SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY DEPARTMENT

OF

CANADA

FOR THE CALENDAR YEAR

1906

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1906

[No. 26—1907.]

No. 959

To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G.C.M.G., &c., &c., &c., Governor General of Canada.

MAY IT PLEASE YOUR EXCELLENCY,—

The undersigned has the honour to lay before Your Excellency, in compliance with 3 Victoria, chapter 2, section 6, the Summary Report of the operations of the Geological Survey Department for the calendar year ending December 31, 1906.

WILLIAM TEMPLEMAN,
Minister of Inland Revenue.

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SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY OF CANADA

FOR THE CALENDAR YEAR 1906

The Honourable Wm. Templeman, M.P.,
Minister of Inland Revenue.

Sir,—In accordance with the Geological Survey Act, 53 Victoria, chapter 11, 1890, I have the honour to submit herewith the Annual Report relating to the operations of this department. Special prominence is given, as in the past, to matter of immediate economic importance; the report also contains short descriptions of new explorations and of original observations and deductions by the several officers engaged in field work.

In order to expedite publication this report is presented without the customary sketch maps. These maps, too rough to be of permanent value, have never given a result proportionate to the work entailed by their compilation, and it is believed that their suppression will enable the field officers to devote much more time to the production of full records and accurate delineation of their explorations. In the form of separate bulletins these records and maps will give to the public definite information upon specific subjects, thus obviating the necessity of a search through bulky volumes dealing with a variety of matter relating to widely scattered areas through this vast Dominion.

It is obvious that there are many areas too large, and subjects too complicated, to be confidently reported on after only one season's work. In such cases the full report cannot be issued until the field labours are completed, but meantime the annual bulletin will fill a temporary want until the finished report completes the work.

EFFORTS TO PROMOTE PROMPT PUBLICATION AND EFFICIENT DISTRIBUTION OF REPORTS.

The main causes of complaint against the Geological Survey have been the delay in publication of reports and maps and the difficulty of obtaining them when published. These complaints have, in the main, been well-founded, and efforts are now being made to remedy the causes. Reasons for delay in publishing the results of field investigations are numerous, but the following scheme will, it is hoped, secure the speedy issue of information to the public:—

1. Press bulletins giving information concerning all matters of public interest in regard to the mineral resources of Canada are issued at frequent intervals by the department, and are sent to all the important newspapers of the Dominion.

2. Arrangements have been made whereby the director's report will be issued as part I. of the annual report, that of the statistical branch as part II., and others of economic or national importance as succeeding parts in the order in which they are ready for printing. These parts, or supplements, will be issued as sessional documents, and will as such receive the benefit of a wide distribution from the Printing Bureau. An extra edition of each will, however, be printed for the department for its own distribution and future needs. Reports of a purely scientific character will be printed, as formerly, by the department. Hitherto the practice has been to print an edition of 3,800 copies of all reports of an economic character; of this edition 1,000 were printed as separates and the remainder were held for binding in an annual volume. This volume, in which the word annual becomes a misnomer, was frequently issued two or three years late, owing to delays which occurred in the procuring of some of its reports or maps. Only annual volumes were sent out to public libraries, boards of trade, scientific institutions and those scientists whose names were included on the department's special distribution list; consequently the general public has not received the reports until years after their publication. It has, therefore, been decided to discontinue these annual volumes, in lieu of which there will be a quarterly distribution of all publications issued by the Survey to all those now on the department's list, which list has lately been considerably augmented.

3. Earlier distribution of reports and bulletins on certain localities and subjects will be made to those persons directly interested, while attention will be called through the medium of the newspapers to the publications of such issues.

4. A small charge to cover the cost of printing has hitherto been made for all maps and reports issued by the department. This, an excellent idea in theory, has not worked successfully in practice. It has been found to be a continual source of petty irritation to the public, while the amount received has scarcely paid for the labour of collecting. With your consent it was decided to cancel this charge and the maps and reports of the Geological Survey are now sent free to any *bona fide* applicant in Canada.

During the spring of this year stock was taken of the number of undistributed publications printed by this department; they were found to total 192,000 copies. Many of these were catalogues of exhibition collections long out of date and six tons of this matter were sent to the contractor as waste paper. A list of surplus reports in stock was compiled and sent to the principal libraries and other public institutions of Canada, England and United States. It has resulted in the distribution of reports to fill breaks in incomplete sets. A goodly reserve is being kept for future use and the remainder is being distributed in places of public access where a better fate awaits them than that of mouldering away in the cellars of the Museum.

5. In order to place before the public some idea of the subjects contained in the Survey's reports a new catalogue of publications has been issued and is being distributed. This catalogue, which has been carefully compiled, gives a list not only of all publications issued in chronological order but of those relating to locality, author and

classification, and it is hoped will do away with frequent complaints made regarding former lists as to the difficulty encountered in locating reports or maps on any specific area. In addition to the general list a smaller one dealing only with reports on economic subjects will in future accompany all publications of the department.

6. In order to reach the prospectors and others directly interested in certain localities a number of copies of the maps relating to each district has been sent to the Gold Commissioners of British Columbia and Yukon, while sets of maps as complete as possible have also been supplied for distribution to the provincial mining authorities of Quebec and Nova Scotia.

These are the efforts towards publicity and distribution now being taken by the department, and it is hoped they will fully meet the wants of the public, especially as the Geological Survey is always ready to impart any information possible in its power to all seeking it either personally or by letter.

It is a pleasure to state that the intimate relations necessary between a publishing department such as the Geological Survey and the Printing Bureau are of the most friendly character, and are rapidly tending to decrease the former irritating delays in the publication of reports. These cordial relations are mainly due to the agreement made between Dr. Dawson, C.M.G., and myself, in accordance with which one officer alone—the editor—makes all arrangements, under my directions, with the Bureau, and is solely responsible for everything appertaining to the publishing department. If the work of the engravers and binders were only as prompt as that of the printers there would be little cause for complaint, but unfortunately the present system of engraving and printing of maps, whereby the work is given to outside firms, over whom this department has no control whatever, leaves their issue at the mercy of each and all of the engravers, a position to be deplored at present and in the near future remedied.

NEED OF LARGER APPROPRIATION.

The following tabulated statement as given by the Mines Section of the Geological Survey illustrates the growth of the mineral production of Canada during the past twenty years :

1886	$10,221,000
1890	16,763,000
1895	20,649,000
1900	64,618,000
1905	68,574,000

The value of the mineral production of Canada is now, therefore, nearly seven times what it was twenty years ago, and a further large increase is expected for the current year. During these twenty years the sums devoted by the Dominion Government in aid of mining and allied industries have been those under appropriations for the working of the Geological Survey and of the Mines Branch of the Department of the Interior. The actual figures are as follows :—

1886	$ 115,053
1890	117,430
1895	129,054
1900	118,783
1905	173,555

These figures show that while the value of the mineral industries has increased 600 per cent the increase in the amount of government aid has been only a twelfth of this; in other words the government expended in 1886 as aid to mining one dollar for every $88 produced, while in 1905 it spent the same amount, one dollar, for every $348 produced.

During the same period the number of field geologists on the staff of the Geological Survey, owing to lack of money to pay them, has only increased slightly, while the field of work has been extended greatly and the opening up of many important mining areas has greatly increased the work required of the staff.

In 1886 mining operations were mostly confined to the older provinces and a portion of British Columbia; at the present the mineral production of Nova Scotia and New Brunswick shows a natural increase, the northern portions of Quebec and Ontario are developing large mineral areas, while new industries have been embarked on in the older portions of these provinces. In northern Manitoba and Keewatin important discoveries of minerals have been made and their active development only awaits the completion of the railways now being built towards Hudson bay. The enormous influx of settlers to the prairie provinces demands that close attention be given to the building materials and fuels found everywhere underlying the plains and only awaiting intelligent development to become of the greatest economic importance to these almost treeless regions.

It is, practically, since 1886, that the great mining industries in southern British Columbia have been created and that the coalfields along the Crow's Nest and main lines of the Canadian Pacific railway have been opened. Coal of the best quality has been discovered extending northward along the eastern flanks of the Rocky mountains and at several places in the interior of British Columbia.

All these call for a close examination by officers of the Geological Survey. The mining of metalliferous ores is increasing along the Pacific coast and northward in British Columbia; important discoveries of ores of gold, silver and copper are being made in southern Yukon, in fact the extension of mineral discoveries throughout the more inaccessible portions of the Dominion is increasing at such a rate that it is only with the greatest difficulty that an intelligent track can be kept of them.

The above remarks show the ever increasing work that falls to the field staff of the Geological Survey.

By including every available officer on the staff twenty-five field parties may be formed under reliable officers for summer field work, and with these it is the task of the department to satisfy the exploratory, geological and mining demands of half a continent.

Geologists are made, not born, and several years must be spent in the making. At present there are few trained men outside the service who are capable of undertaking the work performed by the staff of this department. Owing to the small salaries paid, in comparison with the pay of private individuals and corporations, those who are so trained refuse to accept government employment.

The rapid extension of mining, and the belated knowledge that a technically trained man is as necessary in mining as in any other industry, has created such a demand

for skilled economic geologists as to greatly increase the value of their services and to cause the demand to considerably exceed the supply.

Recognizing these facts, efforts are being made to recruit the field staff by an agreement with the several mining schools of Canada, whereby places will be given on the summer field parties to a number of the best qualified students with a view to partly training them for the work of the Geological Survey during their college vacations and ultimately giving them permanent positions upon the staff if they are found to be adapted to the work.

In past years summer assistants were recruited from all ranks of life, and the young men were paid correspondingly poor salaries. It is now proposed to limit the assistants on field parties to undergraduates and after the first year to pay them a salary sufficient to attract the best among them. In this manner it is expected that the staff of the Geological Survey will be recruited from the best and most efficient graduates of our mining schools; the process may be slow, but it is the best and only one by which a really efficient staff can be secured.

In the past the practice in the department of appointing young men at exceedingly low salaries and of advancing them by the ordinary fifty dollars annually has worked disastrously. It became the custom for students to enter the service for the excellent training afforded them and after a few years to leave to take positions where the salary was much greater than that paid by the government. This state of affairs is to a certain extent unavoidable, as the salary paid to a permanent employee, with a settled position in the government service, can never equal the prices offered by private corporations. That a certain number of the young men trained for the service will leave it when opportunity offers is well understood, but—if the percentage be not too great—this is not an unqualified misfortune to the country, as these highly trained men simply change their employers and pass from assisting the development of the mineral industries of the country at large to that of working a certain area under private auspices, whilst the knowledge and experience gained in the government service still prove of great benefit to the country in a more specific way.

In order to keep a goodly number of these young men in the government service, the minimum of pay upon the permanent staff of the Geological Survey has been raised, but there still remains a considerable difference between the poor salaries of the government officials and that of equally competent men engaged in similar work outside the service. It is to be hoped that recognition will early be given of the efficient work of the staff of the Survey and of the inadequate payment given for the same.

SPECIMENS FOR THE NEW MUSEUM.

The construction of the large and beautiful new Victoria Museum calls for the provision of exhibits to illustrate the natural resources of Canada. The collections now held by this department and the department of Marine and Fisheries form an excellent neucleus for the new Museum, but they both require many additions in order to be in any way representative of the resources of the Dominion. The minerals, rocks and fossils displayed or stored in the Geological Survey Museum are, it is true, sufficient to make an excellent display in those particular branches, but the ethnological and natural history collections are lamentably wanting in many respects. For this

reason the sum of $3,500 was included in the estimates of 1906-7 for the purchase and preparation of specimens for the new Museum. This money has been partly expended in acquiring from Dr. Newcombe his collection of Pacific Coast Indian curiosities. The addition of this collection to those already in the Survey makes the Western Coast Indian exhibit equal or superior to any in America.

Smaller ethnological collections appertaining to the Plains Indians have also been purchased, but much remains to be done in this direction before the exhibits can be considered fully representative.

A number of specimens of large animals have been secured and are being properly mounted. In order to procure more of these animals during the coming year a larger sum has been asked, with which it is proposed to purchase specimens from different localities in all parts of the Dominion. These specimens, when properly set up, will give a fair idea of the animals of the country and their variation according to locality.

It is also proposed to exhibit collections showing the various ores of the different minerals, their productions from mine, mill and furnace, and the finished result, thus affording an object lesson of the various mining and metallurgical processes employed in Canada.

Object lessons, also, in a different branch, will be afforded by the exhibition of cases containing specimens of destructive insects, not only in their final stage—the only form usually recognized by the general public—but in all the many phases of their peculiar metamorphoses.

EDUCATIONAL COLLECTIONS.

During past years it has been the custom of the Geological Survey to distribute free to the educational institutions of the country collections of minerals and rocks. It is now felt that this practice, though excellent in theory, has not met with the success anticipated, and that the failure of the scheme has been due partly to indiscriminate distribution, but more largely to the fact that for reasons of economy the collections have been sent out in a singularly unattractive form. Rough deal boxes packed with minerals accompanied by a mere list of names, are not in themselves likely to inspire interest, and as the schools to which they are sent often failed to provide a suitable case for the specimens, the collections frequently became scattered and lost, especially when sent to lower grade schools, with teachers lacking the knowledge to make use of them. During the past summer Mr. C. W. Willimott, assisted by Mr. A. McKinnon, has been employed securing material for larger and better collections than have hitherto been issued. One hundred of these will be made up this winter, each specimen being accurately labelled and placed in a pleasing cabinet, with a catalogue and text book, giving useful information in an interesting manner. These collections will be distributed to those educational institutions of a grade equal or superior to high schools. The present supply, of course, will not equal the demand, but it is hoped that a larger number will be issued the following winter, and that ultimately every high school in the Dominion will be supplied with a valuable collection of Canadian minerals and rocks so necessary in the teaching of geology.

TRIP TO COBALT.

After my recent appointment to the office of director it was thought advisable, in view of the fact that my personal knowledge of Canada was confined to the eastern portions, that I should visit the western divisions, not only to obtain some acquaintance with the country and its requirements, but to meet and consult with the leaders of the mining and mineral industries. Previous to my departure for the west, advantage was taken of the kind invitation of Professor W. G. Miller to visit the important silver camps about Cobalt. Three days were spent under his expert guidance in looking over a number of the most promising mines and claims of this wonderful camp, and in meeting their owners and managers. Of course, on so short a visit, it would be presumptuous to offer an opinion upon the origin and probable extent of the ore bodies, but enough was seen to pronounce upon the phenomenal richness of the numerous veins, and to make a rough estimate of millions of dollars in silver shown on the surface and in the shallow workings of the claims. The question of the depth to which the silver will be found is an important one, but is one upon which no opinion can or should be given with the data at present available. Granting only a very moderate depth, there is ore in sight sufficient to produce millions, and only a portion of the veins has as yet been uncovered. There is no doubt that great values will be extracted from many of the properties about Cobalt; at the same time it might be wise for the investing public to consider the very large capitalization and abnormal prices of stock of many of these properties, and in consequence the large sum required from production to pay a fair profit on these small veins. Attention is also called to the limited area covered by the silver-bearing veins in this region and to the natural impulse to consider properties situated in the vicinity of bonanza claims as being themselves of great value, when the reverse is often the case. Cobalt is now in the throes of the inevitable great speculative boom, and prices are being advanced in many instances beyond the bounds of prudence and reason.

RELATIONS BETWEEN THE GEOLOGICAL SURVEY AND THE ONTARIO DEPARTMENT OF MINES.

Owing to the late date of the adjournment of parliament and to the transfer of this department from the control of the Minister of the Interior to that of the Minister of Inland Revenue, it was found impossible to leave Ottawa for the west before the end of July.

The journey to British Columbia was made by way of Toronto where a mutual understanding was arrived at with Mr. T. W. Gibson, Deputy Minister of Mines for Ontario, concerning the operations between the federal and provincial departments as to the scope and relations of each in order that they may work in harmony and avoid duplication of surveys. As the control of mines and mineral industries is vested in the provinces it is advisable that the Geological Survey should acquiesce as far as possible in the wishes expressed by provincial authorities as to the mining investigations they consider advisable.

During this conversation with Mr. Gibson, afterwards confirmed in writing, it became evident that the provincial department, while eager to reserve for itself all investigations into the economic mineral resources of Ontario, was willing to supply the Geological Survey with complete mineral statistics of the provinces at the earliest

possible date and in a form suitable for publication in our Mines Section report, provided that the Survey would discontinue the collection of mineral data in Ontario.

A complete agreement as to the collection of these statistics requires fuller negotiations than can be contained in the form of an ordinary letter and the Survey will, at any rate during the present year, continue the independent collection of statistics in the hope of a definite settlement of this question at an early date.

It is proposed for the future to confine the work of the Survey in Ontario to the compiling and publishing of the systematic series of geological map sheets of the more settled parts of the province and to reconnaissance surveys in the northern portions.

INSPECTION WORK IN BRITISH COLUMBIA.

Part of the journey through British Columbia was made by way of the Crow's Nest branch of the Canadian Pacifi railway to Rossland. A stop was, however, made at Fernie, where, under the guidance of Mr. J. McEvoy, lately of this Survey, the mines of Coal creek were visited and the different methods of working the seams were examined. The collieries were being worked to their full capacity and all the coke ovens were burning. The plant at Fernie compares favourably with that of any eastern colliery.

At Rossland Mr. Brock was found at work with his party on the detailed examination of that camp and three days were spent with him in an examination of the geology both on and below the surface. Trips through the great Le Roi and Centre Star mines showed the vast spaces left after extracting the ores, while long levels and cuts through new ore bodies gave promise of several years successful mining. The general air of prosperity and quiet confidence about the mines and town is an indication that the period of depression has passed and that a new era has arrived in which the evils of over-speculation are happily absent. At Trail I inspected the smelter with Mr. Aldrich, who was able to point to several newly installed improvements.

From Rossland I was accompanied by Mr. Brock through the Slocan and Boundary districts. A visit was paid to the Hall smelter at Nelson, where a new plant is being installed to cope with the growing output of the mines. From Nelson a trip was made through the Slocan silver-lead district, beginning at Kaslo and continuing across to Slocan lake. On the way an inspection was made of the lately completed tunnel of the Rambler-Cariboo mines which taps the ore body at a much greater depth than had previously been attained in the district. The successful completion of this work—it has lasted two years—justifies the foresight of Mr. Zwickie and the confidence displayed by the directors of the company in his judgment, for the finding of good ore at such a depth is of immense importance to the district where the rise in the price of silver has given new life to many mines that were practically abandoned. These encouragements, together with the advice and instructions contained in the report of the Zinc Commission regarding the value and best method of treating the zinc ores usually found associated with the lead and silver will, no doubt, go far to make Slocan as prosperous as formerly. No longer will it be necessary for each mine to erect large mills purely for the benefit to be derived from their photographs in prospectuses, and, if instead of each of the mines supporting a costly management staff they are managed carefully in groups, or worked under lease, there is little doubt that a fair profit can be

realized from many of the claims now closed as unprofitable. The excellent results already obtained from both of these methods will probably lead to their trial throughout the silver-lead mining areas.

From Slocan we went to Grand Forks and examined the large and economically run smelter of the Granby Company which I was glad to learn later is looked upon as a model in Arizona and Mexico.

We next visited the low grade copper camp at Phoenix where the extensions of the older mines, and developments in new ones, evince the flourishing condition of the camp.

From Phœnix we drove to Greenwood where the furnace fires were for the time being drawn owing to the installation of a completely new and larger plant to smelt the ore of the Mother Lode and other mines in the vicinity.

A visit was paid to the Providence mine above Greenwood, where the conditions, like those of the other high grade mines of the district, are prosperous.

Mr. Brock left me at Greenwood and the journey was continued by tem to Midway, the smelter of the Canadian Copper Company being visited en route. Here again the enlargement of the plant is a sign of the activity in copper smelting. From Midway the road leads over the Anarchist mountain through the Okanagan valley to Fairview where the mines are temporarily closed awaiting the coming of the railway and its attendant cheap rates. From Fairview the mountains were crossed to the Similkameen valley where the important Nickel Plate Gold mine is situated. Here I met Mr. Camsell who was working in the upper part of the valley about and beyond Princeton. Concerning the mineral prospects of that neighbourhood he was quite enthusiastic and there is little doubt that with the coming of the railway next year there will be great mining activity along the Similkameen, with excellent chances of the development of several low grade copper properties as good at least as those now being so profitably worked at Phœnix.

We visited the large cyanide works of the Nickel Plate and later ascended the long tramway to the mine on the summit of the mountain, where the large masses of ore are visible. Owing to lack of time, I was unable to go beyond Hedley and returned by Okanagan lake to the railway, thence proceeding to Vancouver for a conference with Mr. LeRoy who was at work on the coast and islands of the Pacific northward from the International Boundary. Mr. LeRoy was very favourably impressed with the prospects of many of the copper mines which he had visited on Howe sound and Texada island.

A visit was made to Victoria to confer, as in Toronto, with the provincial mining authorities. In the absence of Mr. W. F. Robertson, Provincial Mineralogist, the Hon. Mr. McBride gave an assurance of hearty co-operation and welcomed a continuation and enlargement of the work now being carried out by the Geological Survey.

My visit to British Columbia has given me some idea of the great extent and value of the mineral resources of the southern part of that province, from which a fair appreciation of the mining wealth of the whole may be gathered. Meeting, as I did, most of the prominent men engaged in the mining and mineral industries, excellent opportunities were afforded of learning their needs and receiving from them suggestions in the way of extension of, and improvement on, the present work of this depart-

ment. A frank interchange of views between the mining men and the director can lead to nothing but benefit to both, and I am sincerely grateful to all of my new and old mining friends of British Columbia for their kind advice and promises of assistance in promoting the efficiency and utility of the Geological Survey.

VISIT TO MEXICO.

The International Geological Congress, whose members include many of the important geologists of all countries, meets every three years in the capital of some country for the interchange of geological information among its members. Its last meeting was held, by invitation of the Mexican government, in the city of Mexico, during September last, and it was thought advisable that I, as Director of the Survey, should attend it officially.

In order to arrive in time I left Victoria on the 29th of August and travelled by rail, passing through San Francisco, where a day was spent studying the effects of the recent earthquake. From Los Angeles the Southern Pacific railway was taken to El Paso. On this route lies the wonderful 'Salton sea,' a lake only a year or so old, formed owing to an attempt to divert a part of the Colorado river into an irrigation ditch. A flood caused the whole stream to leave its old channel and pass through the ditch, flooding a large area at the head of the Gulf of California, part in California and part in Mexico. It is said that the river has been restored to its old channel so that the danger of flooding many other hundreds of square miles is past.

Owing to wash-outs and accidents on the Mexican Central railway, the city of Mexico was not reached in time for the opening of the congress. A week was spent there attending meetings and on charming excursions to neighbouring points of geological interest. The acquaintance of many geologists from all countries was formed and much was learned from conversation with them and from the discussions at the meetings. Several important members of the United States Geological Survey were in attendance and from them was obtained a great deal of information that should be of value in our own work.

On the close of the Congress, I joined the excursion to the mining districts of northern Mexico, and thus reaped the advantage of seeing in very favourable circumstances the most important silver and copper mines. We visited the silver mines of Pechuca, Zacatecas, Guanajuato and Marpil.

At El Paso we were transferred to the hospitality of the Dodds Phepps Co., of which a Canadian, Mr. Jas. Douglas, is the principal stockholder. Under the kind and intelligent guidance of Mr. Ricketts we visited the great copper mines at Bisbee, Cananea and Nacozari, and the modern copper smelter at Douglas.

These visits to the most important mines of Mexico and Arizona have been of great practical benefit to myself, widening my experience, and it is hoped will prove of future benefit to the department.

Thanks are due to His Excellency President Diaz and to the Mexican government for lavish hospitality and courtesy. Signor Aguilera, director of the Instituto Geologico, and his staff were unspairing in their efforts to further the success of the Congress, and to them alone is due the success which attended the meetings in Mexico, and the excursions throughout the country. The kindness of the representatives of

Dodds Phepps and Company in showing and explaining everything connected with their mines and plant will long be remembered by those who had the good fortune to be their guests.

GENERAL INDEX.

Since the new series of annual reports was commenced in 1885, sixteen volumes have been printed, each containing an average of more than a thousand pages. It is manifest that this enormous mass of information loses much of its value unless it is accompanied by a complete and intelligently compiled index. For some years past complaints have been received from scientists in all parts of the world regarding the absence of such a compilation, but it was practically impossible to give the work to any one outside the Survey, and if any geologist on the permanent staff undertook the index it would entail his losing three, or perhaps four, summers' work in the field. Dr. Bell, who was then acting director, finally decided to place the conduct of this work in the hands of the editor, who has been engaged on it for nearly eighteen months. The manuscript, which was finished in September, is now being thoroughly revised and should be ready for the printer early in January.

Since I became director I have had several opportunities of inspecting the work, which I am pleased to say is most admirably compiled, and which should form a standard reference work to Canadian geology for many years to come.

Special arrangements have been made with the Printing Bureau for the regular printing of this index, which it is hoped will be published in May next.

INTERNATIONAL NOMENCLATURE COMMITTEE.

Dr. Frank Adams, of McGill University, has kindly forwarded the following brief statement concerning the work of a special committee on the correlation of the Pre-Cambrian rocks of the original Laurentian area of Canada, the Adirondack mountains and eastern Ontario.

'At a meeting of the International Committee on Geological Nomenclature, held at Ottawa, Canada, on December 31, 1905, it was decided that a special committee on the correlation of the Pre-Cambrian rocks of the areas above mentioned, consisting of President C. R. Van Hise and Dr. Frank D. Adams, who had been appointed at a meeting held in Washington on January 2, 1903, should be enlarged by the addition of Professor A. P. Coleman and Professor J. F. Kemp, and that Dr. J. M. Clarke, State Geologist of New York, should be invited to appoint a representative on this committee. Dr. Clarke appointed Professor H. P. Cushing as representative of the Geological Survey of the state of New York. Dr. A. E. Barlow, of the Geological Survey of Canada, also took part in the work of the committee during a period of about ten days, when the committee was at work in the Adirondack mountains.'

'This special committee met at Whitehall, New York, on July 4, and spent a month in visiting the various parts of the Adirondack mountains, more especially the area about Mineville and Port Henry, in the eastern portion, the district about Lake Saranac and that about Theresa, near the northern border.'

'The committee then crossed the St. Lawrence into Canada at Kingston, from which place they proceeded by train to Tweed. Here they examined the district about Bridgewater and Deloro, and then went on to Bannockburn, and thence up the Hastings road to Bancroft. This road affords one of the finest sections of Pre-Cambrian rocks to be found anywhere in America. From Bancroft they went to the east, taking canoes down the Madawaska river, and visited the corundum-bearing rocks which are exposed along the course of this stream, devoting special attention to the district about Craigmont where corundum is so largely mined. They then returned to Bancroft and proceeded by train to Gooderham. From this point they examined the relations of the great Glamorgan batholith and the encircling limestone of the Grenville series. The committee saw that the batholith in question, which may be taken as a type of all the great batholithic masses of the region, cut through the limestone series, holding many included fragments of the latter, and that in some places at least the limestone was altered by the granite to a dark basic amphibolite, which was frequently partly digested by the granite and appeared in the latter as long basic schlieren. The committee also examined an occurrence of titaniferous iron ore which is found in a large gabbro mass in the vicinity of Gooderham.'

'From Gooderham the party went up the Buckhorn road, crossing the Glamorgan batholith to Haliburton, where the labours of the committee were brought to a close.'

'A report in preliminary form was drawn up upon the conclusion of the field work and received the unanimous approval of the committee. This report, in its extended and completed form, is now being submitted to the various members of the committee for their final approval, and will probably be ready for publication during the coming month.'

THE MINING INDUSTRY IN 1906.

It can be said without fear of exaggeration that the condition of the mining industry in Canada in 1906 has been one of large prosperity, that it has, in fact, achieved greater progress and given bigger returns than during any previous year on record. In the year 1905 the total mineral output reached almost $70,000,000 as compared with but a little over $60,000,000 in 1904, and while actual figures of production are not yet available for 1906, the activity evidenced in both the metalliferous and non-metalliferous mining will, no doubt, result in another large increase being shown. There has been during the year an active demand for nearly all mining products, and the higher prices realized, especially for the metals and their ores, have not only helped to increase the actual present output, but have stimulated development and prospecting throughout the country.

METALLIC ORES.

The increase in prices of metals during 1906 is distinctly shown by the following quotations. The average price of the metals for 1905 was as follows: Silver, 60·35 cents per ounce; copper, 15·59 per pound; lead, 4·7 cents per pound; spelter, 5·82 cents per pound; nickel, 40 cents per pound. During 1906 the prices of all these metals had increased, and in December, 1906, the quotations were as follows: Silver, over 70 cents per ounce; copper, over 22 cents per pound; lead, 5·75 cents per pound; spelter, 6·4 cents per pound; and nickel from 45 to 50 cents per pound.

Nickel.—The nickel-copper mines at Sudbury have been actively worked throughout the year and will show an increased output. Electric power has been introduced and the general efficiency of the works greatly improved.

Copper.—The actual output of copper in Eastern Canada outside of the metal obtained from the nickel ores above mentioned is comparatively small, but a great deal of work has been done during the year in the exploitation and development of copper properties.

British Columbia is now Canada's great copper producing province, and more particularly the great bodies of low grade, but easily mined ores of the Boundary district. The shipments from this district during ten months of 1906 are estimated at close on a million tons or greater than the total output for 1905. The smelting capacity of three furnaces in the district was considerably increased during the year. Dividends were declared by one company aggregating $1,215,000.

The copper mines of the coast district in this province have been actively worked during the year as were also the ores of the Rossland district which are further mentioned under the heading 'Gold.'

Gold.—The gold output in Canada has been showing a yearly decrease since 1900 due to a regular falling off in the Yukon placer production, and this decrease has, in all probability, continued in 1906. In Eastern Canada the output has never been large, but Nova Scotia seems likely to make a better showing in 1906 than in the im-

mediately preceding years. In British Columbia the gold production has shown a slow but steady increase which has to some extent counterbalanced the decrease in the Yukon output. In Rossland an important amalgamation of interests took place in the early part of the year. The War Eagle and Centre Star mines, the smelting works at Trail, with the St. Eugène silver-lead mines of East Kootenay, and other interests were united under one management known as the Consolidated Mining and Smelting Company of Canada. The consolidation is one which will, no doubt, tend to much greater stability in the mining industry.

The discovery of new ore shoots in the Centre Star and other mines, the payment of dividends by the Le Roi, the Le Roi No. 2, and the Consolidated Mining and Smelting Company, and the encouraging detailed geological work done by the Geological Survey under Mr. Brock, have all tended to put new life into the district and a bright future is looked forward to. The total ore shipments for 1906 may possibly not exceed or even equal those of 1905 owing to the unfortunate strike of coal miners at Fernie having caused the smelters to close down for some months in the latter part of the year for want of coke.

In Cariboo several properties, including that of the celebrated Consolidated Cariboo Hydraulic Mining Company, were acquired by the Guggenheim Exploration Company, and a large investment of capital is being made in the construction of many miles of new ditches, which will supply a more regular and larger supply of water for the working of the huge areas of gold bearing gravels this company possesses.

The Atlin placer deposits were worked about as usual, although a shortage of water had to be contended with.

The gold output of the Yukon will again apparently show a decrease. Official figures are not yet available, but from current reports apparently not more than $6,000,000 is to be expected this year. In this district the large corporations are absorbing the smaller operators and the Guggenheim Exploration Company under the name of Yukon Consolidated Gold Fields Company has entered the field, buying up numerous claims. The company has already commenced the construction of ditches and flumes to provide water for operating their claims. Other large works are to be undertaken, such as the construction of reservoirs, a power plant, &c., and altogether a large number of men will be employed this winter.

Iron.—The iron industry has been active throughout the year, a good demand for all classes of iron products having been experienced and the iron furnaces have been operated probably more extensively than ever before. A new furnace plant is in course of erection at Port Arthur intended to utilize the ores of the Atikokan areas. The output of pig is likely to be larger than in 1905, and would probably have been still greater but for an unfortunate dispute between the Dominion Iron and Steel Company and the Dominion Coal Company in November regarding their coal contract.

Lead and Silver.—The argentiferous galenas of the Kootenay districts are again being worked on a large scale, the East Kootenay mines, St. Eugène and others, being large shippers during 1906.

The cobalt district of Ontario has attracted world wide attention during the year and is rapidly becoming an important silver producing district.

Zinc.—The concentrating of zinc ores in British Columbia has continued with considerable success. The large zinc smelter at Frank, Alta., was sufficiently advanced for the first metal to be turned out in June. It is understood, however, that some further changes and improvements were found necessary before regular smelting could be undertaken.

NON-METALLIC.

Amongst the non-metallic class of minerals mined in Canada the more important are asbestus, chromite, coal, corundum, gypsum, mica, natural gas, petroleum and salt, besides the structural materials including the clay products, stone and lime and cement. The mining of all these products, and others of lesser importance, has actively progressed during the year. The coal mining industry especially has made good progress in the various fields exploited, Nova Scotia, Alberta and Saskatchewan and the Crowsnest Pass and Vancouver Island fields of British Columbia. In Alberta a rapidly growing population has created such a demand for coal that new mines are yearly opened up and a much larger output made. Nearly one half the coal mined at the Crowsnest pass is converted into coke to supply the rapidly growing demands of the smelting industry in British Columbia and for export. Labour difficulties have interfered to some extent with the operations at Fernie and at Lethbridge, the latter causing a shortage of coal at certain points in Saskatchewan which threatened to become serious. These difficulties have, however, been happily settled before the close of the year and no doubt in time to avoid any further serious trouble.

The asbestus mining in the Eastern townships of Quebec has been particularly active during the year, prices have been good and a large increase in mill capacity to handle the mineral is contemplated.

The chromite ores of this district have also been mined about as usual.

Gypsum mining in Nova Scotia and New Brunswick and to a lesser extent in Ontario and in Manitoba has been carried on with increased output. Higher prices have also been obtained in this industry.

The corundum of Ontario finds a ready market; mica has been in good demand and at higher prices, while natural gas, petroleum and salt industries of the Ontario peninsula have been worked as usual.

In the structural material class the production of clay products, such as bricks, tiles, &c., stone and lime, has to keep pace with the growth of the population. The increased use of cement in all kinds of structural work such as buildings, sidewalks and roadwork, bridges and monolithic work, &c., has caused a great demand for this product and a largely increased output is being made.

WORK OF THE FIELD PARTIES.

By the advice of the Minister of the Interior the field work during the past season was mainly confined to economic subjects, the investigations being carried on in (a) mining districts developed, (b) mining districts under development, and (c) districts along proposed routes of new railways. No parties were sent into the far north or into regions difficult of access, the chief idea being that exploratory work should advance from the known into the unknown. If this policy, as is intended, be continued, the explorations of the Geological Survey will spread systematically northward until the whole Dominion has been explored. As will be seen, the field parties may be divided into those performing exploratory work and those devoting their time to economic geology. Although the work of the former division frequently includes that of the latter, a tentative classification of the parties under these divisions shows seven engaged on economic geology, six on economic work of an exploratory character, six on exploratory work of a more or less economic nature, and five in special work relating to the mineral and natural resources of the country.

The geographical distribution was as follows:—

Two	parties in	Yukon.
Four	"	British Columbia.
Three	"	Alberta and Saskatchewan
Two	"	Keewatin.
Three	"	Ontario.
Two	"	Quebec.
Two	"	New Brunswick.
Two	"	Nova Scotia.
Four	"	general.

It will be observed that the causes to which this decrease in the number of parties is attributed are two. Primarily, it was deemed advisable to strengthen some of the parties in order to secure more rapid work in certain districts, notably Rossland and the Klondike; also, it was decided to confine the charge of field work almost wholly to officers permanently employed in this department, whose long training enables them to cover more ground and to produce from their observations better and more reliable reports than can be obtained from persons with little systematic training and experience. The decrease in the number of field parties has allowed a larger expenditure upon those sent out, thereby permitting an increase of assistance and better equipment. It is believed that the good work of the field officers during the past season justifies the newly inaugurated policy.

In addition to the work of the field staff, assistance has been freely given to the Superintendent of Mines in the compilation of a report on the iron resources of Canada. This assistance took the form not only of information acquired by the officers of this department, but of a complete set of maps, both in manuscript and print, to-

gether with data relating to the iron ores of Nova Scotia, the result of several seasons' work in that province by Mr. Hugh Fletcher.

The following is a short synopsis of the work performed by the field officers :—

Mr. R. G. McConnell, assisted by Mr. Joseph Keele, geologist, and Messrs. F. H. Maclaren and F. O'Farrell, was engaged in measuring the volume, and estimating the values of the high level gravels in the Klondike district. This difficult work has, I am pleased to say, been successfully performed. There has not yet been time to prepare all the available data for the writing of a report on the matter, but so soon as the necessary calculations can be made a pamphlet on the subject will be issued.

Mr. D. D. Cairnes spent the season in the southern part of the Yukon, where quite a variety of valuable economic mineral deposits have been found and, although quartz mining has just commenced, it is progressing rapidly and in several localities. Considerable work is being done on the Windy Arm silver and gold properties with very good results indeed. Also about 700 claims were located on mineralized quartz veins about fifteen miles west of the W. P. and Y. R'y. between Caribou and Robinson.

Recent developments on the extensive copper deposits west of Whitehorse have shown them to be even richer than expected. Adding to this the fact that there is plenty of available anthracite and bituminous coal in the vicinity, the future looks bright indeed for this district.

Mr. O. E. LeRoy examined that part of the coast of British Columbia lying between the International Boundary and Powell river.

In addition to the purely geological work special attention was given to those formations which are of economic importance. The principal economic areas in the region examined are the Lynn Creek camp, Burrard inlet; the Britannia mineral zone, Howe sound ; and Texada island.

Mr. W. W. Leach was chiefly engaged in delimiting the coal and copper areas in the Telkwa valley, B.C. So far as the coal is concerned this work presented considerable difficulty owing to the large amount of faulting and folding to which the coal measures have been subjected.

Mr. Charles Camsell was surveying in the Similkameen district, B.C. He reports most encouraging activity in mining, both for coal and for the precious metals. He makes a particular point of the large areas of low grade ores that abound in the district, areas which it seems probable will shortly be profitably mined.

Mr. Lawrence Lambe, Vertebrate Palaeontologist, was in the southern portion of British Columbia with a view to ascertaining the definite horizons of the Tertiary coal deposits and the correlation of the sedimentary beds.

Mr. R. W. Brock whose efforts have been so much appreciated in the Rossland, B.C. district, continued and completed his examination of the mines in that area. He is now engaged on his final report of the district, which will be published as soon as possible.

The work of mapping the Rocky Mountain coal districts has been continued by Mr. D. B. Dowling, and the area now receiving attention lies between the Panther and

Clearwater rivers. Mr. Dowling's efforts were crowned with very great success, resulting in the discovery of a large coal field extending northward from the Saskatchewan to past the Brazeau. In view of its proximity to the Transcontinental railway and of the scarcity of high grade coals in the country to the east, this discovery is of great importance.

Dr. R. Chalmers continued his examination of the surface geology of the Great Plains, more especially in the provinces of Saskatchewan and Alberta. A few weeks were also spent in British Columbia towards the close of the season. The character and distribution of the clays suitable for the manufacture of common and pressed brick, fire-brick, sewer pipe, &c., were a special subject of inquiry. The water supply was also investigated and the quality of the soil noted as far as time and other circumstances would permit.

Mr. T. Denis, of the Mines Section, made a short investigation of the oil and gas fields of Alberta and southern British Columbia; he also visited the different coal fields of the mainland, for the purpose of obtaining such information as would bring up to date the records of the section. He is now preparing bulletins on the subjects of coal and oil, which will be published as early as possible.

He reports that a great deal of work is being carried on in the oil fields of southern Alberta, but that so far the results are not commensurate with the outlay. Nevertheless, the 'indications' are sufficient to encourage the operators, and not only are all the companies which originally started in this field some three years ago still operating, but several new ones have been added to their number.

The Western coal industry is very active, as will be seen by Mr. Denis' report of the year's development.

Professor J. Macoun made an examination of the country on both sides of the Transcontinental railway between Portage la Prairie and Edmonton, and writes enthusiastically on the agricultural possibilities of the district.

Messrs. Wm. McInnes and Owen O'Sullivan were instructed to explore the region along the proposed route of the Canadian Northern railway between the Saskatchewan and Fort Churchill. From their reports it appears that there are no serious engineering difficulties to be overcome, that Fort Churchill would form a suitable harbour and that there is a considerable amount of excellent agricultural land along the proposed route.

Mr. E. D. Ingall visited several localities between Port Arthur and Sherbrooke, Que., including the recently reopened Bruce Mines district, with a view specially to studying the copper deposits, the mining of which has been rendered more profitable by the rise in the price of that metal.

Mr. W. H. Collins was occupied in examining the country along the Transcontinental Railway location between Lake Nipigon and Lac Seul. He reports the western portion as auriferous and iron-bearing and well worthy the attention of prospectors, but on the east he found a region rugged, of little economic importance and presenting considerable engineering difficulties.

Mr. W. J. Wilson spent the summer in an examination of the country along the line of the Transcontinental railway from Makamik lake eastward to Bell river. Only a narrow strip varying from five to ten miles on either side of the line was explored.

Most of the rivers and lakes in this area which had not been surveyed were traversed. He also examined the molybdenite area on Kewagama lake and found molybdenite on a small island in Seals Home lake. He found copper pyrites on the Harricanaw river and other points, and reports considerable quantities of good agricultural land in the area.

Dr. R. Bell received three months leave to visit England for the purpose of receiving the gold medal awarded him by the Royal Geographical Society of London. On his return he visited Cobalt, and afterwards the Bancroft district. Dr. Bell also journeyed to Mexico, to be present at the Geological Congress already referred to.

Dr. A. E. Barlow was engaged in the tracing eastward into the province of Quebec of the formations containing the rich silver-cobalt-nickel-arsenic ores now being mined to the west of Lake Timiskaming in the vicinity of Cobalt and Haileybury. For this purpose it was found necessary to closely examine geologically the townships of Guigues, Duhamel, Fabre, Laverlochere and Baby. Both districts are geologically identical, but on the Quebec side very large areas of the Cobalt series are overlaid by the quartzite and conglomerate of the Upper Huronian or the clays of the Pleistocene. The outcrops, therefore, of the Lower Huronian conglomerate and slate are small and often widely separated, so that the prospector and geologist have only a comparatively limited field for exploration. No mineral finds of great significance have been made.

Mr. A. F. Hunter continued examinations of the high level terraces of western Ontario.

In order to complete the surveys necessary for the Peterborough map sheet, Mr. W. A. Johnston was instructed to continue work in the area included in that publication. Afterwards he commenced work in Prince Edward county in order to further the compilation of the Simcoe map sheet.

Mr. Ernest Haycock continued surveys in the graphite and phosphate regions to the north of Buckingham. His work is now in such a finished state as will enable a full report to be compiled.

Mr. R. A. A. Johnston was surveying in the counties of Madawaska, Victoria, Carleton and York, N.B., in which region the probability of meeting economic minerals in payable quantities is remote. Mr. Johnston, however, speaks highly of the agricultural possibilities, as well as of future lumbering prospects, provided adequate protection be given the second growth on the forest areas that have already been so severely burnt.

Dr. R. W. Ells spent the season of 1906 in the detailed study of the formations around the city of St. John, N.B., and in obtaining materials for the compilation of a geological map of the city and vicinity within a radius of ten to twelve miles. In this work he was assisted by Mr. J. A. Robert, of this department.

An examination was also made of the principal mining districts preparatory to the publishing of a report on the mineral resources of the province.

Mr. Hugh Fletcher continued surveys in the western portion of Nova Scotia, while Mr. E. R. Faribault devoted his time to the gold areas north and west of Halifax. The revival of mining in this province has already been noticed in my remarks on the mineral industry for 1906. Mr. Faribault is at present engaged on a bulletin on the gold fields of Nova Scotia, which it is hoped will be published during the summer.

KLONDIKE DISTRICT.

R. G. McConnell.

The season's work consisted in measuring the volume and estimating as closely as possible the gold contents of the high level gravels bordering Hunker and Bonanza creeks. In this work I was efficiently assisted by Jos. Keele, geologist, and F. H. Maclaren and F. O'Farrell, topographers, all of the Geological Survey staff. I was also fortunate enough to secure the services of such experienced miners as Robert Henderson, the discoverer of the Klondike gold-fields, and A. B. McDonald.

In the course of the season all the important bodies of bench gravels along Hunker and Bonanza creeks, and the lower Klondike river, were measured as accurately as conditions permitted. The heavy covering of moss and muck which mantles most of the district rendered the definition of the back line of the gravels in a few places somewhat uncertain, but on most of the hills the outlines of the gravel areas could be closely followed by means of prospecting shafts.

The rocker was employed to obtain the gold values in the gravels. About 350 samples, measuring in most cases a quarter of a yard each, were rocked during the season. The samples where possible were taken in columns six feet in height. Where the gravels were shallow several continuous sections from the bottom to the top of the deposit were washed at intervals along the face. In the deeper deposits continuous columns of the lower gravels only were washed. Above a height of thirty-six feet, samples were taken at intervals of about twenty feet.

In estimating the gold contents of the various gravel deposits due allowance was given to the statements of miners in regard to the values obtained in drifting and hydraulic operations. In most cases the values given agreed very closely with the results of our own work.

No attempt was made to sample the once rich pay streak running through the upper Bonanza Hill gravels. The pay streak in all these hills has been drifted out more or less completely, only occasional pillars and small areas of ground which the miners were unable to reach remaining unworked. These contain the principal values, but their distribution is so irregular that it was considered a closer estimate could be formed by generalizing the results of the various hydraulic operations now in progress than by a limited amount of sampling done by ourselves.

In addition to the Hunker and Bonanza Hill gravels, tests were made of several areas of bench gravels along the Klondike below the mouth of Hunker creek.

Field work was completed at the end of September and Messrs. Maclaren and O'Farrell immediately left for Ottawa, and have been engaged since their arrival in working out the volumes of the various tills. This work, and the estimate of values which depend on it, cannot be completed in time to appear in this year's summary report but will be published later on.

Mining on the Klondike creeks is at present in a transition stage. The individual claim-owner is being gradually replaced by companies owning groups of claims and working them with expensive plants. The fabulously rich placers which made Eldorado, Hunker and Bonanza creeks famous have been mostly drifted out and the gravels which remain are too lean, as a rule, to be worked with much profit by the early pick and shovel methods. The necessity for a more economic treatment of the gravels has been met by the introduction of dredges on the creek and river flats, and hydraulic plants on the hills. During the past season four dredges were at work in the district and three others were in course of construction. Dredging in the Klondike where the gravels are thawed presents few difficulties. The gravels are very uniform in size and include few large boulders. The shattered bed-rock is also easily excavated by the buckets.

The hydraulic miners have had to depend so far on a small intermittent supply of local gravity water, or on water pumped up from the creeks, and no large plants are consequently in operation.

The insufficiency of the local supply has induced the Yukon Consolidated Company to undertake the construction of a ditch and pipe line designed to bring water from a point on Twelvemile river to the camp. The line has a length of fifty-eight miles and a capacity of over 5,000 miners' inches. When completed it will add greatly to the productiveness of the district.

With twenty-five miles or more of proved dredging ground in the valley flats and tens of millions of cubic yards of low grade but still workable gravels on the benches profitable mining on the Klondike creeks is assured for many years.

Dominion, Sulphur and Quartz creeks on the Indian River slope were not visited during the season. The valleys of all these streams still contain considerable unworked areas of medium grade drifting ground. Quartz creek also is bordered for a couple of miles by an important white channel deposit only partly drifted out.

EXPLORATIONS IN A PORTION OF THE YUKON, SOUTH OF WHITEHORSE.

D. D. Cairnes.

I left Ottawa on May 18, with instructions to proceed to the southern part of the Yukon to investigate primarily, the economic resources of certain areas and, incidentally, to gather as much information as possible concerning the general geology and natural resources of the district, and to make such surveys as were required for a map to accompany the work. During the season I was very ably assisted by Mr. H. Matheson.

Windy Arm, Tagish lake, was reached by the usual route and after surveys were completed in the vicinity horses were procured from Whitehorse and work commenced to the north. Just at this time some discoveries of rich gold and silver bearing quartz were reported from about fifteen or twenty miles west of Robinson, which is about twenty miles north of Caribou crossing. We examined a great number of the most likely looking claims and continued south to connect with our previous work. Thence work was extended north of the Watson river to within about ten miles of Whitehorse, including the area of the Whitehorse coal field.

By this time, about September 18, the weather became so severe as to prevent further field operations. We therefore travelled down the river and examined the Tantalus and Five Finger coal mines, as well as the coal on Tantalus butte, and the surrounding country, securing sufficient detail by transit and compass surveys for a sketch map of the district. Afterwards, on my way south from Whitehorse, a couple of days were spent in the Windy Arm district inspecting the latest development in the different mining properties.

GENERAL DESCRIPTION OF DISTRICT.

The country, generally, consists of wide valleys separated by ridges and groups of mountains, the valleys often containing lakes running, for the most part, in a northwest and southwest direction, approximately parallel to the coast line to the west, but often intersecting in an intricate manner.

In the Windy Arm district the mountains are quite rugged and rise to from 4,000 to 5,000 feet above the valleys. The principal trees are black pine, fir, spruce, aspen and balsam poplar. Some of the valleys, as the lower part of the Wheaton River valley, are very thickly timbered, the tree-line being at an elevation of about 2,000 feet. Farther north, in places, the hills become lower and more rolling and west of Cowley and Robinson rock outcrops are often difficult to find. Extensive muskegs exist in places.

AREA SURVEYED.

The district surveyed this season comprises an area of about fifty miles long and twenty miles wide, extending from the British Columbia boundary on the south in a

northwesterly direction to within about ten miles of Whitehorse, the eastern boundary running from Dugdale in a southwesterly direction to the east side of Windy Arm to connect with the northwest corner of Mr. J. C. Gwillim's map of the Atlin Mining district, B.C. The western boundary is approximately parallel to this direction and extends from the west side of Lake Bennett on the south to about twenty miles west of Dugdale on the north. In addition to this the sketch map, above referred to, in the vicinity of the Tantalus and Five Finger mines, is being prepared.

GENERAL GEOLOGY.

The geology, particularly in the southern part of the district, corresponds generally with that in the Atlin district, and the geological subdivisions as made by Mr. Gwillim are practically those which have been found best to adopt here.

Extending along the eastern side of the district, sometimes included in this area and at times lying to the east of it, is a rather straight range of limestone hills, probably of Carboniferous age. A few fossils were collected, but have not yet been determined. The limestones overlie a series of older slates, cherts and limestones, which outcrop in a number of places on both sides of Windy Arm and on Nares lake.

Overlying the limestones is a series of altered sediments including some fine-grained generally greenish rocks, which are at times difficult to distinguish from igneous rocks of later age; also some rocks presenting the appearance of much altered slates, although their slaty structure has disappeared. These sediments are in a few localities quite extensively altered to serpentines. The cherts, slates, and altered sediments are included in Mr. McConnell's Tagish series.

Along the western edge of the district are later rocks, the Coast granites, with outlying areas to the east, the granites themselves often becoming quite porphyritic, especially towards the edge of the series. Following along their eastern edge are some older schists, which are partly altered sediments and partly altered porphyries and may correspond respectively to Mr. McConnell's Nasina and Klondike series, in the Klondike gold fields.

Newer than the granites is a somewhat complex series of porphyrites, porphyries, diorites, gabbros, &c., which apparently represent rocks from the same magma, but which differ considerably in character on account of segregation, cooling under different conditions, &c. Towards the edge of this series is a rather complex porphyry, presenting on weathered surfaces the appearance of a conglomerate, due to portions of a harder porphyry being included in a more easily weathered one. The mines of the Windy Arm district are in this series, and for this reason I have called these rocks the Windy Arm series.

Overlying them are some sediments of Cretaceous or Jurassic age, consisting of sandstones, shales and conglomerates, the lower shale beds being considerably altered. A number of fossils were collected, but have not yet been determined. Towards the northern end of the district these sedimentaries are quite extensive and carry valuable coal deposits.

Porphyry dikes cut the sediments and the underlying formations. These later intrusives vary greatly in appearance, but one, carrying very large, long feldspar crys-

tals is very common. Overlying all, particularly towards the north, are basalt and scoria of recent eruption.

ECONOMICS.

Although numbers of claims had been staked at one time or another, quartz mining, except a certain amount of development on the copper properties just west of Whitehorse, was scarcely attempted until the latter part of the season of 1905, when Col. J. H. Conrad commenced work on the Windy Arm properties, and though so short a time has elapsed a great deal has been accomplished. The little town of Conrad, on the west shore of Windy Arm, has now several hotels, stores, restaurants, churches and so on, and a mining recorder's office. The whole southern part of the Yukon was formerly included in the Whitehorse mining division, but this summer the district became of sufficient importance to warrant subdivision, and the Windy Arm portion, including most of the Watson and Wheaton Rivers district is now in the Conrad mining district. A number of properties were worked continuously last winter and this summer, and considering the amount of development that has been done, several look very promising indeed.

Many difficulties were encountered. In addition to the fact that the mines are situated high up in the mountain, wood for fuel and timbering was difficult to secure; supplies and wages being high, prospecting work was expensive; and experienced miners were exceedingly scarce. The current wage paid is $3.50 (including board) per day of eight hours.

The district is very accessible. Once the ore is landed on the beach by the aerial tramways now running, it is only a matter of ten or twelve miles around by Windy Arm and Nares lake to the railway at Caribou crossing, and a railway spur can easily be built along the shore for this distance. A good route is also possible from Log Cabin, on the W. P. & Y. R'y., via Whynton, B.C., to Conrad.

Practically all the mining claims in the area surveyed this season were examined and a detailed account of each will be given in the final report; at present, only a few of the most important points in connexion with the more promising properties will be given.

WINDY ARM PROPERTIES.

Some of the most important claims in this district, commencing at the north, are, respectively, the Big Thing group, Montana, Joe Petty, Aurora, Thistle, Uranus, M. and M., Vault, Venus No. 1, Venus No. 2, all owned by the Conrad Consolidated; the Ruby Silver, owned by private parties, and the Venus Extension, Beach, Red Deer and Humper No. 1, owned by the Anglo-American Company.

Big Thing.—This property is situated about five miles in a northwesterly direction from Conrad, and differs from all other properties in the district, in that it is in granite formation. In the rest, quartz veins run in true fissures in the porphyrites, &c., of the Windy Arm series. The principal vein on the Big Thing was struck this summer at the end of an eight foot drift. A crosscut was then run sixty feet on the vein, and a winze was sunk which was down about fifty-five feet at the time visited last, early in October. The vein, which dips into the hill and appears to be of the elongated lense type, was widening rapidly in the bottom, becoming almost flat, and

was about ten feet wide. The ore is chiefly secondary quartz and is very porous near the surface, showing considerable leaching action. The minerals are mostly oxides and carbonates, which will eventually change to the sulphides, &c. A considerable amount of stibnite, arsenopyrite and pyrite was found near the bottom. Occasional very high assays, running into the hundreds, are obtained in gold and silver, and it is claimed that the ore body will average close to $30 per ton.

The Montana is about four miles south of the Big Thing and, like it and most of the Windy Arm properties, is situated high up on the bleak mountain sides, and all wood, supplies, machinery, &c., have to be packed or pulled up, or carried up on the tramways. A $90,000 double cable aerial tramway runs from the northern extension of the Montana, the Mountain Hero, to Conrad, a distance of 18,697 feet, and has its upper terminal 3,464 feet above the lower.

A drift was run for about 700 feet in on the vein which is from two to five feet in width, with a streak of rich ore eight to eighteen inches next the hanging wall, assaying about $90. The rest of the vein is much leaner and may run $20. The strike is about N. 45° W., with low dips to the southwest. An incline shaft is being sunk on the lead, and about the first of October, when last seen, at a depth of 320 feet, the vein was about eight feet from wall to wall, containing, however, over four feet near the centre, of almost barren, leached, and somewhat decomposed porphyrite intersected by quartz stringers.

The values are chiefly in silver, the chief mineral being galena, though native silver, silver chloride, lead carbonate, argentite, pyrargyrite, tetrahedrite, pyrite and arsenopyrite are also found.

The Joe Petty is situated on the north side of Uranus creek, and contains a strong vein about six feet wide composed of alternating layers of decomposed iron-stained quartz and mineralized country rock. A shaft about fifty feet deep has been sunk on the lead and drifts run each way; at the end of a forty-foot crosscut that cuts the vein in the hill, drifts were also run. No work was done on the property this season.

The M. and M., to the east of the Joe Petty, holds a vein varying in width from twelve to fifteen inches, but it is high grade ore, and can be traced for a considerable distance. The high grade silver minerals, argentite, pyrargyrite, and stephanite were seen here.

The Uranus is situated just across Uranus creek from the Joe Petty. The vein is quartz and is traceable for at least 2,000 feet, with an average width, where seen, of about three and a half feet. The chief minerals are arsenopyrite and galena.

On the *Thistle and Aurora,* higher up the creek, above the Uranus and Joe Petty, surface work was being carried on, for the greater part of the summer, and very rich ore is reported to have been found. The ore is chiefly quartz, carrying chalcopyrite, zinc blende, malachite, and the rich silver mineral stephanite.

The Vault is situated on the south side of Pooley cañon, about 3,000 feet from the beach. When last seen, in October, a drift on the vein was in over 300 feet. This is the same vein, in all probability, as the Venus No. 2, and can be traced for over 4,000 feet. It is in places twenty to twenty-three feet in width, being nearly all well

mineralized quartz. In places there are four to six feet of almost solid galena. The vein here, as on the Venus, varies greatly in width, and at times is not more than a foot or so, but on the Vault, so far, except at the surface, at the entrance to the tunnel, the vein is fairly uniform, much more so than on the Venus. An aerial tramway to the beach is under construction, and a shorter one spans the cañon for the transport of wood and supplies. On the whole, this is the most promising looking property in the Windy Arm district.

Venus.—A crosscut taps Venus No. 2 about one hundred feet from the entry and drifts were run in the lead about the same distance each way. Some stoping also was done, the vein being eighteen inches to sixteen feet in width. In the stopes there are four to eight feet of good ore which will probably average over $20 in gold and silver. A crosscut intersects the vein at 544 feet where drifts were also run. The vein where opened up in the lower level is narrower and leaner than above, but the narrowing is not likely to be very extensive as the vein looks well both to the north and south.

The chief minerals are galena, lead carbonate, arsenopyrite, chalcopyrite, malachite, pyrite and a good deal of jamesonite and antimony ochre. The ore is chiefly argentiferous galena. Where the vein is wide it consists of alternating bands of quartz and more or less mineralized country rock.

A fifty horse-power gasoline engine operates a compressor here to run the machine drills used on this property, but water-power from Pooley cañon is being installed. An aerial two-bucket tramway 1,525 feet long runs from the lower Venus tunnel to the beach, the upper terminal being 958 feet above the lower.

Some very rich ruby silver ore is found on the Ruby Silver claim to the west of and adjoining the Venus No. 2. The vein is from three to eighteeen inches in width.

On the *Venus Extension* are two veins about thirty feet apart. The upper seam has about four feet of good ore, over half of which was being sacked, when visited in October. The sacked ore will probably run $50 to $60 per ton. An incline sunk on the vein was down about forty feet. The lower seam has about two feet of ore, which is chiefly argentiferous galena with considerable arsenical iron and pyrite.

The Beach claim, lying to the south of the Venus Extension, and supposed to be on the same lead as the Humper No. 1, has over ten inches of ore claimed to average about $150 in silver with probably $5 in gold. The chief minerals are galena, argentite, zinc blende and pyrite.

The Red Deer has about six inches of, in places, almost solid galena, which is claimed to run over $90 per ton.

The Humper No. 1 is a particularly promising property, though only about seventy feet of work, which was chiefly in drifts, had been done at the time of my visit. The vein, which can be traced for at least 1,700 to 1,800 feet, is from eighteen inches to four feet in width and carries a large amount of argentite, ruby silver and stephanite, as well as native silver, galena, and pyrite. About eight inches of the vein will average over 300 ounces in silver and a narrow streak of argentite which is quite persistent and has a width of half to three-quarters of an inch, runs 3,000 ounces in silver.

Some native copper is found in the east side of Windy Arm, but the work done is insufficient to determine whether it exists in paying quantities.

The ore values given in this report were obtained from a number of samples taken and also from a great number of assay returns kindly shown the writer by mine managers, mine superintendents, prospectors and others, during the season.

WATSON AND WHEATON RIVERS PROPERTIES.

Considerable excitement was caused this season by the finding by D. Hodnett and J. Stagar of quartz carrying free gold and telluride minerals between the Watson and Wheaton rivers. The first claim, the 'Gold Reef,' was staked, on June 25, on Gold hill, which is situated about fifteen or twenty miles southwest from Robinson siding. Within ninety days of the staking over 700 claims had been located.

A belt, or belts, of schists, approximately half a mile wide, outcrops in a northwest and southeast direction, near the eastern edge of the granites, which often become porphyritic. Dikes of greenish porphyry and porphyrite occur in the granites, also near their eastern edge, and it is in this disturbed belt that the quartz veins were mostly found. They are, as a rule, very persistent and can sometimes be traced for several miles. Outcrops of quartz closely resembling each other are seen in almost straight lines, at short intervals, and with the same general strike from the Watson river to about eight or ten miles south of the Wheaton river, a distance of nearly twenty miles, and although most of the veins found were in this narrow belt, about two miles wide, Mr. Porter and others discovered, towards the close of the season, some deposits of quite pure stibnite, and other minerals, at a considerable distance to the west.

The first discoveries on Gold hill, Hodnett mountain and Mineral hill are all in the line of strike of the veins and just south of the Watson river. The main lead is, for long distances, ten to fourteen feet of almost solid quartz, in places fairly well mineralized with galena, argentite, chalcopyrite, malachite, and pyrite. The vein on the Gold Reef which is in the schists, and is well defined on the surface, appears to be four or five feet in width. A pocket or seam of very rich ore carrying coarse gold was found in this vein from which came also the rich telluride minerals, sylvanite, hessite and telluric ochre. Further work on this claim has disclosed, as yet, no more of the rich minerals.

A group of claims, the Custer, Alice M, and Ramon, staked just south of the Gold Reef on a grey copper lead looked somewhat promising, although no work had been done when seen. The width of the vein was somewhat indefinite on account of wash and slide rock, but is probably about six feet and appears to be well mineralized.

The Legal Tender, staked by Mr. J. Perkins, lies to the northwest of these properties, and is on a very steep rugged hill on the south bank of the Watson river. The vein is in a fissure in the granite, and is three to three and a half feet in width where exposed ; it is quartz carrying a considerable amount of argentiferous galena with some chalcopyrite, malachite, and pyrite. The values are chiefly in silver and the vein is claimed to average about $40 per ton.

On Big Bend mountain to the south of the Wheaton river and seven or eight miles southeast of Gold hill, and in the line of strike of the mineral belt, a number of claims

were staked by L. Belnew, O. Dickson, J. Perkins and others on strong well-defined quartz veins carrying galena, chalcopyrite, pyrite, &c. Also southwest of this again, in the same direction, on Stevens mountain, and to the west of it, a number of similar looking claims were located by Messrs. Stevens, M. Gilliam and others.

In addition to occasional assays running as high as $300 or over, a number of fairly average assays—from $20 to $60—were obtained in this section, but, with the exception of a small amount of work done on the Gold Reef, no attempt has been made to prove to what extent the veins are mineralized or what values they really carry.

Taking into consideration the large quantity of mineralized quartz in this part of the country and the small amount of prospecting done, the results appear very encouraging and should stimulate both prospectors and capitalists to investigate this belt more closely, particularly to the northwest and west. There are certainly some very rich ores in this section.

Coal, also, was found about two miles to the east of Gold hill, at the same horizon as that in the Whitehorse coal fields to the north, but whether it will be in payable quantities remains to be seen.

A group of four claims known as the Union Mines is situated on the hills just to the west of Annie lake, about nine miles due west of Lansdowne siding and about three or four miles east of Gold hill. These claims were first staked by W. P. Schnobel in 1898, and are supposed to cover the ground known as the 'Lost Mine.' Some development has been done on them and preparations are being made to work through this winter. A ten ton shipment of ore gave, according to Mr. Schnobel, returns of over $20 per ton. The values are chiefly in silver, with a little gold.

WHITEHORSE COAL.

Several seams of anthracitic coal are located in an area known as the 'Whitehorse Coal' and outcrop about twelve or fourteen miles in a southwest direction from Dugdale siding. A tunnel about sixty feet long has been run on one of these seams and a few open cuts have been made; otherwise the coal is entirely undeveloped. The strike at the tunnel is true north 63° west with 42° dip to the northwest. The general strike of the measures, which are quite regular and were traced for over twelve miles, is about north 74° west. The seams measured were nine feet eight inches, ten feet four inches, and two feet six inches, respectively. The samples taken run high in ash, but they were surface samples and with depth the ash will be very considerably less. Probably a number of other seams exist, as the measures have not been prospected to any extent, although they are very favourably situated for so doing, and a small amount of work should give much definite information. There is a very good grade from the W. P. & Y. railway into these claims and, considering their proximity to the Whitehorse copper deposits, the town of Whitehorse, and the Watson and Wheaton Rivers claims, this coal should prove of considerable value in the near future.

TANTALUS MINE.

This mine is situated on the west side of the Lewes river, about one hundred and ninety miles down the river from Whitehorse, being somewhat less than half way to Dawson. As the coal outcrops here on the river banks it is well situated for economic

working. The cars are run out of the tunnels, pulled by cable up an incline, from which the coal is dumped into bunkers, ready for loading. Most of the river steamers burn this coal, of which about 7,000 tons will be loaded this season.

Three workable seams are opened up though only the lower two are being mined at present; others may yet be found as the formation is heavily covered in most places. The coal is worked by the stall and pillar system from two tunnels, which were in about 700 feet when visited in October. Although the seams are dirty, the coal can easily be sorted, but as wages are $5 with board for underground, and $4 with board for surface work, this has not been done as yet.

The following section was measured near the end of tunnels :—

Bottom seam—	
Coal	2 feet 4 inches.
Shale	0 " 7 "
Coal	2 " 0 "
Shale	0 " 6 "
Coal	2 " 11 "
Shale	4 " 0 "
Middle seam—	
Coal	2 " 3 "
Shale	0 " 2 "
Coal	0 " 7 "
Shale	0 " 2 "
Coal	2 " 0 "
Shale	0 " 2 "
Coal	1 " 8 "
Shale	7 " 0 "
Top seam—	
Coal	3 " 0 "
Shale	

These measures are quite regular, and can be traced for over twenty miles down the Nordenskiold river to the south and over ten miles to the north, showing that there is an enormous amount of coal in this district; when the measures have been prospected they may be found to extend much farther. Only coal near the river is, at present, of economic value. The dips are to the east and vary from 24° to 40°. Samples taken show the coal to be a bituminous coal that yields an average of about 75 per cent of a firm coherent coke.

At Tantalus butte, across the river from the Tantalus mine, the same measures again outcrop, but dipping to the west, showing the presence of a synclinal fold in between. The coal outcrops are near the top of the butte about four hundred feet above the river, having wash and terrace material covering the formation lower down. The best seam seen had five feet of good, firm, clean looking coal with one foot more of coal and shale on the bottom. Other seams seen were dirty and narrow, but there may be good ones obscured by the drift, &c., as practically no work has been done, except small surface cuttings. Altogether, the general conditions of the measures are quite similar to those at the Tantalus mine and this property will probably be worked in

the near future. The surface samples obtained did not give a firm coke, but this coal is likely to coke with depth.

FIVE FINGERS MINE.

This is situated on the east side of the river about eight miles north of the Tantalus mine. A considerable amount of coal has been shipped from here, but the old workings, being dangerously situated on the steep clay and sand banks of the river, are not now used. The slope, at present being sunk, is to the north and in safe ground, and at the time visited was down about 525 feet, dipping to the east at 16°. The seam at this depth was about two feet wide, and was apparently becoming wider. It had once narrowed to about six inches. An average of two feet yielded 55·5 per cent of firm coherent coke. These measures are not the same as those at the Tantalus mine, but are below them. The upper measures outcrop in the valley to the east of the ridge of hills just above the mine.

CONCLUSION.

Considering that quartz mining has so lately commenced in the southern part of the Yukon, the results are exceedingly encouraging. Just to the north of the Windy Arm and Watson and Wheaton Rivers properties are the rich and extensive copper deposits west of Whitehorse. The Pueblo, in particular, after this season's development, presents an enormous surface showing of copper ores. A Whitehorse smelter is a probability in the very near future, especially as there is plenty of available coal in the metallurgical coke. Plenty of water power is also obtainable from Miles cañon.

In conclusion I wish particularly to thank Col. J. H. Conrad, Robt. Lowe, Wm. Granger, Theo. M. Daulton, and others for assistance during my season's work and for courtesy shown to myself and party.

ON SURVEYS IN NEW WESTMINSTER DISTRICT AND TEXADA ISLAND, B.C.

O. E. LeRoy.

The area comprised by this season's work extends from the 49th parallel to the mouth of Powell river, a distance of over ninety miles along the main coast of British Columbia. This includes Burrard inlet, Howe sound, Jervis inlet, the islands adjacent to the coast, and Texada island.

From Burrard inlet to the International Boundary the country is underlain by conglomerates, sandstones and shales of Miocene age. These rocks are but slightly disturbed and have low dips to the south. In a few of the sandstone beds small irregular seams of lignite coal are found, but so far no bed of any value has been discovered. The whole area is covered to a considerable depth by glacial and alluvial deposits, and it is only along the south shore of the inlet that the rocks outcrop. In Stanley park and on Fairview heights, Vancouver city, these sedimentaries are cut by dikes of basic lava, but are of very limited extent.

North of Burrard inlet lies the coast range, and in its northern extension as far as Powell river; it is composed of a series of subordinate ranges which run approximately at right angles to the trend of the main coast. The elevation of these ranges is from three to five thousand feet, with individual peaks of one to three thousand feet higher.

A dense forest growth occupies the gentler slopes and the relatively narrow valleys, the principal woods being the Douglas fir, cedar, hemlock and spruce. The steeper slopes are either bare or support a sparse growth of stunted pine.

The streams are nearly all steep grade, and will furnish power as local conditions demand. The stream draining the Clowhom lakes into Salmon Arm and Powell river are of special importance. The former has a fall of over sixty feet and the estimated horse power is twelve thousand, the latter has a total fall of about one hundred and twenty feet and it is estimated that 30,000 horse power could be developed.

The coast range is an enormous batholithic mass of plutonic rocks which vary in composition from the most acid granite to a basic gabbro.

Lying on this batholith and usually occupying depressions are areas of older rocks. These consist of a great variety of massive and schistose rocks of igneous origin, together with limestones, conglomerates, quartzites, and slates representing remnants of the ancient roof of the batholith. These areas are of great economic importance, as nearly all the mineral deposits of any value are either in them or along their contact with the batholith. Both the granite-gabbro batholith and the associated rocks are cut by a large series of dikes which are mainly diabases.

Thormanby, Merry, and Texada islands are underlain by rocks of the Vancouver series, consisting of two formations. The lower is largely volcanic and is made up of

altered ash rocks, chlorite and hornblende schists, porphyrites, and agglomerates. The upper formation is limestone and has a limited distribution along the northeast shore of Texada island, between Van Anda and Blubber bay. It has a length of seven and a half miles and a maximum width of two. Both formations are of economic importance, especially the limestone. The Vancouver series is cut by numerous dikes of porphyry, greenstone, felsite and garnetite, and also by larger bodies of granite, which are extensions from the coast range batholith. Sandstones of Cretaceous age occur along the shore of Gillies bay on the south side of Texada island.

Sandstones also occur on the mainland east of Grief point, between Wolfsohn and Scow bays. From information received it would seem that the formation has a considerable distribution inland. Small seams of impure lignite coal have been found but no beds of any value have been discovered.

Glacial deposits are of limited extent in the coast range. Boulder clays occur at the head of Howe sound on the east side, on Anvil island, where they are used in the manufacture of brick, on Gambier island, and in the vicinity of Gibson landing.

In the region embraced by this season's work there are, in addition to numerous isolated mineral claims, three areas of special importance. They are the Lynn Creek camp, the Britannia Mineral zone and Texada island.

The Lynn Creek camp is about eight miles north of North Vancouver. It has an area of five square miles, and about thirty-five claims have been staked. The rocks are banded siliceous and massive hornblende and epidote schists surrounded by syenites and granites. The ores are zinc blende, pyrite, chalcopyrite, molybdenite and magnetite. Very little development work has been done beyond the actual assessment work required by the Provincial Mining Regulations.

The Britannia Mineral zone lies on the east side of Howe sound twenty-three miles from the entrance. The zone has a width of one and one-half miles along the shore and extends inland about eight miles. The rocks are conglomerates, quartzites, slates and sericite schists. The mineralization is confined almost wholly to the silicified sericite schists. The ores are mainly chalcopyrite and pyrite, the former occurring in lenticular areas and masses while the latter is finely disseminated through the schist and quartz. Both carry appreciable values in gold and silver. On the western half of the zone there are three principal groups, the Goldsmith, Britannia and Empress.

The Britannia Copper Company's mines are 3·8 miles from the beach, and 3,300 feet above sea level. The company has 8,500 feet of lode which has a maximum width of 600 feet. The deposit is essentially a low grade proposition, but the enormous amount of ore in sight, and its situation, present most favourable advantages for economic mining and large output. At present the ore is mined only on the Jane claim at the Jane bluff and Mammoth bluff. The method of mining is by tunnels, crosscuts and stopes, and glory holes. The ore is conveyed to the beach by a Riblet aerial tramway, the shipping ore going directly to the bunkers and the concentrates to the mill.

About 350 tons a day are mined at present, but it is the intention of the company to greatly increase their output at an early date. The ore is shipped to the company's smelter at Crofton, Vancouver island.

The Empress mine lies east of the Britannia, across the divide, in South valley. Development work, principally by tunnelling, is being carried on with a view of reaching the shipping as soon as possible.

The Britannia West Copper Company is situated on the west side of the sound and almost due north of Britannia beach. The ore body is 1,500 feet square and consists of an impregnated zone in granite porphyry. Small quartz veins are numerous and carry bornite.

At present the company is engaged in building a tram line from the mine to the beach, and in constructing a concentrating mill and other mine buildings, and no ore will be mined until these are completed.

TEXADA ISLAND.

On Texada island the more important ore deposits are either in the limestone formation, or along its contact with eruptives or with the schists of the underlying series.

High grade bornite and chalcopyrite associated with felsitic and garnetite dikes occur in chutes in the limestone. Smaller bodies of these sulphides, together with those of lead and zinc, are found along greenstone and diorite dikes, and also in brecciated zones in the limestone.

At the south end of the limestone band, along its contact with granite, porphyrite and chlorite schist, there are about twenty outcrops of magnetite distributed over half of one square mile. The surface showings indicate extensive ore bodies. A considerable part of some of these deposits, especially along their borders, is largely impregnated with pyrite and chalcopyrite, and in places the magnetite could be mined for the copper content.

The contact between the magnetite and chlorite schists and the limestone is marked by a series of small but high grade deposits of chalcopyrite and copper carbonates. They are, however, only superficial and have been nearly all worked out.

In the volcanic series underlying the limestone the ores occur principally in fissure veins in porphyrites and chlorite schists. Galena, chalcopyrite, zinc blende, pyrite and magnetite associated with quartz and calcite gangue are the principal ores. Many of these deposits lack permanence in depth, and their gold and silver values are very much lower than in the similar sulphides in the limestone.

At present the only producing mines on the island are the Marble Bay, owned by the Tacoma Steel Co., and the Cornell, operated under lease by a Seattle syndicate. The Puget Sound Iron Co's. magnetite deposits, and the Copper Queen mine, both of considerable promise, have not been worked this season. The Loyal and Commodore mines are still engaged in development work, and have not yet reached the shipping stage.

The Marble Bay mine is now 760 feet deep, and the ore chute at that level is over 40 feet long, with a maximum width of 20 feet. The ore is mainly bornite, which is disseminated through green felsite and garnetite. The copper, gold and silver values have steadily increased with depth. About 1,100 tons a month are mined and shipped to the smelter at Tacoma.

In the early part of the summer the Cornell mine was pumped out down to the 260 foot level, and the ore on the 160 and 260 foot levels is being stoped out and shipped to the smelter at Ladysmith. The present output is between 500 and 600 tons a month. The ore and its mode of occurrence are similar to those of Marble bay.

The limestones of Texada and some of the coast granites afford good stone for structural and ornamental purposes. Marbelized areas in the limestone have been quarried in the past and some good grade stone produced. The Tacoma Steel Co. have quarries and limekilns on Marble and Limekiln bays. A lime of excellent quality is produced which is in much demand both in the home market and Java. The granite quarries on Granite and Nelson islands, at the entrance to Jervis inlet, are both producing excellent building stone. The former is owned by Kelly and Murray, of Vancouver, and the latter by the Ellis Granite Co., of Seattle.

Work has recently been resumed at the slate quarry on Deserted bay, Jervis inlet. A good grade of slate has been produced in the past, but the amount of waste that had to be handled was one of the serious drawbacks. It is stated, however, that some of the outcrops a little farther inland will permit a more economical development.

At the head of the North arm, Burrard inlet, two quarries are being operated by the Vancouver Quarry Co. and the Coast Quarries, Ltd., respectively. At present no building stone is quarried, the granite being used solely for concrete work and road metal. On Fairview Heights, Vancouver, a basic lava is quarried for road metal.

THE TELKWA MINING DISTRICT, B.C.

W. W. Leach.

In accordance with your instructions, I left Vancouver on May 25, travelling to the Skeena river by way of Ashcroft and Quesnel, this route having been chosen in preference to that via the coast and river on account of the reported scarcity of men and horses in the Bulkley valley.

THE BULKLEY VALLEY.

It is only within the past few years that much attention has been paid to prospecting in this region, at least in regard to quartz and coal, as the whole of this country has previously been run over by prospectors in search of placer gold. In recent years, however, many claims have been staked at various points in or adjacent to this valley; the most important localities being the Babine range, the headwaters of the Zymoetz or Copper river, and on the Telkwa river and its tributaries. It was considered advisable to confine operations for this season to the last-named district.

The Telkwa river joins the Bulkley at a point about sixty miles above Hazelton (at the mouth of the Bulkley), where the new town of Aldermere is situated. The only means of communication with the outside world at present is by pack trail either to Quesnel, 300 miles to the south, or to Hazelton and thence down the Skeena to Essington by river steamer; as, however, the Skeena is navigable only at certain stages, this route cannot always be depended on.

At the junction of the Bulkley and the Telkwa rivers, the former occupies a wide valley, the river itself being confined to a narrow secondary valley cut through gravel terraces to a depth of from 100 to 150 feet. The Telkwa valley is also terraced for a distance of about twenty miles, when the bottom of the valley rises above the level of the terraces.

About thirty or forty miles west of the Bulkley lies the main Coast range, an exceedingly rugged and alpine chain of mountains, flanked on the eastern slopes by a series of volcanic ridges in which the Telkwa takes its rise. These ridges give the general impression of a dessicated plateau with a general and gentle slope towards the south and west, showing precipitous faces towards the north and east. The topography generally is very irregular, the various streams, as a rule, heading in comparatively low passes and following erratic courses to the main valleys, leaving in many cases isolated areas of flat-topped mountains.

The Coast range itself presents an unusually unbroken front, stretching in a continuous array of sharp and jagged peaks as far as the eye can see in a northwesterly and southeasterly direction. Numerous and large glaciers are constantly in view along the eastern slopes of the range.

GEOLOGY.

The rocks of the Telkwa valley may be roughly subdivided into four main divisions consisting, in ascending order of:—1st. The crystalline rocks of the Coast range. 2nd. A great thickness of volcanics. 3rd. The coal-bearing beds; and, 4th. A series of eruptives more recent than any of the above mentioned.

Of the first little can be said; they constitute the back-bone of the Coast range and where seen consist of gneisses, schists, granites, &c., but were in no case closely examined.

Younger than these, and overlying the greater part of the Telkwa watershed, is a great series of volcanic rocks consisting chiefly of tuffs, agglomerates, andesites and other flow rocks. These rocks are more or less regularly bedded and vary greatly in appearance in different parts of the field. No attempt was made to ascertain their thickness, but it is probably not less than 5,000 feet. These rocks probably belong to what Dr. Dawson has named the 'Porphyrite group' (Report of Progress, 1876-77, p. 90, and Report of Progress, 1879-80, p. 101 B.) of the Cretaceous, but, as no fossils were found this season, no evidence of their age beyond their lithological resemblance to those described by Dr. Dawson is forthcoming. Generally speaking, it may be said that red colours predominate towards the top of the series, the beds consisting of reddish andesites, breccias and tuffs, in many cases amygdaloidal with inclusions of calcite and zeolites. Green is the characteristic colour of the base of the series, the beds being composed largely of fine-grained greenish feldspathic rocks, often amygdaloidal and containing much calcite and epidote.

These beds are important, inasmuch as the majority of the mineral claims which have been staked in the district are located in them.

Immediately overlying these rocks and possibly unconformable to them, although both have been subsequently folded and faulted to such an extent that their immediate relationship to one another is somewhat doubtful, occurs a series of rocks composed chiefly of clay shales and containing a number of important coal seams. The lower member of these beds consists of a coarse, loosely-cemented conglomerate mainly composed of pebbles of the underlying volcanics, in places shading into a coarse grit and not more than sixty feet in thickness in any place seen, but on account of its characteristic appearance and permanency throughout the field it affords a very valuable reference horizon when prospecting for coal. This is followed by some thin clay shales, with a few soft, thin, crumly beds of light-coloured sandstone succeeded by more clay shales and coal, the shales being often carbonaceous and containing many beds carrying numerous yellow-weathering clay ironstone nodules. These are the youngest sedimentary rocks represented in the district and, although not of great thickness (in no case seen showing more than 30 feet in all), they are of considerable importance on account of the coal contained therein.

All of the above rocks are cut by a series of eruptives consisting of coarsely crystalline porphyritic rocks which have thrown out dikes in all directions and have crumpled and dislocated the volcanic flows and coal-bearing strata along their contact to a very great extent. Their importance is great as they have apparently afforded a channel for the ascent of the mineral-bearing solutions, as it is along their contact with the

volcanics that practically all the mineral claims have been staked. Their influence on the coal has been very great, as it has been found that, as the main eruptive areas are approached, with the resulting increased disturbance of the strata, the coal becomes much more anthracitic in character. The coal seams themselves have been cut by numerous dikes, in many cases accompanied by faulting; a fact which will materially affect future mining operations.

COAL.

The problem of delimiting the coal areas in this district is one of extreme difficulty. The exceedingly soft nature of the coal-bearing rocks and their consequent failure to resist erosion has resulted in their removal everywhere from the higher ridges, only a few isolated patches remaining in the valleys. The total thickness of the coal formation being small, probably not in excess of 300 feet, and the folding and faulting being considerable, it is probable that even in the lower valleys the volcanic rocks occupy a large extent of the area, the coal rocks having been removed by denudation; this is proved to a certain extent by the volcanics outcropping in various places in the valleys of Goat creek, Mud creek and of the Telkwa river, usually brought up by the action of faulting but in several instances cropping along the axis of a denuded anticline.

The only natural exposures are to be found in the creek bottoms in the few places where the streams have cut through the heavy covering of drift of the wide-terraced valleys. Away from the creeks no exposures need be looked for until the higher ridges are reached, and these are in all cases composed of volcanic rocks, the contact being invariably marked by a drift covering. It will, therefore, require very close prospecting before the extent of the coal areas is proved.

There are, at present, four companies holding coal locations in this neighbourhood, all of which have done some prospecting of a desultory nature.

The Cassiar Coal Company, whose property lies in part on Goat creek, a large tributary of the Telkwa from the southwest, have stripped several seams about six miles up that stream. The following section in descending order was measured by the writer in 1903 :—

	Feet.	Inches.
Clay shale		
Top seam—		
Coal with a few small clay partings	12	0
Clean coal	7	7
Clay	2	0
Grey sandy shale and covered, about	30	0
Middle seam—		
Coal	1	5
Clay shale	2	7
Coal with a few irregular clay partings	14	5
Shale with ironstone nodules	3	3
Coal	2	0
Grey clay shale with nodular ironstone bands, about	50	0

Bottom seam—	Feet.	Inches.
Carbonaceous shale and coal	2	0
Coal	1	5
Shale	0	5
Coal with small irregular clay partings	9	0
Clay shale		

Analyses of the above coals gave the following results:—

	Moisture.	Vol., Com., Mat.	Fixed Carbon.	Ash
1. Lower 7 feet of top seam	1·92	30·45	61·30	6·33
2. Lower 7 feet, Middle bench, Middle seam	4·70	30·40	60·80	4·10
3. Middle bench (14 ft. 5 in.) Middle seam	6·60	29·00	56·90	7·50

No. 3 analysis is by the British Columbia Provincial Assayer (See Report of Minister of Mines, B.C., 1905). No. 1 gave a dense and non-expansive coke, while Nos. 2 and 3 were non-coking. No. 3, the only one of these tested for sulphur, showed 0·52 per cent.

This coal should make an excellent fuel as it is fairly hard and well able to stand considerable handling without much loss in slack; it is, however, apparently not suited for the manufacture of coke.

The strata here dip irregularly at low angles and show several small faults.

A short distance above these openings, in a high cut bank, what are probably the same beds are seen but, in this case, it appears that the two upper seams have been burnt, leaving in their place thin beds of ash and slaggy material and colouring the neighbouring shales a brick red. A fourth seam overlies the other outcrops at the top of the cut bank; it shows about two feet of coal, but no regular roof was seen, the present overlying material being the gravel wash of the terrace. It does not seem probable that the burning extends over any large area here as there is no further sign of it higher up the creek, although a couple of miles down Goat creek a similar occurrence was noted.

These exposures give what is probably the best section of the coal measures in the district, about 200 feet of strata being uncovered between the creek bed and the top of the terrace, but it is by no means complete.

Several other small coal exposures were seen on the property of this company farther down Goat creek, but no other work of any extent has been done.

To the north and west of this property a number of locations are held by the Kitimat Development Syndicate. No work has been done beyond merely surface stripping at various places. On Mud creek, a branch of Goat creek from the southwest, near its mouth, and on the Telkwa river a few miles above the mouth of Goat creek, the coal has been exposed by the action of the streams; several good seams are uncovered of a nature very similar to those of the Cassiar Company, but in all cases are subject to faulting as elsewhere in the field.

The coal lands of the Transcontinental Development Syndicate are situated on Goat creek above those of the Cassiar Coal Company. During the past season two

prospecting tunnels have been driven and a shaft sunk with the intention of proving the number, size and condition of the seams at this point. At the time of the writer's visit No. 1 tunnel had been driven a distance of eighty-five feet across the strike of the measures, the strata here dipping at about thirty degrees. Three seams had been cut, in ascending order, four feet, three feet three inches and four feet, respectively, in thickness.

No. 2 tunnel, seventy-six feet in length, also cross-cutting, had passed through two seams, the lower six feet and the upper four feet thick. The roof of the six-foot seam is missing, a fault having cut through the seam here, but, it is probable that this is the same bed that has been shown in a natural exposure a short distance down the creek, where about ten feet of coal is in sight.

No. 2 tunnel cuts the strata at a slightly higher horizon than No. 1, and it is possible that other seams exist between the end of No. 1 and the entrance to No. 2.

Near the entry to No. 1 tunnel a shaft had been sunk to a depth of twenty-three feet to prospect the strata at a lower horizon than could be reached by the tunnels, but no coal had been found.

The coal measures at this point being nearer to the later eruptive areas are more highly flexed than those farther down Goat creek, evidences of faulting are abundant, and the basin has narrowed down to a great extent. Although in all probability the same seams are represented here as those mentioned before on the Cassiar Company's land, the character of the coal is entirely different, as the following analyses show:—

—	Moisture.	Vol. com. mat.	Fixed carbon.	Ash.
1. Seam 2 ft. 4 in. 200 ft. down creek from No. 1 tunnel (non-coking)	0·80	8·20	81·60	9·40
2. Six foot seam of No. 2 tunnel (non-coking).....	0·90	9·90	75·80	13·40

No. 1 analysis by British Columbia Provincial Assayer, (See Report of Minister of Mines, B.C., 1905).

This coal is firm and bright and may be classed as a semi-anthracite, and should make a most excellent fuel of its class.

As has already been mentioned, on the nearer approach to the newer eruptive areas the older rocks, including the coal beds, have been highly disturbed and the resultant heat and pressure have had a marked effect on the coal, altering it from a bituminous to a semi-anthracite; it must be expected, however, that more difficulties will be met with in mining, due to the probable greater frequency of faulting and increased intensity of the folding.

Similar conditions, probably if anything intensified, prevail at the property of the Telkwa Mining, Milling and Development Company, situated on Coal creek, a small stream running into Goldstream, one of the headwaters of the Morice river, and not far from the head of the south fork of the Telkwa river; here a number of seams of good coal have been opened up. The disconnected nature of the work done, with the disturbed condition of the strata, renders it almost impossible to be sure of the relative positions of the seams and whether several of the openings are on the

same or different seams. It is fairly certain, however, that four different workable seams have been uncovered; in descending order these have the following respective thickness :—Four feet two inches, four and one-half feet, four feet, and seven feet three inches. No analyses have, as yet, been obtained from this coal, but in general appearance it bears a strong resemblance to that from the Transcontinental Syndicate's property; if anything even more anthracitic in nature.

Where these seams have been uncovered the area of coal-bearing rocks is very narrow, probably not more than a few hundred feet in width. It appears to lie on the line of, and on the downthrow side of a great fault, and represents a small remnant of a once great coal field now mostly removed by erosion; it is probable, however, that to the southeast, in the main valley of Goldstream a much wider belt of coal land will be found to exist.

With regard to this field as a whole it may be said that wherever the coal formation has been exposed faults were seen, not, as a rule, of any great size, but in such numbers as to be a matter of serious importance to future mining operations. The coal has also been cut by numerous dikes and nearly everywhere is somewhat severely flexed. These facts, taken in connection with the uncertain extent of the several areas, seem to render it imperative that systematic and careful prospecting should be undertaken, well in advance of regular mining. Some method of boring could possibly be utilized to determine the position and the nature of the strata underlying the great gravel deposits of the terraces; until something of this sort is done it will be impossible to define the limits of the several coal areas. It is possible that in certain cases mining could be successfully carried on by stripping the overlying gravel and shales from the coal, where not of too great depth, a method that has been somewhat extensively utilized in the anthracite fields of Pennsylvania.

MINERAL CLAIMS.

Hunter basin, situated at the head of Cabin or Fourmile creek, a tributary of Goat creek, was the first locality visited. The country rock here consists of bedded volcanic rocks, red and greenish andesites, agglomerates, &c., tilted at comparatively low angles, but occasionally showing locally more severe crumpling, often accompanied by faulting. Across the ridge to the south, at the head of Glacier and Webster creeks, an intrusive area of coarsely-crystalline granitic rocks is found which seems to have had an important relationship to the mineralization of the district, as it is along the borders of this area that many claims have been staked, notably in Hunter basin, Hankin basin, Dominion basin (at the head of Goldstream), and various locations on the heads of Sunrise and Glacier creeks. The eruptive mass is itself in places impregnated with iron pyrites, which has resulted in the weathering of the rocks to a bright rusty yellow, giving a charasteristic colouring to the mountains.

In Hunter basin the veins are, as a rule, small, and appear either in narrow irregular fissures or as replacements along lines of crushing. The 'King' and 'Rainbow' claims are good examples of the former. On the 'King' a shaft had been sunk, said to be fifty feet in depth, but full of water when seen. The vein, at this point, is about two and one-half feet wide and is in places well mineralized with bornite and chalcopyrite, the ore occurring in irregular lenses or pockets; it is reported to carry good values in silver and copper.

On the 'Rainbow' ore of a different class is found, consisting chiefly of highly micaceous specular iron with some iron pyrites, bornite, chalcopyrite and copper carbonates. There appear to be two or more small irregular veins, more or less parallel. Where the most work had been done on one vein it varied from one to ten inches in width, practically all mineral.

On the 'Waresco' claim the ore seems to occur along a crushed zone from four and a half to five feet in width, the country rock having been decomposed and replaced in part by minerals consisting of copper carbonates, copper glance, chalcopyrite and bornite.

Numerous other claims of a similar nature are to be found in this neighbourhood, but very little work has as yet been done in proving them.

Dominion basin at the head of Goldstream is near the opposite border of the Glacier Creek granite area. The country rock here is composed of grey and greenish volcanics not so much disturbed as at Hunter basin, but with generally regular light dips to the southwest. These rocks are cut by a fine-grained, brownish-coloured dike, about forty-five feet in width, which can be plainly seen on both sides of the valley which it crosses about at right angles. It is along the edges of this dike that various mineral claims have been staked, the Dominion and the Black Jack being the most important. It would appear that this dike has afforded a channel for the ascent of the mineral-bearing solutions which have penetrated laterally along the bedding planes of the volcanics, where most readily attacked, decomposing and replacing the country rock in part with secondary minerals and ore. It seems reasonable to suppose, therefore, that the ore bodies will be found to occur in a succession of steps, where the more readily decomposed strata of the volcanics are met with, and will reach their maximum thickness in the immediate neighbourhood of the dike, gradually disappearing at increased distances from it. The ore consists chiefly of micaceous specular iron, chalcopyrite, copper glance and copper carbonates with a gangue of altered country rock, quartz, calcite and epidote.

Another and larger area of intrusive rocks occurs near the head of Scallon creek, an important tributary to the south fork of the Telkwa from the west, extending across the divide to the headwaters of the Morice and main branch of the Telkwa. This rock has sent out numerous dikes in all directions into the surrounding volcanics, and has also caught up and included in it many patches of the latter. Near the contact of these two formations and along the dikes from the former, a large number of mineral locations have been made including the Duchess, the Anna-Eva and the Evening groups on Howson creek, the Starr group on Starr creek and numerous other claims.

The Duchess group owned by the Telkwa Mines, Limited., is situated on the north side of Howson creek near its head. This property has been opened up by a short tunnel about twelve feet long, all in ore. The ground about here is rather heavily drift-covered and, as yet, but little work has been done, so that it is very difficult to gain an idea of the nature of the deposit. It appears probable, however, that the ore occurs in a large dike from the neighbouring eruptive rocks at or near its contact with the volcanic country rock, the volcanics themselves, near the dike, being largely decomposed and in places mineralized and with much epidote developed. The extent of the ore body is not yet shown, but at the entrance to the tunnel it is at least twelve feet wide and can be traced longitudinally for several hundred feet, the whole mass being more

or less highly mineralized with pyrites, chalcopyrite and hematite, weathering to a well-defined iron-cap on the surface. The gangue consists largely of the decomposed and highly altered dike rock with many small quartz stringers parallel to the dike walls.

A short distance down the creek, on the same side, the Evening group is situated, the property of the Telkwa Mining, Milling and Development Company. This appears to be of a very similar nature to the Duchess, but the hillside here being less heavily drift-covered the ore can be traced more rapidly. The mineral apparently is contained in a dike from twenty-five to thirty feet in width, cutting, at a narrow angle the bedded volcanics, which are here tilted at high angles and in places much altered; the whole width is more or less mineralized with irregularly distributed lenses and bands of higher grade ore, as in the Duchess, consisting of chalcopyrite, pyrite and hematite with considerable quartz and remnants of the original dike rock. This deposit has been opened up by cuts at irregular intervals for a distance of about 1,500 feet, in all of which ore is shown.

On the ridge on the opposite side of Howson creek, and consequently farther away from the eruptive rocks, a number of claims have been staked including the Anna-Eva group, the Iron-Horse group, the War Eagle, Granville, Strathcona, Homestake, Walter and many others. All of these show a somewhat similar condition of affairs to that noted at the Duchess and Evening; the mineral occurring in dikes, in streaks parellel to, and generally richer near the walls, and usually is associated with quartz, serpentine, calcite, epidote and other secondary minerals. In places the volcanic country rock is likewise decomposed and mineralized alongside of the dikes. None of these claims appear to be heavily mineralized as are those across the ridge.

Across the ridge, at the head and to the west of Howson and Scallon creeks, in Starr basin, a number of claims are located. The ore here is usually found at the contact of the eruptive and volcanic rocks. This contact is very irregular in outline as the volcanics have been much shattered, and many patches of varying size have been caught up in the intrusive rocks; these small areas are usually highly altered and often somewhat mineralized.

At the Starr group, the ore seems to be developed along two parallel crushed zones in the volcanics near the contact, about two and three feet in width, respectively. The mineral, which is irregularly distributed, consists of pyrite, chalcopyrite and copper carbonates, in a gangue of quartz, calcite and altered country rock.

Although time was not available to visit the headwaters of the Zymoetz (Copper) river or the Babine mountains, where many claims have been located, it may be of interest to note here that many good looking specimens of galena ore said to be from these localities were seen by the writer.

A great part of this district has been over-run by forest fires, but sufficient timber remains in many of the valleys to furnish mine props, &c., as well as supplying the local lumber market, for many years. The principal trees are jackpine, spruce and balsam.

Enough information was obtained for the compilation of a map covering the greater part of the Telkwa basin and immediate neighbourhood. Triangulation (using British Columbia government township surveys as a base), panoramic sketches and traverses of the main trails and streams was the method adopted.

THE SIMILKAMEEN DISTRICT, B.C.

Charles Camsell.

The district in which the field work was this season carried out was that portion of the Similkameen Mining division of British Columbia, lying about and to the south of the town of Princeton; the object being to commence a topographic and geologic survey of a sheet, which shall embrace the whole of the Similkameen district, to be eventually published on a scale of four miles to the inch with a contour interval of 200 feet. Interest in this section of southern British Columbia has been greatly increased in the last year or two by the probability of its being shortly traversed by one, if not two, separate lines of railway; and although it has long been known to contain valuable deposits of gold, silver, copper, platinum and coal, the lack of lines of communication with markets for these products prevented any extensive development of these deposits. With the advent of the railway, however, the country has a promising future, and already some of the principal claim owners are making preparations to open up their properties with a view to the shipping of ore in the near future.

The lack of any detailed geologic information has been a great drawback to the prospectors in the district, for up to this year no attempt has been made by this Department to do much geological work since the publication of Dr. Dawson's map in 1877.*

The field work requisite for the compilation of a suitable map of the whole district must of necessity occupy several seasons, so that, to satisfy the immediate claims of the district, it was deemed best to confine the work of this session to the more important sections where economic minerals had been discovered and mineral claims located. Commencing on the boundary line where it crosses the Pasayton, and tying on to two prominent monuments of the Boundary Survey, a skeleton triangulation was run northward to Princeton, taking in a belt five miles on either side of the Similkameen river. The mineralized areas of Roche river, Copper and Kennedy Mountain camps were connected together on this skeleton, and the geology of these camps studied more carefully than the rest of the country. The boundaries of the Tertiary coal basin about Princeton were defined, and this, with the Copper Mountain camp was plotted on a topographic map of half a mile to the inch with 100 foot contours.

The early part of June was very wet, but no rain fell from the end of June until early in September, so that the bush fires which started at the end of July remained unchecked for several weeks, during which the pall of smoke rendered it impossible to carry on the triangulation. For this reason the original intention of carrying the triangulation up the Tulameen river from Princeton had to be abandoned, and the important camps of Bear creek, Boulder creek and Champion creek in this section were only done geologically, and not connected up with the other camps.

* Dr. Dawson also spent a part of the season of 1888 in a study of the rocks of the Tulameen river, that district having come into prominence a year or two previously owing to the discovery of some very rich placers, and a short account of his observations appears in the Summary Report for that year.

Both in the topographical and geological work Mr. J. A. Allen rendered material aid and made a very efficient assistant.

On May 28, I arrived at Penticton where a pack train and outfit were obtained, and from here the journey of seventy-five miles to Princeton was made on horseback. The latter place was selected as headquarters for the season. Though it is quite possible to continue the field work in the eastern part of the district well on into October, operations were suspended in September, and on the 25th of that month I left Penticton for Rossland, Phœnix and Greenwood, where some days were spent in a comparative examination of their ore bodies with those which I found in the Similkameen district.

PHYSIOGRAPHY.

The Similkameen river forks at the town of Princeton, the west branch being known as the Tulameen and the south branch as the South Similkameen. Twenty miles up the South Similkameen again forks, dividing into the Pasayton and the Roche rivers. The name, Roche river, was originally applied to a smaller branch of the stream flowing in twelve miles above the mouth of the Pasayton, but in recent years it has become customary to refer to this branch of the river as the Roche, while in reality it should retain its original name of South Similkameen.

Both the Roche and the Pasayton rivers draw their water from the high range of mountains lying on and to the south of the International Boundary lines, their branches interlocking with those of the Skagit drainage, and the Methow which flows directly southward into Columbia. The basin occupied by these two streams is enclosed between two spurs of the Cascade range of mountains, which divide in the state of Washington, the true Cascades or Hozameen range forming the divide between the Roche and Skagit rivers and running up northward to the west of the Tulameen river ; while the eastern Cascades or Okanagan range strikes slightly east of north and lies to the west of the Pasayton and Ashnola rivers. The western of these two spurs is the more persistent and stronger range, and its summits show little or no diminution in elevation or ruggedness of relief beyond the limits of this sheet to the north. The eastern range, however, from summits at the boundary line with elevations of 8,500 feet, dwindles down north of the Similkameen river to elevations of 7,000 feet.

Taking as a central point the town of Princeton, whose elevation above sea level has been variously estimated at from 1,885 feet to 2,120, and which lies in a shallow depression occupied by Tertiary sedimentary rocks, there is a marked rise in the slope of the lines radiating to the west, south and east, while the gradient to the north is almost imperceptible. In this curve the hills have all been worn down below the limit of intense alpine erosion and appear as rounded ridges and dome-shaped summits of gradually increasing elevation towards the circumference. Only towards the periphery of this curve do the summits attain an elevation greater than the tree line, which in this district is approximately 7,000 feet above sea level, but except in the immediate vicinity of Princeton these are usually well wooded with spruce, pine, balsam and tamarack. This rounded outline and regularity of form, while in the main due to erosion, is also in part the result of the filling in of old irregularities of the surface by the Tertiary lava flows which still cover such a large proportion

of the surface. Glacial action—both the action of erosion as well as deposition—has also been instrumental in reducing the vertical relief.

Many evidences of recent development in the topography occur. The South Similkameen from the Pasayton to the Whipsaw creek occupies a deep narrow V-shaped valley indicative of a comparatively recent uplift, which imparts to this portion of the stream increased vigor and power of erosion. The valley of the Tulameen also, above Otter creek, as well as many of its tributaries, is very narrow and steep, showing that the drainage has not been very long in operation since the change in elevation.

Numbers of terraces and deposits of gravel also occur at various elevations to a height of 1,100 feet above the present level of the lowest ones. As a rule the higher of these only now occur as small remnants of more extensive terraces, formed in the period immediately following on the disappearance of the Cordilleran glacier, and which have since been reduced in size by the ordinary atmospheric agencies of erosion, or by the action of streams which are now far below them. These are the most apparent evidences of comparatively recent changes of level.

Accompanying the changes of level and either a direct result of them, or of the blocking of ancient channels by recent volcanic flows, have been some striking changes of drainage. The most marked instance of this is the deep wide valley of Wolf creek, now occupied by a stream inconsistent with the size of the valley. It seems probable that this valley, with its continuation through Swelter lake, once carried a great part of the drainage of the Similkameen river which now flows through the Tertiary basin about Princeton. All the smaller streams entering the south side of this valley occupy hanging valleys, so that they debouch in waterfalls, or have been forced to cut deep cañons down to the level of the trunk valley.

GLACIATION.

During the glacial period the Cordilleran glacier covered all the summits north of the boundary line in this belt. The results, however, show that the glacier was losing its great power of erosion and was rather depositing its load. This is evidenced by the small number of grooved and striated rock exposures, and by the thick deposit of rock detritus on the summits of the hills as well as in the valleys. Prospecting for mineral deposits on this account becomes more difficult than in a region where the strength of glacial erosion had been greater. At present no glaciers occur in the belt between the boundary line and Princeton. Many of the highest summits, however, at the boundary line, have beautiful glacial cirques carved out of the solid rock on the sides facing the north. These usually have small lakes in the bottom filled with water drawn from the snow, which lies on the sides and rims of the cirques until well on into the middle of the summer.

Though glacial material is widespread, boulder clay is rarely observed. Terraces of gravel and sand and some beds of clay are frequently found adhering to the sides of the main valleys.

Hanging valleys have already been referred to as occurring on Wolf creek, and also on the Tulameen river above Otter creek.

The thick deposit of glacial drift, though a hindrance to the speedy development of the mineral resources of the district, must be reckoned as a part of its economic

resources in that it has produced a considerable extent of excellent farm and grazing land, which could be made to support a much larger population than it now holds.

SOLID GEOLOGY.

Geological work on the Similkameen becomes very difficult on account of the great variety and complexity of the rock formations, as also on account of the thickness and widespread covering of drift. Plutonic, volcanic and sedimentary rocks are all present covering a period from Palæozoic to later Tertiary times. Fossils occur in the Tertiary lignite basin about Princeton, and also in the Cretaceous sandstones of the Roche river, but the remaining sedimentary rocks—limestone, agillite and quartzite—are either unfossiliferous or have been so badly crushed as to destroy any remnant of animal life that they ever contained. Contacts between the igneous and sedimentary rocks are rarely exposed, so that it is difficult and very often impossible to establish geological relations. Added to this is the difficulty, in the southern half of the belt, of travelling anywhere except on the trails that have been cut by prospectors through the bush. The latter difficulty, however, does not hold in the northern half where one can usually obtain access to any part whether there is a trail or not. The geological boundaries then, that have been traced, and the ages in which the different rocks have been placed, are tentative and will be subject to revision at a later date.

The formations met with and their approximate or relative ages are as follows:—

GLACIAL AND RECENT DEPOSITS.

Tertiary.—Volcanic flows, basalts, andesites, &c., intrusive sheets and dikes, sandstones, shales, clays and lignite beds.

Cretaceous.—Argillaceous sandstones, grits, conglomerates and slates.

Jurassic or Triassic?—Granodiorite and other batholithic intrusions, porphyrites, tuffs and breccias?

Palaozic.—Limestones, argillites and quartzites, green, spotted and chloritic schists, talc and graphite schists, mica and hornblende schists, with some limestone and siliceous bands.

The oldest rocks of the district are the Roche river schists, which cover an area about the junction of the Roche and Pasayton rivers. This area extends from the cañon below the junction of the two streams four miles up the Roche river, and to a point eight miles up the Pasayton, its southern contact on the latter stream being the batholithic intrusion of Remmel granodiorite; while on the Roche river it is in contact with a band of syenite gneiss. On all other sides the schists are overlaid by recent volcanic rocks lying a short distance back from the river banks. The schists are very varied in character. On the south are micaceous and hornblende schists frequently very siliceous and becoming gneissic, and holding some bands of greyish crystalline limestone. The northern part of the area is occupied by soft green, spotted and chloritic schists, with smaller bands of graphitic and talc schists, the latter being frequently mineralized and traversed by quartz-filled fissures. It has been impossible to determine the age of these rocks, and though they have some lithological resemblance to the Archæan of the Shuswap series, they may also be only very highly metamorphosed sedimentaries and porphyrites found in other parts of the district to the north,

The limestones, quartzite and argillites cover a very limited area, but are important as occurring with some of the ore bodies in the southern part of Copper mountain. They also form a highly altered and metamorphosed band crossing the Similkameen river below Allison, and lying between or under young volcanics on the west, and the great mass of granite on the east. They also extend some distance south of Copper mountain until they are covered by Tertiary volcanics. They appear to resemble closely the Cache Creek series of the Kamloops district. They have been cut and greatly disturbed by later intrusions of igneous rock, and so much of these beds has been destroyed that they now frequently appear only as islands or 'roof pendants' in batholithic masses of rock. The limestone is very often white and crystalline, and the argillites and quartzites are very highly altered, and in many cases have probably taken on a crystalline structure. In addition to the metamorphism they have undergone some fracturing, and become brecciated. Much of these sedimentaries is probably covered by volcanic flows, and much also has been digested and assimilated by eruptive masses of plutonic rocks, and the parts that remain are only remnants of once extensive sediments that covered a great part of southern British Columbia.

A small area of green porphyrites, tuffs and conglomerate occurs in the bottom of the valley of Sunday creek. These are shown in the bed of the stream as cutting through the enclosing parts of the limestones and argillites. They are so intimately associated with volcanic rocks, which are of undoubted Tertiary age, that it is very often difficult to separate the two, and for the present, or until they have been studied in more detail, all that can be said with regard to their age is that they are later than the limestones and older than the Tertiary. The porphyrite is much weathered and decomposed on the surface and appears to be an augite porphyrite. The tuff and conglomerate are greenish in colour and consist of rounded pebbles of earlier volcanic rocks. They also contain some fragments of fossil wood.

Batholithic Intrusions.—Under this head are classed the Remmel granodiorite of the Pasayton river, the syenite and syenite gneiss of the Roche river, and the igneous complex of the Copper mountain. The Remmel granodiorite is cut across by the Pasayton river and extends northward from the boundary line for a distance of four miles to its contact with the mica schist. South of it is a large area of Cretaceous rocks. The typical rock of this area is composed of hornblende, biotite, quartz and orthoclase feldspar. On the same strike of the Remmel granodiorite on the Roche river is a band of syenite and syenite gneiss about two miles wide. This is not so coarsely crystalline and is so much more basic in composition as to be almost a diorite, but it is possible the two may have been produced from the same magma.

The composition of the igneous complex of Copper mountain is very variable, ranging from very siliceous in the north and west to a more basic variety in the south and east. The typical rock is hornblende diorite. This is best developed in the south and east, where it has not been affected by mineralizers or altered by later igneous intrusions. In places where this is in contact with some remnants of the older sedimentaries, a gneissic structure has been induced in it. To the centre and north it has been fractured and brecciated, and is now traversed by many little veins of calcite magnetite and feldspar. The rock has also become finer in grain. Large crystals of biotite are often developed in the zone of fracture. The contact between the diorite and the sedimentaries is very irregular whenever it is exposed. It is rarely sharply defined

and in many cases no definite boundary can be assigned to the igneous rock. It occurs under so many different types of dikes, with which it becomes intimately mixed, that it is often difficult in the field to separate the different intrusions.

Lower Cretaceous.—These rocks cover a wide area in the southwest corner of the district. They appear on the Pasayton river just north of the boundary line and striking about 330°, cross the Roche river about six miles above the junction of that stream with the Pasayton. At both these places they are seen to overlie the eruptive rocks. The beds consist of hard sandstones and grits, interbedded with black and red argillaceous slates, all of which appear to have suffered much stress and pressure, for the angles of dip are now all high, being usually about 50°. On the Roche river the bottom bed is a conglomerate, which rests directly on the syenite to the north of it.

Tertiary.—The remaining rocks are all of Tertiary age ; and, grouping the sedimentary rocks with the volcanic, we find that they cover the largest proportion of the district. The sedimentary rocks alone in the northern part of the district cover an area of nearly fifty square miles—the basin being fourteen miles long with a variable width of from three to five and a half miles. These sedimentary rocks consist of thick beds of sandstone, with clay, shales and several seams of coal. The base of the series appears to be a very coarse-grained sandstone containing many large rounded white feldspars in a matrix of calcareous material. This rests, on the eastern side of the basin, on the Copper Mountain series of rocks; while on nearly all other boundaries, the sediments dip under the more recent volcanic rocks, which lie as sheets on them. In parts, also, these volcanics have thrust themselves through the sediments and now appear as islands in the older rocks. The strata do not now lie horizontally, but have been tilted at low angles, making an irregular series of folds. Some faults also occur.

Many drill holes have been bored in this Tertiary basin in search of coal seams, and with some good results. Most of them, however, were put down at or near the edge of the seam and only one near the western edge of the basin. By the kindness of Mr. Ernest Waterman, manager of the Vermilion Forks Mining and Development Company, copies of the records of these drills have been obtained. These have disclosed the thickest coal seams to be in the vicinity of the town of Princeton, where a bed over eighteen feet in thickness was struck at a depth of forty-nine feet below the surface. The hole, in which this seam was found, was sunk near the bridge over the Similkameen river to a depth of 280 feet. In this hole coal seams aggregating thirty-five feet seven inches were crossed in the first ninety feet, while the rest was in shales and sandstones. Four miles up the Similkameen river a bore hole sunk to a depth of 257 feet only went through two feet five inches of coal; while a drill-hole near the south end of the basin at Ashnola, which penetrated to a depth of 398 feet, gave no workable seam at all, and only a few bands of what is called in the record ' coaly shale.'

A bore hole was also drilled near the western edge of the basin, where the sediments dip under the volcanics, and not far from where there is an outcrop of coal four feet thick. The depth of the hole is 863 feet, and in that distance seventeen seams of coal were cut through with an aggregate thickness of fifty and a half feet, of which the thickest seam was nine feet.

From a study of these records it would appear that most, though not all, of the workable seams are within 300 feet of the surface. It must be noted, however, that no prospecting by drilling has been done north of the Similkameen river, and the basin undoubtedly extends as far north at least as the forks of Onemile creek.

Coal outcrops in many places both on the Similkameen and Tulameen rivers, also on Summers creek, Bromley creek and Ninemile. At the latter place a cut in the bank made by the stream discloses a bed fifteen feet in thickness of fairly clean coal, with five thin partings of clay, all resting on white clay.

A sample from the big seam at Princeton worked by the Vermilion Forks Mining Company was sent to Mr. Hoffmann of the Department. He calls it a lignite, but one of the better class. Analysis by fast coking gave:

Hygroscopic water	16·17
Volatile combustible matter	37·58
Fixed carbon	41·67
Ash	4·58
	100·00
Coke per cent	46·25

Character of coke, pulverulent: colour of ash, brownish-yellow.

Though the age of these beds is put down as the same as the Coldwater group of the Nicola valley in which coal occurs, there is a difference in the quality of the fuel contained in each. The Nicola coal is considerably higher in fixed carbon and lower in water, but the amount of ash is also higher. Some of the beds of the Princeton coal basin are only in a primary stage of formation, and they still show the brown woody fibre of the slightly altered vegetable remains. Some also have been completely destroyed by combustion, and it is to the combustion of an underlying bed of lignite that Dr. Dawson attributed the metamorphism and colour of the rocks at the Vermilion bluffs.

The volcanic rocks of Tertiary age have a wide distribution, and prove that this part of the country was the scene of tremendous volcanic activity during that period. Their area must have been considerably diminished during the Glacial period, so that the present distribution cannot be taken as indicative of their original extent. These are the youngest rocks in the district, for they are seen in the Tulameen river and also one Onemile creek and Summers creeks to rest on the rocks of the coal series. On the Tulameen river the stream cuts through beds of clay and sandstone overlaid by these volcanics for a distance of at least two and one-half miles. The schists of the Roche river are overlaid to the north and east by these volcanics, and they also overlie the Copper Mountain series on the north and west. They consist of rhyolites and trachytes, andesiles, basalt, tuffs and breccias. The darker lavas are often amygdaloidal, the vesicles being filled with chert, chalcedony or zeolites. Some agates and wood opal were found in the volcanic area east of Coldwater creek.

Some of the dikes cutting the Copper Mountain rocks appear to be contemporaneous with these volcanic rocks, and in some way connected with them.

ORE DEPOSITS.

In the Roche River district the mineralized area is confined to a belt of soft talc, chloritic and hornblendic schists, lying about the junction of the Roche with the Pasayton river. The ore bodies are of two classes; (1) Small gold bearing fissure veins; (2) Larger bedded veins, copper bearing. The first are usually quartz veins from three inches to four feet in width, cutting across the strike of the schists, and dipping at angles from 60° to 90°. They carry besides gold, bornite, tetrahedrite, chalcopyrite and pyrite. Sylvanite was also reported to occur, but an assay of a selected sample of one of the veins supposed to carry this mineral gave no trace of tellurium.

The second class contains larger ore bodies, lying parallel to the strike of the schists. These may be either quartz veins or mineralized bands in the schists. These carry some gold, and the copper and iron sulphides ; the highest values are in copper.

Only two claims have been Crown-granted and surveyed, and the amount of development work done on all of them is not sufficient to prove the ore bodies, or test their permanence. The surveyed claims are the Pasayton and the Sailor Jack. On both these are small fissures; on the Pasayton a fissure four inches wide, from which the samples were taken to test for tellurides; and on the Sailor Jack a fissure two feet wide cutting across a hornblende schist.

The greatest amount of work has been done on the Red Star and Anaconda claims. On these there is a belt of soft talc and chloritic schist about 400 feet wide, striking 125° dipping vertically, and lying between mica-schists. It appears to be traversed by a fault plane, along which bunches and lenses of white feldspar and quartz have been found, and which were first worked for their gold content. On development the vein ran into the talc schist, which proved to be highly mineralized with copper carbonates and cuprite, and which was farther on replaced by bornite and chalcopyrite. Along with these were pyrite and arsenopyrite, siderite and some blende. A shaft has been sunk in the tunnel to a depth of sixty feet, but this had to be abandoned on account of the gases. Some native copper occurs as sheets in little slips and fault planes in the schist.

Several other claims have been staked in this district, and though there are some indications of high grade ore occurring, the only work done on them has been just sufficient to enable the Copper Mountain owners to hold their claim.

Copper Mountain was reported on by Mr. W. F. Robertson, the Provincial Mineralogist, in August, 1901, and his report appears in the Annual Report of the Minister of Mines for British Columbia of that year. Since then development work has been extended farther to the eastward, but little more has been done in the neighbourhood of the river. In speaking of Copper Mountain camp and Copper Mountain ore bodies, it will be distinctly understood that Kennedy mountain will be included as well, for no distinction can be drawn between the two.

The camp includes about 130 Crown-granted mineral claims, covering an area five miles long from east to west, and about four miles from north to south. Combination camp lies to the south of Copper mountain, but the ore bodies are much the same in character.

The country rock is a batholithic intrusion of igneous rock of very variable composition, which has been intruded into and has almost entirely digested the older overlying sediments—limestones, argillites and quartzites—so that these only now appear as inclusions or remnants in the igneous rock. To the north and west it is overlaid by recent volcanic rocks. Along the southern and eastern border of the mineralized area the igneous rock is a diorite, which sometimes has a gneissic structure, and which frequently holds segregations of the dark minerals. To the north this rock becomes more acid, and is cut by narrow veins of pink feldspar and quartz. Both the sediments and the igneous rock are intimately mixed with, and cut by later dikes of different ages, whose sequence cannot yet be perfectly worked out. These dikes have a general north and south trend and are quartz porphyry, rhyolite, andesite, felsite and diabase, of which the first mentioned are apparently the most recent. The whole series, except the later dikes, is traversed by a set of fracture and fault planes running in an almost east and west direction.

Two classes of ore bodies have been made out—(1) those occurring at or near the contact of the sediments with an igneous rock; and (2) those occurring in the zones of fracture. Both are of a very indefinite character without well defined boundaries. Examples of the first class are found at the southern end of Copper mountain, and on the west side of the Similkameen river. In this class ore bodies are frequently found at the contact of the diorite with a limestone, which may be very much altered. The ore here generally occurs as infiltrations in the small fracture planes with which the rock is traversed. The fissures cut both the igneous as well as the sedimentary rocks, and the metallic sulphides are found in both, but only in the neighbourhood of the contact. The fissures have been filled with secondary calcite which acts as the gangue of the sulphides. Rhyolite and quartz porphyry dikes cut both kinds of rock, and have apparently been injected after the fracturing and fissuring had ceased, for they are not themselves affected by any such dynamic action. The intruded rock alone has been fissured to allow of the flow of mineralized solutions. These dikes are not in themselves mineralized, and do not appear to have had anything to do with the formation of the ore bodies. In the Jennie Silkman claim a highly mineralized diabase dike, which cuts an altered sedimentary rock along with a quartz porphyry, seems to be responsible for the formation of the ore. The minerals occurring in this class are chalcopyrite, pyrite, bornite and calcite with a little magnetite. Bornite is confined to the southern portion of the camp. The Sunset, Helen H. Gardner, Jennie Silkman and Copper Farm claims are examples of this class.

The second class of ore bodies occurs in the centre of Copper mountain and eastward across Wolf creek. In this case the ore occupies a zone of fracturing, which strikes about N. 75° E. It often happens that the country rock has been brecciated and the fragments cemented together by calcite, or it is traversed by a network of small calcite veins with a N. 75° E. trend. These fissures are most abundant about the middle of the mineralized area, and die out to the north and south. They sometimes attain a width of two feet, but are more often only an inch or two. They cut all the rocks except some of the later dikes. These dikes strike at right angles to the course of the fissures, cutting off the ore bodies, and they do not seem to have been affected by any strains or stresses, except those which are consequent on the coaling

of an igneous body. Pyrite, chalcopyrite, mispickel and magnetite occur in the calcite veins. Magnetite sometimes replaces the calcite altogether in the veins and forms the gangue for the other minerals. The Triangle Fraction, Red Eagle, Ada B. Frisco and other claims running east and west across the middle of the camp are examples of this class. In the northern part of the district the little fissures are filled with feldspar, quartz, or magnetite, to the entire exclusion of calcite.

Besides being concentrated in the zones of fracture, the copper and iron sulphides appear often to be original constituents of the country rock, for they appear as idiomorphic crystals disseminated through it without any connection with each other ; and until a great deal more work is done on the claims it will be difficult to give a correct history of the formation of the ore bodies. At present not many claims have been explored to a depth lower than the limit of surface oxidation, but it may be possible to throw more light on the origin of the ore bodies, when the numerous samples obtained have been thoroughly examined under the microscope.

Owing to the nature of the occurrence of the ore on Copper mountain it is a difficult matter to make estimates of the average values that the rock would give on assay. The ore bodies have no definite boundaries, in fact the whole mountain is more or less mineralized, with concentration taking place along certain lines, and what is classed as ore to-day may be too low grade to give a profit to-morrow, depending altogether on the price of copper and the cost of mining. The boundaries then will be merely commercial ones. Mr. W. F. Robertson made assays of samples from many of the different claims in 1901, and the results he obtained were from 1½ to 3 per cent in copper of average samples, with selected samples going up to 8 per cent. Most of them carried a small amount in gold. It will be seen by this that these ore bodies are very low grade, but this is compensated for by their great size, and the ease with which they can be worked.

In the country lying between Onemile and Fivemile creeks, and on the slope of Fivemile creek, several claims have been located, but only the western portion of this area came within the area examined. The United Empire group, consisting of nine claims, is on Allison mountain, and occurs in the same series of metamorphosed sediments as on Kennedy mountain. The whole hill is heavily covered with wash and the rock wherever exposed is decomposed to a much greater extent than in any other part of the country, due perhaps to a covering of volcanic flows during the glacial period, which prevented the decomposed rock from being removed by the scouring action of the glacier. At the base of the hill is a thick deposit of clay and detritus washed down from the hill: it is heavily charged with copper carbonate which has probably been derived from the leaching out of a quartz vein higher up the hill carrying the sulphides of copper. Evidence in support of this is obtained from a shaft forty feet deep sunk about half way up the hill, at the bottom of which blocks of quartz carrying chalcopyrite occur in the decomposed rock.

It is probable that there is a vein of quartz carrying copper sulphides at this place, but not enough work has been done to demonstrate the size of the vein or its strike. Surface indications, however, point to its having an east and west strike across the strike of the fracture planes on Copper mountain.

BEAR CREEK.

At the end of the season a hurried reconnaissance was made of a mineralized belt of rocks running from the Tulameen river at Champion creek northward past the head of Bear creek to the Coldwater river. Some very promising mining properties are being exploited in this region, and this belt of rock well warrants a more extended study next year.

Briefly stated, the geological conditions are as follows : Stretching across in a northerly direction from the mouth of Champion creek to the head of the Coldwater is a belt of light coloured granite. In contact with this on the east side is a series of metamorphosed sediments, limestone, quartzite and schists, extending from the Coldwater river to the Fish lakes. From the Fish lakes to the forks of Eagle creek the granite is in contact with a dike-like mass of peridotite a mile to two miles wide, which then strikes southeasterly at a sharp angle with the strike of the granite. In this angle between the granite and the peridotite is another small area of quartzite, limestone and mica schist, which extends south to the Tulameen river and terminates at Champion creek. Bordering the peridotite and schists on the east is a large body of pyroxenite, which extends from the falls on Bear creek, where the waggon road crosses it, southward across the Tulameen river, where it comes in contact with granite. The pyroxenite is succeeded on the east by enormous masses of volcanic rocks, which have undergone considerable metamorphism, and are earlier in age than those volcanic rocks previously referred to in this report as occurring on the Similkameen river. Dikes of diabase, quartz-porphyry, granite-prophyry and rhyolite cut all the other rocks, and consequently are later in origin.

Contacts between the granite and schists, between the granite and peridotite, and between the schists and peridotite and pyroxenite, were discovered and studied in the field, and from these the geological relations were worked out. The schists which are probably metamorphosed limestones and quartzites are the oldest rocks in the district, for they are cut by all the others and are found as inclusions in the granite and in the peridotite. Next in age comes the peridotite, and with this must be included the pyroxenite, though the latter is slightly the younger, for on Eagle creek dikes of pyroxenite were found cutting the peridotite. Prof. J. F. Kemp, who examined the district in 1900, reports the same conditions on the south side of the Tulameen. The next rock in sequence is the large batholithic mass of granite lying to the west. Contacts between this and the older rocks are well shown on the Tulameen river and on Eagle creek. Following the granite intrusion are the sheared and metamorphosed volcanic flows, and later again are the dikes which have penetrated all the preceding rocks.

Mineral claims have been located all along this granite contact, from Champion creek across to the Coldwater river, and for many years the placers of the Tulameen river and its tributaries below Champion creek have been profitably worked for gold and platinum. These placers are being gradually exhausted, and the Tulameen river from being the principal producer of platinum on the North American continent, now supplies an annual output of thirty or forty ounces of that metal. Mining activity, however, is now being revived and the production from lode mining will probably soon be far greater than it ever was in the best days of the placer miner.

Most of the mineral claims have been located in the area of schists, limestones and quartzites, and some in the peridotite and pyroxenite belt. The metals for which they have been staked are gold, silver and copper; and the minerals occurring are pyrrhotite, pyrite, galena, chalcopyrite and calcite, with some zinc blende and molybdenite.

Molybdenite is found in several places along the granite contact. At Independent camp at the head of the Coldwater river it occurs in fine scales in the large porphyry dike, and at Champion creek it is found in little quartz stringers cutting the schists at and near the contact with the granite.

Among the most promising claims in the district are the St. Lawrence group, owned by the Similkameen Mining and Smelting Company, of Vancouver. These were first located in the fall of 1900 by a party of Swedes, and are situated on the western side of Bear creek, and on the contact of the granite with the schists and limestones. The schists are mica schists, and they enclose narrow bands of white crystalline limestone. They dip at about 65° towards the granite, and are cut by some large and highly mineralized dikes of granite porphyry, which have a north and south trend approximately parallel to the trend of the granite. The ore is always found associated with the limestone, and frequently replaces the lime bands entirely. The granite porphyry dikes appear to be the source of the ore. The limestone bands, being the most soluble rocks, have acted as channels for mineralized solutions emanating from the dikes, and they have become at times entirely replaced by sulphides. These solutions ascending from below, and following the lime bands have deposited their sulphides against the mica schists, which always act as a hanging wall to the vein. Two veins have been opened up on this group, each of them from seven to eight feet wide, and the ore in them appears to be almost pure pyrrhotite. The values are high in copper, gold and silver, and altogether the property has the ear marks of a permanent producing mine.

Another important group of claims is the Independent group owned by Messrs. Johnson, Holmes & Henning, and situated on the summit of the divide between Bear creek and the Coldwater river. This group is also on the contact of the granite body with mica schists. Here the ore body is a highly mineralized zone of rock extending from the edge of the schists about 1,000 feet westward into the granite. Two thousand feet away from the schists the granite becomes gneissic, though still holding inclusions of the mica schists. No sharp line of contact could be discovered between the ore body and the unaltered granite, only that the mineralization by sulphides appears to gradually decrease until at 1,200 feet away from the schist it disappears. The ore body is highly altered and kaolinized, where mineralization is greatest, and it appears to be of the nature of a dike of granite porphyry intruded between the schists and the granite, though it is possible it may only be a mineralization and alteration of the same granite at and near the contact with the schists. Inclusions of mica schist occur in the unaltered granite as well as in the ore body. The greatest alteration is about the centre of the mineralized zone, where a small vein of pure iron and copper sulphides cuts the prophyry at an angle of 45 degrees. The feldspar here is kaolinized, though the quartz is unaltered, and some secondary calcite has been developed. Mineralization throughout the body of the porphyry is usually by individual crystals of iron and copper pyrites, more rarely by veins and bunches of these minerals. Only in the highly altered zone does oxidation extend to a depth of twenty feet from the surface.

Some molybdenite occurs in thin seams and flakes near the contact with the mica schist. The values are entirely in copper, and are low, but the ore body is an enormous one. The group consists of ten claims, which have all been staked on the same contact, running down into the Coldwater river.

Numerous other claims were visited in this section of country, among them being the Keruna group on Bear creek, and the Boulder Creek camp east of Bear creek. The former lies in the same series of altered sedimentary rocks as were described on the St. Lawrence group. These are cut by dikes of a porphyritic character which strike about 330°. The ore occurs as little veins and bunches in the sediments at and near the contact of the dikes. The minerals found are pyrite, chalcopyrite and pyrrhotite, and the values are in gold and silver.

At Boulder creek the claims are located in a soft green serpentine, which often has a schistose structure developed in it, and which appears to be an altered volcanic rock. The ore bodies are in blanket veins interbedded with the country rock, and the minerals occurring are pyrite, chalcopyrite and some galena. The values are in gold, or copper, or both, the one increasing as the other decreases.

Owing to the enormous rise in the price of platinum in the last year, and to the fact that the basin of the Tulameen river once produced a larger amount of platinum than any other part of North America, it is altogether probable that attempts will again be made by interested parties in the near future to locate the source of the metal in this district, or to work some of the higher bench deposits of gravel which are known to carry platinum, but which formerly necessitated too large an outlay of capital to work. Prof. J. F. Kemp spent about three months of the summer of 1900 in investigating the geology of the platinum, and though he was not successful to the extent of finding any large bodies of rock which could be profitably mined for platinum, he was able to throw a great deal of light on the origin and occurrence of the metal. His results are embodied in Bulletin 193, of the United States Geological Survey.

The Tulameen section of the country presents a great many more difficulties to the prospector than the Similkameen country. The former is very heavily timbered, and trails are few and rough. Rock exposures, however, are more common, except where the country is underlaid by the schists and limestones, as in the upper parts of Bear creek. Here the growth of timber is heavier than usual, and the country is so heavily covered with drift that rock exposures very rarely occur, and it has only been by much labour that ore bodies have been located. It is here though that conditions for the formation of ore bodies are so favourable that other important discoveries are to be expected.

In conclusion, my acknowledgments are due to many of the prospectors in the country for their courtesy and readiness to assist, and particularly to Mr. C. F. Law for a history of mining and prospecting in the region and for much other useful information.

ON OPERATIONS IN THE ROSSLAND, B.C. MINING DISTRICT.

R. W. Brock.

The past field season was spent in the Rossland mining camp continuing the survey of the camp begun last season, described in the preliminary report on the Rossland, B.C. mining district. The division of the work made last year was adhered to during the present summer, viz.: W. H. Boyd took charge of the topographical survey; G. A. Young mapped the areal geology, while the writer's attention was given to the veins and ore deposits.

Six student assistants were attached to the party, Messrs. L. L. Bolton, J. M. Sands, S. J. Schofield, A. Boyd, R. E. Fisher, and H. Pedley, all of whom advanced the operations by willing and intelligent services.

The instructions were to complete, if possible, the work in the Rossland district. Mr. Young succeeded in completing his task. Mr. Boyd finished his map of the area embracing the town and working mines, on a scale of 400 feet to the inch, with 20 foot contours, and the main portion of the map of Rossland and vicinity on a scale of 1,200 feet with contours at 40 foot intervals. He was forced to suspend operations for the season, with two or three weeks' work still uncompleted. This, however, can be finished next spring without delaying the publication of the map. My own work will require the same time to complete.

Operations were commenced early in May and suspended the middle of October. In August the writer spent a fortnight accompanying Mr. Low through the Slocan and Boundary districts and on a hasty visit to Franklin camp, on the North Fork of the Kettle river. The geological work was not confined strictly to the areas covered by the map sheets of Rossland but was extended in various directions, in the hope that some of the problems might be more easily solvable outside than within the complicated area in the immediate vicinity of Rossland, and in order to compare the outlying veins with those of the camp itself. With few exceptions all the workings that could be found, and that were sufficiently free of water to be entered, were examined, as well as a number of mineral claims lying outside.

It is probable that the Survey accomplishes most, from a practical standpoint, by furnishing directly to those entitled to it, any information gained regarding a property. Such information, while it may be of value to the individual or company, may not possess any general interest and may therefore not be utilized in a report. While the direct benefit resulting from a survey of a mining camp may lie largely in what may be accomplished in this manner, it is usually of such a nature that the results cannot be made apparent to the public and are, on this account, likely to be overlooked. Where possible, such information was given to those interested on the spot. Where this was not done it may be furnished, if applied for by owners of a property examined

Nothing was found to greatly alter the conception of the geological history of the camp given in the 'Preliminary Report on the Rossland, B.C., Mining district' and it need not be repeated in this place. One of the most interesting and unex-

pected discoveries was that of a bed of fossiliferous stratified rock just above the O. K. mine. While considerably altered to calcite it is hoped that some of the fossils collected preserve enough of their original forms to enable the exact geological age of the rocks to be determined.

Exact figures of production cannot be obtained. As nearly as they can be computed Rossland has produced to Jan. 1st, 1906, 2,227,295 tons of ore containing 1,240,331 oz. of gold, 1,723,249 oz. of silver and 60,753,339 lbs. of copper valued at about $34,879,239.00. This year's production will be seriously affected by the slackening of shipments by the Centre Star while alterations were in progress, which occupied almost half the year, and by a shortage of coke at the smelters occasioned by the strike of coal miners at Fernie. From this cause the LeRoi Company, which had intended to operate its Northport smelter, in addition to shipping to Trail, was obliged to postpone the blowing in of the Northport furnaces.

During the past year, development work in the mines has been pushed more vigorously than formerly with the gratifying result that more ore is now in sight in each of the mines than has been for a good many years.

In the LeRoi work has been largely, but not altogether, confined to the South lode opening up large ore bodies on a number of levels, from the 300 down. Hitherto the workings on the LeRoi had been confined to the ground east of the Josie gulch from about the Josie shaft to the LeRoi stores. Levels are now being extended on the LeRoi west of this dike and good ore has been encountered. This opens up considerable possibilities in extensive but hitherto untested ground. The winze from the 1350 level has been extended to the 1750. On the 1650, the last developed level, the main drives are almost altogether in heavy sulphides. These lower levels will be extended and worked when the shaft has been sunk to them, which work is now in progress. The North and Main lodes are also receiving some attention.

In ground so extensively mineralized as the LeRoi the whole of a lode from end to end and from side to side is worth prospecting ; a narrow drift along it, a narrow stope on it, or a very occasional crosscut or drill hole by no means exhausts the possibilities. On the South lode there are large areas as yet totally unprospected and on the Main vein there is a great deal that has not been wholly tested transversely. This with the ground west of the Josie dike and the deep levels gives a large extent of territory with first-rate possibilities.

The geological work in the LeRoi showed a very large number of the ore shoots to occur along the contact between the augite porphyrite and the tongue of granitoid rock which lies between the Main and South lodes. A dike of quartz-bearing porphyry occurs in or near the latter lode on a number of levels of the LeRoi and also on the South lode of the Centre Star. It might sometimes be useful as an indicator.

The Consolidated Mining and Smelting Company of Canada in addition to work on the upper levels has devoted a good deal of attention to the deep levels of the Centre Star and War Eagle. The shaft of the former has been continued from the tenth to the twelfth levels. It is encouraging to note that the eleventh level, the deepest developed level in the mine, promises to prove better than any level since the fifty. One sill floor had been cut out to a width of forty-eight feet, in pay ore. On the War Eagle,

besides prospecting on the upper levels where some new shoots have been located, work on the newly found downward continuation of the War Eagle vein has been in progress in the ninth, tenth and eleventh levels. Three crosscuts from the War Eagle to the Central Star shaft have been run to enable the two mines to be operated from the Centre Star shaft.

A new 1,100 Nordberg hoist, with a capacity of 1,350 tons per ten hours from 3,000 feet is being installed, and in the new hoist house, a sorting and sampling plant will be placed. The compressors from the War Eagle are being placed with the Centre Star and all will be electrically driven, so that hereafter the two mines will be one with one headworks and shaft.

The Iron Mask mine, lying north of the Centre Star and in the obtuse angle between it and the War Eagle, has been acquired by the Consolidated Mining and Smelting Company and preparations are being made to operate it through the War Eagle.

On the LeRoi No. 2 the most interesting and important development has been the exploration of the Hamilton vein on the 500 foot level. This vein has been followed continuously for a distance of over 1200 feet, most of which, it is said, will be extracted, and much of it is good grade ore. Near the surface this promising vein is far below grade and even to the 300 foot level it is not up to the mark but below this the values come in. This mine is the only one with extensive workings west of the Josie dike, but from it a large quantity of ore has been extracted. The Poorman vein on the Josie claim is also being operated.

The Jumbo mine, after operating several years and after shipping about 30,000 tons, has shut down, having extracted the known ore.

The Crown Point was operated for a few weeks and shipped a little ore but as the ore gave out a short distance below the surface, work was suspended.

The White Bear on the other hand is again in operation, principally on development work, although ore extracted in this work is being shipped.

There is some prospect of several other properties being reopened.

Outside what may be termed the Central area, that occupied by and adjoining the working mines, there are a large number of veins. In some of them a little high grade ore has been obtained but the majority are low grade or have shown so far as developed only small amounts of good grade material.

In the stratified rocks, while some veins have good surface showing, they have failed to maintain their strength and values downwards and the numerous slips in these rocks make it difficult to follow them.

Two main types of veins occur outside the Central area, which, however, may grade into one another, those that consist largely of pyrrhotite with small amounts of pyrite, chalcopyrite and other sulphides and those that have as conspicuous constituents some of the minerals arsenopyrite, pyrite, molybdenite, galena, blende, bismuthinite, garnet epidote and quartz. These obtain both to the north and west and in the south belt. West of Little Sheep creek quartz veins with some sulphides are common.

The O. K. and I. X. L. furnished very rich gold quartz ore from a vein in serpentine but the vein does not reach the lowest level.

The attempt made to map the veins of the camp was not very successful. Veins are too numerous, too much alike, exposures are too frequent, and small faults too plentiful to enable one to interpolate between outcrops. It was decided that it would be more useful to simply mark the exposures with a line sufficiently long to indicate the strike of the vein at that point, except where there can be no doubt as to the identity of the vein. The map will suggest the co-relation of the exposures, and anyone interested may test the verity of his conclusions by trenching. Plotting the outcrops, however, as well as the development work in the mines emphasises the fact that there is a large number of veins, and that they are more persistent than had been expected. This is true also of the ore shoots to a much greater extent than was formerly supposed.

It is evident from early workings that two mistakes of an opposite character were liable to be made; either too great regularity was expected or none at all. Either of these mistakes was fatal. There is enough regularity to make it safe to conclude that when a well marked typical vein disappears, it has been faulted, and when an ore shoot fails to appear at the expected spot, a change of dip or a horizontal heave is sufficiently probable to make a thorough search advisable. In early work prospecting was often stopped by a fault of the dike, or if continued the drive was frequently turned along the fault plane, the worst possible place to look for information.

Almost all the veins strike either nearly east and west or northwest and southeast so that when only a limited exposure is to be seen it may fairly be presumed that the vein strikes it in one of these directions.

It is a noticeable fact that with few exceptions all the claims which have attracted attention in the south belt as well as in the north, lie very close to the contact of the monzonite or gabbro mass. Ground near this contact would therefore appear to be particularly favourable for prospecting.

Starting with the South lode of the LeRoi-Centre Star, there are at least seven veins that are producing ore—and possibly more. From the War Eagle to the Cliff there are four well marked ones.

Unfortunately there are few rock exposures south of the south lode, but the monzonite contact lies somewhere south of it. Since the conditions southward seem as favourable as northward of the South lode, it is scarcely likely that the great ore bodies of this lode have so much ore to the north of them and none to the south. It is less unlikely to suppose the LeRoi-Centre Star Main and South lodes are the central and perhaps the most important members of a co-ordinate system of veins. That there is some mineralization in this ground is shown by the Nickel Plate workings, cuttings on the Red Mountain railway, and by the Spitzee veins. The sheared and mineralized rock of a lode would weather and erode more rapidly than unmineralized country rock and might very well be covered with wash in a gulch. The heavy mantle of wash that covers most of the ground has prevented prospecting, so that as yet it is mostly virgin territory. Its prospecting will be costly, but adjoining as it does ground of such proved richness, and possessing so far as may be presaged, favourable

geological conditions, the chances for success are sufficiently strong to render its exploitation a good business venture. The most favourable point to test it would be in the neighbourhood of the Josie dike.

The work of the LeRoi No. 2 west of the Josie dike proves mineralization to have extended a long distance in this direction. That on the LeRoi proves that the veins east of the dike may be expected to continue west of it. From about the boundary between the White Bear and Black Bear, the contact between the ore-bearing and the stratified rocks extends northward, all west of this being stratified rocks. The workings of the White Bear show the thickness of these rocks to be 500 feet and that they overlie ore-bearing rocks. There is reason to believe that elsewhere along their eastern border their thickness does not exceed a few hundred feet and that they overlie augite-porphyrite concealed by the mantling stratified rocks ; in time other companies besides the White Bear may explore these underlying rocks.

Excepting on the St. Elmo Cliff vein, little has been done on the veins mentioned north of the White Eagle No. 1, outside of a few prospect shafts. Nothing has been produced and only a few good assays are reported, but it may at least be said that the surface showings are as good as they are on the Hamilton vein of the LeRoi No. 2 which is developing as well as on the 500 level.

Some good ore has been taken from the Consolidated St. Elmo, Cliff, Monte Christo, Evening Star, and from C. and K. The main lodes of the Centre Star are mostly drift covered east of the Centre Star gulch, and have not been prospected except by a shaft on the Enterprise which is in heavy sulphides. Between this and the Monte Christo vein are several veins with massive pyrrhotite but little chalcopyrite showing.

The south belt has several veins. The Homestake, Gopher, Lee, Celtic Queen and perhaps the Crown Point appear to be on one continuous lead. Some of these south belt claims had good surface showing, yielding high return, but development work does not seem to have opened up good ore shoots that have continued downwards. Recent work on the Crown Point revealed the disappointing fact that its strong ore body suddenly gave out about twenty feet below the surface, the transition between ore and unmineralized rock occurring in a space of less than two feet. Few of the workings on the south belt could be entered, and most of it is concealed by wash, so that little can be said of its possibilities. Since the covering of wash which makes prospecting difficult might conceal some good ore, it is unfortunate that the work already done on this belt should offer so little encouragement to prospecting.

While there is ground about Rossland that is well worth prospecting, this does not mean that such ground is worth a high cash price. For the testing of it is very costly and may bring in no return for the money invested. The owner should be willing either to take a small cash payment or if he has so much confidence in his claims, to give a bond on it for a guarantee that the work will be done.

The temperature of the rocks at various levels in some of the mines was taken to determine the increase with depth. Chemical thermometers were fitted with wooden handles four feet long with openings to permit reading and to

leave the bulbs free. The measurements were taken in drill holes in crosscuts where there could be a minimum circulation of air. The thermometer was immersed the length of the handle in the hole, and at first the mouth of the hole was plugged, but it was found that no difference in readings resulted when the holes were left open. The readings for similar levels below the surface agreed remarkably well. From the surface to 150 or 200 feet the temperatures regularly decreased to 41·75 F. From here the temperature rises rapidly for a few hundred feet, then more slowly, and for the last few hundred feet more rapidly again. The highest temperature—in the 1,750 level of the LeRoy—is 17·6 F. The rate of increase from the lowest temperature to the highest is 1° per 47·7 feet. The lowest increase—between the fourth and tenth levels of the Centre Star—is 1° every 53·7 feet, and the highest rate of increase between the tenth and eleventh levels of the Centre Star, 1° every thirty-four feet. That the temperature should decrease for such an unusual distance below the surface may perhaps be due to the chilling of the rocks by the Cordilleran glacier. If this is so the increment of increase shown below the cold zone will also be affected and be lower than it should be. As it is, the increase 1° in at most fifty feet is higher than that observed in most regions. The average given by the Commissioner of the British Association in 1889 is 1° for every sixty-four feet and this appears high in the light of subsequent observations. In Grass valley, California, it is 1° in 122 feet, in the Rand 1° in 208, in Michigan, 1° in 223·7. In the Simplon tunnel, 1° in ninety feet, varying from 1° in 210 feet under mountains to 1° in sixty feet in valleys. The high rate of increase in Rossland may perhaps indicate comparatively recent hydrothermal activity—or even comparatively recent volcanism.

Dikes at different levels show the effects of heated waters being bleached in much the same way as rocks by the solfotaric action of volcanoes. But the present mine waters have a lower temperature than the rocks except in the cold zone near the surface. On the intermediate levels, water entering from fractures or diamond drill holes may be 5° F. lower than the rock temperature. On the 11th level of the Centre Star about 1,300 feet below the surface the water is only 1° lower. This is the lowest level on which mine water could be examined. While lower in temperature than the rock, its unusually high content in mineral matter, particularly in the chlorides, and carbonates of alkalis and alkaline earths and in silica, would lead one to expect it had come from a region of higher temperature. There is some evidence of the action of this water on the vein on this level with an unusual development of copper ore at certain places.

An area of serpentine occurs on Little Sheep creek on both sides of the valley in the vicinity of the O. K. mine. In some places veinlets of asbestus are developed. The quality is excellent but the veins are too narrow and small to be of any economic interest. With the view of testing this rock for platinum, samples were taken, pulverized and concentrated by panning. In this way a fairly large amount of rock could be tested. The creek bed was also washed at favourable points between Silica and the O. K. mine. Two small nuggets were found which resembled platinum. Others should be found in the concentrates that have not yet been treated. The sample of the Creek concentrates assayed by Mr. Connor of this Survey yielded nothing but a little gold ($37.00 per ton). Concerning the assay of serpentine concentrates, Mr. Connor reports:—' ·0083 ounces gold per ton, 0·0025 ounces platinum (?) per ton. My reason for

the question mark after platinum is that the amount is so small that I had no chemical proof of its being platinum. On the other hand the gold and platinum (?) had a greyish or brownish tint instead of the gold colour, and were somewhat brittle. Also on alloying this gold and platinum residue with silver and dissolving again in nitric acid (for solution of the platinum), the residue gold was much more natural in colour and softness and weighed less, as expected. From this loss of weight I have given the figure for platinum.'

A few miles north of Rossland, between Murphy and Sullivan creeks, on the Lord Roberts claim, is a large deposit of magnetite interesting as representing the Boundary Creek type of contact deposit in the immediate vicinity of Rossland. The country rock could not be seen but it must be close to the contact between the Nelson granodiorites and the 'Rossland volcanic group' augite-porphyrite with stratified rocks including limestone. The deposit has been disclosed by a few open cuts for several hundred feet. Its width must be more than thirty feet. The upper trench shows a fine grained micaceous syenite porphyry along the hanging wall. Bluish massive magnetite with a little chalcopyrite distributed through it as in the Boundary, pyrite, pyrrhotite, hornblende, epidote garnet, feldspar and quartz were detected. A small pegmatite dike was also seen in the ore. The hornblende is soft and black like that found in the Josie and Black Bear shoot of the LeRoi. Magnetite and pyrite are most abundant near the footwall and pyrrhotite and chalcopyrite near the hanging wall but specimens may be obtained showing all four iron-bearing minerals, sometimes arranged in bands.

Specimens and descriptions furnished by prospectors indicate that other deposits of a similar nature are found in the neighbourhood of Rossland, particularly in altered limestone, at the head of Murphy creek and in Big Sheep basin.

Franklin Camp.

Franklin camp is situated on the east branch of the North Fork of the Kettle river about forty-three miles by road from Grand Forks. At present it can be reached by stage from the railway at Grand Forks in a day. Hotel accomodation and supplies are to be had in the camp.

Recently the camp has attracted some attention as a result of the development work now in progress, and the promise of a railway now under construction from Grand Forks.

A reconnaissance survey of this part of the country was made by the writer and W. W. Leach of this Survey in 1900 and the topographical features and salient points in the geology are shown on the West Kootenay map sheets, issued some time ago.

In the day's visit to the camp this summer nothing could be done toward correcting the outlines of the geological formations as given on the map. When the survey was made the country was timbered and the position of the geological boundaries had usually to be assumed. Since then fires have swept over the camp and the rocks and ledges are much better exposed.

The geology of the camp is somewhat complex. The oldest series of rocks represented consists of limestone usually much metamorphosed to crystalline limestone, to green lime silicate hornfels, to a baked-like siliceous rock, highly fractured, and

to breccia or conglomerate-like rocks, some with limestone surrounded by green silicate and some with green silicate-nodules in a limestone ground mass; of argillites and of greenstone. The altered limestone is much more extensive than represented on the map. A large area consists of grey Nelson granodiorite which is intrusive in the basal rocks. Both these formations are intruded by a gabbro-like rock and a porphyritic syenite with long coarse reddish feldspar crystals. All the above rocks are cut by a light acid granite ('Valhalla granite') towards the west fork divide and by pink alkali syenite ('Rossland alkali syenite') to the east. Numerous dikes from these intrusives cut the older formations. Overlying the older formations like a mantle are Tertiary rocks which now occur in isolated patches but which formerly extended as a continuous capping. These rocks consist of a quartzite-like rock, gritty tuffs with coarse conglomerate bands, and conglomerate beds with interspersed ash rocks. Overlying these again are lava-flows consisting of andesites and trachytes and agglomerates formed from them, basalts and ash beds.

The conglomerates hold boulders, from one-half inch to two feet in diameter, of the older rocks, particularly grey granodiorite, limestone, greenstone, and an older fine grained conglomerate. The conglomerate appears to cover a greater area than represented on the map, reaching in places to the north fork bottom. It is cut by dikes of the alkali syenite and by dikes from the volcanic rocks. The lavas have in places a basaltic jointing. Some beds are rich in gas pores in which calcite, agate and zeolites are developed. The abundant intrusive rocks have profoundly altered the older rocks and ore deposits are developed in the latter.

The deposits consist of several types: (1) Iron and copper sulphides in a gangue of altered country-rock, *i.e.*, green lime silicates, as garnet, epidote, hornblende, quartz, calcite.

(2) Magnetite deposits, with some copper and iron sulphides, and the same gangue minerals.

(3) Galena-blende and chalcopyrite, with only a slight amount of the green silicates.

(4) Quartz veins, with galena-blende, pyrite and chalcopyrite, molybdenite, arsenopyrite, etc.

(5) Chalcopyrite in fractures and replacing minerals of the granodiorite or porphyritic syenite.

Both in the nature of its ore deposits and in its geology this district bears a strong resemblance to the Boundary Creek district. The rocks are very similar and the contact metamorphism, forming lime silicates and magnetic-chalcopyrite deposits is the same. In Franklin, of course, it has yet to be proved that mineralization was on the same gigantic scale as in the Boundary, and that the ores have the minerals in the same proportion to make them so amenable to smelting.

The most exclusively developed claim is the McKinley, which has had about $30,000 expended on it in surface improvements, tunnelling, trenching and diamond drilling. Four leads have been discovered in a band of limestone running north toward Franklin mountain. Development has scarcely determined the strike of the leads, but

they appear to run transversely across the limestone band. Along the ledges the limestone is altered to green silicates, epidote, hornblende, garnet, &c. The lowest ledge yet uncovered has a large development of magnetite, with some iron and copper sulphides.

The second ledge outcrops for a width of about thirty feet, but the dip is at a low angle southwest. It contains a large amount of galena and blende as well as chalcopyrite, the silicates are only sparsely developed, unaltered limestone being in direct contact with galena. It is said to yield high grade ore, with good values in silver. The upper and best developed ledge has iron and copper pyrites as the chief metallic minerals, and a considerable amount of the gangue minerals. It is supposed to be about forty feet wide, dipping about 45° south, and has been followed 300 feet. From a point 213 feet in the tunnel the fourth ledge is cut for a distance of fifteen feet. This seems rich in copper. The gold values are low, probably on an average lower than in the Boundary ores, but the copper is expected to run a good deal higher.

The same company that is developing the McKinley is testing the Banner claim on Franklin mountain, by diamond drilling, etc. This claim was not visited this season. At the time of the first examination there was a strong, very wide lead of quartz, carrying galena, blende and chalcopyrite.

The Maple Leaf claim on Franklin mountain has ledges along the contact of the reddish syenite, with the altered basal rocks. The mineralization is chiefly confined to the syenite. Fractures are filled with seams of chalcopyrite and pyrite, or with green malachite resulting from the alteration of its copper ore, and the constituents of the syenite are selectively replaced by the sulphides. The coloured constituents are the first to suffer, leaving the conspicuous feldspar crystals in a sulphide base, but often the whole rock is replaced by the ore. At several points along the contact, which is drift covered, wide stretches of such mineralized rocks have been uncovered, and in the syenites, a few hundred feet back from the contact, a vein four feet wide of fairly well mineralized rock has been opened.

The Gloucester group, now being worked under bond by the Dominion Copper Company, was not visited. On the G. H. claim of this group is a ledge of magnetite, with a little pyrite and chalcopyrite. In places it is at least forty feet wide, and it has been traced several hundred feet. It seemed to lie wholly in the grey granodiorite. On the Gloucester was a good showing of copper ore, with pyrite, molybdenite, calcite, and quartz, with grey granodiorite on one side at least, but the country-rock is badly altered.

A number of copper lodes occur in the grey granodiorite on Tenderloin mountain, where the rock is crushed, sometimes to a sort of 'ball' structure, round which the granite material wraps. In these crushed zones, particularly along fracture planes, the mineralization is quite heavy.

In addition to those mentioned there are a large number of claims on which discoveries have been made.

Deposits had been found in the older rocks of the camp—the altered basal rocks—greenstone and altered limestones, granodiorite, gabbro, porphyritic syenite. Lodes similar to the McKinley are likely to be found in the continuation of the limestone

band and in other limestone areas in the camp. But deposits are unlikely to be found in the acid granite ('Valhalla granite' of the map), the pink alkali syenite ('Rossland alkali syenite' of the map), or in the capping of Tertiary lavas.

The work done in the camp is limited, and near the surface, so that it has yet to be demonstrated what values the deposits will carry at depth, and for the low grade deposits that they can furnish a large tonnage of pay grade ore. So far the results on the McKinley seem to be encouraging.

Since none of the claims are past the prospect stage, and none of the workings have attained depth, it cannot be definitely stated that another mining camp has been added to the British Columbia list. But the camp has many of the earmarks of a mineral bearing district. Additional discoveries are extremely probable and there seems to be a reasonable prospect that some of the properties may develop into mines.

ROCKY MOUNTAIN COAL AREAS,

BETWEEN THE BOW AND YELLOWHEAD PASSES.

By D. B. Dowling.

The completed maps of the Cascade coal area, and a small map of part of the Costigan area on the Panther river, give, with some detail, the topographic features of all the coal areas north as far as the watershed between the Panther and Red Deer rivers, The work undertaken for the present season was to survey and map by the photo-topographic method a portion of the northward continuation of the Cascade and other coal basins, and also to explore the country to the north in search of other areas, in the hope that workable coal seams of the better class of coal might be found nearer the proposed route of the railways through the Yellowhead pass. To carry out this programme it was necessary to divide the party and leave Mr. Malloch to carry on the triangulation while I went north.

Rejoining the party later I found that Mr. Malloch had made satisfactory progress with his work, and I remained with him for a week to help in laying out the work for the summer.

In going north to the Saskatchewan we followed the rocks of the Cascade coal basin to within fourteen miles of that stream where they are finally denuded away in the valley of Rabbit creek. Reaching the Saskatchewan near the middle of July it was found that the river was at its flood, and we therefore chose it for our journey in search of the coal formation.

On the 1st of August we crossed the river and made our way towards the headwaters of the Brazeau by ascending White Goat river which enters the Saskatchewan below Sentinel mountain, a peak overlooking the 'Kootanie Plain.' From the head of this stream over the Cataract pass we reached the headwaters of the Brazeau and followed it down to the foothills. Turning south behind the Bighorn range we traversed a high plateau of Cretaceous rocks intersected by several streams that also cut through the limestone range to the east, and at the southern slope following a stream that enters the Saskatchewan just above where it passes the end of the Bighorn range.

On our way southward the mountain ridges were again crossed on Sheep river, where the coal measures were seen in two basins within the mountains, and again in an upturn in the foothills to the east of the first range. From here we made our way south to the Clearwater and entering the mountains on this stream we crossed to the Red Deer on a different trail from that followed in the spring. Here we met Mr. Malloch's party and the season's work was concluded after necessary observations from several triangulation stations had been taken. The return to Morley was made just as the weather seemed about breaking up. We reached Morley September 20.

The season was particularly favourable as fine weather and clear atmosphere are necessary to triangulation observations and photography.

WASHING CANMORE COAL.

The output of the mines at Canmore is taken by the C.P.R., and used almost exclusively on the British Columbia section where the heavy grades necessitate the employment of the best coal available. In later years there has been found in the fine coal a large percentage of ash which formed clinkers on the grate bars and these were a source of annoyance to the engineers. Washing the coal and more careful picking was recommended in the Summary Report of this Survey for 1904, p. 113. This led to the installation of a washing plant and the visit I paid at this time was to learn the result of the first trials. An underestimate of the amount of fine coal produced was made in planning the capacity of the plant so that the drying bins were too small. The washing is confined to the material that passes the half inch screen. This is then stored for a couple of days in the drying bins and then delivered along with the freshly mined lump to the railway cars. Owing to the large percentage of fine coal produced, only about half of it is washed, as the storing capacity is small. In a short time additional bins will be added.

The result obtained by washing half the fine coal and picking the lump is that about twelve per cent of the 'run of mine' is removed as rock and the character of the coal has been thus considerably raised. The opinions of the railway engineers were conflicting as to the improvement in the coal, so, on the invitation of Mr. A. Stewart, I visited Field, where 100 tons per day are being used on the heavy grade at the 'Big Hill.' Here the cause of the varying opinions was evident. The increased traffic from the west was responsible for the allotted supply of fresh coal being quickly used up and the unlucky engineers who could not get it were drawing from the old store which had been exposed in the open for as long as six years, and it was undoubtedly dirty and poorly picked. The freshly washed coal was considered satisfactory. And, as before remarked, when the extra drying bins are added and the whole of the slack is washed, the coal should rank with the best in America for steaming purposes.

PHOTOGRAPHIC SURVEY.

The area included in the triangulation accomplished during the summer, and for which it is expected the photographs will supply enough topographic detail to map on the one mile scale, extends from the Panther river northwest to the Clearwater, and from the Vermilion range northeastward to near the outer range. This area is roughly from twenty to twenty-five miles in length and about sixteen miles in width, making an area from 320 to 400 square miles. This work was accomplished by Mr. G. S. Malloch with one assistant, and he will this winter plot the work thus far done. A section of the Cascade coal measures he also carefully measured at a favourable point about half way between Red Deer and Clearwater rivers, clearing away enough of the surface to expose all the coal seams at this point.

GENERAL DESCRIPTION.

The structure of the Rocky mountains, as has been pointed out, consists of a series of long fault blocks tilted up along the eastern edge, but there are two fault lines that may be considered as indicating faults of much greater magnitude than the others. These two are respectively the break in front of the outer range and that in front

of the Sawback range. The first break brings up Devonian limestones above the Cretaceous of the foothills, with the summits of most of the ranges behind repetitions of Carboniferous beds. At the Sawback the rocks are of a different series and are much older than in the ranges in front. Cambrian quartzites and shales are found pushed up over the top of the Carboniferous. This change in the age of the beds is noticeable to the ordinary traveller in the different colour of the slopes. Westward yellowish coloured rocks predominate, but eastward the limestones are bluish white.

The front ranges are fairly continuous, but the amount of horizontal displacement is not so uniform, so that the interval between varies greatly in width. As the upper members of the sections of these fault blocks are found on the west side of the valleys, it is quite evident that in the narrower intervals the higher members may be wanting. This is generally the reason that coal-bearing areas which consist of the Cretaceous beds just above the limestone are not always continuous strips between the ranges. In other cases the whole block becomes so elevated that, even if there were originally coal-bearing rocks on top, the natural wearing down of the surface would affect them to a much greater extent than when not so elevated.

Fractures across each block provide lines of weakness for the inauguration of the breaking away of these barriers so that the drainage of the area might be more direct instead of, as at first, following the trend of the ridges. All the cross valleys are probably along these breaks. Many of them seem to cross several ridges and are generally in the direction of the pressure and consequent movement. The breaks sometimes show slight differences in elevation and alignment of the rocks on either side, but generally they are of small amount and may be spoken of as pressure slips. These are not all at right angles to the general trend of the ridges as frequently there seems to have been two breaks at some of the gaps—often intersecting. The denudation of the loosened material leaves in that case a turn in the course through the ridge, and often a low mountain occupying the centre of the gap with the main streams on one side and a branch on the other. Examples of this feature are seen on Panther river in the gap through two ridges and on Sheep river as it leaves the vicinity of the Cascade coal basin. The general direction, however, of most of the streams through the outer ranges, is in a fairly direct line, and would lead to the supposition that the slips often occur piercing more than one fault block.

Panther River.—This stream, after emerging from the mountains, joins the Red Deer river. The outer range here shows a decided bend in its general course which is confined to a short distance only on each side. The break through this is nearly at right angles to the strike which deflects the stream to an east and west course. Inside through the succeeding ranges the course is more nearly at right angles to the general trend of the main ranges. The interval between the mountain ranges is here wide, and three areas of the Cretaceous coal-bearing rocks are left in situ.

Red Deer River.—This stream occupies a valley which in a general way follows the rule of crossing the ranges along what seems a cross-fracture, but just before reaching the outer range it is deflected to the south and crosses the outer range diagonally instead of going through the gap which is on a prolongation of its upper course. The James river, which rises on this gap, would thus appear to have been, in the early history of this surface after the mountains had been raised up, the original channel,

but a deflection is evident later on down a line of syncline and fault through the range, that was probably more easily eroded. The outer range south of Panther river is very near the second, but they separate widely to north of the Red Deer, and in this basin there is a large block of the Cretaceous rocks which overlie the limestone. Near the Clearwater the beds are dipping slightly to the southwest, but the upper members of the limestone series are there at so great an elevation that the Cretaceous rocks are found only on the tops of some of the hills. The valley of the Red Deer, which is cut through these measures down to the limestone, divides the coal areas into two parts. That to the south is in a compact mass elevated toward the north, and the northern portion in more or less isolated areas.

The course of the stream through the succeeding ranges is in a general straight line, but the Cretaceous rocks do not appear to cross, except those of the continuation of the Cascade basin, which are overridden by rocks of the Vermilion range.

Clearwater River.—The valley by which this stream is led through the ranges starts near the Pipestone pass and not far from the source of Siffleur river which runs north to the Saskatchewan. At the crossing of the Vermilion ranges the Cretaceous is still in evidence, but the coal-bearing beds are raised above the level of the stream. Eastwards the rocks are all of the limestone series and the valley penetrates them deeply. The continuation of the valley out through the foothills has been abandoned, and the present stream is deflected to the northward about three miles. The interval between this stream and the Sheep river is occupied by high masses of flat-lying limestones upturned along the eastern margin in the outer range, and interrupted along the centre by an overfold or broken syncline. This elevated portion forms an interruption to the continuity of the coalfields east of Cascade basin. These do not terminate here, however, as there is again a depression between the ridges northward, and coal areas again occur.

Sheep River.—This stream crosses the ranges in a more irregular course than the other streams already mentioned, and seems to have followed no distinct line of fracture or slip. It rises in the Sawback range in two streams, which unite after crossing the Cascade basin. Between the outer ranges two areas of coal-bearing rocks occur, but form rather shallow basins separated by a fault of relatively small throw, as it brings up only the top of the Carboniferous. At the gap leading to the foothills the river has taken a sharp turn northward along the strike of the limestones before cutting through the range. The outer fault next to the foothills is there, an overthrust with an anticline in front of it, which brings the top of the Carboniferous limestone against the Devonian of the lower slope of the first range. This anticlinal fold is pressed to the east so that the down turning beds are nearly vertical. The Kootanie series, the coal-bearing beds of the mountains, are there exposed just outside the mountains, but are steeply inclined to the northeast and much crumpled and broken. Higher beds succeed them, but in a short distance the general westerly dip prevails and a series of small faults parallel to the mountain range repeats the same series of beds for a considerable distance from the mountains. These appear to be shales and thin-bedded sandstones of the Benton formation.

Saskatchewan River.—The upper part of this stream was examined by Mr.

McConnell some time since, and the rocks are described as being mainly of the Bow River and Castle Mountain series.

From the mouth of Rabbit creek the stream follows a lateral valley, a continuation of that of Rabbit creek. It then turns across the ranges and follows a general direct course, which at the extremity of Bighorn range is evidently along a line of break, both a fault and a slight slip. All the ranges crossed by Sheep river are here compressed to a series that occupies a width of only six miles. The greatest deflection to form this narrow ridge takes place in the outer range and the coal area which is seen on Sheep river ends high up in the hills six miles south of the Saskatchewan. The centre about which this outer range for a short distance may be said to curve is the south end of an outer line of mountains, the Bighorn range, which starts at the Saskatchewan and runs parallel to the mountains as far as the Brazeau. The valley from the mouth of Rabbit creek to the foothills is comparatively wide, and the elevation at the river is less than 5,000 feet, so that this is a favourable winter camp for Indians, as the open patches provide good feed for their ponies. The old name on Palliser's map of 1858, 'Kootanie Plain,' evidently points to the occupation of the valley by hunting parties of Indians from southern British Columbia.

White Goat River.—This stream heads in the lofty range that is on the east of the north branch of the Saskatchewan. The numerous glaciers of this elevated region maintain several large streams which unite to form this river. The largest branch, Cataract creek, comes from the northwest between two ridges and is fed by four glaciers perched along the face of the western ridge. The summit of this branch is low enough for a pack trail, and the headwaters of Brazeau river are reached from this divide.

West of Sentinel Mountain range the Sawback fault brings up rocks that are probably Cambrian, and the ascent of the stream is across an ascending series of beds, which in the divide to the Saskatchewan headwaters are capped by the limestone of the Castle Mountain series. The beds dip to the southwest, but with lessening amount as the headwaters are reached, and appear to form a shallow syncline east of the north branch of the Saskatchewan. Mount Coleman is at the head of this valley, and is a broad, lofty peak. Heavy limestone beds occupy the summit, showing steep walled faces apparently all around, but in the lower part thin bedded rocks have easier slopes.

Brazeau River.—The south branch of the main stream rises in the same range as the White Goat river, but a great part of the water comes from the mountains between this stream and the Athabaska. Brazeau lake lies in a large valley on the north side, which is about on the line of the great Sawback fault. The mountains on the northeast are of Carboniferous limestone, dipping southwest, with patches of the Permo-Triassic quartzites resting against them, but in several places these are covered by yellow quartzites of the lower part of the Bow River series, the line of fault being near the eastern edge of the lake. Glaciers at the head of this valley supply a large part of the water issuing from the lake, and this is probably greater than that of the stream so far followed.

From the vicinity of the lake the valley down to Job creek is directly across mountain ridges made of inclined blocks of the Carboniferous rocks, with occasionally

some Devonian showing on the east and reddish beds above the Carboniferous on the west. At the mouth of Job creek the stream turns to the left along the strike of the beds for five miles, and then again resumes its general course, emerging from the mountains in a wide valley which continues in a north-northeast course to the end of a strong ridge of foothillls, which in a short distance southward rise to mountain heights—the northern end of the Bighorn range.

Before turning the flank of this range the stream is joined by a branch issuing from a gap a few miles north of the main valley. The latter stream was reached by Mr. McEvoy on his journey up Rocky creek from the Athabaska, and the mountain between the two rivers is no doubt Mount Dalhousie, named by the Earl of Southesk.

COAL AREAS.

Extension of Cascade Basin.—This area is the most persistent of the coal areas, and continues north to within fourteen miles of the Saskatchewan river. In the section between the two branches of the Red Deer river there is a fold in the measures which runs out before reaching the Red Deer, or was in the past eroded away, so that the seams now seen are in the block which is overridden by Prow mountain. Northward between Red Deer and Clearwater rivers there is a minor fold which disturbs these seams, but they still appear to go under the limestone. Northward the distance between the ranges narrows, and it is evident that most of the measures are turned up again at the fault line before the headwaters of Sheep river are reached. This is seen plainly on a branch of Rabbit creek, which comes through the western range and whose valley is eroded to the bottom of the coal measures; this area, therefore, loses its value as a coal field before its northern limit is reached.

Midway between Red Deer and Clearwater rivers Mr. Malloch measured a section of the coal-bearing beds, and found in a thickness of 1,420 feet, mainly sandstones and brown shales, twenty-four seams with a total of 114 feet of coal. Some of these were less than four feet in thickness, and are probably not workable, but fifteen of the larger ones range from four and a half to eleven feet, and have a workable thickness of coal which amounts to about ninety-five feet.

Palliser Basin.—To the east of the Cascade area a triangular block, which is partially shown on the map of the Cascade basin, runs north to near the Red Deer river, but in the northern portions there is published no statement as to its coal seams. Last summer Mr. Malloch was in this field and noted six seams or beds which appear to be fairly free from folds dipping to the southwest. This portion may prove of value as a small field. In the elevated region northward the rocks below the coal measures are exposed along this trough to near Sheep river, where elevated areas of coal measures are again seen and continue a short distance north, but it is probable that they will long remain untouched as they are not easily reached.

Costigan Basin.—The southern portion of this was reported on in the Summary Report for 1904. This basin between Red Deer and Clearwater rivers is broken up into isolated patches, but southward it is more compact and the measures form a high plateau bordering the valley of the Red Deer. No exposures of Cretaceous occur in the Clearwater valley and probably there are none until near Sheep river, but this

northern portion is not wide and may not be of immediate importance, although it extends to within a short distance of the Saskatchewan.

Bighorn Basin.—Another range starting at the Saskatchewan and containing the general line of the front of the mountains, but not a continuation of the front range to the south, runs northward to the Brazeau river. This is the result of a local fault and the western side is shoved up over some of the rocks on the northeast. This uplift tilts up the beds of the foothills and exposes the lower beds down through the coal measures. Behind the Bighorn range there is thus brought to the surface the same coal bearing rocks as are found in the mountain basins, and another coal field is available which extends northward to past Brazeau river. In this all the beds of the Kootanie formation are exposed, as the interval between the mountains is wide, and rocks as high as Middle Cretaceous are seen along the western margin.

The beginning of this field south of the Saskatchewan occupies but a small triangle opposite Bighorn range. The top beds only are exposed, but a few coal seams were found. The upper two are only about two feet each in thickness; another of three feet lies six feet above a five foot seam and these two could be worked together as the coal appears to be of good character. A sample from the five foot seam analysed by Mr. M. F. Connor gave:—

Moisture	1·85
Volatile combustible matter	24·95
Fixed carbon	69·70
Ash	3·50
	100·00

The small upper seams are slightly softer but are here too small. Across on the north side of the Saskatchewan the whole set of measures are raised much higher and all the formation can be got at either on the western slopes of the range or in the gorge of Bighorn creek, a tributary from the west behind Bighorn range. The tops of the measures are exposed at the falls and many seams can be seen in this cañon. The lower ones appear here to be generally very dirty and many of the black coal-like streaks are found to be only black shale. The best exposure of coal was found in a valley cutting through Bighorn range just south of Brazeau river. This does not show as great a deposit of river-borne material as the valley of the Brazeau and the coal measures which also cross the latter are more easily exposed.

The only natural exposure here was of the upper seam and the sandstone rib above it. Its thickness is small and not sufficient to pay to work and in this respect resembles the coal on the Saskatchewan. The coal also is slightly softer, as are the others here.

In prospecting for the lower seams one of over seven feet was found occupying about the position of the five and three foot seams of the Saskatchewan but there they are very dirty. Fifty feet or more beneath this a heavy sandstone rib forms a good roof for a seam that had a favourable appearance; when this was cleared its thickness was found to be sixteen feet with one foot of shale in the centre, leaving a thickness of good coal fifteen feet. Half a mile south in another gully what was taken as the same seam had no shale parting and we uncovered from the floor twelve feet of very clean coal without reaching the roof which outcropped above.

These two occurrences, even if on the same seam, show that there is here a large body of coal in a workable position having a dip of about 30 degrees to the southwest.

Samples from the first exposure of the sixteen foot seam, taken from both the top and bottom portions, gave the following analysis:—

Moisture	2·50
Volatile combustible matter	27·10
Fixed carbon	64·00
Ash	6·40
	100·00
Fuel ratio.—Volatile to fixed carbon	2·36

This is a good steam coal and probably of the best grade for coke. The fuel ratio places it at about the grade of Blairmore and Frank coal, though it seems to have less ash.

SURFACE GEOLOGY OF THE GREAT PLAINS AND BRITISH COLUMBIA, ETC.

R. Chalmers.

Your instructions to me in regard to the field work of the season just closed were to study the surface geology of the prairies ,especially in the provinces of Saskatchewan and Alberta, along the lines of the Canadian Northern and Grand Trunk Pacific railways, and if time and expenditure permitted to spend a few weeks in British Columbia. The proposed investigations were to embrace, in as large a measure as possible, subjects of an economic character, and such materials as clays, sands, shales, &c., suitable for the manufacture of the different kinds of brick, pottery, &c., were to receive special attention. The water supply of a number of the towns and villages on the plains has been causing some anxiety, and the conditions affecting it were also to be made the subject of inquiry.

I left Ottawa on the 23rd of May, proceeding directly to Winnipeg, and thence to Dauphin where some days were occupied in examining Riding and Duck mountains, and a number of other places in the vicinity. Along the Canadian Northern railway the country is, for the most part, a plain covered by the black loam, described on a following page, while rolling surfaces are found at the foot of the mountains. Following the railway westward, traverses were made across the plains in a number of places and the upper Assiniboine valley was explored. The black clay, already referred to, continues to form the uppermost stratum as far west as the rolling sand hills beyond Humboldt. At the South Saskatchewan valley there is one of the finest farming tracts on the plains. From Prince Albert the northern branch of the Canadian Northern railway was followed to Melfort, Swan River and Dauphin. Excellent land was seen along a portion of this route, especially in the Carrot River valley ,and at Swan river. On the north side of the Porcupine hills there is a well-wooded district, which in places grows spruce, larch and hacmatack large enough for merchantable timber. Great quantities are treated by the small saw-mills erected along this part of the railway. Arriving at Neepawa, a trip was taken thence to Minnedosa and Yorkton. Good farms and a number of thriving towns were observed along this route. Returning from Yorkton to Minnedosa a trip was made across the country to Estevan where two days were spent. The coal and brick works at Estevan were visited, as well as those at Roches Percee and Pinto siding. Clays were found to be abundant everywhere, but whether adapted for making fire brick has not yet been ascertained. At Moosejaw Mr. W. White manufactures common brick and a limited quantity of fire brick from clay obtained at hills near Wood mountain. This clay he hauls to Moosejaw in winter. The output of fire-clay could be greatly increased and a ready sale obtained if the clay could be obtained at a less cost.

Returning from Moosejaw to Saskatoon the surface beds in the valley of the South Saskatchewan were examined in some detail. In a cutting of the new branch of the

Canadian Pacific railway north of South Saskatchewan river the following series in descending order was noted:—

(1) Ordinary surface loam, sand and gravel.

(2) Fine-grained, stratified sand and silt, in some places in horizontal position, in others in wavy, curving beds, having in some parts apparently been deposited in moving waters of variable velocity.

(3) The decomposed rock surface beneath.

No boulder-clay was seen in this cutting nor in one along the Grand Trunk railway near by.

At and near Prince Albert, on the North Saskatchewan, boulders of Archæan rocks seem to be scarcer than in some places farther south, but a number were observed in the river bed and along its banks.

Terminal moraines of small dimensions were noted to the northeast of North Battleford, three or four miles from the Saskatchewan river. They evidently belong to the latest ice period, for stratified sands and gravels occur beneath them. The wide valley of the Saskatchewan here for four or five miles, has been almost wholly eroded in the surface beds since the ice period referred to. The prairie is at the same level on both sides of the river. Terraces occur at high levels; some quite distinct at 300 feet above the river and others at less altitudes.

At the Canadian Northern Railway bridge crossing the Saskatchewan above Battleford, boulder-clay is exposed in cuttings on both sides of the river, showing that the ancient valley here, at all events, was partly filled with it. This part of the Saskatchewan valley has, therefore, been inter- or pre-glacial.

At Lloydminster settlement there is another of these wide shallow basins with a black clay or gumbo soil, so common on the first and second prairie steppes.

Between this and Edmonton there is a good deal of bush country and stumps of poplar, willow, &c., with open spaces between. In the valley of the Saskatchewan there are flats of varying width with a rich black soil. This is the character of the country to Edmonton and beyond it.

Edmonton stands on the north bank of the Saskatchewan river in a fine agricultural region extending to the north, east and west. The ever-recurring black vegetable soil covers the surface to variable depths, and poplar and willow groves are a prevailing feature. At Strathcona on the south side of the river similar features characterize the plain.

The Saskatchewan valley here contains thick beds of clay suitable for the manufacture of brick, tiles, pressed brick, &c. Fire bricks have also been produced by Messrs. P. Anderson & Co., from certain clays near their works in East Strathcona. With this brick Mr. Anderson has lined his furnace and informs me that it has stood the test for four years.

The Great Plains.—The plains or prairies of the Canadian Northwest are really the upper or northern extension of the great valleys of the Mississippi and Missouri rivers into Canada. As has been shown by the late Dr. G. M. Dawson* these plains rise gradually from east to west in the form of steppes, being 800 or 900 feet above sea-

* The Geology and Resources of the Forty-ninth Parallel, pp. 3-6.

level at or near Winnipeg, while at the foot of the Rocky mountains they are 4,000 feet or more. This ascent is not regular, however, each steppe having certain features peculiar to itself. Elevations called mountains occur in a number of places. The steppes are best seen along the main line of the Canadian Pacific railway. Though these prairies may be called plains, the term can hardly be applied strictly to the features of the second and third steppes, which in many localities have a rolling aspect and numerous inequalities of the surface.

The materials constituting the surface deposits of this great prairie region are of different kinds, as is shown by the following general section of the beds in descending order:—

1. A dark or blackish, tough clay, containing some sand and silt, but nevertheless forming, when wet, a soft tenaceous mass, very sticky and coherent. In dry weather it bakes and becomes almost as hard as a brick. In the western United States this deposit is usually called 'gumbo,' and the name is gradually being adopted in Manitoba and the new provinces.

The thickness of this deposit is variable; sometimes it is only a few inches, while in local areas it is eight to ten feet or more. It occurs in all the hollows of the first and second steppes and occasionally on the higher grounds, though on the latter in a comparatively thin sheet and in flat, wet areas. The more elevated grounds and the ridges and hills are generally devoid of it. So far as it has been studied it seems to be a vegetable formation, which in the lower grounds grew in shallow lakes, ponds and swamps, accumulating *in situ* for ages. Dead and decayed water-and-marsh plants, together with peat and other vegetation growing in moist places, seem to make up the bulk of this deposit. The intermixed fine sand and silt have probably been carried into the swamps and ponds by rains, wind, &c., from the higher and drier grounds surrounding them. The occurrence of this black soil on the higher level tracts indicates that these were also marsh and swamp lands at one time. The wide horizontal areas covered by this formation shows that it must have been formed in water that was very shallow. On the first and second prairie steppes it does not seem that this black soil could have any other but a lacustrine origin, but on the third steppe in Alberta it is possibly of sub-ærial growth in some places, unless the levels of the country have changed very considerably since its deposition or growth. In the latter district it must be admitted that the areas occupied by this black soil are not in all places in the horizontal attitude in which they usually occur in Manitoba, where it is so wide-spread. This fact and its thickness in the province last-mentioned would indicate that it was a region of shallow lakes, marshes and bogs for a long time. This black soil is the formation which makes the plains so fertile.

2. Beneath the black loam just described, a grey clay of variable thickness occurs almost everywhere on the plains. From this clay considerable quantities of common brick are manufactured. It seldom exceeds a thickness of four or five feet, and generally contains more or less sand, and frequently, a few pebbles.

3. Below this lies a harder clay, somewhat similar to No. 2, but with compact, rusty strata, often called 'hardpan.' These harder strata sometimes alternate with

clays of a pebbly or coarse texture. In the Red River valley this member of the series has been found forty feet thick or more. Westward it becomes thinner, or rather is often replaced by other beds.

This series of deposits with the local variation observed in it may be found over most of the plains. In many places, sand, gravel and silts, often of considerable thickness, are intercalated, while in river valleys fluviatile deposits are found to contain clays suitable for the manufacture of bricks, tiles, &c. In descending order, generally speaking, these fluviatile beds consist of (1) clay; (2) gravel and sand, or sometimes silts ; (3) sand, ten to twelve feet, and a harder clay beneath—thickness unknown. This may be partly boulder clay.

An interesting section of the surface beds was seen in the bank of the Canadian Pacific irrigation canal along the Bow river, about four miles below Calgary. These, in descending order are as follows: (1) Sand and gravel, from a few inches to a foot or more; (2) eight to ten feet of stratified clay; (3) boulder-clay twelve to fifteen feet; contains numerous boulders of all sizes up to two feet in diameter, but only one or two small ones that might be called Laurentian. In this boulder clay there occurs a lenticular seam of stratified gravel and sand, two or three feet thick, which was seen to thin out to an edge in one direction and disappear, and apparently did so in the other. This resembles the intercalated stratified gravels and sands observed in the Scottish boulder-clays, and described by Prof. J. Geikie in the 'Great Ice Age.' (4) Decomposed sandstones.

At Medicine Hat there is a good section of the surface beds at the brick yard of Messrs. Purmal Bros. These appear in the face of the bank or cut to be 150 feet thick, while the rock surface is said to be fifty feet lower. It appeared to me, however, that the lower part of the section is merely the weathered edges of the Cretaceous rocks of the district.

GLACIATION, BOULDER-CLAY AND BOULDERS.

Though boulders from the Archaean and other rocks lying to the north of the plains occur scattered over them in trails and patches up to within fifty or 100 miles of the Rocky mountains, yet the quantities of boulder-clay found upon these plains are limited and sporadic. Both boulders and boulder-clay usually occur in belts which range generally north and south, or northeast and southwest, though occasionally these belts, or moraines as they are sometimes called, have an east and west trend. At all events, they do not seem to have been laid down regularly or in continuous beds upon the surface of the region. Whether this is really the result of the original mode of deposition, however, or is due to subsequent denudation remains to be determined. A feature of the boulder-clay may be noted, namely, that it is often found massed against the north or northeast sides of the hills, while the central part of the mountain is generally occupied with deposits of stratified materials, and wherever any contact of the two is seen the latter is found beneath the boulder-clay. This fact, along with others referred to later, tends to support the view that these mountains are really remnants of a former surface of the plains which stood as high then as their present summits now do.

Owing to the irregular occurrence of the boulder-clay its position in the series is difficult if not impossible to determine; in other words, it cannot be stated with

certainty whether a deposit of boulder-clay is upper or lower. The evidence, therefore, as to two or more boulder-clays on the plains is, after all, rather uncertain.

Ice striæ are rarely seen on the plains, but near their northern limits the older rocks are abundantly scored. The principal evidence we have, therefore, regarding ice movements across the prairie region, is that of the transport of boulders and boulder-clay itself, and these, as far as observed, only show such movements along certain lines.

Drainage features.—The drainage features of the plains are most interesting. The Saskatchewan river, with its numerous tributaries, is evidently the oldest of these and is one of the most important physical features of the country. The erosion and trenching of the Rocky mountains, and the distribution of the materials composing the surface deposits of the higher parts of the prairie are largely the work of this river. These materials, on the third or highest prairie steppe, have been derived almost directly from the mountains The loose silty and arenaceous character of much of the materials, however, renders them exceedingly mobile, or easily moved from higher to lower levels. Rivers and brooks, rains, winds, frost and snow denude and cause them to be thus readily moved, and their transport eastward from higher to lower levels and the consequent reduction of large portions of the plains to a comparatively uniform surface seems to be largely due to this cause. There are, however, a number of features connected with the denudation and levelling of the plains which lend countenance to the hypothesis of a fluvial and lacustrine stage preceding the present. The existence of old river valleys and lake basins now empty of water, or nearly so, the former high level of many of the lakes and of portions of the prairies, as shown by old shore lines and flat-topped eminences called mountains, support this view.

BRITISH COLUMBIA.

The surface deposits of British Columbia are somewhat different from those of the great plains. The black clay or vegetable deposit is not often seen there, the materials consisting largely of gravels, sands, silts and clay. The heavier precipitation and the extensive denudation which the western slope of the Cordillera has undergone carried away much of the eroded material. Except in the river flats, which are comparatively narrow until we approach the Pacific coast, the level surfaces are few and limited. The valley of the Fraser river, however, exhibits some fine terraces and meadows in its lower reaches, and where these are overflowed by spring floods periodically there is a black loamy soil. These remarks apply more particularly to the mainland; but the surface deposits of Vancouver island, so far as examined, appear to be very much the same.

CLAYS SUITABLE FOR ECONOMIC PURPOSES.

Clays are common in the prairies and British Columbia, and bricks are manufactured at or near all the principal towns. The clays of the plains, however, contain lime, as they are largely derived from the shales, limestones and other rocks of the prairie and Rocky mountains. Iron and other substances, as for example soda, potash, magnesia, &c., are also found in them and are more or less detrimental to clays intended to be used for refractory products such as firebrick, pottery, &c.

Though ordinary brick clays are so widely distributed over the prairies they are quite thin in many places, and vary in character and composition.

In British Columbia bricks are made in several places, especially at or near the towns. Pressed brick, firebrick and sewer pipes are manufactured at Victoria, Fraser river and other places. Good fireclays occur at Ladysmith and Comox, and on the mainland at Matsqui on the west side of Fraser river.

A highly plastic ferruginous clay, which might be used as a pigment, occurs on Texada island.

From the north arm of Burrard inlet a good brick clay has been obtained.

'A fairly refractory firebrick could be made from an under-clay which occurs in Granite creek, Yale district, and in the Kamloops division of the same district another deposit of good clay is found up Guichon creek.'

Clays of economic value have also been noted on Michel creek, East Kootenay, and on Arrow lake, West Kootenay.

Large cement works are now under construction at Exshaw, east of Banff. They are situated near the Canadian Pacific Railway track. Another extensive establishment of the same kind is being erected in the vicinity of Calgary.

WATER SUPPLY.

A good deal of discussion has taken place recently in regard to the water supply of the great plains. The past summer having been very hot and dry, attention was more particularly directed to the scarcity and impure quality of the water in at least some districts. The chief deleterious substances found in it are said to be soda and potash (generally known here as alkali) and magnesia. Not only are the waters of the lakes impregnated with these substances, but many of the rivers and brooks also contain them.

In spite of the prevalent belief that the waters of the lowest part of the plains are more highly charged with unwholesome substances than are those of the highest parts to the west, it has been found that there is litttle if any difference, and that the rivers as they debouch from the Rocky mountains contain alkali and other unwholesome ingredients. But it is not only the impure water with which so many of the towns and villages on the prairies are troubled; it is also the bad drainage or sewerage. Owing to the level character of so much of the country the drainage is extremely sluggish in some parts, and several of the towns have really been built on sites where there is no outlet of discharge or means of carrying it off. A serious problem faces them, therefore, and unless means are taken at once to obviate these conditions dangerous consequences may follow.

The quality of the soil in the Great Plains is considered to be excellent, yet here as elsewhere the growth of vegetation depends to a large extent upon the quantity of rain that falls. Wherever there is sufficient moisture crops grow bountifully. Even in the arid tracts irrigation has proved that the soil is rich in all the elements which tend to fertility, and only requires the necessary quantity of moisture to enable it to produce good crops. The black loamy soils with clay underneath are considered the richest on the prairies. But all soils are fertile with a moderate amount of rainfall.

In British Columbia the soil is different from that of the prairies. Clays, sands, silts and gravels prevail everywhere, however, and the central part of British Columbia has been found a good fruit-growing district.

FORESTS.

On the prairies there is very little forest growth observed until we approach the Saskatchewan river and lakes, though clumps of poplar and willow occur in the more humid parts. These increase in extent, however, and the trees also increase in size as we proceed northward. In certain areas, as for example in the Riding, Duck and Porcupine mountains, there is a forest growth in which spruce is large enough to be used as lumber. North of the Saskatchewan river many valuable timber lands exist (except in Alberta to the north of Edmonton) and a number of saw mills along the banks of this river are operated by lumbermen. Spruce lumber is the chief product.

MARINE DEPOSITS AND SHORE LINES.

None of the surface deposits of the Great Plains appear to have been formed beneath the sea, and consequently any terraces or shore lines observed must have been built up along the borders of lakes or on the banks of rivers. Marine fossils have not been found in them. In British Columbia, however, evidences of a former lower level of the land with reference to the sea have been noted. These occur in the Fraser River valley and around Burrard inlet. In the last-mentioned place terraces were observed, the heights of which were measured by aneroid. Two of these facing the inlet were found to be 330 and 355 feet above sea level. The latter terrace is uneven, however, and much denuded and boulder strewn. The rough wooded character of the mountain slope prevented observations from being made at higher levels.

ON EXPLORATIONS ALONG THE LINE OF THE GRAND TRUNK PACIFIC RAILWAY BETWEEN PORTAGE LA PRAIRIE AND EDMONTON.

Prof. J. Macoun

Early in May I received your instructions to proceed to Portage la Prairie and from thence to make an examination of the country on both sides of the Grand Trunk Pacific as far as Edmonton, Alberta. Besides making notes on the agricultural capabilities of the districts passed over I was also to pay attention to the natural history and make collections of plants, birds and mammals. The appended summary will show in brief the results obtained.

I left Ottawa, June 1, and proceeded to Portage la Prairie. My party consisted of Mr. William Herriot, of Galt, Ont., who assisted me with the botany; Mr. George Atkinson, of Portage la Prairie, who came as cook and ornithologist; and Mr. Ben. Younghusband, who had charge of the horses. We were ready to start on June 8, but owing to continued wet weather we did not leave Portage la Prairie until June 11.

On August 3, 1872, I had been at Portage la Prairie with Mr. Sandford Fleming and found only the Hudson's Bay Company's post, and no settlement beyond Rat creek. Beyond that creek extended an unbroken, deserted wilderness to Edmonton. Seven years later when I again passed through the country settlements were being formed at many points east of Fort Ellice, and on the publication of my report of 1879, a rush took place to the Qu'Appelle valley, which has since grown until now a continuous wheat field extends for fully 200 miles. The conclusions regarding the fertility of the soil which I published in 1872, 1879 and 1880 have been practically illustrated by the results obtained by actual experiment. At this time it is conceded by all observers that the growth of grain throughout the whole of what was formerly called the 'Fertile Belt' is no longer an experiment, but an actual fact and can be relied on for all time. This being a known fact, my work in Manitoba was merely one of comparison with the line of the Canadian Pacific railway, which lay to the south of the Grand Trunk Pacific. Keeping this in mind, I took the road from Portage la Prairie and passed through Bagot, McGregor, Austin and Sidney, at which point we left the road and kept on northwesterly, passing near Petrel and Woodlea to Forrest. From thence we passed through Carnegie, Pendennis and Westwood, camping on Oak river. All the country traversed up to this time had been long settled and, with the exception of the sandhills, was nearly all fenced and occupied. The Grand Trunk Pacific passes through the most fertile part of the district about ten miles north of Carberry, and will draw much traffic from this rich region.

Owing to the absence of roads and the destruction of the old trails, we found it very difficult to get across the country, but this enabled us to see more of the land and my constant record was rich soil and immense wheat fields. From our camp on Oak river we passed northwesterly to Hamiota, through an almost continuous wheat field and for nine miles beyond on the way to Birtle the same character of country was observed.

After leaving Hamiota we decided to reach the mouth of the Qu'Appelle by way of Birtle, as south of this point the G. T. P. took the valley of the Assiniboine. Owing to the heavy rains and bad trails we found much difficulty in forcing our way to Birtle. We were well repaid, however, as we were able to traverse many miles of country sparsely settled, but naturally rich, though at present wet and much broken up with ponds and marshes.

Our information as to routes being inaccurate, we went from Birtle to Fort Ellice and had to return to the east side of the Assiniboine, and go up the river to St. Lazare where the G.T.P. crosses over to the mouth of the Qu'Appelle. Here we encountered an awful thunder storm, when the rain fell in torrents for twelve hours. On June 29, we crossed the river and travelled by way of Spy Hill, Redpath, Riversdale and northwesterly, to Yorkton. Here we obtained supplies and passed westward to near Willowbrook and thence to Hirzel, where we again reached the G.T.P. From this time forward we were never more than ten miles from the proposed line until we reached Edmonton, and most of the distance was on the engineer's trail.

All the country from the Assiniboine westward to Touchwood and over twenty miles beyond is more or less covered with wood, although there are often great stretches of prairie interspersed with it. Ponds, marshes, rich bottoms and often numerous lakes are scattered without order throughout the whole country. Owing to the heavy rains of June and early July there was a superabundance of water as far as Touchwood, but west of that there was a marked change.

Everywhere the soil was rich, chiefly black loam, and wheat, and all other crops were most luxuriant. In the Beaver hills, the soil was excellent and wood was most abundant. At the Indian Mission near Touchwood, we found excellent wheat and in the garden at the Post all the vegetables of the finest quality usually found in eastern gardens. For twenty miles after leaving Touchwood, the G.T.P. passes through hills or rolling country all of which could be cultivated, and will be when communication is opened up. This district has many settlers now, and will soon fill as all the soil is good.

After leaving Touchwood the hills began to flatten out and there was less wood and brush and more prairie. Settlers' huts could be seen in all directions after the prairie was reached, and about five miles beyond its eastern limit the G.T.P. took a straight course for one hundred miles to Saskatoon. This one hundred miles is almost all prairie and as far as the eye can see in all directions from almost any point, nothing meets it except grass and flowers and occasional homesteads, where there are settlers who are established on the open treeless prairie. All the crops were good, no matter in which direction we went, and the opinions I held of this same region in 1879 were amply fulfilled in 1906. There is practically no bad land, and the alkaline flats or 'bad lands' of former writers are the best wheat fields of to-day. On these extensive prairies the settler's first work is the erection of a sod house and the digging of a well, and then he is established. Fine oats, barley, potatoes and sometimes wheat were found on last spring's breaking, and some settlers would have nearly all they needed for the winter on land broken this year.

When we reached Saline creek, or the discharge of Quill lakes, we turned north for nearly two miles, and found excellent wheat, and settlers who had been there

for several years. West of the creek the land continued good right up to Boulder (Stony) lake. Owing to white mud flats at the south end of this lake, we were obliged to travel around the north end of it. Passing up the east side of the lake, the soil became sandy, but the crops were equally as good as those on heavier soil.

After passing round the head of the lake we had four miles of boulders to cross where the land was useless as the stones were quite close together. Passing these the country continued level for ten miles, then we passed through a belt of poplars and willows and from them into a series of bare hills containing much gravel. After the hills, we crossed a wide plain lying south of Little Manitou lake. On this plain the soil was dry but rich, but water was scarce and wood was altogether wanting.

An examination of Little Manitou lake was made. It was found in a deep valley with very bitter water and margin of boulders on the south nearly a mile broad. The surface in the vicinity of the lake was very dry and stony and this was the characteristic for the next ten miles, and few settlers had taken up land. After this the character of the country changed, the grass became long and green and in numbers of places the grass on the open prairie had been cut for hay, and great stacks were seen on every hand. From this to Saskatoon, a distance of over forty miles, the land was almost all fit for the plough and much of it had been taken up within the last four years.

Owing to the change in colour of the soil from a black to a brown loam, eastern people would be tempted to speak slightingly of the land, but in no case did poor crops appear, and at the Frank settlement, twenty miles east of Saskatoon, we passed through fields of wheat as fine as any we had seen in Manitoba. The soil contains a certain percentage of sand, which, instead of being detrimental, according to a leading farmer in the district is beneficial, as it withstands drought better and heavy rains are not injurious. Frost has never done any damage, and my opinion is that the soil is a naturally warm one and the heat is retained at night instead of being radiated as in the case of black soils. I was constantly struck by the remarkable luxuriance of everything grown in the country between Saskatoon and Touchwood, a distance, as the crow flies, of 125 miles. Wheat, oats, barley, flax and potatoes were constantly good, except where they were very late in being planted or sown.

I am quite safe in saying that all the land from Touchwood to Saskatoon is suitable for wheat-growing except the stony tracts around Boulder lake and Little Manitou lake. Nearly all tthe country is level or gently rolling and fit for the plough, and the Grand Trunk Pacific will open up an immense extent of wheat lands which would otherwise have no outlet.

When we were at Saskatoon, during the last week in July, scores of houses were in course of erection. Having obtained the necessary supplies and made some repairs to harness and waggons, we started west on the afternoon of July 28, and drove sixteen miles. Our way led through the Smith settlement, in which there were many excellent farms, and where immense wheat fields met the eye on every hand. This old settlement, Summerdale, stands next, in my mind, to the splendid farms we saw north of Carberry, in Manitoba. Passing through the settlement, we saw fields of poor wheat amongst the very best, and learned from a farmer the cause. The spring

was cold and backward and all wheat looked well when it came up, but that on the best worked land seemed to get chilled at the time of the cold rains in May, as it never recovered.

The country which we travelled over was thickly settled for about ten miles, after which it became more or less sandy, with alkali flats for five miles. Then for twenty miles to the crossing of Eagle creek there were many settlers. Beyond the creek there were very few settlers, but the land seemed suitable all the way to the Bare hills. This district has little water and no wood, and west of it is the Bare Hills district, so named because they are without tree or bush for many miles. The soil in the Bare hills is very good, and few of the hills are too steep for the plough, so that in time they will be settled. The characteristic soil of the country is a light-coloured, sandy loam changing to brown.

A drive of fourteen miles brought us to a big spring on the western side of the hills. The trail through them is not difficult, and the western side has abrupt hills with much sand in them. The afternoon drive was very varied in character, as the soil changed from a light sand to clay, with many saline lakes and ponds in the depressions. Scarcely a bush was seen and no trees. The Eagle hills lie to the north, but were too far off to be seen.

We now entered on a series of salt ponds and lakes, among which is Whiteshore lake, so called on account of a white incrustation on the shore left by the evaporation of the water. Both here and on all parts of the prairie we found the saline water always in the deepest depressions, and good water in ponds where the land was elevated. All the country covered by drift has either good water on the surface or it can be obtained by sinking wells which are seldom over thirty feet deep. If a well should be sunk through the drift into the clay below, bad water is the certain result.

Ponds only a short distance apart, but on different levels, were often found containing sometimes good water and sometimes bad water. The bad water was always on the lower level.

The forty miles beyond Whiteshore lake to the head of Tramping lake was all prairie, altogether without trees, and having very little good water on the surface. For the first twelve miles the country was very dry and the grass short. Its surface was undulating and the soil apparently very good. After passing through a series of low hills we came on a level plain that extended all the way to the head of Tramping lake. As we neared the head of the lake the grass became greener, but neither water nor brush was noticed until we reached the ravine at the head of the lake. Wells had been dug in the ravine by settlers living close by, but the supply of water was meagre. Considerable breaking has been done since spring, when most of the settlers came in, but the oat crop was scanty, although potatoes looked well. South of Tramping lake many houses could be seen, and the settlement seemed older. The settlers met with were invariably from the United States and all seemed pleased with their prospects.

At Tramping lake the country is almost a dead level, and as a consequence there is neither wood nor water, except a few willows in the ravine and the shallow wells spoken of above. These conditions prevailed until we neared Kill Squaw lake, when the depressions became deeper and occasional bushes and some poplars were seen. Around

this lake there are immense hay marshes a very few feet below the general level of the prairie with its crisp and dried up grass. After passing around the hay marshes we worked around more to the north and could see a line of high ground running around to the northwest. It was now evident that we had passed over a height-of-land and had begun to descend over a very uneven surface towards the west. As we approached the head of Round valley the land dipped considerably, and at the Grand Trunk Pacific construction camp we came on a fine spring of good water, evidently from sand hills which extended to the south.

Round valley is the crossing place of the branch of the Canadian Pacific railway extending from Saskatoon to Wetaskiwin, and the Grand Trunk Pacific railway coming from Saskatoon to Edmonton. From Saskatoon to this point we could never tell which railway we were passing along. The crossing takes place at the east end of the valley, the Canadian Pacific railway taking the south side and the Grand Trunk Pacific railway the north side. On the south side there is a range of low sand hills, and on the north there is a level plateau of excellent soil extending towards Battleford.

The line of the Grand Trunk Pacific passes down the valley from Round lake for about four miles, when a range of sand hills is reached. Passing these we found a hilly country with good water and a fair supply of wood. As we approached Lake Manitou the country became rougher with numerous sand hills, but generally the soil was good and many extensive tracts of good land were passed. Wood and water were abundant and the country is well suited for mixed farming.

Eye Hill Creek valley is well suited for stock farming as there is an abundance of water and wood and extensive hay marshes in many places, especially south of Lake Manitou. The country south of Lake Manitou is very much broken and rises into ridges and high hills with narrow valleys between. There is plenty of wood and water, and a luxuriant vegetation towards the lake. For ten miles after this we were travelling westerly through series after series of sand hills and patches of burnt woods. At last we passed the hills and reached a rich rolling country and lunched at an engineer's camp exactly on the 4th princopal meridian, the boundary between Saskathewan and Alberta. Before we reached the camp even the highest hills bore a very luxuriant crop of grass and were well suited for the plough. After leaving the camp there was a constant improvement in the country; the hills became less steep and the valleys wide enough to make good farming lands. There was not a settler on the whole twelve miles to Ribstone creek, yet we were delighted with it, and there was wood and water and a fairly level country. The vetch and pea vine formed thickets that was almost impassable.

We camped on Ribstone creek, in township 14, rangeII, and section 2, west of the principal meridian. The creek was found to be about twelve feet wide with banks from four to six feet high. Its valley frequently expands, and there are fine hay bottoms, becoming continuous farther west. The settlers west of the creek had cut hay; and oats on this spring's breaking were fairly good—fully ripe on August 12. During the 13th we passed up Ribstone creek, and saw numerous settlers just making a commencement, and all were pleased with their prospects. After passing through four miles of sand hills we recrossed Ribstone creek, and found the whole valley a continuous hay meadow. We saw no settlers, and hay was being cut in only

one or two places, until we reached the location of Mr. George Hunt, where we camped. His location is an ideal one for a stock farm, as he has high sand hills, with wooded ravines to the south, while to the north he has the extensive meadows along Ribstone creek and his ranch house is on a beautiful lake of fairly good water.

From the third crossing of Ribstone creek to Battle river, a distance of twenty miles, the land is all fit for settlement, and much of it is taken up, though few settlers were seen. Some fields of excellent oats on spring breaking were noted and many haystacks were observed. Evidently the country had changed very much for the better, and continuous settlement was only a matter of time.

Battle river flows in a deep, narrow valley at the crossing, but the land on both sides at prairie level is excellent, though water on the surface is scarce owing to the lack of depressions. Along Grattan creek the land is much broken by ravines leading into the creek, but a mile or two back of the creek the whole country is fit for settlement. Passing westward from Grattan creek the country becomes much broken, but the soil was good and there were many ponds of fresh water. Later the hills became more elevated, with many deep depressions, but before we camped the hills had flattened out considerably, and we entered on a splendid farming country where settlement had only begun last spring.

Our camp was in township 47, range XII., and section 22. In every direction from this camp we found first-class soil, plenty of ponds, and land all fit for the plough, with sufficient wood for fuel. We had now reached the outskirts of the settlements, and from this time forward we were never out of sight of houses except in Beaver Lake hills. In a garden at Thomas lake we found all kinds of vegetables growing in perfection: Indian corn, squash, pumpkins and cucumbers. The corn was almost fit for the table and the cucumbers were ripe on August 19. On this date we had a slight frost, but it did no harm, and hardly touched the potato tops.

From our camp to the west side of Beaver Hills lake, a distance of about sixty miles as the crow flies, was more or less settled, and all the oats and wheat were ripe and some of them in stack on August 22. Almost all the land was fit for the plough, and in many places there were large settlements, where the land was fenced in and the roads graded. Owing to the level character of the country water was scarce, and we were informed this was the only drawback.

The district around the south end of Beaver Hills lake, which is fourteen miles long and eight broad and whose waters are quite fresh, is very rich and beautiful, and at no distant date will be one of the finest in Alberta. The lake has no banks and rich lands slope down to it on all sides.

A twenty mile drive through Beaver Lake Hills forest reservation brought us to Base Line road, and along this we travelled rapidly to Edmonton, where we arrived on August 24. Ottawa was reached on September 2.

EXPLORATIONS ALONG THE PROPOSED LINE OF THE HUDSON BAY RAILWAY.

W. McInnes.

The region dealt with in the present preliminary report lies to the northeast of the lower Saskatchewan, extending from that river at the Pas to Split lake, where the Nelson river approaches most closely the headwaters of the Little Churchill.

It is bounded by north latitude 53° 50′ and 56° 10′ and by west longitude 99° 15′ and 101° 15′. Its general elevation above the sea is between seven hundred and nine hundred feet. It is accessible at the present time only by canoes, the northern and eastern parts by way of Lake Winnipeg and the Nelson river and its tributaries, and the southern part by way of the Saskatchewan river, either down stream from Prince Albert or up stream from Lake Winnipegosis by way of High portage and Cedar lake.

For purposes of general description it may, in a broad way, be divided into three areas; the limestone area embracing all the tract underlaid by the horizontal or gently undulating, magnesian limestones or dolomites of northern Manitoba; the Archaean area, a somewhat broken and rugged country extending from the northern edge of the limestone escarpment northward and eastward until covered by the lacustrine sediments of the third or clay area. The latter, a gently-rolling, clay-covered country, extends from the valley of the Nelson river on the east to a contour, westerly, where the general elevation of the land is in the vicinity of nine hundred feet above the sea, or to approximately west longitude 99° 30′. The northern edge of the clay basin was not reached, but the Indians of the Burntwood River region agree in saying that the Churchill River valley forms its most northerly extension.

The last of the three divisions is, generally, well suited for cultivation, but throughout the first two the areas suitable for agriculture are of limited extent.

No part of the region is prairie though along some of the valleys, and here and there on the uplands, are found extensive hay marshes, with only occasional small clumps of willows, that, with drainage, would become virtually prairie lands.

The fairly close examination made last summer has shown that the arable lands of any considerable extent are confined to the old basin of the so-called glacial Lake Agassiz. The tracing of the outlines of this extensive, ancient lake, that has long ago receded from the greater part of its former basin and is represented now only by a series of separate, smaller lakes, would perhaps strike one at first as being of academic rather than practical interest. A little consideration of the conditions prevailing in that country will, however, show that it is a matter of the greatest practical value.

The region has been most profoundly glaciated. At least two great glaciers, almost continental in extent, swept over it, and it will readily be believed that all the softer rock surfaces were planed away. No decayed rock was left and the limited areas under-

lain by the more easily disintegrated rocks became the basins of lakes or the valleys of streams. The horizontal limestones, or rather dolomites (as they are all somewhat highly magnesian), are too hard to give way easily to atmospheric weathering and we must, therefore, look to some extraneous source for any considerable soil cover.

This source is found in the sedimentation that went on at the bottom of Lake Agassiz. Confined on the north and east by barriers of glacial ice, from which poured the sediment-charged streams that supplied its waters, the lake was being constantly and rapidly silted up by the deposits dropped by the quiet and gradually clearing water. The more siliceous and heavier deposits and the greater volume would be laid down nearest to the source of supply at the edge of the glacial boundary, and as the distance from this source increased the clays would be deposited in less volume by the clearer water and would be lighter or less siliceous in character. Quite in harmony with this we find that the northeastern part of the area is covered by a mantle of siliceous clay reaching a thickness, in the valleys, of upwards of a hundred feet. Owing to the gradual recession of the ice the greatest thickness is not found close to the eastern rim of the basin but at some distance from it, where deposition continued for a longer period. Westerly from the zone of greatest sedimentation the deposits become gradually thinner and *pari passu* less siliceous. This thinning out of the clay as the distance from the glacial barriers increases is, of course, not to be attributed solely to the gradual clearing of the water. The increasing elevation of the land in that direction involves a shallowing of the waters of the lake and hence, necessarily, a lessening deposition of sediment.

Though a wooded country throughout there are but limited areas where the forest growth is of a size to be commercially of much value. There are no hard woods, the only deciduous trees that attain merchantable measurement being the canoe birch (*Betuld papyrifera*), the aspen and balsam poplars (*Populus tremuloides and P. balsamea*) and the tamarack (*Larix Americana*). Black spruce (*Picea nigra*) is the most abundant coniferous tree and grows to a size sufficient, at least, for pulpwood. Associated with tamarack, it covers all the more marshy tracts, giving way, where the land becomes dryer, to white spruce, (*Picea alba*), which is the timber tree of the region, and, on the dryest ridges, to Banksian pine.

Forest fires have been wide-spread and most destructive throughout the whole region, sparing only the very wet, muskeg areas and a few tracts isolated by surrounding water or marsh. In some places on the uplands the charred stumps were seen to indicate the passage of two successive fires at intervals of about forty years. Most of the fires seem to have been due to carelessness on the part of native travellers, for violent storms with lightning are not of frequent occurrence and during the whole summer but one trunk was noticed that had been shattered by lightning.

Geologically the region may be said to consist of a deeply eroded Archaean peneplain overlain in its southern portion by Palæozoic sediments consisting chiefly of dolomites and in itts eastern portion by Pleistocene clays. By far the larger part of the area, if we include that portion covered by the clays, is overlain by Laurentian biotite gneisses of various textures and with varying accessory minerals. The basins of Reed and Wekusko lakes and the greater portion of the valley of Grass river down to about longitude 99° 20′ have been excavated in the more easily eroded schistose rocks of the

Keewatin, and a belt of the same rocks crosses Pipe lake and touches the Burntwood river below Manazo fall. This Keewatin is made up mainly of gabbro, diorites, and hornblende, chlorite and other schists. With these are associated areas of intrusive granite, some of which, below Reed lake, are of even texture and bright red colour and would furnish very beautiful stones for monumental work and ornamental building.

Associated with the Keewatin below Reed lake is an area of felsitic rocks and conglomerates that, from the character of the included pebbles, must at least be as high up as Lower Huronian, as it contains among other pebbles pieces of banded jasper similar to that of the iron formations of the Keewatin. The source of these included fragments was not found.

Quartz veins are plentiful throughout the Keewatin belts, but with the exception of arsenical and iron pyrites and traces of copper, no valuable minerals were found in them, though their character, particularly were exposed on the Grass river below Reed lake, was considered promising enough for the occurrence of the minerals that are so often associated with these rocks.

Palæozoic limestones cover all the country between the Saskatchewan and an east and west line cutting the southern ends of Reed and Wekusko lakes. They have been considered to be of Silurian age with but a narrow strip of underlying Cambro-Silurian projecting along their northern edge.* A collection of fossils made at Cormorant lake during the summer, examined by Dr. Whiteaves, seems to indicate that the beds containing them are of about the age of the Winnipeg limestones, and, therefore, Cambro-Silurian. The rocks are, as far as examined, magnesian, and are probably all dolomites. They occur in flat-lying or gently undulating beds varying in thickness from six feet or more to quite thin and shaly, the latter occurring near the base and the heavy beds forming the mass of the formation. Many of the heavy beds are even-grained and uniformly bedded, so that they can be readily taken out in blocks of even thickness and of any required size. Many of the low cliffs near the lakes are so situated as to be admirably adapted for quarrying.

In order to follow as closely as possible the direction that it was considered, from the general conformation of the country, that the line of the projected Hudson Bay railway would probably pursue, a route was selected for the transportation of supplies leading from the Nelson river at Split lake southwesterly to the Saskatchewan river at the Pas. As only the first seventy miles of the road beyond the crossing of the Saskatchewant had been actually located on the ground, there was an interval of one hundred and seventy miles between the end of the located portion and the headwaters of the Little Churchill, where its position could be only approximately inferred. It was necessary, therefore, to make a general exploration of all the section of country lying between these two points and to do this, the valleys of the Burntwood and Grass rivers, between which, for the greater part of its course, the road must be located, were selected as bases from which to work, the intervening country being reached by ascending tributary streams and by excursions across country.

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* Annual Report Geological Survey of Canada, Rep. F.F., Vol. XIII.

The Nelson river, which was descended to Split lake, was but cursorily examined in passing as it did not come properly within the scope of the season's investigations and had, moreover, been reported on by various explorers in the past, notably by Dr. R. Bell* and Mr. J. B. Tyrrell.**

Between Lake Winnipeg and Split lake, a distance of about two hundred and twenty-five miles, the river has a descent of, approximately, two hundred and seventy feet. The current, between the numerous lake expansions, is generally swift, and upwards of a dozen falls and rapids occur, some of the former offering magnificent sites for water powers. The aggregate power that could be generated along the river is enormous, as the amount of water passing over the various falls is very great. The volume of the river can best be appreciated by a consideration of the extent of its drainage area, which embraces all the country, westwards to the mountains, between the watershed of the Churchill and Athabaska on the north and the Missouri on the south, and eastwards to the headwaters of the Albany river and to within fifty miles of Lake Superior. Twenty-one miles down the river the Hudson's Bay Company maintain a fur-trading post known as Norway House; the chief factor in charge of the district cultivates a large garden where, on June 10, peas, beans, beets and other vegetables were well started. Wheat has been successfully grown here as well as at Cross lake farther down the river, in lat. 54° 40'. There are many tracts of land along the river suitable for cultivation, though for long stretches the banks show only rounded surfaces of biotite gneiss, smooth and glaciated. The cultivable areas are confined to tracts overlain by lacustrine clays which alternate along the shores with glacial gravels and the bare rock surfaces devoid of any soil cover. The prevailing rocks exposed along the river are biotite gneisses. Only at two places on the shores are other rocks seen, at Pipestone lake and on the southern shores of Cross lake, where a belt of Keewatin rocks crosses, and for some miles follows, the river valley. The exposures at Cross lake are promising looking for the occurrence of gold, resembling closely, as they do, the gold-bearing strata of the district east of Lake of the Woods. They are cut by intruded masses of the same crushed granite with blue opalescent quartz, known locally in the eastern region as *Protogine*. Below Cross lake no land is under cultivation until Split lake is reached just north of latitude 56°, where the postmaster for the Hudson's Bay Company raises potatoes and the commoner garden vegetables. White and black spruce, tamarack, aspen, balsam and canoe birch form the forest surrounding the lake, the deciduous trees for the most part growing only in a fringe along the immediate shores. Trees of suitable size for sawing into eight and ten inch boards are found on the islands, along the stream valleys and in places near the lake shores, but the general average size of the trees inland is smaller than this. Northwest of the Hudson's Bay Company's post the country is generally low, swampy and intersected by a network of small lakes; near Waskaiowaka lake, however, an extension northeasterly of the clay land of the lower Burntwood valley forms a comparatively dry ridge along which a good route for the railway can probably be found to the valley of the Little Churchill.

Burntwood River.

Burntwood river, a tributary of considerable volume, flows from the west, into the

* Report of Progress, Geological Survey of Canada, 1878-79-80.

** Annual Report, Geological Survey of Canada, 1901.

long westerly bay at the southern end of the lake, and its valley will probably be followed approximately by the railway along this part of its course.

The shores of the bay into which the river flows are, almost all along, low, rounded ledges of fine black and coarser, white biotite gneiss striking east and west. The neighbouring land is low, rising from the lake to a height of about twenty feet in a few chains and then much more gradually to about fifty feet, with occasional ridges of sand and clay reaching elevations of seventy feet.

The forest is mixed second growth, mainly spruce and tamarack, varying in age from recent brulé to fifty years.

The water of the Burntwood carries in suspension more sediment than the main Nelson, so much so as to be hardly at all transparent.

As the lake is left and the river ascended, the banks become higher, rising with a steep slope from the water level to fifty feet, and are composed of a siliceous clay that, where exposed through the burning of the protecting forest cover, becomes readily water soaked and unstable, giving way at intervals and sliding into the river bed. Eight miles from the mouth, the Odei or Heart river, a smooth flowing stream of considerable size, comes in from the west on the left bank, occupying a well marked valley with clay covered hills rising to heights of a hundred and fifty feet on both sides. The main river here makes an abrupt turn, flowing directly west for two miles, and the tributary rather than the main stream seems to be following the ancient pre-Glacial valley. Though the clay mantles covers all the hills an occasional cliff-like slope shows the underlying gneiss and proves that the river is flowing in an old rock-faced trough.

The clay, lying deep in the valleys and covering the summits more thinly, softens the surface contours and produces a country without high relief where the original, somewhat rugged Archæan surface has been smoothed down by the partial filling of the hollows and the lowering of the gradients. A few miles farther up the river, above a series of short rapids, the immediate banks are low, rising by a gradual slope six to twenty feet above water level and then extending back with a moderate slope for from two to three miles, where a height of about a hundred feet is reached. Much of this land is, apparently, well adapted for cultivation; the clay is entirely free from boulders and mixed near the surface with enough vegetable humus to produce a friable and seemingly productive soil. The gentle slopes give good natural drainage and the open character of the forest makes it a country easily cleared. But little timber left is of a size larger than eight inches in diameter, three feet from the ground, all the dryer parts, denuded of old forest by the repeated fires that have swept over the region, being covered by trees of only ten years growth or younger.

For the next nineteen miles the river valley and neighbouring country present the same general aspect. Here the valleys of the main river and the Odei approach one another, separated only by a dividing ridge a little over a mile across and a hundred and fifty feet high. The ridge is clay covered to the flat summit where knolls of the underlying gneiss project here and there from the soil. Beyond the valley of the Odei, to the north, is a rolling, forested country, the hills, clay covered to the tops, rising by gradual slopes to about a hundred feet above the intervening valleys that are themselves from twenty to fifty feet above the river level.

The forest is mainly spruce and tamarack of about sixty years growth, the larger trunks reaching diameters of from eight to ten inches, but the general average not more than six inches. In the valleys occasional white spruces and tamaracks attain diameters as great as eighteen inches. These are trees that have escaped when the surrounding forest was burned and are sufficient evidence that, but for the repeated fires, there would be large areas covered with good timber. For the next twenty-eight miles the river, flowing in a rock bound basin, has the character of a long, narrow lake from half a mile to over a mile in width. Covering the well-rounded ledges of gneiss that form the immediate shores is the same thick mantle of clay forming a country of very attractive appearance. Rising gradually from the river level to heights of from twenty to fifty feet, a flat or gently sloping plateau extends back from two to three miles to another rise, where the general level is increased to about a hundred feet. Recurring forest fires have not only denuded this section of its trees, but the stumps have for the most part been burned away so that it is now covered only by an open growth of small white birch, poplar, willow and Banksian pine, with an undergrowth of vetches, grasses and small shrubs. Just above is the Manazo fall where the river pitches over a ledge of gneiss with a vertical descent of thirty feet.

The probable course of a railway through this country would cross the river at one of the rapids below Manazo fall, where ledges projecting from either shore give good foundations for piers, and follow the north side of the river valley along the plateau land described above to the valley of the Odei, which would be crossed near where the two rivers approach one another. This would afford fairly deep water connexion with Split lake and the Nelson river, and their sturgeon fisheries, by way of the deep and smooth flowing Odei and Burntwood rivers.

Above Manazo fall the river expands again to form a long, narrow lake for the next ten miles of its upward course. The same rolling clay plateau extends back from both shores of the lake, rising gradually to an undulating, higher tract, perhaps 100 feet above the lake level. The forest growth is still very open, allowing a good surface carpet of grasses, vetches and other vegetation. Diversified here and there by small open tracts where the grass-covered surface is free from trees, this country often presents quite a park-like aspect. Throughout all the clay-covered region the absence of erratics is striking; for miles no perched boulders nor transported materials of any kind other than the lacustrine sediments, are seen, and even the country rock is deeply hidden under the heavy clay deposits that seem to be very homogeneous throughout, not laid down in thin layers as in the case of many clays of apparently similar origin in eastern Canada, but, if stratified at all, only in very heavy beds that seldom show their bedding planes. For the next fifteen miles to Wuskwatim lake the river has a quicker descent and its course is broken by several small rapids. The surrounding country is slightly higher, rising in places about 200 feet above the river, and more steeply from its shores. From the south shore a clay-covered bench a quarter of a mile wide rises to a comparatively steep slope to a height of 130 feet, and extends back for miles at about that level, with a gently undulating surface, free from boulders or rock, excepting very rare exposures. As a matter of fact but one small knoll of the underlying rock was actually seen, rising through the clay at a point about two miles back from the river. The low flat along the river is covered by a sixty-years timber growth, mainly of Banksian pine and spruce.

The higher pleteau is wooded principally with spruce from six to eight inches in diameter with scattered Banksian pines, poplars and white birches succeeding an earlier burned forest that was even younger when destroyed, and this following a still earlier, that by the stumps, is shown to have been somewhat larger. Evidently this country has been subjected to repeated burnings that have followed one another, often at intervals of comparatively few years. The areas of muskeg on the upland do not seem to be extensive and no gravel beds nor boulder ridges were seen. The Indians report that this plateau-like country extends right across to the valley of Grass river, with only gently swelling ridges and no high hills.

Wuskwatim lake is eight miles long by four wide, with a long bay extending off to the west from its southern end. The waters are but slightly turbid from suspended sediment, and abound in whitefish of good quality, and small sturgeon. On all sides of the lake are large tracts of nearly level clay land, extending back for several miles at heights of from fifteen to fifty feet above water level, and beyond that continuing at a level of a little over 100 feet. A mixed second growth forest, mainly aspen poplar, covers all the uplands, while on the islands and on low flats bordering bays of the lake are found white spruces and poplars of diameters up to one foot. The grass-covered slopes that rise with very gentle gradients from the shores of the lake make this a country of most attractive appearance, and one that apparently would be well suited for cultivation. The Indian inhabitants of this section cultivate with success small garden patches of potatoes.

Bordering many of the bays of the lake are sand beaches, the first seen on the river, made up principally of garnets and other Archaean detritus, but containing also in smaller proportion limestone pebbles derived from the Hudson Bay basin.

Mr. J. B. Tyrrell, who visited this lake in 1896, has this to say of it.*

'Wuskwatim lake is a very pretty sheet of slightly murky water, six or seven miles long and three miles wide, surrounded by sloping clay-covered hills, wooded with white spruce and poplar. Its surface is varied by a few islands composed of clay overlying a floor of gneiss. The two falls above-mentioned at and near its outlet, would furnish a large amount of power for driving mills or machinery of any kind, while a supply of timber for building and fuel could be obtained from the surrounding country, and the soil would grow any of the ordinary roots or more hardy cereals, so that it is not improbable that before long when this fertile country is made accessible by the advent of a railroad from the south one of the most prosperous towns in the district may grow up on the shore of this now secluded lake.'

Following the most direct practicable route, the line of the prospected Hudson Bay railway will probably pass within a short distance of the south shore of this lake.

Country of the same general character is seen for the next thirty miles up the river valley, covered, for the most part, with a mixed second growth from ten to thirty years old, but with, here and there, clumps of white spruce with tall and straight trunks a foot or more in diameter. Charred stumps of large size show that over considerable areas in this region the original forest was of great commercial value.

* Annual Report, Geological Survey of Canada, 1901, p. 34.

On the shores of Footprint lake, in latitude 55° 45′ small fields of potatoes planted by the Indians were looking remarkably well, the vines being eleven inches in height and about ready to blossom when this locality was visited, on July 10. Above the lake broad flats extend back from the river on both sides rising, from half a mile to a mile back, to fifty feet above the river. The greater part of the flats and practically all the high land has been burned over within twenty years, and is clothed now with an open growth of small mixed timber; the land is free from boulders and gravel and has a good carpet of native grasses, including such good meadow forms as the blue-joint, *Calamagrostis canadensis, Calamagrostis hyperborea* and the wild rye *(Elymus dasystachum)*. The open character of the forest permits a somewhat luxuriant growth of these grasses, mixed with vetches, strawberry vines, &c., and with currant, gooseberry and other small shrubs and bushes.

The land lying to the southward of the most southerly band of the river was found to rise with a comparatively steep slope to a height of sixty feet above the river, and to extend back as a level clay-covered plain with about five inches of clay-loam soil well mixed with vegetable matter gradually merging downwards into pure clay. The plateau has a gently rolling surface, the bottoms of the hollows, where small areas of muskeg often occur, having a deviation forty feet lower than the slopes of the ridges, and the highest land reaching not more than 100 feet above the river. For six miles back the areas of muskeg, that are not sphagnum swamps, but rather grassy marshes, are comparatively insignificant in extent, the higher land, wooded with Banksian pine, poplar and spruce and diversified by many open grassy glades, largely preponderating. Beyond this, however, a broad belt of wet, grassy marsh land extends southwesterly across to the heads of brooks running into Grass river below Wekusko lake, and forms practically the western limit of the clay-covered uplands, though in the river valleys and along the flanks of their bordering hills the clay land extends much farther west.

Of the whole of this extensive plateau land, extending from the valley of the Nelson river westward to near Burntwood and Wekusko lakes (west longitudes 99° 45′) northerly at least to beyond latitude 56° and southerly to the limestone escarpment, an area of about 10,000 square miles, it may be said it is characterized by a heavy clay soil entirely free from boulders. Lacustrine clays, composed of the rock flour once held in suspension by glacial streams and deposited by them as they reached the quiet waters of a great lake, are essentially the soils of this region. There is no distinct surface soil clearly separable from the clay subsoil; the one merges gradually into the other, the clayey character of the soil being strongly apparent at the very surface where merely the shallow cover of decaying leaves and other vegetation is scraped away. Generally, for from five inches to over a foot down, the clay is deep brown in colour from the admixture of vegetable matter, and quite friable, and rootlets of even the smaller surface vegetation reach down far below this level, though on the tops of many of the ridges the light-buff coloured clay without any appreciable coloration from vegetable matter comes quite to the surface. The rolling character of the plateau generally provides fair drainage, but over considerable areas in its central portion, far from the valleys of the larger streams, there are large tracts that have not sufficient gradients for the proper flow of the surface water, and could be made available for agricultural uses only by being artificially drained.

Beyond the western limit of the good country, which is reached in about longitude 99° 45′, is a typical Archæan surface, consisting of high gneiss hills bare and rugged, with intervening deep and sharp valleys generally occupied by muskegs. On the steep flanks of some of the slopes Banksian pine and spruce grow to a fair size, but, owing to the thinness or entire absence of soil-cover, the bare gneiss hills, devoid often even of moss, are covered only by a scattered growth of small trees. Little flats along the river valleys are overlain by clay, which extends up the steep sides of the bordering hills for only forty feet or less. The clay deposits often become quite gravelly, or give place to sand, showing probably an approach to the old shore lines of the lake, in the deeper parts of which the heavy deposits of clay were laid down. On these tracts white spruces grow to diameters of from a foot to two feet, but the areas are very limited in size. This section of country referred to as Archæan embraces all the land extending from the escarpment marking the overlap of the Palæozoic limestones, which follows a nearly east and west line, touching the southern ends of Reed and Wekusko lakes, indefinitely to the northwest; it has generally the same rugged character, with but very limited areas that are fit for cultivation, and must be considered as valuable mainly in the possibilities offered by the Keewatin belts, that here and there traverse it, for the occurrences of valuable minerals. No mineral deposits of value were noted, though traces of copper were observed in the vicinity of File lake.

The country lying to the south of the Archæan area, between it and the Saskatchewan valley, contains very few tracts of land suitable for settlement. Practically only the river valleys, a few tracts adjoining some of the lakes and parts of some of the slopes flanking the limestone ridges can be considered as affording land suitable for cultivation. The upland is generally almost bare of soil, flat-lying limestones forming its actual surfaces, and the slopes, though covered to a good depth by clay, are for the most part too bouldery for tillage. Limited tracts here and there occur suitable for individual holdings, notably near some of the principal lakes. The largest of these, Atikameg (locally known as Clearwater), Cormorant and Reed lakes, are very beautiful sheets of clear water, well stocked with fish, including lake trout and whitefish. All are skirted by the located portion of the line of the proposed Hudson Bay railway, and may be expected with its advent to become favourite summer resorts for the people of the growing western cities.

Atikameg, the most southerly, nearest to the Saskatchewan, is a sheet of quite colourless, pellucid water, about eight miles square, its expanse unbroken by islands, and attaining in its central parts depths of upwards of a hundred and fifty feet. It is apparently fed, principally, by seepage through the gravels and by springs following the bedding planes of the limestones from the Saskatchewan watershed, as no brook, worthy the name, flows into it, though the outflowing stream is of good size even at lowest water.

Cormorant lake, into which the last named flows by a short stream with a fall of twelve feet, is about half as large again. Its water, though not quite colourless, is clear and free from sediment, and its surface is diversified by many islands, some of large size. The islands are flat-topped limestone ledges, generally showing low cliff faces rising from deep water but varied by occasional sandy and bouldery

beaches; they are well wooded, and many of them would furnish ideal spots for summer residences.

Reed lake, the most northerly, lies just without the limestones that terminate in a low escarpment fronting its southern shore. It has about the same area as Atikameg, but a much less regular outline, and the shores are fringed by more than a hundred small islands.

The hard magnesian limestones or dolomites about these lakes would furnish good building stones; the natural bedding of the rocks causing them to break out readily into blocks from a foot to five feet in thickness and of almost any required sizes.

The immediate valley of the Saskatchewan in this neighbourhood is so low as to be inundated annually by the river, excepting at rare points, such as the so-called Pas ridge where a low swell composed of clay and boulders rises a few feet above the highest water level. The rise in the waters of the river between low and high water at this point amounts to as much as eighteen feet and occurs generally in July.

On the north side of the river at the Pas, beyond a low flat, a kame-like ridge, with a gravelly surface and clay and boulder cone, rising from seventy to ninety feet above the river, follows the course of the stream upwards for five miles to the Bid Eddy where it swings northerly and continues for another eight miles, or almost to Atikameg lake. This ridge forms a sort of natural highway along which the Indians have a road to their autumn fishing grounds in the lakes and which has been utilized by the engineers for the location of the railway line. Along the wider parts of the ridge and on the flat at its base are situated Indian and half-breed settlements where the natives are generally living comfortably in good houses, many of them raising horses and a few cattle but few paying much attention to the cultivation of the soil, contenting themselves with small fields or garden plots of potatoes and the commoner vegetables.

Over the whole region the areas of forest, where the trunks are large enough to be of commercial value, are limited, though, but for recurring fires in the past there would be a magnificent forest cover over the whole area, stunted only on the muskegs and in the Archaean and limestone areas and on the hill tops where the soil is wanting or too thin to support a good growth. The principal tracts of large, standing timber are situated to the north of Moose lake, to the west of Atikameg, in the lower Grass River valley and on the ridge separating Cormorant and Yawningstone lakes. The last named tract contains white spruce of exceptionally large size with tall clear trunks. Smaller areas are found on islands and points in the various lakes, along the upper valley of the Cowan river and, in clumps, along all the stream valleys in the district. Smaller timber, mainly black spruce, that would be of value for pulpwood, is much more widely distributed over large areas.

Over part of the Archaean area the white spruces were suffering from the attacks of fungi that infested the leaves, causing them to turn red and wither as though fire-killed.* This fungus which Professor Macoun has ascertained to be *Peridermium decolorans* was found only on the white spruces, though it does not generally confine its attention to any one species of spruce. The injury to the trees will probably not be permanent, resulting only in most cases in a slight retardation of the growth.

*Vide Canadian Forestry Journal for October, 1906.

A table is appended giving the comparative ages of trees throughout the region at various ages.

AGES OF TREES.

	Years.
Spruce, 4 inches in diameter, 3 ft. from ground, Burntwood river..	35
" 7 " " Burntwood river..	85
" 5 " " File lake	58
" 44 " " File lake	52
Banksian pine, 6 inches in diameter, 3 ft, from ground, File lake..	58
" 10 inches in diameter, 3 ft. from ground, Sand plain, north of Reed lake....	95
White spruce, 12 inches in diameter, 3 ft. from ground, Clay flat, below Wekusko lake, Grass river..	85
Aspen poplar, 12 inches in diameter, 3 ft. from ground, Clay flat, below Wekusko lake, Grass river....	110
White spruce, 12 inches in diameter, 3 ft. from ground, below Reed lake, Grass river..	108
White spruce, 14 inches in diameter, 3 ft. from ground, Cowan river, near bank....	153
White spruce, 8 inches in diameter, 3 ft. from ground, Cowan river, 2 chs. back....	155
White spruce, 7 inches in diameter, 3 ft. from ground, south of Yawningstone lake....	156
White spruce, 11 inches in diameter, 3 ft. from ground, south of Yawningstone lake (trees still growing at good rate)..	160

The ages of the trees given in the table above were computed by counting the rings of annual growth and adding from five to eight years for the earlier life of the tree before reaching the height where the rings were counted. It will be noted, that in all cases the trees are of comparatively small diameters for their ages, or, in other words, that the annual growth is small.

They would furnish, therefore very firm and strong lumber and the smaller trees, owing to their closely packed fibres and the comparative absence of open, cellular matter, would be especially well adapted for the manufacture of wood pulp for paper making.

The question of climate is one of vital importance in connexion with this region, and while, of course, no final or very definite statement can be made with reference to it from the observation of one season, some facts bearing on its general fitness for agriculture may be given.

Experimentally but little is known of its capabilities, though we have instances here and there throughout the area, to beyond its northerly limit, of the cultivation of all sorts of garden vegetables, including at the Pas, tomatoes and Indian corn. On September 6, of this year, Indian corn was seen in Mr. Holcom's garden at the Hudson's Bay Company's post, well headed out, the ears large and full and quite fit for table use. As no frost was experienced until September 29, there would be time for the ears to

ripen. From the time the records were begun, on the nineteenth of June, until the night of September 29, when the thermometer fell to 26°, there was no frost that affected even tender vegetation.

On the night of August 10, the temperature fell to freezing point, but did not get low enough to do damage, at least in the valley of Grass river, though some of the potato vines on the summit of the high ridge north of the Pas were slightly touched.

The Indian, never a very enthusiastic agriculturist, succeeds everywhere in getting good crops of potatoes, and at the homestead of an old settler named George Cowan, on Cormorant lake, an exceptionally good yield of very large potatoes was being dug in September.

Though the past season was probably, owing to its dryness, a little warmer than the average in Canada generally, yet the subjoined record of temperatures seems to indicate that this district is not at all too cold for general agricultural operations. The longer daily duration of sunlight in these high latitudes must be taken into consideration, and for purposes of comparison with more southerly localities yearly averages of temperature are of no value. A region lying in a higher latitude, though showing a lower yearly average temperature, may, during the growing months, owing to its longer hours of sunshine, have quite as good an average.

A reference to the subjoined table will show that in the district under consideration the temperature keeps up exceedingly well until late in the afternoon. It will be seen that during July the temperature at 6 o'clock p.m. was equal to or higher than the noon temperature on fifteen days, during August on nine days, and during September on eight days, and that the 6 p.m. averages for these months were lower than the noon averages by only 1°, 1½° and 2°, respectively.

A comparison with the records of temperature kept in previous years under exactly similar conditions, in slightly lower latitudes, farther east, seems to show that this western country is conspicuously warmer than the same latitudes 400 miles farther east, though the altitudes differ very little.

SUMMARY OF TEMPERATURES.*

	6.30 A.M.	Noon.	6 P.M.	Mean Max.	Max.	Mean Min.	Max.	Min.	Monthly Mean.
July.....	58·5	73	72	76	.....	53 .	84	40	64·5
August.	54·5	70	68·5	75	. .....	50	91	32	63·5
September.....	48·5	59·5	57·5	64	.... ..	44·5	76	26	54·3

The maximum temperatures in the above table are undoubtedly too low as it was not possible, owing to the mode of travel to keep a maximum thermometer continually set up, and the figures in the maximum column are merely the highest recorded at the time of observation. The July minimum in the summary is estimated and is probably low also. The instruments used were 10-inch maximum and minimum thermometers, United States weather bureau patterns. The instruments were set up under shade about three feet above the ground.

* It has not been considered necessary to publish in detail the record of daily temperature observations made by Mr McInnes during the exploration.

ON EXPLORATIONS ALONG THE PROPOSED ROUTE OF THE CANADIAN NORTHERN RAILWAY, BETWEEN SPLIT LAKE AND FORT CHURCHILL.

Owen O'Sullivan.

In accordance with instructions to survey and explore the country lying between Split lake and Fort Churchill, on Hudson bay, along the probable line of the Canadian Northern railway, I left Ottawa on June 7, for Winnipeg, where I procured supplies and outfit for the expedition.

At Warren landing, on June 15, four men were engaged, and we went down the east branch of the Nelson river via Norway House, engaging two more guides there, and with three canoes reached Split lake on July 3.

Parts of the route followed have been reported upon by Dr. Robert Bell and Mr. J. B. Tyrrell.

In the undulating country around Split lake the rocks are gneiss and granite, covered with good clay soil with occasional swamps; the trees, chiefly black spruce, are from four to ten inches in diameter.

On leaving Split lake we made a portage at the head of a bay three miles long by half a mile wide, lying in a northerly direction from the Hudson's Bay Company's post. This portage, which is one mile and three quarters long, lies mostly through swamp and leads to the shore of a small lake forty feet above the level of Split lake. We followed its outlet through a low swampy country to Assean lake, a total distance of two and a half miles in a northerly direction. In this last there are two narrow clay ridges running east and west, having an elevation of fifteen feet above the water.

Assean lake, which lies east and west, is about twelve miles long, and has an average width of a mile. Its shores, generally rocky, mostly gneiss, are well wooded with black spruce, tamarack and white birch. A fire that occurred two years ago ran from its southeastern end for several miles eastward.

The Ouatawi river, entering Assean lake at its eastern extremity, is small and crooked. We followed it to Ouatawi lake, a distance of about fourteen miles on a north course. This lake is about three miles long by half a mile wide. Grey granite with foliated mica schist occurs on the west shore at one mile from the outlet.

From this point we made five portages and crossed four lakes, the largest one a mile and a half in length, and reached a bay of Waskaiowaka lake, a total distance of about six miles in a straight line in a northerly course. No rock exposures were noticed in this last stretch. The country is generally low and swampy up to the last two portages, into Waskaiowaka lake (called Big lake by the natives), where hills of clay running east and west rise to thirty feet above the level of the lake.

The canoe route from the last portage follows the eastern shore of Waskaiowaka lake for six miles in a northerly direction to its outlet, called the Little Churchill.

Waskaiowaka lake is about sixteen miles long. It has two expansions, the one on the south being about ten miles in length by five miles in breadth. A short narrows connects it with the northern expansion, which is about six miles long by four wide. The rock is generally gneiss and granite; clayey hills rising to fifty or sixty feet above the level of the lake form the southern shore of the northern expansion.

Three miles south of the outlet, on the east shore, steep banks occur, covered with ten feet of mossy peat. The forest growth is chiefly black spruce and white birch of from four to fourteen inches in diameter.

Starting down the Little Churchill we traversed a swampy country for four miles. Here the river expands, forming a lake two miles long and one and a quarter wide. On the east side, near the outlet of this expansion, a hill of drift covered mostly with black spruce averaging eight inches in diameter rises for two hundred feet above the level of the water.

Three miles farther down, the Beaver river, one chain wide, comes in from the northwest, and one mile below it the first portage was made, passing to the left of a strong rapid giving a total fall of seventy feet in a distance of twenty-three chains.

For a distance of seven miles from here down the river only two portages were made, the longest one measuring twenty-four chains with a total fall of fifteen feet.

Half a mile below this last portage, a cross section of the river, taken on July 14 when the water was at medium summer level, gave a flow of 150,000 cubic feet per minute as the mean volume.

Six miles of swift current from this point brought us to comparatively still water, the river again spreading out and forming many expansions and islands, until Recluse lakes (called Was-kai-ow-a-ka by the natives) are reached, a total distance of forty-five miles from Waskaiowaka lake.

The country on both sides of the Little Churchill so far, is generally rocky or swampy, with black spruce, white birch and tamarack of small size. At the forty-second mile, the Switching river comes in from the west. This river has an approximate volume of 75,000 cubic feet per minute.

Beds of peat of from two to eight feet in thickness, overlying permanent ice, were noticed at several places in this last stretch.

On entering the Recluse lakes the east shore follows an expansion a mile and a half long by a mile and a quarter wide; then occurs a narrows a mile and a quarter long, leading to the northern part of the lake which runs east and west for four miles and has an average breadth of thirty chains. At the narrows the Hudson's Bay Company maintain a winter station, supplied by the Split Lake post.

From the forty-seventh mile, at the outlet of Recluse lake, we made two short portages and ran a strong rapid, giving a total fall of twenty feet, in a distance of half a mile. The last portage on the Little Churchill was made at a point two and a half miles below this rapid. From here the general course of the river, which is nearly due north, keeps a uniform width of about three chains with a swift smooth current to its junction with the Great Churchill, a total distance of 126 miles from Waskaiowaka lake.

Gneiss and granite are seen in many places, particularly in the portages on the upper part of the river. There were no rock exposures seen below the last portage.

At eighty miles down, a good view of the country was obtained from the top of a clay hill, seventy-five feet above the river. From this hill, the Little Churchill could be seen running through a valley about six miles wide to the foot of morainic clay hills which rise to 300 feet above the river.

From this point northward the country, which has been overrun by a fire that occurred some forty years ago, is now partly covered with bunches of second-growth black spruce, tamarack and white birch.

In order to reach the headwaters of the Deer river we left the Great Churchill, three miles below its junction with the Little Churchill. Here we made a portage a mile and a quarter long in a due east course over a hill having an elevation of 300 feet above the river. This portage brought us to a lake half a mile in diameter with banks of peat of from three to seven feet in thickness overlying permanent ice.

From this lake another portage ninety chains in length over a peat bog was made to a lake a mile and a half long by half a mile wide. Then, by a third portage one mile long over a short and steep morainic hill 100 feet high, followed by a mossy black spruce swamp, we reached Deer lake, the headwaters of the Deer river.

Deer lake runs northwest and southeast; it is two miles long by half a mile wide, with low banks of moss. Morainic clay hills having an elevation of 300 feet above the lake are seen three miles to the northward. Lower morainic hills occur all along the upper part of the Deer river for thirty miles down from Deer lake.

The Deer river is 110 miles in length and runs in a northeasterly direction. It is very crooked, and its swift shallow waters occasion many rapids, which we often had to wade with our loaded canoes.

With the exception of a yellowish limestone in the bed of the river eighty-seven miles down from Deer lake, no outcrop of rock was noticed. The river from here down to the Great Churchill flows over limestone; numerous large fragments of limestone were seen all along, and with our paddles, we could feel the solid rock in many places at about three feet under water.

As already stated, the whole country has been overrun by fire. Bunches of spruce and tamarack that escaped the fires were frequently met close to the water's edge.

At sixty-two miles down from Deer lake we came to the open mossy plain which extends northward to the well-wooded banks of the Great Churchill.

The distance from the mouth of the Deer river to the Hudson's Bay Company's post called New Fort Churchill is twenty-two miles in a northerly direction. This part of the Great Churchill is two miles wide with a swift current to Mosquito point. Here the river narrows to one mile, forming a short swift rapid running into the shallow tidal lagoon at seven miles from the mouth of the river.

The post is situated on the west bank of the lagoon three miles from Mosquito point. The tide runs out for nearly a mile in front of the post, leaving a mud-flat strewn with numerous boulders, some having a diameter of seven feet. The lagoon,

when full at high water is over two miles across from the Company's landing, but at low tide the river runs in a channel one mile broad, cut through sand and mud, to Churchill harbour.

Fort Chuchill is the most southern harbour on the west coast of Hudson and James bays for ships drawing over twenty feet of water. It is nearly two miles long and from half a mile to three-quarters of a mile wide. Several soundings were taken and thirty feet of water was measured at low tide within 300 yards of high water mark on the west bank. Sand and gravel, with boulders, form the river bed.

The west bank of the lagoon and harbour, from Mosquito point to Old Fort Churchill or Prince of Wales, at the mouth of the river, is bare and rocky. Hills of quartzite rise to 100 feet above high tide. With the exception of a few square chains around Sloop cove, three miles up from the mouth of the river, the Hudson's Bay Company and Mission have taken nearly all the habitable ground on the west side. This consists of an old clay and sand beach about 800 yards long by 200 yards wide.

From Battery point at the mouth of the river on the east side and nearly opposite the Old Fort, the same quartzite runs eastward for several miles. At a mile and a half up from Battery point, the Hudson's Bay Company have a whaling station which is situated at the foot of the rocky ridge. From this point old beaches made up of clay, sand and gravel are seen at different levels running in a southeasterly direction, the highest attaining an elevation of fifty feet above the river. This side of the lagoon had a more inviting aspect than the opposite rocky, hilly shore.

There appear to be no great difficulties in securing a good line for the construction of a railway along the route followed between Split lake and Fort Churchill. The only part that might prove difficult lies between the lower part of the Little Churchill and the headwaters of the Deer river. Here morainic clay and sand hills rise from 50 to 300 feet, with many lakes, swamps and gullies between.

Wood is scarce at Churchill. The Hudson's Bay Company obtain their fuel supply from a ravine three miles distant, in a southwesterly direction, where black spruce, averaging five inches in diameter, is found.

The porpoise, or white whale, is very common in the mouth of the Churchill river. The Hudson's Bay Company in a few days captured sufficient to ensure oil and dog-feed through the coming winter.

Salmon, sea trout and whitefish are both plentiful and of excellent quality.

The barren ground caribou and deer herd in hundreds all over the country and are the staff of life for the people inhabiting this region.

Wild geese, ducks and ptarmigans breed all over the country and are generally very numerous, but this year a disease among the ducks reduced their number. I saw many of them dead at the edges of the lakes and ponds.

Our return trip was made via York Factory and up the Hayes and Fox rivers to Split lake, the Great Churchill and Deer rivers being too swift to ascend without great difficulty.

We left Fort Churchill on August 5 and arrived at Split lake on September 1, reaching Ottawa on September 27.

ON SURVEYS ALONG THE NATIONAL TRANSCONTINENTAL RAILWAY LOCATION BETWEEN LAKE NIPIGON AND LAC SEUL.

W. H. Collins.

The past summer was spent in exploring the country lying for a distance of ten miles on either side of the N.T.R'y survey locations westward from Lake Nipigon. Our party of five in two canoes left Nipigon station on May 29, ascended the Nipigon river, crossed Lake Nipigon and proceeded up the Wabinosh canoe route as far as Rocky Island lake, where a cache for railway survey supplies has been established. Work commenced at this point on June 8, and continued until October 1, during which time a strip 125 miles long, extending from Caribou lake, north of Nipigon, to Dog lake on the Sturgeon river, was examined. Micrometer surveys of the lakes and rivers were made where required for mapping purposes, geological formations defined and attention given to the various resources of the region. The journey from Sturgeon lake out to Ignace at the end of the season was greatly facilitated by the kindness of Mr. McEwen, manager of the St. Anthony gold mine, who conveyed us the length of Sturgeon lake in his company's steamer. Two more days' canoeing brought us to the C.P.R'y at Osaquan siding.

Like the remainder of the Archæan peneplain, of which it forms part, this area possesses a surface of low relief and moderate altitude. Lake elevations from various points show that the general level does not vary greatly either within short distances or as a whole. Caribou lake at the east stands 1,149 feet above sea level. Dog lake on the west is 1,168 feet. Sturgeon lake midway between these is 1,327 feet, while Duck lake 1,382 feet, a headwater of one of the many Ogoki tributaries, represents the highest water level. Hills seldom reach 250 feet in height. From the top of one such the entire horizon line, distant from eight to fifteen miles, appears level, and the whole area enclosed undulating and forested. This description applies to the greater part of the area. However, in the vicinity of Lake Nipigon, diabases, overlying granites and gneisses, have through erosion, resulted in a rugged country characterized by precipitous hills 150 to 300 feet high and deep-set lakes and streams. Again, near Sturgeon and Savant lakes, the steep-tilted green schist formation has developed a very irregular surface forming alternations of high parallel ridges and valleys, the latter often containing long, narrow lakes.

The surface is practically one of solid rock, for rarely does the soil sheet become sufficiently thick to obscure or vary its appearance. An exception to this is found near Allan Water where glacial débris has been deposited in ridge-like hills 200 feet in height and composed entirely of coarse gravels and sands. Muskegs are never of great extent or depth.

Owing to the gentleness of the slope, scantiness of soils and impervious nature of the rock floor, an enormous amount of water, compared with the drainage volume, lies stored up in superficial depressions, thus giving rise to a territory plentifully

supplied with lakes and admirably suited for canoe travel. These lakes are characterized by shallowness, irregularity of coast line and numerous islands. A large number of small creeks and brooks connect and drain them, which, although commonly of insignificant volume, are usually sluggish enough to provide good canoeing. The height-of land crosses the area diagonally from northeast to southwest near the east end. The country on the south and east drains by the Wabinosh river into Lake Nipigon; all the remaining waters flow to Hudson Bay, Allan Water emptying north into Wabakimmug lake and thence to the Ogoki, and Sturgeon river, flowing westward into Lac Seul, are the only large streams. These rivers are strikingly similar in character being seldom river-like, but rather, strings of irregular lake expansions connected by short stretches of river in which are rapids and falls. Sedimentary materials with which to form a bed of uniform section and gradient are notably absent. Meandering, so typical of streams on soil covered regions, is seen only occasionally in swamps and muskegs.

GEOLOGY.

Rocks constituting the region are everywhere readily accessible for geological study and prospecting. They are easily separable into three groups whose characteristics are sufficiently distinct to make the division a good one for field guidance.

1. *Laurentian.*—A very large proportion of the territory in question consists of a complex intermixture of granitic and gneissic rocks occupying large continuous areas. In the field these are easily recognized by their distinctly crystalline texture, pale colours and richness in feldspars and quartz. They are by no means of one age or composition, but include granites, syenites, diorites, porphyries, &c., in all stages of gneissic modification. A biotite gneiss is especially common. The complex appears to be entirely igneous. Coarse granite dikes are of frequent occurrence, but fine-grained dikes of dark coloured material were not often seen, either in this formation or elsewhere.

A large area of these rocks occupies nearly the whole region between Sturgeon lake and Nipigon. On the east they disappear by degrees beneath a formation of diabase and sediments that encloses Lake Nipigon and extends pretty continuously for twenty-five miles to the west. To the north and south its boundaries were not found although exploration was conducted over forty-five miles in these directions. On the west it terminates within about four miles of Sturgeon lake and its edge is almost coincident with the eastern coast of Savant lake. Between these lakes, which lie in schists, a narrow isthmus of granite connects the area in question with another Laurentian area to the west. This second one extends from the middle of Sturgeon lake along the Sturgeon river to the first portage below Dog river, at which point Mr. McInnes* found Keewatin schists and conglomerate. Northward, it is bounded by a belt of these rocks extending parallel to and two miles south of Dog river.

Nothing of economic value was observed in the Laurentian formation. Fissuring and secondary vein filling is uncommon. The rocks themselves consist largely of quartz and silicates of little commercial interest. In the neighbourhood of Wabakimmug and Smooth Rock Island lakes, very coarse granites are abundant, consisting of quartz and feldspars in large crystals, and, less frequently, muscovite. The last named

* Geol. Surv. of Canada, Summary Rep., 1902, pp. 206-211.

mineral was seen in flakes of more than two inches square. Along Allan Water, south of the survey lines, a good many coarse textured dikes contain magnetite in large crystals, but not in valuable quantities.

II. *Keeweenawan.*—The Lake Nipigon basin and vicinity contains a series of flat lying dolomites, sandstones, &c., and great sheets of diabase, ascribed to this geological period. These rocks, especially the diabase, formerly extended almost to Sturgeon lake but are now found only vestigially over the intervening region. The soft sedimentary members outcrop along the Wabinosh river, beneath a diabase covering, but either did not extend farther west or have been entirely removed. The diabase, being more resistant, remains, and can be readily located from observation of topographical features. Nearly all the higher hills and ridges for fifty miles west and northwest of Nipigon are capped by this rock, which thus forms isolated patches or islands among the Laurentian. The hills so covered have precipitous sides, weather stained a red colour, and are fringed at the base by a heavy talus of angular fragments. Patches of this sort were observed, among other places, at Caribou, Granite and Eagle lakes.

Beyond presenting considerable engineering difficulties to the construction of the railway, the diabases do not appear to be of commercial interest.

III. *Keewatin.*—This group of highly altered sediments and igneous rocks is readily distinguished in the field from either of the preceding groups. It consists typically of highly fissile, fine-grained schists ,dipping at high angles and forming more or less elongated belts. The most characteristic members are dark green sericite and chlorite schists plentifully impregnated with pyrite. These are in various conditions of alteration, being sometimes found merging directly into porphyries and other fine-grained eruptives. Cherts, jaspilite, conglomerate and slate-like schists are undoubtedly sedimentary, consequently the formation is partly sedimentary, partly igneous in nature.

These form the 'mineral belts' of the prospector and, indeed, are the rocks of greatest economic interest. Quartz in veins, stringers and lenses is plentiful, and in the schists themselves can be found abundant evidence of secondary mineral formation. The contact of such belts with the Laurentian is usually marked by black hornblende schists, and a micaceous schist, either in bands or as masses of all sizes contained within the gneisses. The presence of such inclusions in the Laurentian is a fairly reliable indication of the proximity of Keewatin green schists.

Three such belts occur in the explored area :

Caribou Lake.—About the middle of Caribou lake micaceous and hornblende schists appear and are followed to the north and east by green schists and associated rocks that extend beyond the eastern extremity of the lake. Their extent was not determined but probably they connect with a large area of the same age lying farther east. These schists dip about 45° south and strike W.S.W.

Sturgeon Lake.—The northern end of Sturgeon lake lies partly within Keewatin schists. On the west, these are sharply terminated by Laurentian gneiss and more

recent quartz porphyry and porphyrites, the contact and the ordinary green schists lying almost vertically. Eastward these give place to less altered eruptives, quartzites, horneblende schist and, finally at Sassaganaga lake, pass through horneblende and mica schists into the Laurentian. On the north they extend to within a short distance of the N. T. Ry. location, beyond which the Laurentian again appears. Among the various intrusive masses found in this belt, a coarse syenite occurring on what is locally known as the Nipigon route is especially interesting.

Savant Lake and Dog River.—An area of the same character as the preceding encloses Savant lake and extends northward and westward. On the south it is almost continuous with the Sturgeon Lake area, being separated by only a mile or so of Laurentian, in which scattered bodies of green schist are included, suggesting an original continuity interrupted at the time of the granite intrusion. Savant lake lies entirely within these schists, its eastern coast, however, being their approximate limit. Northward their extent has not yet been determined but to the west they can be followed continuously along Dog river to within eight miles of its mouth, the course of the stream being largely determined by their foliation. Their junction with the Laurentian to the south forms a line parallel to Dog river and from one to two miles away. The northern boundary was not found. Green schists of various sorts make up a large share of the formation; some of these show vestiges of an original porphyritic structure. In addition are cherts, conglomerate and jaspilites comparable with similar rocks of the Canadian and Minnesota iron ranges. These lie at steep angles and run approximately northeast and southwestward. More extended knowledge of these and neighbouring rocks to the north may show some of them to be of later age than here indicated but, provisionally, they are all included in the Keewatin.

MINERAL DEPOSITS IN THE KEEWATIN.

Iron.—Deposits of magnetite which may prove valuable were found in the Dog River area. Along the south shore of Kashaweogama lake the rocks are chiefly green schists, with lesser amounts of siliceous bands. All dip nearly perpendicularly and extend in a direction of 230° to 240° or about southwest. Interlaminated with them are bands of magnetite varying from an inch to one or two feet in width and occurring at intervals—across the strike—of from a few inches to several feet. The magnetite bands are either almost pure or, in places, mixed with siliceous matter. This surface condition seems continuous for a distance of 1,000 feet or more across the strike and extends for about six miles along it, from the middle of Kashawaeogama eastward to within a short distance of Savant lake, beyond which the ore bands become diffused. Westward from the centre of Kashawaeogama no magnetic disturbance was observed in crossing the entire formation so that mineralization probably ends abruptly.

Examination of the formation in a north and south direction where the magnetite occurs was not conducted for any distance. To the south of the lake green schists seem continuous to the Laurentian contact, distant a couple of miles. On the north there is a conglomerate of Archæan pebbles in a green schist matrix, pale coloured sericite schist and jaspilite, the extent being unknown.

This formation appears identical with those of the Temagami, Boston tp., and Vermilion iron ranges, and, besides being of possible commercial importance, is of in-

terest as a further link in the chain of iron formations that are being found to extend from Lake Temagami to Minnesota. Magnetic disturbance indicates that it continues northeastward under the waters of Savant, but probably east of that lake it is terminated at the Laurentian contact. Yet on Caribou lake magnetite is present in similar rocks that lie in such a position as to suggest original continuity with those of Savant. In the northeastern bay of the former lake in Keewatin green schists, a ten-foot band of the schists is sufficiently impregnated with magnetite to produce local compass variation. This band dips steeply and extends in a direction of 250 degrees.

A detailed investigation of the geology of Kashaweogama lake would be necessary to trace out and measure the outcropping ore seams and to foresee the likelihood of large underground accumulations of ore. The area and the size of the outcrops seem large enough to warrant such investigation. Closer examination may reveal the presence of favourable intruded dikes or other igneous bodies and the occurrence of hematite. At present, however, only magnetite is known to occur.

Gold.—The Keewatin series is characteristically auriferous, but only in the neighbourhood of Sturgeon lake has it been exploited for that metal. The sericite and chlorite schists are nearly always pyritiferous, that mineral being of secondary formation and disseminated in small crystals through the schists. Secondary quartz in veins and irregular forms is equally typical of the series, and is especially abundant near Island lake and Dog river. When mineralized these quartz bodies contain much pyrite besides free gold and various sulphides.

So constant is this association of green schists, pyrite, free gold and quartz that a chemical relationship probably unites them. The pyrite of the quartz veins is found upon assaying to be gold-bearing, and Mr. McEwan, of the St. Anthony mine, states that pyritiferous blocks of green schist found enclosed in quartz prove as valuable as the vein stuff itself. The pyrite is in all likelihood a secondary product of the alteration that has produced the green schists. But whether or no the gold is thus to be traced directly back to the igneous rocks that now exist as sericite and chlorite schists, it is of importance to the prospector that the green schists are favourable prospecting grounds, and the presence of sulphides equally satisfactory.

At Sturgeon lake the minerals found are gold, pyrite, chalcopyrite, stibnite, galena and zinc blende in quartz, or sometimes quartz and calcite. Galena and zinc blende are regarded with especial favour by the miners. The veins do not appear to conform with any geological structure, but run in various directions, and are generally much ramified and irregular. They occur both in the schists and in adjacent igneous masses. In fact, so abundant are the igneous rocks that nearly all the properties visited may be said to be at the contact of the Keewatin with an igneous intrusion. Probably the latter have been instrumental in the process of mineralization, and the presence of such in other districts may prove favourable prospecting indications. Where veins are observed entering igneous rocks from the schists they are very much broken and scattered to form a cement reuniting shattered blocks of the igneous body.

As a mining region not much has been done yet, and little is known of its underground nature. The St. Anthony mine, opened in 1903, has been worked continu-

ously, and is at present considered a profitable proposition. A force of forty men is employed, and the quartz is crushed in a ten-stamp mill. The free gold is removed by amalgamation, but as yet nothing is done with the pyrite concentrates, although these yield good assay values. Underground working has proceeded to a depth of 100 feet, at which depth the supply of vein stuff and its contents remains pretty constant. Access is obtained by two shafts; a third has been converted into an open cut forty feet in width extending to the shore of Coutour lake.

At Belmon bay, near the northwest of Sturgeon lake, the Belmon Bay Gold Mining Company, which a couple of years ago sank and afterwards abandoned a shaft 250 feet deep, is recommencing operations on a four-foot vein, and in anticipation of good results is now busy erecting a three-stamp mill. In close proximity many claims have been located.

Just north of the narrows, on a small island, a property has been claimed by Mr. Bernard. It resembles the St. Anthony in position, being at the contact of the Keewatin and a porphyrite granite, and shows much free gold.

A number of other prospects, not visited, are reported equally good.

Silver.—A small specimen of native silver was taken from a quartz vein in Island lake. Assays of the Sturgeon Lake materials and the results of prospecting have not aroused any enthusiasm over the silver outlook for the region, yet the results may indicate the presence of larger quantities.

OTHER RESOURCES.

Soils.—Loose deposits of considerable depth are all of glacial origin, and consist of sand and coarse gravel, not forming a large sheet but locally aggregated into hills and ridges. An area so covered occurs near Allan Water, the hills rising to 200 feet, but the materials are coarse and not valuable for agricultural purposes. South of Smooth Rock Island lake is a considerable extent of light, sandy loam; elsewhere soils are thin, and collected into natural depressions of the rock surface. These patches are quite fertile, containing much carbonaceous matter from the decomposition of forest growth and inorganic salts from the ashes of forest fires. The thinness and proportion of inflammable materials are well illustrated after a forest fire by the extent of rock uncovered. Generally speaking, the agricultural possibilities of the region steadily improve as one proceeds westward. Small patches of good soil are obtainable near Sturgeon lake, while portions of the Dog River valley contain excellent clay land.

Although the smaller streams and lakes remained ice-covered until May 6, this year, garden stuffs were successfully grown and harvested before the severe frosts. At Sturgeon lake Mr. Seaton raised a crop of 800 bushels of excellent potatoes as well as other vegetables, even tomatoes being ripened.

Timber is dependent upon soil supply and drainage. Although much of the forest is small and the growth slow, where the soil is deep and dry, poplar, birch, tamarack, spruce and pine attain diameters of 15 to 24 inches. In wet land and muskeg where, even in August, the frost persists at a foot or so beneath the surface, the same trees reach thicknesses of only 6 or 8 inches, although showing 100 to 150 annual rings

of growth. As with the agricultural possibilities, the timber improves in size and character, westward. East of Allan Water jackpine and spruce predominate, with a small proportion of deciduous growth. White and red pines were first met at Allan Water, where the former was found sparingly along the gravel ridges; it attains thicknesses of 1 to 2 feet. White pine was noticed on Sturgeon lake, but not in quantity. Cedars near Island lake grow to 2 feet diameter, but not tall, and they are restricted to low ground and lake shores.

In recent years much of the country east of Allan Water has been burned over.

Good water-power is available on all the larger streams. On Allan Water near the proposed railway crossing is a fall of 22 feet; at this point the river flows through two narrow channels enclosing a high rocky island, the main shores also being high. Sturgeon river has numerous rapids and falls. Dog river near its mouth and only about a mile from the railway route falls about 20 feet. The best timber observed grows in this neighbourhood.

COBALT DISTRICT AND NORTHWARD.

Dr. Robert Bell.

After my return from leave of absence, in August, I visited the Cobalt mining district, and again in the end of October and beginning of November. I found that conditions had improved considerably since my inspection of the district in April of this year. There was a general feeling of confidence in the probable duration of mining. Many prospects were being worked and the rate of production of silver had greatly increased.

The proved argentiferous area of the district has been extended, especially towards the northeast, by the discovery of new prospects and by the testing of indications which had been known to exist. The silver-bearing district was supposed to comprise about 15 square miles, but the actual productive area is confined to about 12 square miles. It has an elliptical or rather pear-shaped outline and measures 5½ miles from southwest to northeast, by about 3 miles in its greatest width, the larger end being near the southwest extremity of Giroux lake, and the centre at Peterson lake. Beyond these limits some of the metalliferous minerals associated with the silver, such as smaltite, continue to be found, but with little or none of the precious metal.

The question as to the depth to which the silver may be expected to hold out is one of great importance. The leading practical demonstration is still that of the Larose mine, where a depth of 300 feet has been attained with good ore all the way. It was said that a bore-hole had been made by the diamond drill for a considerable additional depth with the same result, but I could not verify this. The depth to which silver or its ores may extend in this district does not depend entirely on the thickness of the argentiferous agglomerate, as it is quite possible that the metal may follow planes below its base into the underlying rock.

A striking circumstance in reference to the silver of the Cobalt region is the fact that by far the greater part of it occurs in the native state, and also that much of it is in such heavy pieces, ranging from one ounce to half a ton, the larger masses being generally more or less mixed with vein-stuff and the ores of cobalt and nickel. Most of the masses are of flattened forms, while others are branching. All have exceedingly rugged surfaces, especially at the edges, so that one's hands become injured in attempting to lift large specimens without strong gloves. A considerable proportion of the metal is found as plates, sheets and leaves, filling up narrow fissures in the wall rocks. In these forms the silver is sometimes found passing evenly through the fragments of granite, &c., where the original cracks happen to traverse these fragments, as at the Trethewey mines. The native silver also occurs as grains and heavy scales, scattered thickly through calcite. At one of the openings on the Nipissing Company's property good specimens of both coarse and fine wire silver have lately been found.

At most of the workings the visitor is shown collections of 'nuggets,' each weighing from a few ounces to several pounds. At the University mine two masses

were taken out, both of which consisted principally of bunches of metallic silver adhering together and filled in with calcite, each weighing about 100 pounds. A single mass was taken from one of the openings of the Nipissing Company, which, on being reduced, yielded forty-nine pounds of fine silver.

But the Larose mine has furnished more large masses of the precious metal than any other. Among them were single pieces of the following reported weights: In 1904, an aggregate of masses of metallic silver, connected together by necks, which require to be cut by cold chisels for convenience in handling, was estimated to weigh 700 pounds. One mass, found in 1905, at the outcrop of the veins, and purchased by this Survey, weighs 258 pounds. The drillings from five holes bored at equal distances apart through this mass showed an average of 18 per cent of silver, the balance being smaltite, niccolite and some calcite. A mass found in 1906, partly calcite, is reported to have weighed 610 pounds, and two other similar masses, 250 and over 500 pounds, respectively. Another weighing about 350 pounds was nearly solid silver. A thick slab from a transverse vein on top of the hill a short distance southwestward from the Larose shaft-house, consisted of about equal bulks of gangue and metallic silver.

Besides the native metal, most of the naturally occurring compounds of silver are found in smaller quantity through the district, with the exception of the chloride which appears to be absent. From the opening called Number 19 of the Nipissing Company's property, a notable quantity of argentite has been extracted. A few of the larger single pieces of the pure mineral would be from half a pound to a pound in weight.

On the 22nd of August, during my visit to Lot R. L. 404 of the Nipissing Company's property, a vein was discovered by trenching which has proved to be the most important one so far known to exist on this company's land. It is situated in the southeast quarter of the above lot and a section of it runs from a foot to three feet in width and contains about half its weight in native silver.

Mr. W. H. Linney, manager of the Nipissing Mining Company, had put into practice, on the sloping ground of the northwest side of Peterson lake, an improvement on the old method of costeening the surface-covering for the discovery of outcrops. This consists in washing off the whole of the covering by strong hydraulic jets, forced up by means of a power plant on the edge of the lake. Although the boulders and the larger stumps of trees are left behind these do not prevent a sufficiently continuous view of the rock-surface being obtained. This process is cheaper and more complete than trenching.

The Gillies timber limit was visited in August in company with Professor Nicol, who, in the absence of Professor Miller, was in charge of the explorations that were being made there for the Ontario government. It was again visited in the beginning of November. In the northern part of the limit, with the exception of a few outcroppings of rock, the surface is covered by a sheet of stony earth of glacial origin, which renders prospecting slow, difficult and expensive.

A vein of calcite and smaltite with some silver was found under three or four feet of earth, at a point about 500 feet west of the intersection of the eastern line of

Gillies limit and the northwest side of Cart lake. The outcrop of the vein in the trench was hidden by the fresh earth lying upon it,but judging from the specimens shown me, it would appear to be four or five inches wide. A shaft, to a depth of fifty feet, by the beginning of November, has been sunk in the country rock. It is said that a vein, or an indication of one, had been previously discovered inside of the north angle of the limit, about five or six hundred yards southwest of Little mine, near the southwest corner of Lot R. L. 404, but I could not verify this statement.

THE COUNTRY NORTH OF LAKE TIMISKAMING.

In the month of October I followed the line of the Timiskaming railway from Cobalt to a point on the north side of the township of Otto (a few miles beyond the permanent camp called Boston Headquarters, or a distance of sixty miles north of Cobalt), for the purpose of gaining information as to the geological and general nature of the country traversed. Excepting in the last fifteen miles examined, no crystalline rocks occur near the railway line. The country is level and underlain by stratified grey, drab and blue clays of an unctuous character. Owing to the level nature of the country with only the drainage afforded by the natural water courses, this clay is always wet and prone to move whenever its equilibrium is disturbed by the cuts and fills made in constructing the railway. The cuttings already made have become partly refilled by the sliding in of the clay. Similarly the embankments occasionally subside, their weight at the same time heaving up some part of the surface close by.

The timber along the route of the railway consists of the species commonly found in the same latitude. North of Englehart, at the second crossing of the Blanche river, the trees are mostly of small size, belonging to second growths after forest fires and are of no great age.

The soil is good, but being clayey with a level surface, it is too wet in many parts for cultivation without artificial drainage.

THE REGION ABOUT BANCROFT.

A visit was paid in August to this region in connexion with the correlation of certain rocks in Canada, with others in the United States, for the purpose of a uniform and harmonious representation of the geology of both countries.

ON THE QUEBEC SIDE OF LAKE TIMISKAMING.

A. E. Barlow.

The field work of the past season was confined to the area in the immediate vicinity of Lake Timiskaming on the Quebec side with the object of tracing eastward into this province those geological formations, which to the west in Ontario, contain the silver-cobalt-nickel ores. It had previously been shown that precisely similar rocks did occur in this area between Lake Timiskaming and Lac des Quinze* but it was felt that another attempt should be made to trace in more detail than was previously possible the various geological boundaries so as to permit of the mapping of this area on a scale of one mile to an inch.

For this purpose a detailed geological examination was made of the district contained in the townships of Guigues, Baby, Duhamel, Laverlochere and Fabre as well as of a portion of the unsurveyed region lying immediately to the east of these townships. I was assisted in the geological part of the work by Mr. Morley E. Wilson of Toronto University while a large part of the topographical surveys were undertaken by Messrs. Douglas Ellis and P. W. Racey. Mr. R. Graham, Demonstrator in Mineralogy at McGill University and Mr. Daru, of India, were also attached to my party with instructions to make a study of the minerals of the cobalt veins. Owing to my absence from this field during July, as the Geological Survey representative on the International Geological Correlation Commission, and in August on leave of absence, I was unable to give any large amount of personal attention to this field, so that most of the work devolved upon my assistants, and the map shortly to be issued will be based very largely on their labours.

PHYSICAL FEATURES.

The eastern or Quebec side of Lake Timiskaming presents many deep and important indentations or bays, the bottoms of which are usually bordered with small clay flats. These bays are separated from one another by rocky headlands although the shore lines are not so abrupt and rugged as on the Ontario side. From Fabre wharf to Chief island the whole area in the immediate vicinity of the lake shows a rapid succession of steep rocky hills with small intervening clay flats. These features characterize a strip of country about three miles in width, stretching from the village of Ville Marie to the mouth of Apika creek. Farther inland large and extensive clay flats have been cleared which are at present occupied by a contented and prosperous farming community, the soil being good and yielding abundant crops. Such arable tracts are particularly extensive through the middle and northern portions of Guigues and Duhamel extending northeast into the northern part of Laverlochere and the southern portion of Baby. Numerous roads have been opened up, mainly on the concession and

* Report Geo. Surv., Can., Part I, Vol. X, 1897.

lot lines. One of the oldest and best travelled roads is that which extends from Ville Marie, the chief settlement and place of business, to the southern bay of Lac des Quinze, while still another important road connects this same village with North Timiskaming on the Rivière des Quinze.

The principal stream is the Otter (sometimes called the Ottertail) river, which, with its two small tributaries, the Cameron and Duford, drains most of the area lying within the townships of Guigues, Baby, Duhamel and Laverlochere. The Little river carries off the surface water from a much smaller district in the southern part of Duhamel and Laverlochere, while Lafricain and Lavallee creeks furnish the drainage to Fabre township. These streams for the most part, and especially the Otter, pursue a very tortuous course through the clay flats, showing high banks of stratified clay.

The largest lakes are known as Cameron and Sassaganaga, but with the exception of a portion of Baby and Laverlochere townships lakes are of comparatively rare occurrence.

Micrometer and compass surveys were made of all the roads as well as the streams and lakes included in this area.

The geological succession as recognized by our examination is as follows, with the several equivalents as studied on the Ontario side of the lake.

QUEBEC.	ONTARIO.
Pleistocene—	Pleistocene—
Clays and sands.	Clays and sands.
Silurian—	Silurian—
Clinton and Niagara.	Clinton and Niagara.
(Limestones, shales, conglomerate and sandstone.)	(Limestones, sandstones and conglomerates.)
Great unconformity.	Great unconformity.
PRE-CAMBRIAN.	PRE-CAMBRIAN.
1. Upper Huronian—	1. Middle Huronian—
Quartzite and conglomerate.	Lorraine arkose quartzite and conglomerate.
No apparent conformity.	Unconformity (Miller).
2. Lower Huronian —	2. Lower Huronian—
Conglomerate, breccia and slates.	Conglomerates, breccias, quartzite and greywacke slates.
No deposits of economic importance yet found.	The cobalt-nickel-arsenic silver veins occur in this series.
Great unconformity.	Great unconformity.
3. Keewatin—	3. Keewatin—
Igneous complex, with some minor beds of altered quartzite, chiefly greenstones, quartz porphyries and porphyrites, much folded and disturbed.	Igneous complex, mainly greenstones and quartz porphyries more or less folded and disturbed.
Promising deposits of chalcopyrite, galena and other sulphides with low values in gold and silver.	Occasionally some of the silver-bearing veins extend downward into this formation, but as a rule these high grade ores are replaced by chalcopyrite, galena, zinc blende and pyrrhotite in their downward extensions through these rocks.

IGNEOUS.	IGNEOUS.
1. Post Huronian— Diabase.	1. Post Huronian— Diabase.
2. Post Keewatin— Granite (Laurentian). This granite is intrusive into the Keewatin, but furnishes pebbles to the Lower Huronian conglomerates.	2. Post Keewatin— Lorraine granite (Laurentian). This granite is intrusive into the Keewatin, but not into the Lower Huronian.

It will, therefore, be seen from the foregoing table of formations that the two areas are from a geological point of view practically identical, while, however, exposures of slate and conglomerate on the Ontario side cover extensive tracts which are for the most part well exposed and comparatively free from drift, areas of a similar strata on the Quebec side are covered by a heavy mantle of clay, often continuous for miles with only occasional and comparatively small outcrops of the underlying rocks. By far the largest part of the district shows outcrops of quartzite, granite and green schists with few or small deposits of economically valuable minerals.

CLAYS AND SANDS.

The Pleistocene history of this and adjacent regions seems to be in the main divisible into two parts. (1) That of great accumulation of snow and the production and maintenance of a confluent ice sheet. This is believed to have been accompanied by a vast regional uplift, increasing in amount to the northwest. Following this came (2), a profound submergence, during which time the ocean invaded a large portion of the Ottawa valley rivalling in extent and depth similar encroachments made by the sea during portions of the Palaeozoic. It is very probable that during this period channels may have connected that portion of the ocean covering the St. Lawrence and Ottawa valleys with that existent in Hudson bay. The stratified clays which towards Lac des Quinze pass upwards into sand were probably deposited very rapidly from streams issuing from the margin or front of the retreating glacier. These extensive clay flats often occur as terraces thus serving as marks accentuating the various stages or haltings in the ice sheet of which the margin was buried beneath the rising waters, thus permitting and even favouring such a mode of deposition of the englacial detritus. These great clay plains cover very large areas throughout this district, often partially or completely separated from one another by rough rocky hills that rise abruptly from the plains. While very useful from an agricultural standpoint, they have a most depressing effect on the eager geologist and prospector.

SILURIAN.

CLINTON AND NIAGARA.

The eastern edge of this Silurian outlier which occurs in the form of a synclinal trough may still be seen extending almost continuously along the shores of Lake Timiskaming from Chief island to Piché point with smaller patches as far south as opposite Bryson island. This narrow fringe is made up of conglomerates and sandstones lying at the base of the Niagara formation. The coarse beds are a boulder conglomerate, representing simply a talus of angular and subangular fragments, detached from the elevations in the immediate vicinity of the exposures, consolidated together by a finer grained arenaceous cement of a yellowish colour in which are also embedded

fragments of corals and orthoceratites. This boulder conglomerate passes upward into a fine conglomerate, in turn replaced by a coarse grit, and becoming finally a yellowish rather friable sandstone.

In the bay to the south of Piché point and between this and the Wright mine there are two small patches of thinly bedded light yellow arenaceous limestone dipping in a southerly or southwesterly direction 5°, while immediately south of the Wright mine is another small patch of similar limestone dipping southwest 9°.

On the same shore nearly opposite Bryson island there are two more small patches of the arenaccous limestone exposed at the shore wrapping round the hummocks of Huronian quartzite and dipping in a southeast or southwesterly direction 5°. None of these contained any visible fossil remains.

On Burnt or Mann island, as also on the two smaller islands between this and Bryson island, (Osler and Brisseau islands) are exposed the limestones and shales representing the deepwater deposits of this period. The limestone is of a pale yellow to cream colour, weathering whitish, the beds varying in thickness from a few inches to as many feet. Some of the beds are of a very fine and even texture, very closely approaching the character of lithographic stone.

PRE-CAMBRIAN.

UPPER HURONIAN.—QUARTZITE AND QUARTZITE-CONGLOMERATE.

This topmost member of the Huronian in the Timiskaming district is much more extensively developed on the Quebec side. It is the geological equivalent of what Professor Miller has called the Lorraine arkose of the Ontario side of the lake. This rock passes upward by an insensible, though sometimes rapid, gradation from a slaty greywacke, which in turn gives place gradually downward to a basal conglomerate.

Sometimes this quartzite rests directly and unconformably upon a granite, the slate and conglomerate being entirely absent. The conglomerate, at the base made up largely of granite pebbles and boulders, is well seen at various localities near the centre of the township of Duhamel. At Wine point and in the vicinity of Ville Marie this same quartzite is plainly seen to result in the breaking down of the granite 'in situ.' It is usually in very massive, often much jointed beds, coarse in texture, in most cases showing the character of a grit, while certain bands are conglomeratic. Many of the larger fragments in the conglomeratic phase represent very distinctly rounded or waterworn pebbles, the largest of which vary from an inch to two inches in diameter. These are composed of a greyish white translucent, often much fractured quartz and many of them are surrounded by a thin film of iron oxide. Occasionally some pebbles of red quartz are present, while still more rarely greenish, greyish and pale brownish chalcedony-like fragments occur. In addition there are often small angular fragments of both red and yellow jasper, together with small pieces of both reddish and greyish feldspar. These jasper fragments are evidently derived from the iron ore formations of the underlying Keewatin, small bands of which are known to occur to the southeast of Laverlochere, and also crossing the Quinze river on the tenth portage from Lake Timiskaming. The large fragments are embedded in a matrix composed largely of yellowish green sericite which, on account of its abundance, gives the prevailing 'sea' green tint to the whole rock. This quartzite

may be well examined and studied in the stretch of country about three miles in width extending from the mouth of the Little river to the mouth of Apika creek. It also makes up the larger part of Bryson and Chief islands. As on the Ontario side no deposits of minerals of economic importance have been noticed in this formation.

Lower Huronian.

SLATE AND CONGLOMERATE.

The conglomerate which occurs at the base of the Huronian rests unconformably upon either a granite or the upturned edges of the Keewatin greenstones and schists. This conglomerate is the rock referred to by the earlier geologists, Logan and Murray, in their first geological descriptions as 'slate conglomerate' and 'chlorite slate conglomerate.' Both as a massive rock and in its more imperfect forms of slaty structure, it exhibits the character of a conglomerate or breccia, carrying fragments chiefly of various eruptive rocks, which vary in size from the smallest pebble to boulders which are sometimes several feet in diameter. The largest and most abundant are of the underlying flesh red biotite and hornblende granite and fine grained red quartzite, but pebbles of diabase, diorite, porphyrite and green schist are also abundant. The finer grained matrix, usually dark green in colour, is made up chiefly of chlorite and sericite in which are embodied small fragments of quartz, orthoclase, plagioclase and occasional microline. Wherever any considerable section is exposed, this conglomerate passes upward into a slate by a gradual decrease in the number and size of the pebbles. Over large areas, however, the upper beds cannot be said to be true slates since pebbles are of very common occurrence. Some of the slates are very evenly and beautifully banded in varying shades of green or brown. The whole of the beds of the Huronian in contradistinction to the underlying Keewatin are in approximately horizontal position, but the strike and dip are constantly varying. In this district the various members of the Huronian occur in a series of low domes resting unconformably upon the granite or upturned edges of the Keewatin schists. They seem to be in perfect conformity with one another, the conglomerate, slate and quartzite showing a rather perfect, though at times rapid, gradation.

KEEWATIN.

These deep green, often schistose, rocks are the oldest in the district, being cut through by the granites and gneisses usually classified as Laurentian. The largest area occurs in the southeastern part of Baby and thence north to Cameron and Long lakes, forming a belt from three to six miles in width and extending northwest across the Quinze river. The whole series as here exposed is a highly belted and metamorphosed complex of several varieties of porphyry and porphyrite, diabase, and green schists with subordinate bands of iron formation and quartzite. Some of these schists contain promising deposits of chalcopyrite, galena, &c., which have attracted the attention of prospectors and mining men. Some of these deposits in the township of Fabre were being developed during the past summer. Besides these deposits of sulphides, quartz veins carrying gold also occur, but whether in sufficient quantity has not been demonstrated.

Post Huronian.

DIABASE.

The equivalent of the diabase with which silver has been found on the Ontario side is well exposed in the vicinity of Quinn point, but so far nothing of economic importance has been discovered.

Post Keewatin.

GRANITE.

This granite which cuts the Keewatin and underlies the Huronian is well exposed in the northeastern portion of Duhamel and the northwestern part of Laverlochere. It is the rock from which the upper quartzite has been chiefly derived.

As a result of these examinations, it will be possible to issue a new geological map extending from the southern part of Fabre to the Quinze river, and eastward from Lake Timiskaming, a distance averaging about twelve miles. This will show in a very detailed manner all of the rock exposures, while at the same time the areas occupied by the clay flats will also be delimited.

ON EXPLORATIONS ALONG THE PROPOSED LINE OF THE TRANSCONTINENTAL RAILWAY FROM LAKE ABITIBI, EASTWARD.

W. J. Wilson.

My work for the summer of 1906 was the examination, as far as time would allow, of a narrow tract of country along the proposed line of the Transcontinental railway from Makamik lake.

The most central point from which to carry on explorations seemed to be the Kenojevis cache on the Nawapitechin river, the northern branch of the Kenojevis. At this cache extra supplies were stored, and the Nawapitechin was ascended almost to its source, where an old Indian trail crosses the height-of-land to the Abitibi waters. This portage is over four miles long, and leads into Lake Lois, from which an easy canoe route extends to Makamik lake, where the Fly river enters. This river was examined as far as it could be ascended in canoes, and side trips were made to neighbouring hills. Another river, called the Kakameonan, which enters the lake about three-quarters of a mile south of Fly river, was surveyed and explored along the lower part of its course.

The same route was used to return to the Kenojevis cache, and side trips were made through the forest to the railway line. A special examination was next made of the molybdenite area on Kewagama lake, where Mr. J. F. E. Johnston found this mineral in 1901. Seals Home lake and the Harricanaw river and some of its branches were then surveyed by compass and micrometer down to the northern border of the area to be examined, and also the Natagagan, a branch of the Bell river. The last stream surveyed was the Upper Harricanaw, of which a compass and micrometer survey was made for twenty-six miles east of Seals Home lake, and a track survey of the remainder up to the portage to Wabanoni lake, following the south branch. The railway line was followed the whole distance between Makamik lake and Bell river, and examinations were made north and south of the line at intervals between the various rivers, but owing to the character of the country this afforded very little information about the underlying rocks, as it sometimes happened that no exposures were seen for fifteen or twenty miles.

THE NAWAPITECHIN RIVER.

The Nawapitechin river to its junction with the branch from Kewagama lake flows in a southeasterly direction, and mostly parallels the height-of-land. It is about two chains wide for ten miles up from the forks, through low clay banks of rich sandy loam. The country is well wooded with spruce, poplar and fir, with Banksian pine on the more sandy tracts. There is also an abundance of the smaller shrubs. The land along this river is generally rolling and fairly well drained, so that there is a considerable area of good agricultural land on its banks. At about thirty-five miles from the forks, following the bends of the river, it again divides, one branch coming from

the north and the other from the southwest. The canoe route follows the southwest branch, which is reached by a portage three-quarters of a mile in length. This portage leaves the main river a short distance below the junction of the two branches, at a point where there is no obstruction, and as it was not marked on the map we had much trouble and delay in finding it. The brook above this portage is mostly dead water up to the long portage, the water being held back by beaver dams. The portage across the height of land is over four miles long, but is well cut out and level, and ends at a small stream flowing into Lake Lois. The route then follows Lake Lois and the river flowing out of its western end into Makamik lake. These waters have been described by Mr. J. F. E. Johnston.*

The Fly river enters Makamik lake on the east shore, and is about two chains wide at the mouth. It is navigable for canoes three miles above the forks at Owl mountain. It is very crooked, flowing through low banks composed of rich clay loam. The forest growth is good, and spruce of large size is seen along its course, especially on the lower part. Farther up, there are areas of sandy soil covered with Banksian pine. The Kakameonan river as far as followed was fairly good canoeing, and it has since been cut out to Robertson lake near the south exploration line of the Transcontinental railway. The character of the country and forest growth are the same as on the Fly river.

SEALS HOME LAKE AND HARRICANAW RIVER.

Seals Home lake is really composed of three expansions of the Harricanaw river, connected by narrows. The most southerly is the largest, being somewhat circular in form and over five and a half miles in diameter. Counting in the three expansions the total length, north to south, is twenty-four miles. There is no apparent current in this distance, and the level seems the same. Just below the third expansion Peter Brown creek enters from the east. This stream is 100 feet wide at the mouth, and forms a good canoe route almost to the railway line. There is a considerable amount of good agricultural land along this river, and an abundance of spruce and poplar, some of fair size. On the Harricanaw river, half a mile north of the railway line, the first rapid occurs and below this there are three small rapids with a fall of not more than ten feet in a distance of seven miles. Thirteen miles north of the line there is a lake expansion six miles long and a mile and a half wide. The river was surveyed below this lake for five and a half miles, and in this distance there are three small rapids close together, with a fall of seven feet. Some distance below the point at which I turned back the river is, according to the Indians, a continuous rapid for miles, and consequently is not used by them as a canoe route. For the most part the banks of the Harricanaw are low and composed of clay loam. The land in places rises gently for a short distance back from the river banks and then becomes level. From the lower lake several low hills were visible, rising from 200 feet to 500 feet above the lake. Small black ash were noted in various places along the river.

The Upper Harricanaw river east of Seals Home lake is broad, with little current, for the most part flowing through marshy banks. There are three small lakes

* Summary Report, Geol. Survey, 1901.

above which the stream becomes smaller, and at a distance of six miles from the last lake divides into two equal parts. From this point to the portage to Wabanoni lake the stream is small, and is only navigable for canoes at fairly high water.

THE NATAGAGAN RIVER.

The Natagagan river is a branch of the Bell river which it joins at Kamikwanika island. It is reached by a series of portages from the Upper Harricanaw river starting twenty-three miles east of Seals Home lake. The first portage is about two miles long, the second nearly one and a quarter miles, the third one mile and the fourth a little more than a mile and a half. These portages pass through a heavily wooded country and are well cut out. Spruce, poplar, canoe birch and Banksian pine of large size are common, and there is some land of excellent quality, especially on the fourth portage going north. Between the portages there are three small lakes or ponds of clear water aggregating less than a mile in length. The last portage ends at a small stream flowing into Natagagan lake. This lake is four and a half miles long and one and a half miles wide in the southern part, but the lower part is not more than half a mile wide. The Natagagan river flows from the north end of this lake and is from one and a half to two chains wide. The soil, forest growth, and general character of the country drained by this river are the same as those already described on other streams in this area. The river was surveyed northward thirty miles from the south end of Natagagan lake. In this distance there are no large branches and only a few rapids, all of which can be run with light canoes. The water in all these rivers is muddy and it is impossible to see stones or sunken logs though only a few inches below the surface. These are frequently met with on the smaller streams and sometimes prove dangerous to canoes.

GEOLOGY.

Much difficulty was experienced in working out the geology of the district on account of the scarcity of rock exposures. The railway line runs along the height-of-land plateau where the surface is flat for long distances and the rocks are deeply covered with clay and moss. In places there are large areas of muskeg, so that, except in an occasional hill, outcrops could only be found along the shores of lakes and banks of rivers.

In going up the north branch of the Nawapitechin, northwest of the country examined by Mr. Johnston, the rocks met with for seven miles are altered diabases and porphyrites, followed by a dark quartzitic rock holding cubes of pyrite and considerable lime, and near this a yellowish green quartzite dipping to the east.

At the west end of the portage connecting the main river and south branch there is a small exposure of a light brown, fissile, sericite schist striking N. 60° W. vertical. Grading into this schist is a greenish rock showing the same strike and weathering to the depth of half an inch, the weathered part being a rusty brown ochre. Small quartz veins cut both these rocks. West of the brook and close to it there is a vein of quartz over a foot wide containing large crystals of pyrite. In crossing the height-of-land portage the rocks seen are altered diabase, porphyrite or greenish schists, probably chloritic. The strike varies from N. 70° W. to east and west. There are indications

of iron at one point, but in small quantity, and quartz veins are numerous, but none, so far as I could see, carried minerals of economic importance.

Ascending the Fly river, the first rock seen is half a mile from the mouth and is a fine dark green schist. At the first rapid and portage less than a mile up there is a chlorite schist striking N. 75° W. vertical. Green schists of somewhat varying character extend up the river for three-quarters of a mile. For some miles up no rock exposures were visible; the first was a grey granite, followed a little farther up by green schist and reddish and grey granites. Between the two portages—which are a short distance below the forks—grey granite is again seen, and at the upper portage micaceous schist, holding numerous veins and pockets of quartz. Just above the forks at Owl mountain there is an outcrop of a coarse eruptive, and two miles farther up a diabase. Above this, as far as the river was followed, the rock is a fine-grained dark hornblende schist. The same rock was found between the forks of the river at Owl mountain. The top of this mountain or hill is a diabase. To the east the schist contains many bands of quartz running parallel to the strike. Some of the bands are four feet or more in width and may be traced for a long distance to the east. Prospectors reported masses of quartz of much greater width than the above, which they said could be traced three or four miles eastward. As far as examined no valuable minerals were found in them.

The northern exploration line of the Transcontinental railway crosses the Fly river five miles from its mouth. Eastward from the river at a distance of three miles along the line there is a low hill of hornblende schist and somewhat similar rock is seen for two miles farther. This is succeeded by green schist and porphyrite at six miles. Going eastward small exposures of green schists were noted for two miles, and then for four miles high ridges of granite alternating with green schist. East of this broken country to the Harricanaw river, the only exposures seen were chlorite schist, altered diabase and sericite schist. Between the Harricanaw and Bell rivers chlorite schist, granite, porphyrite and feldspathic schists occur, but the exposures in this distance were few.

The south exploration line runs south of Makamik lake and crosses the river from Lake Lois, less than two miles from its mouth. Half a mile east of the river, chalcopyrite occurs in small veins of quartz which cut diabase and green schists. Eastward along this line the rocks are similar to those on the north line. I am indebted to Mr. W. D. Robertson, engineer in charge, for rock specimens from the eastern part of this line.

The rocks on Seals Home lake, going down the west shore from the height-of-land portage, are micaceous sheared diabase or gabbro, biotite granite, chlorite schist, impure banded quartzite, hornblende schist and mica schist. North, along the Harricanaw river, similar rocks occur. At a small rapid eight miles north of the railway line there is an altered mass of diabase and granite cut by quartz veins holding small quantities of chalcopyrite.

The rocks on the upper Harricanaw and Natagagan rivers are much the same as those described on the adjacent streams.

The green schists are the common rock of the whole area from Makamik lake to

Bell river. They are closely connected with the diabase masses and in places these rocks seem to grade into each other. In a general way the strike is east and west, and the schists are frequently vertical. Large quantities of pyrite are contained in these rocks either as cubic crystals or disseminated specks. Carbonate of lime is also present in many of them, often filling thread-like fissures.

MOLYBDENITE.

The granite in which the molybdenite occurs occupies most of the peninsula which divides Kewagama lake into two parts. It outcrops at intervals for over three miles on the east side. Mr. Johnston found it a mile and a half above the narrows on the west side, and as it forms the hills almost up to the north end it has an area of approximately seven square miles. The molybdenite is best seen at a narrow point which projects out about fifteen chains near the middle of the east shore. Here the granite is cut by vitreous and reddish-rusty quartz veins or dikes, from half an inch to four feet in thickness. Many of the veins strike northwest and southeast, but these are cut by others running in all directions. Some of them have clear cut walls and are very distinct. They all contain molybdenite, usually in thin crystals, some of which are nearly one inch in diameter. Along the shore to the south the granite outcrops for a mile and a half and contains quartz veins with small molybdenite crystals. An examination was made of the hills back from the lake; the same conditions prevail as at the shore except that there were fewer quartz veins and less molybdenite, but the latter could be found in nearly all the veins. These hills are about 265 feet (aneroid) above the lake. An analysis of specimens collected by Mr. Johnston from this locality showed that gold and bismuthite were also present in the quartz.*

Molybdenite was also found on a small island in Seals Home lake. The rock is granite with numerous quartz veins, one of which held molybdenite crystals.

The country has been heavily glaciated, as shown on almost every rock exposure. The stossing is invariably on the north side and is very distinct. The striæ run from south to south 30° west.

Mr. Stanley A. Wookey of Toronto, who was my assistant, performed his work in a highly satisfactory manner.

During the summer I received much valuable assistance in carrying on the work from the officers of the Transcontinental railway, especially Messrs. A. N. Molesworth, K. Weatherbe, W. D. Robertson, B. R. Macdougall, Chas de B. Aumond, N. J. Lapierre, O. Robitaille and G. David McLaren.

* Summary Report, Geol. Survey, of Can., 1901, p. 138.

PETERBOROUGH, PRINCE EDWARD AND SIMCOE SHEETS.

W. A. Johnston.

My instructions for the past season's field work were, to complete the surveys necessary for the compilation of a map of the Peterborough sheet, and afterwards to begin work on the Simcoe sheet, which lies adjacent to and west of the Peterborough sheet.

The work remaining to be done on the Peterborough sheet consisted of surveys of the road connecting Seymour and Belmont tps., and Galway and Cavendish tps., and the previously unsurveyed lakes Scugog, Sturgeon, Balsam and Mud Turtle.

On May 23, I proceeded with my assistant Mr. J. H. Stothers, of Ottawa, to Campbellford, in the vicinity of which a week was spent in making necessary road surveys. From June 1 to June 18 work was continued in Galway, Cavendish and Lutterworth townships, with a special view of finding corundum, a deposit of which and its associated minerals was noted last year as occurring on lot 12, concession 4, of Lutterworth tp. All the hitherto unmapped roads in these townships were also surveyed.

Though no further discoveries of corundum were made, it is quite possible that careful search may reveal other deposits in the central and southwestern parts of Lutterworth township, where there are crystalline limestones and syenites with which corundum is usually associated.

On June 18, Messrs. Cane and Davis of Newmarket, Ont., joined me at Fenelon Falls and the following day a micrometer and compass survey of the above mentioned lakes was begun. This work was completed on July 24, when I received instructions to complete the surveys necessary for the mapping of Prince Edward county. We left Belleville on July 27, and started a micrometer and compass survey of the unsurveyed bays off the Bay of Quinte, including Big Island, Hay and Napanee bays.

The south shore line of the county from the eastern extremity, to the Murray canal, including East and West lakes, was also surveyed, and a tie line of sixty-five miles was run acros the county connecting up different points on the north and south shores.

Upon the completion of this work, on August 29, Messrs. Cane and Davis returned to Newmarket, and the remainder of the season was spent in surveying the roads and defining the geology of the eastern portion of the Simcoe sheet, including the townships of Bexley, Carden, Eldon and Mariposa. The season's survey included in addition to lakes and the Prince Edward shore line six hundred miles of roads. We returned to Ottawa on September 22.

The map of the Peterborough sheet is now being compiled and together with the report on the sheet, will be sent to press as soon as possible.

GEOLOGY.

The construction of that portion of the Trent Valley canal, between Lakes Balsam and Simcoe, has exposed good and lengthy sections of the Trenton and Black River limestones. A cutting of from ten to thirty feet in depth has been made in the Trenton limestone for a great part of the distance between Balsam lake and the lift-lock, which is situated near the village of Kirkfield. Below the lock the cutting is mostly in the Black river and continues so for three-quarters of a mile, to the valley of the Talbot river. The lowest beds exposed in the cutting just below the lift-lock probably form the top of the Black River formation. The Trenton limestone extends for about three miles north of the canal into the township of Carden, the central and northern parts of the township being occupied by the Black River formation, which extends north as far as the south branch of the Black river. About three miles northwest of the lift-lock a granite boss rises above the surrounding country. The Black River limestone, containing an abundance of its characteristic large fossils, rests against its sides at an angle of fifteen degrees.

In the southern part of Dalton township, near Uphill P.O., an outlier of the Black River formation occurs, remarkable for its thickness and the escarpment which it displays.

The wells sunk at the lift-lock for the hydraulic rams, which support the pontoons, showed a thickness of ninety feet of Black River limestone. Near the bottom of the wells soft, yellowish, thin-bedded and arenaceous limestones were encountered similar to some of the beds seen near the contact with the Archaean at Head lake, in Laxton township, and at other places in this district. These contact beds, which are of considerable interest and vary widely in character and thickness, are best seen at the Burnt River quarries in Somerville township, and at Head lake in Laxton. They will be more fully described in the report on the Peterborough sheet.

The limestones of the district between Balsam and Simcoe lakes have a general dip of two to five degrees towards the southwest. This dip, however, is varied by several undulations, one of which is cut by the canal a short distance below the railway bridge near Kirkfield, and shows a slight dislocation in the strata. This fault is probably post-glacial as the crest does not appear to be glaciated.

Glacial markings are numerous and the general direction of the striae, which are well displayed in the limestones along the canal, is south thirty degrees west, magnetic.

The rock dumps along the canal furnish an abundance of Trenton and Black River fossils. The lower beds of the Trenton are especially rich in fossils and contain a great number of well-preserved crinoids, star-fishes, corals, &c. The best hunting ground for these is along the canal for a mile or so above the lift-lock, from which locality a good collection of crinoids and star-fishes was obtained.

The product from a stone-crusher which was in operation during the summer near Kirkfield, utilizing the limestone from the dumps along the canal, was being shipped to Toronto for use in concrete work. Much of this stone would also be fit for the manufacture of lime.

The peat works near Victoria Road were operated throughout the season, and produced upwards of one hundred tons of wet or twenty-five tons of dry peat per day.

The season was an exceptionally good one and the process employed here seems to have met with some success. The plant established a few years ago at the peat bog two miles east of Kirkfield, was not in operation, and some of the buildings were being demolished.

In drilling a well on the farm of Mr. McKenzie, near Kirkfield, a flow of natural gas was struck in the Trenton limestone at a depth of seventy feet. The gas continued to flow at a low pressure for several weeks.

SURVEYS ON PARTS OF THE PROPOSED ROUTE OF THE TRANSCONTINENTAL RAILWAY IN NEW BRUNSWICK.

R. A. A. Johnston.

The early part of the year was devoted to the plotting of surveys of previous years, and to further investigations into the subject of Canadian meteorites. Special efforts have been put forth to enlarge the Museum collection of these objects, and the following additions have been made during the present year:—

By purchase—

Model and mould of Iron Creek—Siderite—1870.
Model and fragment of Beaver Creek—Aerolite—May 26, 1893.
Model of DeCewsville—Aerolite—January 21, 1887.
Whole mass and mould of Gay Gulch—Siderite—1901.

By exchange—

Model of Shields (Shelburne)—Aerolite—August 13, 1904.

Negotiations are in progress for the acquisition of other specimens.

In compliance with your instructions, I left Ottawa July 3, accompanied by Mr. J. R. Marshall, who rendered very efficient service as my field assistant throughout the season. Arriving at St. John we were permitted, by the kindness of Mr. Guy C. Dunn, district engineer of the National Transcontinental railway, to examine the location-plans of the line between the neighbourhood of Grand Falls in Victoria county to its intersection with the Chatham and Fredericton branch of the Intercolonial railway at Portage Road crossing, in York county, the so-called Back or Central route; blue prints of these plans were subsequently furnished us for use in the field, through the permission of Mr. H. D. Lumsden, the chief engineer; for these and other courtesies extended by these gentlemen, I wish here to record my keen appreciation. From St. John we proceeded to Fredericton, and thence to Plaster Rock, where a short time was spent in the examination of some of the more important points in the neighbourhood. On the 9th we moved out along the Grand Falls road to the vicinity of the Dead brook, from which point examination was made of the country to the northwestward as far as Little Salmon river. A week was taken up in this work, and camp was then moved back to a point on the Tobique river about two miles above Plaster Rock, whence examination of the country to the northwestward as far as the south branch of the Gulquac stream was made. On the 20th we proceeded to Reed island, and the remainder of the month was occupied in an examination of the country drained by the Wapskahegan and Odell streams and their tributaries, as well as that about the upper reaches of the north branch of the Southwest Miramichi. On August 1, we proceeded to Bath station, and thence to the mouth of West brook, on the north branch of the Southwest Miramichi; our further progress was now effected by means of canoes, often with very great difficulty by reason of the low water in the streams. We reached Boiestown on August 21, and proceeded to Stanley, from which

place surveys were made of portions of the country about the Nashwaak and Taxis rivers. On the 28th we went up to the village of Grand Falls, and from there completed the survey to the Little Salmon river. Wherever the nature of the country permitted, traverses were made from various points, and in the settled districts odometer surveys were resorted to.

The area examined includes portions of the counties of Madawaska, Victoria, Carleton and York, and is embraced in map sheets 2 N.W. (Grand Falls sheet), and 2 S. W. (Andover sheet). It is, generally speaking, a well-watered area, being traversed by a number of the larger streams flowing into the St. John and Southwest Miramichi rivers. From Grand Falls southeastward to the neighbourhood of Salmon river it is formed of a series of broad undulations frequently cut by deep ravines or water-courses; thence eastward the elevations become more abrupt until the divide between Little Salmon river and Three Brooks stream is reached, where are clustered a number of sharp angular peaks which form a striking feature in the landscape for several miles around; from this point there is a gradual descent through the moderately hilly country in the neighbourhood of Plaster Rock to the banks of the Tobique river. A short distance south of its intersection with the Grand Falls road, the National Transcontinental railway, as it is now surveyed, forks, one branch following a somewhat circuitous route crossing the Tobique river some two miles above the village of Plaster Rock, runs northeastward to within a short distance of the south branch of the Gulquac river, and then swings across Little Wapskahegan and River des Chutes to near the head of Beaver brook, where it reunites with the other branch which has followed a more direct route, but with much steeper grades, crossing Tobique river a short distance below the mouth of the Wapskahegan. From the head of Beaver brook there is a gradual rise across the east branch of the Odell stream to the summit of the ridge separating the valley of the Tobique from that of the Southwest Miramichi at the head of West brook. A descent is then made down the valley of the north branch of the Southwest Miramichi to a point about three and three quarter miles above the forks, where the line crosses over and follows along the slope of a low ridge lying to the north of the Southwest Miramichi until Half-moon cove is reached. The line here crosses the main stream and runs around the heads of Miramichi and Napudogan lakes. It then follows along the valleys of Jewitt and Arnold brooks and intersects the Chatham and Fredericton branch of the Intercolonial railway at Portage Road crossing.

GEOLOGY.

The country traversed has been geologically surveyed in previous years by officers of the Survey and the boundaries outlined on the map sheets previously referred to. The crumpled and upturned rocks of the Silurian strata, interbanded with and invaded by secondary white calcite, are abundantly exposed at various points along the St. John, Little and Salmon rivers. In some places they are interspersed with thin fissile shales, and occasionally with dikes of grey diabase running with the strike. The sharp angular elevations about the heads of Little Salmon river and Three Brooks stream are formed of a series of felsite eruptives, generally of a greyish or reddish-brown colour, often highly fractured and in some instances showing a distinct flow-structure. Extensions of these rocks were traced at intervals as far as Blue Bell mountain to the southwestward; overlying these at one or two places there were

observed some small occurrences of a highly altered schist holding phenocrysts of a brownish feldspar. The precise horizon of these is not as yet clear though there is little doubt that they are of greater age than are the Silurian strata immediately to the westward, and may be referable to the pre-Cambrian rocks found over large areas to the eastward. Passing eastward to near the head of Beaver brook the country is underlain by rocks of Lower Carboniferous age. Outcrops of these are seen at various points along Three Brooks, the Tobique, the Gulquac and the Wapskahegan, the heaviest exposures occurring in the cliffs about Plaster Rock; they at times consist of fine-grained greyish or reddish sandstones, but oftener as banded bluish or purplish argillites, sometimes associated with bands of a pinkish compact limestone. Along the ridge to the west of the north branch of the Southwest Miramichi the metamorphic series of the Cambro-Silurian are observable at many points as grey or white highly siliceous laminated rocks, generally much crushed and highly contorted. Rocks of similar character occur about the head of Miramichi lake and along the Taxis river. Between the forks of the Southwest Miramichi river and Miramichi lake, however, the country is traversed by a belt of greyish or reddish granites and dark-coloured gneisses and mica-schists. To the southeastward the Cambro-Silurian rocks are succeeded by strata of Lower Carboniferous, and these in turn by strata of Middle Carboniferous, age.

ECONOMIC MINERALOGY AND LITHOLOGY.

It cannot be claimed that the district is rich in mineral resources nor does it appear probable that any of the metallic minerals found at different points, more particularly in the metamorphic series, will ever be found in sufficient quantity to warrant any great outlay of capital in their exploitation. Iron pyrites are found scattered in small particles throughout the greater portion of the area and the diabases frequently show insignificant amounts of pyrrhotite. Galena and Molybdenite also occur in small amounts at a few places along the Taxis river and in the country between it and the Southwest Miramichi. Little is being done to develop the plaster industry about the village of Plaster Rock. A small working was recently operated for two or three years by the Canadian Pacific Railway Company about a mile below the village, but was discontinued at this point in June of this year. Discoveries of coal have been reported from time to time from the Middle Carboniferous area east of the village of Stanley. These discoveries have sometimes resulted from well-boring operations and their commercial value has never been proven. Small quantities of building-stone have at time been quarried about the village of Grand Falls to supply a local demand only; flags of large dimensions are often obtainable, but their fissile character and the presence in them of considerable amounts of readily oxidisable iron-pyrites must necessarily militate against their use where great strength and durability are essential. Granite of good quality is to be found in abundance in the area between the forks of the Southwest Miramichi river and Miramichi lake, as well as along Bedell, McKeel and Clearwater brooks. In addition to the ledges of granite exposed at different places in this area, the large boulders with which the country is freely strewn might be made to furnish very considerable quantities of this material.

TIMBER.

The greater portion of the district has from time to time been lumbered over so that, excepting the hardwood growth with which the ridges and also the undulating country about Salmon river are clothed, very little of the virgin forest is still standing. The hardwood timber has been but little disturbed except for the pine and spruce with which it has been in places interspersed. It is made up of yellow and white birch, rock maple, and beech, much of it being of large dimensions. Forest fires have in the past done incalculable damage and over large areas the only evidence of the former growth is to be found in the charred remains of the great pines and spruce with which the country must have formerly been covered. No attempts at artificial reforestration have ever been instituted and these burnt areas are now either barren wastes or are covered with impenetrable thickets of balsams, poplars, birches, tamarack, pin cherries, alders and the like. In exceptional cases a growth of red pines has sprung up which will in a few years, providing they escape the ravages of future conflagrations, become of considerable value. With the application of advanced forestry methods, the forest growth might be greatly improved and should, with adequate fire-protection, in time yield a fair return for any legitimate outlay made upon it.

AGRICULTURE.

Most of the lands at all well adapted to agricultural purposes have already been taken up. The most important of these lie along the St. John river and its tributaries and are embraced in the settlements of Chamford, Commeau Ridge, Ennishone and New Denmark and a strip along the Tobique. A less important area is that to the north and northeast of the village of Stanley, embraced in the Williamsburg, Cross Creek, Green Hill and Maple Grove settlements. The soil of that portion of the St. John River valley lying in the neighbourhood of the village of Grand Falls is in the main made up of the detritus of the underlying Silurian rocks, mixed occasionally with alluvial gravels and drift materials, and is capable of furnishing excellent crops of the various cereals and vegetables in ordinary cultivation. Along the Tobique the red clays derived from the disintegration of Lower Carboniferous rocks afford excellent crops of grain and grasses. The cleared ground about the four last mentioned settlements furnishes fair crops of oats and grasses. The remaining portions of the country traversed by the Back or Central route of the National or Transcontinental railway are generally unsuited to agricultural pursuits since, even where the soil is otherwise fertile, the great accumulation of boulders with which the ground is cumbered renders successful tilling well nigh impossible.

SOUTHERN NEW BRUNSWICK.

R. W. Ells.

The greater part of the season of 1906 was spent in an examination of the area adjacent to the city of St. John, in obtaining materials for the construction of a geological map, not only of the city itself but of the area comprised within a radius of ten to twelve miles. This area would extend westward to Musquash harbour, northward nearly to Devils Back on the St. John river and eastward to Loch Lomond and the Black river. In addition, a couple of weeks were spent by my assistants, under the direction of Mr. J. A. Robert, in mapping the area surrounding the Musquash river and lakes, a district which had never before been closely examined. This was done to connect the work of Mr. R. A. A. Johnston in eastern Charlotte with that along the St. John river.

Owing to the unusually fine weather of the season but little time was lost through rain or fog. The compilation of the map of the St. John area has already been commenced by Mr. Robert, but as most of the geological work in this district was done nearly forty years ago, when no attempt was made to map the several formations accurately, it has been found necessary to make numerous changes in these as depicted on the published map of southern New Brunswick (1878), on the scale of four miles to the inch.

In addition to the general supervision of this work, some weeks were spent in the examination of the mining conditions throughout the province in order to bring out a revised edition of the 'Mineral Resources of New Brunswick,' written by Dr. L. W. Bailey several years ago. In the forthcoming report the latest information regarding the possibilities of economic mineral development will be given. A few days were also spent with Mr. Hugh Fletcher in Nova Scotia in the study of the complicated group of formations lying to the south of the Dominion Atlantic railway between Wolfville on the east and Nictaux on the west.

In field work I was assisted by Mr. J. A. Robert of this department and by Mr. J. Russell Archibald and Mr. A. A. Fleming. While a large amount of work had been done in this district in the matter of surveys as far back as 1877-8, additional information was obtained by detailed work along the shores, wood-paths, new roads, &c., in order that the boundaries of the several geological formations may be laid down as precisely as possible.

DEVONIAN.

One of the most important of the changes made in the geological work about St. John is the transference of the dark red conglomerates and sandstones of Kennebecasis bay, several miles north of the city, from the Lower Carboniferous to the Devonian. Though the resemblance of these rocks to those of the Perry group in Charlotte county was pointed out some years ago, their general resemblance to Lower Carboniferous sediment in the southern part of the province decided the authors of the report on the

district in 1879 to colour them as a part of that formation. During the last three years, however, the study by Dr. David White of the Perry group about Perry in the state of Maine, led to the determination that these rocks belonged rather to the Upper Devonian, a conclusion stated in our report on Charlotte county in 1903. Last summer, during an examination of these rocks on Kennebecasis bay, they were found to be overlaid conformably by grey sandstones, grits and shales, which contain flora of Devonian types. A large collection of these plant fossils was made and examined by Dr. G. F. Matthew of St. John, and their Devonian facies clearly determined. As these grey beds are unquestionably above the Perry dark red conglomerates the Devonian age of these is still more clearly defined.

The importance of this determination of horizons is apparent, since within the last few years a controversy has arisen on the part of certain paleobotanists as to the age of the great series of slates, conglomerates, &c., both to the east and west of the city. These have long been described as of Devonian age by the Geological Survey officers. They have been divided into several groups, known as Bloomsbury, Dadoxylon, Cordaite and Mispec. Last year it was found that the Perry conglomerates, whose Devonian age is now universally admitted, rest conformably upon the upper division of the whole Devonian series, viz., the Mispec, on the east side of Courtney bay, in a large outlier of some hundreds of feet in thickness. There can, therefore, be no longer any doubt as to the actual position in the geological scale of the Devonian rocks of the St. John district. This change in classification of the dark red conglomerates of Kennebecasis from Lower Carboniferous to Devonian will necessitate a recasting of the extension of these rocks to the northeast through King's county, since they can be traced in this direction probably into Albert county. They can be separated from the overlying Lower Carboniferous by careful examination of the district throughout. The details of these formations will be given in the forthcoming report.

In consequence of the great alteration which some of these Devonian rocks have undergone certain portions now closely resemble schists of pre-Cambrian age, and in the general map they were so designated. Part of this alteration is due to local intrusive masses of diabase and granite, and part to foldings and other causes. East of St. John this alteration to schists is well seen near the shore between Cape Spencer and Black river, and westward in the Pisarinco peninsula, and farther west in the direction of Point Lepreau. In this direction, near Musquash, and at Little Lepreau, Belas basin, the associated limestones near the base of the formation have been changed to the crystalline condition and resemble certain pre-Cambrian rocks elsewhere in the province. A close examination of these schists at a number of points showed that the alteration could be traced from the ordinary Devonian slates and shales into the crystalline condition. As a consequence certain areas on the published map will be changed from pre-Cambrian to Devonian.

CAMBRIAN.

Between the Devonian and the top of the Cambrian no sediments of Silurian or Cambro-Silurian age have yet been detected in the area of the St. John map sheet, and these formations, if ever deposited, have been denuded prior to Devonian time. Farther north, however, along the upper part of the Long reach, and west in Charlotte county, fossiliferous Silurian rocks are found in areas of considerable size.

Large areas of intrusive or igneous rocks are seen in every direction. They penetrate all the formations from the highest to the lowest, and comprise fine and coarse granite, gabbro, diorite and diabase, rhyolites and traps. The green diabase rocks abounding in epidote are markedly intrusive in the crystalline limestones everywhere, and the lowest division of the Devonian, styled the Bloomsbury, is cut by green epidotic diabase in all directions. In character these two series of diabase closely resemble each other. They do not, however, appear to affect the upper members of the Devonian, though a reddish-brown and sometimes greenish diabase cuts the Perry conglomerate at some points. A hard green diabase cuts the Cambrian slates and quartzite near St. John city, and the lowest fossiliferous member of the Cambrian—the Etcheminian—is cut by a slaty green felsitic rock, which forms a marked feature for miles between the crystalline limestone and the slates.

The felsite rocks are of two series at least. In parts they appear, as in Charlotte county, to be a portion of the newer granites, but the felsite and associated diabase of the Kingston peninsula, and of the area west of the Long reach of the St. John, underlie the Cambrian there, and the base of the Etcheminian contains pebbles of the felsite rock below. These are distinct from the large masses of granite and green diabase which cut the crystalline limestone all round the city, as well as the Cambrian slates.

The Cambrian, formerly known as the St. John group, comprises a considerable thickness of slate, shale and sandstone, the last often changing into a hard quartzite. Fossils have been collected by Dr. Matthew at many points throughout the series, so that the group, as a whole, is now divisible into several stages. The slates are often well banded in shades of green, black and grey; and in this respect closely resemble what are called the banded slates of the Eastern townships of Quebec. Occasionally, a reddish band is visible in the series. The fossiliferous portion apparently rests upon the crystalline limestone in part, while in places the limestone appears to be part of the slate series. The Etcheminian division near the base represents at present the lowest known fossiliferous portion. It is separated from the limestone in places by a great mass of intrusive diabase, sometimes with a slaty structure induced by pressure, but which can be seen to cut the red beds of the Etcheminian at several points.

The crystalline limestones are found to be merely local developments. Some of the outcrops are exceedingly limited, and are mere lenses in the grey and striped slates, while some can be traced for several miles but have no great thickness, and are much broken by intrusive masses. They are generally interstratified bands or lenses in the grey, black and green slates and hard quartzite. The alteration of these limestones to the white crystalline condition is often due to local intrusions of granite or diabase, and elsewhere the rock is often bluish and slaty in character. The colouring is sometimes due to the presence of graphite. There are no gneisses in the St. John rocks like those of the Grenville or Hastings series, nor are there any of the schists of the old type of those series, though occasionally some of the interbedded slates assume a schistose form. As a whole, these rocks closely resemble portions of the Sillery division of the Quebec group as seen south of the St. Lawrence, both in the nature of the limestones and conglomerates, and in the interbedded slates. If this could be clearly shown on the evidence of fossils, the whole series of limestones

and slates would without doubt be recognized as a part of the Cambrian. In parts bands of limestone conglomerate and thin limestones occur, clearly interbanded with the slates, and these are identical in character with the banded dark slates of the Sillery. In these rocks in Quebec fossils are rarely found, and their alteration in the St. John rocks, together with the fact that no close examination of these interstratified slates appears to have been made, as was done with the St. John City slates, may account for the present lack of fossil evidence. With the exception of the felsites of the ridge north of Kennebecasis bay, and the hornblende schists north of the Long reach, no characteristic pre-Cambrian rocks were seen in the area in question, and, with the exception of some of the more crystalline limestones, nothing resembling the crystalline rocks of the Grenville and Hastings series of Ontario and Quebec was observed.

The division formerly styled Coldbrook, which has usually been regarded as one of the divisions of the Huronian system, consists for the most part of igneous rocks, diorite, diabase, granite and felsite. In many places these present a bedded structure, while elsewhere they cut directly across the lower portion of the Cambrian fossiliferous rocks. In fact, in the volume, 'Cambrian rocks of Cape Breton,' by Dr. G. F. Matthew, the Coldbrook is there included as the lowest Cambrian beneath the Etcheminian formation in which Cambrian fossils have been found. The Cambrian about St. John is much affected by faults, overturns, &c., shows much alteration in many places in the presence of quartz veins and schistosé structure, and in the presence of highly quartzose beds. At the Suspension bridge over the St. John certain beds occur which contain fossils of Upper Cambrian type or the lower portion of the Cambro-Silurian such as *Phyllograptus,* and on Navy island in the upper part of the harbour the slates contain *Dictyonema sociale.* With the former at the bridge are crystalline limestones in narrow lenses, and the interstratified slates are highly graphitic, while both slates and limestones are broken across by intrusives. The details of this structure can only be shown by mapping on a large scale.

ECONOMIC MINERALS.

In regard to the economic minerals, it is to be regretted that but little work is now being done. The principal mining now carried on in the province is in connection with the coal seams at Minto in the Grand Lake area, and at Beersville in Kent county; and in the plaster deposits of Albert country, which have been worked for many years. Building stone and grindstones are still produced in considerable quantities from the freestones of the Millstone grit formation, principally; though at Sackville a very fine quality of brown stone is being quarried from massive beds of Upper Carboniferous age. The granites of the Magaguadavic river and of Spoon island on the lower St. John, are being quarried quite extensively. With the exception of the McLean mine at Letite all work on the copper deposits throughout the province has been suspended, at least for the present.

COAL.

In the coal output there is a marked change for the better, as contrasted with the work of even five years ago. At Minto, the terminus of the New Brunswick railway from Norton station on the Intercolonial, formerly known as Newcastle creek, a number of mines are worked on the coal seam which was tested there many years ago. At

this place there are two seams, one of eighteen to twenty inches, which is that usually worked, and a second and a lower of ten inches. In places these two come together or have a thin parting only, so that it is possible to mine about thirty inches of coal. This is the thickness measured at King's mine and the workings are connected with the surface by a shaft thirty feet deep. In drifting about two feet of shale roof is removed to give head room. The shale parting between the seams at this mine is only three inches.

The coal after hoisting is carefully screened and inspected by an inspector for the Intercolonial railway, before being shipped to Norton, fifty-nine miles distant by rail, where it is used on the locomotives running between Moncton and St. John, and gives satisfaction as a steam producer. A number of mines in the Minto area are connected by railway, all of which are apparently opened on the same seam, though only at four are the two seams worked, the others mining the upper or twenty inch seam only. The output of all the mines in this belt is shipped by rail, but from a number of others situated nearer the shore of Grand lake, the old methods of hauling to the wharf and shipping by water, as run of mine coal, is still maintained. But little if any attempt at cleaning this part of the output is attempted and the resulting output is dirty and unsatisfactory as a first class fuel, containing considerable slate and bunches of sulphur. About 4,000 tons of this variety is thus shipped yearly. The seam is sometimes worked by stripping off the surface rock and soil, but this is only possible when the coal lies near the surface. The entire coal output during the past year is about 40,000 tons, which as compared with the annual out-put under the old system of 8,000 to 10,000 tons, shows a marked advance. This output could be largely increased if miners could be readily obtained. The amount of coal taken per acre from the thirty-inch seam is estimated at nearly 4,000 tons, all the coal being removed as the mining progresses. It has thus been proved that the Grand Lake coal, when properly mined and handled, can furnish a fuel for steam or house purposes equal to that produced from most of the mines of Nova Scotia, and that by economic efforts it will yield a fair profit to the operator. This screened coal brings $3 per ton delivered to the I.C.R. at Norton station. Recent borings in this locality showed no trace of underlying seams to the bottom of the formation. In all, nine mines are operating in the Minto basin, shipping their product by rail and working all the year, while twelve mines are worked irregularly and are shipping by water.

Mining is also carried on at Beersville in Kent county on a seam which is probably an extension of that at Minto. The outcrop is on the bank of the Coal Branch sixteen to eighteen inches, and the levels are driven in from the river bank, with an overhead capping of grey shale and sandstone of thirty to forty feet; the hoisting to the top of the bank is done by a horse whim. The mine is connected with the Intercolonial railway, seven miles distant at Adamsville, by a branch railway. The coal is worth $3.25 per ton on the I.C.R. and mining with a small force has been carried on for several years.

BORING FOR COAL.

Some years ago a series of borings was made at Dunsinane in Kings county, sixty miles from St. John, on the Intercolonial railway. In these two seams were located, similar to those of Minto, at the head of Grand lake, and there was a ten-

dency, as disclosed by the borings, for them to unite and form a seam of about two and a half feet, the supposed junction of the seams being only a short distance north of Dunsinane station. Some coal was mined from the outcrop of the eighteen inch seam several years ago and the quality was found to be excellent. Further borings are contemplated to prove the question of the union of the two seams. The coal basin at this place is merely the extension of that in the Grand Lake area, the character of the rocks and the contained coal seams being similar at both places. The coal outcrops along the western edge of the basin, which is somewhat narrow, and dips to the east at a moderate angle, so that in mining at the supposed junction of the two seams a much deeper shaft than at Minto will be necessary. Its position in close proximity to the Intercolonial is, however, an important factor, and should it be found that the two seams unite and form a bed of thirty inches of good coal the area can probably be profitably worked.

During the past summer borings with the diamond drill have been carried on in Gloucester county at a point about five miles south of the village of Upper Caraquette. A small seam of shale and coal outcrops at this place, but though the boring reached a depth of 650 feet and passed down into red marly shales, probably beneath the Middle Carboniferous formation, no trace of any lower seam was found. The conditions for workable seams in this district are not encouraging.

OIL.

Boring for oil in the Memramcook area has been discontinued for about two years. In all, between sixty and seventy holes were sunk near Memramcook river, at Dover on the Petitcodiac, and on the west side of the latter in Albert county. While many of these holes showed no indications of oil, probably 50 per cent have produced it in small quantity. Of these wells in all about thirty are pumped in the two areas of Dover and Memramcook, and the yield though small is tanked and shipped by the Intercolonial railway from Memramcook. The holes are all bored in the Albert shales, the bottom of which does not appear to have been reached, unless in one hole which was carried to a depth of over 3,000 feet, and was begun in the capping of grey Millstone grit. The borings from the bottom of the deep well appear to be a brownish shale, but this may belong to some portion of the underlying Devonian rocks. Not having cores for determination some amount of uncertainty exists as to the base of the Albert shale formation in this area. The age of these rocks is about the same horizon as that of the shales bored in Cape Breton at Cape Ainslee, as also at Cheverie on the south side of Minas basin in Nova Scotia, and at Gaspé, where the rocks are more sandy and contain less bitumen. In all these places wells have been sunk for oil, but in none has it been found in economic quantity.

The Albert shales are, however, highly bituminous throughout, and contain certain bands carrying from three to nearly twenty feet in thickness which are especially rich in petroleum. As such they are well fitted for the manufacture of oil by distillation after the manner of the oil shales of Scotland, and other countries. Experiments are now being carried on to ascertain the fitness of these shales for the manufacture of oil and by-products by distillation on a large scale. If these are successful the Albert shales will without doubt prove to be one of the most valuable mineral assets of the province.

GYPSUM.

Work on the plaster deposits of Albert county is still carried on extensively, and new deposits have been recently opened up in the southern part of the county near Hopewell; at Martin head, on the coast of St. John county, and at Pink ledge, about one mile north of the end of Cape Maringouin in Westmorland county. The description given by Mr. C. J. Osman in the 'Report on Mineral Resources of New Brunswick' is equally applicable to-day. A large percentage of the gypsum is shipped in the raw state to the United States, while at Hillsborough the calcined plaster industry has assumed large proportions.

IRON.

Iron has been found in large quantity on the bank of the Nipisiguit river about twenty-one miles above Bathurst. The ore is for the most part a magnetite, and forms large masses in schistose rocks which are probably squeezed eruptives. These are cut by dikes of igneous rocks near which the iron is developed. With the exception of some portions near the contact the ore is almost free from sulphur, but contains a considerable percentage, 15 to 20, of silica as well as of phosphorus, the amount of which from a number of samples ranges from ·517 to 1·231. The percentage of iron in the ore is from 46 to 58. The deposit has been traced for nearly two miles back from the river and shows, where uncovered, a breadth of thirty to forty feet at the surface. It has not yet been proved in depth. A branch line of railway nine miles in length is required to connect with the Intercolonial railway and the quantity of ore in sight should render the deposit of commercial value . It is proposed to test it in depth by boring with a diamond drill at an early date.

No work has been done within recent years on the iron deposits near Woodstock in Carleton county. The ores of West Beach were examined and found too much disseminated through the rock to warrant the expenditure of capital in mining. Work on the deposit at Lepreau is at present suspended.

COPPER AND MANGANESE.

Mining for copper is still being carried on at the Letite mine, the shaft having reached a depth of over 300 feet. This property was described in the report of Professor Hind, 1865, under the name of the Wheal Louisiana, and a large amount of money was spent forty years ago in an attempt to develop the mine on a commercial basis, but without success. The ore appears to follow a line of fault or contact between the altered Silurian slates and a mass of green diabase, but the ore-streak is very irregular, thinning out at times to an inch or so, and sometimes enlarging to a foot or more. The ore occurs in quartz along the zone of the contact and consists as yet, for the most part, of iron pyrite and pyrrhotite, with a small amount of chalcopyrite. It is proposed to carry the shaft down to a depth of 500 feet.

The manganese mines are at present unworked. These deposits are apparently all contacts, and very irregular in their distribution.

GRINDSTONES.

Grindstones of excellent quality are made in large quantity during the working season at Stonehaven by the old firm of Bedford Reid, the stone at this place forming

a layer of over twenty feet in thickness, interstratified with a reddish-brown shale. Another firm has opened a quarry in similar stone a mile farther to the east, on the shore of Chaleur bay. In the southern part of the province, at Wood point, about three miles south of Sackville, the stone is reddish, belonging to the Upper Carboniferous formation, and good stones are here also made, some of the material being taken from the old Rockland quarry, a few miles to the south, from beds of Millstone grit age.

BUILDING STONES.

Of building stone many quarries exist which have been worked from time to time as local requirements demand, and are then closed down indefinitely. These are mostly in the sandstones of Millstone grit age. Of these several large quarries were formerly operated along the Miramichi river between Newcastle and Douglastown, from one of which the stone for the Langevin block at Ottawa was taken. These are all closed at present but a fine quarry similar in character to the Fish quarry near Newcastle has been opened at Indiantown on the Southwest Miramichi, about twenty miles west of the main line of the Intercolonial railway. This is owned and worked by Mr. Hood, of Montreal, and furnishes a fine quality of olive stone, in blocks of any required size. The formation is Millstone grit, and the quarry is easy of access.

The only other quarry worked for building stone in the northern part of the province is at Grand Anse, on the south side of Chaleur bay, where the stone for a large church is being obtained. Owing to the great extension of the grey sandstones of this formation throughout the eastern part of the province, quarries can be easily started and supply a local demand very readily.

In brown stone the only quarry at present being worked is at Sackville, owned by Mr. Charles Pickard. This quarry furnishes a fine quality of brown stone, in blocks of any required size, of fine colour and texture, lying nearly horizontal in heavy layers. The output is shipped west to Montreal, Toronto, Ottawa, Hamilton, &c.

GENERAL CONCLUSIONS.

From the examination of the principal mining centres throughout the province it would appear that the mining of ores has hitherto been unprofitable, and that immense sums of money have been wasted in attempts to develop areas which will always be valueless from the economic standpoint. As regards coal, there is a marked improvement within the last five years, the output having increased to over 40,000 tons yearly, which amount could easily be further increased if men could be obtained and the work prosecuted on a more extended scale. From the results obtained at the principal mines at Minto it has been shown that a good quality of coal can be profitably extracted with due regard to screening and general economy of management. In the screening at Minto there is of necessity a considerable amount of small coal, and if the tests now contemplated show that a good merchantable coke can be made from this, it might be possible to utilize this coal in the smelting of the iron ores of the Nipisiguit river, where recent exploration has disclosed the presence of other large ore bodies in addition to those seen during my visit in the summer. If the present system of mining the coal, in which every small owner carries on a small and independent colliery, could be changed so that all could be united under one management, much better results would un-

doubtedly be obtained for all concerned, and a large amount of excellent coal would be supplied for both domestic and steam purposes at a reasonable rate, and with a good return on the capital invested. The local government has now several drills for the purpose of testing, by borings, any mineral localities regarded as worth proving. It is to be regretted that so far no arrangements have been made by which the results of these borings can be obtained. In some cases the logs cannot be found, in other cases the cores have not been carefully labelled or even kept in any kind of order, sometimes being found lying around the boring sites. Instead of this they should be kept properly so as to form a continuous record of the rocks passed through, as a guide to future operations. What is to be desired is the testing of coal lands and other mineral localities in carefully selected places, where the most satisfactory results could be obtained. Such locations should be made by a competent person rather than by the ordinary haphazard method. In this way the actual values of certain areas as mineral producers could be ascertained at a minimum of cost.

SURVEYS IN WESTERN NOVA SCOTIA.

Hugh Fletcher.

The early part of the year was spent by Mr. Fletcher in the usual work of the office, in which he was assisted by Mr. J. A. Robert, who has compiled for the engraver sheets Nos. 84 and 99 of the district lying along the south shore of the Bay of Fundy, between Scots bay and Victoria harbour.

From June 4 to November 18 Mr. Fletcher continued surveys in Nova Scotia in the counties of Hants, Kings and Annapolis, and was mapping the district between the Avon river and Torbrook iron mines, comprising sheets Nos. 85, 98 and 103, already mentioned as embracing the Horton rocks and the iron deposits of Torbrook and Nictaux. These maps are of immediate importance to the province, and their publication is being pressed forward.

Mr. Fletcher was assisted by Messrs. M. H. McLeod, Harold F. Tufts, B.A., and W. W. Hughes, who for a time worked in conjunction also with Mr. Faribault's assistants, A. Cameron and J. M. Cruickshank, who had previously surveyed in this and the adjoining district to the south. Mr. Fletcher testifies to the interest taken by all these gentlemen in their work.

KINGS AND ANNAPOLIS COS.

The season was chiefly occupied with supplementary surveys in the district referred to in the Summary Report for 1905, page 119, Messrs. McLeod, Cameron and Hughes making most of the surveys necessary in the neighbourhood of Hantsport and Benjamin's mills, while Messrs. Cruickshank and Tufts revised the country from Wolfville to Torbrook mines.

Mr. Fletcher left Ottawa in company with Dr. Ells. On their way east they examined in the vicinity of Quebec, Sillery, the Island of Orleans and other places, rocks which in some respects resemble the reddish, greenish and fawn-coloured slates of Wolfville, Kentville and Canaan in Nova Scotia. Dr. Ells, with Mr. Faribault, again in August spent some time with Mr. Fletcher in an examination of the sharply folded rocks of Kings county, where the scarcity and obscurity of fossils and the contorted structure render exact determination difficult, a conference upon the ground on typical areas having been recommended by the Director as desirable for better correlation in the areas in which the surveys adjoin.

The similarity of the *Dictyonema* series to the Sillery of Quebec and the Lower St. Lawrence, and of the grey slates to Cambrian rocks near St. John, N.B., was pointed out by Dr. Ells long ago. On the other hand, the association of the fawn-coloured slates of the Fales river with fossiliferous Silurian sandstones which extend thence to Torbrook mines, and the occurrence of *Dictyonema* with the fossil shells of Messenger brook, makes great caution necessary in their identification. Red slates nearly in contact with the fossiliferous sandstone of Fales river seem to overlie it;

while, a short distance up the river, a quartzite precisely like that of Whiterock is in cliffs; and a third quartzite has been traced east and west from the high falls.

In dark shales of the Horton series from the so-called coal mine of Lockhartville, Dr. Matthew has noted the occurrence of a *lepidodendron* with small areoles raised in the middle like *L. Gaspianum* and *L. Chemungense,* probably on the borderland between Devonian and Lower Carboniferous, and resembling the flora of the Albert shales of New Brunswick, in which Dr. Ells collected last summer two species of *Psilophyton* with *Lepidodendron Gaspianum, L. corrugatum, L. Chemungense* and other forms that go far to determine the Albert shales as Devonian.

In the lower series of rocks, however, in the neighbourhood of Whiterock and underlying the Silurian of Canaan, no fossils have been found but the trails and burrows of annelids mentioned in last report, and *Dictyonema websteri,* at Webster's mills on Moore brook.

Although in some cases the axes of the folds are clearly indicated by a narrow belt of quartz veins and a more coherent condition of the rock, the slates of this district are generally so cleaved and closely folded that even when well exposed in considerable thickness and over large areas it is only by the most careful inspection that they can be distinguished. From the road on the south bank of Gaspereau river at Whiterock, for example, northward as far as the mill near the end of the Deep Hollow, in a distance of less than one mile and a half across the strata, there are nine or ten anticlines and as many synclines. In any estimate of the thickness and geological age of these slates, the few fossils being, as already stated, obscure and referable to any horizon from Cambrian to Devonian, the working out of these folds is of the utmost importance, and in order to determine their structure certain conspicuous bands of quartzite were surveyed and mapped on a scale of twenty chains to one inch to confirm the evidence collected from the dip of the slates; but there is still much that is obscure and requires further elucidation. In and near the quartzite at several points there are stains, small veins and nodules or lumps of iron ore several inches in thickness but of no economic value.

In the millbrook immediately south of Kentville, quartzites, like those of the Spinney brook near Torbrook mines are interstratified with reddish and greenish-grey sandstone and slate, which have as yet yielded no fossils. South of them on the road to Canaan rocks like those of the *Dictyonema* series also bear a strong resemblance to the foregoing, but unlike them they include no quartzites. All are cut by diorite dikes and many beds show annelids. The resemblance in composition, texture and fossils of the rocks at Torbrook to the Dictyonema series farther east has been noticed by Dr. Matthew and others. This much seems to have been proved, that the Whiterock quartzite traced westward passes beneath the fossiliferous Silurian rocks of Canaan, which occupy a narrow, well defined belt between Elderkin brook and Gaspereau lake, and contain beds of limestone, some of which have been burnt for lime, and, in contact with the granite, have been converted into crystalline limestone or marble with obliteration of the fossils.

Only one of the two new shafts described last year as sunk at Torbrook mines has been used. The Leckie mine has been closed and the iron ore is now obtained from the mine at Fletcher Wheelock's. Professor J. E. Woodman has made a survey

of this district, among others, for the Dominion government, so that it need not here be referred to. Professor Woodman spent some days at Whiterock in conference on the geology of this district, and was given tracings of as yet unpublished surveys near the mines and in the country eastward as far as Windsor; for some time he had also the assistance of Mr. Tufts in an examination of the sections along the streams of the neighbourhood of Torbrook mines.

DEEP BORINGS AT NEWVILLE.

During the summer, visits were made from time to time to the deep boring at Newville, described in the Summary Report for 1905, page 122, in order to obtain records of the strata passed through. Bands of unequal hardness in the prevailing conglomerate made progress slow and costly, so that on October 25, Mr. Fletcher was called to Halifax by the Premier and the Commissioner of Mines for Nova Scotia, to confer with Dr. Gilpin, Inspector of Mines, to meet a delegation and advise the government on the advisability of granting aid from the provincial treasury for the prosecution of this and similar borings in Pictou, Colchester and Cumberland counties in search of valuable seams of coal supposed to underlie a great thickness of Permian rocks and to be the continuation of the deposits worked at Stellarton, Westville, Joggins, Springhill and other mines. The borehole at Newville is cased to a depth of 1217 feet, below which for some distance the cable-drill was replaced by one of the government calyx-drills. As the work of the latter, however, in the conglomerate cost six or seven dollars a foot, and as it bored only fourteen inches a day, while the cable drill made twenty-five feet a day at a cost of seventy-five cents a foot, it was taken out and the hole was continued by the cable drill. The core obtained while the calyx-drill was at work shows a reddish-grey coarse conglomerate, composed of pebbles of quartzite, felsite, slate and other Pre-Cambrian rocks, the dip of which does not seem to exceed 7°; and to the present depth of 2,180 feet the drillings indicate a similar conglomerate, hard to bore, but satisfactorily penetrated by the drill used cautiously in a hole six and a quarter inches in diameter, in which the core-drill can, it is said, be inserted to replace the cable-drill without great delay or difficulty should a favourable change take place in the strata. The water was shut off by piping, as stated above, to 1,217 feet, but another flow was met at 1,785 feet which was brackish and supposed to indicate a change of strata.

MACCAN COAL.

As the result of another examination in Cumberland county, a report was made on the mine of the Eastern Coal Company at Maccan station, where, as described in the reports of the Nova Scotia Department of Mines, a seam of coal most favourably situated close to the track of the Intercolonial railway, had been worked for some years at Smith's mine to a depth of 300 feet down a slope of 50° and by levels extending several hundred feet east and west from that slope, a considerable quantity of coal having been taken out to the rise. A new slope, sunk by Mr. Robert Archibald, C. and M. E., at an inclination of 30°, not on the full dip, showed at a depth of 135 feet a seam of coal with a section approximately as follows:—

	Ft.	In.
Coal	1	10
Shale	0	3
Coal	0	6
Shale	0	3
Coal	1	6
Shale	0	4
Coal	1	5
Shale	0	3
Coal with half inch of shale but otherwise clean	4	0
Shale	1	0
Coal	1	3
Total thickness	12	7

This section corresponds with that given by Mr. William Hall for the seam in the old Smith mine. The coal from the latter was found to be suitable for house, steam and domestic purposes, and Mr. Archibald, the manager, has no hesitation in saying that the mine can be profitably worked with a suitable plant so as to yield 500 tons of coal a day. This coal is supposed to be the seam worked at Chignecto mines and at Blenkhorn's mine. At the latter, the top coal, greatly improved, was mined in preference to the four-feet band of the above section upon which Mr. Archibald depends for his yield.

At Springhill mines in sinking the north slope to the 4,400 feet level it was found that the dip flattens to 17° or 20°. The other slopes are in good condition, the coal of the west slope being thick and of good quality.

On August 15, Mr. Fletcher visited Joggins to obtain information concerning old names of places in Sir William Logan's section of that coast, which is now being republished in the transactions of the Nova Scotian Institute of Science, together with other sections of the coast from Shulie to Spicer cove on the opposite side of the Shulie syncline, which are at present of great interest in connection with the search for coal beneath the Permian.

COPPER.

In this connection also it may be mentioned that the colour proofs of twelve sheets between No. 59 and No. 84, have been revised and the maps issued. On one of them, No. 61, there is shown the deposit of copper ore on the land of Mr. John Chisholm at Upper Pugwash, described in the Summary Report for 1903, page 166,* again visited on November 17, and a collection of samples sent to Ottawa. The ore is one of that class of deposits found in association with trunks of trees, leaves and other carbonaceous matter, as described in vol. V., part P, page 185, and other publications of the Geological Survey. It consists of stems and other parts of plants, in part carbonized, in part turned into copper ore, and containing, besides concretionary calcareous matter, barite, pyrite and other minerals. It is found usually in Permian rocks in bands

* Cf. also Sum. Reps. for 1888, page 28; for 1889, p. 29; for 1894, p. 94; for 1897, p. 101.

of grey and reddish sandstone and concretionary limestone conglomerate, or as nodules in red and green marls. At Mr. Chisholm's pits above the bed of a small brook, some excellent copper ore was obtained from a belt, six to ten feet thick, which dips eastward at an inclination of 30°. On the published maps (e.g. sheets 46, 59 and others), belts of this ore are shown as traced for many miles through Pictou, Colchester and Cumberland counties. Many thousand dollars have been spent with but little success in intermittent attempts to mine and reduce the ores, the precentage of metal in the rock being too small for profitable treatment. The history of operations at Dorchester, N.B., of the Pictou smelter, and of the reduction works at Wentworth may be cited as examples. The prospects have, however, improved somewhat with the rise in the prices of copper, and a skilful, judicious test of some of the best localities, of the cost of mining and reduction and the value of the yield in metallic copper might, therefore, perhaps be recommended.

A little prospecting was done last summer on the small coal seam of Toney river in Pictou county, described in the report for 1890-91, page 133 P; but no improvement in the coal seems to have been discovered, and areas in this district can be regarded as valuable only in the event of coal being found by deep boring through these Permian strata.

At Auburn, Kingston and South Farmington in the Annapolis valley, Mr. H. Blackwell, of London, Eng., has bored several holes to a depth of more than 200 feet in search of coal, but none of them seems to have cut through the reddish coarse Triassic sandstone and grit and the white and greenish clay-shales, or to have been more successful than similar attempts referred to in previous reports.*

On the north side of Stewiacke river and east of the Smithfield lead mine (sheet 48), recent discoveries of iron ore are reported, by Mr. C. E. Corbett, of Springhill, along the contact of the Carboniferous limestone and the Devonian rocks and resembling the deposits of Brookfield, Bridgeville and other mines.

At the end of September, in company with Mr. Faribault, a visit was made to the Middle River gold mines in Victoria county, where an American company, represented by Mr. E. J. Foster, is about to thoroughly test the auriferous quartz veins found by Mr. W. C. Scranton near his camp on the Second Gold brook,** from which came most of the gold of the earliest washings at Middle river, as recorded in the report for 1882-84.

About the same time an examination was made of cores from a depth of 780 feet in a diamond drill boring on Peter brook, north of Baddeck bay. These consist of conglomerate and coarse sandstone which underlie dark calcareous shales, containing fish remains and *lepidodendron*, similar to rocks, described on pages 41 and 50 H of the report for 1882-84, which are not the productive coal measures, but underlie them as stated by Mr. Richard Brown in his 'Coal Fields of Cape Breton,' in reference to the coal of Hunters mountain.***

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* Sum. Reps. for 1890, p. 41; for 1904, p. 295.

**Sum. Rep .for 1902, p. 393.

***Sum. Rep. for 1903, p. 173.

PICTOU COUNTY.

On October 1, again in company with Mr. Faribault and his assistants, Mr. Fletcher visited the Dominion Exhibition, in Halifax, at which there was displayed, under the management of Mr. Harry Piers, of the provincial museum, an admirable collection of the raw and manufactured mineral products of Nova Scotia.

The borehole at Rear brook, opposite Trenton, in Pictou county, having been given up in conglomerate at 3,264 feet, without cutting coal, the Pictou Exploration Company is now considering the advisability of boring another hole at Granton, Little Harbour or Pictou.

At Greenwood a slope has been sunk and a little coal extracted for local consumption from the so-called six foot seam on one of the Barton areas, southwest of the Vale colliery.

On October 25, Mr. Fletcher went to Pictou on the invitation of the mayor and town council, to study with them the question of an increased water-supply for the town. The nature of the problem of an adequate supply upon this narrow peninsula of low elevation, through which passes an anticline and possibly also a fault, will be understood by reference to Professor Butler's report on the subject and to map sheets Nos. 44 and 46 of the Geological Survey. Sawmill brook, of course, offers an adequate supply of soft-water of inferior quality, liable to contamination, and requiring purification, but as an artesian supply was preferred and pumps installed, it is hoped that the present supply can be sufficiently augmented in the vicinity of the wells by checking leakage and waste, by damming the lower end of a marsh, and increasing the number of shallow, capacious wells, by boring one or more of the present wells to the greater depth suggested by Professor Butler, and by adding one or more holes farther north, the beds of red marl which yield no water being at the same time protected by piping from the friction of the pumping.

In 1902, after due consideration, the town adopted the present system of pumping into a stand-pipe from seven eight-inch wells bored along the millbrook and old beaver-meadow, near the Boars-back, for a distance of 1,371 feet, and ranging in depth from 93 to 298 feet. They all cut near the surface a thick stratum of sandstone from which most of the water is believed to issue; it is said by the engineer in charge of the pumping station that one of the shallowest, No. 5, 100 feet deep, can alone be depended on for a large supply, and the deepest was shut off by cement as useless below 166 feet. Nos. 1, 3 and 5 were, however, flowing wells showing strong pressure when first bored, and private wells in the neighbourhood seem to point to the probability that other water-bearing beds will be found below 300 feet. The supply for some time after the pumps were started was sufficient, yielding water for the Intercolonial railway engines as well as for the town. During the dry season of 1905, however, instead of a few hours sufficing, the pumps had to be kept going a much longer time to fill the stand-pipe, with a proportionately large consumption of coal. The water was also sometimes too impure to be used in the houses without filtering. In January, 1906, accordingly, the wells were cleaned out, obstructions and a large quantity of mud being removed. By this means the supply was restored, but it was still held to be insufficient for a projected system of sewerage and other growing needs, and during the dry autumn of 1906 fears

were again entertained of a shortage. On a subsequent visit, however, on November 9, after a rainy season had filled the marshes and brooks, the water was found so plentiful that by seven hours pumping a day it could be kept up in the stand-pipe more easily than by seventeen hours pumping during the drought.

VOLCANIC TRAPS OF NORTH MOUNTAIN.

To assist in the classification and colouring of the volcanic rocks of the North mountain on the two sheets now ready for publication, Dr. G. A. Young spent ten days in this district, towards the end of October, investigating the trap rocks from Cape Blomidon westward. He also examined the dike-masses which cut the slates of Black river and Whiterock and took specimens of the curious oolitic, calcareous, sandy and argillaceous Silurian rocks of Canaan for microscopic and chemical examination; and it is hoped that his work in the field may be continued during the season of 1907 among these very interesting and easily accessible rock masses.

Owing to the kindness of Mr. William Salt, of Falmouth, who volunteered to accompany them for several days in November, Messrs. McLeod and Hughes were able to trace on the ground the course of the Hants-Kings county line between Eldridge settlement and New Ross road, and to connect their surveys with the line in order to facilitate the compilation of a map of this district. As it is essential that this and similar lines should be established beyond dispute by some unquestioned authority, and as the records of the Crown Lands Department at Halifax are sometimes meagre or incorrect, and the course and position of such lines ill-defined, it has been suggested that they might be surveyed once for all and established by authority of the provincial government, assistance being given by the officers of the Geological Survey, who could connect all crossings of rivers, lakes, roads and other lines surveyed by them.

On November 26, Mr. McLeod accompanied Mr. Harry Piers to New Ross, in Lunenburg county, to examine a discovery of cassiterite or tinstone reported to have been made at Lake Ramsay, by Mr. Charles Keddy, in a granite vein similar to those from which samples were collected by Mr. Faribault and described in the Summary Report for 1904, page 344.

GOLD FIELDS OF NOVA SCOTIA.

E. Rodolphe Faribault.

Mr. Faribault was engaged in office work at Ottawa from October 14, 1905, until June 19, 1906, when he left for Nova Scotia to resume his work in the field, on which he reports as follows:—

In accordance with your instructions, I left Ottawa on June 19, to resume the examination and surveys of the gold area to the north and west of Halifax. I was assisted the whole season by Messrs. J. McG. Cruickshank, Archibald Cameron and A. Tremblay.

WEST HALIFAX AND SOUTH HANTS COUNTIES.

The field work consisted principally in completing the revision of the topography and structural geology of the gold-bearing rocks lying along the Atlantic coast from Devil island in Halifax harbour to the East river of Chester, and extending inland to Elmsdale, Rawdon and Windsor, where my work joins with that of Mr. Fletcher. The surveys were undertaken with a view to preparing for publication the following eight map sheets: No. 66, Elmsdale sheet; No. 67, Waverley sheet; No. 68, Halifax city sheet; No. 69, Prospect sheet; No. 70, Aspotogon sheet; No. 71, St. Margaret's bay sheet; No. 72, Ponhook lake sheet, and No. 73, Windsor sheet.

The surveys of this region were made several years ago, but owing to insufficient help in the office they were compiled only during the last two years; hence the necessity of re-examining the region in order to revise the topographical features, and define more precisely the boundaries and structural geology of the rock formations.

The northeast half of the area covered by these sheets is, generally, underlaid by the quartzite ('whin') and slates of the gold-bearing series, while the southwestern half is for the most part covered with granite. To facilitate description the two areas will be dealt with separately.

GRANITE AREA WEST OF HALIFAX.

The boundary line between the two formations begins at Portuguese cove and runs northerly, in and out, along the western shore of Halifax harbour to near the head of the Northwest arm, where it leaves the shore in a northwesterly direction, crosses the Chain lakes and keeps about a mile south of the Hammond Plains road; thence runs northerly across Little and Big Pockwock lakes, to the north of which it zigzags through Island, West, Fales and Uniacke lakes, keeping a mile west of Mount Uniacke station; thence runs westerly to Lily lake and along the north end of Five-mile lake, passes half a mile north of King and Bog lakes, crosses the St. Croix river one mile below the outlet of Big Ponhook lake, passes a quarter of a mile south of Martock post office and crosses the Avon river five miles above the railway bridge at Windsor.

From the above described boundary the granite extends south to the Atlantic shore, to Sambro, Prospect, St. Margarets bay, Aspotogon mountain and Mahone bay, and forms the eastern extremity of the largest granite area in Nova Scotia, extending to the southwestern end of the province, where it constitutes the backbone of the western counties. The country is for the most part very rough, with huge blocks and debris of granite, but it is generally well timbered with spruce, hemlock and some pine in the interior on the headwaters of the Indian, Ingram and St. Croix rivers, where lumbering is prosecuted on a large scale by the Dominion Lumber Company, with steam mills located at Ingram Port. It may be interesting to record here that this company has—it is said successfully—sown seeds of white pine in newly burnt up districts.

ECONOMIC MINERALS IN GRANITE.

Deposits of economic minerals have not so far been found in many places in the Nova Scotia granites, and nothing of importance has been discovered in the area under study, although many veins of quartz and dikes of pegmatite have been noticed, some of which are mineralized with pyrites, chalcopyrite, mica, tourmaline and fluor-spar, but so far as known, in no large quantities. At New Ross, fourteen miles farther west, on the continuation of the same granite ridge, pyrolusite, manganite, molybdenite magnetiite, argentiferous galena, zinc-blende, flour-spar, tourmaline, kaolin and fire-clay have been observed at several places; tin-ore is also reported to have been found, but its occurrence could not be ascertained; and a vein of maganese, one mile west of Wallaback lake, was successfully worked for some years. From this it may be inferred that economic minerals may possibly be found here. Gold-bearing quartz has often been reported in the granite, notably at Ketch harbour, Sambro, Pennant harbour, Torrance bay and Hubley lake, but the reports, which could not be verified, must be regarded with suspicion. On the East river, St. Margaret bay, a quarter of a mile below Hubley lake, where the Halifax and Southwestern railway crosses the river, a pit was sunk to a depth of fifty feet in the early days of gold discoveries in Nova Scotia, on a quartz vein running north and south. It included pyrites and possibly galena, and was supposed to contain gold. A ten-stamp mill was built, but, so far as could be ascertained, not a trace of gold was recovered. The pit is now concealed by the bed of the railway, and nothing of the old works or the vein is visible.

The granite is generally coarse and porphyritic, of a light grey or reddish grey colour, but it is often finely crystalline and at times of a rich deep red colour and susceptible of a fine polish. It is generally well suited for building purposes as it splits easily into long blocks. It is much used in Halifax and is to be seen in all the bridges and culverts on the Halifax and Southwestern railway. The principal granite quarries are the Wm. Yeadon quarry and the John Kline quarry situated two miles west of Halifax. The other important quarries near Halifax are the Queen's 'Iron Stone' quarry in blackish altered ferruginous slate occurring near the granite on the west side of the Northwest arm, opposite Pleasant point, and the Beaver Bank slate quarry at Beaver Bank station, where bluish grey slate splits vertically along the cleavage plane on the apex of an anticlinal fold.

Three small isolated patches of altered quartzites and slates of the gold-bearing series not exceeding one mile in width and two miles in length have been observed

in the midst of this granite area; one two miles west of Mount Uniacke station, along the Dominion Atlantic railway, on the west side of Five Island lake; another on the east side of Big Indian lake, half way to Sandy brook, in which a quartz vein was prospected for gold; the third occurs six miles south of Windsor, on the west side of the Chester road, at the outlet of Palmer lake.

Between St. Margaret bay and Mahone bay, on the peninsula extending south from Aspotogan mountain and Deep cove, the granite is succeeded by the gold-bearing rocks which spread southward to New Harbour and cover the islands lying south, including Big and Little Tancook, East Flat, Ironbound, Green and other small islands.

Small patches of Lower Carboniferous limestone, in some places associated with grit, sandstone and shale have been examined where they overlie the granite and the gold-bearing rocks on the shore of St. Margaret bay, at Redman hill, near Seabright, at the head of French Village harbour and at Boutilier station; also on Mahone bay, at Indian point and inland at a short distance east of the point; between Farm lake and the Halifax and Southwestern railway and at Coachman head on the shore between Deep cove and Blanchard, and on the west shore of Snake island. At the two last places the limestone is underlaid by the gold-bearing rocks and at the other places by granite. Much of the country along the shore is covered with lateral and terminal moraines and other deposits of granite debris and it is very probable that some of the limestone areas are larger than represented on the map and that other unobserved areas exist. At Indian point the limestone was extensively quarried for lime which was much used in Halifax some years ago, but it has not been worked for the last few years. Dr. M. Murphy, retired provincial engineer, informed me that it had been used for the old barracks and many of the oldest buildings in Halifax, and had stood the weather better than any other; that it was sowewhat hydraulic and set quickly, but on that account it was hard to work and was not in favour with the builders.

GOLD-BEARING ROCKS NORTH OF HALIFAX.

As stated above, the northeastern half of the area revised for publication is nearly all occupied by the quartzite and slate divisions of the gold-bearing rocks, which extend northward from Halifax and the granite to Dutch Settlement, Enfield, the outlet and north end of Shubenacadie lake and Renfrew, thence easterly to Nine Mile river, northwesterly to Upper Rawdon, northeasterly to Indian Road and Barr settlement and thence westerly to West Gore, Rawdon, Upper Newport, Newport corner, Hartville and Martock, where it narrows down to a point between the granite and the Lower Carboniferous gypsum and limestone. To the north of this boundary the gold rocks are overlaid uncomformably everywhere by the gypsum and limestone of the Lower Carboniferous, except along the foot-hills of Rawdon mountain, from Upper Rawdon to the Herbert river, where a narrow band of Devonian blackish and bluish-grey shale with occasional red layers occurs, overlaid by a great thickness of coarse and fine light grey sandstones, spreading to the northeast and surveyed by Mr. Fletcher. Between Upper Rawdon and Indian Road and between West Gore and Barr settlement are found in the dark shales small seams of coal which have been prospected at several places by shallow pits and a few bore holes. One of the coal seams reopened a few years ago

in the Gore, yielded on analysis by Mr. F. H. Mason (Summary Rep. for 1904, page 299.)

Moisture lost at 110°C.	1.90
Volatile bituminous matter	23.90
Fixed carbon	49.40
Ash	24.80
	100.00
Sulphur	0.15

Evaporative power: one pound of dry coal will, upon complete combustion, evaporate 10·89 pounds of water. The coal burns with a long luminous flame, gives a compact coke and leaves a grey ash.

Grey sandstones were quarried to the north of the Gore mountain and were employed in the building of the Midland railway. Extensive deposits of gypsum occur at several places in the Lower Carboniferous limestone, principally to the east of Windsor, where it is extensively quarried, and in the vicinity of Elmsdale and Enfield, where it was also quarried, more especially for selenite, the crystallized gypsum, which occurs in large transparent sheets, notably at the Horne settlement, on the shore of Shubenacadie lake, and near the Shubenacadie river at Dutch Settlement.

In this section are included two areas of granite cutting through the gold rocks and comprised in the Waverley sheet. The eastern area is five miles wide and extends eastward from the head of Lake Major and Soldier lake to the edge of that sheet, beyond which it extends forty-eight miles eastward to Sheet harbour. The other mass is a small isolated boss, two miles in diameter, rising between Long and Fletcher lakes. The character of the granite is the same as that to the west of Halifax and no minerals of economic value have so far been discovered in them.

In close proximity to the granite the quartzite and slate are everywhere much altered, generally with developments of crystals of staurolite, andalusite, garnets and tourmaline, good specimens of which can frequently be found. At many places along the line of contact the granite is well observed to cut the quartzite and slate, into which it sends dikes and small veins, often along the bedding, and at times along the cleavage-planes, as well as across them. Good and interesting contacts are well exposed to the west of Halifax along the cuttings of the Halifax and Southwestern railway, between Chain and Bayer lakes, on the St. Margaret Bay road to the south of the first Chain lake, on the east side of the Birch Cove lakes and along the Dominion Atlantic railway west of Uniacke lake, where good illustrations of granite capping and altering the gold-bearing rocks may be observed.

Much time was taken up in defining more precisely the boundaries of the different rock formations and in this work I was especially assisted, for the greater part of the season, by Mr. Cameron.

STRUCTURAL GEOLOGY.

On account of the close and intimate relation existing between the occurrence of the gold-bearing veins and the anticlinal folds, it is of the greatest practical importance that the structure of the anticlines and synclines, the dislocations and faults, should be well defined on the map-sheets and sections, in order to help and encourage

intelligent research in new districts where rich gold float has been found, and also to guide in the development of mines that are in operation. In view of the economic and scientific importance of this work great pains were devoted to it. In many cases to arrive at a satisfactory solution the same locality had to be repeatedly examined and surveyed. The difficulty is generally due to the slaty cleavage which is sometimes so much pronounced as to obscure and often obliterate the planes of stratification. I have much pleasure in acknowledging that the successful carrying out of this work is in no small measure due to the energy and zeal displayed by my assistant Mr. Cruickshank, who was engaged in this work most of the season.

The gold-bearing rocks of the region examined have been forced into a succession of folds, almost parallel to each other, bearing a general northeasterly and southwesterly course. A detailed description of the structure of these folds and the faults affecting them could not be followed intelligently unless accompanied by a map and would be too lengthy for this report; it must, therefore, be deferred until a complete report is published with the maps.

The greatest width of the gold-bearing rocks in Nova Scotia, measured at right angles to the folding, is forty miles along a straight line drawn from Three Fathom harbour to West Gore. A line drawn from Devil island, at the entrance of Halifax harbour, to Upper Newport would be thirty-eight miles in length, and would give a section of sixteen anticlines and as many synclines in the country examined. Of the sixteen anticlines, five are in the slate or upper division of the gold-bearing rocks which is generally not gold-producing, and eleven have brought up to the surface the quartzite ('whin') of the lower gold-productive division of the gold-bearing rocks. Out of these eleven anticlines, five have gold mining districts situated on them in the area under study; they are the Montague, Waverley, Oldham, South Uniacke, Mount Uniacke, Renfrew, on the one anticline, and the McKay Settlement gold districts. The structure of these districts has been surveyed in detail and large scale plans and reports have been published of them, excepting of the McKay Settlement district. The anticlines are, on an average, two miles and thirty chains apart; and the greatest intervening distance measured is four and one-half miles, between the Waverley and the Birch Cove anticlines.

A description of eight of the most important anticlines has already been given in the Summary Report for 1896, page 100. In this report the Birch Cove anticline is wrongly given as the continuation of the Montague anticline. A close and repeated examination of the locality has proved that the Birch Cove anticline, after crossing Bedford basin at the north end of Stephen or Navy island, runs easterly between Taylor and Enchanted lakes, north of Mitchell lake, crosses Lake Charles and the Waverley road one-quarter of a mile south of J. McDonald's house, Caribou bog and Lake Major, 200 yards north of the house of Fanny Gross (a negro), where quartz veins have been prospected, and is cut by granite one mile farther east. The exact location of this line may lead to the discovery of a new gold district to the east of Bedford basin, where very rich gold quartz was discovered along the cuttings of the I.C.R. Dartmouth branch, and was wrongly supposed to come from the Montague anticline much farther south. Instead of this, the Montague anticline after crossing the Waverly road at Brady's house, extends only one mile farther west, where the

rocks flatten out, and it terminates by the beginning of a syncline running northeasterly half a mile north of the Montague gold district, and keeping the same distance north of the Montague anticline to the granite.

The anticlinal folds to the north of the Etter Settlement anticline, have not yet been fully described, but they were briefly mentioned in the Summary Report for 1895, page 112. Of these the Mount Uniacke and Renfrew anticline and the Gore anticline are, on account of the gold mines situated along their course, the only ones of special importance.

For information and assistance from miners and others, I wish to offer acknowledgments to the following persons:—Hon. W. T. Pipes, Commissioner of Public Works and Mines; Dr. E. Gilpin, Deputy Commissioner of Mines; R. McColl, Provincial Engineer; Jas. H. Austen, of the Crown Lands Department; Harry Piers, Curator Provincial Museum and Library; Prof. J. Ed. Woodman; Prof. F. H. Sexton; H. W. Johnstone, Assistant City Engineer; Capt. McInnes, Canadian Royal Engineer's Corps; A. A. Hayward, president of the Nova Scotia Mining Society; Fred. P. Ronnan, and Gerald B. Ternan, of Halifax; H. S. Badger, and E. Percy Brown, Goldboro; W. C. Scranton and E. J. Foster, Baddeck; W. J. Prisk, West Gore; Dr. D. Stewart, Bridgewater, in Nova Scotia; and Franklin Playter, Boston.

CHEMISTRY AND MINERALOGY.

Dr. G. C. Hoffmann.

Reporting on the work of this division Dr. Hoffmann says :—

'The work carried out in the chemical laboratory during the eleven months ending November 30, 1906, has been, conformably with the practice of former years, almost exclusively confined to the examination and analysis of such minerals, ores, &c., as were considered likely to prove of economic value and importance. Briefly summarized it embraces :—

1. ANALYSES OF FOSSIL FUELS.

Lignite—

Sections 27 and 28, township 53, range 7, west of the fifth initial meridian, Alta.
Forgetmenot ridge, north of Elbow river, Alta.
Bragg creek, Elbow river, Alta.
Pembina river, Alta. (3 seams.)
Said to be from northwest of Cumberland lake, Sask. (?).
Tantalus butte, Ykn.
Quilchena creek, Nicola valley, B.C.
Similkameen river, B.C.

Lignitic Coal—

Taber coal mines, Alta.
Valley east of Elk lakes, Elk river, B.C.

Coal—

Mabou coal mine, Inverness county, N.S.
Rear brook, East river of Pictou, N.S.
Cariboo cove, Richmond county, N.S.
Bragg creek, Elbow river, Alta.
Fish creek, Bow river, Alta.
Sheep creek, Highwood river, Alta. (3 seams.)
Crowsnest pass, near Frank, Alta.
Elk River tributaries, East Kootenay, B.C. (2 seams.)
Indian reserve, Nicola valley, B.C.
Okanagan lake, B.C
Whitehorse coal fields, Ykn.
Lewes river, Ykn., Tantalus coal mine.
" Five Finger mine.

Anthracitic coal—

Coxcomb mountain, and south of Jumpingpound river, Alta.
Bragg creek, Elbow river, Alta.
Canmore collieries, Alta.
Whitehorse coal fields, Ykn.

Semi-Anthracite—

Sheep creek, Highwood river, Alta. P. Burns' mine.

Anthracite—

Whitehorse coal fields, Ykn.

2. IRON ORES.

Magnetite—

Mansfield township, Pontiac county, Que.
Homer township, Thunder Bay district, Ont.

Hematite—

Dunham township, Missisquoi county, Que.
Northeast of Wabinosh river, Thunder Bay district, Ont.

Clay iron stone—

Falmouth township, Hants county, N.S.

3. ANALYSES OF LIMESTONES AND DOLOMITES.

Morrison's mill, Sydney river, Cape Breton county, N.S.
Walton, Hants county, N.S.
Tennycape manganese mine, Hants county, N.S.
Montcalm township, Argenteuil county, Que.

4. ANALYSES OF NATURAL WATERS.

Cambridge township, Russell county, Ont. From an artesian well.
Shuswap river, Yale district, B.C. From a spring.

5. EXAMINATIONS AND ANALYSES OF CLAYS.

Litches creek, Cape Breton county, N.S.
Whitefish river, Abitibi district, Que.
Hull township, Wright county, Que.
Section 14, township 2, range viii., west of the second initial meridian, Sask.
About twenty miles south of Moosejaw, Sask.
Northwest of Cumberland lake, Sask.
Section 9, township 31, range xxiii., west of the fourth initial meridian, Alta.
Taber, Alta.
Section 15, township 29, range xxiii., west of the fourth initial meridian, Alta.
Section 32, township 30, range iii., west of the fourth initial meridian, Alta.
Near Duck station, Yale district, B.C.

6. MISCELLANEOUS EXAMINATIONS.

Carbonaceous Shale—

West bay, Inverness county, N.S.
Inverness, Megantic county, Que.
Abitibi district, Que.

Graphite, Disseminated—

Suffolk township, Labelle county, Que.
Ramsay township, Lanark county, Ont.

Graphitic Shale—

Frenchvale, Cape Breton county, N.S.

Infusorial Earth—

Pukaist creek, Thompson river, B.C.

Near the mouth of Wood creek, Highland valley, Yale district, B.C.

Marl—

Gloucester township, Carleton county, Ont.

Kinloss township, Bruce county, Ont.

Furlong lake, Rainy River district, Ont.

About fifty miles northwest of Edmonton, Alta.

Petroleum, Crude—

Biddiwell township, Manitou island, Ont.

Sand, Siliceous—

Oneida township, Haldimand county, Ont.

Cullross township, Bruce county, Ont.

Sand, Black—

Big Bar, Fraser river, B.C.

Sandstone—

Wallace, Cumberland county, N.S.

Dorchester, Westmorland county, N.B.

Silt—

Northwest of Cumberland lake, Sask.

The number of mineral specimens received during the period in question for examination or analysis amounted to 741, the number of letters written amounted to 292 and the number of those received to 109.

The regular Annual Report entitled 'Report of the Section of Chemistry and Mineralogy' for the past year is now in the press.

The accomplishment of the work above outlined is very largely due to the active co-operation of assistant chemist and mineralogist, Mr. F. G. Wait, who has uniformly evinced a real interest in the work of the laboratory, and closely and unremittingly applied himself to the same.

Additions to the mineralogical and lithological section of the Museum during the period in question included specimens of anhydrite, chalcedony, cobaltite, disseminated graphite, gypsum, infusorial earth, marl, native copper, nodules of cassiterite, obsidian and pyrite crystals.

A cast of the Iron Creek meteorite has also been added.

Acknowledgments are due to the following gentlemen for presentations to the Museum :—

Boisse, Meynard and David, North Stukely, Que., per 'The Forsyth Granite and Marble Company,' of Montreal, Que.—Two large polished slabs of marble from lots 10 and 11, ranges E and F of Orford, Sherbrooke co., Que.

Donovan, P., Wanapitei, Ont.—A crystal aggregate of pyrite from Wanapitei, Ont.

Herchmer, F. K., Lake Dauphin, Man.—Salt, common, from Salt point, Dawson bay, Lake Winnipegosis, Man.

Holland, Mrs. George, Ottawa, Ont.—A fine specimen of obsidian from the Yellowstone National Park, Wyoming, U.S.A.

Mickle, Prof. G. R.—School of Practical Science, Toronto, Ont.—Crystals of cobaltite, loose and in the matrix, from Cobalt, Coleman tp., Nipissing dist., Ont.

Sohier, M. L., per E. R. Faribault, B.A. (Survey).—A specimen of veinstone from the Maisoneuve mine, Berthier co., Que., holding small quantities of some minerals of the rare earths.

Stevens, A. P., B.Sc.—A specimen of slate from lot 4, range x., Dominion tp., Missisquoi co., Que.

'The Canadian Metal Company' of Frank, Alta.—An ingot of spelter, being the first zinc smelted in Canada. The ore employed being obtained from the silver-lead mines of the East and West Kootenay districts, B.C.

'The Forsyth Granite and Marble Company,' Montreal, Quebec.—A polished tablet of Canadian Verd-Antique marble.

Walters, H. L., per L. Lambe (Survey).—Specimens of native copper from Mussel creek, three miles and a half up Horsefly river, Cariboo district, B.C.

Weeks, Fred. M., Hedley, B.C.—Nineteen samples of ore from the Nickel Plate Mine, Hedley, B.C., and eight samples of ore from the Kingston mine, also at Hedley, B.C.

C. W. Willimott.

'During the early part of the year I was chiefly engaged in arranging mineral collections for educational institutions. Of these collections, the size of which has been increased by fifty per cent, twelve were despatched to various applicants.

I visited a number of localities in the provinces of Ontario, Quebec, Nova Scotia and New Brunswick for the purpose of securing minerals for the completion of collections.

According to instructions I returned to Ottawa at the end of August and prepared a collection of economic minerals for the Central Canada Exhibition. The exhibit was prominently installed in the main building and attracted a great deal of attention. During its installation I was ably assisted by Mr. A. T. McKinnon and Mr. D. A. Esdale.'

M. F. O'Connor.

'In addition to an examination of the many hand specimens that have been brought for identification, the following analyses and assays have been made by me during the year :—

Ores.	Clays.	Coals.	Iron Ores.	Nickel Ores.	Copper Ores.	Lead Zinc. Ores.	Gold & Silver Ores.	Platinum Metal.	Totals.
Character of determinations.	Complete analyses.	Proximate analyses.	Six complete. Twenty-nine partial.	Nickel metal.	Copper determination.	Partial.	Gold and silver.	Metal.	
No. of determinations...	38	80	129	7	5	14	207	12	492
No. of samples	5	20	35	7	5	18	126	11	227

MINES SECTION.

E. D. Ingall.

During 1906 the work devolving upon the section has been, as formerly, along two lines, viz., the Technology and Mining Records and the Statistics.

Along these several lines the main effort consists in gathering as complete data as possible relating to the economic mineral resources of the country and their exploitation. The information sought is naturally of a very varied nature, and is gleaned from every available source.

Through a clipping system, information of a tentative nature is obtained from the technical and general press. Much of this can, of course, only be used as a basis of further inquiry necessary for corroboration and for the obtaining of more extended data.

The proceedings of the technical societies, both American and British, are also searched, and reference card indexes kept, so that for any given deposit, district or industry, all the information available to date may be easily obtained whenever need arises.

A general reference index of the literature of mining and metallurgical processes is also kept, by selecting from that issued by the *Engineering* magazine, mounting on cards and filing away in drawers. The information thus gleaned is mainly of two kinds, which might be classed as permanent and ephemeral. In the former would be included the geological features of occurrence of economic bodies of mineral with all available plans and maps of mines, &c., the nature, qualities and composition of the ores, &c.; their fitness for various purposes and all those varied and voluminous details generally comprised under the designation of Technology and Mining Records. Under the latter heading would come all those features, to a large extent statistical, illustrative of the condition and results of mining and smelting operations for the current year.

The obtaining promptly of complete statistical data illustrative of the production, exports and imports—consumption and markets, &c., for all the varied mineral industries of the country is a very difficult task. Circulars are sent out at the end of the year to all operators, and to those who do not reply in a reasonable time reminders are sent, followed later and where necessary by telegraphic requests.

Based upon the results thus obtained, supplemented by close estimates where data are lacking, an itemed advance statement of the mineral output, imports, &c., is compiled shortly after the lapse of the year dealt with. This pamphlet, which also gives a short résumé of the general progress in each industry, was issued for 1905 on March 2, 1906.

The complete and final figures for the compilation of the detailed statistical report of the mineral industries are not available until well on in the year following

that under consideration, so that with the necessary work of revision and compilation it cannot be ready for press until toward the close of the year.

Among other things demanding considerable attention on the part of the staff of the Mines Section is the answering of inquiries on all kinds of technical matters pertaining to the mineral deposits and mineral industries of the country. These are often so extended in their scope as to require considerable time for their preparation.

The staff of the section remained unchanged during 1906, consisting of Mr. E. D. Ingall, the mining engineer in charge; Mr. Théo. Denis, assisting, especially in the technological work; Mr. Jno. McLeish, having especial charge of the collection and preparation of the mineral statistics, and two lady assistants.

Besides the general office duties as above set forth, the time of the staff is also occupied as time permits in the collection, both from the technical literature available as well as by personal visits to mining districts, of complete information regarding various mineral deposits and classes of ores looking to the continuance of the series of bulletins on the mineral resources of Canada, of which many have already been issued by the Geological Survey.

In this connexion, field studies were made by Mr. Ingall and by Mr. Denis, and résumés of the results of their work are given below.

For about two and a half months during August, September and October, Mr. Ingall was engaged visiting various points in eastern Canada, with a view to collecting further information regarding the progress of exploration and exploitation of the copper deposits of that portion of Canada. Below is given a concise résumé of the points observed by him in the course of this field work.

As a result of the high price of this metal during the year very considerable interest was taken in any new discovery, or older mine promising to develop into a paying concern.

Throughout the eastern provinces of the Dominion, inclusive of Quebec and Ontario, the known copper ore deposits are quite numerous, and in past years many of them have been considerably developed. For many years past, however, the actively working mines producing this metal have been comparatively few considering the great extent of the country comprised and the very numerous occurrences on record. In Nova Scotia and New Brunswick there have been no permanent producing mines for very many years. The production of Quebec for a long time past has been represented by the copper contents of the pyritous acid ores of the Capelton and Eustis mines, while in Ontario, apart from the output of the nickel-copper mines of Sudbury, no steadily producing mines have been in operation, although much interesting development work has been in progress at various points.

From an inspection of the published figures of copper production in Canada it will be noticed that the whole production of the east has only constituted a proportion of from about 14 to nearly 27 per cent of the whole, and that apart from the copper produced at the Sudbury mines, the rest has, for the period covered, never risen to over a quarter of a million dollars worth.

Copper in eastern Canada occurs nearly altogether in the form of sulphuret ores, although in certain districts in Nova Scotia, New Brunswick and on the shores of Lake Superior in Ontario native copper-bearing areas are known.

Whilst in some cases the sulphuret ores carry silver and gold values, the presence of the precious metals has not been a constant feature.

The ore deposits of the maritime provinces have been well described in the Copper Bulletin issued by the Survey in 1904, and prepared by Dr. R. W. Ells. Since the issue of that publication there is little new to note, and although efforts have been made to further develop some of the already known deposits, these provinces remain as yet in the list of non-contributors.

In Quebec the main feature of the copper producing industry is still, as for a long period of years, to be found in the operations at the Capelton and Eustis mines. At these two points lenses of pyrites carrying copper as an accessory constituent are exploited and the ore is utilized primarily in the production of sulphuric acid. These lenses, which are inclosed in schistose rocks in a comparatively flat attitude, have been developed to depths measured on the dip of over 2,000 feet, although their greatest longitudinal dimensions would be approximately 200 to 300 feet.

At the Eustis mine the operations are now carried on by electric power. The ore is raised by means of an electric hoist to the level of the long crosscut tunnel where it is loaded into mine cars. These are hauled out by an electric motor which takes them down the hill to the newly installed mill which is situated near the track of the Boston and Maine railroad. Here, by means of a plant of rock-breakers, rolls, screens and Wilfley tables, the ore is treated so as to produce a grade suitable for shipping, in which condition it is forwarded by rail to the acid works of the company in New Jersey.

At the Capelton mines the acid works and chemical plant form the main feature. Ore, partly from the Company's own mine adjacent to the Eustis already mentioned, and partly acquired by purchase, is burnt in the acid works, and the cupriferous cinder is smelted in a small cupola, and the matte, which also carries the slight silver contents of the ore, is shipped to the Nichols Chemical Company's works in New Jersey, U.S.A., for further treatment.

Thanks are due to Messrs Blue and Eustis, of the Eustis mine, and to Mr. W. L. Spafford, of the Capelton mine, for courtesies and assistance rendered during the visit made to their mines.

The copper ore deposits of Quebec attracted attention at a very early date in the history of the country, and in past years considerable development work was done at a number of points. These historic ventures have been practically all confined to what is known as the Eastern townships, or the district lying south of the St. Lawrence river, and east of Montreal.

These deposits occur mostly in an older schistose series, although some of those worked in the past have been in limestones. The ores obtained throughout the district mentioned have been either similar to those mined at the Capelton and Eustis mines, viz.: cupriferous pyrite, or in contrast, copper ores proper have been the prominent feature, chalcopyrite and bornite being the most frequent.

Whilst none of this latter class have been continuously working for many years, fresh interest is beginning to be taken in them, as evidenced by exploratory and development work now going on at various points.

Chief amongst these may be mentioned the Ascot and the Suffield mines. In both cases the work has been prosecuted by small forces of men in continuation of that done years ago and abandoned. At the Ascot, under the management of Mr. McCaw, further underground developments were made during the year and some shipments of ore from the old dumps were made to Capelton.

At the Suffield mine development work is in progress under the direction of Captain Wm. Jenkins for the owner, Mr. A. O. Norton, of Coaticooke. At this place the intention has been to trace the ore-bearing belt and to block out ore in the mine, leaving the extraction of ore in quantity until some future date.

The two last mentioned mines are examples of the deposits yielding copper sulphurets proper, and the average of the copper contents is claimed to be high, whilst their value is said to be enhanced to the extent of from $5 to $8 by the presence of the precious metals.

At another of the older mines which was visited and which was famous in past years for its yield of high grade sulphurets, viz., the Acton Mine, a couple of men were employed following some of the leaders of ore in the walls of the old pits. It was said to be in contemplation to operate this mine again on an extensive scale. Mr. J. E. Marcile, M.P., and Dr. F. H. Daigneault, M.P., are interested in the enterprise.

Search for new bodies of pyritous ores was reported as active in the district of which Sherbrooke is the centre, but time only permitted of visits to a few points among which may be mentioned the work proceeding under the direction of Dr. Foss of Lennoxville. At this point, which lies about half a mile westerly from the old Moulton Hill mine, the test shaft was down about twenty feet at the time of the examination, and showed a belt of highly pyritiferous schist for the full width of eight feet of the shaft. This property would apparently come within the category of the acid pyritous ore bodies before mentioned.

In Ontario copper ores of two distinct classes are known. Native copper bearing rocks of Keeweenawan age, and therefore similar in a general sense to those of the famous native copper mines of Michigan, occur as small fringing areas at isolated points along the eastern shores of Lake Superior. They also constitute the large islands of Michipicoten and those forming the barrier chain across the mouth of Nipigon bay, as well as the outer end of the peninsula between Black and Nipigon bays.

Considerable mining developments were made in this series at Mamainse point and Michipicoten island, but without ensuring permanent success. For many years little has been done further towards the settlement of the question as to whether deposits may not be found to exist in as yet unexplored portions of these areas which will be profitably workable.

Apart from the above-mentioned, the expectations of this province in respect to copper lie in the sulphuret ore deposits known to exist at very numerous points in the older rocks underlying all the northern part of this province.

The copper resulting from the operations at the famous Sudbury mines has already been spoken of and has practically constituted the whole output of the province for many years.

An interesting feature of this year's operations consists of the re-opening of the old group of mines on the north shore of Lake Huron at Bruce Mines, which were so extensively worked from 1846 to about 1875. The ore occurring here is chalcopyrite in a series of large quartz veins which cut an area of intrusive diabase of considerable extent.

Numerous bodies of cupriferous sulphurets have been located throughout the stretch of country bordering the shores of Lakes Huron and Superior; they extend easterly as far as the head of Lake Timiskaming and westerly as far as the Lake of the Woods district. They generally occur in the areas of schistose and other rocks which are distributed throughout this extensive territory as well as in veins cutting the overlying series of the Huronian proper.

Speaking in a very general way it may be said that the ore-bodies of the Keewatin schistose series often present much resemblance to those already mentioned as occurring in Quebec. They frequently occur in interfoliated lenses, in some of which the ore might be classed as pyrite with accessory copper whilst in others the ores are sulphurets of copper proper.

Attention is being turned to the development of these deposits at a number of points located between Sudbury and Sault Ste. Marie, Ont.

On the occasion of the visit paid to the Massey mine a few miles north of the village of that name, it was found that the work which had been prosecuted for some years had been suspended. At this mine two adjacent lenses of ore occurring in a series of schists often very quartzose, were explored to a depth of 500 feet for a length along the strike of about 250 feet.

Ore croppings have been located on this belt, which has an easterly and westerly trend, for several miles on either side of the above mentioned mine. Extensive developments have been made and are still in progress on the Herminia properties on its westerly extension, one of this Company's mines being located about two miles, and one about three miles from the Massey. The farthest or No. 3 shaft is equipped with a complete hoisting and air-compressing plant, and the intention is to sink a considerable depth and open the ore-body by drifts before contemplating any extraction on a large scale.

Farther west along the Algoma branch of the Canadian Pacific railway, work is progressing at the Dean Lake mine, situated about eight miles westerly from the town of Blind River. This point is interesting in that the ore, which is chalcopyrite and bornite, occurs in the flat lying sedimentaries of the original typical Huronian series which is here represented by the red quartzites and by slate conglomerate with the usual disseminated pebbles. The mine is equipped with hoist and air compressor; the main working consists of a shaft which was 110 feet deep at the time the exam-

ination was made. Besides this, surface croppings of ore had been opened up for a distance of over 1,000 feet. Development work was said to be progressing on a copper ore property in the vicinity of Echo lake, but this point was not visited, nor did time permit of a personal examination of many other rumoured discoveries and operations in this district.

A number of interesting sulphuret deposits located northerly from Sault Ste. Marie have received considerable attention for some years past. The existence of copper ores in the vicinity of Goulais and Batchewana bays has been known since the days of the earliest explorers, and it is interesting to note that similar deposits have been located farther inland. Upon some of these, during recent years, considerable development work has been done, amongst other places, at the Eagle Copper Company's property in Vankoughnet township and at the Superior Copper Company's property. This section has been rendered more accessible by the construction of the Algoma Central railway, and the latter mine is reached by a road four and a half miles from Birch Camp station on that line. This mine has been equipped with a hoisting and power drill plant. Along a length of the ore belt of some 2,000 feet in length, six test-shafts have been sunk, the deepest attaining to over 250 feet. Development work was in progress during 1906. Between these mines at the eastern end of Lake Superior and Lake of the Woods are many areas of the Keewatin rocks, in which, at a number of points, deposits of pyritiferous copper ores have been located, but upon which little or no work has been done for a long time.

At the Tip-Top mine, however, work was in progress during 1906 with a force of ten to fifteen men, for Colonel Ray of Port Arthur, who acquired possession of the mine in June, 1905. At this mine, from information, reports and plans kindly loaned by Colonel Ray, including tests of car-load lots, and assay returns from sampling of the mine, there would seem to exist a body of ore of good grade. This has been followed in depth for over 200 feet and for about 150 feet in length by means of drifts at three levels.

The foregoing remarks have been largely confined to the portion of the country visited by Mr. Ingall and to actually operating properties. When the large number of the known deposits of copper ore throughout eastern Canada is considered, as well as the wide distribution of extensive areas of the copper-bearing formations and the present high prices of copper, it is reasonable to hope that the immediate future may see a great growth of the copper mining industry. This hope is also sustained by evidences everywhere of enterprising efforts to place many hitherto idle deposits on a paying basis. During the summer very efficient aid was rendered by Mr. Percy Marshall.

WESTERN OIL, GAS AND COAL FIELDS.

Theo. Denis.

Mr. Denis left Ottawa at the end of May, with instructions to proceed to the oil and natural gas districts of western Ontario for the purpose of bringing up to date the records of the Mines Section on these subjects, and to confer with the operators as to the best means of keeping in touch with the development of the industries, such as obtaining logs of wells, and reliable information as to relative importance of new fields, &c., and to ascertain in what shape all the data we possess could be compiled and published so as to best meet the needs of the public. Some new and very important information was gathered, and the Mines Section intend to publish as soon as possible a bulletin giving a systematic presentment of all data concerning these subjects. The bulletin will also include descriptions of the western oil fields and operations.

On the 18th of June, with further instructions, Mr. Denis proceeded westward, to investigate the development of the oil and gas fields and of the coal mining industry. With the additional information thus obtained during the season, the Mines Section will publish a bulletin on 'Coal in Canada,' giving a short description of the coal fields and collieries. These bulletins are intended to give in a popular form information concerning the various branches of Canadian mineral industries. It is believed that they will also be useful in acquainting operators in the various fields with the conditions and methods of other districts. They will be liberally illustrated with reproductions of photographs, sketch maps, &c.

It is now more than fifteen years since attention was brought to the occurrences of oil in the region of the South Kootenay pass, by Dr. Selwyn, in the report of the Geological Survey for 1891, but it is only since 1902 that boring operations on a comparatively large scale, were undertaken. At the time of my visit in July, 1906, there were five companies working actively in the district, as follows:—

The Western Oil and Coal Company, Limited, offices at Vancouver, B.C., have two drilling rigs in operation, one on Pine creek, in township 2, range XXX, west of 4th meridian, and another on the shore of Upper Waterton lake, in township 1, same range. One of the wells on Pass creek is said to have struck a fair quantity of oil; it is claimed that it could pump fifteen to twenty barrels a day, but owing to the lack of transportation facilities, the Company was not producing at the time. On Waterton lake, a depth of 1,800 feet had been reached. The intention was to go to 2,000 feet and to move the rig to a point near the mouth of Oil creek, about one-third of a mile from the first well.

The Rocky Mountain Oil Development Company, office at Pincher Creek, are operating on the Alberta side of South Kootenay pass, on Oil creek, at Oil City. One well struck oil at a depth of 1,080 feet, and for some time flowed by itself. Some 200 barrels of oil are stored in galvanized iron tanks erected near the well.. A small still has been contrived and produces gasoline, kerosene and lubricating oil for the

use of the camp and surroundings. The illuminating oil is of a very good quality, and burns without soiling the lamp chimneys.

The well has been capped and is held in reserve until there are better shipping facilities. It is said that it would pump fifteen to twenty barrels per day. The Company was putting down another hole some 1,500 feet higher up the creek.

There seems to be but little room for doubt that all the above wells, as also the one being put down by the S. E. British Columbia Land and Oil Company subsequently referred to, start at the surface, in strata of Cambrian age, or older, which have been thrown over younger formations of Cretaceous age, by a huge overthrust fault.

In the Report of the Geological Survey for 1898, Dr. G. M. Dawson, referring to the numerous seepages found in the region of both sides of the divide, expresses himself as follows:—'The indications certainly seem to be sufficiently promising to warrant some outlay in work of this kind (boring operations) notwithstanding the generally disturbed and broken character of the formation of the region.'

It has also been suggested that the older strata, which, owing to the overthrust, overlie the Cretaceous measures here, could act as the impervious cover necessary for the gathering of the oil, and that petroleum exists in the contact zone.

The Canadian Northwest Oil Company, office at Pincher Creek, Alta., are working farther north on the south fork of the Oldman river, eighteen miles directly west of the town of Pincher Creek. This company controls several sections in township 6, range III., west of the 5th meridian. In July, 1906, they were preparing to put down a bore hole on section 15 of the above township, and the greater part of the machinery was on the ground at the time.

This location is at the base of the foothills, some fifteen miles east of the summit, and the surface rocks are here referable to the Upper and Middle Cretaceous.

The Canadian Pacific railway is also undertaking a deep boring test near Medicine Hat. They have established a boring rig at Dunmore junction, and intend to put down a well to 3,000 feet. These operations are under the immediate supervision of Mr. Eugene Coste.

The result of these borings, which are 170 miles apart, will be awaited with great interest; but there still remains a large territory yet untested, to the south of the railway, where chances of striking oil might be equally good. The superficial covering is so thick and so uniform that very little information as to the underground contours can be obtained. It is to a great extent a matter of onerous testing by bore holes.

The S. E. British Columbia Land and Oil Company, offices at 'The Dell,' Oregon, is operating on Akamina creek, four miles west of the summit of the South Kootenay pass. Work was begun in the spring of 1906 with a rig which was brought in across the line from Montana. In the first week of July the boring had reached a depth of 800 feet.

Another company, the Canada Western Oil Company, office at Greenwood, B.C., has control of 620 acres on Kishehena creek, which is practically the lower part of Akamina. They intended to begin operations this summer.

ATHABASKA RIVER.

A few years ago the Geological Survey put down a bore hole on the Athabaska river, at Pelican portage, some 125 miles from Athabaska Landing. At 800 feet the drill struck a strong flow of natural gas, and drilling operations were abandoned. The flow continued and the well has been burning since. Owing to reports on the part of travellers and traders, that the flame attained great heights and that a large supply of natural fuel was going to waste, Mr. Denis was instructed to make a thorough examination of the well, and to report on the advisability of taking steps towards extinguishing it and plugging it at the seat of the casing.

On examination it was found that the reports had been greatly exaggerated. The gas escapes out of the ground through a four-inch pipe, and the flame, by actual measurements, taken on the second of August, in calm weather, did not exceed a height of fifteen feet. According to the storekeeper for Messrs. Revillon Brothers at the Portage the well has repeatedly been extinguished and relighted by Indians and bushmen, showing that this operation does not present much difficulty.

From all appearance the casing is in bad condition. It is improbable that anything would be gained by stopping the flow of gas. The well is comparatively shallow, and if the previous reports as to volume of flame had any foundation, then the well is decreasing at a rapid rate, either owing to exhaustion of the gas pocket, or the partial filling up of the bore hole, by the caving of the sides.

The effect of this escape of gas on an underground supply would, moreover, be insignificant as compared with the escape from 'natural gas springs,' which occur at several places lower down the Athabaska river, and which certainly have the same origin, and come to the surface through fissures in the rock. Of these, Mr. McConnell in his report on the district says, that 'Some of the jets burn steadily when lighted, until extinguished by heavy rains or strong wind, and afford sufficient heat to cook a camp meal.' When it is realized that this has been going on for geological ages, within a few miles of the Pelican Rapids well, the quantity of gas which has come out of this bore hole is entirely insignificant.

During the course of the summer, two drilling rigs were shipped down the Athabaska to bore for oil in the vicinity of Fort McMurray. The results of their operations will be awaited with great interest.

The following short account of the development of the western coal industry during the past year is given as the result of a visit to the various fields:—

The coal industry along the Crow's Nest branch of the Canadian Pacific railway is developing very quickly. At Taber, some thirty miles east of Lethbridge, the Reliance Coal Company, which started work about a year ago, have now a very complete surface plant and are placing coal on the market. The Taber Coal Company have improved their plant, and are now in a position to produce 300 tons a day.

At Lethbridge, the Alberta Railway and Irrigation Company (late Alberta Railway and Coal Company) have extended their workings under the valley of the river. They are continually introducing improvements and additions at their colliery, the latest being a new Rand compressor with a free air capacity of 3,300 cubic feet a minute.

The Diamond Coal Company are at present starting to develop a colliery six miles north of Lethbridge on the opposite bank of the river. The intention of the Company is to develop the property for the next eighteen months, at which time the new Canadian Pacific Railway bridge spanning the valley is expected to be completed and will bring the line of railway within a short distance of the mine.

At Lundbreck the Lund-Breckenridge Coal Company's mine, which was only in the development stage last year, is now the centre of quite a large settlement. It has a very complete and up-to-date surface plant, with a steel head frame sixty-five feet high. The mine only began shipping in April and has now an output of 150 to 200 tons a day. The capacity of the screens is at present 500 tons, but it is capable of large extensions.

At Frank, the Canadian-American Coal Company's principal addition to their surface works is a tipple which is now in course of construction and is designed to handle 2,000 tons a day. The main entry is now in 8,600 feet.

The Hillcrest Coal and Coke Company, whose mine is situated southeast of Frank, Alberta, on section 18, range III., township 7, west of the fifth meridian, started development in September, 1905, and the first shipment of coal was made in March, 1906. They own a spur of standard gauge railway two miles long, connecting the tipple with the Canadian Pacific railway, and have now a production capacity of 200 tons a day.

The West Canadian Collieries Company, offices at Blairmore, who have the only installation in the west of mechanical coke ovens (a set of Belgian ovens of the Bernard type), had been rather troubled by the high contents in ash of their coke. They have installed at Lille a splendidly equipped washer, designed to wash all coal sent to the coke ovens under three-quarters of an inch in size, with the result that the ash in the coke has been reduced by one-half. The washer comprises Luhrig jigs and Spitzkatsen, and can treat 300 tons in a day of ten hours; all the labour in connection with it is performed by one man at the engine and one labourer. Both collieries, Lille and Bellevue, were working steadily all the year.

At Coleman, the International Coal and Coke Company are building ninety additional coke ovens of beehive pattern. This will double their capacity. The colliery has a very up-to-date plant and a steady output.

On the British Columbia side of the Crowsnest pass the coal industry has been very active. One of the noteworthy features is the start which the Canadian Pacific railway is making to mine coal at Hosmer, a station on the railway about eight miles north of Fernie. The work, up to July, had mainly been of a prospecting nature, but there seems to be little doubt that an important colliery will soon be added to those of the Crowsnest pass.

The Imperial Coal Company, who own some coal lands on Fording river, a tributary of the Elk river, above Michel creek, have begun surveys for a line of railway to tap their areas.

So far, the only producing coal company of the Crowsnest Pass field, is the Crow's Nest Coal Company. This company has two collieries working actively, at Coal creek and at Michel, and a third one at Carbonado, on which a great deal of work

has been done, but which is not producing at present. The year's main improvements at these two collieries have been the completion of a steel tipple at Coal creek, designed to handle an output of 4,000 tons in 10 hours, and the installation of compressed air haulage at the Michel colliery to replace horse haulage. Practically one-half of the coal output is used in the manufacture of coke, which is shipped to the West Kootenay smelters, or exported.

The Nicola valley is now entered by a branch line of the Canadian Pacific railway from Spences Bridge. It is expected that this will be open for traffic during the autumn. The transport facilities thus afforded should be an incentive to prospecting for coal in this region. Coal certainly occurs there, but nothing very definite is yet known as to the extent of the fields. The Diamond Vale Coal Company has been the most active in the work of prospecting. They have a diamond drill at work continuously on their Quilchena area.

A couple of diamond drill holes were also bored during the year in the valley between the Coldwater and the Nicola rivers.

The Pacific Coal Company, with mine at Bankhead, near Banff, Alberta, have completed and put in operation their large breaker, to prepare the anthracite coal for the market. It is of the best modern type and probably the most complete in North America. The coal is thoroughly divested of all friable parts so that it can stand long transportation without breaking up. The result of this preparation, however, is the production of a rather large proportion of anthracite dust. After a long series of careful experiments, the company is erecting a briquetting plant to use this dust. The plant ,which may be in operation at the close of the year, will produce 200 tons of briquettes per day. The presses adopted are of the Zwoier pattern.

In the Edmonton district, all the coal mines have been very active, and everywhere, provision was being made for a greatly increased output. The city of Edmonton has been growing very rapidly and the market for coal has naturally grown in proportion.

The feature of the year in the district has been the inauguration of mining by shafts. Previously, all the mines were worked by tunnels driven into the banks of the Saskatchewan river, but there are now three mines that have sunk shafts from sixty to 195 feet. The individual production of the mines is so far small, the largest not exceeding 200 tons in two shifts.

Mr. Denis also made a short visit to the Pembina River coal crops some seventy miles west of Edmonton. There are in township 53, range VII, west of the 5th meridian, several seams of what appears to be high grade lignite. Two of these exceed twelve feet in thickness, and are lying almost horizontally. They are at the present moment rather far from means of transportation, but both the Canadian Northern and the Grand Trunk Pacific railways have their final location survey lines run within very easy access of this yet untouched field.

The following note gives the results obtained by Dr. Hoffmann as to the composition of these lignites:—

'Memo. *re* three samples of lignite from Pembina river, Alberta, collected by Mr. T. Denis, August 16, 1906.

Of these samples—

No. 1 was taken across the outcrop, of the thirteen-foot seam above the burnt shale outcrop, on the east bank of Pembina river, about four hundred yards above the crossing of the river ; S.E. ¼, section 33, township 53, range VII, west of the 5th initial meridian, Alberta.

No. 2 was taken across the outcrop of the thirteen-foot seam nearest to the crossing of the Pembina river, on the east bank of that stream; N.E. ¼ of section 33, township 53, range VII, west of the 5th initial meridian, Alberta.

No. 3, was taken across the outcrop of the six-foot seam, on the west bank of the Pembina river, at the crossing; NE. ¼ of section 33, township 53, range VII, west of the 5th initial meridian, Alberta.

Analyses, by fast coking, of the foregoing, by Mr. F. G. Wait, gave as follows:—

	No. 1.	No. 2.	No. 3.
Hygroscopic water	12·93	13·78	13·07
Volatile combustible matter	31·96	32·01	32·03
Fixed carbon	45·11	47·35	47·56
Ash	10·00	6·86	7·34
	100·	100·	100·
Coke, per cent	55·11	54·21	54·90

They all yield by fast coking, a non-coherent coke. The ash had in each instance a light reddish brown colour.

NATURAL GAS AT MEDICINE HAT.

The Medicine Hat Natural Gas field is holding out without any sign of diminution of pressure. The municipality have two wells in commission, with depths of 1,000 and 1,100 feet respectively, and a rock pressure of 650 pounds. The Canadian Pacific railway have also a well, and natural gas is practically the only fuel burnt in their repair shops. It is used under the boilers, in the forge, for making and tempering springs, for tire setting, &c. The saving in labour and in coal effected by the introduction of this almost ideal fuel is very considerable.

PALÆONTOLOGY AND ZOOLOGY.

J. F. Whiteaves.

'The fourth and concluding part of "Palæozoic Fossils, Vol. III.," was published in September last. As printed, it consists of 110 pages of letter press, with eight text figures, and twenty full page plates. The explanations of the plates were written in 1906, and the recent receipt of some new material has necessitated the rewriting of a considerable portion of the letter press, in order to include the additional information that has been gleaned from it and from other sources. As now completed the whole volume consists of 352 pages large octavo, with forty-two plates, and twenty-six text figures.

A paper descriptive and illustrative of a new Canadian species of *Cyrtoceras (C. cuneatum)* has been published in the *Ottawa Naturalist* for October, 1906. A commencement has been made of a paper on the fossil fishes of the Devonian rocks of Chaleur bay. This paper is intended as a supplement to two papers on this subject, that were published in the Transactions of the Royal Society of Canada for 1886 and 1888.

Several collections of fossils have ben examined during the year, most of which have been reported upon, either verbally or by letter. Among these are the following:—

Cambro-Silurian.—Fifty-three small pieces of highly fossiliferous argillites from the Utica or Lorraine formation at St. Bruno mountain, Chambly county, Quebec, collected by Dr. J. A. Dresser in 1905. Most of the species in these argillites have been determined, but some of them are new to science and have yet to be described. By far the most abundant fossil in them is a brachiopod that Dr. Ulrich identifies with *Dalmanella multisecta* (Meek). This is the species which is so common in the Utica formation at Ottawa, and which has previously been identified with *Orthis testudinaria.* According to Dr. Ruedemann, the most characteristic graptolite in these argillites is *Dendrograptus tenuiramosus,* Walcott.

Silurian.—A few fossils from the Guelph formation at Belwood, Ont., recently collected by Mr. Joseph Townsend.

Devonian.—Ten fossils from the Braine pass, and one fossil from Braine creek, Yukon, all collected by Mr. C. Camsell in 1905. These are clearly of Devonian age, but their precise horizon in that formation has yet to be ascertained. Small collections of fossils from the Corniferous limestone near Formosa, Gorrie and Belmore, Ontario, recently made by Mr. Townsend; and from near Waterford, in the same province, recently made by Mr. N. H. Cowdry.

Triassic.—A few fossils, that are probably of Triassic age, collected by Mr. Joseph Keele on the Rackla river, Yukon, in 1905.

Cretaceous.—Six fossils from the Snake river, and seven from the Peel river, Yukon, collected by Mr. Camsell in 1905. Fifteen fossils from the Cretaceous rocks at Roger creek, Alberni, Vancouver island, collected by Mr. W. J. Sutton in 1905. These prove to be eleven specimens of *Amauropsis tenuistriata,* three of *Cytherea subtrigona,* both of which are species characteristic of, and previously only known from, the lower shales and sandstones or subdivision C, of the Queen Charlotte islands—and a fragment of a dicotyledonous leaf. These fossils indicate the existence of a detached area of Cretaceous deposits, corresponding in age with the 'coal-bearing rocks' of the Queen Charlotte islands, at the head of the Alberni canal. Between forty and fifty fossils from the Benton, and Pierre Fox Hill, or Colorado formations, in Southern Alberta, collected by Mr. D. D. Cairnes in 1905. A few fossils from Harrison lake, B.C. sent for determination by the Rev. G. W. Taylor, of Wellington, B.C. These prove to be specimens of *Aucella crassicollis,* a species which is indicative of a very low, and apparently the lowest known, geological horizon in the British Columbia Cretaceous.

Pleistocene.—On the 5th of September last, while digging a well on his farm, in lot 21 of the 11th concession of Pakenham, Ont., Mr. Patrick Cannon discovered the skeleton of some large vertebrate animal, in a mixture of blue clay with marine shells, of Pleistocene age, fourteen feet below the surface. Only a portion of this skeleton was exhumed, which was sent to the writer for determination. It proved to consist of the skull, with most of the cervical and two of the dorsal vertebræ, of a young individual of a whale, which is clearly referable to *Delphinapterus vermontanus.* This is the *Beluga vermontana* of Thompson (which was first described as *Delphinus vermontana*), but it has long been conceded that Rafinesque's generic name *Beluga* is synonymous with *Delphinapterus,* Lacepede. Moreover, it is very doubtful whether Thompson's provisional species can be satisfactorily distinguished from the common White Whale or Beluga (*Delphinapterus leucas*) now living in the Gulf of St. Lawrence and North Atlantic. Portions of the skeleton of *D. Vermontanus* had previously been found in Pleistocene clays on the Jacquet river, N.B.; at Rivière du Loup and Montreal, Que.; also at Cornwall, Ont.; as well as in Vermont; but this is the first time that remains of this cetacean have been discovered in the Post Tertiary deposits of the Ottawa valley.

In Zoology, several small collections, mostly of land and fresh-water shells, have been examined and the species determined, for Professor Macoun, Mr. Joseph Keele, and various correspondents. In some of these collections there are a few species that are either new to Canada, or that were not previously represented by Canadian specimens in the Museum of the Survey. Three papers on Canadian zoological subjects have been contributed to the *'Ottawa Naturalist'* for February, May and September, 1906.

During Mr. Low's absence from Ottawa for a little over two months last summer, the duties of Acting Deputy Head and Director were performed by the writer. In addition to letters written or dictated in that capacity, the writer's official correspondence in 1906 consisted of 156 letters received and 185 written.

The following specimens were received in 1906, either from members of the staff or from employees of the department:—

Macoun, Professor John:

Two small collections of fresh-water shells; one from a small lake four miles and a half due west of Hamiota; and the other from a small lake in the sand hills west of Pine creek and northeast of Carberry, Manitoba.

Ells, Dr. R. W.:

Collection of fossil plants from the north side of Kennebecasis island, N.B.

Ami, Dr. H. M.:

About 200 Cambro-Silurian fossils from the 'crush and thrust' conglomerates at Quebec city; and about the same number from the Trenton formation of the Montmorency river.

Twenty-five fossils from the Lower Trenton rocks at Pine Tree island, Ottawa, and twenty-five from the Trenton formation at Governor bay, Ottawa.

150 concretions, holding remains of fishes, plants and shells, from the Pleistocene clays near Ottawa.

Lambe, L. M.:

A large collection of fish, insect and plant remains, from the Tertiary lake deposits of the Horsefly river, the vicinity of Kamloops lake, Quilchena, Coutlee and Princeton, B.C.

McInnes, William:

Thirty fossils from the Lower Palæozoic rocks at Cormorant lake, Saskatchewan river; and small collections of land and fresh water shells from six localities between the Saskatchewan and the head waters of the Little Churchill river.

Dowling, D. B.:

Twenty-four fossils from the Upper Banff limestone, and ten from rocks apparently of Triassic age, from the Brazeau river, Alberta.

Thirty-five fossils from the Fernie shale of the Red Deer and Sheep rivers, Alberta; and forty from the Cretaceous beds above the Kootanie, on the Saskatchewan and Sheep rivers, Alberta.

Wilson, W. J.:

Four species of fresh-water shells from the Harricanaw river, north of Seals Home lake, Que.

Keele, Joseph:

Specimens of three species of fresh-water shells, (ivz., *Limnæ palustris, L. truncatula,* and *Planorbis parvus*) from small ponds in the valley of Hunker creek, Yukon.

Spreadborough, W.:

248 specimens of birds and small mammals, from the Chilliwack valley, B.C.

O'Sullivan, Owen:

Small collection of fresh-water shells from the Nelson river, and headwaters of the Little Churchill river, Keewatin.

Two specimens of *Conchidium decussatum,* and eighteen Pleistocene fossils, from the Deer branch of the Churchill river, Keewatin.

Brock, R. W.:

About fifty fossils from a zone in the stratified rocks in the western portion of the Rossland camp; and about a dozen specimens of plant remains from Little Sheep Creek valley, at Paterson, on the International Boundary line.

Cairnes, D.D.:

About ten specimens of Carboniferous or Devonian fossils, thirty of Cretaceous invertebrata, and six of Cretaceous plant remains, from the southern portion of the Yukon.

Johnston, W. A.:

Large collection of fossils, including some fine crinoids, cystideans, and a few starfishes, from the Trenton limestone along the Trent Valley canal, near Kirkfield, Ont.

The additions to the palæontological and zoological collections in the Museum during 1906, and from other sources, are as follows :—

By presentation:—

(A.—Palæontology.)

Grant, Colonel C. C., Hamilton, Ont.:

Five small parcels of fossil bryozoa from the chert beds of the Niagara formation at Hamilton, determined by Mr. Ray S. Bassler.

Thirty-four fossils from the Silurian rocks near Hamilton, and seven from the Cambro-Silurian drift at Winona, and the lake shore at Hamilton.

Sutton, W. J., Victoria, B.C.:

Eleven specimens of *Amauropsis tenuistriata,* three of *Cytherea (Callista) subtrigona,* and fragment of a dictyledonous leaf, from the Cretaceous rocks at Roger creek, Alberni, Vancouver island.

Cowdry, N. H., Waterford, Ont.:

Two small specimens of *Cypricardinia indenta,* and tail of a trilobite, *Lichas (Conolichas) eriopis,* Hall, from the Corniferous limestone of Ontario.

(B.—Zoology.)

Ives, C., Miscouche, P.E.I.:

Specimens of *Astyris dissimilis* and *Cingula minuta* (two small sea shells), from Miscouche.

Whiteaves, F. K., Ottawa:

Sets of eight eggs, of the Chickadee; of seven, of the Belted Kingfisher; and of six, of the Baltimore Oriole, House Sparrow, and Bank Swallow; all from near Ottawa.

Winkler, G. E., Penticton, B.C.:

Four perfect and fresh specimens of *Gonidea angulata* (a rare fresh-water mussel or clam), from the Okanagan river at Penticton.

Fletcher, Dr. James, Ottawa:

Specimens of two small fresh-water limpets *(Ancylus caurinus* and *tardus)*, from Cowichan lake, Vancouver island.

Stoker, Dr. R. N., Duncans, V.I.:

More specimens of *Ancylus* from Cowichan lake.

Wilson, Eli, Armstrong, B.C.:

Small collections of land and fresh-water shells from four localities in British Columbia.

By purchase:—

Two specimens of the Rocky Mountain goat, and two of the Canadian lynx, from Closson, Alberta.

Albino mink, female, shot in Wainfleet township, Ont., by Mr. D. Moore, January 15, 1906, and purchased from Mr. James Crysler, taxidermist, Low Banks, Ont.

Skunk, nearly albino, shot at Garnett settlement, St. John co., N.B., by Mr. J. C. Garnett, in October, 1903.

A few fossils from the Corniferous limestone at Formosa, and near Gorrie and Belmore, Ont.

Lawrence M. Lambe.

Work on the 1904 collection of vertebrates from the Oligocene deposits of the Cypress hills was continued last winter. The vertebrate fauna of the Cypress hills, as represented by the 1904 and previous collections, includes fishes, reptiles (turtles, snakes and crocodiles) and mammals. The last named class is represented by numerous species of the four orders Ungulata, Rodentia, Carnivora and Insectivora. In all, the fauna consists of between fifty and sixty species of which one-fourth are apparently new to science. In the preparation of the report on this extremely interesting fauna the manuscript is more than half completed and about half of the drawings necessary for the plates have been made.

Some attention was given to the small collection of Tertiary fishes from the Horsefly, Kamloops and Similkameen districts of British Columbia, as a result of which a paper entitled 'On *Amyzon brevipinne* Cope, from the Amyzon beds of the southern interior of British Columbia,' was read before the Royal Society of Canada at its Annual meeting in May last. This paper has since been printed and distributed (Trans. Royal Society of Canada, new series, vol. xii., p. 151, pl. 1). The above collection has been for some time in the Museum of the Survey and is referred to in the Summary Report of last year as pointing to the probable equivalency in age of the Tertiary fish-bearing beds of Horsefly, Tranquille and Tulameen rivers.

A new Testudo recognized during the study of the turtles of the Cypress hills collection (Oligocene) and further information obtained regarding the structure of

some of the Cretaceous forms from Red Deer river, made it expedient to publish during the year the two following papers:

'Descriptions of new species of *Testudo* and *Baëna,* with remarks on some Cretaceous forms,' *Ottawa Naturalist,* vol. xix., p. 187, pls. 3 and 4.

'*Boremys,* a new Chelonian genus from the Cretaceous of Alberta,' *Ottawa Naturalist,* vol. xix., p. 232.

(*Summer Work*).

Pursuant to the instructions received to proceed to British Columbia and there examine the Tertiary sedimentary deposits in certain districts of the southern interior of that province, viz., in the neighbourhood of Kamloops lake, to the north at Horsefly river, to the south in the Nicola district and in the vicinity of the junction of the Similkameen and Tulameen rivers, I left Ottawa in the middle of June. Two and a half months were spent in the field, the aim of the expedition being to secure a better understanding of the age of these Tertiary deposits with the acquisition by systematic search of collections of their fossils, with special reference to remains of vertebrates. Of the fish, plant and insect remains occurring in these rocks, those of fishes were considered as excellent horizon markers and a probable means to a more definite determination of the age of the Tertiary sedimentary rocks of the above-mentioned districts.

Starting in the Kamloops district some time was spent in camp at the mouth of Tranquille river on the north side of Kamloops lake. From here Red point, six miles to the west on the north shore, and the southern shore of the lake opposite the mouth of the Tranquille, were reached; at both of these places Tertiary sedimentary rocks occur.

I next proceeded to Horsefly river, by means of the stage northward from Ashcroft, to 150 Mile House, and the branch stage eastward from there via Parker's camp, to Horsefly mine, a point on Horsefly river seven miles from Quesnel lake and distant about one hundred and sixty miles by the stage route from Ashcroft.

Returning to Kamloops, the Nicola district to the south was next visited and the rocks in the neighbourhood of Quilchena and near Coutlee were closely examined. Thence I drove to Princeton (Vermilion forks of the old maps), about forty miles due south of Nicola lake, in the vicinity of which settlement numerous outcrops of Tertiary shale occur on both the north (Tulameen) and south forks of the Similkameen river.

I was ably assisted in the field by Mr. E. Wilson, of Armstrong, B.C., whose zeal and interest in the work largely contributed to the success of the expedition.

The collections of fossils obtained in the above-mentioned areas from the Tertiary lake beds are from the following localities:—

Kamloops district—

Near the mouth of Tranquille river, north shore of Kamloops lake.

Red point, north shore of Kamloops lake.

Horsefly district—

Horsefly mine, seven miles above the mouth of Horsefly river.

Nicola district—

The Diamond Vale Company's mine, near Quilchena.

Coal Gully, near Coutlee (Coal Gully basin).

Similkameen district—

At a number of points at and above Princeton on the Tulameen and Similkameen rivers.

A number of fossil plants were received by me, whilst at Princeton, from Mr. Charles Camsell, of this Survey, who collected them from Tertiary shales at the mouth of Whipsaw creek, a tributary of the Similkameen.

The above collections comprise fish, plant and insect remains. Professor D. P. Penhallow, of McGill University, has undertaken the study of the plants with a view to reporting on them, his report to take the form of a monograph, to be issued by this Department, on the plants of the Tertiary sedimentary rocks of the southern interior of British Columbia. The plant material available for study, besides last summer's collection, includes former collections made by Dr. G. M. Dawson at a number of localities, and by Dr. R. Ells and Mr. R. A. A. Johnston, in 1904, in the Nicola valley. The insects it is proposed to submit to a competent authority. The fishes include a number of interesting forms, some of which may prove to be new to science.

From a preliminary study of these fishes it would appear that the view already expressed,* that the Tertiary shales of Horsefly, Tranquille and Similkameen rivers are probably of the same age, is substantiated. That the fish- and plant-bearing beds of the vicinity of Quilchena have a similar age appears probable, relying on the occurrence in these shales of a fish that is thought to be referable to *Amyzon brevipinne*, a species common to the Horsefly and Tulameen beds. Further study of last summer's collection, however, is necessary before a more definite opinion regarding the exact age of the Quilchena shales is expressed.

Last year a number of casts of types and original fossils, and photographs of mounted skeletons and restorations of Tertiary vertebrates were purchased from the American Museum of Natural History, New York. This year, casts and photographs of a few Mesozoic and some additional Tertiary vertebrate species, that it was thought desirable to have represented in the Survey collection, were obtained from the same institution. These latter with those previously received, form a valuable series illustrating the land and marine vertebrate life of American Mesozoic and Tertiary times.

H. M. Ami.

In addition to the preparation of reports on the occurrences of petroleum, gas, and the natural resources of Northern Alberta; and on coal occurrences along the line of the Medicine Hat and Northern Alberta railway, my time was largely occupied in determining, and arranging for the Museum, fossils from various localities, especially in Eastern Canada.

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* 1906, 'Note on the Age of the Horsefly, Similkameen and Tranquille Tertiary beds of the Southern Interior of British Columbia,' Summary Report of the Geol. Survey Dept. for 1905, p. 137; and 1906, 'On *Amyzon brevipinne*, Cope from the Amyzon beds of the Southern Interior of British Columbia,' Trans. Royal Soc. of Canada, vol. xiii; second series, p. 151 pl. 1.

The faunal lists prepared for the Director's 'Cruise of the *Neptune*' were supplemented by a further study of several species which proved to be rare or altogether new to science.

Considerable progress was made in preparing fossil lists to form appendices to reports of the Ottawa and Cornwall, Kingston, Pembroke and Haliburton sheets.

In connexion with the Chaudière Power case now before the Canadian courts a report on the geology of Phileum island, Ottawa river, and of the south side of Hull island, has been prepared and handed to the Attorney to the Crown.

Pursuant to a report made by me last year on the geology of the cliffs below the Citadel, Quebec city, an additional report was prepared this year, which included recommendations for the prevention of erosion along the face and adjoining the strata on which the terrace and fortifications are built.

Some two weeks were spent in making an examination, for the Quebec Railway Light and Power Company, of the Montmorency valley, about one mile above the falls.

For the Department of Militia and Defence a brief report was made on the geology of the vicinity of the Beaumont shore, in connexion wth the excavations for the Beaumont fort.

A report was also made for the promoters of the Lake St. John Railway extension on the prospects furnished by the Chibougamau mining region.

By permission, I spent about two weeks in New York state giving geological evidence in a suit of law regarding the springs at Saratoga.

Acting on the Director's instructions I prepared a report on the rocks included in and adjacent to the golf links along the north shore of the Ottawa river and their relations to the probable sources of water supply at the links.

At the request of Dr. G. F. Kunz, of Messrs. Tiffany & Co., an examination was made of specimens of the rocks or pebbles constituting the drift of a district in Indiana where 'loose diamonds' had been found. In Ottawa, Messrs. A. E. Barlow, W. J. Wilson and Professor W. Miller, and subsequently Dr. F. Adams in Montreal, examined the specimens, which showed a striking resemblance to the rocks constituting the rock formations of western and northern Ontario.

During the year a number of fossil plants were forwarded for determination to Professor D. P. Penhallow of McGill University.

Some five hundred specimens of fossils collected by me were added to the Palaeontological section of the Museum.

On May 14 by request of the Director I took over charge of the archæological and ethnological collections of the Survey.

NATURAL HISTORY BRANCH.

Professor John Macoun.

During the last eleven months my assistant, Mr. J. M. Macoun, and I have been engaged on the ordinary routine work of this branch, except for the three months I spent in the Northwest. The large collection of plants made by me in Quebec during the season of 1905 has all been named and mounted, good progress has been made with the collection made by Mr. J. M. Macoun in British Columbia that year and all the smaller collections made by members of the Geological Survey staff and others have been determined and placed in the herbarium. The Catalogue of Mammals is approaching completion and the new edition of the Catalogue of Birds will be ready for the printer early in January.

The number of Natural History specimens sent to us for determination has greatly increased during the past year, especially in botany, and much of our time is employed in this work. During the past eleven months 4,924 sheets of botanical specimens were sent to herbariums in different parts of the world, chiefly in exchange for specimens received. Of the 3,604 specimens mounted 1,842 were from foreign countries.

Nine hundred and forty-nine official letters were written and about the same number received. This is a larger number than has been written by us during any previous year and indicates the increase in the work of this branch.

PUBLISHING DEPARTMENT.

F. J. Nicolas.

The following reports and catalogues have been published since January 1, 1906:—

No. 913. The Mineral Pigments of Canada. By C. W. Willimott (pp. 39). Published February 18, 1906.

No. 914. Supplementary List of Publications during 1904 and 1905 (pp. 11). Published February 20, 1906.

Mineral Production of Canada for 1905 (pp. 16). Published March 15, 1906.

No. 939. Preliminary Report on the Rossland, B.C., mining district. By R. W. Brock (pp. 40). Published June 2, 1906.

No. 923. Report on Chibougamau Mining Region. By A. P. Low (pp. 61).

No. 940. Report on Graham Island, B.C. By Dr. R. W. Ells (pp. 46). Published July 20.

No. 888. The Geology and Petrography of Mount Yamaska. By G. A. Young, forming Pt. H, Annual Report, Vol. xvi. (pp. 43).

No. 955. French edition of 923 (pp. 57). Published August 2.

No. 947. Summary Report of the Acting Director, for 1905 (pp. 144). Published August 31.

No. 950. Palaeozoic Fossils, Vol. iii., Part iv. (and last). By Dr. J. F. Whiteaves (pp. 208). Published October 10.

No. 956. Catalogue of Publications (pp. 129). Sent to printer June 11. Signed for printing September 21. Published October 12.

No. 907. Annual Report (New Series), Vol. xiv. (pp. 1193), Containing the following reports:—

(A) Bell, R.—Summary Report of the Acting Director.

(B) McConnell, R. G.—Report on the Klondike.

(F) Dowling, D. B.—Report on an Exploration of Ekwan river, Sutton lakes and west coast of James bay.

(H) Barlow, A. E.—Report on the Origin, Geological Relations and Composition of the Nickel and Copper Deposits of the Sudbury Mining District, Ont.

(J) Ells, R. W.—Report on the Geology of a Portion of Eastern Ontario.

(M) Poole, H. S.—Report on Pictou Coal-field.

(O) Adams, F. D. and LeRoy, O.—Report on the Wells of Island of Montreal.

(S) Ingall, E. D.—Report of Section of Mines, 1901.

No. 911. Annual Report (New Series), Vol. xv. (pp. 1025). Containing the following reports:—

(A) Bell, R.—Summary Report of the Acting Director, for 1902.

(AA) Bell, R.—Summary Report of the Acting Director, for 1903.

(F) Dowling, D. B.—Report on Coal-fields of Souris river.

(S) Ingall, E. D.—Report of Section of Mines, 1902.

No. 905. 'Cruise of the Neptune,' by A. P. Low (pp. 355). Published November 19, 1906.*

No. 928. Section of Mines, Annual Report, 1904.

The following reports have been printed and are in the bindery:—

No. 902. Report on Brome mountain, Que., by J. A. Dresser.

No. 942. Report on the Upper Stewart river, Yukon, by J. Keele, and
No. 943. On the Peel and Wind rivers, Yukon, by C. Camsell.

The following reports are going through the press:—

No. 952. Annual Report (New Series), Vol. xvi. (pp. 733). Containing the following reports:—

(A) Bell, R.—Summary Report of the Acting Director, for 1904.

(B) Ells, R. W.—Report on Graham island, B.C.

(C) Keele, J.—Report on Upper Stewart river.

(CC) Camsell, C.—Report on Peel and Wind rivers.

(G) Dresser, J. A.—Geology and Petrography of Brome mountain.

(H) Young, G. A.—Geology and Petrography of Yamaska mountain.

(S) Ingall, E. D.—Report of Mines Section, 1903.

No. 958. Annual Report on Chemistry and Mineralogy, by G. C. Hoffmann.

No. 949. Cascade Coal-field, by D. B. Dowling.

No. 961. Reprint of Report on Nickel and Copper Deposits of Sudbury district, Ont., by Dr. A. E. Barlow.

* Out of print.

MAPPING AND ENGRAVING.

C. O. Sénecal.

Mr. Sénecal reports as follows on the work accomplished under his supervision during the past eleven months:—

During the early part of this period, the work was carried out by a staff of seven draughtsmen and a general assistant and typewriter. At the beginning of the summer Messrs. J. A. Robert and F. O'Farrell were detached for field work, and later Mr. P. Frèreault resigned. A new draughtsman, Mr. G. Aitken, was afterwards given employment, but the staff is still numerically weak to cope with the increasing demand made on this branch. However, the progress made, it is hoped, will be found satisfactory, and thanks are due to my present assistants for their courteous and efficient services.

Fairly well equipped rooms for the preparation of blue-prints, photo-copies and reductions of maps, and for general photographic work are now placed at the disposal of this office, and although the work may, in part, be done by the draughtsmen themselves, the employment of a professional photographer is suggested.

The assignment of the work was as follows:—

Mr. L. N. Richard compiled and prepared complete copies for photo-lithographing the map of raised beaches of the Ontario Interlake peninsula; completed the compilation of the map of Moose Mountain region, Alberta; prepared the colour copy of the map of Chibougamau district, Quebec; revised the plate proofs of Pembroke and Ottawa and Cornwall geological sheets Nos. 120 and 122 of the Ontario series, and prepared the colour work of the same.

Mr. Richard completed the plotting by latitudes and departures of the railway and road traverses he made in Nova Scotia last year, and laid them as base-lines on projected sheets Nos. 92, 93, 94, 95, 103, 104, 105, 106, 107, 108, 119, 120 and 121 of the systematic series of sheets on the scale of 4 miles to 1 inch.

Mr. O. E. Prud'homme traced and lettered the following maps, plans, &c., for engraving: Sections for Lawrencetown sheet No. 53, N.S.; Musquodoboit Harbour sheet, No. 54, N.S., and Gay River sheet, No. 55, N.S.; the geological map of Graham island (Queen Charlotte group), B.C.; plans and sections of Leipsigate and Harrigan gold districts of Nova Scotia and the geological map of the districts of Algoma and Thunder bay, Ontario. He prepared for lithographing the relief copy in crayon shading of the four sheets of the map of Cascade Coal basin, Alberta. He also prepared the black and colour copies of additions and corrections required for a second edition of the Victoria Mines and Sudbury maps.

Mr. Prud'homme spent a considerable time during last summer in rearranging and indexing original plotted sheets, manuscript maps, and reserve stock of printed maps for reference in the map room.

Mr. P. Frèreault assisted Mr. J. Keele in the compilation of the Peace River map, and traced the same for engraving. He has drawn the following maps for photo-lithographic reproduction: The Windy Arm mining district, Yukon; the Graham Island coal field, British Columbia, and the southwest coast of Hudson bay. He also prepared the colour work on the index map of Nova Scotia, on the map of the country between Temagami and Rabbit lakes, Ontario, and on the Graham Island geological sheet.

Mr. Frèreault resigned on August 28.

Mr. A. Dickison compiled and traced for photo-lithographing the index map of Nova Scotia; compiled a geological map of southwest Nova Scotia on the scale of 4 miles to 1 inch, and has a tracing of the latter in progress. He compiled and traced for engraving a general index map of the Yukon; traced for engraving the maps of the Rossland mining camps and of the Upper Stewart River region, and prepared the colour copies of the Manitoulin Island sheet, No. 126, of the Ontario geological series. Mr. Dickison almost completed the compilation of the maps of the Upper Winisk River region, on the scale of 8 miles to 1 inch, and has also in hand the compilation of the geological sheets Nos. 16 and 17, Nipigon district, Ontario. Besides the above, Mr. Dickison made a large number of plans, diagrams and sketches for photo-engraving to illustrate various reports, &c.

Mr. J. A. Robert compiled and traced for engraving the map of Lake Chibougamau region, Quebec, and began the compilation of the geological sheets Nos. 84, 98, 99 and 103 of the Nova Scotia series. He was detached for field work on August 21.

Mr. F. O'Farrell assisted Mr. E. R. Faribault in the compilation of the Nova Scotia geological sheets of the vicinity of Halifax, Nos. 66 to 73. He finished the compilation of the map of Temagami and Rabbit lakes and traced the same for engraving. Mr. O'Farrell left for the field on April 21.

Mr. H. Lefebvre revised the four sheets of the map of Cascade Coal basin, Alberta, and prepared the colour work on the geological and topographical editions of the same for lithographing. Mr. Lefebvre assisted Mr. Dowling and spent the greater part of last summer in making photo-enlargements of and compiling photo-topographic surveys of the coal fields of the Rocky mountains, between Panther and Clearwater rivers, Alberta. These are well advanced and it is expected the map will be completed during the coming winter.

Mr. Lefebvre also made a large number of pantagraph reductions of railway plans for a new edition of the map of the Nottaway River basin, northwestern Quebec.

Mr. G. Aitken was appointed on the temporary staff on the 1st of August. He traced for engraving and prepared the coloured copy of a contoured map of the Moose Mountain region, Alberta, and made reductions of new surveys for the map of the basin of Nottaway river.

The routine work of laying down projections, revising and correcting map proofs, making reductions, tracing for field use, lists of instrument repairs, &c., was divided among the staff and attended to.

The map-work carried out by the several field officers is as follows:—

The coal fields of the Rocky mountains in part of Kananaskis and Elk River valleys, Alberta, on the scale of 40 chains to 1 inch, by Mr. D. B. Dowling ,assisted by Mr. H. Lefebvre.

The coal fields of the Rocky mountains between Panther and Clearwater rivers, Alberta, on the scale of 40 chains to 1 inch, by Mr. D. B. Dowling, assisted by Mr. G. S. Malloch.

The compilation of Mr. C. Camsell's surveys of Peel river, Yukon, and the map of Upper Stewart River region, both on the scale of 8 miles to 1 inch, and a sketch map of Tantalus and Five Finger coal fields, by Mr. J. Keele.

A sketch map of Windy Arm mining district, Yukon, by Mr. H. Maclaren.

Compilation of map of Moose Mountain region, Alberta, on the scale of 2 miles to 1 inch, and progress on compilation of a portion of the Yukon, south of Whitehorse mining district, on the scale of 1 mile to 1 inch, by Mr. D. D. Cairnes.

The Peterborough Geological Sheet, No. 117, Ontario series, on the scale of 4 miles to 1 inch, in progress by Mr. W. A. Johnston.

Messrs. W. J. Wilson and H. Collins completed their geological map of portions of the districts of Thunder Bay and Algoma, Ontario, on the scale of 8 miles to 1 inch, from a variety of surveys, including their own, carried out between 1903 and 1906.

Mr. W. H. Boyd compiled a preliminary map of the Rossland mining camps, British Columbia, and has in progress the mapping of his surveys in the same field on the scales of 400 feet to 1 inch in contours of 20 feet intervals and of 1,200 feet to 1 inch in contours of 40 feet intervals.

The serial geological sheets Nos. 66 to 73 Nova Scotia on the scale of 1 mile to 1 inch were completed by Mr. E. R. Faribault. These sheets, except for the addition of geological sections and minor details, are ready for publication and will be traced for engraving at the first opportunity.

The revision of the eastern sheet of the Dominion geological map on the same scale of 50 miles to 1 inch was attended to by Mr. J. White, geographer of the Department of the Interior, and the copy was placed in the King's Printer's hands at an early date. No proofs of the revised map have as yet been received.

The compilation of the Kingston district, Ont., covering sheets Nos. 111 and 112 on the scale of 4 miles to 1 inch is also in the hands of the geographer of the Interior.

The Manitoulin Island Geological sheet, No. 126, Ontario, held over for many years, was placed in the lithographer's hands and the edition is expected during the winter.

New editions of the following maps now out of print, are in progress viz.:—The Victoria mines, Sudbury; Copper Cliff, and Elsie and Murray mines of the Sudbury mining district; the Basin of Nottaway river, the geological map of the Bancroft district, Ontario, and the Nipissing and Timiskaming map sheets Nos. 131 and 138, Ontario and Quebec.

Two maps of the Gorge and Falls of Niagara river, to accompany a monograph on the physics of the Falls, were also supplied by Dr. J. W. Spencer, and engraved on copper.

There are at present twenty-six maps in various stages of progress in the hands of the King's Printer. Among these are the two editions—geological and topographical—of the four-sheet map of the Cascade Coal basin, which was engraved on copper, and will be issued to the public, it is expected, early in 1907.

The examination and repairing of the field instruments was, as usual, attended to. Several worn-out instruments were replaced by new ones.

The meetings of the Geographic Board of Canada were also attended regularly.

The following is a list of the maps, plans and diagrams received from the King's Printer during the period covered by the report :—

Catalogue Number.	Description.	Area in square miles.
906	Geological map of the Northeastern part of the Dominion of Canada—Scale 50 miles to 1 inch.	
942	Yukon—Map of Peel and Wind rivers, scale 8 miles to 1 inch.	
916	Yukon—Sketch geological map of Windy Arm Mining district. Scale 2 miles to 1 inch.	
917	Yukon—General index map. Scale 32 miles to 1 inch.	
921	British Columbia—Geological map of Graham Island. Scale 4 miles to 1 inch.	
922	British Columbia—Geological map of Graham Island Coal field. Scale 1 mile to 1 inch.	
941	British Columbia—Preliminary Geological map of City of Rossland and vicinity. Scale 1,600 feet to 1 inch.	
915	North-West—Southwest Coast of Hudson Bay. Scale 16 miles to 1 inch.	
663	Ontario—Ignace Geological Sheet, No. 5. Scale 4 miles to 1 inch.	3,456
919	Ontario—Recession Lines of Niagara Falls. Scale 200 feet to 1 inch.	
920	Ontario—Part of the Interlake Peninsula showing Ancient Shore lines of Great Lakes.	
903	Ontario and Quebec—Ottawa and Cornwall Sheet, No. 210. Scale 4 miles to 1 inch.	3,264
887	Quebec—Geological and Topographical Map of Yamaska Mountain. Scale 20 chains to 1 inch	About 12
901	Quebec—Geological and Petrographical Map of Brome Mountain. Scale 40 chains to 1 inch	" 90
918	Quebec—Geological Map of Chibougamau region. Scale 4 miles to 1 inch.	
793	Nova Scotia—Tatamagouche Geological Sheet, No. 59. Scale 1 mile to 1 inch.	216
794	Nova Scotia—Malagash Geological Sheet, No. 60. Scale 4 miles to 1 inch.	216
795	Nova Scotia—Pugwash Geological Sheet, No. 61. Scale 1 mile to 1 inch	216
796	Nova Scotia—Wentworth Geological Sheet, No. 62. Scale 1 mile to 1 inch.	216
836	Nova Scotia—Londonderry Geological Sheet, No. 63. Scale 1 mile to 1 inch.	216
837	Nova Scotia—Noel Geological Sheet, No. 64. Scale 1 mile to 1 inch.	216
878	Nova Scotia—Kennetcook Geological Sheet, No. 65. Scale 1 mile to 1 inch.	216
879	Nova Scotia—Walton Geological Sheet, No. 74. Scale 1 mile to 1 inch.	216
838	Nova Scotia—Five-Islands and Tennycape Geological Sheet, No. 75. Scale 1 mile to 1 inch.	216
839	Nova Scotia—Economy River Geological Sheet, No. 76. Scale 1 mile to 1 inch.	216
840	Nova Scotia—Southampton Geological Sheet, No. 82. Scale 1 mile to 1 inch	216
841	Nova Scotia—Parrsboro Geological Sheet, No. 83. Scale 1 mile to 1 inch.	216
945	Nova Scotia—Plan and Section of Harrigan Gold District. Scale 400 feet to 1 inch.	
937	Nova Scotia—Plan and Section of Leipsigate Gold District. Scale 500 feet to 1 inch.	
	Also a series of eight diagrams showing the Mineral Production of Canada, 1905.	

LIBRARIAN'S REPORT.

Dr. John Thorburn.

During the eleven months from January 1, 1906, to November 30, there were distributed 21,730 publications of the Geological Survey, comprising reports, parts of reports, special reports and maps; of these, 18,746 were distributed in Canada; the remainder were sent to foreign countries, as exchanges to universities, scientific institutions, and to individuals engaged in scientific investigations. A much larger number of our publications has been sent out this year than in any previous year, showing that an increased interest is being taken in mineral industries relating to Canada.

The sale of publications during the year, including reports and maps, amounted to $362.78. As mentioned in last year's report, the amount received for our publications has been gradually decreasing, as the free distribution has been on a more liberal scale than heretofore.

There were received, as exchanges or donations to the library, 2,949 publications, including reports, transactions, proceedings, memoirs, periodicals and maps. The volumes purchased during the year were 354, and seventy-three scientific periodicals were subscribed for. The number of letters received in connexion with the library was 2,845, besides 1,925 acknowledgments from exchanges and individuals. The number of letters sent from the library was 2,788, besides 644 acknowledgments for publications received.

There are now in the library about 16,200 volumes, besides a large number of pamphlets on various subjects.

The number of volumes bound during the year was 178.

My assistants engaged in library work have given faithful and efficient service during the year.

The library is open from 10 a.m. to 4 p.m. for persons wishing to obtain information in regard to scientific matters.

ACCOUNTANT AND SECRETARY'S DEPARTMENT.

John Marshall.

The staff at present employed numbers 74.

During the year the following changes have been made in the permanent staff :—

In March, 1906, Mr. A. P. Low was appointed Deputy Head and Director of the Department.

In July, Mr. C. W. Willimott was promoted from the second to the first class, and Miss Bessie Urquhart was transferred from the temporary to the permanent staff.

The funds available for the work and expenditure of the Department during the fiscal year ending June 30, 1906, were :—

Details.		Grant.	Expenditure.
		$ cts.	$ cts.
Civil-list appropriation		65,030 00	
General appropriations		115,293 33	
Civil-list salaries			62,036 78
Explorations and surveys			50,515 01
Boring operations			1,000 00
Department of Interior, zinc commission			7,500 00
Wages of temporary employees			35,943 69
Printing, engraving and lithographing			6,791 18
Books and instruments			5,780 82
Chemicals and apparatus			289 76
Specimens for Museum			3,356 08
Stationery, mapping materials, &c			2,349 70
Incidental and other expenses			2,287 06
Advances to explorers			29,295 75
			207,145 83
Less—Advanced in 1904-05 on account of 1905-06	$40,065 96		
Deduct—Unexpended advances credited Casual Revenue	1,296 77		38,769 19
			168,376 64
Unexpended balance Civil-list appropriation			2,993 22
Unexpended balances General appropriations			8,953 47
		180,323 33	180,323 33

The correspondence of the Department shows a total of 15,720 letters sent, and 17,892 received.

I have the honour to be, sir, your obedient servant,

A. P. LOW,
Deputy Head and Director.

OTTAWA, December, 1906.

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