned to camp. Mr. Baltzly went down the river to take photographs of waterfall ; weather too dull. At 9 p.m., barometer 27.37.

Reach Slaugh-
ter Camp.

30th September.—6 a.m., barometer 27.41. Our train which was sent back yesterday to assist in bringing up supplies for the railroad survey party did not return last night, and we shall not be able to move camp to-day. Took the canoe up the river to 1,300 yards above Slaughter Camp, then returned to camp by trail. 9 p.m., barometer 27.47. Train returned at dusk.

1st October.—Fine morning ; 6 a.m., barometer 27.60. Started at 10 a.m., and left instructions for camp to follow. Paced from where we left canoe last evening 6,570 yards forward, to where I overtook clearing party grading the trail along a thickly timbered siding, sloping steeply

to the water's edge. As there was no prospect of the trail being completed before dark, I turned back to meet our train, and camped at 5 p.m. on a sandy flat at the edge of the water, along which the trail passed, to avoid a large swamp immediately to the rear, around the border of which our starving animals were able to find a little coarse grass. To-day, wanting to go a short distance off the trail, I tied the horse I was leading to a tree, and laid my note book, with some loose sheets of paper, on which were notes of the past three days, and a rough sketch of the river from below Garnet-creek Falls camp, on a mossy bank at the foot of the tree. When I returned the book was pushed off the bank, and the sheets of paper had disappeared. After searching a long time for them in vain, I concluded that the horse must have eaten them. To test this I offered him a blank page from the book, which he at once greedily devoured, thus fully confirming my suspicions. 9 a.m., barometer 27.62. 10 p.m. raining steadily. ^{Horse eats my notes.}

2nd October.—6 a.m., barometer 27.54. Rained all night, and still raining. Paced from bluff where I turned back yesterday 3,630 yards to the North West Fork where I found the railroad party encamped, the men all busy clearing and grading the trail ahead round a steep bluff, to reach the crossing place. We are now opposite the Island in the river described, page 273, *North West Passage by Land*, (Milton and Cheadle), to avoid which we ought to cross lower down, near the junction of the Albreda Lake tributary, which we have to follow up. The main river, or north-west branch, here has three channels, forming a small and a large island. It has been raining all day, and the river is rising fast. 9 p.m., barometer 27.44. A good deal of thunder in the distance. ^{Heavy rain.}

3rd October.—Wet all night, and still raining. 6 a.m., barometer 27.21. Decided to move back and to make the crossing below the islands. Heavy rain all day, with thunder and lightning; clearing the trail up the opposite bank to the junction of the Albreda Lake branch. One of our Indians returned to-day to our Sunday night's camp, to try to get two horses back which had crossed the river there with their packs. For this purpose, he made a small raft, and succeeded in getting the horses, but could not bring the packs across, the raft being unmanageable in the swift current; will have to go down again to-morrow with a canoe. This afternoon we found a fine bark canoe *cached*, belonging, we supposed, to some Indian who is hunting in the mountains. It will be very useful in crossing our cargo. We also found the tree and inscription referring to the guide, André Cardinal, *North-West Passage by Land*, p. 271. 9 p.m., barometer 27.21. ^{Find bark canoe.}

4th October.—6 a.m., barometer 27.48. Fine morning. One of our horses was dead this morning. Last evening all the animals were driven over the river on to the island, as there was no feed for them around our ^{One of our horses dies.}

camp, and this one was swept by the current against a steep part of the bank, and was so long in the water that he got chilled, and was unable to recover. He was already quite knocked up and useless, being barely able to carry an empty saddle. At 9.30 I started, with our Indian guide and a half-breed, down the river in the bark canoe found yesterday, to get the cargo above mentioned. In one hour and twenty minutes we had got it all safely across, and it then took us four hours' hard work, poling, paddling and tracking, often up to the middle in the water, to get back to our camp at the crossing. Our train—ten horses—went back to-day to help bring up railroad supplies from our last Sunday's camp: rest of party clearing trail, and helping to build large canoe to take cargo over.

Crossing the
North-west
branch of the
Thompson.

5th October.—6 a.m., barometer 27.47. After breakfast we lashed our two canoes together, and commenced crossing the supplies, camp equipage, etc., of the whole party. At 11 a.m. everything was safely across to the east bank, following which, for 460 yards, we came to the junction of the North or Albreda Lake branch, which we are able to ford without unloading the horses, and after recording the date of our crossing on trees, alongside that of André Cardinal, we proceeded, following the right bank of this branch for 2,715 yards, when we camped. Day tolerably fine; only a few showers; fog low on the mountains; road swampy and bad; no feed for the horses.

Indian grave,
and cotton-
wood canoe.

Friday, 6th October.—6 a.m., barometer 27.25; showery. Worked all day clearing trail. At 300 yards above our camp we found a newly-made grave and a good cotton-wood canoe. We made 4,550 yards to-day, and camped at 4.30 p.m. on the edge of a swampy flat covered with long, withered grass, and, in some places, by a recent deposit of sand and silt, brought down from the neighboring hills by storm waters. Our pack-train did not come up this evening, the horses having all strayed back to the crossing.

7th October.—6 a.m., barometer 27.17. Started at 7 a.m. and made 5,500 yards. At 3,139 yards after having crossed three streams coming from the north-westward, and passed a high gravel terrace about 200 feet above the river, we crossed to the east bank, just above a steep rocky gorge; thence, following that bank pretty closely for 2,361 yards further, we camped at 5 p.m. at the confluence of a strong stream, about 50 links wide, coming in from the eastward. 9 p.m., barometer 27.08. The railroad party camped 540 yards further, at the confluence of another strong stream, likewise coming from the hills to the eastward.

Sunday, 8th October.—Did not move camp. We found to-day that the main stream also turned to the eastward, a short distance beyond our camp. It had all the appearance of a mountain torrent fed by glacier water. We therefore decided to cross it, and to seek for the trail more towards the west side of the valley. At a short distance we struck a

stream of quite a different character, evidently fed by swamp water, and full of pools and beaver dams. This we concluded must be the Albreda Lake branch, and accordingly determined to follow it to-morrow. As there was no improvement in the character of the country, and no prospect of our making more rapid progress through the interminable succession of swamps, bogs, and brush, I decided to start early on Monday, with one horse and an Indian, and make a push for Tête Jaune Cache, to ascertain, as quickly as possible, whether the party from Cariboo, under Mr. Mahood, had arrived there, and whether we would be able to return by their trail. It was also very important to ascertain whether we could find grass for our animals. They were daily getting weaker, and without improved feed it was evident they would soon perish.

Albreda Lake
branch of the
Thomson.

9th October.—Started at 8.30. a.m., with La Rue, and one pack-horse, carrying blankets, a tarpaulin, and provisions for four days. We followed up the east bank of the stream found yesterday, and after crossing two long, open, swampy meadows, came into burnt forest. Here the old *blazed* trees were nearly all destroyed by fires, and it was very difficult to find the trail. It runs mostly along gravel benches and steep, rocky side-hills, and through occasional belts of young, unburnt, spruce forest. The stream is left a considerable distance to the west, running through swampy flats, and forming long lake-like expansions, the uppermost of which is Albreda Lake. At 2.30 p.m. we gained the summit opposite Albreda Lake, and, a little further to the right, a considerable valley running into the hills on the west, its upward course being about S. 20° W. magnetic. A short distance further we observed below us, on the left, a strong stream running to West 28° North magnetic. This was also very nearly the course we had been following up the valley from our camp of the 7th and 8th October, the position of which was marked by a precipitous gap in the range to the east of it, distinctly visible from where we now were. A short distance further we descended to the level of the stream, which is about one chain wide, and from eighteen inches to two feet deep; fine clear water running swiftly over a sandy and gravelly bed, and bordered by flats covered with bushes and abundance of good feed, consisting chiefly of rather coarse grass and a species of vetch. Not knowing whether we should find grass further on, and our horse being much in want of a good feed, we encamped on the edge of the stream at 3.30 p.m. Barometer 27.04. I thought we had travelled about eight miles; subsequent pacing, however, proved the distance to be rather more than eleven miles.

Start with one
horse and In-
dian guide. La
Rue, for Tête
Jaune Cache.

Swampy mea-
dows and burnt
forest.

Albreda Lake.

10th October.—6 a.m., barometer 27.02. Fine; slight frost. Started at 7 a.m., course down the valley W. 12° N. At 8 a.m., we observed, a short distance ahead, the smoke of a camp fire, which turned out to be that of a Shushwap Indian family, consisting of the man, his wife and two

Meet an Indian
family.

Cache broken
into by a wol-
verine.

children. They were on a hunting expedition, but did not appear to have been very successful. Their camp was at the base of a pile of rocks, in which they had made a *cache*. This had been broken into by a wolverine, and a few minutes before our arrival, the Indian had succeeded in shooting the depredator. Through the medium of my Indian, I learnt that we could reach Tête Jaune Cache on the following day, that the trail was good and that there was plenty of grass at intervals. We are now in a tolerably open country, rocky hills on the right, flanked by irregular gravel benches intersected by gullies; young poplars and spruce, in patches; nearly all the old timber burnt. Our Indian acquaintance accompanied us for about three miles down the valley to show us the trail, which, to us, was almost invisible, but which he seemed to follow through a maze of fallen logs, as easily as I could a cleared waggon-road. (See *Photographs*, Nos. 69,991, and 59,992, the first looking toward Albreda Lake and down the valley of the Thompson.) At 10 a.m., having shewn us the general direction we had to follow, he left us to examine his beaver traps on the river below. I gave him a note which he promised to deliver the same evening to Mr. McClennan, informing him of the improved character of the country, and that I expected to reach Tête Jaune Cache the following day. This, I knew, would be most welcome news to him, and to the whole party.

Gravel benches.

We were now travelling along the edge of one of the gravel benches, which was about thirty feet above the river, flat, and thinly clothed with small pine trees and aspen, the trail gradually trending to the right, and across the shoulders of the benches which here encircle the base of the fine massive mountain, in which the snow-clad range dividing the waters of the North

Mount Thomp-
son.

Thompson from those of Canoe River and the Columbia terminates. At noon we had reached, by several steep ascents, the level of the highest terrace, the barometer on the top reading 26.77; course forward north magnetic, across a wide sandy flat, openly timbered with pine, to the top of the descent from the terrace towards Canoe River, which latter was reached at 1.30 p.m.; barometer at the water's edge 27.22, showing the terrace from which we had just descended to be nearly four hundred feet above the

Canoe River.

river. The crossing of Canoe River was not as formidable an operation as we had expected from the account given of it in the *North-West Passage by Land*, (pages 265 and 266.) We were fortunate in finding the water low, and only about two hundred feet wide. From the flat near the crossing the following bearings were taken:—

Camp River valley and Albreda Lake..	S. 15°	E.
Mount Thompson.....	E. 40°	S.
Down centre Canoe River valley.....	E. 18°	20' S.
On Peak above Fraser River pass....	W. 46°	25' N.
On the Cache....	W. 36°	35' N. 15 miles.

Down Selwyn River valley W. $26^{\circ} 20'$ N. across Cran-
On Three-peak Mountain, head of Canoe [berry Lake.

River valley S. $36^{\circ} 30'$ W. 8—10 miles.

Leaving the left bank of Canoe River the trail crosses a small ana-branch, then about seventy or eighty yards of boggy ground, thickly timbered, and then ascends by a steep zig-zag path, about one hundred feet, to a terrace or wide sandy plateau, which it crosses in a very indirect course towards the south-west corner of Cranberry Lake. This plateau is mostly covered with a thick growth of young pine and spruce. All the old timber is burnt, and either remains standing as bare poles, or lies cumbering and obstructing the trail. Following for about one mile along the west shore of Cranberry Lake through thick poplar, willow and alder coppice, we encamped at 4 p.m., having been travelling nine hours. From the edge of the terrace above Canoe River there is, I think, a slight fall towards the lake, the southern end of which is likewise bounded by an abrupt terrace slope of from thirty to fifty feet high, and there is probably not more than fifteen or twenty feet difference between the level of the water of Canoe River and that of Cranberry Lake; the latter being the higher. The lake has probably an extreme length of about two and a half or three miles, by a breadth in the west part of about one mile. It appears to be very shallow; there are several small islands in it, and over nearly the whole of it the tops of reeds or swamp grass stand above the water. The soil on the west side of the lake is either peaty or a sandy loam, and is thickly covered with a species of light feathery grass, standing about one foot high, and now quite brown and useless as fodder. The character and appearance of the lake and the surrounding country are well shown in the photographs 70,009 and 70,010. On the lake shore, 5 p.m., barometer 27.05, quite a strong breeze blowing, the first we have experienced since leaving Kamloops; 10 p.m., raining slightly; 1 a.m., calm, barometer 27.19; rain ceased.

11th October.—Started at 7.15 a.m., barometer 27.23, sharp frost, clear and calm, course along lake shore N. W. magnetic. At 8 a.m., we missed the trail and came upon a small clear stream, three feet deep, and about four feet wide, flowing to the north-west. This brook, which from the abundant and recent traces of beaver along its banks, I named Beaver Brook, is the outlet of Cranberry Lake. After searching here nearly two hours for the trail, we at length discovered it on the east side of Beaver Brook, bearing towards the base of the eastern hills. In about one and one-half miles, through pine forest, generally tolerably open and good travelling, the ground quite flat and the soil very poor and sandy, we came to the bank of a rapid mountain stream flowing over a stony bed; the water now only from forty to fifty feet wide, and about eighteen inches deep. This stream has all the appearance of being sometimes quite a Selwyn River.

large river. Mr. McClennan subsequently named it Selwyn River. A short distance below where we crossed it, it makes a sharp bend to the north-west, and receiving the waters of Cranberry Lake, through Beaver Brook, passes down the valley to join the Fraser below Tête Jaune Cache, about thirteen miles from Cranberry Lake. The four photographs, Nos. 70,001 to 70,004 show the character of the scenery at Selwyn River looking

Scenery at Selwyn River.

down the valley. In No. 70,004, on the right, is a cliff section of a gravel terrace, with the river at its base. Leaving Selwyn River the trail keeps a tolerably direct course down the valley and along the base of the hills on the east side, crossing, in the first five or six miles, several small brooks; after which no running water was met with till we reached the Fraser at the Cache; after crossing it Selwyn River is not again seen from the trail, as its course is quite on the opposite side of the valley, which is here nearly three miles wide. For three or four miles before reaching the Cache, the ground

Sandy pine-ridges.

along which the trail passes, consists almost entirely of sandy ridges, thinly clothed with pine, and also a few spruce, juniper, and small blue-berry bushes; while here and there are tufts of dry wiry grass. We reached the banks of the Fraser at 3.45 p.m., and were much disappointed at finding no traces of the party from Cariboo; barometer 27.25.

Tête Jaune Cache: no traces of the party from Cariboo.

12th October.—6 a.m., barometer 27.85. Fine, clear and calm. A very sharp frost last night. From the Cache, Mount Thompson bears E. 31° S.; down the valley of the Fraser the bearing is W. 10° N., and up it into the pass E. 33° N. Having satisfied myself that the Cariboo party had not reached the Cache, and that I should have to return by the valley of the Thompson, I determined to hasten back to meet Mr. McClennan in order that he might decide on the best course to pursue for the safety of his pack-trains, and have an opportunity of stopping them at Canoe River, where the grass was much better than at the Cache. Starting at 7.40 a.m., we reached Selwyn River at noon, and Canoe River at 3.30 p.m., and crossing it, we camped on the right bank. 8.30 p.m., barometer 27.46.

13th October.—6 a.m., barometer 27.10. Strong breeze from south-east. Started at 7.45, and at 10 a.m. met railroad party, grading the trail up the steep terrace bank which I had passed at noon, on the 10th, a little less than four miles from Canoe River crossing. In the photographic view, No. 70,006, the terraces over which the trail passes from Canoe River to reach the valley of Camp River, are well seen, immediately below the gap in the mountains, out of which one of the main sources of Camp River issues. The four views, 70,007, 70,005, 70,006, 70,008, if placed together from left to right, give very nearly a panoramic view of the ranges as seen from the bank above Canoe River crossing; on the left, looking down the valley of Canoe River; on the right, up it to the glaciers from which it takes its rise, but which in the picture are hidden by clouds; and, in the left centre, the grand and massive Mount Thompson, with the wooded

Panoramic view from the terrace above canoe River crossing.

terraces mantling round its base. In the two first, to the left, Canoe River is seen in the foreground, and in the third, a lagoon, the river being hidden by the trees in the foreground. This evening, we encamped on the edge of this lagoon, and the half-starved mules and horses seemed to appreciate the good feed in which they now found themselves.

Saturday, 14th October.—It is now evidently quite impossible to reach Jasper House this season, and as the country where we now are appears to be better suited for winter quarters than either Cranberry Lake or Tête Jaune Cache, Mr. McClennan has selected for this purpose a sheltered site on the banks of Camp River, about four or five miles above its junction with Canoe River, and where there is abundance of timber, both for fuel, and for the construction of the buildings, which will be required for the men and for storing the supplies. Thence along the course of the valley to where we are now encamped, there appears also to be sufficient grass for the support of such of the animals as we may be compelled to leave here for the winter. To-day we determined to make an attempt to reach the summit of the Leather Pass, with a small party, lightly equipped, and decided to start early on Monday morning. From the information given us by the Shushwap Indian, whom I met on the 10th, and who had remained with our party, we calculated on being able to reach the summit of the pass, and to return to our camp on Canoe River in eight days; the Indian, who knew the country, acting as our guide.

16th October.—6 a.m., barometer 27.48; fine, clear and frosty; thermometer during the night 26°. Mr. McClennan, myself, Mr. Baltzly, Mr. Hammond, with Philip, our Indian packer, LaRue, the Indian who accompanied me to the Cache, and the Shushwap Indian, "Jem," as guide, constituted our party for the pass. We started at 8 a.m., and reaching Tête Jaune Cache at 4 p.m., crossed the Fraser and encamped on the right bank. The water at the crossing place was only about three chains wide, and from three to four feet deep, running with a rapid current over a bed of large rounded stones. In some places the banks are rocky and precipitous, showing fine exposures of the strata. The river when full would be at least five chains wide, and from six to seven feet deep. 4 p.m., barometer 27.42.

17th October.—6 a.m., barometer 27.40; thermometer 28°; fine and clear. Started at 7.45 a.m., trail very bad; stones, rocks, logs and boggy creeks. We only travelled about seven miles to-day, having had to ford the river five times between Tête Jaune Cache and the Grand Forks, and to travel most of the distance along the now dry bed of the river. At 4 p.m., we camped about one and one-half miles above the Forks, in a thick forest of fir, spruce and pine, on the edge of a small meadow, on which we thought our horses would be able to get some grass. The old trail, at one time used by the Hudson Bay Company, runs up the right bank of the

river to the Forks, but, owing to fires, is now so encumbered with logs as to be quite impassable for horses. If the water in the Fraser had not been very low we should have been obliged to turn back.

Lofty cliff of
crumbling slate.

18th October.—6 a.m., barometer 27.09; thermometer 37°. This morning the horses could not be found. Some of them had strayed back to below the Forks, and were not all found till near noon. Our course forward up the valley was E. 10° N. magnetic. To-day, to get round the "Lofty cliff of crumbling slate," mentioned by Milton and Cheadle, (*North West Passage by Land*, page 251,) we had to climb the mountain by a dangerous zig-zag path, to an elevation of probably more than nine hundred feet above the river: at the highest point reached the barometer reading was 26.10. By a somewhat less abrupt descent we again reached the level of the benches, and at 4.30 p.m., camped about 70 or 80 feet above the river, on a burnt hill side, thickly covered with fallen logs, and so steep that we had to dig and level the ground, to make flat spaces of sufficient size to accommodate our tents. 8 p.m., barometer 26.42.

Moose Lake.

Forest trees.

19th October.—6 a.m., barometer 26.37; fine and clear, slight frost. Started at 7.40 a.m., and at noon crossed a considerable mountain stream from the left, and about one mile further we came to a large open meadow, on which earlier in the season, and before the frost had withered it, the grass must have been very fine. This is probably the open space mentioned in the *North West Passage by Land*, page 249. We stopped here for lunch, and to let our horses have a good feed. About three miles further, after crossing some very swampy ground, and following for some distance along the margin of the river, over slippery rocks and stones below high-water level, we suddenly found ourselves on the shore of Moose Lake, a short distance above its outlet. It was only 2 p.m., but our guide said we must camp here, as we should find no grass further up the lake, which appeared to be from eight to ten miles in length. The stereoscopic views No. 69,994. to 69,997. were taken at this camp. We have travelled about eight miles to-day. The forest is chiefly of spruce, balsam, and hemlock, and rarely cedar. To-night we had some tea made of the "Hudson Bay tea-plant," *Ledum latifolium*. It was better than cold water, but a little sugar would have made it more palatable. 9 p.m. barometer 25.91. The extreme width of Moose Lake is not more than two miles, and at our camp only about 300 yards.

20th October.—6 a.m., barometer 26.05; thermometer 40°. Course up the lake E. 3° S. Bearing down the valley W. 3° S. The greater part of the lake shore, especially the upper portion, is a bed of stones and very bad to travel over. There is a little grass here and there, above the stones, and between the forest and high water mark. At times of high water, it would be necessary to travel almost the whole length of the lake in the water, or else clear a road through the forest. At the south end, rocky hills rise

steeply from the water's edge, exhibiting in their upper parts cliffs of apparently horizontally stratified rocks. At 10 a.m. we reached the head of the lake: immediately above it is a large lagoon and swamp, on which there were numbers of wild ducks, the first we had seen since leaving Kamloops. Passing round the north side of this swamp, and following the valley, we crossed at noon a strong stream from the north, probably Moose River, ^{Moose River.} about fifteen yards wide: at 6 p.m. we crossed another about ten or twelve yards wide, strong and rapid, but not more than eight or ten inches deep. From the large rounded stones, and the clean washed gravel in their beds, these streams are evidently subject to heavy floods. On the south side of the valley between these streams, our guide pointed out a steep pass through the mountains, which he tells us is used occasionally by the Indians, and leads directly to the valley of Canoe River, not far below our camp. ^{Pass to valley of Canoe River.} Some Indians had recently crossed it with a band of horses, on their way to Jasper House. We came upon the tracks of their horses shortly after, and from here the trail was cleared and well marked, but very boggy in places. At 2.50 p.m. we camped on the edge of a small swampy meadow, in which we hoped our horses would be able to find something to eat amongst the tall withered grass, with which it was covered. 3 p.m., barometer 25.92. Our guide now tells us we could not reach the head of the pass till to-morrow night. To-day we must have travelled nearly sixteen miles. Rain commenced falling at 2 p.m., and continued to fall heavily the whole evening, and through the night.

21st October.—6 a.m., barometer 25.97; still raining, and the hills all hidden in mist. This morning we decided on retracing our steps, as we had neither tea nor sugar, and barely sufficient bacon and flour left to last ^{Scarcity of provisions.} us to our camp at Canoe River. At 2 p.m. we reached our camp of the 19th (at the lower end of Moose Lake), barometer 26.04, and at 3.30, and camped on the meadow where we lunched the same day. It has been raining all day, and everything is wet and uncomfortable.

22nd October.—6 a.m., barometer 21.16. Fine morning. Started at 8 a.m., travelled till 3.30 p.m., and camped on the bank of the Fraser, about one and one-quarter miles below the Forks, where there was a good bed of rushes, which the horses fed on greedily, and apparently relished much more than the frosted grass in the swampy meadows. To-day, coming over the Slate Mountain, one of our horses gave in and we had to leave ^{Slate Mountain.} him on the trail; some of the others are now very weak, and I fear we shall have to abandon them also, before many days elapse. 9 p.m., barometer 26.99.

23rd October.—6 a.m., barometer 26.32. Cloudy, mild and inclined to rain; 9 a.m., barometer 26.77. This morning I sent back our Indian guide "Jem," to look for the horse we left behind yesterday, thinking he might be sufficiently recovered to travel. At 10 a.m., Jem returned,

Camp at Tête
Jaune Cache.

bringing the horse with him, having found him only a short distance from where we left him. At 3.40 p. m., we reached our old camping ground at Tête Jaune Cache, and this evening we again enjoyed the luxury of a cup of tea, having found our tea and sugar lying uninjured on the trail, where it had been left on the morning of the 17th. I also killed six grouse to-day, which were a very welcome addition to our stock of provisions, now reduced to a small quantity of flour only, and the tea and sugar recovered this afternoon. At 3 p.m. rain commenced to fall, and continued in heavy showers up to 9 p.m.; barometer 26.72. Still no signs of the party expected from Cariboo. Mr. Baltzly got one or two views of the hills on both sides of the pass below the Forks, but was not able to get one of the magnificent mountain, Robson's Peak (Milton and Cheadle, page 252), which stands in the angle made by the Frazer Grand Forks, and rises with mural precipices to a height of two or three thousand feet above the river. Yesterday, it was cloudless, and presented a truly splendid picture, while to-day, it has been wreathed in mist and capped with clouds. Our Indian told us that their name for this mountain signified, "The lines in the rocks." The whole face of the mountain, and its various spurs and buttress-like projections in their upper portions, are marked out in horizontal lines, due to the unequal weathering and to the varying color and texture of the strata, which apparently consist of alternating calcareous and siliceous bands.

Robson's Peak.

Camp on Canoe
River.

24th October.—6 a.m., barometer 26.86. Started at 8.50 a.m., and reached Selwyn River at 11.30 a. m. We stayed here an hour to take photographs, and reached our camp on Canoe River at 4 p. m. At 9 p.m., barometer 27.20. Thermometer 30°, clear and calm.

Preparations
for return to
Kamloops.

25th October.—6 a.m., barometer 27.30; thermometer 17°. The coldest night we have yet experienced. Towards mid-day clouds and mist with gusty winds, snowing on the mountains and light rain in the valley. The day spent in preparation for our return journey to Kamloops: shoeing horses, repairing pack saddles, &c., &c. 9 p.m., barometer 27.17; foggy and calm; thermometer 40°.

Winter quar-
ters of railroad
party.

26th October.—6 a.m., barometer 27.15; thermometer 38°. At 9 a.m. we left Canoe River, and at 12.30 reached the encampment of the railroad party, who were to be left here through the winter, under Mr. Green, C.E. They had already, during our absence, completed a large and substantial hut in which the supplies were housed, and another near by, to be used for a dwelling, was almost finished. With good water, abundance of fire-wood, and a well stocked store, there is every prospect of the party being able to pass the winter comfortably, in this far-off mountain wilderness. We remained here only long enough to make up some deficiencies in our supplies for the return journey, and then proceeded on our way towards the Albrede Lake summit. We were now a party of twelve, the Geological

Survey party of eight, with Mr. McClennan and three Indians. The latitude of the winter camp is $52^{\circ} 27' 15''$, magnetic variation $25^{\circ} 21'$, and the elevation probably about 2,760 feet. It is, as already mentioned, situated on Camp River, which issues from the western ranges, and forms one of the principal sources of Canoe River, which it joins about five miles to the northward. At 4 p. m., we camped at about ten miles from the summit; barometer, 4.20 p. m. and at 9 p. m., 26.56. It had been raining slightly since 3 p. m. and at 8 p. m. came on heavily.

27th October.—4 a.m., barometer 26.42. The ground covered to a depth of three inches with snow, which still falls thickly. At 9.40 a.m. reached my camp of Monday, 9th October; barometer 26.37. At 10.10, opposite Albreda Lake, barometer 26.30, and at 5.30 p. m. we reached our camping ground of Saturday and Sunday, 7th and 8th October. It had been snowing all day, and we were all cold and wet. One of our horses knocked up, about two miles from camp, and we had to abandon him. 9 p.m., barometer 26.41, rising; moonlight night, clear, calm and frosty.

28th October.—6 a.m., barometer 27.20. Sharp frost, very cold and uncomfortable all night, everything buried in snow, and nothing but twigs for the horses to eat. Started at 9.45 a.m., and reached the crossing at 2.30 p.m.; freezing hard all day. Had to abandon another horse too weak to travel. It will be impossible to take any of our horses further, and we must now build canoes, and descend the river, leaving the horses with the hope they may survive the winter, but which their weak and exhausted state will, I fear, render almost impossible.

The party which left Canoe River to return to Kamloops, on the same day we left there for the Leather Pass, had built a large *cache* here, (photographs 70,012 and 70,013), in which nearly 4,000 lbs. of flour was deposited. In it we also placed all our horse gear, pack-saddles, blankets, &c. It had been very hastily built, and was by no means secure; all the flour bags were damp, and much of the flour had been wetted, and if left as we found it, would probably have been quite spoiled in a month or two. We therefore set to work to empty the *cache*, and to dry and re-bag the flour. This work, building a large canoe, and making paddles and poles occupied all hands from daylight till dark for the next four days; snowing and freezing nearly all the time.

Monday, 30th October.—About seven inches of snow fell during the night.

Tuesday, 31st October.—Thawing slightly.

1st November.—Snow falling nearly all day. This evening our preparations were all finished, and the following morning, at 9.10 a.m., we embarked in our four canoes, the two largest carrying four, and the others two each. At 4 p.m. we camped in a thick willow scrub, wet, cold and uncomfortable. The following morning, 3rd November, starting at 7.20

Murchison's
Rapids.

a.m., we reached Wild-goose Creek camp at noon, and at 2.30 camped on a sandy beach at the head of Murchison's Rapids, about five miles further down the river. On our journey up, we had worked hard for twenty-three days to accomplish this distance.

4th November.—6 a.m., barometer 27.25, rising. Started at 8.10 a.m. To-day we had to portage and walk nearly the whole distance, letting the empty canoes down the rapids, one by one, with the aid of long ropes attached to bow and stern. We did not make more than three and a half miles, and encamped at 4.30 p. m., on a narrow rocky beach, about fifty feet above the river. 9 p. m., barometer 27.78; fine and mild, and the snow nearly all melted.

5th November.—6 a. m., barometer 27.85. To-day we have not made more than one mile. In running the first rapid, one of the canoes capsized in the middle of the river, with two of our Indians, who, however, were none the worse for their cold bath. Fortunately nearly every thing had been taken out of the canoe to lighten her, and our losses from the accident were not important. This evening we camped at the upper end of the upper Gate or Canon. 9 p. m., barometer 28.5; clear and frosty. The cedars here are very fine, tall and straight.

Fine Cedars.

6th November.—6 a.m., barometer 28.12; sharp frost, clear and calm. Commenced at 7.30 a.m., portaging canoes; 282 yards to the top of the hill, 170 feet rise, forty yards level and 208 yards down to still water below the Gate. Before dusk we had all the canoes and some of the baggage over.

7th November.—6 a.m., barometer 28.13. At 6.45 commenced packing tents and baggage over portage, and descended the river for about one mile of still water to the head of the rapids, through the second gate or

Porte D'Enfer.

Porte D'Enfer, (photographs 70,020, 70,025.) Got all the baggage over the portage, about three-quarters of a mile, and camped on the edge of the pool below. 9 p.m., barometer 27.77.

8th November.—6 a.m., barometer 28.12. Slight rain last night, fine and frosty this morning. At 7.30 went back to get our canoes over the portage. By dusk we had all the canoes over, and camped amongst the stones, on the edge of the pool below the Porte D'Enfer canon. The photographs, Nos. 70,014, 70,016, 70,017, 70,019, to 70,023, and 70,025, afford an excellent idea of the character of the scenery of Murchison's Rapids.

9th November.—6 a.m., barometer 28.10; hard frost, very cold in the tents. Started at 8.10 a.m., crossed to the left bank: below the pool more rapids, and we had to lighten the canoes and let them down with ropes: made about two miles and camped at dusk on a stony beach. 9 p.m. barometer 28.05.

10th November.—6 a.m. barometer 27.95. Start at 7.20 a.m.; in about one mile, more bad rapids, extending for nearly three-quarters of a mile, obliging us again to lighten the canoes and let them down stream with ropes. At 11 a.m. re-embarked, and made eleven or twelve miles. All still water, often lake-like and very shallow, with a soft sandy bottom. At noon we came to a camp of the party which preceded us down the valley. They had left here on the 5th. At 3.30 p.m. we arrived at their next camp, where we found sundry articles which they had *cached*, probably to relieve their worn out animals. It was very cold to-day in the canoes; ice forming rapidly along the shores, icicles hanging from the canoes and paddles; 9 p.m., barometer 27.71. The banks of the river here are mostly low and sandy, bordered by flats extending back a considerable distance. There is apparently abundance of good grass on these in summer; they are all flats suitable for cultivation. suitable for cultivation.

11th November.—6 a.m., barometer 27.70, probably indicating snow or rain. The frost was very severe last night, and the ice on the river, floating and fixed, is increasing rapidly. Start at 7.30; in ten minutes came to more rapids, which continued as far as we travelled to-day. At 3.30 we encamped on a gravel bench a few miles above Mad River. At dusk it commenced snowing. 9 p.m., barometer 27.80. Severe weather.

12th November.—6 a.m., barometer 28.00; snowing slightly; about one and a half inches fell last night. At 10.30 a.m. reached the rapid and canon, above the confluence of Mad River; here we had to get the canoes up a very steep hill, and down a much longer and equally steep slope, at the lower end of the portage. While hauling one of our canoes up, the rope broke, and the canoe went down the hill like a sleigh, and shot out into the current, capsized going over the rapids, and passed beneath the ice on the pool below. The largest canoe was so heavy and ice-coated that we were unable to haul it up the hill, and were obliged to abandon it. We had now only two canoes left with which to continue our journey; shortly after dark we had these, and nearly all our baggage over the portage, and we camped, cold, wet and tired, on the left bank of Mad River, at its confluence with the Thompson. Fire-wood was scarce, and there was barely space to pitch our tent, between the steep hill side and the water. Confluence of Mad River and Thompson.

13th November.—Passed a very uncomfortable night. At daybreak commenced portaging our baggage over Mad River to a point lower down, where we could embark. At 10.30 everything was across, but as our two canoes would not carry all our baggage, we were obliged to *cache* the photographic apparatus, and everything not indispensable, and send the canoes down with two Indians in each, the rest of the party following by the trail on foot. We started at 11 a.m. and at 3.30 p.m. reached our camp of the 29th of August, thirteen and one-half miles from Raft River. The snow was from eight to ten inches deep, and walking through it very fatiguing.

Clearwater and Raft River 14th November.—6 a.m., barometer 28.10, at water level. At 7.30 started to walk to Clearwater. Snow deeper than yesterday. At one o'clock we reached Raft River, which we had to ford, the water above our knees, and covered with ice not quite thick enough to bear. At 3.30 p.m. we reached Clearwater, after a very fatiguing walk of twenty miles: the canoes had arrived safely about one hour before.

Red Pine Indian Reserve. 15th November.—Having procured a boat at the depot, we left Clearwater at 8 a.m., and continued our journey down the river. At 3 p.m. we reached the Red Pine Indian Reserve, and camped again in the hut we had occupied on the 23rd August. It was then vacant, but we now found it occupied by an old Indian and all his family. It was a bitterly cold night, and we were glad to share the floor with the Indians and their dogs.

16th November.—Started at 8 a.m.; very cold, the ice forming rapidly in the river. At dusk we reached the *lastranche*, fifteen miles above Kamloops, where we arrived the following afternoon, having only once had to cut our way, for about forty yards, through ice, which had formed quite across the river, though often there was only just room for the canoes to pass between the heavy ice-floes which were floating slowly down the stream.

Distance travelled. We found Mr. Tate in charge of the Hudson Bay Company's post, and we thoroughly appreciated the comforts and kind hospitality with which he entertained us. We had been ninety days absent, having travelled 535 miles; the journey up the valley by land occupying sixty-two days, and the return by water only twenty-eight days.

The following are the distances from Kamloops, measured by pacing along the trail to Canoe River, and thence estimated to the furthest point which we reached in the Leather Pass :—

Distances from Kamloops.	Kamloops to Clearwater.....	75 miles.
	“ “ Raft River.....	82 “ 7
	“ “ Mad River.....	105½ “ 23½
	“ “ Blue River.....	154 “ 48½
	“ “ Crossing at Albreda Lake Branch.....	186½ “ 32½
	“ “ Canoe River.....	216½ “ 30
	“ “ Tête Jaune Cache.....	232½ “ 16
	“ “ Moose Lake.....	251½ “ 19
	“ “ End of Journey.....	267½ “ 16

Approximate elevations determined by barometric observation, mostly from a series of readings. The figures are probably rather above what the height will prove to be by accurate instrumental measurement :—

Elevations.	Kamloops.....	1250 feet.
	Clearwater.....	1403 “
	Raft River.....	1410 “
	Wild-goose Creek Camp, 3½ miles below Blue River.....	2214 “
	Crossing at junction of Albreda Lake Branch.....	2370 “
	Albreda Lake.....	3063 “
	Canoe River.....	2484 “

Cranberry Lake.....	2511	feet.
Tête Jaune Cache.....	2430	"
Fraser Grand Forks.....	2889	"
Moose Lake.....	3600	"
End of Journey near Cowdung Lake.....	3654	"

We left Kamloops on the 20th of November, and reached Victoria on the 29th. At Yale we found that the ice in the Fraser had stopped the steamboats, and we had to descend the river in a canoe. We finally left Victoria on the 7th of December, and arrived in Montreal on the 26th of the same month. Mr. Richardson left Victoria on the 22nd of December and arrived in Montreal on the 9th. of January.

GEOGRAPHICAL FEATURES.

The boundaries of British Columbia on the main-land are, on the south, the forty-ninth parallel of latitude; on the east, the main chain of the Rocky Mountains; on the north, the fifty seventh parallel of latitude, and the boundary of the United States Territory of Alaska; and on the west, the Pacific Ocean and the Strait of Georgia to the forty-ninth parallel. In the province are now likewise included Vancouver Island, at one time a separate colony, and Queen Charlotte Islands, as well as a number of smaller islands in the Strait of Georgia. A line through the centre of the country, from the south-east corner of the province on the forty-ninth parallel to the boundary of Alaska on Nasse Harbour, is nearly nine hundred miles in length, and the average breadth of the province, from the shores of the Strait of Georgia to the summit of the Rocky Mountains, is about three hundred miles, or an area of about 270,000 square miles. Pemberton, in his *Facts and Figures relating to British Columbia and Vancouver Island* (published in 1860), says the area of British Columbia is about three and a half times as large as Great Britain, while Vancouver Island is about half the size of Ireland, or respectively 311, 517 square miles, and 15,937 square miles.

The main orographical features of this region are the Coast or Cascade Range, the great central hilly plateau or table land, and the Rocky Mountain chain: subordinate to the latter, and more or less parallel with it, are two other belts of mountainous country, the Selkirk Mountains and the Gold Range. All these mountain chains, and likewise the central plateau, have a general north-west and south-east course. The coast or the Cascade Range is the northward extension of the Sierra Nevada; the hilly central plateau bears a similar relation to the great volcanic arid and hilly table land of the state of Nevada; and the Selkirk and Gold Ranges may be paralleled with the Bitter Root Mountains between Montana and Idaho, the Wasatch Mountains in Utah, and other chains which occupy a similar position in relation to the main axis of the Rocky Mountains.

Exclusive of the volcanic cones and craters of Mt. Baker, Mount Hood, Mount Rainier, and others from 10,000 to 15,000 feet high, none of which,

however, occur between the Fraser River mouth and Alaska, the highest points of the Cascade Mountains probably do not exceed 7,000 feet. The central plateau has an average elevation of from 1,000 to 3,000 feet. The Selkirk Mountains, especially towards the north, in the vicinity of Cariboo, and about the sources of the North Thompson, have a somewhat greater average elevation than the Cascades, and they likewise appear to contain a greater number of glaciers and of points above the snow line, though their more inland position may perhaps account for this fact, irrespective of their altitude. The highest known summits of the Rocky Mountains are Mt. Murchison, Mount Hooker and Mount Brown, estimated at from 12,000 to 15,000 feet. They have never been ascended, and their geological structure has not, I believe, been ascertained.

Drainage.

Excepting the western slope of the Cascade Mountains, and the extreme northern portions,—the latter drained partly by the Skeena River and partly by Peace River, an affluent of the McKenzie,—the whole of British Columbia is drained by only two great rivers, the Fraser and the Columbia. The former receives all the waters of the Cascade Mountains, the greater part of those of the central plateau, and of the western slope of the Gold Range, while its main eastern sources are on the western flank of the Rocky Mountains, north of the fifty-third parallel of latitude. The principal eastern branch issues from the Leather or Yellow Head Pass: and from its source at the summit of the pass above Cowdung Lake, 3,750 feet above the sea, following the course of the stream to its mouth below New Westminster, is a distance of not less than six hundred and fifty miles. Its main western branch issues from Francois Lake, only a few miles less distant from the mouth, and one degree north of the eastern source in the Leather Pass, giving a fall of a little more than five feet to the mile. There are however many long stretches of almost level water in the upper part of its course, and it is stated to be navigable for steamers, with but few interruptions, from above Quesnel Mouth to near Tête Jaune Cache. At the latter place, in October last, the water was not, where we crossed it, more than four feet deep, and the appearance of the river was not very promising for steamboat navigation. I have not myself seen any part of it between Tête Jaune Cache and Lytton.

**Character of
upper courses
of the Fraser.**

The Columbia River drains a much smaller area within the British territory than the Fraser, its waters being chiefly confined to a triangular tract of country, the base of which is the United States boundary along the forty-ninth parallel, and the western side, the 120th meridian as far north as Tête Jaune Cache and the Leather Pass. Canoe River to the north, the Kootenay River to the east, and the Similkameen and Kettle Rivers on the west, are the only important tributaries of the Columbia north of the British boundary. There is a remarkable parallelism in the general course of these two great rivers. From their sources they both

**Parallelism in
courses of
Fraser and Col-
umbia Rivers.**

flow in a nearly north-westerly direction for about 180 miles ; they then both make a sharp turn, generally known as "The Big Bend," to the south, flowing nearly due south, and almost parallel with each other for 350 miles ; the Fraser to Hope and the Columbia to Colville, whence respectively they reach the sea by an almost rectangular bend to the westward. The Fra-^{Navigability of the Fraser and Columbia Rivers.}ser is navigable for steamboats for only one hundred miles above its mouth. The navigation of the Columbia from the sea, for more than 300 miles, is interrupted by only two short portages ; and above this, with the exception of a few short intervals of impassable rapids, it is navigable nearly to the Boat Encampment, at the junction of Canoe River, 250 miles above Fort Colville, and more than 800 miles above Astoria.

GEOLOGICAL STRUCTURE.

The rocks in the vicinity of Victoria and Esquimalt were, I believe, ^{Explorations of Mr. Bauerman and others.} examined first in 1858 by Mr. Bauerman, the geologist attached to the British and North American Boundary Commission ; and again in 1859 or 1860, by Dr. Hector, who accompanied Captain Palliser, in his exploration of the southern passes of the Rocky Mountains within the British territory. The result of these observations has been published in the Journals of the Geological Society. The geology and mineralogy of Vancouver Island and of portions of British Columbia have also been investigated and described by other authors, among whom are Dr. Forbes, of the Royal Navy, Lieutenants Mayne and Palmer, the Rev. C. Lundin Brown, of Lillooet, Mr. Justice Begbie and Mr. Pemberton. A number of papers and communications have also been published by Dr. Robert Brown, giving the result of his observations extending over four years from 1863 to 1866, during which time Dr. Brown made several scientific explorations in the Island on behalf of the local government, and also extended his observations to portions of the mainland. I have had an opportunity of reading only two of Dr. Brown's papers ; one, *On the Physical Characteristics and Geographical Distribution of the Coal-Fields of North-west America* (published in the Transactions of the Geological Society of Edinburgh, 1868-1869), and which contains an excellent description of the Coal-fields of Vancouver Island ; and also one, *On the supposed absence of the Northern Drift from the Pacific Slope of the Rocky Mountains*. (American Journal of Science and Arts, November, 1870). I was not able to make any personal examination ^{Coal-fields.} of the coal-fields in British Columbia, but Mr. Richardson did so, and the detailed result of his observations is embodied in his official Report. The opinion he has formed respecting the value and extent of the coal deposits on Vancouver Island is exceedingly favourable, though perhaps not quite so high as that of Col. Moody, R. E., who when speaking of Nanaimo at a meeting of the Royal Geographical

Future of
Nanaimo.

Society in 1864 said it is destined to be "a Newcastle, a Birmingham, a Glasgow and a Swansea, all in one," while the future of Victoria and Esquimalt be considered as entirely commercial.

The few days I remained in Victoria were almost entirely taken up with the necessary preparations for our contemplated journey to the Rocky Mountains, and I therefore saw but little of the geology of Vancouver Island.

Rocks of Van-
couver Island.

In the immediate vicinity of Victoria, and around the shores of the harbours of Victoria and Esquimalt, crystalline diorite and epidotic and greenish fine-grained rocks prevail, associated with massive granitoid, chloritic, feldspathic and hornblendic gneisses, quartzites, and bands of more or less crystalline and silicious grey limestone, also epidotic. Mr. Bauerman mentions the occurrence of serpentine, and dark green sandstones and mica slates, penetrated by crystalline greenstone and syenite; the beds being fused at the lines of contact. We saw no serpentine on Vancouver Island, nor any rocks which I should be disposed to consider as certainly intrusive. Their generally crystalline character is more probably due to metamorphic action on original sedimentary deposits, notwithstanding that often no trace of stratification can now be discerned in them: and this view is strengthened by the very important fact, which, through the labours of Mr. Richardson, we are able to establish, namely, the fossiliferous character of the associated limestones. Though the fossils in these limestones are too fragmentary for specific determination, yet the external forms, as developed by the action of acid on the specimens, leave no doubt of their organic origin. The Vancouver Island limestones do not differ materially from others from the main-land, in some of which we have found well preserved fossils, but which up to the period of our examination were supposed to be equally devoid of organic remains.

Fossiliferous
limestone.

Huronian and
Quebec Group.

I examined several outcrops of the limestones between Victoria and Esquimalt, and also on the west shore of Esquimalt Bay. They are everywhere associated with epidotic and crystalline metamorphic rocks of the nature already described; and which, according to their lithological character and general aspect, might pass for strata either of Huronian age, or of that of the altered Quebec Group of Canada. A specimen from the last mentioned locality, supposed to be serpentine, has been analysed by Dr. Hunt. He finds it to contain 54 per cent of silica, and only a small proportion of magnesia, and having the composition of a fine-grained diorite. This rock almost immediately overlies a thick band of limestone, the run of which is nearly magnetic east and west with a high southerly dip. In the paper already referred to by Dr. Brown on the glacial phenomena, he mentions gneissose rocks, crystalline limestones and traps, as being the only rocks seen for long tracts on the north shore of De Fuca Straits; and also says "A great portion of the island is occupied by igneous rocks—chiefly traps

and metamorphic sandstones,—seen in the southern and south-eastern sections.” On the Leech River, a tributary of the Sooke River, Dr. Brown first discovered gold, and he states that \$100,000 worth was extracted from Gold, the stream in less than three months, and that nuggets of forty, fifty, sixty and even seventy and eighty dollars, were not uncommonly found.

Leech River takes its course along the junction of two classes of rocks which Dr. Brown describes as trap and metamorphic slates; the slate forming the bed of the river, and in many places changing into micaceous sandstone or shale. Numerous quartz veins run in the same direction as the cleavage of the slate. No gold has been found in the creeks on the right bank coming off the trap. Since the first discovery by Dr. Brown, gold has been found in all parts of the island where similar slaty rocks occur; but nowhere, except in the first locality discovered, in paying quantity. There are many fine examples of ice-grooves and scratches on the rocky shores of the island, some of which, near Victoria, are well shewn in the stereoscopic views taken by Mr. Baltzly during our stay there. The direction of the grooves where I observed them was N. 10° to 15° W. magnetic. Dr. Hector states their course to be N. E., and also that they are equally conspicuous on the main-land shores of the Straits of De Fuca. We did not observe any similar markings on the main-land, but our observations did not extend to the coast, or to any part of the western slope of the Cascade Mountains. The course assigned to the glacial grooves by Bauer-Glacial action.man, is N. N. W., and S. S. E., very closely coinciding with my own observations of them near Victoria. Mr. Richardson’s observations make them S. 27° W. It therefore appears that they occur in two directions nearly at right angles to each other.

Professor J. D. Whitney has stated that a northern drift does not occur in California, and that no evidence of its occurrence has yet been detected on the Pacific coast, as far north as British Columbia and Alaska. This conclusion having been arrived at on the authority of Mr. W. D. Dall, naturalist attached to the Collins Overland Telegraph Company, and who states that though he had carefully examined the country over which he had passed, in Alaska, for glacial indications, he had not found any effects attributable to such agencies; and that no boulders, no scratches or other marks of ice action had been observed by any of his party, though carefully sought for.

Dr. Robert Brown, in the paper before cited, in *Silliman’s Journal*, November, 1870, states that there is abundant evidence of glacial action, and of the wide distribution of a true glacial boulder-drift, and quotes Mr. Bauerman in support of his views. Of the existence of ice-grooves on the shore of Vancouver Island there can be no question. Inland, neither Mr. Richardson nor I observed any.

Geological observations on the main-land.

Our geological observations on the main-land commenced on the 28th July, at Yale, the head of steamboat navigation on the Fraser, and for 110 miles, or to Cache Creek, were restricted to one line of traverse and its immediate vicinity. From Cache Creek two lines were examined, the one by Mr. Richardson along the line of the waggon-road to Cariboo, and the other by myself, via Kamloops and the North Thompson River, to Tête Jaune Cache on the Fraser, and thence nearly to the source of the latter, at the head of the Leather Pass, in the Rocky Mountains,—the distances being respectively about 268 and 318 miles from Cache Creek. Thus, only a very small portion of the Province has yet come under our observation, and, therefore, any even general conclusions we may have arrived at respecting the geological structure of the country and the sequence of the various formations, based, as they necessarily are, on so cursory and limited an examination, will probably require considerable modification after further and more detailed examination shall have been made. So far, however, as we at present know them, the rock formations of British Columbia may be grouped under the following divisions, reversing the order of their deposition :—

Grouping of Rocks.

- I. *Superficial Deposits.*
- II. *Volcanic Series and Coal and Lignite Group of the Main-land; and the Coal-rocks of Vancouver Island.*
- III. *Jackass Mountain Conglomerate Group.*
- IV. *Upper Cache Creek Group (Marble Canon Limestones.)*
- V. *Lower Cache Creek Group.*
- VI. *Anderson River and Boston Bar Group, and Upper Rocks of Leather Pass and Moose Lake.*
- VII. *Cascade Mountain and Vancouver Island Crystalline Series.*
- VIII. *Granite, Gneiss and Mica-schist Series* of North Thompson, Albreda Lake and Tête Jaune Cache, including the micaceous schists of the Cariboo district.

Terraces or Benches.

I. *Superficial Deposits.*—These are chiefly developed in the ancient terraces or benches, which, throughout the country, are wonderfully regular and persistent, occurring from the coast up to elevations of nearly 4,000 feet, in the passes of the Rocky Mountains. They give a marked and peculiar character to the scenery of the river valleys, rising like gigantic stairs to elevations of sometimes more than four hundred feet above the adjoining river or lake. In some places two, three, four and five distinct steps can be seen; while often they have either become merged into one by subsequent denuding agencies, or else the precipitous character of the side of the valley has altogether prevented their formation. The steps vary greatly in width and in height, the greatest height observed being as much as one hundred feet; what the greatest width is I have not ascertained; from one to five chains is not uncommon. In some of the stereo-

scopic views these terraces are well seen, especially in those of Lytton, the north bend of the Thompson and Canoe River.

Recently, February, 1871, Mr. Justice Begbie has brought the subject of the terrace deposits of British Columbia under the notice of the Geographical Society in London. He suggests that they are due to a vast lake, or series of lakes, and that their drainage was connected with an elevation affecting a large mass of the continent, raising at different periods various ridges of hills and mountains, either together or separately, resulting in protruding them through the wide-spread lacustrine formation. Reviewing these suggestions by Mr. Begbie, Professor James Dana remarks, that, if admitted to be lake terraces, the facts would prove that a large part of the continent had been covered with lakes in place of rivers, and just where rivers should have existed, which he says is a view not to be entertained; and he thinks that successive elevations of a portion of the continent a few feet would, by increasing the excavating force of the streams, be sufficient to produce all the results observed.

Movements of elevation such as are indicated might, however, produce an exactly opposite effect to that assigned to them by Professor Dana. If the elevation happened to be greater along the coast than inland it might operate in such a manner as to cause the formation of lakes in valleys which were previously traversed by rapid rivers.

Nearly all the lakes in British Columbia occupy long, narrow depressions in the river valleys, and are, in fact, lake-like expansions of the rivers. There is, I think, no doubt that such lakes were at one time much more extended and more numerous than they now are; and that in many places, as for instance at Lytton, and on the north bend of the Thompson, and at Canoe River crossing, the terraces mark the old margins of these lakes, while in others they doubtless represent only the ordinary flood-flats of the rivers. The removal of the rocky barriers by which these inland waters were confined would result in the formation of such gorges and canons as we now find on the Fraser at Yale, and below Lytton, as well as on the North Thompson at Murchison's Rapids, and on Canoe River below the wide flats at the crossing, and would, without any general movement of elevation, drain off the waters of the lakes, leaving the old shore lines exactly as we now see them, at corresponding heights on both sides of the valleys. Ordinary alluvial river flats do not commonly occur in that manner, but where a flat occurs on one side there is usually a steep bank on the other, and especially is this so along rapid rivers which traverse a mountainous country. If the terraces are due to river action only, the detrital accumulations in which they have been excavated must at one time have filled the valleys to elevations corresponding with the highest terraces, and this implies the existence of broad flat-bottomed valleys, where now there are steep gorges and rocky canons. The filling in of

these valleys must have taken place during a lengthened period of depression of the land, followed by successive movements of elevation during the terrace epoch.

Gold in Lower
Fraser Valley.

The gold of the Lower Fraser Valley is apparently all derived from the terrace deposits. Often the workings have been on the upper benches ; but the principal " bars," as they are locally termed, are below the highest flood levels, and, as their name indicates, are situated above some rocky bar or barrier in the bed of the river, which has acted like a riffle in arresting the heavier particles of gold. The deposits consist of sand, silt, clay and gravel, mixed with large, more or less water-worn blocks of local rocks, occurring chiefly in the lower portions. The gold is not confined to the layers which rest directly on the bed-rock, but occurs equally rich at several distinct horizons.

Indians and
Chinese as Gold
washers.

The rich " bars " of the Fraser are now supposed to be for the most part exhausted, and have for some time been abandoned by white miners. There seems, however, to be a process continually going on by which the lower bars and flood-flats become replenished with fine gold through the annual floods operating on the slopes of the terraces within their range, and redistributing the gold they contain along the course of the stream. Nearly all the Indians of the Fraser above Yale have now become gold-washers. They return to the same point on the river year after year, at the season of lowest water, to wash the sands, and, it is asserted, can almost always earn for a day's labour from one to two dollars' worth of gold. Besides the Indians there are quite a number of Chinese who make a living in the same way, and appear to have permanently located themselves at intervals all along the banks of the river, where they have built themselves log huts, and often, on the most unpromising-looking places, have made small gardens, in which by dint of carrying soil and water, they succeed in raising fine crops of vegetables, for which they find a ready sale to the teamsters on the waggon-road. The soil of the terraces is generally poor and sandy or stony, but by the aid of irrigation small gardens and fields of a few acres are successfully cultivated, especially on the lower flats which are occasionally flooded. There seems no reason to doubt that the gravel benches or terrace deposits of the Fraser and of the North Thompson, which border these rivers with but few interruptions from Yale to the Leather Pass, as likewise those of many similar valleys in British Columbia, would afford a highly remunerative field for hydraulic gold-washing on a large scale, the only drawback being the unavoidable suspension of operations during the winter.

Hydraulic
Mining.

II. *The Volcanic Series ; the Coal and Lignite Group of the Main-land ; the Coal rocks of Vancouver Island.*

On the main-land the rocks of this division are, so far as known, confined Central plateau. to the central plateau, which, preserving its peculiar geological and phy-

sical features, extends with varying width throughout the country from the forty-ninth parallel, I believe, to Alaska. The valleys of the Fraser and the Thompson intersect it diagonally from north to south. On the Fraser, the south-western edge is about fifty miles above Lillooet, and the north-eastern not far from Quesnel Mouth. On the Thompson, its south-western boundary is about thirteen miles below Spence's Bridge, and its north-eastern about sixty or seventy miles above Kamloops. Between Lillooet and the North Thompson it appears to have a maximum width of only fifty to sixty miles. To the north the great Chilcote plain forms a part of it, and both there, and in the Okanagan and Similkameen valleys to the south, the width is not less than one hundred miles.

The very few observations we have yet made scarcely justify any attempt to define its geological structure. Probably nearly all the groups enumerated are represented within the area, the older ones especially where the valleys are deeply excavated. It may be described as consisting of a base of more or less crystalline and slaty rocks, much disturbed and dipping at high angles; resting on these unconformably, filling up depressions, and sometimes capping the higher elevations' and forming buttress-like hills are the rocks of division II. They consist of a series of comparatively undisturbed and unaltered deposits, partly sedimentary, and probably often of fresh-water origin, and partly volcanic, associated with seams of coal or lignite and plant-bearing beds. Sandstones, shales and conglomerates, of various textures and degrees of hardness, are also met with in the series, and amongst the volcanic accumulations there are columnar basalt, dolerite, cellular lava, and various amygdaloidal, brecciated and fragmental rocks, containing zeolites, calc-spar, opal, chalcedony, agate and quartz in veins and cavities. Copper and silver ores have also been found, but whether they belong to the lower crystalline rocks, or to the newer volcanic period, has not been ascertained. In the corresponding regions of Nevada, according to Mr. Clarence King, silver ores occur in nearly all the formations from the Palæozoic Carboniferous to the Tertiary Volcanic series inclusive.

I was not able to examine the site of the silver-bearing ledges at the Eureka Silver Mine, near Hope, but was informed that the proprietor of the claim valued it at \$300,000. Difficulty of transport, the high price of labour, and the want of the requisite capital have, however, hitherto prevented its development. The mine is situated nine miles south from Hope on the Fraser River, at an elevation of about 6,000 feet above tide water. Messrs. George Dunbar and Thomas Schooley are the proprietors. They state that the vein is from three to twelve feet wide; that a tunnel has been driven on it for 500 feet, and that it can be seen for a thousand feet, on a strike N. E. and S. W., dipping S. E. $< 80^{\circ}$ - 90° . The specimens for

analysis, (for which see Dr. Hunt's Report,) were taken from a heap of several tons, and were considered a fair average of the whole.

Fossiliferous beds. On the south side of Kamloops Lake, the volcanic rocks are exhibited in perpendicular escarpments of columnar basalt, and are associated with plant-bearing beds, and fossiliferous shales and sandstones. Dr. Dawson has examined a thin slice of one of the latter, prepared at the museum by Mr. Weston, and he states, "It appears to contain quantities of *Orbulina* and *Globigerine Foraminifera* and sponge spicules. The forms are distorted as if by metamorphism or excessive pressure, and may be Cretaceous." Of the plant remains from the same locality, Dr. Dawson says, "On a few small specimens I observe a Coniferous plant, apparently *Taxodium cuneatum* of Newberry, and also what seems to be a fragment of a Cycadean leaf. I should think these Cretaceous."

Clinton. Similar rocks, Mr. Richardson states, extend westward to within a few miles of the Bonaparte River. In the vicinity of Clinton, they cross to the west side of the river; alongside the waggon-road, twelve miles above Clinton, a chasm has been excavated through them from 200 to 300 feet deep, and about half a mile wide, which stretches for five or six miles to the southward. From the bottom the sides slope upwards at an angle of about 30° to the base of the vertical cliffs of horizontal volcanic strata, from 100 to 200 feet high, which form the walls of the chasm. The slope below being composed of a fine earth-like deposit, resulting from the disintegration of the debris fallen from the cliff above, and bearing a scanty covering of grass and a few small trees.

From here to the 150 mile house, where a small outcrop is seen, rock exposures are rare; but a few miles above Soda Creek, similar volcanic rocks rise wall-like to a height of several hundred feet, at about one mile from the river. Further on they bound the river valley on both sides, extending sometimes for miles in an unbroken wall, from half a mile to two miles from the river, between which and the base of the cliffs there are rich grassy slopes.

Coal-bearing rocks. Above Fort Alexander, and at intervals to Quesnel mouth, the coal-bearing rocks crop out along the river, in a horizontal position. Whether they extend beneath the cliffs of horizontally-bedded volcanic rocks, which, as before stated, bound the valley from two to five miles distant, has not been ascertained. At Quesnel Mouth, an interesting section of the coal strata has been exposed by a recent slide. It is in descending order as follows:—

Section at Quesnel Mouth.

	Feet.	In.
Pale grey, yellow, red and black beds, some of a very light compact rock containing thin grass-like stems and in places pieces of coal; others hard.....	100	0
Grey mud.....	20	0
Grey sandstone with leaves and stems of plants.....	1	0
Sand with rounded pebbles.....	25	0

Mud with impure coal.....	26	0
Drab ferruginous sandstone with leaves and stems of plants, from two inches to.....	2	0
Impure coal, mixed with earth, stems and leaves of plants. On the top a few trees remain with part of the stems and roots as they grew, both being partly mineralized.....	10	0
Grey clay.....	6	0
Total.....	190	0

The rocks exposed in the upper part of the above section shew marks of having been subjected to considerable heat. About one mile above Quesnel Mouth, smoke and hot vapours have for several years issued from the ground. The residents in the vicinity have erected a hut over the orifice whence the vapours issue, which they use when they wish to enjoy the luxury of a steam bath. A few miles above Fort Alexander, a similar escape of smoke and steam has been observed. In both cases it is supposed to be due to the slow combustion of beds of coal or lignite, which have taken fire, either accidentally from the surface, or more probably by spontaneous ignition. In the geologically somewhat similar regions in Nevada and Idaho, emissions of steam and heated vapours are very common, and can be witnessed in close proximity to the railroad, in many parts of the Humboldt valley.

Dr. Dawson has examined the plant remains from Quesnel Mouth. He says, "The prevalent genera seem to be *Quercus* and *Platanus*. There is also a leaf referable to *Pterospermites*, Heer; and possibly an *Acer* and *Populus*. The species seem to be different from those of Vancouver Island, and, I should think, not improbably of Miocene age. Larger and more perfect collections should be made." Slices of the fossil woods collected at Quesnel Mouth have likewise been examined by Dr. Dawson. Some are of Exogenous woods, shewing structure like that of modern poplar, probably *Populus* or *Platanus*; others are of Coniferous wood in the state of Lignite or brown coal. One of these is remarkable for its density, and Dr. Dawson thinks must be heart-wood of a large tree or a knot—the structure is similar to that of Cypress.

"The specimens," Dr. Dawson says, "do not throw much light on the age of the formation, except to strengthen the probability of its being Tertiary. They are different from the woods examined from Vancouver Island, and fossilized in a different manner. In nearly all the specimens the woody cell-walls appear to be in the state of brown coal."

Several miles to the westward from Quesnel Mouth, white wall-like cliffs of these rocks are seen, which, with their associated volcanic strata, apparently stretch far to the north-west, beneath the rich grassy plains of the Chilcoten district.

The Vancouver Island Coal rocks are fully described in the Report of Mr. Richardson, and do not therefore require further notice here. Though

Vapour emissions.

Plant remains from Quesnel Mouth.

Coal Rocks of Vancouver Island.

apparently of the same age as those in the vicinity of Kamloops, they are not associated with any rocks of volcanic origin, and, I am inclined to think, they are somewhat lower in the series.

Sandstone,
shales and con-
glomerates.

III. *Jackass Mountain Conglomerate Group*.—The rocks of this group were first observed on the waggon-road between the fortieth and forty-second mile posts. They consist of hard, close-grained and thick-bedded, greenish sandstones or quartzites, green and black shales, and, above these, massive thick-bedded pebble conglomerates, dipping generally at low angles in various directions: some of the enclosed pebbles are of rocks belonging to the Cache Creek series. At Jackass Mountain the road is built round, or excavated out of vertical cliffs of these conglomerates, at from 800 to 900 feet above the river, into which you can almost drop a stone from the parapet of the road; and at a short distance back they rise into hills, not less than 3,000 feet above the valley, which they occupy to within about five miles from Lytton. Another small area of these rocks was observed by Mr. Richardson, commencing between the 127th and the 128th mile-posts, and extending on each side of the road for about seven miles, after which no rock exposures occur for many miles. The geological position of this group is at present uncertain; no fossils were found in it, but it is supposed to be younger than the Upper Cache Creek group.

Roads to
Cariboo.

IV. *Upper Cache Creek Group*.—Clinton, or "The Junction," is situated at the junction of the two waggon-roads to Cariboo; the one to the west by the valley of Harrison, Lillooet and Seton lakes, and Lillooet; and the other by the valley of the Fraser and the Thompson. It was on the latter road, between Clinton and Lillooet, that Mr. Richardson first observed this group. The road runs there through a valley, transverse to the strike of the rocks, from one to two miles wide, on either side of which hills rise abruptly from 1,000 to 2,000 feet. The base of this group Mr. Richardson supposes to be here, about two miles west of Clinton. The beds have generally a high westerly dip. They consist of a great volume of bluish, dove-colored, and white limestones, often a good marble, interstratified with brown dolomitic limestone, red and green shale, and epidotic and chloritic rocks, with others which closely resemble rocks of the Quebec group in the Eastern Townships of Canada. These rocks occupy the country westward for about six miles. On their strike to the northward they can be easily traced by the eye, from the almost snowy appearance of the limestones, for twenty or thirty miles; and in the opposite direction they can be traced, by the same characters, for ten to twelve miles, to another transverse narrow valley called Marble Canon. A narrow, deep lake, of clear water, occupies the bottom of this canon, the white cliffs of limestone rising on either side of the lake to heights of from 2,000 to 3,000 feet above the water. About half-way up, on the north side, the limestone

Limestones,
shales, &c.

Marble Canon.

beds stand up in masses which look like detached columns of a diameter of from fifty to one hundred feet, and from three hundred to four hundred feet high, due probably to unequal weathering of the here almost vertical strata.

How far the rocks of this group extend to the southward has not been ascertained. It is not unlikely that in that direction they pass beneath the rocks of the volcanic series which extends westward from Spence's Bridge, on the Thompson, towards the valley of the Fraser.

The only other locality where similar rocks were observed was near the 164th and the 165th mile posts, on the waggon-road, which is very nearly on what appears to be the direction of their strike to the north-westward from Clinton. In both localities the limestones are succeeded by a considerable thickness of black shales, sometimes soft and calcareous, *Black shales.* but often hard and flinty.

The only fossils discovered in these rocks are in specimens of the *Fossils.* limestone from Marble Canon. Of these, Dr. Dawson says, "They contain large Foraminifers of the type of *Loftusia*, but different generically; also other smaller Foraminifers, probably Eocene or Cretaceous."

V. *Lower Cache Creek Group.*—The rocks of this group were first met with on the waggon-road, a short distance above Spence's Bridge, and they extend thence along the line of the road to four or five *Extent.* miles above Clinton, where they become covered by rocks belonging to the Volcanic and Coal groups. At Clinton they occupy a breadth of six or seven miles, being overlaid on the west by strata of the Upper Cache Creek group, apparently in conformable succession, and on the east by rocks of the Volcanic series. Between Spence's Bridge and Cache Creek, these rocks can be well studied in cuttings on the road, as well as in the numerous exposures on the adjacent hill sides. They *Characters.* consist of massive beds of grey sub-crystalline limestone (Photograph No. 69,926), black flinty shale in beds of from one to three or four inches thick, chloritic and epidotic rocks with serpentine and soapstone; there are also great thicknesses of crystalline dioritic rocks and porphyritic felsite—a brown compact rock holding small crystals of pinkish feldspar. I also observed bands of brown calcareous and gypsiferous slaty shales or schists. The limestone in one place was found to contain abundance of fossils, which, *Fossils.* though in a very fragmentary condition, are sufficiently well preserved to throw some light on the age of the formation, even with the aid of the present small and imperfect collection. The specimens have been carefully worked out with dilute acid, and Mr. Billings, who has examined them, says the fossils from this locality, ten miles above Spence's Bridge, consist principally of the comminuted remains of several species of *Brachiopoda* in a greyish limestone. As they are partially silicified, by treatment with

acid we have extracted sufficient material to enable us to recognize the following genera :—

1. *Cyrtina*.....2 sp.
2. *Spirifera*.....1 sp.
3. *Rhynchonella*.....1 sp.

There are also a small *Myalina* and an *Euomphalus* with angular whorls. Although none of the above have been determined specifically, they indicate almost certainly a horizon between the base of the Devonian and the summit of the Permian.

Serpentines.

The limestones holding these fossils are so intimately associated and interbedded with the serpentines and other crystalline rocks above described, as to leave no doubt that they all belong to the same series.

Decomposition
of rocks.

In some places a remarkable amount of decomposition has affected the outcropping edges of the Cache Creek rocks: occasionally this action has extended to a depth of more than twenty feet, as shewn in numerous transverse gulleys cut by the surface waters through the soil and soft earthy material, which is then seen to pass gradually into the solid rock below. In these areas of decomposition, which are often of considerable extent, iron pyrites is largely disseminated in the rocks. On the surface they are characterized by a succession of rather steep mounds or mound-like hills, from fifty to as much as 300 feet high. The soil often presents a curiously parti-colored appearance, in tints of brown, yellow, red and black, which, with their peculiar outline, renders these hills conspicuous at a considerable distance.

Robbin's
Ranche.

At Robbin's Rancho, ten miles above Kamloops, on the east side of the valley, there are two outcrops of grey crystalline limestone, apparently in a synclinal form. These are associated with dark blue and grey flinty shales, and calcareous breccia conglomerate, with crystalline feldspathic and dioritic rocks. Similar rocks occur in the vicinity of Kamloops, and up the valley of the North Thompson to near Clearwater. They are overlaid, in places, at as much as 1,200 feet above the river, by hard black columnar basalt of division II.

Anderson
River.

VI. *Anderson River and Boston Bar Group, and Upper Rocks of Leather Pass and Moose Lake.*—These rocks were first seen at Anderson River, twenty-five miles above Yale, where they succeed the crystalline rocks of division VII, and where the change in the geological structure of the country is accompanied by a corresponding change in its physical features, indicated by the widening out of the valley and the less abrupt character of the hills. The rocks here consist of dark and bluish-grey earthy shales, with calcareous and sandy bands: between Boston Bar and Butcher's Flat they are exposed in numerous road-side cuttings, and are mostly blue and grey banded shales, much jointed and breaking up into rubbly and lenticular fragments. They

Shales.

are all more or less calcareous, and there are occasionally thin bands of limestone. Dykes or bands of a partially decomposed and rusty-weathering diorite-porphry are often seen associated with the slates. Wherever they occur, the latter appear to be much broken and twisted, though not otherwise altered. The rocks seen in the upper part of the Leather Pass, Slate Mountain, and along the shores of Moose Lake, which I have, chiefly on lithological grounds, associated with these, are slates and sandstones, with a good deal of grey quartzite or quartz rock, and thin-bedded limestones or calcareous sandstones. They dip pretty regularly N. 15° W. < 35°-40°. I did not see any limestones in place. Amongst the loose stones, however, along the shore at the upper end of the lake, pieces of impure limestone which look as if they came from beds near by, are not rare, and nearly all the water-worn pebbles from the bed of the river at the Grand Forks are of impure grey limestone. I was not able to collect any fossils in them, and therefore the age of these rocks is uncertain. The opportunities for observations during this part of our journey were, I am sorry to say, very limited, and those which I made confined to such exposures as could be seen on the trail we were following.

VII. *Cascade Mountains and Vancouver Island Crystalline Series.*—

The crystalline rocks which I have already mentioned as occurring in the vicinity of Victoria and Esquimalt, and which are described in more detail in Mr. Richardson's Report, are supposed to belong to this series. Our first observations of them on the main-land were at Yale, and thence along the waggon-road, closely following the right bank of the Fraser for thirteen miles to the Alexandra Suspension Bridge. Crossing the bridge, the road continues up the left bank of the river, and similar rocks are seen for thirteen miles further to Anderson River, where, as has been already stated, they are overlaid in the valley by the rocks of divisions III and VI to within a few miles of Lytton. Thence similar rocks occur along the road to about sixty-seven miles from Yale, where they are concealed by the rocks of the volcanic series, division II.

Close to the toll-gate, leaving Yale, the hills rise in precipitous rocky slopes, exhibiting sections of massive beds of whitish granular rock, composed chiefly of quartz and feldspar; also bands of a dark grey fine-grained gneissoid rock. These rocks all shew more or less a banded structure, and resemble a hard feldspathic granitoid gneiss, holding epidote, black mica, quartz, orthoclase and hornblende, with occasionally sphene. At about one mile from the village, the cliffs and likewise the stratification are vertical, with a general strike about W. 25° N. magnetic. At a little more than six miles above Yale a band of white and greyish-white crystalline limestone crosses the road. It has been quarried to a small extent and burnt for lime, but most of it is apparently too siliceous for lime burning purposes. It dips at about 70° to the N.E. No fossils were recognized in

Thin bands of limestone.

Leather Pass, Slate Mountain and Moose Lake

Crystalline rocks.

Gneiss holding epidote, &c.

Crystalline limestone.

it; the siliceous patches stand in relief on the weathered surfaces, and some of them may not unlikely be similar to those observed in the Vancouver Island limestone, which prove to be silicified fragments of fossils. Immediately beyond the limestone outcrop, the rocks are more schistose, and the stratification is more distinct; there are also lenticular veins or bands of white quartz in a rusty-weathering grey gneiss. Near the seventh mile-post the rocks are less crystalline, quartz veins are numerous, and the stratification distinct dipping E. 35° to 45° N. At 250 yards beyond the seventh mile-post, crystalline limestone again crops out on the road with dip N. E. $<79^{\circ}$ (Photos. Nos. 69,915 and 69,916), and again between the ninth and tenth mile-posts, where it is of a bluish color, and nearly fifty feet thick. It is here associated with green chloritic-looking rocks. The three outcrops are probably on the same band, the windings in the course of the road causing it to intersect the band in three places. In the neighbourhood of the suspension bridge the rocks are chiefly grey feldspar porphyry, and feldspathic granitoid rocks holding hornblende and black mica, and passing occasionally into feldspathic diorites; these are cut by large reticulating veins of milky white orthoclase, mixed with large plates of a silvery-white mica. There are also grey feldspathic diorite porphyries. At fifteen miles above Yale, the rock is a grey, micaceous, rather slaty gneiss, cut by similar veins of orthoclase feldspar. From seventeen to twenty-two miles from Yale, including China Bar Bluff, the heaviest rock cuttings on the road occur. They are chiefly through greyish-white, fine-grained, granitoid rock, very feldspathic, and cut by feldspathic veins, but also containing a little black mica, quartz and hornblende.

In some places this rock is traversed by three sets of joints, running respectively north and south, east and west, and horizontally, dividing it into blocks, with very regular even sides, from five to twenty feet long and from two to ten feet wide. An unlimited quantity of durable and handsome building-stone could be procured from these cliffs.

Beyond Anderson River, and to about fifty-two miles from Yale, the valley, as already stated, is occupied by newer rocks, but on either side, at some distance back from the river, the mountains are apparently entirely made up of similar feldspathic and dioritic crystalline rocks, rising steep and rugged to the line of perpetual snow.

VIII. *Granite, Gneiss and Mica-schist Series.* — The rocks of this division were first met with at Raft River (Photograph No. 63,958) a tributary of the North Thompson, six miles above Clearwater, and thence to the Grand Forks of the Fraser above Tête Jaune Cache. They represent, I believe, the oldest rocks observed in the country. The talcose micaceous schists of the Cariboo region, and the base rocks of the Selkirk Mountains and the Gold Range, probably belong to the same series. The stratification in the rocks of this series is often

Quartz veins.

Porphyry.

Feldspathic veins.

Building-stone.

Oldest rocks observed.

Characters of rocks.

obscure, and they are much broken and disturbed. Among them we find gneiss and mica-schist of various textures and degrees of hardness, with large scales of white and black mica, and holding garnets ; also masses of almost pure feldspar, as well as hornblende rock, the former likewise holding garnets and black tourmaline. Specimens of these were found at Blue River Bluff, and at Garnet Creek Falls (Photographs Nos. 69,977 ; 69,978 ; 69-980). No limestone was seen *in situ* on the upper North Thompson, but, when crossing a stream flowing into it from the west, and which at some seasons must be a formidable mountain torrent, I found quite a number of pebbles and large fragments, some of them not much worn, of grey or nearly white crystalline limestone, and which, judging from their size and number, did not appear to have travelled far. This stream I named Limestone River. Limestone River. It was the only one of the numerous streams which we crossed, in following the left bank of the Thompson, where indications of limestone rock were found ; and it will perhaps become important in connection with the construction of this section of the railroad. It is about 170 miles above Kamloops, and between Blue River and Garnet Creek, which comes in on the opposite or east side of the Thompson.

Near Albreda Lake, and soon after reaching the water-shed to Canoe Albreda Lake, River, rock exposures are plentiful on the hill sides, at short distances above the trail. They are, however, so far as observed, all of similar crystalline gneissose, granitoid and micaceous rocks. The distinct and often very regular stratification which is observable above the limits of the forest, on many of the high peaks and summits which rise abruptly from the river to the perpetual snow line, induces the belief that they are composed of a less altered and more recent set of rocks than those which are exposed in the valley and on the lower hill-slopes. Except the limestone fragments observed at Limestone River, however, and which might belong to rocks of the age of the Cache Creek group, I did not find on the North Thompson, above Clearwater, any direct evidence of the occurrence of such rocks, though carefully looked for in the detritus of all the tributary streams : nor in crossing the mountains to avoid the canons of Murchison's Rapids, between Mad River and Blue River, and which took us to an elevation of probably more than 6,000 feet above the sea, were any but granitoid and gneissose rocks met with. The rocks exposed along Granitoid and gneissose rocks. the rapids, which we descended on our return journey, are all of similar character.

On the wagon-road between Vanwinkle and Barkerville these rocks Vanwinkle and Barkerville. are first seen, about one and one-half miles north from Vanwinkle, on Lightning Creek. Thence to Barkerville on Williams Creek, a distance of nine miles, no other rocks are seen. At Barkerville they are overlaid unconformably by rocks apparently of the Cache Creek group, with bands of crystalline white limestone in thin beds.

Average strike. The average strike of the micaceous schists is about N. 70° W. and S. 70° E. They are much disturbed and crumpled, and are generally dipping at high angles.

Gold indications. The country in which Raft River and Mad River have their sources presents favorable indications as a gold-bearing region, and is, I think, worthy of being carefully explored and prospected.

Appended is a Report by Dr. T. Sterry Hunt on the silver ores from the Eureka Mine near Hope, and on some of the fossil woods and rocks from the Fraser near Quesnel Mouth, as well as from the section given on page 123.

There are many more specimens from the several groups enumerated which require further study and analysis for the precise determination of their characters.

REPORT BY DR. T. STERRY HUNT.

With regard to the specimens, ores, coals and rocks lately placed by you in my hands, from the main-land of British Columbia, I have to report that time has not allowed me to make so complete an examination as I should have desired; they have, however, yielded me some interesting results, which I beg to lay before you.

Silver ore from Eureka Mine.

Silver ore from the Eureka Mine, near Fort Hope.—These specimens show a veinstone of spathic iron, with some quartz, through which is disseminated a massive steel-grey ore giving a black powder, and yielding by analysis sulphur, antimony, copper and silver. I was not able to obtain sufficient in a pure state for a quantitative analysis, but, from the comparatively large proportion of antimony and copper which the ore contains, it would seem to be probably a highly argentiferous fahlerz or freibergite. An average sample of the veinstone, in a much decomposed condition, gave 1.19 per cent of silver, of which 0.11 per cent was present in the form of chlorid, and was dissolved from the raw ore by a solution of hyposulphite of soda. Other considerable masses of the ore would yield a much larger proportion of the precious metal.

Coal from Nicola River.

The coal from Nicola River gave a firm dense coke, and a very small amount of grayish ash. The analysis by slow coking gave as follows:

Fixed Carbon.....	74.58
Volatile.....	21.51
Ash.....	3.91
	<hr/>
	100.00

Lignites.

The lignites from the Fraser River at the mouth of the Quesnel are very variable in character: some of them are a light brown-coal, approaching

to jet in texture, while others are impregnated with carbonate of iron, which has nearly replaced the woody matter. These are brownish in color, very heavy and hard, and dissolve in heated hydrochloric acid, leaving a small ligneous residue, which is yellowish-brown in color, and in one specimen was found equal to about 7.0 per cent. The analysis of this, which was a portion of an unflattened trunk, several inches in diameter, *Iron Ore.* showed it to be a good iron ore. It gave:

Carbonate of Iron.....	85.00
Carbonate of Lime.....	3.60
Carbonate of Manganese.....	1.10
Carbonate of Magnesia.....	2.80
Organic Matter.....	6.60
Insoluble Ash.....	50
	<hr/> 99.60

Several specimens of volcanic rocks from near Quesnel Mouth were *Volcanic rocks.* examined. One of these was fibrous, another scoriaceous, and a third compact and vitreous, but all were highly ferruginous lavas, readily fusible before the blowpipe. The last mentioned had a specific gravity of 3.96.

Two other specimens were much less dense; of these the one having a specific gravity of 2.36, was of a pale purplish or lilac color, nearly opaque, with a conchoidal fracture, a somewhat waxy lustre, and the hardness of quartz, or near it. This resembles what is called *pearlstone.* *Pearlstone.* The other, with a specific gravity of 2.45—2.52, resembled the last in hardness, lustre and fracture; but was in great part of a pitchy-black, with, however, an adherent portion of a material, which, with a similar hardness, lustre and fracture, had a light reddish-brown color. The black mineral has the characters of *pitchstone.* *Pitchstone.*

Accompanying these specimens was a portion of fawn-colored rock, which was apparently an indurated clay, having a considerable hardness *Indurated clay.* and cohesion, and very absorbent.

CHARACTER OF THE LAND.

I have already, in a previous part of this Report, alluded to the character of the soil of the Fraser Valley between Yale and Lytton. Approaching Spence's Bridge a marked improvement in the character of the country is observed. We here come upon the western edge of what I have designated the great central plateau, the soil of which, wherever we traversed *Soil of central plateau.* it, appears to be excellent, but, owing to the extreme dryness of the climate, it is only in exceptional seasons that it can be cultivated successfully, without irrigation; wherever this had been resorted to we observed splendid crops of wheat, oats, barley, potatoes and vegetables of all kinds.

The following facts on crops and vegetation were collected by Mr. *Crops.* Richardson. At Mr. Robert Carson's Pavillion Mountain Farm, of three

hundred acres, on the Lillooet road, there are one hundred and fifty acres under cultivation.

Wheat 30 acres, yield 1,400–1,500 lbs per acre.
 Barley 30 " " 1,300–1,500 " "
 Oats 70 " " 1,600–1,800 " "
 Peas and Beans 3 acres, produce not ascertained.
 Potatoes 6 acres, yield 30,000–40,000 lbs per acre.

The oat crop sometimes reaches 2,700 lbs per acre. Timothy grass from one and a half to three tons per acre. Red clover grows well. This farm has been only four years settled upon. Mr. Carson continues to break up from twenty-five to thirty acres each year. The whole farm is irrigated by water brought seven miles. The prices obtained on the farm are for wheat, barley, oats and potatoes, two to three cents per lb. ; hay, forty dollars per ton ; bacon, twenty to twenty-seven cents ; beef, ten cents per lb.

Sowing time
and harvest.

Sowing time, 1st April ; harvest, from middle of August to middle of September ; reaping and thrashing done by machine. Cattle live out of doors all winter. Snow-fall averages about eight inches.

At the Australian Rancho, about twenty miles below Quesnel Mouth, of 640 acres belonging to Henry Downs and Compy., there are one hundred acres under cultivation.

Wheat 14 acres, yield 2,500 lbs per acre.
 Barley 32 " " 2,500 " " "
 Oats 16 " " 2,500 " " "
 Turnips 7 " " 25 tons of 2,000 lbs per acre.
 Potatoes 2½ " " 25 " " "
 Timothy 30 " " 3,500 lbs per acre.

Prices at Cariboo.

The proprietor stated that by careful cultivation and attention to irrigation the wheat crops could be brought to 3,700 lbs. per acre. All kinds of vegetables grow equally well. The prices obtained at Cariboo, eighty miles distant, are wheat, barley and oats, nine cents per lb., potatoes, ten cents per lb., butter, seventy-five cents per lb. Sowing and planting commences the first week in April ; harvest, August and September. Stock require to be fed from the first week in December to the last week in March.

Value of irrigation.

All the foregoing yields are obtained by irrigation. The average of lands not irrigated on the same farm are, wheat, barley and oats, from seven hundred to one thousand lbs. per acre. Potatoes and turnips from six thousand to ten thousand lbs. per acre. Timothy from one thousand to twelve hundred lbs. per acre. This proves the great value of irrigation, the character of the soil in both cases being the same.

On lands about four miles nearer Quesnel Mouth, large fields of oats and barley, grown without watering, were being harvested on the 4th of September. On one of the fields of oats, which appeared to be an average of all, the straw was about five and a-half feet high, and strong in proportion ; and one head counted eighty corns on five stalks.

Vegetation about Kamloops.

Intoxicating beverage.

In the central plateau country, the service-berry does not appear to be so plentiful, and about Kamloops is confined to the river flats. A few bushes of it were seen in the Leather Pass above the Grand Forks of the Fraser. It is, however, rare on the North Thompson, above Clearwater. Raspberries, strawberries, gooseberries, currants and choke-cherries are abundant. I also observed near Kamloops a large *Crataegus*, loaded with

Wild flax and
hemp.

blackish-red fruit. On the central plateau country, wild flax and hemp were observed, growing luxuriantly.

Valley of the
North Thompson.

For the purpose of settlement, very little can be said in favor of the valley of the North Thompson, above Clearwater. The soil is generally of a light sandy or gravelly character; and the flat lands bordering the river, and which might be available for cultivation, seldom reach three-quarters of a mile in width, and occur only at considerable intervals. After passing the water-shed, however, at Albreda Lake, the valley opens out, and from Canoe River to Cranberry Lake, and thence down the valley of Selwyn River to the Fraser at Tête Jaune Cache, the valley, including the lower benches or terraces, is seldom less than three to four miles wide, with but little timber, and affording excellent summer pasturage. Indeed we were informed by the Indians that they frequently winter their horses between Canoe River and Tête Jaune Cache, and that they find them in excellent condition in the spring. Several varieties of grass are abundant in this district; two species of *Equisetum*; a vetch and a blue lupin, both locally called pea-vine, are also plentiful, and apparently form a very favorite food of both horses and cattle.

Plants.

Grazing country.

On most of the mountains above the limit of the thick forest (from 4,000 to 6,000 feet,) there seem to be very considerable tracts of fine summer grazing country. The ground is mostly swampy, and numerous small lakes and ponds, belts and patches of stunted fir and pine, and open plains or meadows are the usual features met with. These alpine pastures possess a characteristic vegetation; the blue lupin, before referred to, being a very conspicuous plant.

The stereoscopic views taken near the summit of the mountain trail, between Mad River and Blue-River, afford an excellent idea of the general aspect of this elevated region.

Forests.

The stereoscopic views taken near the summit of the mountain trail, between Mad River and Blue-River, afford an excellent idea of the general aspect of this elevated region.

Birch is the only hard-wood tree seen in the forest of the North Thompson and the Fraser; but for cedar of gigantic size, hemlock, spruce, and other species of fir and pine, the forests of the North Thompson offer a magnificent field for the operations of the lumberer. The cedar is, I believe, the *Thuja gigantea*; and trees of from ten to eighteen feet in circumference, and from 100 to 150 feet high, are not uncommon. The photographs Nos. 69,974 and 69,975, afford a good representation of one of these cedar forests. The cotton-wood grows to a very large size, and is the best wood for making canoes. One, out of which we made our largest canoe at the North-west Branch crossing, was nearly four feet in diameter. Various species of willow, alder, poplar and aspen form the woods on the flats bordering the river. A species of *Viburnum* (tree-cranberry), and the mountain ash, enliven the forest with their bright red-berries; hazel, elder, and ground-hemlock or yew, and an occasional maple shrub, were also observed. The most obtrusive and troublesome plant to the traveller in these forests, however, is a species

of prickly *Aralia*. It has a large, deeply-cut leaf, not unlike that of the *Aralia*. purple-flowering raspberry, which is also common, and a long, trailing, rather woody stalk. Every part of the plant is thickly covered with small sharp prickles. It grows to a height of about four feet, and often thickly covers the ground. A gentle touch with the naked hand was sufficient to get the skin filled with the prickles, which really seem to have a greater affinity for human skin than for the parent stalk. When clearing the trail through it, even stout clothing afforded very imperfect protection, and the subsequent inflammation and irritation, particularly in the hands and knees, were most unpleasant and painful. Ascending the mountain trail we soon got above the limit of these irritating companions, but only to find them more abundant on our return to the valley.

At 4,000 feet and upwards, the principal undergrowth on the hill sides, is *Alpine plants*. a plant resembling *Azalea*, with a small white flower and a somewhat trailing woody stem.* It often stands three feet high, sometimes even more, and forms quite a dense thicket, difficult and very fatiguing to travel through. A species of heath, (*Erica*), with a pink flower, and many other plants, not seen in the woods below, were likewise observed on these heights. Among the smaller plants observed, the pigeon or bunch-berry (*Cornus Canadensis*), has perhaps the greatest horizontal and vertical range. The *Mahonia*, or holly-leaved barberry, locally called the Oregon *Common plants*. grape, is also widely distributed, and on a hot day the fine-flavored, acid fruit, which it bears in the greatest profusion, is very refreshing to a thirsty traveller. Two or three species of blueberry are also common, but were not observed above 4,000 feet. A species of *Smilacina*, with bright orange-colored berries, is also common in damp shady places. There are many other plants which I am not familiar with. Of some of these specimens were collected, but had to be abandoned when we lost our canoes. The plant locally called Hudson Bay tea is abundant all through the upper country, in moist or swampy situations, and is, I believe, the same species as that known on this side as Labrador tea,—*Ledum latifolium*. The infusion from it, if not made too strong, is by no means an unpleasant beverage, even without milk or sugar. The *Kinnikinnik*, or Indian tobacco plant, is also common; probably, however, a different plant from that known by the same name, and used in a similar manner, by the Indians in Eastern North America.

There are no Indians resident on the North Thompson above Mad River, or on the Upper Fraser. After leaving Mad River to cross the mountains, we met only three families until our return to Clearwater. These were *Indians*. out on hunting expeditions, but did not seem to have met with much success. Except squirrels, the only quadrupeds seen, or reported to have been seen by any of the party, during the journey from Kamloops to the Leather Gama,

* Specimens for determination were collected, but were abandoned when we lost our canoes.

Pass and back, were one bear, one porcupine, two hares, one fox, one marten and one mink. Traces of bears and of beaver were occasionally pretty abundant, and we also observed a few tracks of deer, moose and cariboo. The marmot, or ground hog is, I believe, one of the most abundant of the fur-bearing animals; the lynx is not rare, and the carcajou or wolverine is met with occasionally. Two or three varieties of grouse or wood-partridge are abundant. In their habits they do not differ from those found in Canada. The willow-grouse and the black-grouse are the commonest species. The former frequents chiefly the willow and alder coppice along the river flats, and the latter the thick pine and cedar forests on the hill sides. We commonly killed from two to six every day, and they formed a very welcome addition to our daily bill-of-fare of beans and bacon. These birds are an easy prey to the hunter, and are locally known by the appropriate designation, 'fool-hens.'

Beasts, birds and fishes are decidedly scarce throughout these gloomy forest regions; of the latter only two small trout were captured, and only one salmon seen during the expedition above Kamloops.

**Fisheries and
Mines.**

Though British Columbia possesses considerable tracts of fine agricultural and pastoral land, amply sufficient to produce all the food her own population is ever likely to require, yet it is not probable that she will ever hold a prominent position as an exporting agricultural country. Her chief resources are her forests, her fisheries and her mines; and these are capable of almost unlimited development. Her gold-fields, her silver-veins and her coal-mines are yet in their infancy; her timber trade is in a similar condition, and her fisheries, which may fairly be expected to rival those of the Atlantic Provinces, have not yet extended beyond the supply of local requirements.

**Future of the
Alpine Pro-
vince.**

There can scarcely be a doubt in the mind of any one who has visited the country, that a bright and prosperous future is in store for the Alpine Province of the great Dominion; only to be realised, however, when the iron road shall have brought her into closer communion with her elder sisters in the east.

I have the honor to be,

Sir,

Your most obedient Servant,

ALFRED R. C. SELWYN.

REPORT
ON THE
COAL FIELDS OF THE EAST COAST
OF
VANCOUVER ISLAND,

WITH A MAP OF THEIR DISTRIBUTION,

BY

MR. JAMES RICHARDSON ;

ADDRESSED TO

ALFRED R. C. SELWYN, ESQ., F.G.S.

DIRECTOR OF THE GEOLOGICAL SURVEY.

MONTREAL, May 1st, 1872.

SIR,—The geological exploration in which, under your instructions, I have been engaged during the past season on the Pacific side of the continent in British Columbia, may be divided into two parts ; namely, those general preliminary investigations in the interior of the continental portion of the Province, in which I had the honor for some time to accompany yourself, and those of a more special character connected with the coal deposits of Vancouver Island.

The geological facts collected by me on the former, with my impressions of the country, have already been communicated to you, to be embodied, as I understand, in your own Report ; I need not therefore repeat them here ; and I shall only further allude to this part of the work, for the purpose of stating the extent of the area it covered and the time it occupied.

Leaving Victoria in Vancouver Island by steam, on the 25th of July, in company with the various surveying parties appointed on the Canadian Pacific Railway, we crossed the Strait of Georgia to New Westminster, near the mouth of the Fraser River, and ascended that stream to Yale, which is the present head of steam navigation from the sea. Starting

Exploration in
British Colum-
bia and Van-
couver Island.

New Westmins-
ter to junction
of North and
South Forks of
the Thompson.

thence on foot we followed the Cariboo road, keeping along the margin of the stream to Lytton, situated at the junction of the Thompson river. Proceeding farther by stage, we ascended the valley of the Thompson, along the same road, to Bonaparte House on the Bonaparte River, near its junction with the Thompson, and then, leaving the Cariboo road, continued up the valley of this stream to Kamloops Lake. This we ascended by boat, and reached the junction of the North and South Forks of the Thompson, close by the head of the Lake, the distance to this point from Yale being about 160 miles, and the time spent in accomplishing the journey from Victoria, including many stoppages on the road, having been fifteen days.

Measurement
of roads.

The experience which we had by this time acquired, convinced us that we should get through the examination of a much larger extent of country in a given time by separating and pursuing the investigation of distinct tracts. Leaving you therefore, on the 19th of August, to accompany Mr. McLennan's railway party, I returned westward to Bonaparte House, descending Kamloops Lake by boat and hired canoes, and examining the rocks on each side in some detail. From the outlet of the Lake I proceeded on foot, measuring the road by prismatic compass and pacing as I went along, and registering the position of the rock exposures after the investigation. The distance of this part to Bonaparte House was found to be twenty-four miles. From this, turning northward and following the Cariboo road, my measurements were continued to Clinton for thirty miles, and for twenty-four miles farther to what is called the seventy-mile house. Understanding that in the next eighty miles to Deep Creek there was only one exposure of rock, and that of no great extent, it was judged expedient to travel the distance by stage, an opportunity being afforded for the examination of the exposure as we passed along. In the next ninety miles, by Soda Creek and the bank of the Fraser River, along which the Cariboo road again runs to Quesnel Mouth, the rock exposures, with the exception of those in the first ten miles, were said to be almost continuous, and in some places to display coal. These ninety miles were therefore measured.

Coal.

Vanwinkle.

From this point the road turns eastward, crosses the Cotton-wood River, and runs up the valley of its tributary, Lightning Creek. On this creek is situated Vanwinkle. The distance between Quesnel Mouth and Vanwinkle is about sixty miles, and the exposures not being numerous, I availed myself of the stage between them, trusting that such stoppages as might occur would afford opportunities for the examination of them. Thence to Barkerville and beyond, in the Cariboo gold region, twenty miles more were measured.

It was now the 17th of September, and part of my instructions being that before the close of the season I should visit some of the Vancouver

coal deposits, it was deemed prudent to return towards the Island. I did so by stage as far as Bonaparte House, stopping on the way at Clinton to make a measurement on the Lillooet road, as far as Carson's farm on Vermillion Mountain, thence across the hill to and up Marble Canon, the distance being altogether about thirty miles; and another eastward from Clinton of some eight miles across to the Bonaparte River.

From Bonaparte House to Yale, the road was measured all the way, the distance being about 110 miles; and additional intermediate measurements were made from Spence's Bridge, one of them twenty-five miles up the Nicola River, to the south-east, and an opposite one of ten miles on the flank of the Cascade Mountains. From Yale returning to Vancouver Island by steam, I reached Victoria on the seventh of October.

The whole of these measurements amount to about 370 miles, about 500 having been travelled on foot to accomplish them, and it is hoped that they will hereafter be serviceable in the construction of a final geological map.

Before entering on the examination of the Vancouver coal deposits, it was necessary to equip myself with a tent and provisions, to look out for a boat, and to hire such men as might be required to assist me; and, while, arrangements in connection with these preparations were in progress, my time was occupied in such examinations as could be made of the neighbourhood of Victoria.

Leaving this place on the 17th October, I was conveyed by steamer, with my boat and two men, as far as Nanaimo, a village on the south-west side of the strait, about seventy miles from Victoria, where coal has been worked for the last twenty years. A week was spent in the examination of the rocks of this vicinity, and a free passage having been afforded me on the government steamer Sir James Douglas, through the kindness of Mr. W. B. Pearce, Assistant Crown Land Commissioner for British Columbia, I proceeded about seventy miles farther to Comox Harbour, near which several coal claims have been taken up within a year or two, reaching it on the 27th of October. Coal is known to occur sixteen miles still further along the coast, but as I understood there was no good shelter, and as I wished to make my chief examinations by returning along the coast in my boat, it appeared to me that the season was too far advanced to render it prudent to go beyond Comox. I accordingly returned from there to Victoria, where I arrived on the 23rd of November, and after continuing my examinations in its vicinity until the 22nd of December, started on my return to Montreal.

COAL DEPOSITS.

Coal-seams are known to exist in other parts of Vancouver Island, besides those already alluded to. They have been met with towards the north-western end, one locality being on the north-east side, near Fort

Return towards
Vancouver
Island.

Total measure-
ments in British
Columbia.

Nanaimo.

Coal claims.

Return to
Montreal.

Rupert, on Queen Charlotte Sound, another on Quatsino Sound, which opens on the south-west side into the Pacific; and there appears at present nothing to render it impossible that they may spread out in some places into the centre of the sound. But I shall here confine my remarks to those parts which I have visited on the Strait of Georgia. These appear to belong to a narrow trough, which may be said to extend from the vicinity of Cape Mudge on the north-west, and to approach to within fifteen miles of Victoria on the south-east, with a length of about 130 miles. It is occupied by a series of rocks which in some places present a rolling surface, with no elevations rising to a greater height than 800 or 1,000 feet, and in others is comparatively level. It possesses generally a good soil, and may hereafter be thickly settled. It is mostly covered with forest, but in some parts presents a prairie or park-like aspect, with grass-covered ground, studded with single trees or clumps of them, and offers great encouragement to agricultural industry.

Trough.

Soil and vegetation.

Crystalline rocks.

Height of mountains.

The north-east side of this trough lies beneath the waters of the Strait of Georgia, and on that side is bounded by crystalline rocks coming apparently from beneath it in Lasqueti, Texada and other islands, and on the main-land beyond; while on the south-west it occupies a strip along Vancouver Island, limited by a range of very bold mountains of the crystalline series, which runs nearly parallel with the coast, having points of from 4,000 to 7,000 feet above the sea. In the first or nearest ridge of these are Mount Washington, 5,410 feet, Beaufort Range, 4,900 and 5,420 feet, Mount Arrowsmith, 5,970 feet, and Mount Moriarty, 5,185 feet; while in the second ridge, farther in the country, is Alexandra Peak, 6,394 feet, and Mount Albert Edward, 6,963 feet; all as represented by Captain Richards in his Admiralty chart, a copy of which was kindly lent me for use by Captain Clark of the Sir James Douglas Steamer.

Claims.

In the general trough, coal-seams are exposed in upwards of a dozen different places, and in five distinct localities *claims* have been laid before the government by different companies. The most instructive exposure is one that occurs about five miles (S 63°W)* from the shore on the south-west side of Comox harbour, on the claim of the Union Coal Mining Company.

Here in an almost perpendicular cliff, which rises on the north side of a small brook, tributary to the Puntledge River, there occurs the following descending section, the coal-seams in which I shall number in ascending order: †

* All the bearings in this Report are given in relation to true north, magnetic north being twenty-two degrees to the east of it.

Analyses of samples from the principal coal-seams examined by me in Vancouver Island will be found by reference to Dr. T. Sterry Hunt's Report, appended.

	Ft.	Ins.
Brownish or drab-coloured, slightly calcareous sandstone, the grains of which are composed of quartz, feldspar and mica, with some of a black substance supposed to be peroxide of manganese, the beds being from one to five feet thick.....	45	0
Coal (No. 4), black and shining, apparently clean and free from shale.....	4	6
Brownish-black argillaceous shale and greenish-brown sandstone, interstratified with one another in thinnish layers, the shale predominating, and both holding thin, irregularly-distributed, lenticular patches of coal, which may constitute about one tenth of the mass; no indications of roots penetrating the upper part of the bed were observed.....	15	0
Coal (No. 3), apparently all of good quality	5	4
Brownish-gray or light drab sandstone, in beds of from one foot to eighteen inches.....	10	0
Coal (No. 2), apparently clean and of good quality.....	6	0
Brownish-gray or light drab sandstone, interstratified with thin layers of black, soft, argillaceous shale.....	3	0
Coal (No. 1), without observed impurities.....	10	0
Total.....	98	10

The dip of the measures in this part is N. 32° E. $< 11^{\circ}$. The brook, which, ^{Dip of mea-} is, as already stated, a tributary of the Puntledge, runs north-westward, ^{asures.} nearly on the strike, and at some height on the right bank, about 600 paces down the stream, a coal-bed of four feet and a half is exposed, which very probably corresponds with number 4 of the above section, and shows an apparent regularity in its course, and in the attitude of the measures, for at least that distance.

None of the seams in this locality have yet been opened for productive working; but during the past summer a road has been cut out and cleared ^{New road.} of wood to a breadth of some twenty or twenty-five feet, for a distance of four miles, leaving about three miles more still to be freed of heavy timber. The level of the brook where the seams are exposed, is about 500 feet above the sea, and the road will have a pretty even fall the whole way to it.

Coal-seams, said to resemble those which have been described, occur at ^{Coal-seams N. W. from Union Claim.} no very great distance in a north-western direction from the Union Claim. They were first discovered by Mr. P. J. Leech, and are mentioned by him, in the Report of his exploring expedition of 1864, as being an eight-feet and a five-feet seam, situated on a western tributary of the Puntledge, which falls into the Courtney River about two miles above its mouth. Not having obtained information of their precise position until I had left the Union Claim, they were not visited by me, and I cannot therefore offer an opinion as to their stratigraphical relations. I was told also that still further to the north-west, the position being sixteen miles from Comox Harbour and close upon the coast, there is a four-feet coal-seam, but the weather prevented me from visiting it.

About five and a half miles along the coast from Comox Harbour, in a general bearing about S. 28° E., there occurs a trail or path leading to

Beaufort Mine. what is called the Beaufort Coal Mine; the general bearing of the path being S. 80° W., and the distance from the coast a little over five and a half miles. Here, on the left side of a small stream called Bradley's Creek, there occurs a seam of good hard coal, measuring 3 feet 2 inches, and resting on two feet of soft black argillaceous shale, beneath which there are visible between five and six feet of brownish-gray sandstone, holding disseminated pebbles of quartz, feldspar and diorite. The dip of the strata is here N. 27° E. < 18°, and Bradley's Creek, which, flowing north-eastward, ultimately gains Baynes Sound, at this place crosses the measures nearly at right angles.

Sandstone. Proceeding down the stream, the coal-seam appears to be overlaid by a considerable thickness of sandstone, and, at the distance of about half a mile, another coal-seam occurs, of which, from the quantity of water in the brook, no more than two inches were visible; while half a mile farther on, there are indications of still another seam. These two seams, from the quantity of water caused by recent heavy rains, were very imperfectly seen by me; but Henry Bradley, one of my men, who was one of the first discoverers of the seams on this claim, and was afterwards employed to ascertain their thickness, informed me that the two in question were from one to two feet each. He also informed me that about a mile and a half to the westward of the position where the lowest of the three seams is exposed, there occurs a fourth seam on the Trent River. The quantity of water prevailing, and the occurrence of an intervening swamp, prevented me from visiting this seam, but Bradley gives the thickness, as far as ascertained without reaching the bottom of it, as nine feet.

Seam on Trent River.

The transverse distance in which these four seams occur appears thus to be upwards of two miles, while the four seams of the Union Claim, with a less apparent dip, would not occupy a greater breadth than 250 feet; and the strike of the latter would seem to place them considerably higher in the measures. If it should hereafter be ascertained that any of the seams of the two localities are identical with one another, it can only be through the occurrence of undulations or faults, of which we at present know nothing.

Baynes Sound Coal Mines.

Five miles along the coast, in a bearing S. 18° E. from the trail to the Perseverance Claim, a path runs inland, in general bearing S. 70° W., and leading, in a distance of a little over two miles in a straight line, to the Baynes Sound Coal Mines. Here in a deep gorge, through which a small stream of water finds its way in its course to Fanny Bay on Baynes Sound, occurs the following descending section:—

	Ft.	Ins.
Brownish-gray or drab, moderately fine-grained sandstone, slightly calcareous, with scales of white mica, and in layers of from six inches to two feet, holding fragments of the stems and leaves of plants.....	30	0

Coal, clear and hard.....	5	10
Brownish-gray or drab sandstone, in beds of from six inches to four feet thick; holding fragments of plants.....	48	0
Black, soft, argillaceous shale, with short thin lenticular patches of coal....	5	0
Brownish-gray or drab sandstone, in beds of from six inches to two feet...	5	6
Black soft argillaceous shale with obscure impressions of plants.....	2	0
Coal, which appears to vary in its thickness, being in some parts not over 5 feet two inches, and in others seven feet, while the lower two feet shew occasionally thin seams of carbonaceous shale, with obscure impressions of plants, say.....	6	0
Brownish-gray or drab, moderately fine-grained, slightly calcareous sandstone, with scales of white mica.....	5	0
	107	4

The dip of the strata is here N. 86° , E. $< 15^{\circ}$, gradually increasing to 40° , and the two coal-seams are seen descending in both sides of the ravine, the edges of the lower one meet in the bottom of the stream, but while those of the upper one are still about twenty feet above the water, a fault occurs cutting them off. The underlie of the fault is S. 62° W. $< 38^{\circ}$, and the dip of the strata on the other or eastward side of it is N. 64° E. $< 43^{\circ}$. The strata on that side, after an interval in which seventy feet of the base are concealed, consist of seventy-two feet of brownish-gray sandstone, holding a few fragments of plants, overlaid by ten feet of black argillaceous shale. As these beds are not recognized on the west side of the dislocation, the amount of it, on the side on which the strata are thrown down, cannot be determined with certainty, unless a small mass of coal which is caught in the fault, and lies lower than the extremity of the upper seam, be derived from it. In that case the down-throw would be on the east side. In a position, which appears to be close to the east side of the fault, a shallow shaft has been sunk in search of the upper seam; it penetrates the measures on that side, but sandstone alone appears to have been excavated.

The section which has been given above does not suggest any means of identifying the coal seams displayed in it with those of the previous localities. It may reasonably be supposed, however, that the whole of those described belong to the lower part of the measures, and the localities may each belong to a separate zone.

On the coast, no rocks are seen from the path leading to the Baynes Sound Claim all the way to Qualicum River, a distance, in a general south-eastward course, of sixteen miles. But on Denman's Island, lying on the north-east side of Baynes Sound, there is a continuous exposure for ten miles, which is nearly the whole length of the island, in an escarpment rising up from ten to seventy feet, and running pretty much with the strike. The rocks presented consist almost altogether of brownish-gray or drab sandstones, in beds from two inches to two feet thick, but chiefly of about six inches, separated by thin partings of black argillaceous shale, of which,

however, occasional beds occur of ten feet in thickness, the shales hold occasionally thin lenticular patches of coal, sometimes extending unbroken for twenty feet, but often displayed interlocking with one another, for a mile or more on one horizon.

Lenticular patches of coal.

Calcareous veins.

At the base of the escarpment the sandstones frequently display ovoid masses, from six inches to one foot thick in one direction, by from nine inches to two feet in another. These present occasionally a net-work of calcareous veins, giving them the aspect of septaria, and the sandstones themselves are probably in general slightly calcareous. Impressions of plants did not seem to be abundant. The strike of the beds coincides with the general bearing of the island; in some places they appear to be quite flat, but generally the dip is in a northeasterly direction, at from one to ten degrees.

Two distinct basins.

From Qualicum River to North-west Bay, in a bearing about S. 75° E., there is a distance of about twenty miles in which no rock exposures were observed. Beyond this, masses of the crystalline series present themselves, continuing for fourteen miles in the same bearing, and separating what may be called the Comox field from one farther on; shewing that the general trough is divided into two distinct basins.

Productive area.

The Comox basin would then have a length, between Cape Mudge and North-west Bay, of about sixty four miles, but limiting it, for safety sake, and the probable occurrence of some thickness of unproductive measures at the base, to the distance between Kookooshun Point and Qualicum River, it may safely be called forty miles. The greatest breadth from the Beaufort Claim to a line in the run with the outside of Cape Lazo, or, as it is commonly called, Point Holmes, would be about thirteen miles, without taking into consideration what may be beyond under the water. But estimating the average breadth to be somewhat over seven miles, the productive area may safely be considered to hold about 300 square miles.

Quantity of coal.

The rule applied in the coal-field of South Wales in the United Kingdom, to calculate the productiveness of a coal-seam, gives 1,000 tons for every square foot in each acre of a seam one foot thick, leaving a sufficient quantity for pillars to support the roof. In the Union area the total thickness of workable seams is a little over twenty-five feet. This would give 25,000 tons per acre or 16,000,000 tons per square mile. In the Baynes Sound Mine the quantity would be about 12,000 tons per acre, or per mile 7,680,000 tons. Not having seen the full thickness of all the seams on the Beaufort Claim, I shall not venture upon a calculation, but any one can easily make it for himself. To attempt a calculation of the productive yield of the whole field would be premature, before all the details of its structure have been ascertained, seeing that where the seams sink beyond a certain depth they can scarcely

be profitably worked, and until all the seams have been discovered, the undulations determined, and the dips every where observed, how much or how little of the seams are in this condition cannot be known. For the facilities of trade, Comox Harbour would afford excellent accommodation ^{Comox Harbour.} to both the Union and the Beaufort Mines. The former being, as already stated, five miles from it, with a fall of about 500 feet, while the latter is about seven miles distant, with a fall of about 700 feet, Baynes Sound with proper wharfage, might be made available at most places. It is in one place less distant from the Beaufort Mine than Comox, but the fall is not so even. Baynes Sound Mine is about 200 feet above the sea, and Fanny Bay on the Sound is about three miles south-east from it, while Deep Bay is about eight miles. Both of these harbours, though small, ^{Safety of harbours.} are safe, especially the latter, being thoroughly protected from all winds. The approaches to all the harbours named, as well as the harbours themselves, have a depth of from five to twelve fathoms at low water. The more southern division of the two into which we have separated the general trough holding them both, may be called the Nanaimo Field or Basin. ^{Nanaimo Field}

On the Strait of Georgia, at the entrance to Nanoose Harbour, a narrow strip of the brownish-gray sandstone, which belongs to the coal-measures, comes upon the coast at Blunden Point, and strikes along it in a southeasterly direction for six miles, resting on the crystalline series, and dipping north-easterly toward the strait at angles varying from two to fifteen degrees. Further on, these sink beneath the surface of the water, and, concealed by it, seem to turn the point bounding the north side of Departure Bay. In conformity with this they occupy a small island about 200 yards from the shore, just at the entrance of the bay, where they present the character of a conglomerate, the pebbles of which are siliceous, varying from a quarter of an inch to three inches in diameter, while the matrix holds a considerable quantity of carbonate of lime. These beds are interstratified with light drab sandstones, the whole having a thickness of forty feet; dip S. 8° E. $< 17^{\circ}$.

On the shore, immediately behind the island, moderately fine-grained brownish-gray sandstones are seen, resting on the crystalline series, filling up inequalities in their surface, and nearly conforming in dip with the beds on the island. For a quarter of a mile along the shore of the bay, the sandstones continue, with occasional sharp craggy intervals occupied by the crystalline series, the dip of the sandstones gradually becoming south, and then west of south. Within fifty paces of the last of these sandstone exposures, a rock occurs which is composed of a brownish arenaceous matrix so thickly studded with rounded calcareous forms as to constitute an impure limestone. Here, a very little over high water mark, a lime- ^{Limestone.} kiln had been built, and the rock quarried, and burnt for quicklime.

The experiment, however, does not appear to have been very successful, as the kiln is now abandoned.

Fossils, Cretaceous or possibly older.

This impure limestone is visible for about twenty paces, along the strike, and there may be a thickness of it of some ten or twelve feet, in beds of from twelve to eighteen inches. The rounded calcareous forms which stud it were taken on the spot to be water-worn fragments of shells, but, upon microscopic examination of thin slices of them, prepared by Mr. Weston at the museum, Dr. Dawson finds that they contain hexagonal tabulate coral, like *Stromatopora compacta*; a Bryozoon-like *Escharina*, with square cells; also fragments of *Ceripora* and of shells like *Inoceramus* or *Pinna*, Cretaceous or possibly older. On the surfaces of some of the beds there were displayed patches, occupying from two to three inches where least, and about a foot in diameter where largest, of yellowish-white calc-spar, rather over a quarter of an inch thick, very much resembling the remains of thin seams of satin-spar. These, upon the microscopic examination of thin slices, were determined by Mr. Billings to be of the genus *Inoceramus* or *Pinna*, belonging to the *Aviculina*. The dip of these beds is S. 24° W. < 18°, and opposite them, at a distance of about 100 yards, there are four or five rocky islets, composed of the brownish-gray sandstones, which, having the same dip, would overlies them. The fossils which have been mentioned as probably Cretaceous are of importance, in proving that the coal deposits of Vancouver Island are of that horizon.

Dunsmuir Coal Mine.

Nine-foot seam.

Bearing S. 88° W., three miles from the bight of Departure Bay, but how far above the base of the sandstones mentioned is uncertain, there being no exposures in the interval, occurs the Dunsmuir Coal Mine. In a part of the coal-bed, which had been covered with a few feet of clay, a trench six feet wide was being cut at the time of my visit, and had already been extended to fifty yards in a bearing N. 63° E. The thickness in this part was sometimes nine feet and sometimes, perhaps from denudation, reduced to seven feet. At the end of the distance the seam had become covered with about a foot of decomposing argillaceous shale, and was of its full measure, while all the way it rested upon a bed of light drab sandstone, which was quite horizontal.

Four-foot seam.

Proceeding from the commencement of the trench, in nearly the same bearing as before (S. 88° W.), the surface of the ground gradually rises above the base of the coal about twenty feet, and exhibits a mass of light gray conglomerate-sandstones, with pebbles derived from the crystalline rocks, varying in size up to an inch in diameter. The ground again falls about twenty feet, and in a distance of a little more than a quarter of a mile from the first coal exposure, we meet with a second. This, three or four years ago, was worked to the extent of several hundred tons; and I was informed by Mr. Dunsmuir, Postmaster of Nanaimo, that the

seam is from four to seven feet thick, and like the other, it is so nearly horizontal that, being on the same level, it might readily be supposed to be identical with it; but, according to Mr. Dunsmuir, the one gives a red, and the other a white ash; moreover, the second one being nearer the run of the coal-measures, and upon strict examination appearing to slope towards it at the rate of about one degree, it may, from some slight increase of inclination in the interval between them, sink beneath it.

Nanaimo Harbour is situated about three miles S. 25° E. from Departure Bay. A sound leads from the one to the other, on the south side of which are Newcastle and Protection Islands; the latter so named from the shelter it affords to Nanaimo. The northern extremity of Newcastle Island bears a little east of south from the small island which has been mentioned at the entrance of Departure Bay, the distance between the two being about three-quarters of a mile. It presents bold cliffs to the water, which rise to heights of from 100 to 150 feet in some places, and are perpendicular, or even overhanging. These are composed of a coarse conglomerate rock, in which rounded masses of various sizes, up to a foot in diameter, consist of diorite, quartzite and other hard materials, derived from the crystalline series. The breadth of the conglomerate was found to be about a quarter of a mile, and in the cliffs it nowhere shewed distinct stratification; but on the two sides of the island finer beds which succeed have a slope of nine degrees, conformable, in the direction of the dip, with those at the entrance of Departure Bay. The following ascending section, from the crystalline rocks on which it rests, may be constructed of the coal series in the vicinity:—

	Feet.	Section of the Coal measures
Brownish-gray sandstone, in beds of from six to eighteen inches, occasionally merging into impure limestone from the presence of calcareous remains of <i>Bryozoa</i> and <i>Aviculina</i> , such as in the band already described.....	30	
Concealed under the water.....	35	
Gray sandstones, with beds of fine conglomerate.....	40	
Concealed under the water.....	35	
Gray conglomerate, with siliceous pebbles, varying in size from a quarter of an inch to an inch, in a matrix of fine sand, and much carbonate of lime.....	77	
Concealed under the water, between Small Island and Newcastle Island.....	917	
Brownish-gray coarse conglomerate, with rounded masses varying in size from a quarter of an inch to a foot in diameter, consisting of diorite, quartzite and other hard materials.....	211	
Gray, fine-grained, thinly-laminated sandstone, separated into beds from half an inch to four inches thick by carbonaceous partings, showing remains of plants as well as of <i>Inoceramus</i>	37	
Black argillaceous shale.....	4	
Coal, clean and hard, with a cleavage oblique to the bedding, thin leaves of carbonate of lime filling the cleavage joints in some places; thickness from three and a half feet to.....	4	
Concealed.....	24	

Brownish-gray sandstone.....	Feet. 5
Brownish-gray sandstone, holding sub-globular masses harder than the rest of the rock, from the presence of carbonate of lime, of from two to four feet in diameter, which stand out in relief on surfaces exposed to the beating of the sea waves.....	4
Brownish-gray or light drab sandstones, in beds of from six to eighteen inches, interstratified with bands of conglomerate with pebbles up to two inches in diameter.....	21
Brownish-gray sandstones with sub-globular masses, as before.....	3
Concealed.....	10
Coal, clean and hard, not seen, from the presence of water in the slope which has been opened on it, but said to be from three feet thick to.....	4
Concealed.....	17
Gray, thinish-bedded sandstones, with fragmentary remains of the stems and leaves of plants.....	3
Gray, fine-grained sandstone, holding iron pyrites disseminated obscurely in small grains in the rock, which crumbles away on weathering.....	6
Gray fine-grained and finely-laminated sandstones, separated into beds from an inch to a foot in thickness by the presence of thin carbonaceous partings.....	4
Gray fine-grained sandstone in one bed.....	5
Gray fine-grained sandstone in one bed.....	4
Gray fine-grained and finely-laminated sandstones, separated into beds from an inch to a foot thick by thin carbonaceous partings, and yielding excellent flag-stones; on some of the surfaces remains of plants are displayed.....	12
Gray fine-grained sandstone, which constitutes a good building stone in some places, and in others, from the decomposition of finely-disseminated iron pyrites, crumbles on weathering.....	16
Gray fine-grained sandstone in one bed yielding excellent building material.....	10

1538

The dip between the two coal-seams of this section is S. 25° E. < 15°; but, proceeding across the measures which overlie them, it gradually diminishes, until, at the summit, the strata become nearly horizontal.

The gray sandstones of the upper portion yield in most parts excellent material for building and flagging. At the time of my visit, the quarry which has been opened on them was leased by the Vancouver Island Company, on whose claim the coal-seams and gray sandstone occur, to Mr. E. E. Emery of San Francisco, who was raising stone from it for the construction of a United States mint in that city. Six blocks for pillars had been procured from the ten-foot bed, one of which was being dressed into shape for use. When finished the length of the pillars would be twenty-seven feet and a half, with a diameter of three feet ten inches. Mr. Emery was also quarrying flag stones from the twelve-foot bed, from which are obtained very even-surfaced slabs, from one to six inches thick. One of the latter thickness, which I measured, was ten feet square. Both the flags and building stones are easily quarried. The stone dresses freely,

Flag-stones and
building ma-
terial.

Size of blocks.

and it will probably preserve its colour, seeing that natural causes have produced little or no change in its tint on exposed surfaces still unquarried. It is not impossible that grindstones may in some places be obtained from this part of the measures. The flatness of the beds gives a considerable area in Newcastle Island to these useful gray sandstones, and extends their distribution to Protection Island to the south of it.

About a mile south-east from Protection Island, brownish or drab, moderately fine-grained sandstones occur at Sharp Point, and they are seen thence along the coast, almost continuously, all the way to Dodd Narrows, a distance of three miles and a half. The dip varies in direction from N. 39° E. to N. 71° E., and in inclination from twelve to twenty-four degrees. The coast crosses the measures obliquely, gradually gaining higher strata, and there appears to accumulate a thickness of 532 feet. The concealment under the water between Protection Island and Sharp Point, and the increase of dip in the latter locality make it difficult to determine how the rocks in the two are related to one another, and it would scarcely be safe, without more information, to add these sandstones to those in the previous section.

Both the coal-seams mentioned in the Newcastle section have been tested by openings. A slope was sunk in the upper one, upwards of a dozen years ago, to the extent, I was informed, of about 120 yards, and coal shipped from it to Victoria. It seems to have been out of working for a considerable time, and the Vancouver Island Company are at present erecting a small steam-engine at the mouth of the slope for the purpose of bringing it into operation again; but when I was there the slope was full of water. The lower seam is in actual working, a small steam-engine standing at the mouth of the slope to haul up the coal. Several schooners and steamers were supplied with coal from it while I was on the neighbouring coast, and several hundred tons were piled on the wharf at the time of my visit to the mine.

The main working of the Vancouver Island Coal Company, however, is at Nanaimo, on a six-foot seam, about two miles south of the seams on Newcastle Island. Of the measures associated with this seam, Mr. John Brydon, the under-ground manager of the mine, has been so kind as to furnish me with the following descending section, the data for which, having been obtained from a vertical bore-hole, the thicknesses have been reduced by me to measurements perpendicular to the plane of the beds:—

	Feet.	
Bluish-black argillaceous shale.....	11	Section of the measures.
Brownish or drab, coarse-grained sandstone, holding a few disseminated pebbles up to half an inch in diameter	11	
Coal, clean and hard, holding thin leaves of carbonate of lime in the cleavage joints; the thickness varies from two and a-half feet to.....	6	
Brownish or drab, coarse-grained sandstone	65	

	Feet.
Gray fine-grained sandstone.....	75
Coal, associated with from two to three feet of bluish-black shale, the thickness both of the shale and coal being very irregular.....	7
	<hr/> 175

In the working of the upper seam on the slope it has been found that the dip is N. 54° E., with a very regular inclination of sixteen degrees in the first 350 feet, increasing to seventy and eighty degrees in the succeeding 300 feet; the seam then suddenly rises and dips south westerly at an angle of twelve degrees, on which it has been followed for sixty feet. There may possibly be some variation in the bearing of the dip in the steepest part.

Extent of the workings.

Not having seen any under ground plan, I am unable to state how far the seam has been worked on the strike; but it must now be a considerable distance, as the colliery was first opened upwards of twenty years ago, and has been in operation pretty regularly ever since. In 1860 the produce of the mine is said to have been 14,000 tons, and I was informed by Mr. Brydon that the quantity of coal now daily raised is from 160 to 180 tons as it comes from the pick, which would probably give about 40,000 tons of saleable coal per annum.

Produce of the mine.

Three seams of coal.

In a bearing S. 22° E., a little over a mile from the mouth of the slope, there is an exposure of coal on the coast in which three or four seams of good coal, varying in thickness from a quarter of an inch to an inch, are interstratified in about four feet of black shale, resting on about sixty-three feet of light drab sandstone. The dip in the neighbourhood is N. 32° E. $< 15^{\circ}$, gradually changing to S. 83° E. $< 7^{\circ}$, in something less than a mile along the coast.

Seams on Nanaimo River and Dodd Narrows.

Continuing in about the same bearing as before, S. 22° E., for about four miles, two seams of coal are said to occur on the Nanaimo River, about a mile up from the mouth, but I was not so fortunate as to ascertain their thickness or the distance between them. Another reported locality of coal is about a mile south from Dodd Narrows, which would be about four miles south-east from the previous one; but I could gain nothing satisfactory from my informant, of either the thickness or the character of the seam. How these reported seams are related to the Nanaimo coal-beds is uncertain. They may not, however, be far removed from this horizon. On the outside of Dodd Narrows stands the Island of Gabriola. It has a length of ten by an average breadth of about three miles, and, judging from an examination across the strike at the north-west end, and along it on the south-west side, the rocks of the island seem to consist almost wholly of brownish-gray sandstone, sometimes becoming conglomerate, particularly on the south-west side. No coal-seams were observed to be associated with the strata. The dip on the outside of the island appears to be north-eastward, with an average inclination of about four degrees. But in Rocky

Gabriola Island

Bay at the north end, towards the west side, there are evidences of a small undulation.

The area, including all the coal-seams which have been already mentioned as belonging to the Nanaimo field, has a length from the Dunsmuir claim to the end of Gabriola Island of about sixteen miles, with an average breadth of about six miles. Its surface would then measure upwards of ninety-square miles. In the remaining part of this basin, to the south-east, no important coal-seams, as far as I am aware, have as yet been met with. But little of the region is up to the present known, and there is every probability that the same seams will extend to it.

Two long narrow islands, Valdes and Galiano, to the south-east of Gabriola, appear to be a continuation of the same rocks which characterize this area, as far at least as Montague harbour which is near the south end of Galiano. The escarpment along the south-west side of them is seldom less than 200 feet in height, and in one part of Galiano it becomes 900 feet; while the dip, which is north-eastward, is in general moderate. But in Thetis, Kuper and Saltspring Islands, as well as in the smaller ones, called Indian, Secretary, Reid and Hall, the strata appear to be affected by numerous undulations, the dip changing continually both in direction and amount. In the smaller islands mentioned, which have a range parallel with Valdes and Galiano, the strata consist of sandstones, but, at the northern extremity of Saltspring Island, and extending to Saltspring Settlement, a distance of four miles, the sandstones become largely interstratified with black, soft, argillaceous shales, occasionally becoming partially arenaceous. Some of the argillaceous bands are from twenty to thirty feet thick, and these occasionally hold bivalve shells, apparently belonging chiefly to one species; but the shale is of so crumbling a character that it was found next to impossible to preserve a single specimen. Many of the argillaceous bands are from two to five feet thick, separating belts of sandstone, subdivided into beds from two to four inches thick by the presence of shale, varying from mere partings to layers of a quarter of an inch. These sandstones would form excellent flagging, in slabs varying from two to seven feet square.

Southward of Saltspring Island, or, as it is named upon the chart, Admiral Island, are situated Moresby, Portland and Coal Islands, displaying sandstones and shales belonging to the coal-series. Near the centre of the last named island, about twenty feet of dark gray argillaceous shale are overlaid by seventy or eighty feet of gray sandstones. The uppermost two feet of the shale enclose many fragments of tree stems, impregnated with carbonate of iron, and usually in the form of transverse slices, with sharp edges, measuring from two to eight inches in width and from four to twelve inches in length.* Impressions of well formed

* For description of these fossil plants, see Dr. Dawson's note, following Report.

Fossil leaves. broad leaves, distinctly veined, were abundant on the surfaces of the shale-layers, and in one place there lay upon a surface, and extended in a serpentine manner for a length of some ten or twelve feet, the remains of what appeared to be a root, perhaps in its original site of growth, with a thickness of three-quarters of an inch at one end, and gradually tapering to a quarter of an inch at the other. It appeared to be wholly composed of clean coal; whether any branches proceeded into the shale beneath I could not ascertain. The conditions of the case made it appear as if the supposed root, before denudation, had been imbedded in a thickness of shale just sufficient to cover it. On the immediate surface of this covering portion, there was evidence in a vertical section of the succeeding layer, that patches of coal of seven or eight feet in diameter had lain to the thickness of a quarter of an inch.

Shoal Bay. About two miles and a half to the westward of this locality, there is another, in North Saanich, about half a mile west of the entrance to Shoal Bay, on the north side, so exactly resembling the one already described that it suggests an identity of horizon. Here, in addition to the remains of stems,

Fossils. and impressions of veined leaves and root-like forms, fragments of *Inoceramus* are met with in patches. Some of the fragments are eighteen inches in diameter, and occasionally five or six inches thick. In these the shell, which exhibits a transverse fibrous structure, is separated into layers by the interposition of thin leaves of shale, which probably indicates that the thickness is due to an accumulation of fragments, while the layers mark the real thickness of shell in each fragment.

On the same side of Shoal Bay, about half a mile farther west, another similar exposure occurs, with the same sort of remains, with the exception of the supposed roots.

Crystalline rocks. A large part of Admiral or Saltspring Island, on the south-west side, is composed of crystalline rocks. They may have a breadth of six miles, which is more than half the full breadth of the island. These rocks here separate a cluster of united troughs in the coal-measures on the north-east, from a synclinal form on the south-west. The whole number of these synclinal forms, great and small, may be six or seven, and perhaps more. Valdes and Galiano Islands, with part of Gabriola, seem to be in one; Secretary and Reid Islands in another; Moresby Island in a third; Portland Island in a fourth, which seems to run up to Fulford Harbour,* and to be continued, after an interruption, in Burgoyne Bay; Coal Island and Shoal Bay are in a fifth, and there is possibly a sixth in a very small undulation. These six synclinals as a group are separated from a seventh by a run of the crystalline series, extending seventeen and a half

Coal-measure troughs.

* On the west side of Fulford Harbour, near Isabella Point, *Inoceramus* again occurs, in black argillaceous shale, dipping N. 32° W., probably shewing a small fold.

miles north-west, and swelling as it proceeds to the breadth given, the seventh having a length of twenty miles from Cole Bay to the foot of Provost Mountain, with a breadth of probably three miles.

At Coal Point, in the last synclinal form, on the south side of Deep Bay, which is on the east side of Saanich Inlet, there is a seam of coal, from which a few tons have been excavated; but the coal appeared to be a good deal mixed with shale. The seam is thirty inches thick, and dips N. 22° E. < 18°. I was unable to trace it beyond the opening. Three-quarters of a mile on the strike eastward, on the farm of Mr. Cloake, an opening has been made in search of coal; but, although a seam was observable in it, its thickness did not appear to be more than the eighth of an inch.

The numerous undulations which have been indicated in the Nanaimo coal-field, make it difficult to estimate the total volume of the measures. The thickness presented in the Newcastle Island section, from the base to the gray sandstones, is 1,538 feet. As already stated, it would be scarcely safe as yet to add to this the 532 feet displayed on Dodd Narrows; but I am disposed to think that the sandstones of the outside of Gabriola Island, which are the same as those of Valdes and Galiano, are higher strata. In the escarpment in the last named island, we have in one place 900 feet, and for the present it may be safe to suppose that the total thickness of the measures will prove to be at least 2,500 feet.

Belonging to the formation, salt-springs occur in the north part of Admiral Island, giving the popular name by which the Island is known in the country. The water has a bitter, saline taste, and is said by Mr. C. Forbes—quoting from Mr. J. D. Pemberton,—to contain 3,446 grains of salt to the imperial gallon; but, not having seen the full analysis, it is impossible for me to form an opinion as to how far the salts giving it a bitter taste, would be prejudicial to its use for the manufacture of salt.

CRYSTALLINE ROCKS.

The rocks which come from beneath those associated with the coal deposits are of a decided crystalline character, shewing different aspects in different places. In my examination along the coast south-eastward from Comox Harbour, the first exposures of these which presented themselves have already been alluded to, as dividing the general trough containing the coal-measures, into two parts. They occur between North-west Bay and Nanoose Harbour, forming the coast for between seven and eight miles, and rising up into Notch Hill, which, although only 624 feet in height, is rendered conspicuous by its isolated position. Like the peninsula on which it stands, it is composed of a dark gray diorite, minutely jointed in various directions, causing it in its destruction to fall into small fragments. It extends into several small islands and reefs along the coast,

Fine-grained
syenite.

of which the names are Cottam, Mistaken, Gerald, Douglas and Yeio. On the east side, this diorite seems to be united with a considerable mass of fine-grained syenite, consisting of white quartz and feldspar with black hornblende, with which is associated an occasional small quantity of mica. The presence of this rock is indicated in the Islands of Winchelsea, Rudder Reef, Ada, Southly and Maude. The diorite is projected five miles farther to the south-east, in the tract separating the coal rocks of Blunden Point from those of Departure Bay, and where it is seen at the extremity of this its joints are occasionally invested with yellowish-green epidote. Neither the diorite nor the syenite presented any evidences of stratification.

Epidote.

Cape Keppel
and Isabella
Point.

The next locality in which the crystalline rocks occurred was that in which the distribution has already been given, in Admiral Island. The only spot here which I had an opportunity of examining, was in Fulford Harbour, both sides of which shew great masses of a rock composed of bluish-white quartz and feldspar, in which is disseminated a sparing quantity of what appears to be chloritic matter. In that part of the distribution which runs north-westward from between Cape Keppel and Point Isabella, a portion of the breadth rises to the height of 2,329 feet. I am not able to state of what this portion is composed, but to the south-east and south, in the peninsula lying between Saanich Inlet and Haro Strait, and stretching to Victoria, there is a great development of speckled diorite, with much black hornblende, in large masses in the greater part of which no evidences of stratification were observed. On the Saanich road, however, about five miles north-eastward from Victoria, the rock becomes a finely-laminated dioritic gneiss, cut by thin obscure veins holding a small quantity of epidote. Three miles south-east of this, in Cadboro Bay, a similar rock is characterized by the presence of mica, and has a thickness of not less than 150 feet.

Dioritic gneiss,
with epidote.

Crystalline
limestones.

The general trend of the crystalline rocks, which in Admiral Island appears to be south-eastward, seems gradually to turn to the south-west approaching Victoria, conforming apparently to the shape of Vancouver Island, and limestones frequently present themselves associated with the diorite. The most northern exposure of limestone met with by me is in Cormorant Bay, in Haro Strait, eight miles nearly north of Victoria. Here, running along the shore, which is nearly north and south for about 500 paces, there occurs an exposure of limestone, darkish-gray and very finely-crystalline in some places, and in others bluish-white and of an impalpable grain, with a conchoidal fracture. The arrangement of the colours is difficult to understand, as the stratification appears to be obliterated. Both of these limestones hold forms which Mr. Billings is inclined to consider organic. In the dark gray variety they appear like irregular cylinders and fragments of shells which have been silicified, and are weathered into relief on the surface; while in the bluish-white, similar forms,

Fossils.

without silicification, appear of a whiter colour than the matrix, and are also slightly weathered into relief with a shallow furrow close around them. The whole of the forms are too much obscured by distortion to be determined. In some parts both the limestones become intermixed with epidote, the quantity of which gradually increases on receding from the water, while the limestone diminishes, until at last, the whole rock is epidote, of which in some places there is a thickness of twenty feet. Beyond this the epidote gradually becomes intermixed with diorite, and again diminishes until the rock is all diorite, while still farther on, the rock is a diorite of the speckled variety already mentioned, but the junction of the two diorites is concealed. In the passage between the limestone, and the epidote, the rock in some places is marked by the occurrence of small quantities of copper pyrites.

Copper pyrites.

On the Saanich road, about a mile south of the dioritic gneiss which has already been alluded to, there occurs another exposure of limestone, in a vertical bed of eight feet thick, which was traced S. 68° E. for half a mile, and in an opposite direction at intervals for a quarter of a mile. It is a brownish-gray compact rock, of impalpable grain and conchoidal fracture. The rock in contact with the limestone on the north side is a speckled diorite, exposed in some places for a breadth of 200 paces, and probably more; while on the other, at ten paces from the limestone, diorite occurs, which is exposed for an equal breadth.

Limestone bed
eight feet thick.

About a mile and a half from Victoria, to the east of the same road, limestone occurs on the farm of Dr. Tolmie, who has burnt it for quicklime. It is of the same colour and character as the previous band. Only a small amount of the rock is exposed. In the immediate vicinity of the limestone the rocks are concealed; but, about three hundred paces to the north there is a band, 100 feet thick, of bluish-white quartzite, weathering to a yellowish colour. To the south and south-east of it, diorite forms a low range of hills which continue half way to Victoria, and there are occasional exposures of the same rock in Victoria itself.

Quartzite.

The fourth locality in which limestone occurs is less than a mile west of Victoria, on the north side of the entrance to the harbour. It appears in a small cove, where it rises about ten feet above the water, and runs about twenty paces along the bank, in which it is overlaid by clay. Its dip or strike could not be determined, but it is compact and of a mottled-gray. On going south the limestone gradually becomes impure and merges into a diorite, which is the prevailing rock in the neighbourhood.

A fifth locality of the rock is about three miles and a half west of Victoria, on the east side of Esquimalt Harbour. The exposure extends for about 100 paces on the strike, which on the average is N. 82° W., and has a breadth of from twenty to thirty paces. In some places it is confusedly mixed with diorite. It is gray in colour, somewhat crystalline in

Limestone on
the east side of
Esquimalt Har-
bour.

Silicified Encrin-
al columns.

texture, and holds a great quantity of siliceous grains, and some forms which seem to be silicified fragments of Encrinural columns. Immediately north of the limestone, the rock is diorite of the same speckled character already mentioned.

- A sixth locality is in the same bay, about a mile farther west, where there is a bluish-white limestone of an impalpable grain, and having a conchoidal fracture. It has a thickness of ninety feet, and shows thin closely-joined beds, dipping S. 24° E. $< 70^{\circ}$. It is traceable on the strike for about 200 paces. Speckled diorite is seen within a few yards of it, both above and below, that below being visible for a breadth of fifty or sixty yards.

In a seventh locality, about half a mile north of the last, a limestone, of the same character in every respect, occurs, with an exposed thickness of forty feet, which is probably not the full amount. The rock immediately south is speckled diorite, of the same character as the last, and the band of limestone is probably a repetition of the previous one, on the opposite side of a synclinal. It has been burnt for quicklime in both localities.

On the west side of the same bay, from one to two miles southward of these two localities, you have yourself observed the eighth exposure, where a compact bluish-white limestone with a conchoidal fracture occurs, very similar to the bluish-white limestone of Cormorant Bay. The specimens from it seem to show that, as in the case of the Cormorant Bay rock, it becomes greatly mixed with epidote, which, apparently, in some places becomes interstratified with it, and constitutes a large part of the mass.

A ninth locality is met with about a mile west of the sixth and seventh exposures. The limestone is gray and crystalline, and holds many siliceous grains and forms similar to those already mentioned as occurring in the fifth locality. The exposure has a breadth of twenty-four paces in a bearing N. 87° E. It in every respect so thoroughly resembles the limestone of the fifth locality, that specimens from the one cannot be distinguished from those of the other, and there can be little doubt of the identity of the bands.

Identity of the
bands exposed
in the fifth and
ninth localities.

In the tenth locality, which occurs about three-quarters of a mile northward from the last, the rock is a bluish-white compact limestone with a conchoidal fracture. It has a strike of S. 78° E., across which is the following horizontal section going northward :—

	Feet.
Bluish-white compact limestone, with a conchoidal fracture.....	24
Dark-gray or blackish hornblendic rock, soft but hardening on exposure, cut by a multitude of thin veins of epidote, run- ning in all directions intersecting one another.....	35
Bluish-white compact limestone as before.....	38
	—
	97

Knockan Hill
limestone.

In the eleventh locality, which is the last, at Knockan Hill, nearly one mile from the head of Victoria Arm, or about four miles from Victoria

itself, the rock is again a bluish-white compact limestone, with a conchoidal fracture, and has a visible breadth of twenty paces, which may not be the full thickness. It is in contact with speckled diorite on the south side, which has there a breadth of 200 or 300 paces, but its associations on the north are concealed by drift. The strike is E. and W., and in this direction it is traceable for 1,200 paces, at the end of which it is on the land of Mr. Robert Anderson, and close to Colquet River.

It seems probable that these limestones will resolve themselves into at least three bands; one, to which will belong the bluish-white compact variety; another, the gray crystalline variety, with the supposed silicified fossils; while the third will comprehend the epidotic limestone. The second, sixth, seventh, tenth, and eleventh localities will probably belong to the first of these bands, which we may call A. The fifth and ninth localities to the second band, B, and the third band, C, will comprehend the first and eighth localities. The third and fourth localities must for the present be left out. It may be conjectured that the sixth and seventh exposures are on the opposite side of a southern fold, while the tenth and the eleventh, continued to the first, are on the opposite sides of a northern and parallel fold in A; that B, running conformably on the outside of A, shows itself on the opposite sides of the southern fold in the fifth and ninth localities; and that C, running on the outside of all, displays itself on the south side of the southern fold and on the north side of the northern fold, in the first and eighth localities. The whole, therefore, may be conjectured to belong to an anticlinal or synclinal form, the evidence not being sufficient to say which, with a double fold subordinate to it. I have been informed that there are many more exposures of limestone in the neighbourhood than those I have seen; and, by the future study of these, and perhaps of some fortunate locality connected with the supposed fossils, not only the structure, but possibly the age of these crystalline rocks may be made out in this part of the country.

SUPERFICIAL DEPOSITS.

Deposits of stratified clay, sand and gravel are very extensively spread over the rocks belonging to the coal series. With the exception of escarpments towards the base of this series, almost all the exposures of coal rocks were observed only where the drift had been swept away at the margin of the sea, or in channels of streams. Sections of the drift were scarce, and I have only a few examples from which to form an opinion of the general character of the superficial deposits. They consist generally of a grayish-brown clay, mixed with sand, sometimes becoming gravelly with well rounded pebbles, derived from the crystalline rocks, from a quarter of an inch to an inch in diameter. In some places the clay is free from sand, and in others sand prevails, and is usually marked by false bedding.

Superficial deposits, of sand and gravel.

False bedding

Thickness. The greatest thickness that came under my observation was in a cliff forming the coast part of the way between Comox Harbour and Cape Lazo, or Point Holmes. The estimated height was about 150 feet. The lower part is composed of good brick-clay, with very little sand. Layers of sand gradually become more prevalent on ascending, while toward the top the sand predominates, and shows occasional rounded pebbles. In Cormorant Bay there is a cliff of a similar character, but its greatest height is not more than 100 feet.

Brick-clay. To the east of Beacon Hill, which is on the coast just south of Victoria, a cliff, extending a mile, is composed of from fifty to eighty feet of clay, with a small mixture of sand throughout; and, from a similar looking clay, red bricks are made on the west side of the Saanich road, about half a mile from Victoria.

Soil resting on the drift. The drift in general presents horizontal layers, which in a multitude of places are worn into gentle inequalities. Throughout the country it is covered with an unconformable mantle of black soil, consisting of from two feet six inches to four feet of an earth, apparently, containing a large proportion of vegetable matter. This soil is probably marine, seeing that the lower layer from six inches to a foot in thickness, holds sea-shells sometimes, crowded together in great quantities. Owing to the loss of the gelatine, they crumble on being handled, and perfect specimens are, therefore, difficult to collect. The highest position in which the shell-bed was observed is to the east of the Saanich road, about five miles from Victoria. It occurred in a slight depression, at a height of about 300 feet above the sea; but it is not improbable that it may be met with at still greater heights in other places. Some of the shells appear to me to be the same as the recent species.*

Erratic blocks and ice grooves. In all the area examined by me on and about Vancouver Island, erratic blocks were only occasionally observed. Ice grooves were remarked on the beach, below Beacon Hill, near Victoria, running S. 27° W.

Character of the soil. The vegetable soil, which has been mentioned, seems to be of a very productive character, and, whether in the forest, the field or the garden, appears, aided by the favorable climate of the country, to yield great returns. In the Comox district, about 140 miles from Victoria, as already stated, this soil is spread over a considerable area of prairie country, commonly designated *openings*, extending from the coast up the different branches of the Courtnay River for seven or eight miles. The surface of this district, which is naturally free from timber, with the exception of single trees and

* A few of the recent shells were collected on the coast, and Mr. Whiteaves, Secretary of the Natural History Society, has kindly determined them for me. They are as follows:—*Mytilus Californianus*, *Cardium corbis* (= *Nuttallii*), *Saxidomus opacus*, *Tapes staminea*, *Macoma inconspicua*, *Natica russa*, *Lunatia Lewisii*, and *Purpura crispata*.

clumps, chiefly of oaks (*Quercus Garryana*), and strips of alder (*Alnus Oregona*) in the bottoms, may be some twelve square miles, the scenery being picturesque and park-like. Its margin is very irregular in shape, and it is surrounded by a growth of very heavy timber, among the trees of which are the Douglas Spruce (*Abies Douglasii*), often attaining two feet in diameter and 200 feet in height, in one half of which it is free from branches, and the cedar (*Thuja gigantea*) often equally large. The open country, in its natural state, is mostly covered with a growth of ferns, which sometimes attain a height of ten feet, with stems three-quarters of an inch in diameter, and roots descending to a depth of three feet. These roots the native Indians prepare in some peculiar way for winter food, and excavate deep trenches to obtain them. The farmers are under the necessity of grubbing up the fern roots before the ground is ready for use, and they are often voluntarily assisted by their pigs in this operation, these animals, it is said, relishing the fern root as food.

I was informed by Mr. John Robb and Mr. George Macfarlane, two settlers of the district, that the average yield of the land, after it is cleared and thoroughly under cultivation, is

Of Wheat from 30 to 45 bushels per acre.						
" Barley "	40	" 45	"	"	"	"
" Oats "	50	" 60	"	"	"	"
" Pease "	40	" 45	"	"	"	"
" Potatoes "	150	" 200	"	"	"	"
" Turnips "	20	" 25 tons.	"	"	"	"

Some of the turnips exhibited by Mr. Robb at the agricultural shows are said to have been remarkably heavy, but those of the Swedish and yellow varieties seen by me, I considered rather small. The season, however, was said to be an unusually dry one. The yield of Timothy hay is about two tons per acre. Clover thrives well, and rye grass is valued for its after-crop. The yield of butter per cow, after calf-feeding, is about 150 lbs annually; the ordinary selling price being 40 cents per pound. Cattle require generally to be house-fed from the beginning of December to the middle of April. Snow seldom lies long. Heavy falls sometimes occur, but generally disappear in a few days. Once or twice snow has remained on the ground for two months.

Apples, pears, cherries, plums, white and red raspberries, red, white and black currants, and most kinds of fruit thrive remarkably well. Some apples, of which I obtained a sample, measured thirteen inches in circumference, and weighed nineteen ounces, they were highly flavoured, and well adapted for eating and cooking; of the pears, many measured eleven inches in circumference, and were highly flavoured and juicy.

On Gabriola, prairie lands or openings occur, such as those already described at Comox. More of them are met with on Saltspring Island, but

Fern roots used
for food by the
Indians.

Fruit.

Prairie lands
on Gabriola and
Saltspring
Islands.

Fine vegetables
and fruit.

in neither place of the same extent as at Comox. Mr. Griffith, one of the settlers at Salt Springs, informed me that fall wheat thrives well there, and yields from thirty-five to forty-five bushels per acre. Of other grains the yield seems to be about the same as at Comox. In Mr. Griffith's garden there was a large plot of common winter cabbages, the solid heads of most of which measured from three to four feet in circumference. Red cabbage and cauliflowers were equally large and sound. Carrots and parsnips were large, as well as onions, and there was an abundance of tomatoes of several varieties; of gooseberries, which did not seem to thrive so well at Comox, Mrs. Griffith informed me that at Salt Springs the bushes gave a crop equal in quantity and quality to the best English. The crops of all the varieties of currants and raspberries vied with those of Comox.

Fowls and eggs.

Mr. Griffith's orchard occupies about two acres, and has been set out only three or four years. I saw different varieties of apple, pear, peach, plum and cherry trees, and the proprietor informed me that all kinds bore fruit last year. The apples are of excellent quality, and the pears, though not large, were equal in flavour and juiciness to any I had ever tasted.

Mr. Griffith has about three hundred barn-yard fowls, which are fed on the grain of the farm, and enable him to supply a great abundance of eggs to the Victoria and Nanaimo markets, where they sell for from 25 to 40 cents per dozen.

Pumpkins at
Fulford Harbor.

At Fulford Harbor Mr. Theodore Frago showed me a pumpkin of the mammoth variety, which measured thirty-two inches in length, with a diameter of fifteen inches at the small end, and twenty-two inches at the other, and he informed me that larger ones had been used before my arrival.

Beautiful farms
on the oak-open-
ings.

Hops.

The settlements of North and South Saanich, as well as of other districts near and around Victoria, show a good deal of prairie land. From the abundance of oak trees on these lands they are known in this part of the country as *oak-openings*. In them many beautiful farms are met with, and their soil and aspect resemble those of Comox. In addition to the grain, fruit and vegetables, enumerated elsewhere, the hop vine has been introduced in North Saanich, and in the neighborhood of Victoria. In the former place, Mr. Isaac Cloake and Mr. Henry Wain, with some others, have each a *hop-orchard*, as it is there termed, of several acres in extent. Mr. Cloake, who spent nine years among the hop-fields of Kent, in England, informed me that his hops are quite equal, if not superior, to the English, which, according to him, was tantamount to saying that they were the best on the face of the earth; and Mr. Wain, who likewise had practical experience, stated that in regard to aroma they were equal to the best he knew. They are of the variety called the grape-hop. It was introduced from California, and is said to have greatly improved in British Columbia. The yield of hops is here from 1,000 lbs. to 1,700 lbs. to the acre, and they bring in the

Victoria market from 22 to 60 cents a pound. When railway communication is established, the article will probably become one of trade between British Columbia and the Eastern Provinces.

The following report on a sample of a few pounds of these hops which I brought from Vancouver Island, grown within a mile of Victoria, has been furnished by Messrs. William Dow & Co., of Montreal, and must prove highly satisfactory to the growers.

Montreal, 13th May, 1872.

"DEAR SIR,—At your request we have much pleasure in reporting upon the hops of British Columbia, a sample of which you favored us with. Report on sample of Vancouver Island Hops.

"In our opinion they are of very superior quality, rich and fine in aroma. These hops resemble the Californian, and would be equally sure to find a ready sale in this or other markets at the highest rates; they have been well dried, and are in first-rate condition. Our estimate of the value of these hops is that they are worth fully 10 cents per lb. more than the best Canadian growths, the prices of which during the past season ranged from 50 cents to 70 cents per lb., according to the demand, exceptionally high prices however."

Yours faithfully,

(Signed,) WM. DOW & CO.

Other settlements of a similar character to those described are established between Saanich and Nanaimo, but I had no opportunity of visiting them. Near and around the farms which I saw, rocky hills rise up, in many places to heights of 1,000, 2,000, or even 3,000 feet and more, the surface of which is in some parts craggy, but in others presents patches with a thin soil, covered with a fine, short but thick grass, on which sheep and cattle thrive well; all those I saw there appeared to be in good condition. The temperature is cooler in such places than in the lower and more level country, and during the heat of summer they afford excellent pasturage, which will much assist agricultural industry. Settlements between Saanich and Nanaimo.

Along the coast, and in the interior of Vancouver Island, as well as on the shore of the Archipelago surrounding it, equally good farming localities will be discovered, and hereafter become the homes of thousands of hardy and industrious people.

I have the honor to be,

Sir,

Your most obedient servant,

JAMES RICHARDSON.

NOTE BY DR. DAWSON ON THE FOSSIL PLANTS REFERRED TO IN
MR. RICHARDSON'S REPORT.

Note on fossil
plants by Dr.
Dawson.

The specimens are not numerous, and most of them are very imperfect. They are principally from beds associated with coal at Nanaimo and North Saanich. They belong to a flora which has occasioned some controversy. It was originally described by Lesquereux * and Heer as Tertiary, being indeed very nearly allied to that of the Miocene of Europe. Newberry, however, on the evidence of the associated marine fossils, and on the analogy of the Cretaceous flora of Nebraska, † regards it as of the latter age, and this is, I believe, the view more generally adopted. The present collection is too imperfect to throw much light on these questions, and it will be better to await the arrival of larger collections before describing any of the species which it contains. It may be anticipated, however, that the investigations of the survey will develop very interesting facts with regard to these plant-bearing beds of Vancouver Island and the associated coals.

In the meantime the following list may serve to indicate the more important genera recognised in the collection :

List of genera
of fossil plants.

- | | |
|---|------------------------|
| No. 1.— <i>Teniopteris</i> , ? N.S. Distinct from <i>T. Gibbsii</i> , of Newberry, Nanaimo. | |
| " 2.— <i>Taxodium cuneatum</i> , Newberry, | do |
| " 3.— <i>Sequoia Langsdorffii</i> , Heer, or allied, | do |
| " 4.— <i>Sabal</i> (fragments of leaves of a fan-palm). | do |
| " 5.— <i>Palmacites</i> , fragments of leaf, | North Saanich. |
| " 6.— <i>Populus</i> , | |
| " 7.— <i>Quercus</i> , | } Fragments of leaves, |
| " 8.— <i>Platanus</i> , | |
| " 9.— <i>Cinnamomum Heeri</i> , Lesq., | do |
| " 10.—Indistinct fragments of wood, | Union Mine Comox. |
| " 11.— <i>Taxites</i> , belongs to a <i>Taxine</i> tree, possibly <i>Salisburya</i> . | |
| " 12.— <i>Cupressinoxylon</i> . Other specimens from Vancouver Island, Coal Island and North Saanich have the structure of <i>Cypress</i> , and belong to two or three species. | |

ANALYSES OF COALS AND CRYSTALLINE ROCKS FROM VANCOUVER ISLAND,
BY DR. T. STERRY HUNT.

Analyses of
coal, and of
crystalline
rocks.

Of the eight specimens of coal, numbers I. to IV. were, you informed me, from the outcrops of seams, and, consequently, much modified by the weather.

- I. Beaufort Mine, Comox.
- II. Union Mine, Comox, 10 feet seam, very much weathered.
- III. Baynes Sound Mine, Comox, upper seam, somewhat weathered.
- IV. " " " " lower seam.

* Silliman's Journal, Vol. XXVII.

† Fossils plants collected by Mr. G. Gibbs, and Report on Yellowstone and Missouri Expedition.

V. Nanaimo Mine, upper seam. Vancouver Island Coal Company.

VI. Dunsmuir Seam, Nanaimo.

VII. Newcastle Island, lower seam. Vancouver Island Coal Company.

VIII. Locality uncertain, supposed from Nanaimo, marked "lower 7-foot seam."

The results obtained from these by slow coking were as follows :

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Fixed Carbon.....	55.75	54.57	57.48	64.70	51.45	55.50	52.57	59.29
Volatile.....	29.30	23.83	29.10	29.55	38.40	34.70	35.49	27.63
Ash	14.95	21.60	13.42	5.75	10.15	9.80	11.94	13.08
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

I. of the above, gave a bulky soft coke, with a fine gray ash ;

II. scarcely coked, and gave a coarse gritty ash ;

III. gave a firm dense shining coke, with gray ash ;

IV. a firm coke, with a fine reddish ash ;

V. a firm coke, with a grayish ash ;

VI. and VII., like II, scarcely coked, and gave a soft gray ash ;

VIII. gave a firm coke and a fine gray ash.

Lignite.—A specimen of lignite from North Saanich, Vancouver, was remarkable for being in great part replaced by carbonate of lime. It was a part of a flattened trunk or stem, measuring two by four inches, and was black, brittle and devoid of lustre ; but was coated with true coal, apparently derived from the epidermal tissues. The powder of the ligneous interior was dark chocolate-brown in color, and, when exposed to heat in a close vessel, gave off a vapor with an aromatic odor, burning with a bright flame. The black residue, by calcination at a low temperature, became grayish-white, and was chiefly carbonate of lime with a little magnesia.

The analysis of a specimen gave as follows :

Carbonate of lime.....	79.00
Carbonate of magnesia	7.78
Iron and alumina, traces.....	
Insoluble siliceous matter.....	1.50
Volatile matter.....	3.35
Fixed carbon.....	7.00

98.63

The following are notes on various rock specimens :

- No. 18 is a fine-grained grayish hornblende gneiss or granite, consisting of white orthoclase, white quartz and greenish-black hornblende. From Maude Island, Georgia Strait. Rock specimens.
- No. 33 is a gneissoid diorite composed of a white triclinic feldspar, with greenish-black hornblende and a little light brown mica in layers. From Cadboro Bay, near Victoria.
- No. 44 diorite, contains the same elements as the last, but more hornblende. Anderson's farm, near Victoria.
- No. 47 diorite, like the last, but finer grained, gneissoid. Near Beacon Hill, Victoria.
- No. 41 diorite, fine-grained, gneissoid. East Saanich Road.

No. 45 diorite, gneissoid, with greenish-white feldspar, vitreous white quartz, and greenish-black hornblende. Victoria.

No. 63 diorite, greenish, fine-grained, almost impalpable; with compact pale green epidote in the joints. From Departure bay.

Supposed serpentine from Esquimalt Harbour.

Another specimen of a similar fine-grained diorite from the west side of Esquimalt Harbor, which had there been called a serpentine, was found to be somewhat calcareous. When the carbonate of lime has been removed by a dilute acid, the residue is somewhat attacked by strong acids, which remove portions of alumina and lime, showing a feldspar related to labradorite in composition.

The analysis of the rock freed from carbonate of lime gave as follows:

Silica.....	54.10
Alumina.....	18.70
Protoxyd of Iron.....	9.18
Lime.....	3.58
Magnesia.....	4.97
Potash.....	1.10
Soda.....	4.51
Volatile.....	3.60
	<hr/>
	99.74

The presence of a considerable amount of water shows that the rock contains a hydrous species, probably something like chlorite or delessite, containing alumina, so that any attempt to calculate the mineralogical constituents of the rock from the results of analysis, would be of little value. It is a hydrated, chloritic, feldspathic rock, probably containing also a hornblendic element.

No. 27 is quartz, holding only a little chloritic matter, penetrating and coloring it, Fulford Harbor, Saltspring Island.

No. 45 is an impure quartz rock, penetrated like the last by some greenish coloring matter. Dr. Tolmie's farm, near Victoria.



REPORT
ON THE
COUNTRY BETWEEN LAKE SUPERIOR
AND THE
ALBANY RIVER,

BY
MR. ROBERT BELL, C.E., F.G.S.,
ADDRESSED TO
ALFRED R. C. SELWYN, ESQ., F.G.S.,
DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, April 17th, 1872.

SIR,—I beg to report the progress made during the past season in the geological survey of the country lying to the north-west of the great lakes, with the investigation of which you have done me the honor to entrust me. The Thunder Bay and Lake Nipigon regions were examined and reported upon in 1869, and the country lying further east, including Long Lake and Pic River, was worked out in 1870, and described in my report to you for that year; while the section explored last season lies mostly to the northward of both of these tracts. Region examined.

Not having been able to leave Collingwood until the 1st of July, our operations in that northern latitude were necessarily much retarded by the lateness of the season, and it was the 23rd of November before we again reached Collingwood. Owing to the unusually great demand for men for parties of explorers and others who had gone to the woods just before me, I found it very difficult to get together a suitable party; but, notwithstanding these drawbacks, I am happy to be able to report a very satisfactory season's work. I may be here allowed to express my obligations to my assistant, Mr. Geo. F. Lount, to whose energy and interest in the work our success was largely due. I have also again to acknowledge our indebtedness to all the officers of the Hudson Bay Company, with whom we came in contact, for their kindness in aiding us in our labors. Party. Acknowledgment of aid.

In geological work, such as that allotted to me last year (consisting principally in ascertaining the geographical distribution of the rock formations), the results are best shown upon a map, and for this purpose I have, during

Plans shewing results. the winter, laid down all our surveys on a scale of half a mile to the inch, and recorded our geological notes upon the face of the plans. In the present report I shall, therefore, merely endeavor to give a summary statement of the work done, and a general description of the country examined.

Nipigon region. One of the duties assigned to me being to ascertain, if possible, the relation of the Upper Copper-bearing Rocks to other formations to the northward, we entered the country by way of the Nipigon River, and proceeded to make surveys to the north-west, north and north-east of Lake Nipigon. The first of these was by way of the Wabinoash River and chain of lakes, which together form the canoe-route to Osnaburgh House; the second was by the Pikitigouching River, and was performed by Mr. Lount; while the third was by the Ombabika River. On our way to the country north of Lake Nipigon, we had opportunities of adding somewhat to the geological knowledge of that country gained while making the survey of 1869, and also of perfecting, to some extent, our topographical plan of the region.

South Bay. Having been detained by head wind for a few days at Flat Rock Portage, I made a survey of the shores of South Bay, and, while doing so, discovered a small discharge flowing from Lake Nipigon by way of Lake Hannah. It consisted, at the time of our visit, of a brook large enough to drive a mill, but was dry in 1869, owing to the water in the lakes having then been about three feet lower. A traverse was made from island to island across the main body of Lake Nipigon, from Nipigon House to the mouth of the Ombabika River, the distances having been ascertained by Walker's patent log, and bearings taken from numerous points, which have enabled me to make a more complete map of the islands in the centre of the lake.

Small outlet. Having ascertained that the best route for a further examination of the country was from the head waters of the Ombabika River, we continued thence, northward, all the way to the Albany River, surveying our course as we went. On reaching the Albany, we turned down stream, and surveyed the river to the point where it is joined by the Kenogami or "English" River, a distance of one hundred and eighty-four miles. Here we turned southward, up the Kenogami River, and surveyed it as far as Pembina Island, which I had reached the previous year from Long Lake; so that we have now completed two distinct lines of survey from Lake Superior to the Albany and also surveyed the intervening portion of that river.

Traverse of Lake Nipigon. The following list shews the distances actually surveyed, without including side explorations or geographical features fixed by triangulation :

Two lines from Lake Superior to Albany River.

Summary of surveys.

	Miles
New traverse of Lake Nipigon.....	34
Route northwest from Lake Nipigon by Wabinoash River.....	33
Pikitigouching River.....	30

	Miles
From Lake Nipigon to the Albany River.....	142
On Albany River, to the mouth of Kenogami River.....	184
Kenogami River from its mouth to Pembina Island.....	99
Total number of miles of new survey.....	522

These surveys were made by means of the Rochon micrometer and the prismatic compass, with the exception of the traverse of Lake Nipigon, where the distances were ascertained by means of Walker's patent log, and a small section of the Kenogami River, just below Pembina Island, where they were determined by pacing along the banks of the stream. Where the line of our survey passed through lakes, their correct dimensions and forms were ascertained by triangulation and other means, as accurately as our time would permit. The latitude was taken every day, if the state of the weather allowed, and a regular record was made of the reading of the barometer, at least twice a day, for the purpose of comparison with another record which was kindly kept for us at Nipigon House by Mr. Crawford and Mr. Henry De la Ronde, with the view of ascertaining general levels. Comparative levels were taken at all falls and rapids, and at portages between lakes, and the heights of hills or mountains were ascertained whenever we had opportunities. Throughout the region examined, the magnetic meridian corresponds nearly with the true north and south, but the amount of variation was ascertained as often as was considered necessary. Observations were also made with the view of determining the volume of water discharged by the principal rivers. Some of the rivers, of which we surveyed portions, may yet prove valuable for the purposes of navigation, although even their existence appears to have been unknown, except to the few Indians and fur-traders who inhabit the country. We made frequent notes of the temperatures of the rivers and lakes, and of the nature of the vegetation, as being the best means within our reach of judging of the climate of the country we travelled through. We also took care to register any notes, both from original observations and the information derived from the inhabitants of the country, which appeared likely to enable us to furnish useful information of any kind in regard to this great region.

ADDITIONAL NOTES ON THE GEOLOGY OF LAKE NIPIGON.

Some of the geological notes made while we happened to be on Lake Nipigon may be worth mentioning here, to supplement the geological description of the lake contained in my report of 1869. The red quartziferous feldspar-rock, which is there described (page 348) as occurring near Nipigon House, was found on the west side of Dog Island opposite the Post, where it forms a cliff about forty feet in height, divided by joints into large perpendicular columns. The stratigraphical relation of the prevailing trap of

Lake Nipigon to these rocks and to the sandstone of the same neighborhood was not clearly made out; but, at the locality just described, the dark-colored trap is seen, apparently overlying the other rock, which, in one place, is cut by a small dyke of the trap. In the same locality, and on a higher level than either the trap or porphyry, there is a bed at least five feet thick, of a soft grey magnesian rock, dipping northward at a low angle.

Nipigon House. The eastern slope of the hill, which rises above Nipigon House to a height of about 200 feet, is composed of a feldspar rock, similar in lithological character to that above referred to, but occurring in beds, some of which are thin while others are massive, all dipping N. N. W. at angles varying from forty to sixty degrees. Many of the beds shew well marked diagonal stratification. This rock may have a thickness of 800 or 1,000 feet, and is followed by the dark-colored trap, apparently in beds having the same dip, and which form a cliff seventy or eighty feet high at the summit of the hill.

Inner Barn. On the southern point of the Inner Barn, in Wabinoosh Bay, I discovered, near the water's edge a section of about ten feet of mottled, green and purple, shaly, arenaceous limestone, dipping easterly at an angle of 15° or 20°. Beds of a purer limestone, having a grey and greenish color, mottled with purple patches, are interstratified with the others; and fragments derived from them are strewn in abundance upon the beach, and may prove of value for burning into lime. None of the beds were observed to contain fossils. The common trap, having a vertical columnar structure, rises to a height of 520 feet (by barometrical measurement) immediately above these unaltered sedimentary deposits. Some loose fragments of fine-grained, light-grey sandstone, and large worn gneiss boulders were found lying upon the rounded surface of the trap on the highest part of the island.

In going from Nipigon House to the Ombabika River, the only rock found *in situ*, on any of the islands examined, consisted of the common dark trap; but on one lying about seven miles north-east of Nipigon House there are many very large angular masses of thick-bedded, greenish-grey and reddish, rather fine-grained, hard, quartzose sandstone, and others of a mottled green and grey color, derived from thinner beds. The rock was not found in place, but from the abundance and angularity of these large masses, it cannot be far off. The Indians report one of the islands lying off the south Peninsula of Ombabika to be composed entirely of sandstone, and Mr. McKellar found this rock *in situ* in several places on the main shore of this peninsula. (See Report for 1869, page 344.)

Sandstones.

I was shewn specimens of iron pyrites by Indians who said that they obtained it on Medicine Lake on the Red Paint River, which enters the east side of Lake Nipigon, and at another locality near the mouth of the same river; also of a slaty iron ore from the east side of the lake. Specimens

of a similar ore but of a poorer quality, from a point on the Sturgeon River, a short distance above Poplar Lodge, were shewn me by Mr. H. De la Ronde.

SURVEY OF WABINOSH RIVER.

The survey by way of Wabinoah River and the lakes beyond the height of land, began at the outlet of Wabinoah Lake, one mile from Lake Nipigon (to which Mr. McKellar had surveyed it in 1869), and extended to a point twenty-nine miles in a straight line from the head of Wabinoah Bay, or thirty-three miles following the canoe route. In this distance we made nineteen portages, and passed through eighteen lakes, the largest of which are Wabinoah and Round Lakes, each three and a-half miles in width, and Oval-rock Lake, four miles in length. The south branch of the Wabinoah River enters the south-west angle of the lake of the same name, and is a larger stream than the north branch, which we followed. A portage which occurs on this route between Clear and Oval-rock Lakes, at a distance of twenty miles in a straight line from Wabinoah Bay, the Indians told us was on the height of land between the waters of Lake Nipigon and the Albany River, although the water of the next lake to the north-west of Oval-rock Lake flowed into the latter. The surface of Clear Lake has an elevation of thirty feet over Oval-rock Lake, and of 100 feet over the lake to the south-east of it, into which it discharges.

For a distance of ten miles from Lake Nipigon, or around Wabinoah and Round Lakes, the country has the same mountainous aspect as about Wabinoah Bay, the trap hills rising from 200 to 500 feet above the level of the water, and often presenting perpendicular cliffs. The same kind of trap prevails as far as the height of land, beyond which gneiss was the only rock seen, with the exception of a ridge of dark grey crystalline trap, running in a north-westerly course, near the furthest point which we reached. The general attitude of the trap beds appears to be horizontal. The stratification is particularly well seen about the outlet of Round Lake, where the bluffs, viewed from a short distance, resemble cliffs of thinly-bedded limestone.

A small island in the middle of Round Lake consists of a dark red, coarsely crystalline rock, composed of red feldspar, green hornblende, and a little mica, quartz and magnetic iron. For a distance of four miles north-west of Round Lake, a dull red granite is met with almost everywhere along the lower levels. A small exposure of grey contorted gneiss occurs, however, at one place three miles north-west of this lake. At the eighth portage, which is about fifteen miles from Lake Nipigon, a breadth of about 200 feet is occupied by altered sandstone and a hard, compact, dark grey, siliceous rock, which is full of straggling veins and patches of uncrystalline red feldspar; and in one place this mineral is associated with large aggregated.

crystals of green hornblende, mixed with calc-spar. On the north side of this band the rock is dark trap with numerous specks of magnetic iron; while on the south side, a compact, hard, red, splintery, quartz and feldspar rock occurs. Beyond the height of land, the gneiss, which is the rock of the country, as far as we went, presents nothing remarkable to note. Proceeding north-westward, it first dips N. E., then E. and finally S. E.

Glacial striæ.
Moraines.

The direction of the glacial striæ along this route varies from S. 15° E. to S. 30° W. Moraines of boulders, having a southerly course, are conspicuous on both sides of Round Lake.

Soil.

The country which we passed through by the route just described, is generally rocky and of little value for agricultural purposes. The only good land which came under our observation was on the west and north sides of Wabinoosh Lake, where the soil consists of fine sandy and clayey loam.

SURVEY OF PIKITIGOUCHING RIVER.

Pikitigouching
River.

The Pikitigouching, or Little Muddy River, flows into Windigo's Bay in the northern part of Lake Nipigon. In 1869 we measured four and a-half miles of this stream, and last year nearly thirty miles more were surveyed by Mr. Lount. Although the highest point reached by Mr. Lount is only about twelve miles from the mouth of the river in a direct N. N. W. course, yet, following the windings of the stream, the distance is about thirty-four miles. Besides the great bends which the river makes, its whole course is extremely crooked. At one place, a portage of about sixty chains saves eight miles of river navigation. Mr. Lount's survey terminated at the north side of a sheet of water, two miles wide, called Round Lake, which is the first one met with in ascending the river. In the above distance only four short portages occur, and two of them are past wood-jams.

Character of
the country.

In the portion examined the Pikitigouching flows through a flat region, with apparently a good soil; but hills of trap could be seen from the river here and there, as far as Round Lake, beyond which the country is said to be everywhere of a level character. In the bed of the river, Mr. Lount reports having met at six miles, in a straight line, bearing a little north of east from the mouth of the river, with a dark green dioritic schist, running north-east and south-west; and at nine miles, in a direct north-north-westerly course from the same point, an indurated, pink-colored, calcareous marl in horizontal beds; also a deposit of iron pyrites at the fourth portage, which occurs about two miles below Round Lake.

Rocks observed.

SURVEY FROM LAKE NIPIGON TO THE ALBANY RIVER.

Lake Nipigon
to Albany
River.

In crossing the country from Lake Nipigon to the Albany River, we first followed the Ombabika River to its source, which is in Shoal Lake, three and a-half miles long and one mile wide, lying at a distance of twenty

five miles north-east of the mouth of the river. This lake lies due north and south, and discharges both ways, the stream flowing northward towards the Albany, called the Powitik River, being nearly as large as the southern outlet. No portage occurs on the Ombabika for about nine miles before reaching Shoal Lake, nor for nearly five miles beyond its northern outlet; so that we passed the height of land with the greatest possible ease, having had about seventeen miles of uninterrupted canoe navigation, from the time we made the last portage, in going up on the southern side, till we came to the first in going down on the northern. Shoal Lake has an elevation of scarcely 300 feet over Lake Nipigon, or about 1,200 feet above the sea. Before reaching this (summit-level) lake we passed through twelve others on the Ombabika River, the largest of them, Cross Lake, being four miles in diameter. Although the distance from the mouth of the Ombabika River to Shoal Lake is only twenty-five miles in a straight line, it amounts to forty-two miles by the river. Of this distance, however, upwards of eight miles, in the form of a long acute bend, and four portages may be avoided, by making a portage of sixty-eight chains in length, which would be the fifth from Lake Nipigon.

The stream which flows northward from Shoal Lake, at the distance of six miles joins a larger river called the Ka-pi-ko-tongwa, which we descended for twenty-one miles, and then turned up a small branch from the left side called the Mokoké River, from which, crossing the water-shed, we followed the canoe-route north-westward and descended the Zhob-schquay to the Ogoké River, another of the branches of the Albany, and probably the largest from the south side above the Kenogami River. In the ten miles of the Ogoké River which we examined, it averaged about 500 feet in breadth, with large lagoons and marshes on either side, and was from fifty to sixty feet deep in the middle. The Indians informed us that it maintained the same dead-water character as in this section, for a long distance, both above and below; so that it would appear to be well adapted for steamboat navigation in this part of its course; but it is said to spread out to a great width and to become very shallow after it reaches the flat-lying palæozoic rocks further down. We left the Ogoké River by what is called the French Channel, and at less than two miles crossed the height of land which separates its waters from those of another tributary of the Albany lying further north, and which is known in different parts by four distinct names, corresponding with those of the lakes upon its course, the largest of which is called Ka-gé-i-na-gami. We surveyed the lower part of this lake and found it to measure eight miles in length by four in breadth. The upper or south-western part, which is said by the Indians to be equally large, is separated from the lower by a channel, less than half a mile wide. Following this tributary northward, we reached the Albany at a lake called Abazotikitchewan, which, according to our survey, lies at a distance of

Aspect of the country.

eighty-three miles in a straight line, bearing N. 15° E. from the mouth of the Ombabika River. By the canoe-route, which we surveyed, the distance is about 142 miles, in the course of which twenty-nine portages require to be made, or thirty-three by way of the great bend of the Ombabika River. The country traversed by this route presents a generally level aspect, but the surface is rocky or swampy, as far as we could examine it, with the exception of some small tracts of good land. Some sections are hilly, but the highest points seldom rise more than fifty or sixty feet above the general level. The nearest approach to a completely level tract is in the neighborhood of the height of land, the surface of the country having a greater tendency to become broken in approaching Lake Nipigon on the one side and the Albany River on the other.

Character of the rocks between Lake Nipigon and Shoal Lake.

The rocks consist of common Laurentian gneiss from Lake Nipigon to Cross Lake, the distance being about twenty miles in a straight line. Towards Lake Nipigon the general strike is a little north of west, but in approaching Cross Lake it becomes nearly south-west. A ridge of massive red granite makes its appearance on the south side of this lake, but on other parts of the shore the rocks consist of close-grained, dark green dioritic, and fine-grained, green mica schists, all having a nearly vertical attitude, the strike being from 10° to 20° north of west. Quartz veins, mostly small, irregular and branching, run both with the strike and across it. Leaving Cross Lake, the next rock seen was along the west side of Shoal Lake, and consisted of fine-grained, grey, imperfect gneiss, holding quartz grains and mica in the form of schistose bands in some parts, and as disseminated scales in others; also branches and veins of quartz, measuring from six inches to two feet in thickness, and containing crystals of epidote and scales of chlorite. The average strike is here from 10° to 20° south of west. The fine-grained green mica schists are again seen on the Powituk River near its junction with the Ka-pi-ko-tongwa, and are here cut by quartz veins a foot thick containing specks of iron pyrites, and also by a vein of coarse granite fifteen feet thick. The strike at this locality varies from S. 72° W. to S. 85° W. The above-mentioned rocks, which appear to have a breadth of twelve or thirteen miles from south to north, are all of the same character as those described, under the same names, in my report of last year, as occurring around the head waters of the Pic River and elsewhere, and are supposed to be of Huronian age.

Huronian rocks.

The next rock met with was at about three miles down the Ka-pi-ko-tongwa, and consisted of a massive, bright grey granite, composed of white quartz, white feldspar and black mica. A coarse massive micaceous gneiss, which runs in a south-westerly direction, and is cut by straggling granite veins, occurs about a mile further down. From this point, gneiss and granite were the only rocks met with all the way to the Albany River. The gneiss is generally of a massive character, and its average strike south-westerly

the most remarkable exceptions being along the Zhob-schquay River before it joins the Ogoké, and again where we approached the Albany, in both of which localities it is north-westerly. Around Lake Ka-gé-i-na-gami the only rock observed was a massive bright grey granite, composed principally of quartz and black mica, and traversed by reticulating veins of mixed quartz and feldspar.

The general course of the glacial striæ between Lake Nipigon and the Albany is south-westward, usually approaching more nearly west than south. ^{Glacial striæ.}

SURVEY ON ALBANY RIVER.

Gneiss, striking from west to north-west, is found all around the southern part of Lake Abazotikitchewan, but in going northward, dark crystalline trap, like that of Lake Nipigon, (see my Report of 1869), is met with on the shores in approaching the inlet of the Albany, which is from the north-west. On a small island near the inlet, a dark colored granite and a green hornblende rock are cut by a trap dyke five feet thick, running north-west, and having a basaltic structure, the columns being at right angles to the walls. From the inlet of Lake Abazotikitchewan, the course of the Albany River is south-east for eight miles, when it enters Makokebatan Lake. In this section seven rapids, but no portages, occur, and the width of the river varies from ten or twelve chains at the rapids to more than half a mile in the smooth places between them. Gneiss running N. 70° W. was observed in one place in this section of the river. ^{Crystalline trap.}

From the head of Makokebatan Lake to Martin's Falls, a distance of fifty-six miles, the general course of the river is N. 70° E. Makokebatan Lake is nearly straight, and measures sixteen miles in length by one and a-half in breadth. No rock *in situ* was seen upon its shores, which are strewn with small rounded boulders, interrupted in some parts by sand beaches; and the country all around is so low and level, that, looking from one end of the lake, the land cannot be seen at the other. At the eastern extremity of the lake the Albany flows out by two channels, which only come together again at Moosewaké Lake, nearly twenty miles further down. Ten miles below Makokebatan Lake, the northern channel enters the lower part of Washi-sagaigan or the Lake of the Narrows. This part of the lake is four miles long, but the Indians informed me that the upper division approached close to a bay on the north side of Makokebatan Lake, and that a portage leads from one to the other. This would give it a length of twelve miles more, or sixteen in all, which is equal to that of Makokebatan, and the Indians also consider these two lakes to be of the same length. Washi-sagaigan was also formerly called Gloucester Lake from a Hudson Bay Company's post of that name, which existed many years ago at the Narrows. ^{Makokebatan Lake to Martin's Falls.}

The distance from the Lake of the Narrows to Moosewaké Lake is about five miles. Fine micaceous and dioritic schists (like those already described) running S. 65° W. occur at the east end of the former, and again running S. 30° W. at the west end of the latter; while on the river, between these two localities, is exposed a massive, reddish-grey, micaceous gneiss, much of which is thickly studded with crystals of light red feldspar, giving the rock a coarse porphyritic appearance. From Moosewaké Lake to Martin's Falls (a distance of about twenty miles) the river is full of islands and rapids, and the rocks appear to consist entirely of fine-grained green, micaceous, dioritic and hornblendic schists, with which are associated small veins, strings and patches of quartz, and large veins and masses of coarse granite. Specks of copper pyrites were observed at one place in the dioritic schist. The average strike is west, varying to ten and sometimes to fifteen degrees both to the south and north of that course. The rapids mostly occur where great veins of the granite cross the bed of the river. Towards the end of the above twenty miles, bands of gneiss become interstratified with the schists, and just at Martin's Falls the latter have become entirely replaced by red and grey gneiss, apparently shewing a conformable passage from the Huronian into the Laurentian rocks. What appeared to be a similar blending of these formations was noticed last year in the neighborhood of White Lake.

Blending of
Huronian and
Laurentian
rocks.

Portages.

Glacial striae.

Journals kept at
Martin's Falls
for the last
forty years.

Crops.

At Martin's Falls there is only a rapid with a descent of about twelve or fifteen feet, down which light canoes are easily run. Fifteen portages occur between Makokebatan Lake and Martin's Falls. The greatest single descent is at Ka-gé-ami, where the river descends forty-five feet at one chute. The surface of the country on either side of this section of the river appears to be only slightly undulating, and the soil in many places seems to be good. The general direction of the glacial striae is about W. S. W., corresponding with that of the upward course of the river. Between Abazotikitchewan Lake and Martin's Falls twelve rivers and large brooks enter the Albany.

When at Martin's Falls, Mr. McKay, the gentleman in charge of the Hudson Bay Company's post there, kindly afforded me an opportunity of looking over the journals of the last forty years, which had been kept by his predecessors. From these I ascertained that the river between this point and James's Bay is open, on an average, six months of the year. Hay, turnips and potatoes have been successfully cultivated for a long time at this post, and the cattle kept here thrive well.

Below Martin's Falls the river changes its character entirely, becoming more uniform in breadth, depth and velocity of current. In the 120 miles which we surveyed to "The Forks or junction of the Kenogami River, the width is from twenty to thirty chains, the depth in the middle from five to twenty feet (averaging about eleven), and the mean velocity

about three miles an hour. Below The Forks, the river is described as maintaining similar characters all the way to the sea. A rapid occurs near the mouth, but this is said to be easily passed by boats going both up and down. Except in very low water, the river would appear to be navigable by powerful steamers, with shallow draft of water, all the way from its mouth to Martin's Falls, a distance of about 250 miles. As shewing its freedom from obstructions, I may mention that the Hudson Bay Company's boats, in descending, are allowed to drift all night with the stream, in any part of this distance, the submerged top of a fir tree being sufficient to keep them in the channel.

River navigable
below Martin's
Falls to its
mouth.

From Martin's Falls to the junction of the Ogoké River, the Albany makes a curve to the north, equal to a semi-circle measuring over thirty-seven miles. The Ogoké is nearly twenty chains in width where it joins the Albany. From this point the latter runs due east for twenty-one miles, and then turns south-east, and maintains that course for upwards of sixty-one miles, to the Kenogami, which it joins at right angles; the Albany, at this point, turning abruptly to the north-east, while the upward course of the lowest stretch of the Kenogami is south-west.

Junction of the
Kenogami
River and the
Albany.

All the way from Martin's Falls to The Forks, the Albany is flanked by steep banks, either immediately overlooking the water, or rising at a short distance back from it. In descending the river their general height increases gradually from forty to about ninety feet, and they also become more regular and continuous in approaching The Forks. They are at first composed entirely of drab-colored boulder-clay, capped with sand; but, after reaching the palæozoic rocks, these deposits are by degrees replaced, in the lower part of the banks, by drab and chocolate colored marls and shales, the upper part being usually composed of the boulder-clay, overlaid by sand. The bed and shores of the river consist of either smooth, flat-lying rock, or small rounded boulders, packed closely together, and all brought by the drifting ice to a uniform surface, so that they bear a strong resemblance to a well laid pavement.

Character of
river-banks..

Packed boulders.

Gneiss, with the usual east and west strike, was the only rock seen *in situ* from Martin's Falls to the most northern point of the great bend; but, immediately on passing this, yellowish limestone strata make their appearance in the bed of the river. Similar limestones, and others of a grey color, are seen in the bed and banks of the river, here and there, to within about twenty miles of The Forks, where they become replaced by the overlying drab and chocolate-colored marls and shales. The inclination of the strata towards the sea is greater than that of the bed of the river, so that the line of division between the chocolate-colored and the underlying drab marls and shales becomes gradually lower and lower in the banks, and at length sinks beneath the river bed. Layers of the two colors are interstratified with each other for a certain thickness at

Limestones.

the junction, so that for some miles the banks have a banded appearance. In this interval a small quantity of soft, thin-bedded, grey sandstone occurs. The few fossils found in these rocks appear to indicate an equivalent of the Niagara formation; but in one place, just below the mouth of the Goose River, or three miles below the point where the river turns south-east, bright red marl occurs on the north bank, and on a small island, a mile further down, some loose fragments of a bright bituminous coal were found. The Hudson Bay Company's officers informed me that coal had never been brought into the country; and, considering that the conveyance of even light and valuable goods is so expensive in this region, this is only what might have been expected, so that I cannot suppose this coal to have been brought here by human agency.

The large proportion of boulders of a very dark-colored granular quartzite, and the abundance of rounded fragments of a hard, banded, silicious hematite, containing usually about 50 per cent. of iron, which occur in the drift along the Albany, are worth noting. These erratics have probably come from a long distance to the north-eastward, as indicated by their worn character and the direction of the glacial striæ.

The country on either side of the Albany below Martin's Falls is quite level. The steep banks drain a narrow strip of land on either side of the river, but beyond this great swamps appear to extend on all sides. Water is constantly oozing from the foot of the banks, rendering it very difficult to walk along the sides of the river, on account of the deep mud, except upon the boulder pavements already described. The Albany receives nineteen rivers and large brooks between Martin's Falls and The Forks.

KENOGAMI RIVER.

The Kenogami River, and the Albany below The Forks, flow in the same great valley, which appears to be a more considerable depression of the country than that occupied by the portion of the Albany already described. On coming to The Forks we found, for the first time, marine shells in the drab or bluish-gray pebbly clay in the bank of the river. The species, in order of abundance, are *Saxicava rugosa*, *Mya truncata*, *Tellina proxima*, *Cardium Grælandicum*, *Leda truncata* and *Mytilus edulis*. A short distance up the Kenogami River we found, in addition to these, *Tellina Grælandica* and *Buccinum undatum*, making eight species in all. Along the east bank at the junction of the two rivers, the drab or bluish-gray, gravelly clay, which holds the marine shells, is about thirty feet thick, and is overlaid by about thirty feet more of clay, sand and gravel, holding fresh water shells, and having a band of impure black lignite, two feet thick, at about six feet from the top.

From The Forks to Mamattawa, a distance of fifty miles in a straight line, or sixty by the river, the upward course of the Kenogami is a little

east of south. At its mouth this river is thirty chains in width, but it soon contracts to about twenty, which it maintains all the way to Mamattawa. Throughout this distance, it is shallow with a slack current, except in a few places; while the banks are generally low and the country level on either side. The marine shells are found in abundance in the clay and sand of the banks all the way to Mamattawa, and for a few miles above it, when they disappear entirely. Mamattawa is a contraction of an Indian word signifying the coming together of many branches, and refers to the fact that two large tributaries here join the main stream from the east, and both of these again receive branches near their mouths. The Hudson Bay Company had a post at this locality many years ago, but it is now re-established, under the name of Newpost, further down the river, at a distance of thirty miles from The Forks. From Mamattawa, the river has a nearly straight upward course, bearing S. 50° W. to the junction of the Bagutchewan River, the distance being twenty miles in a straight line, or only three more by the stream. The general upward course of the Kenogami, from the mouth of the Bagutchewan River to Pembina Island is S. 60° W., and the distance is about twelve miles in a straight line, or sixteen by the river.

On the east side of the Kenogami River, where it joins the Albany, the chocolate-colored marl and shale hold a band, about four feet thick, of a coarse oolitic character, the spheroidal concretions being about the size of salmon roe, and composed of clear calc-spar, while the interstices are filled with soft, porous, calcareous marl, or sometimes with limestone. This rock was met with at other points on the river as far as Mamattawa and in one place about six miles above it.

In ascending the Kenogami River, we have a repetition of the geological conditions which were observed on the Albany. From The Forks to Mamattawa, drab and chocolate-colored marls and interstratified bands of earthy yellowish limestone are exposed in a few places. Following up the stream, at about seven miles above Mamattawa, the bottom of the river is composed of beds of limestone which are in places somewhat disturbed. The river between this spot and the Albany appears to run upon the axis of a slight anticlinal. At the end of the seven miles indicated, we enter between banks composed of chocolate-colored marl interstratified with bluish-green bands, and varying from fifty to eighty feet in height. These banks continue on both sides almost uninterruptedly for about ten miles up the stream. Above this, the banks, which maintain almost the same height, especially on the southern side, are mostly composed of stiff gravelly clay with boulders, but the chocolate-colored marl is seen here and there almost to Pembina Island, beyond which the geology of the country, all the way to Lake Superior, was described in the report which I had the honor to submit to you last year.

From Pembina Island we pushed on as rapidly as possible, by way of
Return journey. Long Lake and the Pic River to Lake Superior, which, with our small
party, we had great difficulty in reaching, owing not only to the lowness
of the water and the great number of portages which we were obliged to
make, but also to the snow and ice, and the unusual severity of the season,
even for that region. The party, however, suffered no inconvenience from
Provisions. any want of provisions, as we succeeded in taking with us, all the way from
the mouth of the Nipigon River, at the same time that we carried on the
survey, an abundant supply for the four months during which we were
gone, not only for the use of our regular party, while travelling over the
800 miles on the round trip back to Lake Superior, but also for the addi-
tional men whom we required in making the other surveys from Lake
Nipigon, and for our Indian pilots on the Albany River. Besides frequent
presents of small quantities to the Indians whom we happened to meet, we
were obliged to leave a considerable proportion of our surplus provisions at
Newpost and at the mouth of the Bagutchewan River.

I have the honor to be,

Sir,

Your most obedient servant,

ROBERT BELL.

REPORT
ON
EXPLORATION OF COUNTRY
BETWEEN
LAKE ST. JOHN AND LAKE MISTASSINI,
BY
MR. WALTER McOUAT,
ADDRESSED TO
ALFRED R. C. SELWYN, ESQ., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

SIR,—In compliance with instructions received from you in May last, I was engaged during the past season, in company with Mr. John Leitch, in making a geological exploration in the country to the north and north-west of Lake St. John, on the Saguenay, and extending to, and embracing a portion of Lake Mistassini; and I now beg to submit to you a statement of the work accomplished.

Leaving Montreal on the 10th June, I arrived on the 17th at Lake St. John, where I joined Mr. Leitch, who had preceded me by about a week. Our departure from this lake, where we had arranged to procure men and canoes, was seriously delayed by the unusual lateness of the spring in that region. Owing to this cause the Indians, with few exceptions, did not return from their spring hunt till nearly a month after the time of our arrival, so that we were unable to procure the necessary men. From the same cause, it was near the middle of July before the spring flood had subsided sufficiently to allow of the ascent of the rapid rivers flowing into the lake from the north. For these reasons, we did not leave Lake St. John till the 13th of July.

A short reference to the work done in the same part of the country, during the previous season, will explain the considerations by which we were guided in deciding upon the route to be selected for our line of traverse from Lake St. John to Lake Mistassini. Mr. Richardson, by ascending the Ashuapmouchouan River, reached a point bearing N. 58° W. from the mouth of that river, and distant from it a hundred and twenty miles, where the Laurentian is overlaid by newer rocks. Within about six miles of this point, the line crosses the height of land between the St.

Selection of
route.

Lawrence waters and those flowing to Hudson's Bay. Continuing from this point, the direction of Mr. Richardson's exploratory line is N. 34° E. or nearly at right angles to the foregoing, to the southern extremity of Lake Mistassini, a distance, in a straight line, of fifty-five miles. This line, with the exception of the last mile or two, lies entirely on the outcrop of a series of rocks which are in some parts characterised by rich deposits of copper ore. According to Mr. Richardson, the general strike of these rocks is about N. 41° E. and S. 41° W., or a few degrees further from north and south than the line on which he crossed them. Near Lake Mistassini, they give place to rocks of a different character,—the flat limestones mentioned in his Report. As required by my instructions, we endeavoured to reach Lake Mistassini by some route that would enable us to cross the run of these copper-bearing rocks at some considerable distance from where they were seen by Mr. Richardson, and thus obtain some idea of their distribution. After careful inquiry, we concluded that the only practicable route by which this object could be attained, considering the shortness of the season, would be by way of the Mistassini River.

Ascent of the
Mistassini River.

Leaving Lake St. John, as already stated, on the 13th of July, we ascended the Mistassini for a hundred and five miles, to a point bearing N. 13° W. from its mouth, and distant, in a straight line, eighty miles. At this point we left it on the west side; and here also we commenced our survey, the Mistassini River having been previously surveyed by Mr. Blaiklock, P.L.S. The distance from this point to Lake Mistassini, in a straight line, is sixty-one miles, in a bearing N. 50° W., although the distance actually measured was about ninety miles. We struck the lake at the end of a long narrow arm, called Cabistachuan Bay, and about nine miles to the north-eastward of the southern extremity of Abatagush Bay, where Mr. Richardson's line comes upon it. Continuing our measurements on the lake, our survey was connected with that of the previous season at the Hudson Bay Company's post, where we arrived on the 14th of August, thirty-three days from the time of our departure from Lake St. John. Having despatched a canoe to Blue Point, for the remainder of our provisions, we set out from the post to make a survey of such portions of the lake as the time at our disposal would permit; and on the 14th of the following month we returned to the same place, the season being then so far advanced that it was necessary to return, without any avoidable delay, to the Canadian side of the height of land. We were obliged, however, to remain at the post till the 20th, on account of the failure of our provision canoe to arrive at the time expected. On that date we left on our homeward journey, reaching Lake St. John on the 7th, and Montreal on the 22nd of October.

Measurements.

The first portion of our survey—that from the Mistassini River to the lake of the same name—may be conveniently divided into three

parts. The first extends to the Chief River, mentioned in Mr. Richardson's report as the main branch of the Ashuapmouchouan, the distance, in a straight line, being twentyeight miles, in a bearing N. 80° W. Rather more than half way the line on this part crosses the Wassiemska, which appears to be nearly as large as the Mistassini, into which it flows. The second part is from the last mentioned point to the height of land between the St. Lawrence and Hudson's Bay waters, the distance being thirty five miles, and the bearing N. 25° W. The Chief River, about a mile above where our line strikes it, divides into two branches, which are nearly equal in size. The most westerly of these we surveyed for about twenty miles above the fork. The general course is nearly north and south. This is also the course of nearly all the small streams, tributary to the Ashuapmouchouan, between this and the height of land, many of which are crossed obliquely by the line just defined. Both this line and the preceding, pass entirely over a Laurentian country. The rocks are mostly grey, moderately fine-grained, micaceous gneiss, with considerable dark green, hornblendic gneiss interstratified, usually in layers from one inch to a foot thick. Red gneiss is rarely, if ever, seen. The dip is very uniformly east, or a little south of east, and the angle of inclination is always high, the strata being often nearly vertical. There is a very noticeable connection between this fact—the uniformly north and south strike of the strata—and the peculiar conformation of the surface. Over the whole region from the Mistassini River to the height of land, and two or three miles beyond it, as far as it could be seen from our line of traverse, the surface is broken by low, narrow ridges, running nearly north and south, or a little east of north and west of south. These ridges are seldom more than three hundred, and often not more than one hundred, feet above the general level. The direction of the rivers generally conforms with this arrangement, and the small streams found in all the valleys frequently expand into lakes from a quarter to half a mile wide, and perhaps several miles long. These are so numerous that from the top of Frog Mountain, a hill rising to a height of about 350 feet, and situated about the middle of the second of the two lines referred to, I counted upwards of forty of them within a radius of six or eight miles.

The remaining distance, from the height of land to Lake Mistassini, is the last of the three parts into which the whole exploratory line is divided. The distance, in a straight line, is only five and a-half miles, and the bearing N. 60° W. The ridge forming the water-shed is about ten chains wide, and, where we crossed it, has a small lake on each side, that on the south-east side discharging by a stream which is tributary to the Ashuapmouchouan, and the other sending a contribution to Rupert's River, through Lake Mistassini. These two small lakes are nearly on the same level, and only sixty feet lower than the highest part of the dividing ridge. We

Mistassini River
to Chief River.

Chief River to
height of land.

Gneiss.

Character of
the surface.

From the
height of land
to Lake Mistassini.

Limestones.

descended to within a mile of Lake Mistassini by a small rapid river called Little Perch River. About three miles from the lake, this stream falls about sixty feet over an escarpment facing to the north-west, and overlooking a comparatively level tract of country, extending in that direction as far as the eye can reach. The rock in this escarpment is grey gneiss, similar to that already described, and dipping about S. 65° E. $< 50^{\circ}$. About a mile to the westward, and within about two miles of the lake, hard bluish-grey limestones are met with. These are the flat limestones of Lake Mistassini, mentioned in Mr. Richardson's Report as the northernmost of the three successive groups of rocks crossed by his exploratory line.

About mid-way between the last exposure of gneiss and the first of limestone, a distance, as already stated, of about a mile, there are some small exposures of a reddish feldspathic rock, apparently of a brecciated character, with calcareous seams, and shewing a considerable amount of a dull green steatitic mineral. This rock occupies as nearly as possible the position in which one might expect to meet with Mr. Richardson's second group, which includes the copper-bearing strata, and may represent some of the conglomerates of that group; but, if it does not, no rocks of that series were observed. Nothing was seen at all like the chloritic slates of Lakes Chibogomou and Wakinitchee, which, on the former lake, Mr. Richardson found to contain important deposits of copper ore.

Surveys on Lake Mistassini.

The Surveys on Lake Mistassini constitute the second of the two divisions into which our season's work naturally divides itself. We measured on this lake a coast line of about a hundred and fifty miles, including no bays less than a mile in width. The main body of the lake was found to be of a very elongated form, lying in a south-west and north-east direction, with a perceptible curve between the south-west extremity and the farthest point seen by us, the concavity of the curve being towards the south-east. A long, ragged tongue of land, upwards of twenty miles in length, running from the south-west end, divides that end of the lake into two parts; and, of these, the one on the south-east side divides into several long narrow arms, which are out of the general direction, having a nearly north and south trend. A series of long narrow islands, which were seen only from a distance, extends for many miles in the same direction, beyond the above-mentioned point, being, like it, apparently parallel with the longer axis of the lake. We carried our measurements round the long point, to the bottom of the bay on the north-west side of it, called Poonichuan Bay, and thence along the main north-west shore of the lake, for about seventy miles from the extreme south-west point. As no land was visible from this position, looking in a north-easterly direction from a point about forty feet above the level of the water, the whole length of the lake cannot be much, if any, less than a hundred miles. It appears, however, to be comparatively narrow, being probably not more than fifteen miles wide, unless the width increases beyond where we saw it.

Measurements.

All the rocks met with on the lake are the flat limestones already mentioned. They seldom dip at a higher angle than twenty degrees, and although very much disturbed by minute undulations, the general strike appears to be with the direction of the lake. These strata appear to occur over the whole area occupied by the lake, but they are bounded all along the north-west shore by Laurentian gneiss. They would appear not to extend far beyond the lake in a south-westerly direction, as it seems probable that they are there cut off by the meeting of the Laurentian gneiss with the rocks of Mr. Richardson's second group.

The character of the land being much the same as that described by Mr. Richardson, I have nothing to say on that head which appears worthy to be introduced into this preliminary Report, although I made numerous notes both on this and other subjects, which will find an appropriate place in a more detailed Report after further exploration.

The whole of the season's work has been protracted on a scale of forty chains to an inch, and also reduced from that scale to one of four miles to the inch; and will be available for the construction of a general map of the region. It may be added that all the bearings given in this Report have been corrected for variation, and, therefore, refer to the astronomic meridian.

I have the honour to be,

Sir,

Your most obedient servant,

WALTER McOUAT.

MONTREAL, May 9th, 1872.

PROGRESS REPORT OF EXPLORATION AND SURVEYS

IN THE
COUNTIES OF LEEDS, FRONTENAC AND LANARK,

With Notes on the Gold of Marmora.

BY

MR. HENRY G. VENNOR, F.G.S.,

ADDRESSED TO

ALFRED R. C. SELWYN, ESQ., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

SIR,—The following Report is a summary of the result of my geological researches in the Province of Ontario during the season of 1871.

Frontenac
Leeds and
Lanark.

As you directed, my investigations were continued through those parts of the counties of Frontenac, Leeds and Lanark which had not previously been explored. The rocks met with do not differ in their general characters from those described in the *Abstract of Report* on the geology of these counties which I had the honor to lay before you last spring, and in which they were divided into three groups, represented by the letters A, B, C, or the figures 1, 2, 3, corresponding with the divisions previously adopted for the rocks of the county of Hastings, described in my Report on that county. [Report of Progress, 1866-69.]

Crystalline
limestones.

In commencing the investigation last summer I made the crystalline limestones of division A a special study, and consequently chose that portion of the country where these were most largely represented, namely, the townships of Bedford, Loughboro', Olden and Oso, in the county of Frontenac; North and South Crosby, in the county of Leeds; and North Burgess, Bathurst and South Sherbrooke, in Lanark; and which is furthermore rendered important by the occurrence of deposits of magnetic iron ore,* and of apatite, or phosphate of lime. During the course of my exploration all these deposits were examined and their respective stratigraphical positions determined as far as possible.

Magnetite and
apatite.

The mapping of the crystalline limestones occupied a much greater part of the season than I had anticipated, for, owing to the incorrectness of the surveys through this section of country, we were obliged to keep up a continuous line of measurements throughout the whole area ^{Measurements.} examined, and, for the same reason, found it necessary to re-survey all the roads through the townships of Bedford, Olden and Oso. The instrument used was the prismatic compass, with measurements by pacing, and occasional chaining.

Later in the season I again visited the townships of Madoc and Mar- ^{Madoc and Marmora.} mora, in the county of Hastings, and spent some time in a further examination of certain auriferous zones, the existence of which was first pointed out during the years 1866 and 1867, and on which are now situated several promising mines with stamp-mills. From the managers of these mines much assistance was received, and I would particularly ^{Acknowledgement of assistance.} acknowledge the kindness of Mr. W. J. Gatling, J. D. R. Williams, M.D., Mr. J. H. Dunstan, Mr. O'Neill and Mr. Jenkins. From Mr. Dunstan I have, further, received plans, drawn to scale, of a rotating cylinder-furnace, recently patented by him in the United States; and from Mr. Gatling a sketch-map, shewing the position of the shafts on his own and adjoining locations. The results of the foregoing explorations may be given under the following heads:

- I. Notes on the Iron Ores occurring in the Counties of Frontenac, Leeds and Lanark, with assays.
- II. Summary of the Phosphate of Lime or Apatite Deposits now being worked in North Burgess, Bedford and South Crosby.
- III. The Geological Position of certain Ore-zones in the Township of Marmora, now being worked for Gold, with assays.

I. *Iron Ores.*—The iron locations examined were the Chaffey and ^{Iron Ores.} Yankee or Mathews mines, in South Crosby; the Howse mine in Bedford; the Bygrove, Fournier and Christie's Lake mines in South Sherbrooke; the Foley mine in Bathurst; and the Dalhousie mine in Dalhousie township; all of which have already been alluded to in my *Abstract of Report* for the year 1870. Of these, the only ones worked to any extent during the year 1871, were the Chaffey, Yankee, and Dalhousie mines.

The *Chaffey Iron Mine*, is situated on an island in Mud Lake on the ^{Chaffey Mine.} Rideau, in South Crosby, and is about one mile distant from the village of Newboro'. Two excavations have been made, about thirty feet in depth, on a solid bed of magnetic iron ore, which strikes in a N. N. E. direction. During 1871, some twelve men were employed, and 3,500 tons of ore raised and sold. The ore is shipped to Cleveland, Ohio, via Kingston. At the mine it is worth \$2.25 per ton, and delivered at Cleveland it brings from \$6.00 to \$6.50 per ton. The cost of carriage to Kingston—a distance of forty-four miles—is seventy-five cents per ton

Yankee or
Mathews Mines.

The *Yankee*, or *Mathews Mine*, is situated about one hundred rods N. N. E. from the Chaffey mine, and on a continuation of the same bed. It is owned by S. H. Mathews Esq., and has been more or less worked since the year 1860. On this bed an excavation of irregular form has been made to the depth of about forty feet. During the year 1871, fifteen men were steadily employed, and upwards of 4,000 tons of ore mined and raised, 3,300 tons of which were sold, and shipped to Cleveland, Ohio, via Kingston. The price per ton at the mine, and delivered at Cleveland, is the same as that of the Chaffey mine. The total amount of ore sold and shipped to Cleveland from these two mines, for the years 1870 and 1871 combined, amounted to about 14,520 tons.

The demand for this quality of ore (*see analyses*) varies considerably at different periods, and, I understand, was much greater during the year 1869, than during 1870 and 1871.

Dalhousie Mine.

The *Dalhousie Iron Mine* is situated on the east half of the first lot, in the fourth concession of the township of Dalhousie, and is about twelve miles distant from the town of Perth. From the time of its being opened, in 1866, until September, 1871, this location was worked by Alex. Cowan, Esq., of Brockville, and partners; but subsequently they sub-leased it to Messrs. Hannah and Spearman, of Cleveland, Ohio, who at present work it. The mine is on a bed of red hematite averaging seven feet in thickness, striking N. E. by E., dipping south-eastward $< 45^\circ$, and contained in a band of crystalline limestone. Six shafts have been sunk on the dip, as follows:—

Shafts.

No	1	shaft, 8 by 10 feet and timbered.....	68	feet	deep
"	2	"	49	"	"
"	3	"	25	"	"
"	4	"	20	"	"
"	5	"	45	"	"
"	6	"	29	"	"

Quantity, trans-
portation and
value of ore.

Mr. Jerald C. Brown, who has for some years managed the workings at this mine, informs me that the total length of *stopes* amounts to 408 feet; and that the quantity *stoped* from the opening of the mine, up to November, 1871, was 80,800 cubic feet. From this opening there has been extracted very close upon 10,000 tons of ore. About twenty-five men are employed, including one mining-captain and one blacksmith. The ore is drawn to Perth by waggons in summer, at the rate of \$1.70 per ton, and in winter by sleighs, at \$1.00 per ton of 2,240 lbs. From Perth it is carried by railroad to Brockville, and shipped thence to Cleveland, Ohio. The cost of the ore, laid down in Cleveland, is \$5.00 per ton. The quantity raised from April 1st, 1871, to November 6th, 1871, was about 2,500 tons of 2,240 lbs.

Analysis of ore
from the Dal-
housie Mines.

Mr. Alexander Cowan informed me that it contained an average of 60 per cent of iron, according to numerous analyses made in the United

States. An analysis of it made in the Geological Survey laboratory by Mr. Gordon Broome gave as follows :—

Peroxyd of iron.....	82.250 = metallic iron 57.6
Insoluble residue.....	16.050
Lime.....	trace
Phosphorus.....	.026
Water.....	.660
	<hr/>
	98.986

Five further determinations recently made, have afforded an average of 56½ per cent. of iron, showing a close agreement with the result obtained by Mr. Broome.

Samples of ore from the Chaffey, Yankee, Bygrove, Fournier and Foley, mines were, in accordance with your instructions, submitted to Dr. B. J. Harrington for analysis. The following figures shew his determination of the percentage of metallic iron in these ores, but more time will be required for their complete examination :—

Chaffey Mine.....	52.91 per cent. metallic iron.
Yankee Mine.....	52.09 " " "
Bygrove Mine.....	59.55 " " "
Fournier Mine.....	59.59 " " "
Foley Mine.....	58.69 " " "

The ores from the Chaffey, Yankee and Foley mines were all found to be titaniferous. That of the Chaffey mine is stated by Dr. Hunt to contain 9.80 per cent. of titanitic acid (Report of Progress for 1866-69, page 257.)

Dr. Harrington finds 12.32 per cent. of titanitic acid in the ore from the Yankee mine, and also a large amount of sulphur, which renders it altogether an inferior ore.

The ore from the Foley mine contains only 2.63 per cent. of titanitic acid, which is not a sufficient amount to detract from its value.

The Chaffey and Yankee ores were also examined for phosphorus, but neither of them was found to contain a weighable amount.

The Bygrove and Fournier ores are free from titanium, and I think it extremely probable that they will be found to belong to beds somewhat higher in the series than the titaniferous ores.

II. *Phosphate of Lime*.—Last year I was enabled to determine the true position of the deposits of phosphate of lime, or apatite, in the townships of North Burgess, South Crosby and Bedford, and to establish the fact that, with very few exceptions, all of the workable deposits of this mineral occur in a certain belt or zone of pyroxenic and gneissic strata, and in the form of lenticular bedded masses, and irregular veins. This belt or zone, which was found to have a thickness of from 2,600 to 3,900 feet, lies in a long irregular trough, the axis of which may be described as running from the north-east to the south-west corner of North Burgess, thence south-westward through South Crosby, into the

Partial analyses
by Dr. Har-
rington.

Phosphate of
lime.

Irregular
trough.

south-east corner of Bedford township—between Devil and Opinicon Lakes—and still further in this direction, through the townships of Storrington and Loughboro.' All along this line, bed-deposits of phosphate of lime are of frequent occurrence. The width of the trough or basin seldom exceeds six or six and a-half miles, and is often narrowed to less than one-fourth the distance. In it the detailed sequence of the rocks has yet to be made out, but the available deposits of phosphate would appear to occur towards its outer rim, and within the 3,900 feet of pyroxenic and gneissic strata already alluded to.

Phosphate
Locations.

The following list of *Phosphate Locations* comprises the most important of those examined by me last season, and in all of which work to a greater or less extent was being carried on:—

						WORKED OR OWNED BY
No.	1.	North Burgess—Concession VIII, Lot				1.—Ed. Schultze.
"	2.	"	"	"	"	2.—R. Matheson.
"	3.	"	"	"	"	3.—Ritchie & Jackson.
"	4.	"	"	"	"	4.—Watts Brothers.
"	5.	"	"	"	"	5.—R. Matheson.
"	6.	"	"	VII,	"	10.—Ed. Schultze.
"	7.	"	"	"	"	11 & 12.—A. Cowan.
"	8.	"	"	VI,	"	10.—E. Clark.
"	9.	"	"	"	"	13 (W. $\frac{1}{2}$).—Ed. Schultze.
"	10.	"	"	"	"	13 (E. $\frac{1}{2}$).—J. F. Baker.
"	11.	"	"	"	"	14, 15 & 16.—Morris & Griffin.
"	12.	"	"	"	"	18 & 19.—Matheson & Bell.
"	13.	"	"	"	"	21.—E. Clark.
"	14.	"	"	V,	"	16.—R. Leckie & Co.
"	15.	"	"	"	"	18 & 19.—Matheson & Bell.
"	16.	"	"	IV,	"	11.—E. Clark.
"	17.	"	"	III,	"	15 & 16.—Moro Philips.
"	18.	South Crosby,	"	VI,	"	12.—Ed. Schultze.
"	19.	Bedford,	"	XVII,	"	1.—A. Cowan.

Schultze's Loca-
tions in
Burgess.

Schultze's Locations.—The apatite on these locations, Nos. 1, 6, 9, in North Burgess, was being worked by Mr. Edward Schultze for export to Germany. The most promising location is that on the first lot of the concession, where bedded deposits of a beautiful green crystalline apatite, entirely free from calcite, strike almost east and west with a slight underlie to the northward. On the tenth lot of the seventh concession Mr. Schultze owns one hundred and fifty acres. Here, a bed of apatite was uncovered for a distance of about four hundred feet, having an average width of from two to three feet. In this bed, there is an abundance of tolerably transparent mica, in large crystals, which may yet be of economic value. The apatite is of the red variety, and both it and the mica are further colored red by the decomposition of a bluish-grey hematite, which is more or less mixed with the former. From the fact that the mica constitutes the larger portion of this vein, and owing to its low position, and consequent difficulty of drainage, I hardly think it can be worked with profit. On the road

allowance between lots thirteen, of the sixth and seventh concessions, a shaft has been sunk to a depth of thirty feet on an irregular vein of red apatite, from which about forty tons of the mineral have been raised, averaging as high as 90 per cent. of phosphate of lime. A number of small openings have also been made by Mr. Schultze on the thirteenth lot in the sixth range, and a considerable quantity of apatite raised, of the quality known as "seconds." It occurred in layers or beds of from eight to twelve inches in thickness, and contained a large amount of black mica. Several bands of a pink calcite, highly charged with crystals of apatite, also occur on this lot. These crystals are very easily removed from the matrix, and although at present this form of deposit is looked upon by the miners as useless, there is little doubt that, at some future period, a simple process will be devised by means of which it will be treated with profit. Altogether Mr. Schultze has mined, raised and bought, in North Burgess, upwards of nine hundred and seventy-six tons (of 2,240 lbs.) of apatite, of which he has shipped six hundred to Germany.

Mica and pink
calcite.

Matheson's Locations, Nos. 2 and 5 of the foregoing list, namely, lots two and five, in the eighth range of North Burgess, have been owned by Roderick Matheson, Esq., of Perth, for many years; but no work was done until the fall of the year 1870, from which period operations have been carried on, to a greater or less extent, up to the present. The rocks on the first of these lots are chiefly pyroxenic, with quartzose garnetiferous gneiss, and have a pretty uniform east and west strike, with uncertain dip. The apatite occurs in three bedded deposits, one of which has a breadth of nearly six feet. This has been opened upon for a distance of sixty feet on the strike, and to about fifteen feet in depth, and from it a large quantity of a beautiful green apatite has been raised and sold to Mr. Schultze for shipment to Germany. The deposits on the fifth lot are more irregular, and are much mixed with calcareous matter.

Matheson's
Locations.

Ritchie & Jackson Location, No. 3, lot three, in the eighth range of North Burgess, is at present being worked for Messrs. Ritchie and Jackson, of Belfast, Ireland, by Mr. W. Hargreaves of Perth. Here, the strata are very quartzose reddish gneiss and pyroxene rock, striking almost east and west, and dipping to the northward $< 45^\circ$. A considerable amount of work has been done on two bedded deposits of apatite, eight to nine feet broad, which, with the enclosing strata, strike almost east and west, with underlie to the northward. This location has already been alluded to by Mr. Broome, as *McKinley's lot*, in his notes on the Phosphates of this section of country, (Report of Progress, 1870-1871, page 320.) It was very actively mined during the season of 1871, but I have been unable to obtain any return of the exact amount of mineral raised.

Ritchie and
Jackson Loca-
tion.

Watt Location, No. 4, lot four, in the eighth concession, was leased for twelve months, by two brothers named Watt, from Mr. Flaherty, for the

Watt Location.

sum of eighty dollars. Work was commenced in the autumn of 1870, and was continued during the ensuing winter, and during the summer of 1871. With very little outside help, these two young men succeeded in mining and raising upwards of two hundred and twenty-five tons of a very pure apatite, which they sold to Mr. Schultze for export to Germany, at the rate of \$10.50 per ton, at the mine. The vein or bed from which this amount was raised is conformable with the adjacent strata, and runs in an almost east and west direction. Owing to the expiration of the lease, which ran out on the 24th September, 1871, and was not permitted to be renewed, the work was suspended. The vein, however, still holds forth good prospects.

Alex. Cowan's
Locations in
Burgess.

Alex. Cowan's Location, No. 7.—The lots worked by Alex. Cowan, Esq., and partners (*Brockville Chemical and Superphosphate Company*) are the eleventh and twelfth in the seventh concession, on the latter of which is situated the *Victoria Phosphate Mine*. This mine is nine miles distant from Perth, and about seven from the Rideau Canal. It is on a bed or vein, apparently conformable to the immediately surrounding pyroxenic and gneissic strata, striking in a N. N. E. direction, and having an average width of about three feet. This has been worked pretty steadily since the month of April, 1870. Two shafts have been sunk, one to the depth of about fifty-six feet, and another to about forty-eight feet, besides numerous other minor openings of varied extent. The total area worked over is about three hundred acres. From the main deposit there has been raised from April, 1870, up to April, 1871, upwards of eight hundred tons of apatite, averaging about 85 per cent. Work was also actively carried on here during the summer of 1871, and a large additional amount raised, the exact return of which I have not yet received. The produce of this mine is shipped to the Brockville Superphosphate Works, near the town of Brockville, whence it is exported, as superphosphate, both to the United States and Europe.

Quantity raised.

J. F. Baker's
Location.

J. F. Baker's Location, No. 10, (Cambria Phosphate Mine).—This location is on the east half of the thirteenth lot in the sixth range of North Burgess. It is worked by Mr. J. F. Baker, for an English company, which commenced operations during the month of September, 1871. A number of bedded deposits occur here, varying in width from a few inches to seven feet. Seven of these have been opened, and, although the lowest point reached last fall was only fifteen feet, Mr. Baker had succeeded in raising about two hundred tons of first quality phosphate, — the result of about three months' working. The mineral here varies in character from green, coarsely crystalline and massive, to white, finely granular and saccharoidal. This would appear to be a very promising locality. It is only one mile from the Rideau, to which the apatite can be drawn by winter road, for fifty cents a ton. The general character of these deposits has yet to be investigated.

E. Clark's Locations, Nos. 8, 13 and 16.—The eleventh lot of the fourth, and the tenth and twenty-first lots of the sixth concession in North Burgess are three lots out of a number purchased by Mr. E. Clark, of Sherbrooke, from the Bank of Upper Canada. On these Mr. Clark, during the summer of 1871, commenced and personally superintended a series of experimental workings, and was fortunate enough to discover a number of most valuable deposits of apatite, especially on lots ten and twenty in the sixth concession. Those on the tenth lot were clearly seen to occur as parallel bedded deposits, alternating with bands of reddish gneiss and pyroxene strata. Towards the rear part of the lot the general strike is N.N.E., and here some of the apatite beds are a good deal mixed with a fine bluish-grey hematite, in much the same manner as the deposit already noted on Mr. Schultze's property, on the tenth lot in the seventh concession. Towards the front of this lot, and approaching Long Lake, the strike of the rocks changes to almost east and west, and here further deposits of apatite were observed, also bearing in an east and west direction. Although the work on this lot was, as I have before stated, merely of an exploratory or experimental character, a very considerable amount of "first quality" red and green apatite was extracted, and piled on the ground for future disposal. There appear to me to be four distinct main parallel beds, besides a multitude of minor ones, some of the more important being of at least five feet in thickness. The work on the twenty-first lot, in the same concession, was also personally superintended by Mr. Clark, but was not commenced until late in the season, and after stormy and cold weather had set in. Here, however, a few days' work uncovered some very promising deposits, from some of which large masses of nearly pure apatite were extracted. At the time of my visit to this lot sufficient work had not been done to permit of my properly understanding the true nature of the deposits, but, from the openings which had been made, they appeared to me to consist of large bedded masses, striking and dipping with the enclosing rocks. Mr. Clark is at present, I understand, in treaty with an English company, which proposed purchasing these lots, with a view to their further development.

*E. Clark's
Locations.*

*Apatite associated with
hematite.*

*Four distinct
beds.*

Matheson and Bell's Locations, Nos. 12 and 15.—The lots on which Messrs. Matheson and Bell were at work during the year 1870 have been mentioned in the notes by Mr. Gordon Broome, already cited. During 1871, other deposits of apatite were opened up by them on the eighteenth and nineteenth lots, in the sixth, and on similarly numbered lots in the fifth concession of North Burgess. On the first-mentioned lot, a great number of openings have been made on a series of parallel and bedded deposits of this mineral, which strike, with the enclosing strata, in an almost east and west direction, along the point of land which here juts out into Black or Salmon Lake. Much of the apatite is very largely mixed with a pink or

*Matheson and
Bell's Locations.*

Pink calcite
with greyish
pyroxene.

reddish calcite, which holds aggregations of large-sized crystals of a greyish pyroxene. A considerable quantity both of "firsts" and "seconds," has been raised on these lots, but I am not aware that any was shipped during last summer. Much of the work done has been, up to the present time, of an experimental character, but there can be little doubt that a large amount of marketable phosphate will yet be found here.

Morris and
Griffin's Loca-
tions.

Morris and Griffin's Location, No. 11.—During the year 1870, Messrs. Morris and Griffin, of Wolverhampton, England, manufacturers of artificial manures, purchased seven hundred and fifty acres of land in North Burgess; namely, the fourteenth, fifteenth and sixteenth lots in the sixth and seventh concessions. Early in the season of 1871, Mr. Wm. Davis, agent for these gentlemen, commenced a series of explorations on these lots, and succeeded in discovering on those in the sixth concession some important indications of phosphate of lime. These occurred towards the rear ends of lots fourteen and fifteen, and close to the line between concessions six and seven. The openings made during the season were chiefly shallow surface pits, many of which, however, gave considerable encouragement for the further prosecution of the work. The lots in the seventh concession have not, and are not likely to yield anything of importance, as they are chiefly occupied by the horizontal sandstones of the Potsdam formation. Messrs. Morris and Griffin, I am informed, will commence systematic work on the most promising portions of their lots during the approaching summer.

Potsdam sand-
stones.

Locations 14
and 17.

The remaining locations in North Burgess noted in the foregoing list, namely those of R. Leckie and Company, of Montreal (No. 14), and Mr. Philips of Philadelphia (No. 17), were not worked during the past summer, although both of them still hold out good encouragement for further development. From No. 14 upwards of sixty tons of phosphate have been extracted, and still remain on the ground at the mine. From No. 17 about one hundred tons have been shipped by Mr. Philips to the United States, via the Rideau Canal. No. 14 location, R. Leckie and Company, is, I believe, now in the market, but the price placed upon it is rather beyond the means of present purchasers of phosphate lands.

Schultze's
Location in
South Crosby.

Schultze's Location, No. 18.—On this location, in South Crosby, Mr. E. Schultze has made a few experimental openings on the twelfth lot of the sixth concession, near Sand Lake. He has discovered a very fair show of apatite, and already raised about fifteen tons of first quality. Very little prospecting has yet been done in this township, but it is altogether likely that many large deposits of apatite will yet be discovered on the course of the pyroxenic and gneissic belt already alluded to, where it is not concealed by the sandstones of the unconformable Potsdam formation.

Sand Lake is a part of the Rideau waters, and from it the phosphate may be shipped by barges to Kingston, or to any other port on the St. Lawrence.

Cowan's Location, No. 19.—This location in Bedford was first worked Cowan's Location in Bedford. in the fall of 1870, and is mentioned in my Report for that year (Report of Progress 1870-71, page 315); since that time there has been more or less work done. On the first lot in the seventeenth concession Mr. Alexander Cowan has opened some exceedingly promising bedded deposits of from two to four feet thick. The strata—consisting mainly of heavy, dark, hornblendic rocks, entirely free from limestone—lie in an almost horizontal position, the incline being to the north-westward. The phosphate is of the red and green varieties, but principally the latter, and is of a very beautiful crystalline character. At the time of my visit about three tons a day were being extracted, and two hundred and thirty tons were piled on the wharf at Opinicon Lake, about half a mile distant from the mine. Altogether there had been mined and raised from this location, up to the fall of 1871, some five hundred and forty-nine tons of first quality phosphate. Mr. Oatey, the superintendent, has recently informed me that there is now visible a thickness of about twenty feet of phosphate, with but very little rock intervening. The beds, however, are very variable in their dimensions, often changing within a few yards from five or six feet in thickness to as many inches.

III. *Gold in Marmora*.—The geology of the townships of Madoc and Gold in Marmora. Marmora has already been given in considerable detail in the *Report of Progress* for 1866-69, pages 144 and following. Much additional information, however, and many important facts have been gathered since the publication of that Report, and more particularly during the past summer. The portion of these townships to which I would at present refer, and in which the only mines now being worked for *gold* are situated, is that immediately surrounding the granite area known as the Huckleberry The Huckleberry Rocks. Rocks. These rocks have been shewn (Report of Progress already cited, page 146) to occupy a very large part of the south-western quarter of Madoc, and the south-eastern quarter of Marmora, extending north-westward on the boundary line between these townships as far as the middle of the eighteenth lot, with a breadth of about four miles, the River Moira in Marmora forming their western limit.

Surrounding the granite mass, and apparently conforming to its general outline, occurs a series of stratified deposits, consisting of greyish talcoid mica-slates, opaque white and reddish felsites with epidote, greenstones or diorites, ferruginous dolomites, crystalline limestones and rusty quartzites, towards the base of which occur deposits of magnetic iron ore, and small quantities of red hematite. In the talcoid slates are found large bedded Quartz veins, holding sulphurets of iron and copper, and native gold. quartz veins, holding sulphurets of iron and copper, and native gold. All these deposits appear to me properly to belong to DIVISION B., (Report of Progress for 1863-69, page 145, and Report of Progress for 1870-71, page 310.)

Map.

In the map accompanying the present Report, I have endeavoured to represent the western outline of the granite mass in Marmora, and to show the position of the various openings made for gold in its proximity. It will at once be observed that were a line drawn, connecting these openings, it would represent a zone conforming to the general contour of the granite, and be at a nearly uniform distance from it. The probability of the existence of such an auriferous zone or belt was first pointed out by me in the Report first before cited, which I had the honour to submit to Sir W. E. Logan, early during the year 1867, before openings of any consequence had been made in Marmora. In this Report, after giving a detailed description of the course of the iron-bearing rocks through these townships, pages 150 and 151, I further stated on page 169, that the various localities in which gold had been found appeared to have a nearly uniform relation to the ferriferous belt, "a close proximity to the summit of which" would "in my opinion afford the most probable positions for the discovery of gold." This view has been most satisfactorily borne out by the openings since made in Marmora, all of which, as represented in the accompanying map, occur close to the valley of the River Moira, "the course of which might almost be said to denote its further run through this township." (Same Report, p. 151.)

Uniform relation between the gold and the iron-bearing zone.

Age of the granite.

The age of the granite, on which these gold-bearing rocks rest, is not yet satisfactorily determined. That it is of more ancient date than the latter, is I think clearly shown by the manner in which they repose upon its flanks, and conform to its general outline. My own conviction is, that this, and other like masses of granite met with throughout the Hastings district, represent eruptions which probably took place towards the close of the Laurentian period, or at some time prior to the deposition of the greenstones, schists, dolomites and limestones, of DIVISIONS B. and C. For wherever these higher rocks are wanting, we find the Laurentian gneisses, quartzites, and limestones, where in proximity to, or even at a considerable distance from the granites, cut up by a perfect net-work of veins, which differ from the parent mass only in being of finer texture. This is the case in a very marked manner in the township of Burleigh, Peterboro' county, about twelve miles west of Marmora, where the Laurentian gneisses and limestones are seen intersected in every direction by veins of a pale red syenite, often containing tourmaline, which apparently emanate from the red granite area, known as the Pine Plains, in the township of Methuen; while immediately adjoining these Plains on the east side, in Lake, rocks of the same age as those of Marmora remain unaffected.

Syenite veins.

Mode of occurrence of the gold in Madoc and Marmora.

The general characters of the strata surrounding the Huckleberry rocks in Madoc and Marmora have been already given. In them gold occurs as follows:—

- 1.—In bedded metalliferous lodes.
- 2.—In slate bands, impregnated with sulphurets.
- 3.—In nests, or bunches with quartz and sulphurets in dolomite.
- 4.—In cross or fissure veins (of minor importance.)

1. *Bedded Metalliferous Lodes*.—As in Nova Scotia, so in the township of Marmora, the most productive quartz lodes are conformable with the stratification. They consist chiefly of translucent vitreous quartz, coarsely crystalline masses of mispickel with black mica, sulphurets of iron ^{Tin ore.} and copper, more rarely of zinc, and in one instance oxide of tin. The oxide of tin occurred in a specimen submitted to Prof. James Bell, of Belleville, for examination, who, in a letter to me, dated February 6th, 1871, stated that on one occasion he had found a few small crystals of tin ore, adhering to a specimen of iron ore containing arsenic, and associated with quartz and mica. Unfortunately, the locality from which this specimen was obtained was rather doubtful, but it was among a number sent from Madoc and Marmora. The gold occurs visibly both in the quartz and the mispickel. In the former it is in very minute particles, but in the latter often in irregular lumps of considerable size. The foot-wall is generally the grey talcoid or unctuous mica-slate, and the hanging-wall either a greenstone, or a feldspathic band with disseminated pyrites. In some instances the mica-slate is wanting, and then both walls of the vein are of a dark grey hornblendic gneiss, which is slightly calcareous, as at the Williams mine in Marmora.

These bedded lodes have been traced continuously all along the Marmora ^{Character of the bedded lodes.} side of the Huckleberry rocks, and are represented in the accompanying map by disconnected black lines. They are not of uniform thickness, but assume more the character of a series of lenticular patches, which in some instances have an extreme thickness of from ten to fifteen feet.

2. *Slates impregnated with Sulphurets*.—These are next in importance to the quartz lodes, of which they generally form the foot-wall, and in some instances both walls. They resemble somewhat the gold-bearing slates of Nova Scotia, and contain interposed layers of vitreous quartz, holding mispickel, sulphurets of iron, and free gold. Sometimes instead of the sulphurets, layers of magnetic oxide of iron occur, to such an extent as to form deposits of economic importance, in which cases the gold and iron are intimately associated in the same horizon, specimens having been obtained in more than one locality, where small grains of the precious metal were seen to be embedded in the iron. In places, on the run of the unctuous slates, occur deposits of steatite or soapstone, a fact which has already been pointed out in my Report for 1870. ^{Soapstone.}

3. *In nests with Quartz in Dolomite*.—This is an exceptional form in which the gold occurs in some few localities, and generally of too irregular ^{In greenstones and Dolomites.} a description to be worked with profit. Examples of this mode of occurrence

are the Richardson and Empire mines in Madoc, in both of which instances, although gold was found in comparatively large quantities at the outset—as shown in the Report of Progress for 1866–1869—it was subsequently found to be of too irregular and uncertain occurrence to be mined with profit.

Limestones and dolomites.

It is only towards the summit of the auriferous horizon that limestones and cavernous dolomites make their appearance. Through Marmora, numerous small openings made on the course of the latter have yielded small amounts of gold, more interesting, however, in a geological point of view, than profitable to the miner.

4. *Cross or fissure-veins*.—A few of these cross or fissure-veins, or, as the miners term them, *spurs* and *leaders*, are met with, crossing from one bedded lode to another, and cutting the intervening strata at various angles. In them gold occurs both in the quartz and the sulphurets, but they are generally of so limited an extent that they rather serve as guides to the discovery of the main veins than as workable deposits themselves.

Ore district in the Schwarzenberg, compared with those of Madoc and Marmora.

In *Von Cotta's Treatise on Ore-Deposits*, page 120, he describes a certain ore-district in the Schwarzenberg, Germany, which, in a very marked manner, resembles those of Madoc and Marmora. The Schwarzenberg district consists, according to him, of a series of crystalline mica-schists, through which protrude several masses of granite, “the most important of which is the Rackelmann. The crystalline schists all have a gentle slope away from this granite dome, so that their lines of strike surround it concentrically. The ore-deposits of this district occur as :

1. Bedded veins, combined with greenstone, and containing many different ores.
2. Hematite lodes.

The bedded veins surround the granite of the Rackelmann also concentrically, as they follow the schistose structure of the mica schist, not as a continuous circle, but as small fragments of rings. These often attain a great breadth in the central portion of their extent; and from this cause approach, in horizontal section, an irregular lenticular form. They are always so firmly combined with the greenstones, that they are only with difficulty separated from them, and are frequently accompanied by granular limestone, or dolomite.” This description may be said to apply, word for word, to the Marmora ore-district, which, however, contains in addition deposits of magnetic iron.

Gold-workings in Marmora and Madoc.

During my exploration in 1871, the workings for gold were confined to the Marmora side of the Huckleberry rocks. The feverish excitement which pervaded this district in 1868, has entirely subsided, and is now replaced by steady working in some three or four localities. In Madoc, though similar deposits to those of Marmora are known to exist (Report of Progress for 1866–69), they are unfortunately so much concealed by the

horizontal limestones of the Trenton group, which overlies them unconformably, as to render it impossible to trace out their distribution, or to mine them profitably. A glance at the map accompanying the Report on the county of Hastings (Report of Progress for 1866-1869, page 143) where these higher limestones are represented by the dark blue colour, will at once make this fact evident.

The following is a list of the lots in Marmora, on which work is now, or has recently been in progress, and where openings of some importance have been made; commencing with the most southerly:—

1. The Cooke, or Williams Mine.....	Lot 7	Con. IX	Marmora.
2. The Gillen Mine.....	" 6	" VIII	"
3. The Severn Mine.....	" 8	" VIII & IX	"
4. The Gatling Mine.....	" 9	" "	"
5. The Hawk-eye Mine.....	" 10	" "	"
6. The Neill Mine.....	" 14	" X	"
7. The Powell Mine.....	" 17	" XI	"

The *Cooke, or Williams Mine*, is situated on the south-west corner of the seventh lot in the ninth concession of Marmora, and was mentioned in the list of localities in which the presence of gold had been verified, in the *Report of Progress* for 1866-69, page 168, and again on page 171. The mine is owned by Cooke Brothers, of Toronto, and is superintended by J. D. R. Williams, M.D. It is on a vein of quartz and mispickel, with black mica and sulphurets of iron and copper, the whole having an average width of from four to five feet, striking about N. 17° W., and dipping to the westward > 45°. The immediately adjoining rock is a heavy, dark grey, hornblendic gneiss, and the total absence here of the unctuous slate is a noteworthy fact. On this vein, a shaft, six feet by ten, has been sunk to a depth of seventy feet, and levels driven on either side to an extent, in all, of ninety feet. A large quantity of ore, chiefly quartz and mispickel, has been raised; but the greater part of it still lies on the ground awaiting treatment. Up to the winter of 1872, the work carried on here, apart from the mining and raising of the ore, has been chiefly experimental, and although the results arrived at by Dr. Williams, from time to time, exceeded his expectations, he still found by further treatment of the tailings resulting from his mill process, that a large percentage of the precious metal was being lost. The first mill used was one that had formerly been worked by Mr. Berry, in the township of Barrie, near the Addington Road, in Frontenac County, but was subsequently sold and removed to Dr. Williams' location. It was of the ordinary form, consisting of one battery with five circular rotating stamp-heads, worked by an engine of fifteen horse-power. I saw it in operation during the month of January, 1870, when some two hundred and fifty tons of ore were put through. The shaft then was sixty feet in depth, and numerous beautiful specimens were shown to me, which had been recently

^{Cooke, or Williams Mine.}

^{Character of the vein.}

^{Loss of gold.}

extracted, composed of quartz and mispickel, with visible gold. The ore was being calcined in an open kiln, prior to its entering the mill. The kiln, when filled, held forty tons of ore, which it took four days to calcine properly. Before its erection, the ore had been taken to the mill without previous calcination, and a cleaning up, shortly before my arrival, after the treatment of four and three-quarter tons, had resulted in the yield of a little over \$10.00 to the ton. This mill remained in use during the ensuing summer of 1870, with variable results, all the ore being first calcined in the open kiln. During the month of September, of the same year, another cleaning up, after the treatment of one hundred and seven tons and three-quarters of ore—quartz and mispickel—yielded \$1,035.00. The depth at this time was sixty-six feet, only six feet deeper than during my visit in the previous January, but a considerable quantity of ore had been extracted by *drifting*. Still later, in February, 1871, this lode continued to be worked with profitable results. At this time Dr. Williams made arrangements for the introduction of J. W. Forbes' *Automatic Steam Quartz Crusher*, in place of the ordinary five-stamp mill. This invention was warranted, *with two stamps, and a five horse-power engine, to do the work of an ordinary mill of twenty stamps, with twenty-five horse-power engine*. The patentees further offered to put it up on trial, free of cost, and to remove it if not approved of. It was accordingly put into operation during the month of March, 1871, but, after a very short trial, was abandoned in the ensuing month of April as quite unsuitable, and the old stamps replaced. The open kiln was also set aside, and preparations made for erecting a suitable reverberatory furnace for roasting the ore.

Forbes' Automatic Steam Quartz Crusher.

During the fall of 1871 and commencement of 1872, Dr. Williams was engaged in enlarging and improving his mill, by the addition of fifteen stamps, making in all twenty stamp-heads, and in the erection of a revolving Cylinder-furnace, recently patented by Mr. John H. Dunstan. These changes were completed early in the month of February, 1872, at which time I again visited the mine and collected some further information. About thirty-five men were being employed in the mill and shaft. The mill is erected a short distance to the south-west of the shaft, and close to the east bank of the Moira River, on the sixth lot of the eighth range. The stamps are all of the circular rotating description, arranged in four batteries of five each, and are similar to those in use in many parts of Nova Scotia. They are worked by an engine of fifty horse-power, which is also used to turn the revolving cylinder of the roasting furnace, erected in the same building and close to the batteries. The quartz is crushed in the batteries with water, and the pulverized ore passed over a set of blanket troughs previous to its treatment in amalgamating pans of the Wheeler pattern. The other internal arrangements of this mill are much the same as in stamp-

Dunstan's Revolving cylinder-furnace.

Treatment of the quartz.

SCALE 4 FEET TO 1 INCH.

Fig. 1.

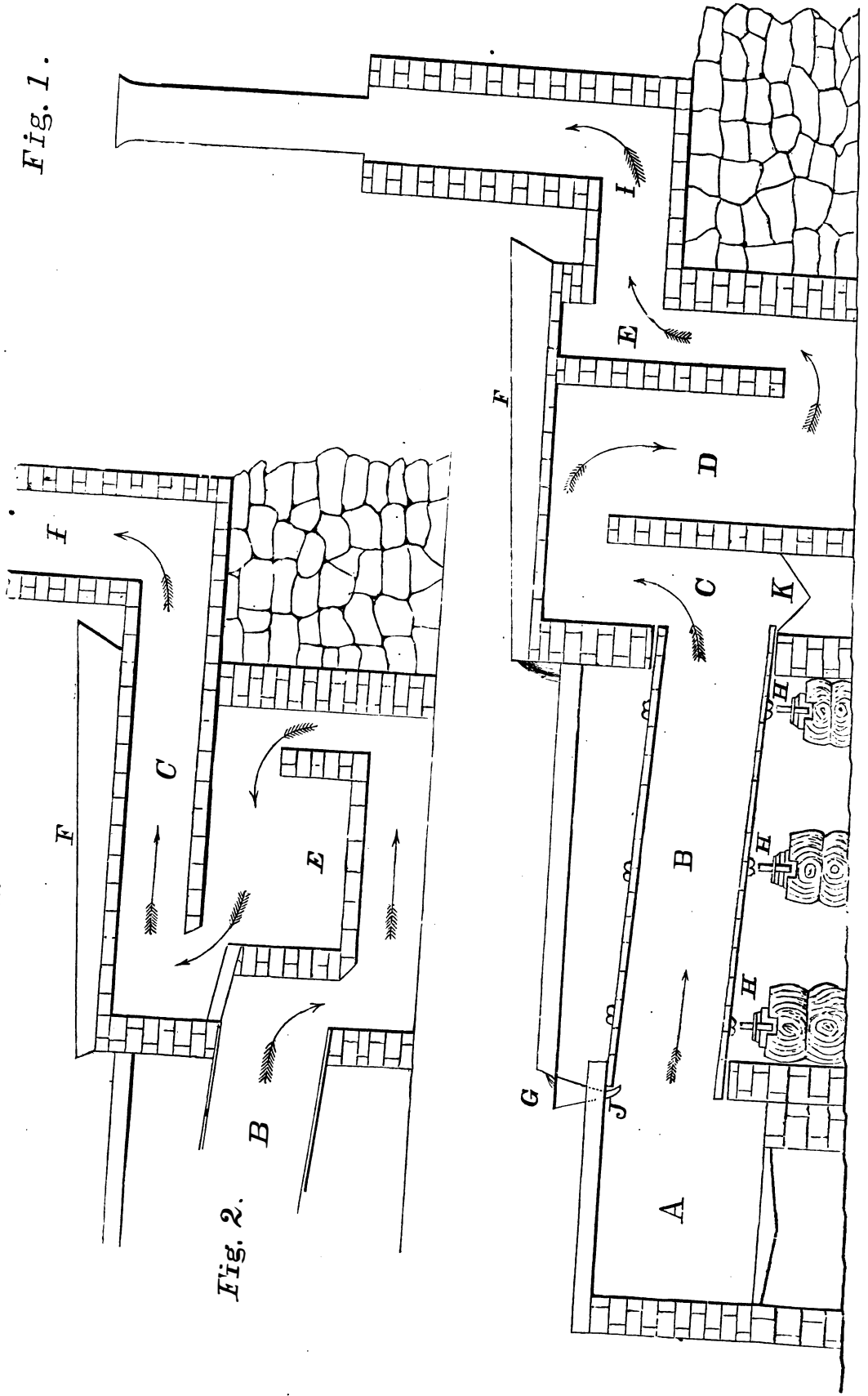


Fig. 2.

mills used in Nova Scotia and elsewhere, and being well known need not be further described.

In the Dunstan Cylinder-furnace no new principle is claimed by the patentee, but merely a simpler combination of those already well known, and applied in the *Stetefeldt*, *Keith*, *Whelpley & Storer*, and *Brückner* furnaces, to which he has added some details of his own invention. The accompanying plan, Fig. 1, drawn to the scale of four feet to one inch, will give a good general idea of the furnace :—

In Fig 1, A is a brick fire-box ; B, a revolving sheet-iron cylinder, inclined from the fire-place, and in which are built six shelves of fire-brick, the whole interior being also lined with the same material ; C, a chamber in which is a water trough K, with a running stream of water ; D, a dust chamber ; E, an arsenic condensing chamber ; F, a sheet-iron drying tray or pan, furnished with a mechanical rake ; G, a hopper into which the ore is raked, and from which it passes, through the tube J, into the cylinder, being at the same time scattered by a fan-blast, from another tube enclosing J ; H H H are friction rollers on which the cylinder B revolves ; I, the flue.

Description of
the Dunstan
Cylinder-fur-
nace.

The pulverized ore, coming from the batteries wet, is spread out in the drying pan F, being at the same time slowly raked towards the hopper G, from which it passes into the cylinder. The cylinder turns at the rate of five revolutions per minute, or faster if necessary, and in it the ore is tossed from shelf to shelf through the flame, which passes through the centre, and, after about twenty revolutions, reaches the further extremity, and falls into chamber C, and the tank K. In this tank or trough, Mr. Dunstan contends that the pulverized and roasted ore is yet more finely divided, and is also freed from a coating which appears to render it unfit for amalgamation. In any case, the tank, if of no other use, saves a considerable amount of manual labour, as the water passing through it carries the ore to the amalgamating pans. Instead of chambers C, D and E, Mr. Dunstan has devised another plan, Fig. 2, dispensing with the tank, and in which the pulverized mineral passes at once into a chamber, where it is treated as in an ordinary reverberatory furnace, and which has also combined with it a chamber E, for condensing the arsenic.

The cost of erecting this furnace is nearly as follows :

Cost.

Iron-work.....	\$200.00
Fire-brick (6,000).....	60.00
Sand and lime.....	25.00
Labor.....	90.00

Total.....\$375.00

All the iron-work is protected from fire and fumes by fire-brick. Respecting the working of this furnace, but little can be said at present, it having been so short a time in operation. That it has defects, and that

it will yet require some very important alterations, seems to me evident; but the fact that it has already effected a considerable saving in gold, indicates the trial to be in the right direction.

At the time of my last visit to the 'Williams' mill, the furnace had hardly been fairly put into operation, but after some weeks working, Mr. Dunstan furnished me with the following information. The furnace burns one cord of soft wood in twenty-four hours, and the whole of its machinery and connections can be worked by about two and a-half horse-power. From partially concentrated tailings—say 60 per cent. of sulphurets—which had previously yielded from \$9.00 to \$11.00 per ton, a trifle over \$18.00 per ton was extracted, after treatment in this furnace. The average yield of the ore as it comes from the mine would appear to be from \$17.00 to \$20.00 per ton.

Oxland's furnace.

A furnace which would, perhaps, much better suit the ores of Marmora is one known as '*Oxland's furnace*,' in very general use both in Europe and America. In this, the revolving cylinder inclines in the opposite direction to '*Dunstan's*,' namely, towards the fire place, instead of from it, the ore being introduced at the end farthest from the fire, and brought from lesser to greater heat; whereas, in the furnace first described, the ore being introduced into the flame is subjected to an extreme heat at the outset, and gradually cools on its passage through the cylinder.

The Gillen Mine.

2. The *Gillen Mine* is situated in the north-eastern corner of the sixth lot, in the eighth range, and about twenty-four chains south-west of the Williams shaft. The lode is a parallel but somewhat higher one in the series than the one last described, being separated from it by about seven hundred feet of a grey hornblendic rock, surmounted by a band of greenish-gray talcoid slate. It is clearly an interposed or intercalated lode, striking with the associated rocks to the west of north (N. 17°—20° W.) and dipping to the westward 30°—35°, and is from four to six feet wide. The foot-wall is the talcoid slate with interposed layers of quartz and sulphurets, and the body of the vein is chiefly quartz, carrying about 10 per cent. of mispickel, with sulphurets and free gold. The rocks immediately overlying this, are greenstone and opaque white felsites, above which occur dolomite and limestone.

During the year 1870, a mill of five stamps, worked by water-power, which had formerly been in use at Eldorado in Madoc, was used by Mr. William Gilbert in connection with this mine. Two small openings were at this time made in the vein, and some ore extracted, of which about two hundred tons were put through the mill, and returned from \$5.00 to \$9.00 per ton. Mr. Dunstan, however, succeeded afterwards in obtaining upwards of \$20.00 per ton, from samples of concentrated ore, which had already been twice worked through this mill. Shortly after, owing to the breaking down of the water-dam, work was suspended on this location.

In 1871, Mr. Andrew White, contracted to raise one hundred tons of ore from the Gillen lode, which was to be tested in the mill at the Williams mine. An opening was made on the course of the vein, of about fifty feet in length, five or six feet in width, and of irregular depth, the lowest point reached being about twenty feet, and the cost of mining and raising the ore only \$1.50 per ton. The mill return on the one hundred tons averaged \$6.00 per ton, which, there is very little doubt, was considerably less than the actual contents of the ore. The property is now in the possession of W. J. Gatling and partners. Numerous laboratory assays have been made of the ore from this mine, and are reported to have shown a large yield in both gold and silver. The assays given below are taken from a Report on this location recently made by Professor E. J. Chapman, of University College Toronto.

Professor Chapman says: "In order to obtain a fair average sample of the vein, as at present opened, I had two blasts put in at a distance of about twelve feet apart, and about six feet below the surface of the ground. From the fragments thrown out by these blasts, I broke off between 30 and 40 lbs. of ore, taking a piece or two from each fragment."

"A single trial-assay made from a selected piece of the pyrites, free or nearly so from quartz, (but in which no visible gold could be detected by the magnifying glass), gave me, per ton of 2000 lbs., the extraordinary yield of 8 oz. 3 dwts., equivalent to \$168 per ton."

"This, however, can scarcely be regarded as a fair criterion of the yield of the vein, and it is only mentioned here to show the actual amount carried by some portions of the ore. But the following results were obtained from portions broken fairly from every piece of the ore thrown out by the two shots or blasts, (from all, at least, that could be collected.) Several fragments were thrown to a great distance, and could not be found."

"ASSAY 1.—(Portions of powdered ore from both shots.)

Gold.....6 oz., 10 dwts., 16 grs.—\$134 per ton of 2000 lbs. of ore.
Silver.....9 dwts, 8 grains.

ASSAY 2.—(Portions of powdered ore from both shots.)

Gold.....6 oz., 8 dwts., 8 grs.—\$132.56 per ton of 2000 lbs. of ore.
Silver.....7 dwts.

Average yield of gold per ton of ore=\$133.28.

"These results, obtained by the most scrupulously fair treatment of the ore, are decisive as to the general richness of the vein. If at other parts at present unopened, the yield sink to even a third or fourth of the above, the ore would still be of more than average quality."

During the summer of 1867, while engaged in mapping the distribution of these gold bearing rocks in Marmora, I succeeded in tracing the Gillen vein through the seventh, eighth, ninth and tenth lots, in the eighth con-

cession, its course being plainly indicated by broken fragments of rusty surface-quartz, holding mispickel. Through lots nine and ten the course changed from N, 17° W. to almost north and south magnetic, and the vein disappeared beneath an extensive swamp in the south-west corner of lot eleven, in the ninth concession, beyond which all trace of it was lost for some distance, owing to low swampy ground, which continues northward through lots eleven, twelve and thirteen of the same concession. On reaching, however, the fourteenth lot, in the tenth concession, I again found loose fragments of quartz and mispickel, and shortly afterwards, on the same lot noted a well defined vein, striking N. N. E., doubtless the continuation of that already traced up to the swamp commencing on the eleventh lot of the ninth concession.

The Severn
Mine.

(3). The *Severn Mine* is situated half way up the line between the eighth and ninth concessions, about the eighth lot, but no work has been in progress recently. At the time of my visit, the shaft, which has, been sunk to the depth of about fifteen feet, on a vein of quartz and mispickel, was filled with water; but, from an examination of the immediately adjacent strata, the vein appears to me to be on the run of that from the Williams shaft. During the winter of 1870, about three hundred tons of ore from this mine were put through a small stamp-mill, which had formerly been in use at Eldorado, and I am informed that yields have been obtained, varying from \$4.00 to \$12.00 per ton.

The Gatling
Mine.

4. The *Gatling Mine*, the property of W. J. Gatling and partners is situated on the north-eastern corner of the ninth lot, in the eighth concession of Marmora. It is on a bedded vein, striking nearly north and south magnetic, and having a dip to the westward $< 30^\circ$. The vein is composed largely of white translucent quartz and mispickel, with abundance of a very black mica, and has an average width of from seven to ten feet. On this lode, besides a number of small openings, two shafts have been sunk, No. 1, to the depth of sixty-eight feet, and No. 2.—eighty feet distant from No. 1.—to the depth of sixty-four feet. Another shaft, No. 3, has been sunk on a parallel vein, three hundred feet west, to the depth of twenty feet. The foot-wall of both these veins is composed of a greyish-blue nacreous or talcose schist, similar to that accompanying the Gillen vein; it is intercalated with layers of quartz and sulphurets, through which gold is very frequently visible. The hanging-wall is a greenstone or diorite with disseminated pyrites. In making a section across the north-eastern quarter of this lot, there appeared to me to be evidence of at least three distinct and parallel ore-zones, within a distance of three hundred feet, in each of which gold had been found by Mr. Gatling and Mr. O'Neill. These zones are separated from one another by bands of greenstone, felsite and slate. Limestones do not occur in their immediate vicinity, but rather more to the westward, and a few hundred feet higher in the series.

Character of the
vein.

Limestone.

From shafts Nos. 1, 2, 3, about two thousand tons of ore have been mined and raised, of which the greater part still lies on the ground awaiting treatment. From this pile, however, Mr. Gatling has sent to Mr. Balbeck & Brothers, of Newark, N. J., two barrels of samples, amounting to about 1700 lbs.—one lot, representing ore taken from the east, and the other from the west vein. By smelting, Mr. Balbeck obtained from the former about \$28.00, and from the latter upwards of \$30.00 per ton, \$4.00 of which was in each case silver. Numerous beautiful shows of gold were found all along the course of the veins on this lot by both Mr. Gatling and Mr. O'Neill, who also panned out considerable quantities of gold from the decomposing ferruginous vein-stuff. Mr. Gatling has made many improvements on the property, having cleared over six acres, and erected a number of substantial and neat frame buildings in proximity to the shafts. Among these, are a dwelling-house, a boarding-house with accommodation for thirty workmen, a work-shop, stable, carriage-house, and smith's forge. A good road has also been constructed, connecting with the main travelled road from Madoc, to the village of Marmora. Preparations have already been commenced by Mr. Gatling for the erection of a twenty-stamp mill and suitable roasting-furnace, and there is little doubt but that this mine will be in full working order within a very few months. Following the strike of these bedded lodes in a northerly direction, we next come to the Hawk-eye Co.'s mine.

5. The *Hawk-eye Co.'s* mine is situated on the east quarter of the tenth lot, in the eighth range, and less than one-quarter of a mile north of Mr. Gatling's mine. Here, gold occurs under conditions similar to those last described. Slate, greenstone and felsite bands are interstratified and accompanied with veins or beds of quartz and mispickel. Two shafts have been sunk on one of these veins by Mr. Jones of Iowa, one to the depth of forty-six feet, and another to thirty feet. From these openings a considerable amount of ore has been raised, but has not yet been milled. During my visit no work was in progress, but I was informed that operations were to be commenced early in the spring of 1872, on the return of the proprietors. Beyond this lot the gold-bearing zones are lost sight of, in the swamp already noted as covering the greater portions of the eleventh, twelfth, and the thirteenth lots, of the ninth range. Proceeding northward we next come to Neill's mine.

6. *Neill's Mine* is situated on the west half of the fourteenth lot, in the tenth concession of Marmora. I discovered and traced out the vein on this lot in September, 1867, before any mining locations were being worked in Marmora. Specimens of quartz with mispickel, brought down at that time, and subsequently examined, yielded me by assay, in the laboratory of the Geological Survey Office, upwards of \$5.00 to the ton. During the years 1870 and 1871, an opening was made on the vein by Mr.

Neill, the owner of the lot, but with what result, I have not been informed. The geological conditions of this deposit resemble those of the Williams vein, on the seventh lot of the ninth concession. It almost immediately borders on the great granite area existing to the eastward, but from which it is separated by a granitic and greenstone breccia, to which I have already referred. (Report of Progress for 1866-69, pages 146, 147.) There is little doubt but that mispickel zones or belts carrying gold will yet be discovered above the horizon of Neill's vein, on the eastern portion of the fourteenth lot in the ninth, and probably on the western portion of the fifteenth lot in the tenth concession, corresponding with the upper zones on the Gatling lot.

The Powell
Mine.

7. The *Powell Mine* is situated about one mile and a-half N. N. E. from *Neill's* mine, being on the western portion of the seventeenth lot of the eleventh concession of Marmora, and more or less work has been done there since the year 1867. During the fall of 1866, while mapping the distribution of the ferriferous belt of rocks through Madoc, I succeeded in tracing a band of sulphurets—mispickel and iron pyrites—through this lot, and noted the occurrence of some deposits of magnetic iron-ore. (Report of Progress for 1866-69, page 151.) A shaft, now about fifty feet deep, has been sunk on a vein of quartz and mispickel, in greyish talcose slate, which strikes nearly due north and south, magnetic, and dips to the westward $< 25^{\circ}$ — 35° . The vein is said to average about ten feet in width. A temporary stamp-mill with five stamps, worked by an engine of twenty horse-power, has been erected for testing the ore. The pulverized mineral is roasted in a small, ordinary reverberatory furnace, previous to its treatment in the mill. Mr. Jenkins, who is at present superintending the work informs me that the mill crushes about five tons in the twenty-four hours. The proprietors intend, however, should they meet with sufficient encouragement, to erect a mill of at least twenty stamps. Only a small quantity of surface ore has yet been operated on, but has yielded on an average about \$5.00 to the ton. Some seven or eight men are at present employed on the location.

The table on the following page contains the results of assays made by Dr. B. J. Harrington, in the laboratory of the Geological Survey Office. The specimens were all collected by myself, with the exception of the ore from the Cooke or Williams mine, and the poorer of the tailings from the same place.

I have the honor to be,

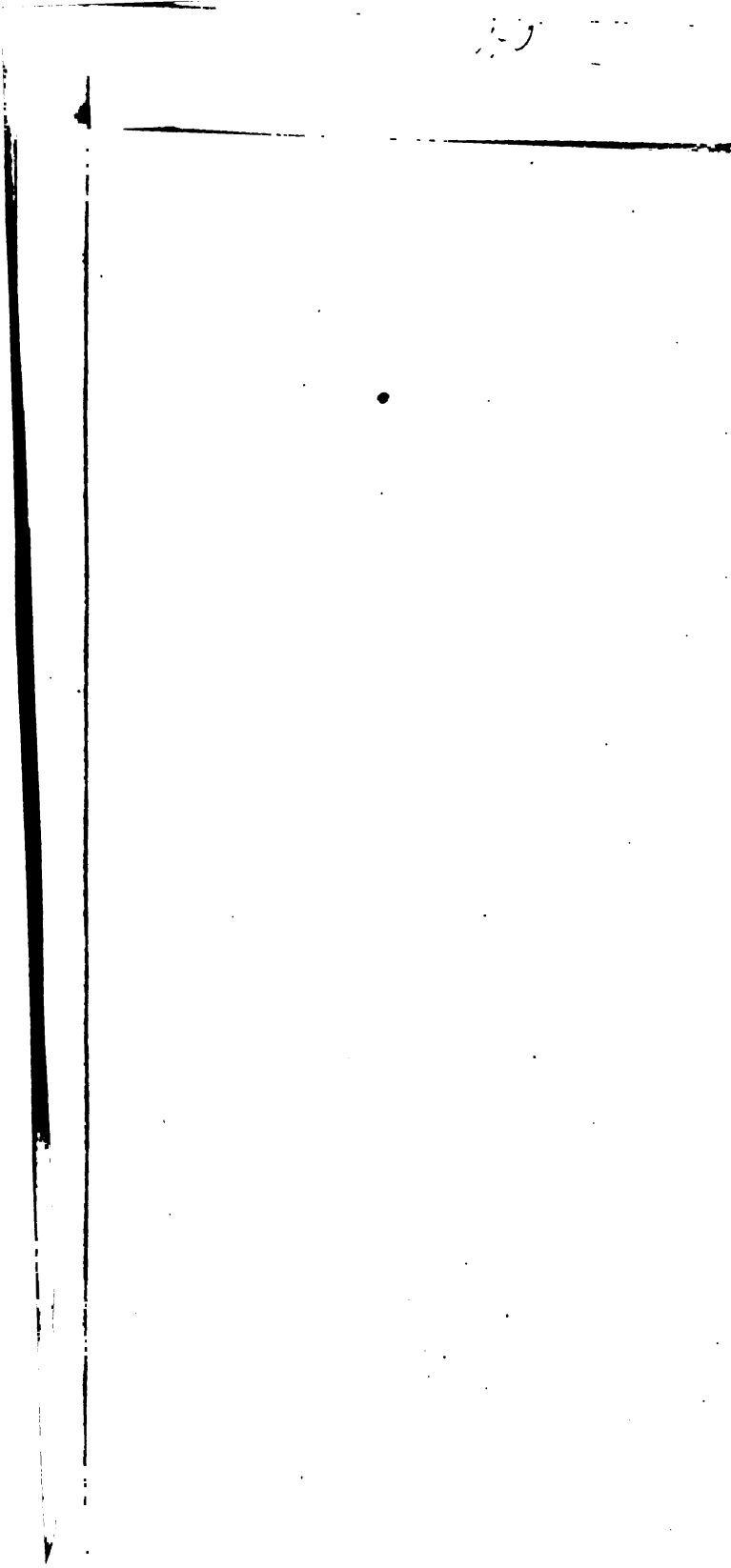
Sir,

Your obedient servant,

HENRY G. VENNOR.

Geological Survey Office, }
1st May, 1872. }

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Th
M

ASSAYS BY DR. B. J. HARRINGTON.

In the foregoing Report nothing is said with regard to gold localities outside of Marmora; but a few specimens from the Townships of Levant and Elzevir having been examined at the same time as those from Marmora, it has been thought advisable to include the results in the following table. In most cases silver was absent, or, if present, occurred in such minute quantity as to be of no economic value :—

Names of Mines or of Proprietors.	Township, Lot and Range.	Character of Ore.	Ounces of Gold per ton (2000 lbs.)	Value per ton (2000 lbs.)	Remarks
Gillen Mine....	Marmora, 6, 8.	{ Mispickel and quartz }	4.90	\$101 23	A vein worked at present.
" " ...	" "	{ Mispickel and quartz }	0.6125	12 65	Not from the same vein as the above.
Gatling Mine...	" 9, 8.	" "	3.736	77 18	Now being worked.
Williams & Co.	" 8, 9.	{ Ordinary and magnetic pyrites with chloritic matter..... }	No trace of gold or silver.		Occurs in magnetic iron in the vicinity of the Marsh Ore Bed.
" " ...	" "	{ Finely granular mispickel..... }	"		This, like the last, was a surface specimen, no openings having been made.
Cooke or Williams' Mine. }	" 7, 9.	{ Mispickel and Vitreous quartz..... }	4.14	85 53	Worked at present.
" " ...	" "	{ Concentrated tailings from Dr. Williams' Mill, chiefly quartz and mispickel..... }	0.8458	17 47	Trial on a large scale are said to have yielded a much larger amount of gold; but the quantity of course varies according to the degree to which the tailings have been concentrated.
" " ...	" "	{ Similar to the last, but not so well concentrated..... }	0.466	9 71	
Williams, Dean & Co. }	" 20 5.	{ Mispickel with a little quartz..... }	1.545	31 92	From a locality not yet described, and belonging apparently to a different horizon from any of the above.
B. Hutchins, Esq..... }	Levant, 6, 7.	{ White quartz with chlorite and copper pyrites..... }	No gold or silver.		Some years ago a few small openings were made on this and the following lots for copper.
" "	" 4 or 5, 7.	Fahlband.....	Trace of gold		
" "	" 8, 7.	{ Compact quartzose dolomite, holding sulphides of iron and copper..... }	0.255	5 27	

REPORT
OF PROGRESS
OF GEOLOGICAL INVESTIGATIONS
IN
NEW BRUNSWICK.

BY
PROFESSOR L. W. BAILEY, A.M.,
ADDRESSED TO
ALFRED R. C. SELWYN, ESQ., F.G.S.,
DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

SIR,—In accordance with a request conveyed to me in your letter of the 4th inst., I beg leave to lay before you the following general statement of the progress of geological investigation in this Province during the summer of 1871, and some of the results at that time obtained.

Geological
Map.

Having been honored with your instructions, in the month of May last, to direct my efforts during the ensuing season towards the preparation of a geological map of southern New Brunswick, supplementary to, and illustrative of the general Report submitted by Mr. Geo. F. Matthew and myself relative to that region, the greater portion of my time was devoted to the obtaining of the materials necessary for that purpose. With this object in view, not only was attention paid to the more accurate limitation of the different groups of strata in the region to which that Report particularly relates, but an effort was at the same time made to trace them in their eastward extension through the counties of St. John, King and Albert, of which but a limited portion had been previously examined. Many additional details, relative both to the character and distribution of the formations in question, were thus obtained. Before attempting, however, to represent these, and the previous conclusions, in pictorial form, it seemed essential that certain difficulties, to which reference has been made in the preceding Report, and upon the solution of which depended the correct delineation of considerable areas within the region under consideration, should, if possible, be removed. In endeavouring to effect this object, I have, during a portion of the summer, been accompanied by Dr. T. S. Hunt, to whom I am indebted for much valuable advice and assistance. Though adding much to our previous knowledge

Assistance from
Dr. T. S. Hunt.

upon the subject, I regret to say that our labours in this direction have not as yet proved entirely successful, several important questions still remaining, for the solution of which additional study is required. Under these circumstances, and until such investigation shall have been made, it has been thought advisable to defer for the present the farther preparation of the map alluded to, the presentation of which has, accordingly, and with your consent, been postponed.

Among the subjects remaining open for determination is that relating to the age and relations of the different bands of schistose rocks lying to the northward of the great belt of intrusive granites which traverse the central portion of Charlotte, and parts of King's and Queen's Counties, and in some of which organic remains [See Report of Progress, 1870-71] of Upper Silurian and Devonian aspect have been observed. This determination is the more important from the fact that upon it depends also the determination of the age of similar strata extending over large districts in the central and northern portions of the Province. The latter were observed by Dr. Gesner, Sir William Logan, Professor Hind and others, as well as by the writer, and in them Mr. Charles Robb has recently discovered fossils belonging to a type similar to that of the organic remains mentioned above. It is accordingly proposed, with your permission, to devote a portion or the whole of the coming season to a minute and critical study of the region in question, with a view to determine whether more than one series is here represented, and, if so, to ascertain their true age and relations.

A second subject, to which a considerable share of my attention has been devoted during the past season, is that of the Huronian series, more particularly as regards the features and distribution of its different subdivisions in the hilly region lying to the eastward of the city of St. John, and along the northern shore of the Bay of Fundy. Among the more important results attending the examination of this region may be mentioned, the confirmation of the view expressed in the Report of last year, as to the probable identity of the rocks of eastern St. John county with those to which the designation of the "Coastal Group" has been applied in other parts of the southern metamorphic district, as well as the recognition of the latter in portions of King's, and over a large part of Albert County. The rocks in question being those in which are contained the principal deposits of copper ore in the last-named county, as well as in that of St. John, this recognition is important, not only as establishing their relationship to the similar copper-bearing rocks of Charlotte, but also as indicating the wide area over which such deposits may be looked for. It should, however, be mentioned that, although indications of this metal have been observed at many different points over this region at but few of these does it appear to be present in quantities sufficient to warrant its profitable extraction. Where most abundant, it

is usually in connection with the more chloritic members of the group, especially where these, as in the southern part of the parishes of Alma and Harvey, in Albert county, are associated with granitoid and dioritic rocks.

Allusion may be made in this connection to the probable want of conformity between the coast rocks last mentioned and those of the Coldbrook group, as indicated by the want of parallelism in their geographical distribution, and the entire absence of the former, as far as known from among the folds by which the latter has been made to spread over so extensive an area. It is to be observed, however, that no direct proof of such unconformability has as yet been obtained, the contact of the two groups being obscured in all those cases where an attempt has been made to determine their relations, in some instances by over-lying Carboniferous or Devonian sediments, and in others by the presence of intrusive syenites.

In addition to the subjects referred to above, and upon which farther information is required, the following may be mentioned as among other results of the last season's explorations:—

- (1.) The determination of the exotic origin of much of the so-called granite of southern New Brunswick. In addition to that of the Nerepis Hills and the St. Croix River, alluded to last year, may be mentioned
Exotic granites. several large areas of such rocks in eastern King's and Albert Counties, not before represented in the geological maps of the Province. On the western frontier the intrusion of these masses (which include both true granites and imperfect syenites, the latter usually of a bright red colour) has been in part through the mica-schists and imperfect gneisses, to which allusion has been made in a preceding paragraph as of uncertain age, and in part through dioritic rocks, holding serpentine and diallage, which, on lithological grounds, are regarded by Dr. Hunt as probably Huronian, those of the last named counties are in part through the petrosilicious rocks of the Coldbrook series, and in part through the chloritic and nacreous schists of the Coastal group.
- (2.) The existence of a considerable area of true carboniferous rocks,
Carboniferous rocks. marked by the presence of plants of the type of the Middle or Upper Coal formation, in the eastern part of King's County, and indications of a probable want of conformity, both in this county and in that of Albert, between the coal measures and the Lower Carboniferous formation. Excavations made several years since in the rocks first mentioned (at Dunsinane Station, on the line of the European and North American Railway), showed
Coal. the presence, near the surface, of thin beds of coal, similar in composition to that of Springhill in Nova Scotia, but the locality has not yet received the attention which it apparently deserves.
- Lastly, the occurrence of trappean rocks similar to those of the North
Trappean rocks. Mountains of Nova Scotia and of the island of Grand Manan, near

Shepody Mountain in Albert County, an observation of some interest as tending to confirm the view expressed by Mr. Matthew and myself in earlier publications as to the Mesozoic age of a portion of the red sandstones occurring along the north shore of the Bay of Fundy.

Fuller details upon the several points above referred to are, with your permission, reserved until a more complete examination shall have been made of the districts to which they relate.

I have the honour to be, Sir,

Your most obedient servant,

L. W. BAILEY.

RECORDS OF MINES AND MINERAL STATISTICS,

COMPILED BY

MR. CHARLES ROBB.

THE following Tables exhibit in a concise form the results of Mining operations during the last three years throughout the Dominion of Canada and the British American Provinces. They have been compiled chiefly from information obtained by the Officers of the Geological Survey, under the arrangement specified in MR. SELWYN'S SUMMARY REPORT, addressed to the Legislature, and dated May 2nd, 1870, pp. 13 and 14 ; and partly from the Reports of the Commissioner of Mines for Nova Scotia, supplemented by other authentic sources of information. In some cases, in order to render the Tables more complete and uniform, it has been deemed necessary to fill up some of the items by estimating according to the compiler's best judgment. In such cases, the figures are marked by an asterisk. It is to be regretted that the returns are so incomplete as to render such an expedient necessary ; and it is hoped that, when the importance and value of such records are duly recognized, the parties more immediately interested will give their cordial co-operation. These Tables comprise the records only of such mines as have been in operation during the whole, or any part of the three years referred to ; and in some instances where it has been impossible to obtain any information all notice has necessarily been omitted. In the column indicating the year, the brackets denote that the " aggregate " production, number of men, etc., for each year of all the mines of the class referred to is recorded.

TABLE I. — PROVINCE OF ONTARIO.

Description of Mineral Product.	Designation of Property or Company.	LOCALITY. Lot, Range, Township, County.	Year.	Number of			Value of Plant and Machinery.	Quantity Produced.	Value of Product at the Mine.	Destination of Product.			REMARKS.
				Men.	Horses.	Engines. No. H. P.				D.C.	U.S.	G. B.	
GOLD.....	Cook Mine.....	7 in 9th, Marmora, Hastings.....	3 yr	38	6	1 20	\$ 10000	*500 oz.	\$ 9250	All			In operation since 1870.
SILVERORE.....	Silver Islet Mining Co....	Woods Location, Thunder Bay, L. S.	1869	5	1			10791 lbs.	69760				First year of operation.
	" " " " " "	" " " " " "	1870	77	4	1 40		172825 "	105328	All			in operation since 1870.
LEAD ORE.....	Thunder Bay " " " "	Thunder Bay, Lake Superior.....	1871	40	3	1 40	*30000	969454 "	645397	All			Total to date.
	Frontenac Lead Co.....	S. 1, 16 in 9th, Loughboro', Frontenac	1869	50	4	2 30		3294 "	2592	All			Operative since 1869.
IRON ORE.....	Peterboro' Lead Co.....	W. 1, 2) A, Galway, Peterboro'.....	1871	10	1		17200	*550 tons	4400	All			Do.
	" " " " " "	" " " " " "	1871	10	1			167 "	2000	All			Work suspended, but to be resumed.
IRON ORE.....	Chaffey & Mathews Mines	Near Marmora, Hastings.....	1871	110	6	3 40		22720 "	56800	All			Has been worked for many years.
	Blairton Iron Mines.....	8 in 10th, Marmora, Hastings.....	1869	135	23	3 40	114000	17720 "	44300	All			Cobourg, Peterboro', M'mora Co.
IRON PYRITES.....	Cowan Iron Mines.....	E. 1, 12 in 10th, Marmora, Hastings.....	1871	122	8	3 40		25000 "	62500	All			Worked since 1868.
	Elizabethtown Mine.....	19 in 10th, Elizabethtown, Hastings.....	1871	5	3		500	460 "	*3000	All			Used at Brockville with produce of two following phosphate mines in manufacture of fertilizer.
PHOSPHATE OF LIME.....	Do do do do	Do do do do	1871	5	3			150 "	1000	All			
	Brockville Chemical Co.,	9 and 10 in 7th, Burgess, Lanark.....	1871	10	6			400 "	5200				
PLASTER.....	Victoria Phosphate Mine	12 in 7th, " " " "	1871	12	3		1200	800 "	8400				
	Cambrian " " "	W. 1, 13 in 6th " " " "	1871	18	3			200 "	2100	All			
HYDRAULIC CEMENT.....	Grand River Plaster Beds	Near Cayuga, Haldimand.....	1871	22	3		15000	5000 "	10000	All			In operation for many years, with little variation in production.
	Alexander Taylor's " "	Near Yorkville, Seneca, Haldimand	1871	22	3			5000 "	10000	All			
MICA.....	Brown's Quarry and Mill	Thorold, Lincoln.....	1871	8	2	1 40		4250 "	8500	All			
	Napanee " " "	Near Napanee, Lennox.....	1871	26	16	1 35	28000	17000 bu.	3825	All			Do. Do.
PETROLEUM.....	New York Mica Co.....	16 in 9th, North Burgess, Lanark.....	1871	28	16	1 35		22000 "	4950	All			
	Enniskillen Companies...	Petrolia, Enniskillen, Lambton.....	1871	5205	750	400	*6000	52000 lbs.	11700	All			But little worked since 1870.
SALT.....	Huron & Bruce Co.'s...	Salt Wells in Huron and Bruce Cos.	1869	200	20	10	100000	300000 bls	875000				The return for 1870 is the only one obtained.
	" " " " " "	" " " " " "	1870	*200	20	10	*140000	100000 "	108000	All			
COPPER ORE.....	West Canada Co.....	Lake Huron.....	1871	*150	15	10	*160000	70000 "	73000	All			Production limited from want of adequate market.
	" " " " " "	" " " " " "	1869	173	5	6	170000	2180 t'ns	141000	All			Recently this Co. have erected at their mines works for the reduction of the copper, in part by a humid process.
Annual Average.....	" " " " " "	" " " " " "	1870	205	9	6	237000	1945 "	118645	All			
	" " " " " "	" " " " " "	1871	194	6	6	257000	2256 "	117900	All			

most important discoveries of auriferous veins have been made and operations commenced at several other points besides those indicated, and most important results are anticipated; but no specific details. In Marmora, a quarry of excellent lithographic stone has lately been opened, and in Huron's Report.

TABLE III.—PROVINCE OF NOVA SCOTIA.

COAL.

SUMMARY of the Production of Coal in each County in Nova Scotia and Cape Breton in 1869-70-71, condensed and compiled from Official Records contained in the Reports of the Chief Commissioner of Mines for the Province of Nova Scotia.

COUNTY.	Year.	Number of				Aggregate Horse- Power of Engines.	Expenditure on New Works.	Quantity Raised.	Quantity Sold.	Value of Quantity sold at the Mine.	Total Quantity		Value of Quantity sold.	Sales compared with previous Years.		Destination of Product.		
		Mines.	Men.	Horses.	Engines						Raised.	Sold.		In- crease.	De- crease.	Nova Scotia & Cape Breton.	Adja- cent Prov- inces.	Other Coun- tries.
						H.P.	\$	Tons.	Tons.	\$	Tons.	Tons.	\$	Tons.	Tons.	Tons.	Tons.	Tons.
CUMBERLAND....	1869	4	57	13	3	41	4474 21	15066	8515	16168								
	1870	4	65	13	3	41	2194 21	9053	7884	14790								
	1871	4	118	14	3	41	9609 25	12332	11737	22742	89451	28136	53696	4153		1655	9757	290
PICTOU	1869	7	831	81	30	1535	71464 29	218673	198212	373498				53360		29810	60068	84036
	1870	8	1044	76	29	1520	67784 47	248880	226525	417992				28313		47364	86802	92178
	1871	6	937	80	29	1520	37991 84	285994	245800	456301	763547	670637	1247791	19275		67147	82473	97162
CAPE BRETON...	1869	17	1446	210	30	1274	45949 79	343399	304320	591346				7575		83171	74069	157064
	1870	12	1480	197	36	1437	95713 60	387873	333578	639676				29259		81372	79873	153536
	1871	15	1448	192	35	1417	122767 60	370948	338431	659428	1081720	976329	1890450	4864		81795	68160	82904
INVERNESS and VICTORIA.....	1869	2	39	3	1	7	13582 80	895	749	1409					1176	496	262	....
	1870	2	11	2	1	7	24374 00	463	290	575					461	286	.....	....
	1871	2	16	2	2	27	5415 00	4018	450	894	5376	1489	2878	160		63	387	....
Annual Average..	.....	28	2514	294	67	2956	167,107 02	625,698	558,830	1,064,938	....	....	....	.....	.....	132,092	157,612	222,998

12; horse-power of engines, 200.

The returns relative to gypsum, which is a most important article of export, are more imperfect. From the best information we can obtain, we may state that from the port of Windsor alone, at least 125,000 tons of raw gypsum are annually exported, being the produce of 15 or 16 quarries, and amounting in value at the port of shipment to about \$100,000. Only about one-twenty-fifth is used in Canada, the remainder being exported to the United States. The number of men annually employed in this branch of mining industry may be estimated at 200.

TABLE IV.—PROVINCE OF NOVA SCOTIA.
GOLD.

CONDENSED and compiled from the Reports of the Chief Commissioner of Mines for Nova Scotia.

DISTRICT.	Year.	Number of			Quartz Crushed.	AVERAGE		Total Yield of Gold.	Total Value.	Yield compared with that of previous year.	
		Mines.	Men.	Mills.		Yield $\frac{\text{oz.}}{\text{Ton}}$	Val. $\frac{\text{\$}}{\text{Man}}$			Increase.	Decrease.
					Tons. cwt.	oz. dwts. grs.	\$ c.	oz. dwts. grs.	\$ c.	oz. dwts. grs.	oz. dwts. grs.
SHERBROOKE.....	1869	17	134	11	11500 11	9 15	765 76	5546 11 16	102611 78	.....	1523 8 13
	1870	13	157	11	11428 06	12 12	840 65	7134 4 0	131982 70	1537 12 8	.....
	1871	14	171	12	14332 15	9 3	711 87	6579 19 7	121729 33	.....	554 4 17
	1839	10	112	5	7258 09	8 13	511 68	3097 15 7	57304 63	.....	275 19 2
RENFREW.....	1870	9	33	5	3243 15	7 5	602 24	1171 18 11	21630 56	.....	1925 16 20
	1871	6	33	5	2443 10	9 14	606 33	1179 17 16	21827 83	7 19 5	.....
	1839	6	54	4	3015 15	8 3	545 31	1591 14 10	29446 82	.....	795 14 12
	1870	3	42	4	2616 00	6 5	357 31	811 3 21	16077 07	.....	780 10 13
WAVERLEY.....	1871	3	56	4	2742 10	10 10	471 72	1427 18 12	24416 61	616 14 15	.....
	1869	4	65	5	2726 12	5 7	204 76	719 8 19	13309 62	.....	528 17 8
	1870	2	26	5	2356 15	7 13	650 90	914 15 14	16923 41	195 6 19	.....
	1871	3	33	5	2327 00	10 12	790 53	1538 6 16	28459 16	623 11 2	.....
WINE HARBOUR.....	1839	3	51	4	1332 02	17 21	482 45	1192 3 10	22055 15	270 15 1	.....
	1870	3	94	4	2732 10	13 7	357 03	1814 2 10	33561 22	621 19 0	.....
	1871	5	88	4	2924 00	14 7	440 01	2098 0 7	38720 76	278 17 21	.....
	1839	14	71	6	3171 13	11 18	486 52	1867 3 12	34542 72	.....	1380 0 5
UNIAKE.....	1870	3	20	6	1794 10	6 7	524 21	566 14 5	10484 14	.....	1300 9 7
	1871	3	14	4	900 00	8 0	476 84	310 17 3	6675 84	.....	205 17 2
	1839	3	29	2	572 07	1 8 4	513 97	805 13 14	14905 06	220 18 16	.....
	1870	3	49	2	956 08	4 0 3	1476 71	3331 9 6	70882 05	3025 15 16	.....
MONTAGUE.....	1871	3	51	2	848 15	3 9 9	1143 53	3152 8 15	58319 97	.....	679 0 16
	1869	9	56	5	1735 02	16 2	460 78	1334 16 0	25303 80	675 15 20	.....
	1870	13	65	3	2644 02	15 12	583 96	2051 15 3	37957 49	656 19 3	.....
	1871	12	43	3	1374 00	1 5 0	739 41	1718 12 12	31734 56	.....	333 2 15
OLDHAM.....	1869	4	19	2	784 02	5 19	221 06	227 0 13	4200 00	.....	446 2 4
	1870	5	21	3	1535 10	7 14	509 44	578 5 15	10698 20	351 5 2	.....
	1871	5	18	3	1937 09	5 19	575 44	559 17 21	10358 02	.....	18 7 18
	1869	2	20	2	223 00	2 17	27 79	30 0 20	555 76	.....	242 1 12
LAWRENCETOWN.....	1869	2	36	2	1532 17	12 15	514 43	1001 0 23	13519 37	.....	.....
	1870	2	21	2	755 00	16 6	540 51	613 11 2	11350 75	.....	287 9 21
	1871	2	10	2	479 13	1 1 1	933 88	504 15 23	9833 75	.....	108 15 8
	1869	7	29	6	622 09	12 16	251 72	394 11 19	7299 89	850 7 5	.....
UNPROCLAIMED and other Dis- TRICTS.....	1870	3	25	8	812 17	9 7	279 98	378 5 15	6998 20	.....	16 6 4
	1871	1	9	9	231 00	7 23	231 49	112 2 16	2074 46	.....	286 2 23
Annual Average.....		66	588	53	32,517 01	.....	.....	18,987 7 18	\$351,266 56	.....	.....


In addition to the above return of gold extracted chiefly from quartz, an amount of 386 oz. 7 dwts. 9 grs. of alluvial gold is reported as having been obtained during the three years specified. The annual production of alluvial gold has, therefore, been only 122 oz., 2 dwts., 11 grs., or \$2259.25. The value of the gold is taken at \$18.50 per ounce, as in the Official Reports.

TABLE V.—PROVINCE OF NEW BRUNSWICK.

Description of Mineral Product.	Designation of Property or Company.	LOCALITY.		Year.	No. of		Value of Plant and Machinery.	Quantity produced.	Value of Product at the Mine.	Destination of Product.			Remarks.
		District.	County.		Men.	Horses.				Canada.	United States.	Great Britain.	
COPPER ORE.....	Adams Island Mine....	Adams Island..	Charlotte....	1869	30	1	\$ 8000	170 tons	\$ 11700	All	Work was suspended in 1869. do do do 1870. The return for 1870 is the only one obtained, but the works are supposed to have been in operation for three yrs. with little change. Suspended since 1869. Irregularly worked; now suspended. Partially worked, with little change. Total from 1852 to 1872, 210,874 tons. Regularly worked, with little change.
	Alma Copper Mine.....	Salmon River..	Albert.....	1870	4	1	1000	50 "	2000	.....	.....	.....
MANGANESE.	Markhamville Mangane- nese Mining Company.	Markhamville..	Kings.....	1869	26	7	2000	800 "	11700	.....	.....	.....
				1870	26	7	2000	800 "	11700	.....	.....	.....
				1871	26	7	2000	800 "	11700	.....	.....	.....
ANTIMONY ORE.....	Prince William Mines..	Prince William.	York.....	1869	12	3	*8000	185 "	2000	.....	.....	.....
PLUMBAGO..	Split Rock Mine.....	Portland	St. John	1869	19	2	700	5000 brls	12000	.....	.....	.....
COAL.....	Grand Lake Mines.....	Grand Lake....	Queens.....	3 Yrs.	12	8	1000	22050 tons	26300	All	.....	.....
ALBERTITE..	Albert Mines	Near Hillsboro'	Albert.....	"	12	4	*30000	19267 "	192670	.....	Chiefly	.....
SALT.....	Sussex Salt Works.....	Sussexvale	Kings	"	2	2	*1000	4500 bus	3618	All	.....	.....
Annual Average.....				.....	108	28	47,700	.....	262288	.....	.....	.....

There are important works near Hillsborough, in Albert County, for the manufacture of plaster from the gypsum which abounds in that neighborhood, but no detailed statements regarding them have been obtained.

TABLE VI.—BRITISH COLUMBIA.

Description of Mineral Product.	Designation of Company, &c.	Year.	Number of				Value of Plant and Machinery.	Quantity Produced.	Value of Products.	
			Men.	Horses.	Engines					
					No.	H. P.				
GOLD	Return of Gold Mining generally throughout the Province.....	1869	*2,000	....	....	....	\$	....	\$ 1,324,871	<div>Pub. Works.</div>
		1870	2,000	....	....	....	....	....	1,333,745	
		1871	2,000	....	....	....	....	....	1,349,581	
COAL	Vancouver Coal Mining and Land Company (Limited.)	1869	....	....	....	....	....	35,802 tons	147,504	Sales in the last ten years, 800,000 tons. There is one other Coal Company in the Province, from which no returns.
		1870	....	....	....	....	....	29,848 "	122,953	
		1871	194	5	10	222	94,000	45,000 "	185,400	
	Annual Average.....	.....	2,194	5	10	222	.....	36,882 coal	1,488,014	† Probably one-fourth more gold is taken away by private hands.

The coal produced by the Vancouver Coal Mining Company at Nanaimo and Newcastle Island is supplied to the Town of Victoria, and to Steamers calling at the place on their way to San Francisco in California, Portland in Oregon, and Honolulu, in the Sandwich Islands.

TABLE VII.—NEWFOUNDLAND.

The geological structure and economic interests of this Island are so closely allied with those of the Dominion, that it has been deemed desirable to include in this Report the record of its most important mineral products. Although various other minerals of economic importance, such as coal, galena, gypsum, &c., are known to exist in the Island, the Copper Mines of Tilt Cove are the only ones now systematically worked.

Description of Mineral Product.	Designation of Property.	LOCALITY.	Year.	Number of			Value of Plant and Machinery.	Quantity of Copper Ore produced.	Value of Copper Ore at the Mine.	Quantity of Nickel Ore produced.	Value of Nickel Ore.	REMARKS.
				Men.		P.						
COPPER AND NICKEL.	Union Mine	Tilt Cove, Notre Dame Bay	1869	288				Tons.	\$	Tons.		
	Do.	Do. Do.	1870	288				45,091	448,242	37		
	Do.	Do. Do.	1871	140				4,000	120,000	135		
								3,000	90,000	20		
		Annual Average.....		289				17,364	219,414	64		

TABLE VIII.

GENERAL SUMMARY of Mining Statistics for the Dominion of Canada and British Provinces.—Average of the years 1869, 1870 and 1871.

NAME OF PROVINCE.	Number of				Value of Plant and Machinery.	Value of Pro- duct at Mine.	REMARKS.
	Men.	Horses.	Engines.	H. P.			
ONTARIO.....	6495	820	423	6734	\$ 2270816	\$ 966982	Expenditure on new works only included. Total in ten years from 1862, 196,776 oz. 1 dwt. 17 grs.
QUEBEC.....	1264	98	17	550	876400	330209	
NOVA SCOTIA.....	2514	294	67	2956	167107	1192385	
Do. ....COAL.....	588	...	53	*1000	.....	351266
Do. ....GOLD.....	500	25	6	200	.....	220000
Do. ....OTHER MINERALS.....	108	28	47700	262288	Total in six years, beginning 1866, \$1,274,746. Total sales in ten years, 300,000 tons.
NEW BRUNSWICK.....	239	1	1	35	80000	233792	
NEWFOUNDLAND.....	2000	....	....	....	.....	1338066
BRITISH COLUMBIA.....	194	5	10	222	94000	151952	
Do. Do. ....COAL.....	.....	.....	.....	.....	.....	.....
Grand Total, Annual Average.....	18,902	1,266	577	11,697	3,036,023	5,044,880	

Some of the above figures are probably too low, as it has been impossible in many cases to obtain complete returns.