SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR

1908

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY C. H. PARMELEE, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1909

[No. 26—1909.] *Price 15 cents.* [No. 1072.]

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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 6-7 Edward VII., chapter 29, section 18, the Summary Report of the operations of the Geological Survey during the year November 30, 1907, to November 30, 1908.

WILLIAM TEMPLEMAN,
Minister of Mines.

Hon. WM. TEMPLEMAN,
Minister of Mines,
Ottawa,

SIR,—I have the honour to submit herewith the Director's Summary Report of the operations of the Geological Survey during the year November 30, 1907, to November 30, 1908.

I am, sir,
Your obedient servant,

A. P. LOW,
Deputy Minister.

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SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR 1908

To Dr. A. P. Low,
Deputy Minister of Mines.

SIR,—I have the honour to submit herewith a summary report on the operations of the Geological Survey for the calendar year 1908.

ORGANIZATION.

Some slight changes were made in the organization of the Geological Survey during the year.

COMMITTEES.

A geological committee has been formed to carefully consider all geological reports, and the geological colouring of maps before printing. The slight delay caused in publication will, it is hoped, be warranted by increased clearness and accuracy.

An editing committee for maps has also been appointed to standardize the maps, settle upon scales, and to critically examine all maps before they are allowed to go to the engraver.

TOPOGRAPHICAL DIVISION.

A topographer was appointed to have general supervision of the topographical work in the field, and the compilation of this work in the office. The rapid opening up of the country has increased the need for accurate topographical maps, and the development of this part of the 'Survey's' work has reached a stage which makes it desirable to give it distinct recognition. This is secured by the creation of a topographical division under the supervision of a topographer. It is hoped that greater uniformity and accuracy in methods will follow the improvement in the official status and organization of this branch of the 'Survey's' work.

PHOTOGRAPHIC LABORATORY.

The photographic laboratory has been refitted and improved, and the negatives catalogued and filed. All photographic work: including illustrations of the districts

examined and explored, photographs for plotting the topographic work, illustrations for reports and Museum purposes, and map reductions will be done in this laboratory.

Well-boring Records.

Considerable activity is being manifested in deep boring in various parts of the country. The geological information to be gained from the records of such deep bore-holes is extremely important, not only from a scientific standpoint, but also from the economic side. Valuable information is to be obtained regarding conditions bearing on oil, gas, salt, water and other economic problems, consequently it is very desirable that samples of the borings and logs of the wells should be preserved. Such material, systematically collected from all parts of the country, will be invaluable for guiding and directing future operations; since exact information will be available as to the character and thickness of the strata to be penetrated, the economic substances likely to be encountered, the depth to be drilled, etc., thereby enabling the prospective operator to accurately estimate the cost of the proposed undertaking, and the probabilities of success.

To secure such records, and to render this information available to the public, a Well-boring Records division has been formed. The 'Survey' is endeavouring to get in touch with the drillers all over Canada, and is asking their co-operation in making this the valuable information bureau for drillers that it ought to be. Sample bags, log books, etc., are sent to the drillers, which they can return free of charge. With the active assistance in this matter, of that portion of the public which should derive most benefit from it, this should become one of the most useful divisions of the 'Survey' organization.

Changes in Personnel.

Several changes have occurred in the personnel. The 'Survey' lost through death Dr. Robert Chalmers, and by superannuation Dr. Robert Bell and Mr. Charles Willimott. There have been three accessions to the staff.

Special Features of the Work.

In a young and only partially developed country such as Canada, with limited appropriations for exploration service, the energy of the Geological Survey should be almost wholly directed towards assisting in the opening up of the country, and in the exploitation of its natural resources: that is, all its work should have a direct economic bearing. It does not necessarily follow that the scientific side would be neglected; for the economic problems furnish as fruitful scientific results as purely academic studies, and some problems of apparently only academic interest have a most important economic value. But in general only such work should be undertaken as gives promise of affording direct economic results.

Some years ago there was not the same demand for economic work that now exists. The mining public were not as a rule technically trained, and did not realize the practical value of geological work, nor were they prepared to utilize it if they did. Now there is a highly trained body of mining men who recognize the close connexion between geology and mining, and who can make practical use of the geological informa-

tion acquired by the 'Survey.' There is, in consequence, a wide demand for the careful study of districts containing economic minerals, and this assistance the mining public can reasonably ask of the Government. There are two main classes of geological work for the 'Survey' to do: exploratory work, and detailed work. The exploratory work is necessary to furnish the prospector with maps to guide him through the country and to point out the areas where, for certain minerals, prospecting is most likely to be attended with success; the detailed work is useful in assisting in the intelligent development of known mineral-bearing areas. The exploratory work should be done in those districts that are likely to attract attention in the immediate future, and the detailed work in areas that are under active development. The allotment of field parties during the past season was, so far as practicable, in accordance with the above outlined principles.

The field season was somewhat curtailed, owing to the late date at which supplies were voted. The small fund available before this, was used to get out parties going to distant fields, who had to start early to reach the field at all. The rest were forced to await supplies. The number of field parties was limited by the number of officers qualified to take charge of field operations. Most of the parties were numerically stronger than in previous years, a larger number of student assistants being appointed. This served the double purpose of enabling the work to be done more rapidly, and of training a larger number of men to form a corps of trained assistants from whom, in time, men may be drawn for the permanent service, or for supplying the demand by private companies for trained men to direct prospecting work.

FIELD WORK.

The distribution of the parties was as follows:—

YUKON AND MACKENZIE.

Mr. D. D. Cairnes, assisted by Dr. O. Stutzer, was engaged in the Tantalus district near Whitehorse, defining the coal area, with the object of determining the character of the coal and discovering the point nearest transportation where a commercial supply exists. Mr. Matheson had charge of the topographical work in connexion with this investigation.

Mr. V. S. Stefansson descended the Mackenzie and will winter with the Eskimo in the Arctic. The expedition, which is sent out by the American Museum of Natural History and the Geological Survey conjointly, while primarily for ethnological purposes, is expected to add to the geographical knowledge of the Arctic coast. In addition, an endeavour will be made to obtain information regarding mineral occurrences. Mr. Stefansson took with him a set of ore specimens to assist in eliciting information as to ore occurrences from the natives.

Mr. Joseph Keele, who wintered on the divide at the head of the Pelly river, continued his exploration across the continental divide to the Gravel river, and descended this stream to the Mackenzie.

BRITISH COLUMBIA.

Mr. R. G. McConnell spent the season on Texada island in a somewhat detailed geological survey of the northern part of the island. The copper and iron deposits here are attracting attention, and it was in response to an urgent appeal for

a geological survey of the island that this work was undertaken. Mr. F. H. MacLaren was engaged in a topographical survey of the same field, as a foundation for the geological map.

Mr. R. Graham continued the survey of the Pacific coast and inlets begun in 1906 by Mr. LeRoy and continued in 1907 by Mr. Bancroft. The work this season was the section between Kingcome inlet and Bella Coola.

Mr. W. W. Leach continued his explorations in the Bulkley valley near the route of the Grand Trunk Pacific. Coal, copper and lead prospects and the advent of transportation facilities make this field important.

Mr. C. H. Clapp, assisted by Mr. Kenneth Chipman, commenced a survey of Vancouver island.

Some work had been done by the Geological Survey in the Nanaimo coal areas in the 70's. The northern end of the island was studied by Dr. Dawson in 1886, and a few of the inlets of the west coast in 1902, but for the most part the geology and topography of the island is unknown to the Geological Survey. From an agricultural as well as from the mining standpoint the island is rapidly increasing in importance, and it was decided to begin its systematic survey. Mr. Clapp made a start at the southern end of the island as affording the most favourable opportunities for geological investigation.

Mr. John Macoun, naturalist to the 'Survey,' assisted by Mr. W. Spreadborough, was engaged in making a representative collection of the fauna and flora of the island for the new Museum. Mr. C. H. Young, one of the preparators of the 'Survey,' was stationed at Nanaimo mounting the fresh specimens. Mr. Macoun was also instructed to visit the Rossland mines for the purpose of studying the fungi whose growth in mine timbers causes their rapid destruction, entailing a heavy expense upon the mines. The object of this investigation was to discover if possible a cheap and effective method of preventing their growth. On a subsequent page will be found an account of a cheap method of preserving the timbers, kindly furnished me by Mr. Watson, —one of the visiting British Engineers—with whom I discussed the problem.

Mr. Charles Camsell completed his detailed study of the Hedley mining camp, and began a survey of the Tulameen district. The latter is unique in that it is the only district in Canada where platinum gravels have been worked on a commercial scale. Railway facilities for this section are projected, and with the solution of the transportation problem it is expected that this portion of the country will be actively developed. The present work is in anticipation of this.

Mr. L. Reinecke was engaged in the topographical surveying of the districts examined by Mr. Camsell.

Mr. W. H. Boyd was employed on a detailed survey of the Phœnix camp. At the close of the season he made a hasty examination of the Slocan district to outline a plan for its survey next season.

Mr. O. E. LeRoy made a detailed investigation of the Phœnix camp and its ore deposits. After finishing this he spent a month on the underground geology near Sandon.

ALBERTA.

Mr. George Malloch made a geological and topographical survey of the Big Horn coal area on the Brazeau river. Coal in quantity, and of exceptional quality is found here.

ALBERTA AND SASKATCHEWAN.

Mr. Dowling was engaged in investigating the coal supply of various portions of Saskatchewan and Alberta.

SASKATCHEWAN AND KEEWATIN.

Mr. W. McInnes spent the season on surveys from Lac la Ronge down the Churchill to South Indian lake. The prospect of a railway to Hudson bay has created a demand for information concerning this north country and its mineral possibilities. The 'Survey' had no information concerning this section of the Churchill, although the upper and lower portions had been explored. To fill the gap this work was undertaken. Reported discoveries of valuable minerals at Lac la Ronge made exploration of that region important.

KEEWATIN.

Mr. Owen O'Sullivan completed the instrumental survey of the shores of Hudson bay. A section of 250 miles remained undone, and as so much interest now centres round Hudson bay it was deemed advisable to complete its survey.

ONTARIO.

Mr. A. W. G. Wilson spent the field season about Lake Nipigon, completing the geological work necessary for the map of this region, which the National Transcontinental railway will open up.

Mr. W. H. Collins made a geological examination of the upper part of the Montreal river. The lower portion of this river received much attention from prospectors last year, and this exploration was undertaken to secure geological information regarding the upper country before it would be required by the advancing prospectors.

Mr. W. A. Johnston continued work on his Simcoe sheet in southern Ontario.

Mr. F. B. Taylor and Mr. Goldthwait, who have been for some years working on the superficial geology and the history of the Great Lakes region for the United States Geological Survey and for State surveys, extended their studies into Ontario under the auspices of the Canadian Geological Survey. Mr. W. A. Johnston co-operated with them in this work.

Mr. E. D. Ingall spent the field season in the gas and oil region of southern Ontario, obtaining information for a new map of the productive districts.

QUEBEC.

Mr. M. E. Wilson, who had been studying the country east of Lake Timiskaming during the past two seasons, was this year engaged in extending this work northward. Considerable prospecting is being done in this region, east of Larder lake, on the Quebec side of the Interprovincial line.

Mr. W. H. Boyd, with a party of topographers, spent a few weeks on a map of St. Bruno mountain, required for Mr. Dresser's report on the geology of this old volcano.

Mr. J. A. Dresser, in the early spring, examined the recent gold discoveries in Megantic, and issued a preliminary report on this field. Mr. E. R. Faribault also visited this district and contributed a sketch map for the report. Mr. Dresser's main field work was along the National Transcontinental railway in eastern Quebec, which will open up a district about which we could furnish but meagre information to the numerous inquirers.

Mr. R. W. Ells investigated and reported on the landslide at Notre-Dame de la Salette.

Mr. W. McInnes, and later Mr. H. M. Ami, made brief visits to Bergeronnes, on the lower St. Lawrence, to examine the condition of the clay banks in its vicinity, as the inhabitants were in some apprehension of slides.

NEW BRUNSWICK.

Mr. G. A. Young was occupied during the field season in a detailed survey of the Bathurst district. The iron ores of this district are receiving attention, and the 'Survey' has been petitioned to make a detailed study of the local geology.

Mr. R. W. Ells spent the early part of the season in Scotland, examining the oil shales, and oil shale industry.

Mr. Lawrence M. Lambe, vertebrate palæontologist, was engaged in collecting vertebrates in New Brunswick and Nova Scotia, chiefly in Albert county, N.B., and Kings county, N.S., to secure palæontological evidence regarding the geological ages of the formations believed to be, or which might possibly be, Devonian. In the Maritime Provinces, where economic materials, such as coal, occur in definite geological horizons, such data is of great economic value.

Mr. W. J. Wilson made collections along the bay of Fundy: paying special attention to plant remains.

NOVA SCOTIA.

Mr. Hugh Fletcher continued work on the map sheets of parts of Cumberland, Kings and Annapolis counties.

Mr. E. R. Faribault was engaged in extending the surveys on his map sheets in Lunenburg county and Kings county, covered by the Gaspereau River, New Ross and Chester Basin sheets.

Mr. H. M. Ami spent a portion of the summer in Antigonish, establishing the horizon of rocks near Big Marsh, which had been mapped as Lower Carboniferous. The presence of bituminous shales (which in places pass into coal) in these rocks had led a number of locally interested people to question the accuracy of the previous determination. Mr. Ami also collected fossils from several Nova Scotia localities.

PRINCE EDWARD ISLAND.

The work of the Geological Survey in Prince Edward Island took the form of deep-boring operations to determine the depth at which the Coal Measures occur, and if possible to prove the presence or absence of coal seams within working distance of the surface.

SCIENTIST FOR ARCTIC EXPEDITION.

Having been requested by the Department of Marine to nominate a man as scientist to accompany the Arctic expedition, Mr. J. McMillan was selected, and assisted with instruments, etc., for this interesting work.

MUSEUM.

Preparations are being made for a worthy exhibit when the new Museum is occupied. As time permits, the collections in the present Museum are being overhauled, and additional specimens and collections procured. Arrangements have been made whereby the collection of British Columbia minerals which will be exhibited in the forthcoming Seattle exhibition will be permanently lodged in the new Museum.

PUBLICATIONS.

The growing demand for the publications of the Geological Survey makes it necessary to enlarge the editions printed, and to reprint some of the maps and reports already issued. This increased interest is shown by the fact that, the publications distributed during the past year were more than double those of the previous year. Public libraries which have hitherto not had Geological Survey publications have applied for and been supplied with sets of the reports. A number of sets have been sent to mining centres as neuclei of scientific libraries which are being established by the Canadian Mining Institute for the convenience of prospectors and mining engineers.

One of the most serious difficulties in the way of securing full effectiveness is, in getting the individual reports into the hands of those who would find them of interest and value. There being no profit in handling them, tradesmen will not distribute them. Wherever a provincial or federal government agent or public spirited citizen will undertake to place them in the proper hands reports of local interest are sent them for distribution. Bulletins announcing the 'Survey' publications are sent from time to time to newspapers, and a page has been secured in a mining journal to announce the 'Survey' publications.

The knowledge of the work of the 'Survey,' and of the mode of obtaining publications is spreading, necessitating the printing of larger editions of maps and reports; but a large portion of the population that would be interested in securing the information published is still in the dark regarding the 'Survey' reports and how to secure them. The 'Survey' has been at work for a great many years, and the information, particularly regarding the older districts, is often scattered through a large number of reports. There is a great need for general reports on larger districts, which will bring together and summarize this accumulated information, and general reports or bulletins bringing together all the information regarding the occurrences in the Dominion of individual economic products. This want is alleviated to some extent by the full and complete index to the reports of the Geological Survey (1885-1906) which was

issued in 1908, but the general reports are still urgently needed. A large proportion of the inquiries received are for such general information. A small beginning has been made towards supplying this deficiency. An officer has been appointed to compile such reports. Under Mr. Faribault's direction a general report on the gold-bearing rocks of Nova Scotia is first being prepared, and a brief summary of the Geology of Canada will, it is hoped, shortly be issued.

Library.

An effort is being made to make the scientific library more complete and representative. This library is open to the scientific public, and still greater use will probably be made of it when it is housed in more commodious and attractive quarters in the new building.

Now that no annual volume is published except the Summary Report (the individual reports appearing as separates), it has been decided to maintain two distributing lists: (1) an exchange list, on which will be placed public libraries and institutions publishing scientific reports; and (2) a notice list of private individuals who desire to be kept informed of 'Survey' publications. All reports and maps issued will be sent to addresses on the former list; to the latter, notices of all publications as they are issued, and such publications as are requested therefrom.

This change is made necessary on account of numerous changes of addresses of private individuals, and on account of the fact that only a portion of the reports issued are of interest to any one person.

Educational Material.

The cabinets of representative Canadian rocks and minerals prepared for the more advanced schools and colleges are being eagerly sought after. The great interest now being aroused by the rapidly expanding mining industry, and the attention given to nature study in the schools, has created a demand for this educational material that overtaxes our facilities to supply. Colleges, finding difficulty in obtaining Canadian material, also frequently apply for large collections of Canadian specimens, which we at present have not the means of preparing. A large number of requests are received for samples of Canadian ores and minerals, from private individuals who are interested in Canada's mineral resources. As a result of the mineral exhibit in the Canadian section of the Franco-British Exhibition in London, a large number of requests are also coming in from British schools whose scholars are looking towards the 'dominions beyond the seas,' as their possible future home. Collections could be very advantageously placed in these schools. In our present quarters facilities which would enable us to meet these educational demands cannot be provided, but when moved to the new building our work along these lines should be greatly enlarged. This branch of educational work need not be confined to minerals and rocks. Fossils, woods, plants, animals and photographs are also much sought after for educational purposes, and these could be most easily and most cheaply supplied by the 'Survey.' In the matter of photographs, for example, the 'Survey' has thousands of good negatives from all parts of Canada, illustrating the character of the country, geological phenomena, the rocks, mining camps, agricultural resources ,forests, trees, etc. From these, illustrative collections for educational uses could be readily prepared.

Ethnology.

In the new Museum one of the most popular sections is likely to be the ethnological exhibit. Very little investigation has been made in Canada of the native races, and what has been done has mostly been under the auspices of foreign institutions. The opportunities for such studies are fast disappearing. Under advancing settlement and rapid development of the country, the native is disappearing, or coming under the influence of the white man's civilization. The older people who are familiar with the folk lore or traditions of the tribe are dying off, and the rising generation under the changed conditions is acquiring a totally different education.

If the information concerning the native races is ever to be secured and preserved, action must be taken very soon, or it will be too late. It is a duty we owe to the Canada of the future to see that such material is saved.

The work on the Eskimo of the Arctic, undertaken this year in conjunction with the American Museum of Natural History, is hoped to prove only the beginning of a serious effort to acquire the valuable ethnological data that is yet to be had.

Co-operation.

In many branches of the work, co-operation with the provinces is highly desirable, and during the year efforts have been made to get into closer touch with the various provincial departments. One line in which co-operation might be effective is in the topographical work. A contoured topographical map, while necessary for a proper representation of the geological features of a district, is also almost indispensable from a provincial standpoint, in the development of its natural resources, and the study and carrying out of all engineering projects. It promotes an exact knowledge of the country. It can be used for planning engineering works. Highways, electric roads, railroads, aqueducts, and sewage works, may be laid out on such maps, saving the time and expense of preliminary surveys. They afford accurate information as to the relations of boundaries and towns to natural features. They are useful as base maps for the graphic representation of facts relating to population, industries, and other statistical information, and to show the location, extent and accessibility of lands, forests, water supply and economic minerals. For such mapping, that is of equal benefit to Dominion and province, and that is of such immediate importance to both, co-operation is desirable, as it would hasten and facilitate the work.

In spite of repeated efforts to overcome the difficulties in the way of a speedy publication of the reports after the field work has been finished, vexatious delays still occur. A report often loses a great part of its usefulness unless it reaches the public soon after the facts have been collected, particularly if it relates to a district that is under active development. Under the most favourable circumstances a considerable time must elapse before it can appear.

Few, who have not had to do it, recognize the amount of labour that is entailed in the preparation of a scientific report which is to have official accuracy, for a hasty report is of little service, if not harmful. It is hoped, however, that improvements may be made which will make possible the more speedy presentation of the facts secured by the operations of the 'Survey.'

The investigation of the water resources of the Dominion is becoming more and more pressing. In Central Canada information regarding the distribution and amount of water-power is urgently needed. In the North West provinces the problem of a water supply is one of the most serious in connexion with the settlement of the country. The Geological Survey, in accordance with the Mines Act, has been entrusted with the investigation of water supply and water resources, and provision must be made for systematic work in this field.

Disabilities Under Which Officers Labour.

Field officers of the 'Survey' have, as a rule, to labour under serious handicaps, which greatly lessen the value of their work. In many cases they have no accurate maps on which to lay down the geology in the field, the topographical and geological work being done concurrently. This interferes with the accurate delimitation of geological boundaries; it often prevents the geologist recognizing in the field where his information is weak, and it prevents his seeing relationships that should be investigated, until his return to the office, when it is too late; for the geologists seldom get back to a field to revise their maps before publication. It is expected that this condition will be remedied when the topographical division is developed, so that instead of working with a geologist, the topographer will be sufficiently in advance to be able to furnish a map of the field before geological work commences.

Another handicap is in rarely having an opportunity in the field of consulting with a colleague upon the critical points in the geology of his district. To have to demonstrate the geology to another would throw new light upon the problems, bring out new facts and new viewpoints, and serve as a check upon the work. An effort will be made to supply such assistance wherever possible.

Inadequate Accommodation.

The 'Survey' has long since outgrown its present quarters. The congestion is such that not only is it impossible to display or store further Museum material, but it is also impossible to properly carry on the office work in connexion with maps, reports and the various materials brought in for investigation. It is hoped that the new Museum will be far enough advanced next year to admit of at least partial occupation. When in the commodious quarters which the new building will provide, a marked increase in the usefulness and efficiency of the 'Survey' will be possible.

Salary Question.

To cope with the growing demands occasioned by the rapid opening up of the country a large increase in the staff of the 'Survey' is absolutely necessary. But before this can be successfully made, it is required to put the technical staff on a more satisfactory footing in regard to salary. The technical officers have always been underpaid, but at present the conditions are more acute than hitherto. For the proper prosecution of the work, only picked, well trained, expensively educated men can be successfully employed. They should properly have seven years of college training (graduate and post graduate), and in addition, wide experience in the field. Such men are keenly sought after by colleges, by foreign and other surveys, and private companies, who are willing to pay much higher salaries than are obtained in the Geological Survey Branch of the Department of Mines.

Formerly, when the cost of living was much less, when there was no outside demand for the type of men required by the 'Survey,' and when a permanent position carried with it superannuation privileges, the need was not so pressing. In the United States Geological Survey the salaries range from $6,000 down: most of the responsible officers receiving from $4,500 to $3,000—nearly double the salaries on the Canadian Geological Survey. Notwithstanding the higher salaries, the United States Geological Survey finds the basis still too low to retain its men in the face of the outside demand, and steps are being taken to improve the conditions for them in the service. The Provincial governments, whose salaries are uniformly lower in other lines, do better in regard to such technical employes than the Dominion Government.

The Canadian colleges, as a rule, pay much better salaries, and in addition their men are free for four or five months of the year, and are at liberty to do private professional work, or to become financially interested in mining. The stamp of man required by this 'Survey' for responsible work is equal to that required for a chair in a university.

It is evident that on the present salary basis the 'Survey' cannot compete. Not only will it not attract the class of men required, but it will lose its effective men, who will be picked up by outsiders as fast as they demonstrate their capabilities, and the 'Survey' will be officered and manned by the 'culls.'

An efficient Geological Survey staff will be one of the most powerful instruments in the hands of the Government for opening up the country; through its assistance in discovering, making known and developing the natural resources. An inefficient organization will be worse than none at all.

Economy as well as efficiency demands that quality in the officers should alone be considered, and not the price which must be paid to secure it.

WORK OF THE DIRECTOR.

The greater portion of the year was spent upon executive work in the office, which demands no notice. Reference may, however, be made to some special work.

On December 25, I left for Alberquerque, N.M., to attend the meeting of the Geological Society of America. A short excursion was made to the Sandia mountains, the petrified forest of Arizona and the Grand Cañon of the Colorado. On February 8, on my invitation, a meeting of Canadian geologists was held in the Redpath Museum, Montreal, for the purpose of arriving at an agreement as to how the Pre-Cambrian rocks, developed in Canada, should be interpreted on the map of North America in course of preparation by Mr. Bailey Willis for the United States Geological Survey. After a thorough discussion a scheme of classification was drawn up and unanimously adopted.

On February 21, an International conference was held at Chicago to discuss the same subject. Messrs. T. C. Chamberlain, C. R. Van Hise and Bailey Willis represented the United States Geological Survey, and Messrs. F. D. Adams, W. G. Miller and the writer represented the Canadian Geological Survey and the Ontario Bureau of Mines. It was decided that for the representation of the Pre-Cambrian of Canada on the map of North America, the scheme of classification agreed upon at the meeting of Canadian geologists would substantially be followed.

The annual meeting of the Canadian Mining Institute was held in Ottawa, the first week in March, which enabled the Geological Survey to take a more active part in the proceedings than is usually the case.

On the invitation of the Mining Society of Nova Scotia, I also attended the annual meeting of that society, held in Halifax the last week in March.

MINERAL PROSPECTS IN EASTERN ONTARIO.

On May 29, a copper showing in the township of Lavant, V, 10 and 11, was visited. The ore occurs in dolomite along its contact with an intrusion of reddish granite. Along the contact zone the dolomite has suffered more or less contact metamorphism, green silicates (hornblende, etc.) being developed, and in places considerable chalcopyrite.

The granite here forms the western wall of a valley in the bottom of which a gabbro-diorite (field name) outcrops. On the eastern slope crystalline limestone is further exposed, somewhat silicified and otherwise altered. Along joint planes and fractures of this limestone, tetrahedrite in narrow stringers has been found. This copper-bearing mineral, while rather common in the silver lead districts of western Canada, is exceptional in the east.

While the body of ore exposed in this locality is not of sufficient magnitude to have any great economic importance, it suggests that in eastern Ontario the granite contacts, especially along limestones and dolomites, may be worth prospecting.

The copper deposit of Eldorado, Hastings county, which has been developed with some success, is also a contact metamorphic deposit on a granitic contact, although it is marked by a notable development of magnetite, and its oxidized surface, which was altered to hematite, caused it to be first worked as an iron ore.

Many of the iron, as well as other ores of eastern Ontario are also contact metamorphic deposits, so that the invaded and altered rocks of these contacts would seem to be favourable ground for prospecting. The extent to which green lime-silicates are formed along the contacts, or along fissures in the lime rocks near the contacts, somewhat masks the relationship between the limestone, the ores, and the intrusive rock; the green metamorphic product being sometimes mistaken for an altered dike of diorite or similar rock, or where foliated, for a band of green schist.

COBALT CONGLOMERATE.

Two days were spent, at the end of July, in visiting Cobalt, with Professors Chamberlain and Salisbury, of Chicago University, and W. G. Miller, the provincial geologist of Ontario.

The Huronian conglomerate of this district has a strong resemblance to a glacial till, but while this resemblance has been pointed out in official reports of the Bureau of Mines and the Geological Survey, the opinion was expressed that there was no evidence pointing to its glacial origin, while there was a mass of negative evidence against such a theory. As the glacial origin of these conglomerates has been strongly advocated, Messrs. Chamberlain and Salisbury, who are specialists in glaciology, graciously accepted the invitation of Mr. Miller and myself to examine typical occurrences of the rock in the Cobalt district. After two days examination the opinion

formed was that, while many of the pebbles resemble glacial pebbles and while some portions of the rock simulate, exactly, glacial till, the position taken by the Geological Survey and the Bureau of Mines with regard to the question of the origin of this rock was correct—there is no evidence to prove its glacial origin, there is a great deal of negative evidence against it—and that the burden of proof must rest upon those who suggest its glacial origin.

PRINCE EDWARD ISLAND.

The first week in August was spent in Prince Edward Island completing arrangements for the boring operations to test the coal, gas and oil possibilities of the island, details concerning which will be found on a later page.

OFFICIAL VISIT OF THE HONOURABLE THE MINISTER OF MINES TO SOUTHERN BRITISH COLUMBIA.

On August 14, I accompanied the Hon. W. Templeman, Minister of Mines, on an official visit to some of the chief mining camps of southern British Columbia.

FRANK AND COLEMAN.

The first stop was made at Frank. The surface works of the Canadian American Coal and Coke Company were visited. Active work was suspended, but steps were being taken to renew operations.

The Hillcrest collieries, with a daily output of about 600 tons, the Belleview collieries, with 800 tons, and the International Coal and Coke Company collieries, Coleman, with daily capacity of 2,500 tons, were also visited. Time did not permit a visit to the Lille collieries, or other coal properties in the vicinity of Frank. A cement plant of the Rocky Mountain Cement Co., of 1,000 bls. capacity, was under course of construction near the lime kilns at the Gap. Turtle Mountain limestone and clay will be used for cement making.

HOSMER.

The next point visited was Hosmer, where the new modern surface plant designed to handle an output of 4,000 tons of coal was inspected.

FERNIE.

A day was spent at Fernie, and at the extensive collieries of the Crow's Nest Pass Coal Company on Coal creek. At the time of our visit mining was curtailed on account of damage done to No. 2 colliery by a severe bump, and the destruction of Fernie by forest fires, both misfortunes having occurred only a fortnight before. The extensive battery of coke ovens at Fernie (426 old ones and 50 in course of construction) were put out of commission by the burning of the slack bins, trestles, etc.

The fine courage and confidence of the citizens of Fernie was well shown in the face of this almost overwhelming disaster, for not only had they already recovered from the shock, but rebuilding was in progress all over the old townsite. In the evening a successful smoker was given by the citizens, at which the only suggestions of recent

disaster were furnished by fire-marked clothes, and the presence of insurance underwriters.

CRANBROOK.

A brief stop was made at Cranbrook, where the Board of Trade, after discussing with us the pressing need of geological work in East Kootenay, tendered a banquet to the Minister of Mines.

MOYIE.

A day was next spent at Moyie inspecting the St. Eugene mine and mill, of the Consolidated Mining and Smelting Company. Recent development work on this great lead mine has been most encouraging. Particularly important discoveries have been made on so-called avenues (inclined veins connecting the two main parallel veins), and on the deeper levels of the mine. One shoot on 4th avenue has a width of about 40 feet, almost 20 feet of which is crude ore. More ore is now in sight than at any other time during the last few years. Changes have been made in the concentrating mill, enabling the feed to be treated several times, thereby increasing its efficiency by diminishing the losses. About 500 men are employed at this property. Favourable reports were given us regarding the development being done on the Aurora claim, across the lake from the St. Eugene, but time did not permit a visit to this property.

NELSON AND YMIR.

From Moyie we proceeded to Nelson. From Nelson a trip was made to Ymir, where the Ymir mine was visited. This, with its extensive equipment, including an 80 stamp mill, was formerly a larger producer, but at present work is confined to development. The main workings are on a large lens-shaped ore shoot about 500 feet long and 30 feet wide, which was continuous downward for 500 feet. There gangue began to become prominent, but rich pockets continued for several hundred feet, the gangue, however, gradually increasing. At 1,000 feet in depth the ore was confined to streaks. At the east end of this ore shoot it seems to gradually peter out, but the west end may be cut off by a fault, although I understand that what is thought to be the same fissure has been traced on the surface for several thousand feet without finding another body of ore. The second level has been drifted on for 250 feet west of the dike, and then a cross-cut 800 feet long has been made into the hill. At this point broken ground is encountered, and a drift run along it with a raise on a bunch of ore.

On the surface above the outcrop of the producing vein a large amount of rich float has been found, which must have originated in a second vein; but extensive prospecting has failed to discover this lead. The float would appear to indicate a point of origin near the edge of the main ore shoot block, about in line with the ore at present being worked at the end of the long cross-cut in the second level.

Although a good deal of prospecting has been done on the property it has been chiefly to test the ore shoot at depth, and a considerable amount of very promising territory still awaits exploration. The ground west of the ore shoot, beyond the probable fault, has been tested only by the drift on the second level and the long cross-cut. No cross-cut in the opposite direction has yet been made and no cross-cuts have been run from the main shoot to test for parallel ore bodies. The rich float up the hill,

and the frequency with which parallel veins and ore shoots occur in southern British Columbia, renders such exploratory work a promising venture. This ground should be tested, for the Ymir mine has been one of the prominent dividend payers of the West Kootenay district.

A visit was made to the new electric zinc smelter at Nelson. The plant was not quite completed, but it was expected that it would be ready for trial runs during the autumn.

BLUE BELL MINE AND KASLO.

A trip was made from Nelson to Kootenay Lake points: Ainsworth, Bluebell and Kaslo being visited.

The striking feature of the Bluebell is the large size of the ore shoots. The ore occurs in a limestone band between schist walls. The ore consists of lead, zinc, and iron sulphides, which replace the limestone, sometimes mixed with one another and sometimes segregated into fairly clean masses of a single sulphide. Several dikes occur almost completely altered (apparently largely by kaolinization). The ore is confined to the limestone, except along the dikes or fractures, along which it may extend a short distance into the schist walls. In form the ore occurs in large chimney-like shoots which may reach a width of almost 100 feet. The main buildings and mill are well laid out, unusual attention having been given to the comfort of the men. The mill employs ordinary water concentration. The ore contains a considerable proportion of zinc, and an effort is being made to utilize the zinc middlings, for which a small roaster and magnetic concentrator are being installed.

A dinner tendered to the Minister at Kaslo, afforded an opportunity of becoming acquainted with Slocan miners and their problems.

TRAIL AND ROSSLAND.

A day was spent at Trail visiting the copper-lead smelter and refinery. A new steel furnace-room was in course of erection. A huge new copper furnace was in successful operation, and it is planned to enlarge one of the smaller furnaces to even greater proportions. The lead refinery was turning out about 60 tons of lead a day.

BOUNDARY DISTRICT.

From Trail we proceeded to Rossland and spent a day visiting the mines. The following day we reached Grand Forks, and were shown through the Granby smelter. It is now equipped with eight furnaces and a converter plant, and can treat 3,500 tons of Boundary ore per day. One of the furnaces was being lengthened by four feet, and each in turn will be so altered. When this is effected, the plant will be able to handle 4,500 tons daily, which the mines of the Company at Phœnix are prepared to supply. These mines were visited next day. Here we also met the Geological Survey parties at work under Messrs. LeRoy and Boyd.

A stop was also made at the British Columbia Copper Company's smelter at Greenwood, where with three furnaces and a converter 2,000 tons of ore are treated daily.

SIMILKAMEEN.

From Greenwood we went to Keremeos, and thence by stage to Hedley, where a day was spent at the Nickel Plate mine and in the mill of the Daly Reduction Com-

pany. Mr. Camsell's party was met at this point. From Hedley we returned to Penticton and reached the main line of the Canadian Pacific railway at Sicamous, thence proceeding to Vancouver and Victoria.

At all points visited the mining men showed their appreciation of the recognition of the mineral industry by the creation of a Department of Mines, and emphasized the pressing need of greatly enlarging the activities of the Geological Survey.

MINING ENGINEERS' EXCURSION.

From Victoria I returned to Winnipeg to meet the excursion of continental mining engineers who were visiting the leading mining centres of Canada, under the auspices of the Canadian Mining Institute. It was at first proposed to limit the excursion to the eastern portion of Canada, and a grant of $3,000 was asked from the government to help defray the cost of the undertaking. At the suggestion of the Minister of Mines, the scope of the excursion was enlarged to embrace the western half of Canada as well as the eastern, and the grant of the Dominion government was increased to $10,000. The excursionists assembled at Quebec and first visited Nova Scotia, where particular attention was given to the iron and coal industries of the Province. Returning from Nova Scotia the chrome and asbestos regions of Quebec were examined. After seeing Montreal, Toronto and Niagara, the visitors were conducted through the Cobalt camp, Timagami, the Moose Mountain Iron Range and the Sudbury district. I joined the party at Winnipeg and remained with them throughout their western tour. The first stop was at Medicine Hat, where the natural gas wells were examined. From here the route lay through the Crowsnest pass and Southern British Columbia, where the leading camps and mines were visited. Two days were spent at Victoria, and a visit was paid to the Ladysmith smelter, and the collieries and powder works at Nanaimo.

A day was spent at Vancouver, and the return journey was by way of the main line of the Canadian Pacific railway, with a stop over at Banff to visit the Bankhead mines, and another at Calgary to get a glimpse of ranching on the plains.

The excursion was a success from every standpoint. About fifty availed themselves of the opportunity, though all were not able to take time for the whole trip. Representatives from the prominent mining societies of Germany, Belgium, Great Britain, and the United States took part in the excursion. Among them were some of the leading mining engineers of the continent, most of whom were visiting Canada for the first time. It was generally agreed by those who had the pleasure of meeting them that they were the finest body of business men who have yet visited this country, and they spared themselves no time or trouble to learn all that could be acquired under the circumstances. The arrangements for seeing the utmost within the time, and the facilities afforded for acquiring first-hand information were excellent.

Good results are sure to follow from this visit. The papers by such authoritative writers, published as reports to the societies they represent, on mining in Canada, will do much to call the attention of Europeans to our mineral resources, and to give them a correct idea as to our mining conditions and possibilities.

One of the most valuable results is that a number of leading mining men of Europe have become interested in this country, and now know how to secure informa-

tion concerning mines and mining districts, when desired. Already the practical effects are seen in the inquiries received from abroad for men for special examinations of mining properties. Invaluable suggestions were made by the engineers, many of them specialists in certain branches, that will be found extremely valuable to operators here; and on the other hand, some new ideas were acquired by the visitors from our mining practice.

The main impressions made upon the visitors were the extent of our territory; the scale and magnitude of the operations in the districts at present accessible; the rapidity with which a district is developed as evidenced by Cobalt, and the industries along the Crowsnest Pass railway, which were practically non-existent a decade ago; the modern plants and methods and the calibre of the men at the head of the successful properties.

The magnitude of the operations of the Dominion Coal Company, the richness of Cobalt, the extent of the nickel-copper industry of Sudbury, the immense coal resources of the Crowsnest pass, the Trail smelter with its ingenious lead refinery, the first of its kind in the world, and the labour-saving appliances of the Granby mine and smelter were among the most striking and interesting features noted by the visitors.

The following excerpts are from a series of articles written by the secretary of the Mining Institute of Scotland, one of the distinguished guests who took part in the excursion:—

'The excursion gave rare opportunities to those from Scotland of getting not only a general idea of the external features of Canada from sea to sea, but of acquiring a knowledge of many details in connexion with the mining fields and mineral concerns visited. The kindness shown the visitors at all hands, and the readiness with which every sort of information was given, were most gratifying, while the hospitality extended was lavish. . . . . The Premiers of the provinces, and other important government officials, lent their aid in giving the visitors a good time, and succeeded admirably. It was apparent that the Government was giving every encouragement to the various institutes represented in the party to get all the information possible on the mineral resources of Canada, with a view of having their riches and abundance more widely known.

'This excursion among the mines of Canada, from Sydney, N.S., on the Atlantic, right across the continent to Victoria on the Pacific, was carried through in perfect weather and under exceptionally good conditions in respect of comfort and convenience and kindness shown.

'It is hoped that the particulars given in these articles have served to encourage a wider interest in one of the spheres of Canada's activities, which hitherto, perhaps, has been too little regarded in this country. While much has already been done in opening up its minerals, a very cursory study of the map of Canada will show that the mineral development of the Dominion is only in its infancy; that there are immense areas still undeveloped for want of means of transport, and immensely greater tracts still unexplored which may yield rich returns to the prospector. The country is healthy. Its people are enterprising and loyal. The King is everywhere honoured; law is held in respect and order prevails.'

The Canadian Mining Institute is to be congratulated on its enterprise in initiating and carrying out this important undertaking, and the mining men throughout the country for their generous assistance, which made the excursion a success.

The railways, particularly the Intercolonial and the Canadian Pacific, did everything in their power to add to the comfort of the excursionists. By having a passenger agent on the train, and moving it whenever we were ready, the Canadian Pacific railway made it possible to utilize all the time for the work in hand, and thus enabled the visitors to see far more in the time available than would otherwise have been possible.

FIELD WORK.

From Calgary I returned to Phœnix and spent several days with Mr. LeRoy going over some of the important points in connexion with his investigation of the geology of the ore deposits.

From Phœnix, accompanied by Messrs. LeRoy and Boyd, I went to the Slocan to look over the work to be done by the 'Survey' in this district, and incidentally visited some of the mines. As Mr. LeRoy is working in this district, and will describe it in detail, it is unnecessary for me to refer to it further.

SILVER LEAD.

The past season has been marked by an increase of interest in silver-lead mining, to a considerable extent due to the renewal of the lead bounty. Several important finds have resulted, notably the new ore shoot in the Rico at Sandon. This district has only been partially prospected. On most of the properties good ground adjoining the old ore shoots has never yet been cross-cut—what ore was to be seen was extracted, then work stopped.

It seems practically certain that further exploration will discover other ore-shoots similar to those which made the Slocan famous.

SHEEP CREEK CAMP.

A few days were spent examining the developments on Sheep creek near Salmo. A reconnaissance survey of this district had been made in 1897 by Mr. R. G. McConnell, assisted by the writer, who drew the attention of prospectors, who had been confining themselves to silver-lead and iron caps, to the promising quartz veins. A number of quartz claims were staked and a few developed with more or less success, notably the Yellowstone, on which a 10 stamp mill was erected, and the Queen, but only recently has any marked interest been taken in this camp. About $250,000 will be recovered from the limited operations of this year, and it gives promise of receiving vigorous development.

Geology.

The veins at present being worked occur in a band of quartzites, slates and schists, which extend northward from about Lost mountains across Sheep creek, at the forks of Sheep and Wolf creeks, and up the ridge between Sheep creek and Fawn creek. To the west is a wide band of crystalline limestone. Some granitic and aplitic dikes are intruded into the formation, and also some basic mica dikes. The general strike of the rocks is about N. 12° E. with a dip of 50° to the east. The veins are fissure veins cutting the formation, usually the quartzite.

QUEEN MINE.

The Queen vein on the south side of Wolf creek, near the forks, is a well marked quartz vein from 6 to 11 feet in width, probably averaging about 7 feet in the workings. It is very regular, and has usually clean-cut walls with seams traversing it parallel to the walls. The country rock is white quartzite, with micaceous partings, striking about north and dipping eastward at an angle of 50°. The vein, which is about vertical, strikes in a south-westerly direction, thus angling across the formation, but stringers from the vein may take off parallel to the quartzite. A few mica dikes cut the vein, the largest being about 25 feet wide. While the walls are usually clean-cut, in places the quartzite may be mineralized to some extent, in which case it is difficult to distinguish the vein matter from the white quartzite, except by the bedding planes of the latter which differ in direction from the parting planes of the vein.

The ore is white milky quartz, with pyrite and pyrrhotite in about equal proportions developed in it. There is also some galena, and a sprinkling of blende and chalcopyrite. These sulphides constitute about 8 per cent of the ore. The values are chiefly in gold, more than 50 per cent of which is saved on the plates. The concentrates are said to run $48 to $70 per ton. The gold is reported to increase with the percentage of galena present, suggesting a relationship between the two.

The main tunnel has been driven 900 feet in on the vein. At 575 feet, a 200 foot shaft has been sunk and a second level started from the shaft. All the workings are said to be in ore which, in the bottom level, is reported to run higher than in the upper level. The ore as milled is reported to run from $10 to $18.

The ore is treated in the Yellowstone mill, run by water-power. About 55 tons of ore per day are milled and 4½ to 5 tons of concentrates are produced. The Yellowstone lies between the forks of Sheep and Wolf creeks, and was the banner claim, but work at present is confined to the Queen. I was informed by the manager that in all 39,000 tons of ore had been treated in the Yellowstone mill, producing about $370,000.

KOOTENAY BELLE.

Just beyond the Yellowstone, on the steep southern slope of Sheep creek, lies the Kootenay Belle. Here in a formation of quartzite and schists cut by aplite or quartz porphyry dikes, are two parallel veins 80 feet apart, with the same south-west strike as the Queen. The north-westerly vein runs from 15 inches to 3 feet in width, and the other vein approximately 5 feet.

The ore consists of rusty quartz, but in the lowest workings, though still mostly oxidized, some unaltered galena and pyrite may be detected. In the smaller lead, wolframite and scheelite occur in the quartz, generally near the walls. They are segregated into bunches or kidneys; occasionally about 30 pounds of this exceedingly valuable material will be found in one bunch. In places tungstite occurs as an oxidation product. Occasionally the ore is very rich. The shaft and slope on the smaller lead, for example, has a width of 3 feet of decomposed quartz that shows abundant free gold everywhere. In the lower workings, 200 feet below the surface, the ore is said to run higher than above, that is, it is getting richer as the lower limit of the zone of oxidation is approached.

The ore mills freely and very little concentrates are as yet produced. This is to be expected while the ore remains oxidized. The mill is situated in the valley bottom,

the ore being dropped by an aerial tramway. The mill is equipped with two batteries of two triple discharge stamps each, and an Overstrom table. Twelve to fifteen tons of ore are treated per day.

On the Nevada claim, which is across the creek from the Yellowstone, a vein 8 inches wide cuts the formation in the same manner as the Queen vein. Several other veins are located on the property. The filling is vesicular quartz, with pyrite in the undecomposed cores. The decomposed quartz pans freely.

The Nugget, Golden Fawn and Mother Lode claims lie close together on the ridge separating Fawn creek from the upper reach of Sheep creek, the Nevada lying on the Fawn Creek slope, the Golden Fawn on the summit, and the Mother Lode on the Sheep Creek slope.

NUGGET MINE.

The Nugget vein is also a quartz-filled fissure traversing the quartzite. It stands vertical and has a strike of about N. 66° E. The vein varies in width, in places reaching 10 feet. A pay strike of high-grade ore, from a few inches to several feet in width, is usually found in the vein. The vein stuff consists of oxidized quartz. Blue, watery quartz is said to carry the best values.

The vein is developed by three tunnels connected by raises. The lower tunnel starts from a contact between schists and quartzites, as a cross-cut to the vein, which has been drifted on for 200 feet. The intermediate tunnel has opened up 80 feet of the vein, and the upper tunnel 60 feet. The end of the lowest tunnel is about 200 feet below the surface, and here the vein is still highly oxidized and burnt looking. The ore pans freely, and very good returns are reported from trial shipments. Shipping ore from the richer portion of the vein is said to run $90 to $120 per ton, and milling ore $20 to $40.

A car shipped from the intermediate tunnel representing 10 feet across the vein yielded $34 per ton. Two hundred tons shipped are reported to have averaged $115 per ton, and 100 tons from the full width of the vein $23.50. From the face of the lower tunnel near the raise, 6 feet wide, $72 per ton was obtained, and from the raise itself 3 feet of the vein yielded from $150 to $250. Good ore from what was believed to be a second vein was found during our visit. A mill is being erected below the mine on Fawn creek, buildings are being constructed and the mine put in condition for operation.

The Golden Fawn ledge on the crest of the ridge a little north of the Nugget strikes N. 75° E., and dips 75° south.

MOTHER LODE MINE.

The Mother Lode has a vein several feet in width, which strikes 80°, very nearly the same course as that of the Nugget vein. It has, however, a slight dip to the south. The vein is several feet in width, with a pay strike of about a foot in width next the foot wall. About 100 feet of the vein has been stoped to a depth of 20 feet, and a winze sunk 40 feet. A cross-cut tunnel 80 feet long taps the vein at the foot of the winze: $17,000 are said to have been recovered from these workings. At the entrance to the tunnel is a second vein, which, however, appears to be barren where exposed. Its course is about 105°, with a dip to the north. One hundred feet below this tunnel the main working tunnel has been started.

About 200 yards west are further workings on a vein which has the same course as the main vein just described, but which the management believe to be a second vein. Three tunnels have been run in on this vein. The pay-streak runs from about 8″ to 12″, and consists of highly oxidized quartz with free gold. The face of the lowest drift shows 4 feet of good looking ore. Arrangements are being made for a tram to Sheep creek, a distance of 4,300 feet, where a mill will be built.

FUTURE PROSPECTS.

From the foregoing description it will be apparent that the gold veins of Sheep creek are of considerable promise. They are clean-cut fissure veins of fair size; they appear to be persistent in a horizontal sense and are likely to be so in a vertical sense also; they appear to carry good values and to have high grade pay-streaks; and the ore mills freely. They are oxidized to a depth unusual in British Columbia. While no doubt they will be found to change from oxidized to sulphide ore if followed to any deeper levels, the experience with the unoxidized ore of the Queen mine below the zone of weathering justifies the hope that they will remain to a large extent free milling, that the sulphides will be profitably concentrated, and that the ore, while perhaps becoming poorer, may still remain of pay grade.

The conditions for mining are favourable. The properties can usually be developed by tunnels along the leads. Wood and water are generally conveniently available. A first-class wagon road, with easy grades, extends from the railway at Salmo to the Yellowstone and Kootenay Belle mills, a distance of about 10 miles. Short aerial trams would ordinarily place the ore at a point where it may be milled by water-power. If too great a demand should be made upon the local power, electrical energy might be brought in from the outside.

While the outlook is distinctly encouraging for profitable, small mines, it is to be understood that none of the veins as yet show signs of becoming large and heavy producers. Heavy capitalization would be as unwise as it is unnecessary.

So far it has the appearance of being a good poor man's camp. There are a large number of quartz veins about the head of Sheep and Lost creeks which afford a good field for the prospector.

AINSWORTH CAVE.

A day was spent at Ainsworth exploring the Ainsworth cave, with Mr. W. H. Boyd, Mr. Blake Wilson, of Nelson, and Mr. D. B. Kane, of Kaslo. The cave is situated about four miles back of Ainsworth at an elevation of 2,850 feet above it. The opening leading into the cave, about 15 feet wide, is surrounded by brush, and is therefore rather difficult to locate, for there is nothing in the neighbouring topography to suggest its presence. The descent is down a slope of loose boulders into a room about 20 feet wide and 120 feet long, from which is a descent to the underground stream which is responsible for the formation of the cave. Almost at the point the stream is encountered it drops into a pothole 12 feet deep. To follow it down-stream entailed a wetting, so that it was decided to first explore the up-stream portion of the cave. In general it is narrow and canyon-like, in fact it is an underground canyon, but it opens into several rooms a little smaller than that first entered. At one or two points it is constricted into a narrow, low tunnel, but in general it remains lofty

even if narrow. Stratified gravels are found, especially near the upper end, sometimes to a height of 15 or 20 feet above the stream bed, and occasionally filling the canyon to the roof, except where excavated by the stream. At the head the cave is filled with boulders, some 3 feet in diameter, mostly of granite, and these extend up a fissure which evidently communicates with the surface, as a draught of fresh air could be felt, and mud and sticks washed in from the surface were found among the boulders.

The stream flows northward and follows fractures and joint planes, northerly and transverse, giving it a step-like course. Where it turns in its course a tributary opening usually extends some distance back from the main channel. Narrow openings like 'raises' branch off from a chamber occasionally, and in one place at least, there is a second channel above the present one, connected by raises, like levels in a mine.

The country rock is a beautifully banded crystalline limestone, in which narrow bands of black, blue, gray, white, and yellow alternate. In places these show fine folding. This underground canyon has been excavated by the stream through erosion and solution, along the fractures and parting planes of the rock. Fantastic forms result from the unequal corrasion, such as pendant ribbons from the roof. These, with the stalactites and stalagmites, the falls and basins of travertine, the banded wall rock, and the aisle-like canyon render the cave a beautiful spot, and one well worth a visit. The finest effects from the deposition of lime carbonate from the infiltrating waters are found in the narrow tributary chambers. The air was everywhere fresh. The end of the upper portion of the canyon is about 900 feet south of the mouth, but the winding of the stream makes the actual distance travelled about 200 feet farther. All our time was taken in the upper portion of the canyon so that the exploration of the lower portion had to be deferred. Unless the stream soon emerges to the surface this portion of the cave is likely to be more impressive than the upper, as the chambers are growing larger down-stream.

ROSSLAND.

A few days were spent at Rossland correcting the proof of the economic geology sheet of the camp. The recent developments have added considerably to the knowledge of the geology of the camp, as well as to the supply of ore in sight. Many of the dikes unite at depth, so that in the lower workings they are less numerous but bigger. On the lowest working that cuts the Nickel Plate dike it had a width of 250 feet.

The development on the Iron Mask has straightened out some of the questions regarding the identity of veins in this neighbourhood, but more work will yet have to be done before the problem will be cleared up. At least eight veins are now known in this section, around the corner of the War Eagle, Iron Mask, and Centre Star.

In the work on the Idaho, two main veins have been located, which may represent the main and south veins of the LeRoi and Centre Star. The deep developments are encouraging: one of the notable finds being the location of an unusually rich ore shoot on the 1,650 level of the LeRoi. At the time of my visit it had been developed for a length of 150 feet, and its width was about 6 feet. The ore consists of quartz, with some pyrrhotite and pyrite, and a little chalcopyrite. The quartz has a fractured appearance and the sulphides occur in veinlets and bunches in the reticulating fractures. Where the pyrrhotite forms considerable masses, quartz occurs in it in the

form of blebs. This ore differs materially in appearance from that of the upper workings, which certainly was never of the same character as this deep level ore. The discovery of a shoot of such rich ore at this depth is one of the most encouraging developments in the recent history of the camp. The development in the deep levels of the Centre Star mines has also been promising. While shipments from the Centre Star mines have been greatly increased, the development work appears to have more than kept pace with the ore extraction.

Exploratory work on an extensive scale has been in progress on the California. A shaft has been sunk from the tunnel and a level run connecting with the west end of the 500 foot level of the LeRoi No. 2, to explore the continuation of the Hamilton vein of the latter mine in the California ground. This work has furnished evidence of the intrusive nature of the contact of the augite porphyrite with the stratified rocks. The ground in the neighbourhood of this contact is much faulted, increasing the difficulties in the way of development work.

The LeRoi No. 2 mine has had a successful year, maintaining its reputation as a dividend payer. In addition to development work in the LeRoi No. 2 mine itself, prospecting was being done on the Surprise claim.

More attention than usual has been paid during the past season to outlying claims. Many of these, on which extension work was done in the early days of the camp, are reopened, mostly under lease, and from some of these, shipments have been made. The more favourable rates for transportation and treatment enable ore to be now shipped at a profit that formerly was too low to touch. It is believed that such ore, exposed in the old workings of some of the properties, may be utilized to develop them into shippers.

Particularly interesting are the results in the silver lead veins of the South Belt. The pyrrhotite leads in the belt which were worked in the boom days proved disappointing. The silver lead claims, though the first staked in the camp, never received very serious attention, as they were immediately eclipsed by the iron caps of Red Mountain, which soon became all the rage. Some attractive little veins with high-grade ore, however, occur in the belt, though the faulting to which the rocks here have been subjected may interfere with their development. The Blue Bird has been worked throughout the year and several carloads of high-grade ore shipped. If the work on this property proves permanently successful a revival of activity in the South Belt may be expected.

Further time could have been spent with advantage in Rossland in examining the recent developments, but the necessity of resuming office duties at Ottawa prevented this.

Returning, I found the railway on the plains blocked with snow, and hence a detour by way of Edmonton was made. There a day was spent visiting local coal occurrences. As these were examined by Mr. D. B. Dowling in detail, and are described by him on a later page of this report, no further mention of them is here necessary. I reached Ottawa on October 28.

PRINCE EDWARD ISLAND.

At the beginning of December I again visited Prince Edward Island in connexion with the drilling operations being conducted there under the auspices of the 'Survey,' and made arrangements for the drilling of a new well.

The Permo-Carboniferous rocks exposed on the island overlie the coal-bearing formations. Ever since the first geological examination of the island the question of the depth at which the coal-measures might occur, and of the possible extension of coal basins from Nova Scotia or Cape Breton, has been of more than local interest. If coal should occur within commercial limits of the surface, it would mean much not only to the island itself, but also to the other maritime provinces, for the coal prospects of the latter would be vastly increased.

This question can only be settled by deep-boring. Such holes will also test the possibilities for oil and natural gas. Indications of oil, sufficient to have induced extensive prospecting, occur in Gaspé and New Brunswick. On the island the conditions for the formation of gas or oil reservoirs, so far as can be judged by the surface geology, are rather better than at either of the former localities. These considerations, coupled with the fact that no surface geological examinations that could at present be made would be of any economic benefit to the Province, led the 'Survey' to undertake underground investigation by means of bore-holes. A contract was accordingly given to an experienced driller to put down four bore-holes on the island, if possible to a depth of 2,500 feet each.

The first bore-hole was located on the flat anticline running through Gallas point, in what are believed to be the lowest rocks exposed on the island. The coal measures should, therefore, be nearer the surface here than at any other point on the island. The hole was located at a convenient point on the farm of Jas. Twedie, near a spring which would supply the boiler with water. This is a little to the south of the precise axis of the anticline, but the low dip makes it immaterial whether the hole is located on the axis or a short distance off. The well was begun on September 26.

The following log gives the main features disclosed by the boring:—

Depth.				
Surface to 65 feet				Red sandstones. Soft water.
65 feet to		145 feet		Red shales. Soft water.
145	"	205	"	Red sandstones.
205	"	295	"	Red shales.
295	"	395	"	Blue shales.
395	"	405	"	Light red sandstone.
405	"	435	"	Blue sandstone. Small amount of fresh water.
435	"	635	"	Red shales. Salt water.
635	"	995	"	Red shales.
995	"	1,015	"	Red sandstone.
1,015	"	1,125	"	Red shale.
1,125	"	1,155	"	Gray shale.
1,155	"	1,165	"	Red sandstone.
1,165	"	1,170	"	Red shale.
1,170	"	1,190	"	Red sandstone.
1,190	"	1,195	"	Gray shale.
1,195	"	1,205	"	Gray sandstone.
1,205	"	1,355	"	Red shale.
1,355	"	1,395	"	Red shale.
1,395	"	1,415	"	Red sandstone.
1,415	"	1,620	"	Red shale.
1,620	"	1,660	"	Red sandstone.
1,660	"	1,725	"	Red shales.
1,725	"	1,750	"	Fine red sandstone.
1,750	"	1,870	"	Red shales.
1,870	"	1,875	"	Red sandstone. Salt water.
1,875	"	1,880	"	Red sandstone.
1,880	"	1,910	"	Gray, porous sandstone. Salt water.

The hole was started with a 10″ drive pipe and 8″ casing, which had to be reduced owing to water and caving. At 1,800 feet a cave took place, necessitating the intro-

duction of a string of 5⅝″ casing, causing a delay of a month through the slow delivery of the casing. At 1,910 feet the soft porous sandstone was caved by the pressure of the salt water, and with the water, the caving sandstone, and the small diameter of the casing, it was found impossible to make further progress with this hole, so that on November 28, work was stopped.

From the surface down to 1,880 feet the hole is evidently in the characteristic, reddish, Permo-Carboniferous rocks. The last 30 feet are in a gray, porous saltwater-bearing sandstone, unlike any of the rocks previously encountered. The casing has been drawn, and a new hole is being started two miles farther north on the other side of the axis of the anticline. This hole will be started with a 13″ drive pipe, and 10″ casing. It is hoped that with the larger hole no difficulty will be experienced in getting it down to the required depth.

PRELIMINARY REPORT ON A PORTION OF THE YUKON TERRITORY, WEST OF THE LEWES RIVER AND BETWEEN THE LATITUDES OF WHITEHORSE AND TANTALUS.

(D. D. Cairnes.)

INTRODUCTION.

The work during the season of 1908 was virtually a continuation of that commenced last year, being chiefly devoted to the mapping, and geological examination of those areas north of Whitehorse and south of Tantalus, known to contain coal or to be underlain by coal-bearing formations; it being more particularly desired to ascertain the nearest points accessible to Whitehorse at which coking coal, similar to that at Tantalus, could be obtained. During the greater part of the season I was ably assisted in geology by Dr. O. Stutzer, lecturer in geology at the Royal School of Mines, Freiberg, Saxony; while Mr. H. Matheson performed in an efficient manner the greater part of the topographical portion of the work.

Men, horses, and supplies were obtained in Whitehorse, whence a start was made for Tantalus situated at a distance of 131 miles along the Whitehorse-Dawson road. The trip occupied twelve days, during which time certain reported coal discoveries along the route were investigated, and a rapid geological reconnaissance was carried on with the view of assisting in the determination of the best localities to map during the season.

AREAS MAPPED.

Actual mapping was commenced at a point about 4 miles south of Tantalus, in order to extend to the south the Tantalus sheet which, begun during 1907, reaches from there to the north, and includes the district in the vicinity of the Tantalus and Five Finger coal mines. The territory examined and surveyed during the first part of the past season, extends from the limits of the older sheet, in a southerly direction for about 35 miles, with an average breadth of about 12 miles. It includes the first range of hills west of the Nordenskiold river and the mountains on the east side of this stream as far as the easterly limits of the coal-bearing strata.

Between the southern bounds of the district thus examined and the northern edge of the Lake Leberge map, lying to the south, and surveyed during 1907, lies an unmapped area 14 or 15 miles wide. Since this strip of country was not known to be of economic interest, it was decided to omit it, and to devote the latter part of the season to the gathering of data for extending the Lake Leberge sheet to the south and west, so as to include certain known coal areas. This added portion is about 19 miles long by 14 miles wide, and extends along the wagon road from a point 2 or 3 miles above Braeburn to within about a mile of Kynocks.

In addition to the work in connexion with these coal areas, the writer made a rapid trip up the Hutchi river to Mack's Copper and to the Gilltana Lake claims. On the way south from Whitehorse, during the latter part of September, a day was spent at Conrad, investigating the latest developments on Windy Arm.

PHYSICAL FEATURES.

The entire district strictly belongs to the interior plateau region of the Yukon Territory, which, originally eroded to peneplain conditions, was subsequently subjected to a rather rapid uplift. Consequently the erosive agencies were greatly

augmented, and the plateau thus formed was soon dissected, so that now it is only in places that distinct remnants of it are left, and these are not particularly evident within the area examined this season. The district consists, in a general way, of low, rounded hills, with only here and there a higher and more rugged peak or ridge relieving the otherwise monotonous landscape, though few rise more than 1,700 feet above the surrounding valleys.

The Nordenskiold river and its three chief branches, the main waterways of the district, flow in wide, flat valleys, generally at least one mile, and often nearer two miles broad, forming the most pronounced topographical features of the country. One other important valley, though containing only a very small creek, apparently extends to the north end of Lake Leberge, and joins the Nordenskiold valley about 6 miles above Montague. All the main valleys have beautifully terraced slopes rising from 5 or 10 feet to several hundred feet above the valley bottoms, possibly indicating successive uplifts of the district.

The effects of glacial action gradually decrease towards the north, and although glacial markings were seen within 5 miles of Tantalus, towards the northern end of the district, yet the chief results of glaciation have been to fill the valleys, cover the hillsides, and often the summits as well, with great thicknesses of gravels, clays, silts, etc. To such an extent is this the case that in many places there is almost an entire absence of rock outcrops, thus rendering the bed-rock geology very obscure.

All the valleys of the district are dotted with irregularly shaped lakes ranging in size from mere ponds to others 6 or 7 miles in length. They often have no apparent inlets or outlets and seemingly originated during the final stages of the glacial epoch.

GENERAL GEOLOGY.

What are believed to be the oldest rocks seen this season were discovered only in one place, where they consist of a group of chiefly fine grained, dark coloured amphibolite schists with light coloured, generally reddish gneisses. They resemble members of the Older Schistose Rocks and are considered to be of Pre-Ordovician age.[1]

In a gulch just north of Poplar mountain are some dark, generally thinly bedded, highly disturbed slates and cherts, resembling members of the lower Cache Creek series of Carboniferous or possibly Devonian age.[2]

At numerous points in the southern portion of the district are outcrops of limestone similar to that seen in the southern portion of the Yukon, and there considered to be of Carboniferous or possibly Devono-Carboniferous age.[3] Fossils have been collected from these rocks, and it is hoped that when examined they will definitely decide the age of the beds.

Newer than the above limestones, but older than the Cretaceous, are some quartz porphyrys which outcrop over considerable portions of the district. They generally are reddish blue to reddish gray in colour; and feldspars, biotite and quartz occur in well outlined, easily discernible crystals lying in a ground mass varying in grain from felsitic to quite coarse. A series of generally fine grained volcanics, chiefly tuffs, porphyrites, gabbros, etc., are also present in the district and belong to about the same period of igneous activity as the quartz porphyries.

Younger than all of the preceding groups is a series of Cretaceous age, consisting of a great thickness of sediments overlain by volcanics and bedded tuffs. Fossils were collected from this series, but as yet they have not been examined. In the Conrad district the representatives of these sedimentary and volcanic beds were placed in the Tutshi series.[4]

1. Cairnes, D.D.—'Report on a portion of Conrad and Whitehorse Mining Districts, Yukon,' pp. 24-25, Geological Survey, 1908.
2. Op. cit., pp. 26-29.
3. Op. cit., pp. 25-26.
4. Op. cit., pp. 31-36.

The basal member of the Cretaceous is a coarse, massive conglomerate having a total thickness of 500 to 800 feet, and in places, possibly more. The component pebbles and boulders are chiefly of granite, quartz porphyry, fine grained, green volcanics and limestone, those of granite predominating. This conglomerate is of frequent occurrence and is overlain by a thick group of conglomerates, sandstones, shales, etc., varying in thickness in different localities, from 1,000 to 3,000 feet or more.

The lower half of the column of Cretaceous sedimentary beds above the basal conglomerate is characterized by the presence of dark coloured, hard sandstones, with considerable thicknesses of dark to almost black, thinly bedded clay slates and shales. These are overlain by a group containing the lower coal horizon, and consisting chiefly of massive, coarse, friable sandstones, gradually becoming lighter coloured towards the top, where, in places, there is a thickness as great as 1,000 feet of almost perfectly white—except where iron stained—coarse sandstones composed of clear white, quartz pebbles cemented by a pure white, calcareous base.

The upper half of the group of Cretaceous sediments largely consists of massive beds of conglomerate, sometimes aggregating as much as 1,500 feet in thickness, and in this horizon occur the Tantulas coal seams. The pebbles of these conglomerates are altogether of chert, quartz or slate of the lower Cache Creek series.

Overlying the above conglomerates is a group of fine grained, bedded tuffs, often appearing as thinly bedded, dark to almost black, shales. These are intimately associated and interbedded with greenish tuffs showing no bedding and appearing to pass into porphyrites, etc. In fact, in this district, the truly bedded deposits laid down under water, grade into and are so closely associated with the volcanics that it has been found impracticable to map them separately.

Newer than the above series of sediments and volcanics is a very extensive group of andesites, dacites, tuffs, etc., different members of which respectively cut or overlie the older formations. It is this volcanic group which is found overlying the conglomerate containing the coal horizon in so many places, and which renders the exploration of the coals very difficult.

Youngest of all is a volcanic group, in all probability of Tertiary age, consisting of scoria, basalt and basalt tuff, the tuff being the newest rock in the district. The basalts are either reddish or bluish in colour and are generally quite amygdaloidal. The tufaceous beds are often as much as 1,500 feet in thickness and are commonly quite coarse, containing bombs ranging from one to even two feet in diameter.

ECONOMIC GEOLOGY.

Coal.

There are two coal-bearing horizons of economic interest in this portion of the Yukon Territory. An upper horizon occurs near the top of the thick assemblage of conglomerate beds forming the upper half of the group of Cretaceous sediments, and to this higher zone belong the seams at the Tantalus mine and on Tantalus bluff. A second, lower coal-bearing horizon lies towards the base of the Cretaceous column as seen at the Five Fingers mine, also at a point west of the 69 mile post from Whitehorse on the Whitehorse-Dawson road and elsewhere.

The seams of the Tantalus bluff and the Tantalus mine doubtless extend a number of miles to the north and south of these places, but prospecting for coal is rendered particularly difficult there by the thick mantle of glacial and recent alluvial material which covers the greater part of the district. Beginning within a distance of two or three miles south of Tantalus, the Cretaceous sedimentary rocks are, for the greater part, covered with more recent Tertiary basalts, basalt tuffs, etc., so that although in the 20 miles immediately south of the Tantalus mine there is believed to be a great amount of coal, it will, in most places, require very careful prospecting to find it suitably located for mining purposes.

South of this district in which the strata have been so largely covered by later volcanics, the coal-bearing formations have been removed by erosion for a distance of over 30 miles to where a belt of the conglomerate of the upper coal horizon was found, traversing the district in a direction somewhat north of east. About 4 miles east of the wagon road the formation passes beneath a great thickness of volcanics, but to the north-west, the formation is believed to extend a number of miles, and may exist as a continuation of the outcrops seen crossing the Hutchi River valley about 30 miles from the mouth of the river. The formations near the road are in the form of a double synclinal fold, the upper portion of the formation, and consequently the upper coal horizon, being here eroded away. The seams of the lower horizon, however, were seen in several places, being particularly well exposed along a small creek about 4 miles west of the 69 mile post from Whitehorse. At this point a number of seams were uncovered and others probably exist, as very little prospecting has been done here. Of the seams seen, one was 7 feet wide, one about 4 feet wide, and several between 6 and 8 inches in width. The following are approximate analyses by fast coking of these coals, furnished by Mr. F. G. Wait, of the Mines Branch. No. 1 represents an average of an 18″ seam, and No. 2 of a 7′-6″ seam:—

	I.	II.
Water	8·98	12·02
Volatile combustible matter	29·62	34·28
Fixed carbon	48·30	42·56
Ash	13·10	11·14
	100·00	100·00
Coke, non-coherent	61·40	53·70
Ratio of volatile combustibles to fixed carbon	1:1·63	1:1·24

The ash in No. 1 is white; in No. 2, pale reddish brown.

Coal was seen also along the side hills to the east of the wagon road between the 117 and 118 mile posts, but the very thick covering of glacial material made the measuring of the seams very difficult. One seam, less than 2 feet wide, was seen on a small creek which crosses the road between the 113 and 114 mile posts. The following is an approximate analysis by fast coking of a sample from this seam by F. G. Wait, of the Mines Branch, who states that the coal 'is probably a lignite which has been altered by intrusives.'

Water	4·68
Volatile combustible matter	15·59
Fixed carbon	72·26
Ash, reddish brown	7·47
	100.00
Coke, non-coherent	79·73
Ratio of volatile combustible to fixed carbon	1:4·64

All information that can be gathered concerning the Tantalus, Tantalus Butte and Five Fingers mines has already been published.[5] The areas described in this report, and two other areas previously mentioned[6]—one along the Lewes river between Hootalinqua and the Big Salmon river, and the second at a point a short distance from the Tantalus mine—include all the places north of Whitehorse and south of Tantalus at which the upper coal horizon is known to occur.

Mack's Copper.

A few miles to the south-west of Montague, and only a short distance west of the western edge of the Tantalus map, are a number of mineral claims, locally known as Mack's Copper, because originally they were mostly owned by Mack brothers. The property is reached, usually, by a branch road leaving the Whitehorse-Dawson road

5. Op. cit.
6. Cairnes, D.D.—'Report on portions of the Yukon Territory, chiefly between Whitehorse and Tantalus,' Summary Report for 1907, Geological Survey Branch.

about 6 miles above Montague, and following approximately the old Dalton trail south-westerly up the Hutchi river. From a point about 8 miles in on this road, a trail ascends the hills to the north of the claims which virtually are on the summits about 4 miles distant from and 1,900 feet above the valley. Practically all the ore in the vicinity appears to be on one claim.

The ore, which occurs in a fine grained, greenish, porphyrite at or near its contact with limestone, consists chiefly of magnetite, with hematite in minor quantities, both being more or less impregnated with copper minerals, chiefly chalcopyrite, malachite and azurite. The main mass of mineral is in the form of a small knoll of almost solid iron ore, about 200 feet wide, by, perhaps, 300 or 400 feet long. On the south side of the hill the iron carries considerable copper, while the ore on the top of the knoll shows no copper, possibly because of leaching. A cross-cut tunnel has been started in one of the most promising places on the hillside, and when visited was in about 35 feet.

The only other work done on the property is in the form of an open-cut on an adjoining knoll to the west. The ore bodies in the two places apparently are not connected. The ore body in the more westerly locality is only 10 to 12 feet wide and lies next to and more or less in the limestone. The richest ore is found here, but has only been traced a short distance; it may, however, continue farther along the limestone, for the contact is so deeply covered with superficial deposits that only a few feet as yet have been uncovered.

The following samples were taken by the writer and have been assayed by Robt. Smart, government assayer at Whitehorse. No. 1 is an average of the end of the tunnel, No. 2 is an average of the best 4 feet of the open-cut.

	I.	II.
Gold, ounces per ton..	Trace	0·025
Silver, ounces per ton..	Trace	3·400
Copper, percentage..	1·80	5·55

The Gilltana Lake Claims.

Most of these claims were staked during the season of 1907, though a number were located during the last summer. They are located on both sides of Gilltana lake, which lies some 15 miles in a north-westerly direction from Hutchi lake and village. Locally the claims are known both as the Gilltana Lake claims, and as the Hutchi copper.

The ore on the north-west side of the lake occurs at the contact between granite and limestone, and is in the form of narrow lenses of mineralized matter and quartz. The widest lens seen had a breadth of about 4 feet, but as a rule, the bodies are only from 1 to 2 feet wide and have at present no economic value.

Across the lake the claims are chiefly located over the face of a hill rising about 1,200 feet above the water. The country rock is mainly mica schists, interbanded with which are some beds of quartzite and limestone, the latter generally being narrow—3 to 4 feet wide, but sometimes as much as 50 feet thick. The strata strike about parallel with the lake and dip into the hill, so that the different bands of schist extend along the face of the hill, one above the other, maintaining an almost horizontal outcrop. In places these bands have become mineralized with magnetite, generally carrying copper minerals, chiefly chalcopyrite and malachite, and these constitute the ores bodies. The original schists show all degrees of mineralization and replacement, from portions entirely non-metalliferous to others now consisting of almost solid iron ore.

The best of these mineralized bands or zones average from 6 to 10 feet in width, although one was seen having a breadth of 20 feet and consisting of almost solid ore. The mineralized bands generally can be traced for 50 to 100 or even 200 feet, when the iron and copper minerals gradually disappear, or at times seem to be continued along other parallel bands. Three prominent, with other less important bands, were observed at different elevations on the face of the hill.

At the surface the copper minerals appear to have been leached out, but may be found re-deposited lower down. On the Helen claim, up Franklin creek, some open-cut work has been done, and there, in places, streaks of copper ore 1 to 3 feet thick were seen, included in wider bands that are much richer than observed elsewhere.

Apparently the ores are connected in origin with the intrusive granites found in the vicinity. The strata have been cut by dikes of light coloured hornblende andesites and dark fine grained basalts, but these have had no visible effects on the ore deposits. The district is well worth prospecting and a number of the claims look very promising.

The following represent the results of assays of two samples from this district. No. 1 is a sample taken across the strike of one of the best looking bands which had a width of about 6 feet. No. 2 is a sample of one of the 3 foot streaks of copper ore on the Helen claim.

Gold, ounces per ton..	Trace	Trace
Silver, ounces per ton..	Trace	Trace
Copper, percentage..	1·35	9·00

WINDY ARM.

Since the season of 1905 the Venus has been worked continuously with very satisfactory results, so that now a large amount of ore has been blocked out and some small, though high-grade shipments have been made to outside points. During the past year this is the only property in the district upon which work of any considerable importance has been performed; the reason for this inactivity being chiefly difficulties in company organization, etc., rather than the lack of promising conditions on the claims themselves.

The first concentrating mill built in the Yukon has, this season, been completed. It is situated on Windy Arm just below the Venus, the ore being carried from the workings to the mill by an aerial tramway. A 100 h.p. boiler, and a 75 h.p. engine, at present generate the motive power, but a water-power plant is being installed. The ore is first hand-sorted, then passed over a grizzly and the overs crushed by a Blake crusher. The ore is sized by trommels giving three products. Fine crushing is performed by a set of high-speed rolls and a Huntington mill. A set of jigs and four Callow screens concentrate the crushed and sized materials. The slimes are settled in six Callow settling tanks, and afterwards concentrated on three Wilfley tables and two Frue vanners.

The mill appears to have been well designated and constructed, and it is hoped that its erection will mark the introduction of the properties of the Conrad district into the class of producing mines.

FLORA AND FAUNA.

The principal varieties of trees in the district are white spruce, black pine, balsam poplar, aspen and willows. The white spruce is, by far, the commonest of these, covering perhaps half of the hillsides. Only in a few places were patches and isolated specimens of black pine noted, these being chiefly along the valley bottoms. Balsam, poplar, aspen and willow occur very plentifully in the valleys and on many hillsides, giving place very often to thick, dense growths of dwarf birch towards the summit.

Crowberries were very plentiful on all the hillsides. Black and red currants, blueberries, high bush cranberries and strawberries also occur.

Moose and bear are rather common in many places, caribou being less often seen. Fresh beaver cuttings were noticed in several places. Lynx and porcupine are very plentiful; while foxes, wolverines, wolves, and coyotes are in somewhat smaller numbers.

The lakes and streams are generally well filled with fish, chiefly grayling and pike. Salmon also come up the streams in great numbers in the autumn months.

The wide and extensive valleys of the Nordenskiold and its branches are often covered with very luxuriant growths of certain wild grasses and timothy. Oats

accidently scattered along the roads, are seen to grow well. Many varieties of vegetables grown in Dawson, Whitehorse and intermediate points, compare very favourably with those imported. It is well known that horses generally winter safely in the valleys without being fed. A collection of the common plants of the district has been made by the writer, and these have been examined by Mr. John Macoun, of the Geological Survey, who considers them as proving the district suitable for agriculture, since the specimens are similar to those found in the Canadian Northwest and more particularly in the vicinity of Prince Albert and Edmonton. For these and other reasons it is hoped that it will not be many years before this district proves itself to be an important one for stock raising and agricultural purposes.

EXPLORATIONS ON THE PELLY, ROSS AND GRAVEL RIVERS, IN THE YUKON AND NORTHWEST TERRITORIES.

(J. Keele.)

INTRODUCTION.

In the spring of 1907 I received instructions to investigate the mineral resources of a portion of the Pelly River basin, in the Yukon Territory; to inquire into the truth of certain rumours which had reached this Department concerning the existence of an active volcano near the headwaters of this river; and to explore and map as much as possible of the unknown region from the Pelly to the Mackenzie river, between latitudes 62° N., and 64° N.

I left Ottawa on June 2, 1907, travelling by way of Vancouver and Skagway, reaching Dawson on June 16.

To carry out the above instructions, it was necessary that I should winter in the country, hence sufficient provisions and outfit for this purpose were purchased in Dawson and three men engaged, namely, R. B. Riddell, J. M. Christie and Geo. Ortell, all of whom had been residents in the country since 1898.

Riddell was to remain with me during the whole time of the exploration; Christie was to leave me during the autumn, trap during the winter and join me in the spring; Ortell returned to Dawson in the autumn of 1907, from our winter quarters, with specimens and letters. Riddell and Christie owned two dogs each, which accompanied the expedition.

I succeeded in obtaining the services of Mr. Robt. Henderson, assistant mining engineer to the Yukon government, for the summer. Mr. Henderson, who was accompanied by his two sons, had his own boat and outfit. He visited several important points on the Pelly, doing some careful prospecting and collecting specimens.

ROUTES TRAVERSED.

We left Dawson on board the *La France,* on June 22, and reached the junction of the Pelly and Ross rivers, the head of steamboat navigation, on June 29; a distance of 160 miles on the Yukon, and 250 miles on the Pelly; all up-stream against a strong current.

After leaving the bulk of my stores with Messrs. Lewis and Field, who have a trading post at the mouth of Ross river, we continued the ascent of Pelly river from this point in two canoes, with provisions for one month.

On July 15, we reached Wolf canyon, a distance of 143 miles above the mouth of Ross river. From the mountain in this vicinity we could overlook the country in which the alleged volcano is supposed to exist, but saw nothing of it, and there are no recent volcanic rocks, either in the bed-rock or river wash.

I surveyed this portion of the country as completely as time would permit; then returned down-stream to Ross river. On our way down we met some prospectors toiling up-stream with their heavily loaded boats. Several of them were bound for Hoole river, which enters the Pelly 40 miles above the Ross.

At Ross river we built a wooden boat large enough to carry our entire load. On August 8, we started up the Ross river, accompanied by Charles Wilson, a prospector. The task that now lay before us was to traverse an unexplored mountain province about 300 miles wide, in the centre of which lay the great continental divide. This chain of mountains, comprising several groups and sub-ranges, is the northern

continuation of the Rocky mountains. We hoped, by following the valley of the Ross river to the watershed range, to find on the other side one of the branches of the Gravel river, and to descend that river to the Mackenzie. On August 28, we reached Third lake on the Ross river, about 120 miles from the Pelly. We made our headquarters at this point.

On September 5, George Ortell left us and started down the stream, carrying our letters and specimens. On October 1, Christie left for the trapping ground which he had selected. In the middle of February, the days having become sufficiently long, I was joined by Christie, and we began our journey toward the Gravel river. Our progress was slow, as we had a heavy load to move, and only three dogs. Strong winds, often increasing to the intensity of gales, and a heavy snowfall during the month of March, also contributed to delay us. During the first week in April we crossed the divide, through a pass about 5 miles long, totally devoid of trees. The elevation of the divide was estimated at 4,500 feet above sea level. Some of the mountain peaks bordering the pass rose 3,000 feet above it. A small stream trickled down from one of these mountains at the farther end of the pass. This stream proved to be the extreme head of the main branch of the Gravel river.

On April 23, we reached a point on the Gravel river about 30 miles from the divide, where we were satisfied the stream would afford boating water when the ice went out. We, therefore, decided to rest here and make our spring camp.

On July 18, we reached the Mackenzie river, and two days later boarded the Hudson's Bay Company's steamer *Mackenzie River* going up-stream, and returned to Ottawa by way of Edmonton.

The main geographical results of the journey are:—

(1.) A traverse of 520 miles through an unexplored territory, and the mapping of about 5,000 square miles of mountain country along this route.

(2.) The discovery of the sources of the following rivers: the main branch of the Pelly, the Ross, the south branch of the McMillan and the Gravel.

The survey was carried on during the winter months of February and March without discomfort, since the winter season was an unusually mild one in this region.

During the winter months the geological information gathered was necessarily rather meagre, the section obtained being based on occasional rock exposures seen in cliffs and canyon walls along the line of travel, too steep for snow to rest on.

TOPOGRAPHICAL FEATURES.

Although the greater part of the region between the Yukon and the Mackenzie is mountainous, three distinct but not sharply separated topographic types of country are apparent.

The country through which the Yukon river and lower portion of the Pelly river flow appears to be a dissected plateau. Here, an originally low, rolling country has been elevated to a height of about 4,000 feet above sea level, and carved by stream action into a series of long, gently sloping ridges, or dome-shaped hills, whose summits may be remnants of the original plateau. Following the Pelly river eastward, these hills become higher, and merge into mountains more or less rugged, with crests standing at a much higher elevation than the plateau region; from 6,000 to 7,000 feet above sea level. These mountains extend eastward to within 40 miles of the Mackenzie, and are then flanked by a narrow belt of foothills, which gradually decline in elevation until a fairly level plain is reached, standing at an elevation of about 600 feet above sea level. The Mackenzie river has trenched this plain to a depth of about 350 feet.

Of these three topographic provinces, the central, or mountainous one, is the most extensive, and is drained by streams flowing in both an easterly and westerly direction. The water parting on the route traversed is about 250 miles from the Mackenzie, and 450 miles from the Yukon. The streams flowing toward the former river are extremely

swift throughout their course, and are confined in narrow valleys; while those draining to the latter river have a comparatively easy grade, through wide valleys.

GENERAL GEOLOGY.

Until the observations made in the field are laid down on the map, it will be impossible to give with precision any account of the geological features of the region. The rocks, in a general way, however, may be roughly divided according to the topography.

The western plateau region is underlain by what is generally regarded as the oldest rocks of the region. These consist chiefly of various crystalline schists, of both sedimentary and igneous origin; but also contain a subordinate quantity of later intrusive rocks, including granites, diorites and andesites, which generally still retain their massive character.

The heterogeneous character of the rocks included within the mountain province precludes any lengthy description of them in this report. Briefly, those on the Ross river consist chiefly of sedimentary rocks; including slates, cherts and quartzites, together with a few small intrusive bodies of granite, diorite and andesite; while those on the Gravel river consist of sandstones, limestones, dolomite and conglomerate; and intrusives are seldom seen.

A small collection of fossils was obtained at several points in the mountains, and Mr. Lawrence Lambe has already examined the fossil corals from this collection. Mr. Lambe concludes that various horizons of Palæozoic rocks, ranging from the middle of the Ordovician to the Devonian, are represented. The stratigraphy of a portion of the section has since been worked out, and agrees closely with Mr. Lambe's conclusions.

The plain lying east of the foothills, and bordering the Mackenzie river, is underlain by soft sandstone, and conglomerates, probably of Cretaceous age.

In the plateau and mountain regions, the rocks were found lying at all possible attitudes. Folding and faulting of the strata, and the intrusion of igneous bodies of rocks have given rise to such a degree of complexity in the structure of the mountains that no attempt to give an estimate of the thickness of the various series of rocks passed over is here made. Towards the Mackenzie river the effects of the disturbing influences to which the mountain system is due, die out, or almost cease, so that the foothills and plain have simpler structure, and in places the beds for long distances are nearly horizontal.

Some features of special scientific interest occur in connexion with the superficial deposits and the evidences of glacial action. It is merely stated here that in both the Pelly and Ross valleys traces of heavy glacier ice moving in westward and northward directions are often apparent. This ice sheet was sufficiently thick to submerge the divide between the Ross and Gravel river, and to extend some distance down the valley of the latter stream. The greatest development of the ice sheet appears to have been on the western side of the watershed range, as the results of glaciation on the Gravel river appear to be feeble when compared with those on the Ross and Pelly. The direction of ice movement in the glacial period is of special interest, since it has an important bearing on the distribution of placer gold.

ECONOMIC GEOLOGY.

Prospecting for gold began on the Pelly river as early as 1882. For some years subsequently, miners working on the gravel bars made as much as $10 to $20 a day each, their operations being confined to the lower portion of the river. Since then prospecting has been carried on along the greater part of the river and many of its tributaries; but no mining of importance has yet been done in the region. Fine colours of gold are found in the gravels over a large area, but no coarse gold has

yet been located. For the last few years work in the district has been confined to the streams entering the Pelly from the south, between Lapie and Hoole rivers. These streams head in a high range, lying south of and parallel to the course of the Pelly. Along the base of these mountains lies a wide valley, floored with gravel and containing several lakes. This valley is separated from the Pelly river by a line of low rocky hills through which the streams have cut channels. The gravels of the valley carry fine and coarse colours of gold, and a portion of the gold, concentrated from them, is caught in the bed-rock in the lower portions of the streams tributary to the Pelly.

The Stewart River region, to the north of the Pelly, resembles the country in the vicinity of the latter, in many respects. Coarse gold was found in that region about ten years ago, and almost every year since then discoveries of more or less importance have been made. Two serious difficulties, however, hard to overcome, prevent the Stewart River country from becoming a successful mining camp. These are (1) underground water, and (2) lack of adequate transportation to ensure a supply of provisions for miners all the year round. The same difficulties apply to the Pelly River country. A good deal of rich ground, which could be worked by the open-cut method, was mined in the Stewart country, but individual miners have never succeeded in deep digging whenever they encountered underground water.

At least two parties of miners, and probably more, have prospected in late years on the Ross river, but without success. Chas. Wilson, who has prospected on the upper portion of the river during the last two years, informed me that he only got colours of gold in one small creek which flows into the south branch of the MacMilan river, and that he found no coarse gold at all. Our experience corroborates these statements. The explanation of Wilson's persistence in remaining in an apparently barren field is that he is in search of a phenomenally rich deposit of gold said to exist in this neighbourhood.

It is possible that coarse gold may exist on bed-rock on either the Ross or Gravel rivers, or their tributaries, but the apparent absence of fine gold in the gravels tends to discourage any hope of it being found there. A fact, frequently commented on by men who accompanied me, was the marked absence of quartz, either in the bed-rock or the wash gravels, along the route travelled from the Pelly to the Mackenzie.

There appears to be a close connexion in the Yukon Territory between the crystalline schists and the placer deposits. In the Pelly valley these rocks appear to occupy a belt extending for a distance of about 10 miles on each side of the river, which flows generally parallel to the strike. In the vicinity of Campbell creek, however, the Pelly river turns north-eastward, while the belt of crystalline schists continues south-eastward to the Francis river.

Fine gold is found in the gravels all along the Pelly, from Campbell creek to the Yukon, while none is found above that point on the river. Small veins and stringers of quartz are abundant in the schist, and quartz pebbles form a considerable percentage of the wash gravels along the Pelly. Mr. Henderson tested a few bars on the Pelly, at and above Hoole canyon, using two sluice boxes about 12 feet long. He saved for me several pounds of the black sand which accompanied the gold. A grayish white, malleable mineral in small scales, which I thought might be platinum, is abundant in this sand. The sample was submitted to Mr. Robt. Johnston, mineralogist to the 'Survey,' who states it to be ferro-nickel, a rare mineral; but of no commercial value in such small quantities. The bulk of the black sand is composed of magnetite and garnet.

Quantities of drift lignite are found along the lower part of Campbell creek, but the seams from which it is derived were not found. There is probably a small Cretaceous area lying on the schists in this vicinity, similar to the one on the Pelly, some distance below Ross river.

Drift lignite is found on the Gravel river where it enters the plain bordering the Mackenzie, and which is no doubt derived from seams in the adjacent Cretaceous

rocks. On the Gravel river, about 130 miles from the Mackenzie, there is an occurrence of hematite. This iron ore is coarsely laminated with red siliceous slate in a bed having a thickness of about 50 feet and lying between conglomerate and limestone.

FAUNA AND FLORA.

The valleys of the Pelly and Ross rivers are well wooded, the forest growth extending far up the hillsides. The principal trees are the white and black spruce; but poplar, birch and balsam, of inferior economic importance, are also present in small quantities.

The best timber grows on the islands or on the immediate banks of the river, in a strip varying in width from a few yards to over a mile, and consists of white spruce, with straight clean stems, averaging about 12″ in diameter 5 feet from the ground,

Beyond this strip the timber on the valley bottom and hillsides is thin in growth and of inferior quality. Between the headwaters of the Ross and Gravel rivers there is no timber of any kind for a distance of about 20 miles.

The timber resources of the Gravel river are only moderate. The valleys are narrow and rather steep, and therefore are not timbered to as great a height as those on the Yukon side, where the slopes are more gentle. The principal tree here is the white spruce also, with the best timber along the river banks, and a generally sparse growth on the hillsides, which may be white or black spruce. Poplar is to be seen at intervals along the greater part of the river, and some groves of small tamarack were observed on the lower portion. The plain bordering the Mackenzie is generally sparsely wooded with an inferior growth of poplar and black and white spruce.

There are evidently no great commercial timber resources anywhere on the route. Whenever special demand on the supply is made in any locality the timber within reach is soon exhausted.

Several white men and two bands of Indians make a living by trapping on the Pelly river and its tributaries, and large quantities of valuable furs are annually exported. The principal fur until the last few years was marten; but of late the principal catch has been lynx.

The upper part of the Pelly and its tributaries embrace a famous game country. Moose, woodland and mountain caribou, and mountain sheep (both white and saddle-back), are numerous. Black, brown, and grizzly bears, and timber wolves infest parts of the region, in considerable numbers. Although a few moose are to be found along the valley of the Gravel river, they are by no means plentiful. Small numbers of caribou inhabit the hills on the upper part of the river. Sheep, however, are plentiful on the mountains, about 50 miles from the divide.

ON A PRELIMINARY SURVEY OF THE GEOLOGY OF THE BRITISH COLUMBIA COAST FROM KINGCOME INLET TO DEAN CHANNEL, INCLUDING THE ADJACENT ISLANDS.

(R. P. D. Graham.)

During the summer of 1908, the writer, with the assistance of Mr. E. G. Montgomery, was engaged in a continuation of the reconnaissance survey of the British Columbia coast, which was commenced in 1906 by Mr. O. E. LeRoy, and carried a stage further by Mr. J. A. Bancroft in 1907. The launch *Dawson*, belonging to the Geological Survey, was again used as a means of transportation. Altogether, rather less than three months were spent in the field.

Commencing at the entrance to Kingcome inlet, the examination of the coast, together with the adjacent islands, was carried as far north as Bella Coola, at the head of the north Bentick arm of Burke channel; a distance along the main coast of about 100 miles.

PHYSICAL FEATURES.

The coast maintains its general north-westerly trend until Cape Caution is reached, then it takes a rather decided turn, and for the next 70 miles or so, runs almost due north. Beyond this, it again approaches the former direction. This north and south stretch lies between the northern extremity of Vancouver island and the most southerly point of Queen Charlotte islands and faces the open Pacific.

In its general aspect, the coast in the area examined is very similar to that to the south previously described. It is intersected by numerous inlets which, however, have as a rule a more nearly east and west direction, often branching abruptly to the north, especially near their heads. The mouth of Kingcome inlet is completely hidden behind a network of islands, of which Broughton is the largest, but between it and Smith sound the shore line is singularly continuous, with few off-lying islands. Beyond the latter point they form a continuous chain, parallel with the coast, thus affording a well sheltered channel for steamers.

GEOLOGY.

An excellent résumé of the geology of the coast from Powell river to Kingcome inlet was given by Mr. Bancroft in his preliminary report for 1907, and as the area under consideration presents the same general features, little need be added in the present instance.

The Coast Range batholith was intruded during Upper Jurassic times, and subsequent erosion has removed almost the entire rock roof which covered it at that time. It now stands exposed, and forms the principal feature of the geology of the British Columbia coast.

Where the process of erosion has been arrested in time, we find remnants of the old roof in the form of more or less highly metamorphosed rocks; chiefly schists, cherty argillites and limestones. Their strike is variable, but as a general rule approximates N. 30 W., which is parellel to the axis of the range, and the dip is usually high to the northward.

Examples of these roof pendants were found in Drury inlet, Actæon sound, Seymour inlet and Nugent sound, possibly in this case representing a continuous belt stretching across the intervening country, since they lie roughly along the same line.

These occurrences are of great economic importance, as the altered roof remnants are always mineralized to a certain extent, and may be expected in some cases to yield valuable results when carefully prospected. There are many exposures of similar argillitic rocks and limestones along the shore between the West arm of Moses inlet and the entrance to Fitz Hugh sound. They were also observed in several other localities.

From the greater part of the area, however, the roof has been completely removed, leaving the batholith exposed, and it is possible to observe the changes which have taken place within the magma during its intrusion. As seen towards the heads of the larger inlets, where these have penetrated into the hearts of the range, the batholith appears to have been originally, in its upper portions at least, a light, medium to coarse grained granite, containing rather more hornblende than biotite; but elsewhere it presents many differentiations, which in some cases have been due to segregation in the magma itself, and in others are possibly due to its having dissolved and assimilated portions of the roof material during its intrusion.

In some cases the magma has been unable to assimilate the engulfed blocks, hence these remain embedded as highly altered inclusions, but still preserving their stratified character. An example of this was noted on an island of the Southgate group, the included blocks being quite large, 20 feet or more in length. But in nearly all the observed cases the evidence might be taken as indicating assimilation of the engulfed roof material. This may show itself in the occurrence of areas of a more basic facies of the granite, of gabbro, or even of an almost pure, coarsely crystallized hornblende. Broughton island is composed largely of such basic rocks, which also occur extensively along the main coast and in many of the inlets. It is not supposed that these basic differentiations are all to be explained in the above manner; they no doubt very often represent segregations from the original magma.

In other cases where assimilation seems to have taken place, diffusion has not proceeded sufficiently far to produce a homogeneous solution, and the rock after solidification presents a blotched or striped appearance, which at times is very striking. All possible gradations between the light acid granite, containing only a few dark inclusions, and the homogeneous basic gabbroid differentiations, are met with continually.

Following the granitic intrusion there have been at least three distinct periods of dike formation, the earliest of these having produced aplites, which were then succeeded by two sets of dark basic dikes.

The occurrence of a small area of conglomerate, probably of Tertiary age, was observed in Millbrook cove, Smith sound. No microscopic examination of the specimens collected has yet been made, but some included granite is apparently identical with that found in place in the neighbourhood.

Although search was made for fossils wherever sedimentary rocks occurred, none were found. It is therefore impossible to state definitely to what period these belong. From their similarity to the corresponding rocks in the area covered by Mr. Bancroft's report, in which fossils of Triassic age were found in five localities, it is very probable that some stratified rocks in this season's area also belong to that period, others may represent remnants of Devono-Carboniferous formations, which Mr. O. E. LeRoy has noted as occurring on Texada island and elsewhere.

It might be expected that, in some instances at least unconformities might be found within such patches, representing as they do isolated portions of the stratified rocks, which, in early Jurassic times, blanketed the whole of this district; but although careful attention was directed to the possibility of such an occurrence, no evidence was forthcoming to suggest that the rocks within any one patch were not laid down in a single geological period.

The general elevation of the Coast Range in this area, as judged by the mountains forming the shores towards the heads of the longer inlets, is from 4,000 to 6,000 feet, but at the mouths of the inlets and along the main coast, the country is considerably

lower, and wherever the more easily weathered limestones and argillitic rocks occur in any quantity, the effect of erosion on the topography of the country is very pronounced.

Drury inlet may be mentioned as a remarkable instance of an inlet running due west. It is a comparatively shallow channel, and the country for many miles around is low, being more nearly related in its topographic features to some of the island scenery than to that of the fiords. This inlet has indeed narrowly escaped forming an island, its head being only about two miles distant from the main coast.

ECONOMIC GEOLOGY.

There are no mines in the district, and very little prospecting appears to have been carried on at any time. The timber and salmon fishing industries have proved more attractive in the past, while at the present time, prospectors are turning their attention to the Queen Charlotte islands, which lie off the coast, a little farther north. The only place at which mining operations were being carried on at the time of our visit was at Bella Coola at the head of North Bentinck arm. The northern shore of the latter is formed by a mountain rising 5,700 feet above the sea, and several claims have been staked along a band of highly altered green schists which occur near the summit. These have a general north-easterly strike, and are bounded on each side by the granite which forms the mass of the mountain. The schists are mineralized with sulphides of iron and copper. Some assays of the ore are said to run as high as 9·6 per cent copper as well as something in gold. Mr. Scribner had two men working on one of the Bella Coola group of claims during the summer, while the North Coast Copper Company had driven in two tunnels on a similar proposition, but had suspended operations prior to our arrival.

In Kilbella bay, Rivers inlet, a patch of limestones in the gneissoid granite includes a seam of massive magnetite which was staked some years ago, but abandoned after a shaft had been sunk 100 feet. The width of the magnetite near the shore varies up to about a foot, and it is said to have been traced back into the mountain for 1,800 feet. It is probable that a further examination of this property will be made shortly.

There is a somewhat similar occurrence of magnetite near the head of Seymour inlet, on its eastern shore opposite Wigwam bay.

The granite along the south shore of Bramham island maintains an even grey colour over a large area. There are few inclusions, and dikes are rare. It is dissected by joint planes into rectangular blocks and would make an excellent building stone which could be conveniently shipped from Miles inlet.

Our season was curtailed a week or two owing to an unfortunate accident which necessitated our beaching the launch for repairs, after which it was thought advisable to return to Vancouver.

It might be well here, to call attention to the inadequacy of the existing charts for the purposes of a geological survey, in a portion of the territory covered this year, and also along the coast immediately north, as far as the International Boundary, Although the main coast from Seymour inlet to Fitz Hugh sound is well charted, on a scale of about one inch to the mile, the inland waters have been mapped from a sketch survey only, and the greater part of Smith and Boswell inlets and the whole of Naysash, Mereworth and Belize inlets have never been surveyed at all. Beyond Fitz Hugh sound, the only charts at present available are on a scale of about 4 miles to the inch, and in the case of a large portion of Burke and Dean channels, representing some 200 miles of shore line, the scale is 15 miles to the inch. This renders even an approximate location of contacts and other data almost impossible.

THE BULKLEY VALLEY AND VICINITY.

(W. W. Leach.)

During the past season the work undertaken in this district was chiefly in the upper parts of the valleys of the Morice and Zymoetz (Copper) rivers, though some time was spent in collecting sufficient geological and topographical information for the compilation of a new and enlarged edition of the map published last spring.

MORICE RIVER DISTRICT.

As the season was exceptionally late, it was found necessary to spend the earlier part of it in the lower levels; the valley of Clarks fork of the Morice being the first point to be visited. This stream rises with the south fork of the Telkwa, near Howson camp, in a wide, flat pass with an elevation of about 3,600 feet, thence its course is nearly due south for a distance of about 20 miles, when it unites with the main Morice river. Its chief tributaries are Starr creek, Goldstream, Gabriel creek, and a large unnamed creek coming in from the east a few miles below Gabriel creek. From the mouth of Gabriel creek down, the valley is wide, the hills on either side being comparatively low, with gentle slopes, while the grade of the stream itself is not great.

Geology.

From the pass southward to about one-half mile below the mouth of Gabriel creek, the rocks met with consist of the volcanics of the Porphyrite group (underlying the coal-bearing beds), except for a short distance midway between Starr creek and Goldstream, where the basal conglomerate of the coal series crops. It appears, however, that here the coal seams have been almost entirely eroded.

A short distance below Gabriel creek, the conglomerates again outcrop on the west side of the river, for a distance of at least eight miles, that being as far south as the valley was explored. Along this stretch the river follows pretty closely the strike of the rocks, near, but usually a little west of a synclinal axis. On the west side the dip of the strata is very low, conforming more or less to the slope of the hills. Practically the whole of the coal measures above the conglomerates has been lost by erosion. On the east side of the valley, however, the hills have a steeper slope; the dips are quite low and the synclinal axis is roughly parallel to, and some distance to the east of, the river bottom. Taking these facts into consideration, it was thought probable that an important coal basin might be found on the east side of the valley. Some days were spent, therefore, in carefully examining a number of small creeks on the east side, with the result that the conglomerates were found outcropping at from one to one and a half miles back from the river, at elevations varying from 400 to 600 feet above it, and with westerly dips. The conglomerate here appears to reach a much greater thickness than where observed elsewhere in this country. Two distinct beds were noted, the lower about 100 feet thick, and the upper probably 30 or 40; they are separated by about 50 feet of soft sandstone. On a small creek, about one mile below Gabriel creek, and about one mile from the river, the coal-bearing shales were seen overlying the conglomerates. Two coal seams were here found, the lower one showing 3 feet of coal, with no roof, while the upper one gave the following section:—

Clean coal 12″.
Shale, 4″.
Coal, 3′-6″.

Later on in the season this point was again visited, when it was found that during the interim Messrs. C. B. Clark and T. Howson had done considerable prospecting in the vicinity, and staked a number of coal claims. They had opened up what is undoubtedly the upper of the above-mentioned seams, at several points, showing it to be about ten feet thick and dipping to the west at thirty degrees. At none of these openings had they reached below the level of the surface waters, the coal in all cases being wet and decomposed, so that any sample taken at that time would hardly give a fair idea of the character of the coal. The seam, however, appeared to be quite regular, except at one point, where a slight local disturbance was noted.

The following analysis is from a sample taken under the conditions already mentioned. It can be confidently expected that the percentage of moisture, and probably of ash, will be materially reduced in a sample taken under more favourable circumstances:—

Moisture	10·81
Volatile combustible matter	31·22
Fixed carbon	48·62
Ash	9·35

Coke: non-coherent.

This area appears to be one of the largest in a district where the coal beds occur, as a rule, in small basins. Although the seams were opened up at one point only, still there is little doubt that this basin extends down to the forks of the Morice, and probably widens out below the place where the seams were stripped, at which point it is approximately three-quarters of a mile in width.

The general attitude of the strata is quite regular; the valley is wide, with an easy grade, and no serious engineering difficulties need be looked for in the construction of a branch line of railway down the Morice river, to connect with the main line of the Grand Trunk Pacific. There is a plentiful supply of timber in the valley for all future mining purposes.

Goldstream Coal.

On Goldstream, to the north-west of this area and separated from it by a short distance only, another important coal basin is found, which was briefly described in last year's Summary. Since then, however, the locator, Mr. F. M. Dockrill, has opened up the seams at several new points, which proves this basin to be at least as large, and probably larger than it was estimated to be last year, viz., two by two and one-half miles.

The following results are from analyses made of samples taken this season:—

	Moisture.	Vol. Comb. Matter.	Fixed Carbon.	Ash.
(1) 8 ft. seam	4·67	30·55	55·23	9·55
(2) 6½ ft. seam	6·36	28·36	58·75	6·53
(3) 3½ ft. seam	6·86	27·24	59·47	6·43

Coke: non-coherent in all cases.

All these samples were from surface coal, so that the percentage of moisture is in all probability higher than what will be found at greater depth.

ZYMOETZ RIVER DISTRICT.

Two other coal areas were examined rather hastily, both on that branch of the Zymoetz river which rises with Pine creek near the Hudson Bay mountains.

Glacier Creek Area.

The first of these is situated near the head of the river, which here occupies a wide, marshy valley. The coal-bearing beds were seen cropping in the bed of Glacier creek, a small stream rising in the Hudson Bay mountains and entering the Zymoetz from the east. The contact of the conglomerate and the underlying volcanics is at an elevation of from 500 to 600 feet above the valley, and at this point the strata are very highly flexed and otherwise disturbed, but have general high westerly dips. Following down the creek from the contact, it was seen that everywhere the rocks have been severely folded and faulted till near the flat, where they become more regular, dipping under the valley to the west at about twenty degrees.

Some time was spent here in an endeavour to uncover a workable coal seam, but without success, although a number of small seams, from four to nine inches thick, were stripped. It would appear probable that the large seams of Goat creek are here split up into a number of small ones, though it is possible that larger ones do exist, whose outcrops are covered deeply with drift.

The coal here is very hard, with all the appearance of an anthracite, but the one sample taken showed by analysis such a high percentage of ash as to render it useless.

Coal Creek Area.

About eighteen miles from Glacier creek, down the Zymoetz river on its north-west bank, another area of the coal-bearing beds is met with. The best exposures are seen in a small stream from the north-east, locally known as Coal creek, which cuts the strike of the rocks at a wide angle. The beds here appear in the general form of a shallow syncline, with a general strike nearly north-west and south-east; but there are many minor undulations and the strata were seen to be faulted in a number of places. The width of the basin is probably about two miles, but its extent along the longer axis was not seen, though it is fairly certain that it does not go any great distance south-east of Coal creek. To the north-west the country has a gentle slope, is heavily drift-covered, and for a considerable distance there are no transverse valleys, so that it was found impossible to trace the coal-bearing beds farther in that direction, in the time available.

A number of coal claims have been staked here by Mr. J. Ashman, but so far little or no work has been done. Two small seams only were seen outcropping in the bed of Coal creek, about one and a half miles above its mouth. The lower of these showed 3 feet of clean coal, while the upper one was 1'-4" in thickness. Mr. Ashman has since informed me that he overlooked another seam that had been uncovered a short way from the bank of the creek and farther up-stream, which was about 5 feet thick, with a small parting. The following analysis is from a sample from the lower or 3 foot seam:—

Moisture	5·45
Volatile combustible matter	34·03
Fixed carbon	48·17
Ash	12·35

Coke: partly fritted.

On the other coal properties, which have been described in previous reports, no new work has been undertaken during the past year, as all the owners of the lands in question are waiting for railroad construction, before going to the expense of further development.

MINERAL CLAIMS.

During the past season comparatively few prospectors were in the district, and new discoveries of importance were rare, while on the older and better known properties little work was attempted, except the annual assessment work required by statute.

On the Hudson Bay mountains, more particularly on their western slopes, a number of claims are located and a large amount of prospecting has been done. The geological conditions here are very similar to those in the neighbourhood of the copper claims of Howson and Scallon creeks, described in previous reports, the ore occurring in dikes from or near the edge of an eruptive area.

The northern part of the Hudson Bay mountains is composed of rocks of the Porphyrite group, chiefly volcanics (andesites, tuffs, etc.), but including, towards the top of the series, some sedimentary beds. These rocks have been very severely folded and crumpled; some splendid examples of folding on a large scale showing very plainly on the bare rocky walls of the higher peaks. Towards the southern end of this group of mountains, extending nearly down to the Telkwa river, there is a large intrusive area of granite-porphyry, which has shattered, diked and altered the volcanics near its edge to a very large extent, thus affording channels for the ascent of mineral-bearing solutions.

Most of the chief showings are on a group of claims which are quite close together, and reached by a number of short branch trails from the main Aldermere trail.

Coronado Group.

On the Coronado group a considerable amount of work has been done, consisting of open-cuts, by means of which the vein can be traced for the length of two claims The ore occurs in what appears to be a dike from the intrusive porphyry area, striking about north-east, with a nearly vertical dip, the strike conforming very closely to the slope of the mountain, here very steep. At the lowest opening a cut has been made 35 feet long and 12 feet deep at the face, exposing a lens of almost pure galena, varying from 14 inches in width at the face, to nothing, 12 feet back from it. Four and one-half tons of galena were shipped from the opening to a smelter, but the writer was unable to hear with what result. On the western or hanging wall there are about 3 feet of siliceous vein filling, carrying a little pyrites. A specimen of the clean galena gave by assay: gold $1.20; and silver 62·63 oz., to the ton.

In the other cuts, farther up the mountain, the ore shows much less galena, but the mineralization is fairly heavy as a rule, one opening exposing about 4 feet of ore with no walls, the ore consisting of galena, blende, arsenical pyrites, pyrites, and lead carbonate in a quartzose gangue, but all much decomposed. A sample from this point assayed as follows: gold $10; silver 3 oz., to the ton.

Near the eastern boundary of the Coronado, on the west bank of Sloan creek, a similar and parallel ore body has recently been discovered. Here a lens of galena, nearly pure, but carrying a little blende and chalcopyrite, has been uncovered, the greatest width of solid ore being 14 inches. This vein has been traced about 200 feet along the strike to the north-east; but as only the surface dirt has been removed in two or three small holes, the character of the ore could not be definitely seen. A specimen of the solid galena on assaying, gave: gold $4.40; silver 36.47 oz., to the ton.

Victor Group.

The Victor group, consisting of the Standard, Victor and Triumph claims, is situated west of the Coronado. The ore occurs in and along the east wall of a dike about 60 feet wide, striking about north-east, and dipping at 80 to 90 degrees south-west. It has been traced by means of open-cuts up the hill for a considerable distance. In the lowest cut about 3½ feet of ore are exposed, consisting of galena, blende and pyrites, irregularly and rather sparsely distributed in a gangue of altered dike rock and a little quartz. The ore appears to follow a line of faulting and shearing parallel to the walls of the dike. Fifty feet up the hill the ore has narrowed down to about 8 inches, with 3 inches of clean galena, a specimen from which assayed: gold, trace; silver, 43.33 oz. per ton.

Continuing up the hill, a number of superficial cuts show the dike rusty and decomposed, and varying from 12 to 60 feet wide, with mineralization strongest along the hanging wall. In one of these cuts about 2 feet of ore was seen, composed of blende, arsenical pyrites, with a little galena and chalcopyrite. At the highest opening up the mountain, about 2½ feet of ore is exposed, here highly decomposed and consisting of stringers of galena, associated with much lead carbonates. A sample from this point gave the following results by assaying: gold, 20 cents; silver, 39.20 oz. per ton.

Dominion and Newcastle Group.

The Dominion and Newcastle claims are located on the east bank of Sloan creek, near its head. On this property a dike about 6 feet wide cuts the country rock, consisting of greenish and grayish andesites. The dike, with nearly vertical dip, has the usual north-east strike, and where opened up by means of a shaft and several open-cuts, is very heavily mineralized, the chief constituents of the ore being blende, arsenopyrite, iron pyrites, a little chalcopyrite and a very little galena, in a gangue of altered dike rock and much quartz.

Two samples were taken here, the first consisting of the general run of the ore, while the second was from a band of almost pure arsenical pyrites; the results by assay are as follows: (1) gold $5.80, silver 12.40 oz.; (2) gold $3.60, silver 0.55 oz.

Humming Bird Claim.

On the Humming Bird claim very little work has been done (by no means sufficient to prove the extent of mineralization) consisting of several small cuts, the chief one of which is about 15 feet wide, with neither wall uncovered. The rock is much decomposed, with a considerable quantity of a black, earthy material on the surface, which in the laboratory was proved to consist largely of pyrolusite. Beneath this decomposed material the ore is composed of blende, arsenical pyrites, galena, and iron pyrites in a felsitic gangue of altered dike rock, much shattered and brecciated; the mineralization being irregular and somewhat sparse. An assay of a sample from this cut gave the following results: gold 60 cents; silver 10.37 oz. per ton.

Limestone.

As limestone suitable for smelting purposes has not before been noted from this district, the discovery of a bed of good quality may be of interest. This limestone occurs on the north side of the pass followed by the old trail from Moricetown to Hankins camp, on the Zymoetz river, and not far from the summit. As the only outcrop seen was in heavy timber it was impossible to ascertain the thickness of the bed, but it would appear to be of good size. The following analysis was made in this office:—

	Per Cent.
Insoluble matter	1·31
Fe_2O_3 Al_2O_3	1·30
Ca CO_3	92·41
Mg CO_3	3·63

As the writer was on the point of leaving Hazelton for Ottawa, a number of samples of ore were brought in from a reported discovery near that town. The ore consisted chiefly of stibnite, and gray copper. As the snow was then deep in the mountains it was not possible to investigate this new find at that time.

NORTH-WESTERN PORTION OF TEXADA ISLAND.

(R. G. McConnell.)

The work of the past season consisted of an examination of the geology, working mines and prospects on the north-western portion of Texada island, B.C.

This important island has been visited at various times by members of the Geological Survey, notably by Richardson, Dawson and LeRoy, but no general detailed examination has heretofore been undertaken. A reconnaissance topographical and geological map prepared by Mr. LeRoy was published by the 'Survey' in 1907.

Texada island is situated in the Strait of Georgia near the mainland, about 50 miles north of Vancouver. It has a length of 30 miles, a maximum width of 6 miles, and a total area of about 125 square miles. The south-eastern portion consists of a high, irregular ridge surmounted by occasional peaks rising to a height of nearly 3,000 feet. Going northward the general elevation decreases and the topographic outlines become more regular. The surface is rough and rocky over the greater portion of the island. Rolling boulder plains, usually of limited area, occur at a few points, mostly towards the northern portion of the island.

The streams are small and most of them have carved out canyon-shaped valleys of moderate depth. Small lakes dating from the glacial period occur at a number of points.

The island was originally well forested throughout except on the summits of the higher ridges and peaks, and notwithstanding the usual ravages by forest fires and the large quantity cut for commercial purposes, the timber resources are still considerable. The forest is open and consists mostly of Douglas fir. The trees of this species on the island usually range from 2 to 4 feet in diameter, although occasional specimens attain a diameter of 6 feet and rise to a height of over 150 feet. Besides the Douglas fir, the conifers are represented by the hemlock, spruce and two species of pine and cedar. The principal broad-leafed trees are the alder, maple and arbutus.

GEOLOGY.

The rocks represented on the island consist in order of age (1) limestones, (2) a series of basic, predominantly porphyritic rocks often passing into breccias or agglomerates, (3) small stocks and dikes of dark basic rocks the character of which has not been determined, (4) granites and grano-diorites, (5) clays, sandstones and shales of Cretaceous age. No Tertiary rocks, either sedimentary or volcanic, were identified, and the Cretaceous deposits are followed by the sands, clays and boulder clays of the glacial period.

The limestones, the most important formation economically, occur mostly in the northern portion of the island. A band usually a mile or more in width follows the south-east coast from Point Marshall southward to Sturt bay and a short distance beyond, then bends almost at right angles and extends in a south-westerly direction nearly across the island. A second area measuring about 2 square miles in extent occurs in the vicinity of Davies bay on the west coast, and other small areas are frequently found in the vicinity of the larger masses as inclusions in the surrounding porphyrites and associated rocks.

The limestones occur characteristically in heavy beds often 6 or 8 feet in thickness. The beds undulate in easy folds, and except where broken by small faults or thrust up by dikes, are seldom steeply tilted. They are cut everywhere by steep, often

vertical jointage planes. These are so strong and persistent that in many places they simulate bedding.

Normally the limestone is bluish in colour and fine grained, almost compact in texture. Exposures of this character are, however, infrequent, as most of it has been altered into moderately coarse, grayish and white crystalline limestones and marbles. In the vicinity of some of the ore bodies small areas of limestone are completely replaced by coarse white calcite.

The limestone when unaltered is remarkably pure and furnishes an excellent lime. This has led to the erection of six kilns at the northern end of the island with a capacity of somewhat over 550 barrels per day.

The porphyrites and associated rocks outcrop over the greater part of the island. All the peaks and ridges examined in the southern mountainous portion are built almost exclusively of these rocks, and they alternate with the limestones in the lower northern portion.

The porphyrites, while apparently all belonging to the same period of volcanic activity, vary greatly in character in different parts of the field. They have not been examined in thin sections and can only be briefly described here. The prevailing type is a brownish weathering, moderately coarse green rock usually considerably altered and epidotized. The feldspar phenocrysts are seldom fresh and are often replaced by calcite or calcite and epidote. The ferro-magnesian minerals are rarely conspicuous as phenocrysts. While the prevailing type is distinctly porphyritic, greenish compact and finely granular varieties also occur.

Along the west coast and at points in the interior the porphyrites alternate with and apparently pass into breccias or agglomerates made up of angular and sub-angular fragments of porphyrite enclosed in a porphyrite matrix. These rocks contain no foreign material and probably originated largely from the breaking up of a porphyrite crust by subsequent intrusions of the same or a similar magma.

The porphyrites are cut by small gold-bearing quartz veins, and also contain numerous magnetite lenses always carrying a small percentage of copper.

The porphyrites and limestones are cut by numerous dikes and stocks, usually of small areal extent, of dark intrusive rocks. Macroscopically these appear to range from dark augite porphyrites to gabbros. They are closely associated with the copper deposits and are often bordered by ore bodies.

Granites probably connected with the Coast Range batholith occur at a number of disconnected points on the east coast, and also at one point on the west coast some distance north of Gillies bay. They present the usual variations in composition, varying in this respect from typical biotite granites to grano-diorites and probably also to diorites.

The granites, with the exception of a few small dikes, are the latest intrusives on the island. They are succeeded by sedimentaries of Cretaceous age. These consist mainly of soft sandstones passing in places into conglomerates, and clay and shales containing a few calcareous nodules. A bright red clay occurs at the base of the formation at a couple of points. The beds are nowhere steeply tilted and in most of the exposures seen the dip does not exceed 5°.

Cretaceous rocks are exposed at several points on the west coast, the largest area occurring in the vicinity of Gillies and Lower Gillies bays. No coal seams were seen in the surface outcrops, and a bore-hole put down some years ago on Lower Gillies Bay creek proved unsuccessful in finding them in depth.

The Cretaceous rocks are succeeded by boulder clays of glacial age, no deposition of sedimentaries or intrusion or extrusion of volcanics have taken place so far as known in the long intervening period. The glacial deposits, consisting of boulder clays occasionally underlaid by sands and clays, are distributed irregularly over most of the island up to an elevation of 1,200 feet. Above that they thin out and on the summits of the higher peaks and ridges are represented only by occasional erratics.

The presence of these on the highest points shows that the whole island was totally submerged by ice. Well marked grooves and striæ indicating a general south-westerly movement of the ice occur on Surprise mountain and at other points.

MINERAL DEPOSITS.

The northern portion of Texada island, the only portion examined during the season, is widely mineralized and has been pretty completely staked as mineral claims in the various excitements which have overrun the island. Of the hundreds of claims staked many have been abandoned, a considerable number are still held in a more or less undeveloped condition, and a few have attained the status of producing mines.

Only a brief description of the mineral deposits is attempted as neither the rock nor mineral specimens collected have yet been examined.

The deposits worked include quartz veins containing free gold, lenses of copper-gold ores, mostly replacements in limestones, and lenses of magnetite usually carrying some iron and copper sulphides.

Work on the gold-quartz veins, most of which cut the rocks of the porphyrite group, proved disappointing and has now almost entirely ceased. The known veins with few exceptions are small and non-persistent, and the general tenor in gold is low, although small rich shoots carrying high values are occasionally found. The total output of the gold quartz veins to date is probably less than $20,000.

The exploration of the copper-gold lodes has been attended with better results. These occur in limestones and are usually situated either at the contact with or in the vicinity of masses of granite, or of the older basic intrusives referred to in the geological sketch. They all belong to the class known as contact metamorphic deposits, and represent replacements of limestone and occasionally of a portion of the bordering intrusive by copper minerals, chiefly chalcopyrite and bornite, accompanied by garnet, augite, epidote, serpentine and various other silicates.

Among the more important mines working in deposits of this character are the Marble Bay, Cornell, Copper Queen and Little Billy in the vicinity of Sturt bay, and the Loyal Lease at the north end of the island. Occurrences of chalcopyrite ore have also been worked to some extent at various points along the Iron range on the west coast.

The Marble Bay mine, the principal copper-gold mine working at present, is described in considerable detail by Mr. LeRoy in a report published by the 'Survey' in 1907. At the time of his visit the workings had reached a depth of 760 feet; since then they have been continued down to a depth of 920 feet.

The ore bodies in this mine have the irregular outlines characteristic of replacement deposits, but are unusually large and persistent considering their richness. The ore bodies first worked extended from near the surface down to the 260 foot level and for some distance beyond. At the 260 foot level a new ore body was discovered in a drift to the westward and has been followed continuously downwards for a distance of 530 feet. It terminated against limestone at a depth of 790 feet. Below it the workings are barren for a distance of 70 feet. At the 860 foot level rich ore was again encountered and has been followed to the present 920 foot level. At this level, the lowest reached, the ore body has a width in places of over 20 feet and is rich in bornite.

The ores consist mainly of the two copper sulphides bornite and chalcopyrite, enclosed in grains and small masses in a garnet-augite gangue. The shipping ores carry about 8 per cent of copper, and while varying to some extent on the different levels, the general average has remained practically unchanged from the surface down to the present level. The gold values are high, the whole yearly output averaging about $10 per ton.

The ore bodies of the Marble Bay mine occur in limestone cut by numerous basic dikes and are situated at some distance from large intrusive stocks. The dikes where

they cross the ore bodies are always altered, and occasionally are partially replaced by the same minerals which occur in the limestone, showing that they are older than the mineralization. The limestone is brecciated in places and is traversed by numerous fissures running in different directions and often crossing each other. It is probable that these controlled the mineralization, to some extent at least, as most of the ore bodies have been found by drifting along or sinking on them.

The Cornell mine is situated about a mile south of Van Anda. The limestone is intruded here by a long narrow basic stock and the ore bodies occur along the contact of the two rocks. The workings of this mine consist of a shaft sunk to a depth of 460 feet, with long drifts at intervals of 100 feet. Several important ore bodies somewhat similar in character to those of the Marble Bay mine have been discovered and mined. During the past season the Cornell, after being idle for some time, was re-opened under lease by Dr. Tanzer. The drift at the 360 foot level was extended along a fissure for a few feet and reached what is considered to be a new ore body, although it may be an extension downwards of one of those mined on the upper levels. The unsuspected presence of this bornite-chalcopyrite mass near the end of an old exploratory drift illustrates the erratic and uncertain distribution of the ore bodies, and also furnishes an incentive for further exploratory work.

The Cornell ores, like those of the Marble Bay mine, carry good and often high values in both copper and gold.

The Copper Queen mine was not examined. It has been idle for some time and the workings are partially filled with water. This mine has been worked to a depth of 750 feet, and rivalled the Marble Bay in the extent and richness of its ore bodies. It has, however, latterly been worked under lease with the usual result. Exploratory work, even the extension downward of the shaft, has been neglected, and a considerable expenditure would be required to put it in a condition to continue the search for new ore bodies.

The Copper Queen mine is situated in a limestone area traversed by numerous basic dikes, and is distant about 1,600 feet from the nearest intrusive mass.

The Little Billy mine differs from the other mines in the neighbourhood in occurring at a limestone-granite contact. It has not been explored in depth, and so far only one moderate sized lens has been mined. A shaft was sunk during the season on a second ore body outcropping in the limestone a short distance away from the contact, and a few tons of ore were shipped.

The geological conditions at the Loyal Lease, situated in the north end of the island, are similar to those at the Marble Bay and the Copper Queen. The croppings occur in limestone cut by numerous basic dikes and intruded at various points by small basic stocks. A number of small lenses outcrop at the surface, and shafts have been sunk on these to varying depths. Some ore has been shipped, but notwithstanding the favourable prospects no large ore body has so far been found.

On the west coast of the island, lenses of rich copper ore have been mined at a number of points along the Iron range. The lenses occur in limestone along both the granite and porphyrite contacts, and are often found fringing the magnetite ore bodies. They are small and so far, with the exception of some development work at the Lake mine, no attempt has been made to explore them in depth. The ores, while apparently similar in origin to those mined in the vicinity of Van Anda, differ in consisting altogether of chalcopyrite. The gold values are also smaller.

IRON ORES.

Lenses of magnetite are widely distributed on Texada island. On the south-west coast numerous outcrops occur north-west of Raven bay, and extend in diminishing number south to Pocahontus mountain and northwards to Sturt bay. The lenses are all of moderate size and vary in shape from rounded irregular masses to long vein-like forms bounded by walls and evidently deposited along zones of fissuring. They occur

in the main limestone area, associated with small limestone inclusions in the porphyrite, and in the porphyrite itself. The magnetite is seldom pure and is usually intergrown with appreciable quantities of pyrite, chalcopyrite and more rarely pyrrhotite.

The principal iron deposits on the island occur on the west coast nearly south from Van Anda at what is known as the Iron mine. The limestone here is intruded on the north by grano-diorite and on the south by augite-porphyrite, and a zone of magnetite lenses follows the winding contact between the limestone and both igneous rocks for a distance of about 2 miles. The lenses are not confined strictly to the contact and occur in all three formations at some distance from it. They are often of large size, in some cases exceeding 200 feet in length. The impurities consist mainly of iron and copper sulphides in varying proportions. The ore in some of the smaller lenses, and a part of that in the large Lake mine deposit, is comparatively pure; but most of it will probably require to be roasted before treatment.

Considerable time was spent during the season on the Iron range, and a number of maps showing the principal deposits have been prepared and will be published with the detailed report. The abundance of the ores, their high grade in iron and easy accessibility must make them extremely valuable in the event of an iron industry being established on the coast.

TOPOGRAPHICAL WORK ON TEXADA ISLAND, B.C.

(F. H. MacLaren.)

I left Ottawa on May 9, for Texada island, accompanied by Mr. Hugh Pedley, of Montreal, who acted as topographical assistant during the summer.

The first month in the field was spent in making a topographical map of an area which includes the Marble Bay, Cornell, Copper Queen and Little Billy mines. These are the four principal copper mines on the island.

The area covered by this sheet is about 1·5 square miles. The work will be published on a scale of 800 feet to an inch, with a 20 foot contour interval.

The second detailed map attempted was that of the Iron range. This sheet covers an area of about 0·5 square miles. It will be published on a scale of 200 feet to an inch, with a 10 foot contour interval. All roads, mine tramways, buildings, shafts, tunnels, prospects, mine dumps, streams and open-cuts are shown.

A general map of the island was started this year and will be completed next season. This sheet will be worked out on a scale of 2,000 feet to an inch, with a 50 foot contour interval. About 65 square miles were covered by the party this summer.

A topographical assistant, two rodmen, and a cook comprised the party engaged in this work.

SOUTH-EASTERN PORTION OF VANCOUVER ISLAND.

(Charles H. Clapp.)

INTRODUCTION.

The instructions given in regard to field work during the season of 1908 were, to proceed to Victoria, B.C., and commence a geological and topographical survey of the southern portion of Vancouver island, the work to be largely of the nature of a reconnaissance, but detailed where advisable. I was to prepare a general map of the entire area explored, also small, large-scale maps of particular mining localities, at other districts where detailed geological work was done. In addition, I was requested to make a careful study of the geology about Victoria, with its easily accessible environs, in order in my final report illustrating the geology of Vancouver island to include a chapter on that particular area.

I was late in starting for the field, leaving Ottawa June 21, in company with my assistant, Mr. Kenneth Chipman. We arrived at Victoria on June 26, where we outfitted, secured the services of Mr. George Penketh, of Victoria, as teamster, and left for the field on July 1.

Three excursions were made: one of two weeks, on the Saanich peninsula; one of three weeks in the district of Esquimalt, Metchosin, Sooke, and west along the coast to Point No point; and one of five and a half weeks in the districts of Goldstream, Malahat, Shawnigan, Helmcken, Cowichan, Quamichan, Sahtlam, Comiaken, Somenos, Seymour, Cowichan lake, Chemainus, and Oyster. On the last two trips Mr. James Caffery, of Sooke, gave me very valuable assistance as guide and helper. Although the weather was still favourable, the writer was compelled to leave the field by the middle of September in order to resume instructional duties at the Massachusetts Institute of Technology. The season was, therefore, very short.

In general, an area confined entirely to Vancouver island was mapped, covering the south-eastern portion, north to the 49th parallel, which crosses the island near Ladysmith, and west to the 124th meridian, which passes through Point No point. The area is somewhat less than 1,000 square miles. The photographic method of mapping was used, Mr. Chipman doing a great deal of the topographic work, as well as assisting in the geology.

The geological work was necessarily of a very hurried nature, but the general extent of the formations and their relations have been determined. As considerable work has been done both by the Geological Survey and by private parties on the Coal Measures and surface geology, special attention was given the metamorphic rocks—Dawson's Vancouver Series. More detailed work was done on the Sooke peninsula and at Mt. Sicker. As the geology in the immediate neighbourhood of Victoria is exceedingly obscure, requiring for its satisfactory solution the most painstaking field work, based on a previous petrographic knowledge of the rocks of the vicinity, it was thought best not to spend the time on the problem during this, my first summer on the island. Instead, I have collected material for a special report on the country between Esquimalt and Sooke harbours; which district is easily accessible from Victoria, is traversed by good roads, and the geology is not only more simple but more representative of the geology of the whole island.

Little previous work, especially of a general or correlative nature, has been done on the island. In the seventies, Drs. Selwyn and Dawson made one or two very hurried reconnaissances in the neighbourhood of Victoria and Leach river, and Mr.

James Richardson worked up, in a rather cursory manner, the Coal Measures of the east coast. In 1885, Dr. Dawson made an examination of the northern part of Vancouver island, and in the 1886 report of the Geological Survey, made the most valuable published contribution to the geology of the island. Since then, Mr. Arthur Webster and Mr. Ernest Haycock made a hurried reconnaissance of the west coast in 1902; and Dr. Poole, in 1905, examined the coal fields of the east coast. Notes on certain mining districts and mineral claims have been made by the provincial mineralogist, Mr. W. F. Robertson, and the provincial assayer, Mr. Herbert Carmichael. Several short papers have been given by Messrs. W. M. Brewer and W. F. Best, in the Journal of the Canadian Mining Institute, on the mining geology of particular localities on the island. More or less private and unpublished work has been done, notably by Mr. W. J. Sutton. As yet, little attention has been given by the writer to the work of these men, and no work has been done on the collections of rocks and ores made this summer, so that the following sketch is based entirely on unrevised field notes, and should, therefore, be considered as only preliminary in character.

TOPOGRAPHY.

The topography of the south-eastern part of Vancouver island is in general that of a heavily wooded, low mountain region. It is in rather marked contrast to the more rugged and higher mountainous districts to the north and west. The eastern coast is marked by low rocky hills and mountains, with occasional broad, flat areas underlain by the softer rocks of the Coal Measures. The southern and western coast is more bold and rocky, although in the neighbourhood of Victoria and Esquimalt, and south-west to William head, the rock headlands are low and are separated by low, flat, drift-filled valleys. From William head west to Point No point, with the exception of the north shore of Sooke harbour, and several small patches underlain by the softer Tertiary sediments, the shores, although not very high, seldom more than 500 or 600 feet, and usually less, are steep and rugged. The coast line is deeply indented, a fiord coast. Although along the west coast several of the inlets penetrate into the very heart of the mountains in the region we are considering, the Saanich inlet is the only one bordered by very high hills, which in this case range from 1,000 to nearly 2,000 feet above sea level. In the interior, the mountains are higher and more rugged and form broad, flat-topped ridges which are often separated by wide valleys, now occupied by lakes. The highest elevations attained during the present season were nearly 4,000 feet, found on the mountains and ridges farthest to the north and west.

The mountains have characteristically flat, or rounded summits, partly due to glacial erosion. Glacial erosion cannot, however, explain the gently rolling, wide, tableland-like summits, which in the majority of cases are so broad and flat as to be marshy, small swampy ponds or lakes often occuring near the very tops of the mountains. The summits have a gradual and fairly even and uniform slope from a few hundred feet above sea level in the south-east, to nearly 4,000 feet in the north-west. The mountains seldom occur in distinct ranges consistent with the structure of their component rocks. These facts indicate that this section of the south-eastern part of Vancouver island has been once nearly levelled: that is, peneplained by erosion, and that the region has been subsequently elevated and partially dissected.

The rivers and lakes in general follow north-south and north-west, south-east valleys. The former are the larger in this region, being those occupied by the Saanich inlet, Sooke river and Sooke lake, Shawnigan lake and the lower part of the Koksilah river. The latter system corresponds more or less closely to the underlying structure of the rock formations, which strike in the main from N. 50° W. to N. 70° W. Some of these valleys have been filled with drift; the Langford and Colwood plains are good examples. Others are occupied by streams and lakes generally small, but including the upper part of the Goldstream river, the Leach river, the upper Koksilah, the Cowichan and Chemainus rivers and Cowichan lake.

The glacial and more recent periods have greatly affected the present topography. Most of the rounding of the higher peaks is directly traceable to ice erosion, as striæ of large size, and glacial polishing and grooving, are often observed. No evidence is seen in this part of the island of the formation of cirques and hanging valleys. In most mountain regions where local glaciers have been developed the tendency of glacial action has been to heighten rather than lessen the ruggedness of the country; here on the other hand, the peaks are rounded; talus slopes—exceptionally well illustrated a few miles north of Victoria, at Mt. Tolmie and Cedar Hill—were formed on the southern slopes of the hills; and much of the country is covered by thick layers of drift, some of it morainal in character, but most of it stratified. In recent time, the country has been submerged, thus giving rise to the fiord, or drowned coast of the present day, although there is evidence of a comparatively slight uplift of a late date.

GENERAL GEOLOGY.

The formations exposed in the southern part of Vancouver island range from the Devonian period or older, to the Pleistocene and recent. A provisional field classification has been made into the following:—

Unconsolidated superficial deposits	Pleistocene and recent.
South coast deposits	Tertiary.
Coal Measures	Cretaceous.
Younger metamorphics, Mt. Sicker series	Mesozoic.
Older metamorphics, Victoria series	Devonian.

The Tertiary sediments of the south coast are the youngest consolidated rocks. Rocks which when unaltered resemble the Coal Measures, have, along certain belts, been metamorphosed. Metamorphic rocks underlie the greater part of the region.

The older metamorphic rocks cannot be definitely assigned to any one period. A careful search for fossils was made in the calcareous rocks, now completely crystallized; but without success until the writer's attention was called to the occurrence of fossil corals on the south shore of Cowichan lake, about 9 miles from the east end. The locality was visited and identifiable corals, brachiopods, pelecypods and gasteropods were collected. Although the material has not yet been worked up, the fauna undoubtedly belongs to the Devonian period. These fossils fix a series of limestones and calcareous slates in the neighbourhood of Cowichan lake, as definitely Devonian. The series is very similar in character to the old metamorphics near the east coast. Definite correlation, however, will take further work, as the greater part of the territory between the formations is covered by drift, and it was impossible to get their exact relation in the hurried work of the past season. The formations are lithologically similar, although no volcanic members were noted at Cowichan lake. It is very probable that the rocks in the neighbourhood of Victoria and north are of the same general age as those at Cowichan lake, that is Devonian; with some that are possibly younger or older.

Provisionally, therefore, one can place the great series of old metamorphics in the south-eastern part of Vancouver island as late Middle Palæozoic. Dawson and other earlier writers, classify the old crystallines which underlie the Coal Measures as the Vancouver series, and place them in the Triassic period with possibly some Carboniferous members. As the evidence for assigning part of this great series of rocks—especially those in the northern part of the island—to the Triassic, is indisputable; and as Dawson suggests [1] that, should this series eventually prove separable into other formations besides the Triassic, the name Vancouver series be retained for the Triassic members, it seems best to restrict the term Vancouver series to Triassic

[1] Report on a Geological Examination of the Northern Part of Vancouver Island and Adjacent Coasts, Ann. Rep. Geo. Sur. of Can., 1886; p. 10 B.'

rocks of the northern part of the island, and to introduce a new term for the older rocks. Hence, I suggest the term Victoria series,[1] as a general name embracing the older metamorphics of the southern part of the island, belonging to the Palæozoic era. Dawson has already used the name in a limited sense; but it seems best to enlarge its meaning.

The Victoria series consists of a great group of rocks comprising not only sedimentaries, but large masses of intrusive and effusive volcanics, mainly of a basic nature. The sedimentaries are principally of deep water origin, calcareous and fine grained. Some non-calcareous argillaceous members, and even quartzites are, however, present. They have all been very much altered and recrystallized, resulting in massive marbles, and crystalline 'cement rocks,' calcareous slates, ordinary slates and phyllites, slaty quartzites and graywackes, and quartzites; with some hornfels amphibole schists and gneisses which are of sedimentary origin. The volcanic members are both intrusive and extrusive, largely the latter. They are mainly massive flows, porphyritic and amygdaloidal, but tuffs, breccias and agglomerates are present. Some of the agglomerates may represent old vents. The original lavas were mainly basic augite andesites and basalts, but are now altered to the characteristic greenstones. Associated and at times seemingly interbanded with both the sedimentaries and volcanics are dioritic rocks such as those in the immediate vicinity of Victoria, whose origin is very obscure. Some of them are doubtless old intrusives; but in part they appear to be the product of extreme metamorphism of beds of impure argillaceous limestone.

These formations have a general strike of N. 70° to 50° W., with steep dips both to the south and north. The series is very thick, but at the present time an estimate of the total thickness is little better than a guess, as the problem requires further detailed work, both in the field and office. The rocks are tightly folded, and also faulted, and are, therefore, repeated many times. It is probable that the lowest beds are exposed in the most southerly portion of the island, and as one goes north across the strike higher and higher beds are exposed.

Roughly, the distribution is as follows:—

The southernmost beds are massive greenstones, which form a belt 5 to 7 miles wide, extending from Cape Church north-east to Albert head, and from Potter point north-east, nearly to Leach river. To the north of this belt of greenstone, there is in the western part of the area, and extending eastward beyond the lower northward flowing portion of the Goldstream river, a belt of slates, argillaceous schists and quartz schists from 2 to 3 miles in width. Still farther to the north, and apparently forming a continuous conformable series, is a great succession of calcareous beds, limestones, argillaceous limestones, now metamorphosed to amphibole schists and gneisses, and some argillites and quartzose rocks, with intercalcated volcanics. This series is 7 or 8 miles wide, and extends to the north of Shawnigan lake. In the eastern part of the region, near the coast, the greenstones are bounded on the north by a deep, wide, drift-filled valley, extending from Langford to the Royal Roads. All the evidence obtainable goes to show that this valley is underlain by limestone; but there may also be present representatives of the argillaceous sediments. Directly to the north of this valley is the great series of calcareous and argillaceous rocks, met with in the west, north of the schist belt, and which extends from Esquimalt and Victoria northward some 10 miles. The absence in the east of the greater part of the argillaceous series, so pronounced along the Leach river, seems to be best explained by faulting.

Intrusive into this Victoria series are plutonic rocks, ranging from a hornblende gabbro, or gabbro diorite to a granodiorite, and even a granite. There are several of these intrusive bodies. The East Sooke peninsula is underlain almost entirely by hornblende bearing plutonics, principally of the composition of a gabbro-diorite, but

1 Geological Survey Report, (76-77), p. 101.

with some amphibolites and intrusive apophyses and dikes of a feldspathic rock, syenitic in nature. These plutonics are intrusive into the greenstones to the north and east. Similar areas, but smaller, occur in the Esquimalt peninsula and Victoria West, and still smaller, cross-cutting bodies, seemingly related to these rocks, occur to the west of Cedar Hill and near Elk lake. In the northern part of the Saanich peninsula, south of the Cretaceous sediments, is a considerable area of granodiorite and granite, which rocks cut the old metamorphic series. Similar granodiorites occur to the westward on the opposite shore of the Saanich inlet, south of the Coal Measures which occupy Cowichan bay. Another small area is also found at the northern end of Sooke lake.

In the Sooke peninsula the diorites are cut by trap dikes, some of them being clearly diabase. The Saanich granodiorite is also cut by a system of dikes which appear to be andesitic in nature.

To the north-west of the Victoria series, and unconformable upon them, is another system of sediments with andesitic volcanic members. As far as known these rocks contain no distinctly calcareous members, and consist not only of shales, slates and sandstones, but of conglomerates as well. Their principal occurrence is north of the Cowichan river, where they form a belt some 8 to 10 miles wide, with a strike of about N. 60° W. The actual thickness is probably not more than 15,000 feet, but is repeated by folding or faulting. There are also one or two down warped areas, or down faulted blocks of the same formation along the Koksilah river. To judge from the report of the prospectors and others, this formation appears to form a continuous belt extending to Alberni. The beds are well exposed along the Chemainus river north and west of Mt. Sicker. Since at Mt. Sicker the formation is best known, as it is the country rock of the copper ores found there, it will be called, provisionally, the Mt. Sicker series.

In places this formation has comparatively low dips, is free from intrusive and extrusive igneous rocks, and is not metamorphosed. Thick beds of conglomerate with sandstone and carbonaceous shale occur, which closely resemble the coal-bearing Cretaceous rocks. These unmetamorphosed rocks, if traced across their strike, grade into conformable, tightly folded, highly inclined, metamorphic rocks, slates, graywackes, quartzites, crystalline conglomerates, graphitic and quartz schists. Associated with these metamorphosed sedimentaries are intrusive and probably extrusive basic igneous rocks mainly of an andesitic composition. Where the metamorphism has been excessive, these andesites have become recrystallized, gnessoid, and even schistose, forming amphibole gneisses and chlorite and talc schists. The transition from the unaltered sediments to the crystalline ones, which in some cases are stratigraphically the same beds, is particularly striking along the Chemainus river, where to the southwest of Mt. Sicker the rocks are unaltered conglomerates, sandstones, and carbonaceous shales, which grade gradually into the rocks directly at the base of Mt. Sicker, where they are mainly gneisses and schists.

The definite determination of the age of the Mt. Sicker series is at present impossible, as no fossils have been found in them, and their structural and lithological correlation will require further work. That they are separated from the Victoria series by a profound unconformity is unquestionable. Structurally, they appear to underlie the Cretaceous Coal Measures. However, the formation has been disarranged by great overthrust faults which have in places brought older beds over younger, and this disarrangement may have also affected the Coal Measures. The contact between the Mt. Sicker series and the undoubted Coal Measures is not well exposed; that this contact is unconformable is suggested, but not proved by the exposures examined during the past summer. This point can easily be satisfactorily worked out by further field work. On the other hand, the striking lithological similarity of the unmetamorphosed sediments with those of the Coal Measures indicates most strongly that the Mt. Sicker series is related to the coal-bearing Cretaceous rocks, and may be of nearly the same horizon. From the occurrence of lower Mesozoic formations on the island, and

the suggested unconformity between the Mt. Sicker series and the Coal Measures, it may be argued, however, that the doubtful strata most probably belong to the Triassic or Jurassic periods.

Sediments belonging to the Coal Measures, principally sandstones and conglomerates, with carbonaceous sandy shales, were encountered where Richardson maps them, at the extreme northern end of the Saanich peninsula, and at Cowichan. The southern end of the Nanaimo area was seen in the neighbourhood of Ladysmith, and at the coal mines at Extension. The areas underlain by this formation are more extensive than Richardson maps them, and the thickness somewhat greater. If, as he declares, all the rocks of the Cowichan area belong to the Productive Measures,[1] they are in this region about 1,800 feet thick. Few fossils were found in this series, but from the evidence collected by Richardson and others, they clearly belong to the Cretaceous period.

Along the south-western coast, from Beecher bay westward, occur several small basins or down faulted areas of consolidated, but rather soft, sandstones and conglomerates, associated with relatively thin beds of shale and marl. These have been mapped by Richardson as Tertiary, and there is abundant fossil evidence to warrant the determination.[2] These sediments are shown, not only by their enclosed fauna, but by their character, to be undoubtedly marine. They are separated from the underlying greenstones and plutonic diorites by a marked unconformity and a thick basal conglomerate. This conglomerate rests on an old eroded surface of the crystalline rocks which formed the coast of the Tertiary sea. The irregular surface, the immense, wave-polished boulders, and the characteristic wave-worn dike, and joint-chasms filled with sand and coarse gravel of the sea coast of to-day, are strikingly parallel in the unconformity and basal conglomerate. The beds have only been gently folded, but have been faulted very considerably. The exact estimate of their thickness cannot be made until the throw of the faults has been calculated, but the total thickness exposed is probably not more than 300 or 400 feet.

The heavy covering of drift has already been spoken of. Some of this material is certainly morainal, although much of it can be considered as part of the outwash apron of the immense continental glacier which overrode the island. Some of the stratified drift, as shown by its fauna, is marine. Notable examples of the marine deposits are found in the unconsolidated sands, clays and gravels overlying the low, flat Tertiary basins of the south-west coast. Fluviatile, lacustrine and bog deposits likewise occur. One of the most interesting of these is the old valley which extends from Langford lake to the Royal Roads. This valley is now completely filled with river drift, so that there has developed a flat, broad plain, with well marked, longitudinal terraces.

ECONOMIC GEOLOGY.

The mineral wealth of the district is of considerable importance, but with the exception of copper, it is very doubtful if any of the other metals of commerce have been produced economically. Placer gold has been obtained, and placer mining is still carried on in a very small way. Coal is an important industry on the east coast. Lime and cement are manufactured, clay and sand are used for brick, and, with increasing demand, and greater facilities of production and transportation, other non-metallic deposits will doubtless be mined and industries established.

The principal copper deposits occur at East Sooke, Mt. Malahat, Koksilah ridge and at Mt. Sicker. Other claims of less importance are scattered over the entire area, notably in the Highland and Goldstream districts, and in the neighbourhood of Leach river. There are three main types, which are illustrated by the occurrences at Sooke, Mt. Malahat and Mt. Sicker.

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1 Report of Progress, 1876-77, Geol. Survey, Can., p. 187.
2 J. C. Merriman, Bull. U. of Cal., Vol. 2, No. 3, pp. 101-108, 1896.

The principal deposits at Sooke are in the diorite or gabbro diorite of that area. Intrusive into this formation are dikes and apophyses of more acid plutonic rocks, dioritic and syenitic in nature, and also dikes of diabase. These intrusions seem to have had little or no effect on the formation of the ore. The diorite has been rendered gneissic, and is broken by prominent shear zones, along which, shown by the slickensides, considerable movement has taken place. The diorite is very generally, though sparsely impregnated with pyrite and chalcopyrite. In the shear zones the sulphurets have been concentrated and sometimes form low-grade ore bodies of quite large size.

These shear zones are very numerous. The majority are small and low in sulphides. Some of them are, however, large and quite extensive, and the development of the chalcopyrite more pronounced. The zone in which the Margaret, Copper King and Eureka claims (not registered) are located, is some 200 feet wide, and traceable for at least 4,500 feet and probably for a greater distance. There are two main sets of shear zones in the Sooke district, one set striking about N. 45° E., and the other a little to the west of north. The sheared diorite has, however, been broken and slickensided in all directions. Tiny quartz stringers and a large amount of secondary hornblende have been developed in it. The secondary development of the hornblende has sometimes taken place to such an extent that, very little of the original feldspar remains and the rock resembles an amphibolite. Veins of coarse bladed hornblende often seam the diorite in many directions. There is no field evidence that these veins are representatives of a basic intrusive, but it all goes to prove that the component materials have been derived from the diorite. Along the shear zones waters have easily penetrated, removed the feldspar, recrystallized the hornblende and deposited the sulphides of iron and copper. As a rule the sulphides are disseminated through the shear zone in small patches, but occasionally they occur in small veins and lenses, due to a complete replacement of the country rock. In the shafts on the Willow Grouse and Blue Bird claims, chalcopyrite and pyrite occur with but little of the silicate gangue. This more complete replacement is probably to be accounted for by the fact that it occurs near the junction of two shear zones. Native copper frequently occurs in the outcrop of these deposits, but only near the surface, and is due to surface alteration of the chalcopyrite. It is improbable that any marked secondary enrichment of these deposits will be found, as the chalcopyrite and pyrite occur unchanged at the surface, except for the most superficial oxidation and alteration. These copper deposits, considering the entire sheared zone, are all essentially low-grade, but are of large size.

Towards the west end of the East Sooke peninsula is a large deposit of almost pure sulphides, with a little magnetite. The sulphides are, however, very low in chalcopyrite, consisting mainly of pyrrhotite and pyrite. The material is too low in copper to be mined profitably, although one or two attempts have been made. It occurs in a more basic rock, a gabbro, which is related to the normal gabbro diorite. The whole deposit may be a basic segregation from the original magma, but it has been secondarily concentrated in a well marked shear zone in the gabbro. Less important deposits of iron and copper sulphides also occur in the shear zones of the greenstones to the east and north.

On Mt. Malahat, to the east of Shawnigan lake, sulphides of copper and iron, with considerable magnetite, are developed in limestones near the contact with dikes and apophyses of granite and granodiorite. In the contact zone of the limestone the usual contact minerals have been developed, garnet, diopside and wollastonite; the diopside altering to serpentine. Replacing the limestones are large irregular bodies of magnetite, pyrite and pyrrhotite, with small percentage of copper. Several attempts have been made to work these bodies, but they are too low in copper to pay the present cost of mining and transportation.

The copper ores on the ridge between the fork of the Koksilah and Cowichan rivers, the King Solomon and Blue Bird group of claims, are developed in the calcareous members of the Victoria series. They are not, however, directly contact

bodies, although they may owe their origin to unexpected or neighbouring intrusive masses. The ore minerals occur in shear zones and veins in the metamorphosed calcareous rocks of the region.

On Mt. Sicker is found the only copper deposit that has been mined profitably, the ore body of the Lenora, Tyee and Richard III mines. At present, however, there is no production from the district. The ore is chalcopyrite, pyrite and sphalerite, with a quartz and barite gangue, and the country rock is the much metamorphosed Mt. Sicker series. The Tyee ore body is a flat lens, and Mr. J. W. Bryant, of the Tyee Company, believes it to have been developed in a syncline of the black, lustrous, partly graphitic schists. Mr. W. H. Weed[1] infers from the occurrence of the barite in the ore, and its absence in the surrounding rocks, that the ore-bearing solutions must have come from a depth. Ores of a similar nature occur elsewhere on Mt. Sicker, to the west on Mt. Benton, and to the east on Mt. Richards. They do not, however, occur in distinct lenses of relatively massive ore, but as disseminations, and partial replacements in the more schistose rocks and shear zones. They are usually in close association with the basic volcanic rocks, which in the neighbourhood of the ore bodies have been sheared and altered to chlorite and talc schists. The ores have doubtless been formed by hot waters, indicated by the alteration of the country rock, while the presence of so large a percentage of barium—as Mr. Weed has shown—strongly supports the view that the waters are of magmatic origin. But it is possible that the concentration of ores into distinct lenses has resulted from the work of relatively shallow, circulating, meteoric waters.

The other copper deposits of the region are of much less importance, but of the same general type as those described above. They are principally disseminations and replacements in the rocks of the Victoria series, along shear zones or fissures easily penetrated by waters. All the ores of the district are low-grade, but some of the ore bodies are large, hence by mining on a large scale, and by concentration at the mine, it seems probable that some of them may be profitably worked.

The discovery of placer gold has caused much excitement and prospecting in the district. From Leach river and vicinity considerable placer gold has been obtained, most of it in the late sixties. Of late there have been unsuccessful attempts to continue placer mining in the river and in the north fork. One or two Chinamen have been working up Leach river for some time; but it is believed have hardly made living wages. The writer is of Dawson's opinion that the gold in Leach river and North Fork has been derived from small quartz stringers in the slaty rocks of the district.

The quartz stringers and veins are very abundant, and although usually small, sometimes attain a considerable size, four to six feet in width and traceable for several hundred feet. In spite of the fact that they seem to have been the source of the gold found in the streams, they are too low grade to be worked profitably. Every attempt, and the attempts have been many, to obtain gold from the quartz veins of the vicinity has been a failure. The veins are doubtless similar in character to the quartz veins which are so numerous in any strongly metamorphorsed region, and which commonly are practically barren. It has taken a long period of erosion and the disintegration of many hundreds of these veins through a very considerable thickness, to produce the small amount of gold which has been found in the rivers. At present it appears that even Leach river has been, from an economic standpoint, worked out, and that the other streams are unlikely sources of much placer gold.

The non-metallic mineral products of the district are of far greater value. The excellent coals of the east coast are well known, and form the basis of a large well established industry. The above-mentioned coal basins were merely visited. Some prospecting has been carried on in the Cowichan basin, and at the present time a diamond drill is in operation prospecting the measures at the northern end of the Saanich peninsula. The Coal Measures of this basin are much thicker, probably 1,800 feet; and

1 Notes of the Tyee Copper Mine, Eng. and Min. Journal, Jan. 25, 1908; pp. 199-201.

also more extensive than Richardson reports. As far as the surface exposures may be relied upon, the amount of coal present is small. The few seams found are thin and generally sandy. They occur near the base of the formation. There is a large area in the Cowichan valley underlain by the Coal Measures, in which there are practically no exposures, so that one cannot judge as to the probable presence or absence of workable coal; nevertheless, one is tempted to inquire if it would not be advisable to prospect this basin more thoroughly than has been done.

Prospecting has also been carried on in the small basins of Tertiary sediments of the south-west coast, at Sooke and Coal creek. Although there are a few small, thin lenses of lignite and lignitic sandstones present, there is nothing else to encourage the prospecting of these beds. The beds are clearly of marine origin; shown not only by their lithological character, but by their fauna, so that the occurrence of extensive coal seams in them is most improbable. Elongated cylindrical masses of lignite are found in the sandstones and are doubtless old logs which have been washed into the Tertiary seas and have become lignitized. The rest of the carbonaceous matter in the sediments is probably of the same drift origin. The little coal that has been found is all lignite, and there is little or no hope that any semi-bituminous or bituminous coal occurs in these basins. The individual basins are not only small in extent, but have been extensively broken and faulted, and these faults would very seriously interfere with any mining that might be attempted. One feels very confident therefore, in discouraging any attempts at mining or even prospecting for coal in these basins of Tertiary sediments.

Of very considerable importance is the lime and cement industry. On Tod creek, a small branch of the Saanich inlet, the Vancouver Portland Cement Company's plant is located. They are procuring their cement rock, which requires little or no admixture of clay, from a thick band of a crystalline argillaceous limestone, one of the members of the Victoria series. Formerly, a little drift clay was mixed with the limestone, in order to bring up the alumina and silica content; but at present this is found unnecessary.

Lime is manufactured from the purer limestone or marbles of the Victoria series. The plants are located on the west side of Esquimalt harbour, on the west coast of Saanich inlet, and to the north-west of the head of Esquimalt harbour near Parsons bridge. At the latter plant the lime is used by the Silica Lime Brick Company to make sand-lime brick. The sand is obtained from a pit near the plant, in stratified sands and gravels of fluviatile origin. Lime has also been burned inland, in the Highland district, along the mill stream road, but at present the high transportation charges make the industry unprofitable. Other localities of good limestone, suitable for the production of lime, are numerous, and although other occurrences of natural Portland cement rock are not necessarily to be expected, the materials for the manufacture of Portland cement are convenient to any of the purer limestones of the Victoria series.

At present, with the exception of ordinary brick manufacture, the clay industry is confined to a small pottery plant in Victoria. Part of the clay is procured from the shales of the Coal Measures at Extension. Many of these are reported to be of good quality, some of them fire-clays. Other high grade clays are absent. None of the argillaceous members of the Victoria series, on account of their metamorphic character, are to be considered. The shales of the Mt. Sicker series, the Cowichan Coal Measures and of the Tertiary basins are not abundant, and are generally impure. The clays of the surficial deposits are also impure, and unsatisfactory for higher grade wares than common brick.

OSOYOOS AND SIMILKAMEEN MINING DIVISIONS.

(Charles Camsell.)

The geological work of the season 1908 was again carried out largely in camp Hedley, in continuation of the work of 1907. On the retirement of the party from the field in 1907, about one-third of the topographical work yet remained uncompleted; while the whole of the mapping of geological formations was left over until the season just ended. All this work was finished before the close of this season. In the geological investigations the writer was again assisted by Mr. J. A. Allan; while Mr. L. Reinecke had charge of the topographic work.

On the completion of the Hedley sheet, Mr. Reinecke moved his party up to Otter flat on the Tulameen river, where work was commenced on a new topographic sheet. It is intended that this sheet shall cover an area of about 200 square miles; forming a rectangle with sides about 12 miles in an east and west direction, by 17 miles north and south. The sheet will cover many important economic deposits. Gold and copper ores are being developed in the north-west portion; a coal field lies in the south-east; magnetite, chromite and molybdenite are known to occur in the south and west; while gold and platinum placers are being worked in the bed of the Tulameen river and several of its tributaries.

The photographic method was employed in the field work of this sheet, and it is hoped that sufficient data have been obtained to allow of the compiling and publication of the map by the spring of 1909.

MINING DEVELOPMENTS.

In the Hedley camp and adjoining district, except by two or three companies, little additional development work has been undertaken or carried out during the past year. Nearly all the mineral claims in the camp have been Crown granted and the British Columbia mining law does not compel owners of these to do more than pay the annual taxes; consequently, much promising prospecting ground is tied up, with nothing being done to demonstrate for prospective investors its potential wealth.

Daly Reduction Company.

The Daly Reduction Company had a most successful year, the weather being so favourable during the winter that the whole plant was in operation almost continuously throughout the year. The lack of water for power, and the freezing up of the flume during some of the winter months, had in former years necessitated the closing down of the mill and the suspension of most of the mining operations, but the weather was so mild during the last winter that no difficulty was experienced in keeping the flume free from ice. Moreover, under the present management the efficiency of the stamp mill and cyanide plant has been greatly increased, and the daily average tonnage of ore treated brought up to about 130 to 135 tons.

At the mine itself, where a year ago ore was being stoped only from the Nickel Plate, and Sunnyside No. 2, large ore bodies lying between these two places have since been exposed and are being worked at Sunnyside No. 3 and Sunnyside No. 4. The former of these two is worked by an incline shaft, which is down about 175 feet. The latter is at present being worked as a large glory hole, but the intention is to drive a tunnel along the strike of the ore body and stope out from either side. Some exploration has been done by means of the diamond drill and by open-cuts on other properties of this Company.

Adjoining Districts.

In the adjoining Hedley districts the most important sections in which development has been going on are, the Henry Creek claims, situated on the south side of the Similkameen river two miles above Hedley and the Golden Zone group, lying to the north, about 11 miles by wagon road.

Henry Creek District..

In the Henry Creek district some local excitement was caused during the last winter and spring, owing to the finding of free gold in a vein on one of the claims belonging to the Pollock Mines Company.

This Company owns five Crown granted mineral claims, on which a great deal of prospecting has been done by tunnels, shafts and open-cuts.

GEOLOGY OF THE HENRY CREEK DISTRICT.

The country rocks of these claims are interbedded limestones, argillites, and black, volcanic tuffs, belonging probably to a higher horizon than the limestones and quartzities of Hedley. A stock of monzonite resembling the darker variety of the Hedley monzonite cuts these sediments and occasionally sends off tongues into the sediments. The sediments stand in an almost vertical attitude and strike north and south. Fissures have been developed in these in a north and south direction, and in many cases dikes of andesitic and lamprophyric character occupy these fissures. The lower workings are on a strong and well defined fissure, which has been explored for nearly 400 feet. This fissure varies in width from a few inches up to ten or twelve feet, and is filled with crushed and broken rock, traversed by small quartz veins which cement the broken fragments. Mispickel occurs abundantly in the main fissure, besides appearing in considerable amount in the numerous small parting planes which traverse the sedimentary rocks in the neighbourhood of the monzonite.

The upper workings of these claims are on a well defined quartz lead, which cuts both the sediments and the monzonite. The quartz is well mineralized with mispickel, pyrite and galena, and is said to carry good values in gold in the sedimentary rocks. In the monzonite the values are not sufficiently high to induce prospecting.

Many claims have recently been taken up in this neighbourhood, and on some of those lying to the east of the Pollock mines there are indications that values in silver may be obtained.

Golden Zone Group.

Another important group of claims on which a small 5-stamp mill has recently been erected and considerable development work done, is the Golden Zone group lying on the headwaters of one of the branches of Twenty-mile creek, about 11 miles from Hedley. This group consists of four claims lying at an elevation of about 5,900 feet above sea level. They were first located in 1900 by the present owners, who had been doing development work on them annually until a year ago when a 5-stamp mill was brought in and erected on the ground. Actual milling of ore began about the beginning of August, but owing to a lack of water there were numerous interruptions, and about three weeks later the plant had to close down.

The geological conditions on this group are as follows:—

A belt of sedimentary rocks consisting of limestones, quartzites and some tuffs covers the northern portion of the claims running from east to west across all of them. On the two western claims these sediments are cut by a very fine grained micaceous granite, and to the south this fine grained variety is cut by a large batholithic mass of coarse reddish granite.

Later in age than all of the above-mentioned rocks, an intrusion of granite porphyry of dike like proportions has been injected between the sediments and the coarse grained granite, exhibiting well marked contacts with each of these rocks.

The four mineral claims have been staked on a well defined and persistent quartz vein which can be traced by its outcrop for about 1,000 feet in an east and west direction. This vein cuts both the fine grained granite and the sediments. In the granite it occupies a strong fissure varying in width from two to four feet, but on passing into the sediments, it appears to split up into four or five smaller veins which become lost under the drift and may possibly pinch out altogether.

It is a true fissure vein, and, in the granite—when not much oxidized and well exposed—shows a well marked banded structure due probably to the filling of an open space. In the sediments, and in the contact zone where oxidation goes deeper, the true nature of the vein is not so apparent. The gangue is a hard, white quartz and the ore minerals found in it are pryite, arsenopyrite, zinc blende and chalcopyrite. Besides the secondary minerals due to oxidation and surface alteration, a later fracturing of the vein has taken place and these fractures filled with secondary sulphides. The walls of the vein are clean and often show slickensided faces.

The values are in gold and are said to be lower in the granite than in either the contact zone or the sediments. On panning some of the oxidized ore of the surface, a number of very fine colours of gold are obtained among the arsenopyrite concentrates in the bottom of the pan.

The value of the property will depend to a large extent on the size and persistence of the veins where they lie in the sediments, but sufficient work has not yet been done to demonstrate either of these factors.

Princeton District.

In the Princeton district, little in the way of mining development has been going on. The coal mines have not been operated since the summer of 1907 and there is little evidence that anything will be done until the Great Northern railway reaches that point.

On Copper mountain, like camp Hedley, most of the mineral claims have been Crown granted, so that no assessment work is necessary for the owners to hold them. The Reco mineral claim, however, has been steadily worked for a year and a half by a crew of four men; and on the other side of the river at Friday creek, the Gladstone claim was further prospected by the owners during the summer.

Some claims on Fivemile creek and at Roche river were considered by the owners sufficiently promising to warrant the expenditure of a considerable amount of money in development.

Tulameen District.

In the Tulameen district, where the new sheet is being mapped, much more development work has been going on than in other sections. The Granby Company of Phœnix have had a gang of from eight to twelve men working continuously for the last two years in prospecting the Independence group of claims at the head of Bear creek. Over 1,000 feet of tunnelling and 180 feet of shaft and winze have been done besides a large amount of surface prospecting. A large shoot of good copper ore has been defined by these workings. This shoot has been followed in a north and south direction for about 350 feet, and downward for a depth of 180 feet. At a level of 126 feet below the surface, cross-cuts show the ore body at its northern end to be about 90 feet in width, and the tunnels from this end running in a southerly direction along the east and west wall, show these walls to be gradually diverging from each other, increasing the probable width of the ore body. The eastern wall, along which the tunnel has been driven for 300 feet, is a well defined plane of fracture which shows a selvage of clay and talc. There has been some movement along this plane, as shown by the slickensided faces. The western wall is not so well defined, the ore apparently fading away into low grade rock.

The ore body, which is in a granite porphyry, appears to be cut by a darker syenitic variety that is also highly mineralized with copper ores. The whole is much fractured and cut by small calcite veinlets, which carry the ore minerals. Where the fracturing is greatest, the rock is richest in sulphides. The whole ore body is very porous with geodes of calcite and many cavities. All the workings are very wet. Much alteration is going on even at the present time; the feldspar is being altered to kaolin; calcite is being deposited and the chalcopyrite is being changed to higher grade ores, such as bornite, chalcocite and cuprite. The water itself contains a large percentage of copper and where it flows down the shaft or over the walls of the tunnel the red oxide of copper is deposited.

On this group operations have been suspended until a wagon road from Otter flat can be built and mining machinery imported.

A new discovery of Tertiary coal, of a fairly high grade, was made a couple of years ago on the north fork of Granite creek. An English company obtained a bond on a group of these claims and spent several thousand dollars in the work of driving tunnels and making cross-cuts to expose the different beds. Owing to inability to secure an extension of time on their bond from the owners, with a view of making thorough coking tests, operations were suspended last spring and nothing further has been done. The work of this company, however, was sufficient to show the great economic importance of this coal field, which though somewhat smaller in extent than the Princeton coal field, contains a coal which will be in great demand for steam purposes, as soon as a railway reaches the Tulameen. The work done also demonstrated the identity of the Collins Gulch coal, which has been known for years, with that of Granite creek. But while the outcropping edges of the basin on the Collins Gulch side have undergone a good deal of disturbance, the seams on the Granite Creek edge have only been slightly tilted and lie in such a position that they can easily be mined. The area of the whole basin does not cover more than about 8 square miles; but three different coal-bearing horizons have been defined, and each of these is likely to contain from one to three workable seams. This coal formation is probably of the same age as that of the Princeton basin, which has been defined as Oligocene. The two are separated from each other by a broad belt of volcanic rock. The Coal Measures are seen to be resting on a flow of earlier volcanic rocks, while a younger series of volcanic rocks overlies and covers a part of them on the western part of the basin.

The geological relations of these rocks will be worked out next summer.

Other portions of the Tulameen district in which operations have been carried on, are at Laws camp, on Bear creek, at Boulder creek, and on Champion and Eagle creeks. At Laws camp where work has been continuously in progress for the last three years on some very promising gold properties, briefly described in the Summary Report for 1906, operations were discontinued last spring on account of the difficulty of getting in supplies through the destruction of a part of the wagon road leading up to the camp.

Placer mining of the gold and platinum bearing gravels of the Tulameen river and Granite creek has been carried on in an intermittent manner by some white men and a few Chinese, and a small quantity of these two metals has been recovered. The most important work of this nature is that being done by Mr. Lambert, on the main branch of Granite creek, just above the North Fork. The preliminary work of building a dam and 600 foot flume has been completed, so that the actual work of sluicing the gravels should be commenced next summer, and good results ought to be obtained. Leases have also been taken up by Messrs. Law and Godfrey on the benches of the Tulameen river above Otter flat, with a view to working some of those higher benches on a more extensive scale than has hitherto been attempted.

With the advent of a railway these and many other mining enterprises in this district promise to develop into importance.

PHŒNIX CAMP AND SLOCAN DISTRICT.

(O. E. LeRoy.)

INTRODUCTION.

The season of 1908, from May until the end of September, was occupied in making a detailed geological survey of the Phœnix camp. In this work the writer was most ably assisted by Mr. C. W. Drysdale.

The area examined was 2 square miles in extent and embraced the whole of the mineral zone on which the mines are situated. A special report and map will be published as soon as possible. The latter will be issued on a scale of 400 feet to one inch; a scale sufficient to show all the geological features, which are in the main rather broadly developed.

The courtesy of the three operating companies permitted free access to all underground workings and allowed an examination to be made of the logs of all the diamond drill holes, the total length of which amounts to about 7 miles. The data thus acquired and correlated with the surface geology give, within certain limits, very accurate information regarding the geological structure of the camp.

GENERAL GEOLOGY.

With reference to the general geology, no additional information was derived regarding the age of the older rock formations and they can only be referred to the Palæozoic, as outlined on the geological map of the Boundary district. The granodiorite of Jurassic or Post-Jurassic age, is represented by a few poorly defined dikes cutting the Palæozoic, while the Tertiary is made up of both sedimentary and igneous rocks.

The Palæozoic admits of a three-fold division. The lower consists principally of massive, gray quartzites and basic porphyrites, altered in places to quartz and hornblende schists respectively. The porphyrites are intrusive in the quartzites, in the form of dikes and sills, and are not found cutting any of the younger rocks. Crushed argillites and altered limestones occur as small isolated masses with the schistose varieties of the above rocks.

The middle division is composed of quartz breccias and conglomerates derived from the lower series, siliceous, chloritic and feldspathic tuffs and crystalline limestones. In places, the conglomerates show an assortment of material into finer and coarser beds of rounded pebbles. It is generally massive, however, and passes insensibly into the breccia with no hard and fast line separating them. The tuffs are both banded and massive, and stratigraphically cannot be separated from the breccia, with which they are always associated. The limestones occur in irregular and lenticular areas and are erosion remnants of a once extensive formation which suffered from folding along with the breccias and tuffs.

These two divisions form a basin or trough, with the lower outcropping at intervals along the border. The mineral zone occupies the upper part of the middle division.

The upper division is unconformable to the quartzite breccia, and consists of black carbonaceous argillites, which have but a limited exposure on the east border of the map sheet.

The sedimentary portion of the Tertiary consists of conglomerates, grits and tuffs of a prevailing white or light gray colour when weathered. They are unconformable

to the Palæozoic, and form a long irregular band extending from the War Eagle to the Gilt Edge claim, crossing the east side of the town of Phœnix. The present attitude of the beds varies from almost horizontal in the south to steeply inclined and vertical in the north portion of the exposure. The character of the stratification shows that the deposition occurred in quiet waters, and the beds evidently represent a small portion of the floor of a Tertiary lake.

This period of sedimentation and erosion was followed by one of wide spread volcanic activity, during which a great part of the Boundary district was covered by great lava flows, which filled up the valleys and covered some of the highest ridges.

Subsequent erosion, with the complete removal of large areas of the lava, shows that, the topography prior to the eruption of this extrusive was very similar to that of the present.

One isolated remnant occurs in this area, and parallels the stratified rocks along their eastern border. The lava in general is andesitic in character, but more acid and basic varieties also occur with vesicular and amygdaloidal types.

Later intrusions of basic alkali rocks and pulaskites, as dikes and stocks, have cut all the older rocks; and with these, the period of igneous activity in this area closes. Both intrusives are genetically connected, and are probably closely related to the lava flow.

ECONOMIC GEOLOGY.

As previously stated, the mineral zone belongs to the intermediate division of the Palæozoic. The principal portion of this zone outcrops in the form of a large L, and extends from the Gilt Edge and Montezuma claims, south to the Gray Eagle and War Eagle, then eastwards through the Monarch and Rawhide and northwards through the Curlew and Gold Drop into the Snowshoe. A subordinate zone lies to the west on the Idaho and Brooklyn claims. It was originally connected to the main zone and its present isolation is due to subsequent erosion.

The exposed area is about 120 acres in extent, but the actual area is much greater as a considerable portion is overlain by the sedimentary and extrusive rocks of Tertiary age.

The field evidence goes to show that the mineral zone represents a metasomatic replacement of part of the limestones and tuffs by epidote, garnet, chlorite, hornblende, calcite and quartz, together with chalcopyrite, hematite, pyrite and magnetite. Throughout this zone, the principal lines of fracture as shown in the underground workings of the several mines have approximately a north and south trend. Between these the ground is intersected by a host of minor fractures. The former represent the trunk channels, and the latter the distributaries; the whole forming a complete system of underground circulation for mineral solutions, by the action of which the country rocks have been replaced by the above gangues and ores. The concentration of the chalcopyrite along certain lines has formed ore bodies of enormous size, lying at various attitudes in the mineral zone and bounded by walls which in the main are commercial rather than structural.

In the commercial success of operation, the low-grade character of the ore is offset by its fluxing qualities, by the size and favourable situation of the deposits, and by the many economies that can be practised in the handling of a large tonnage. The pillar and room method of mining, and the non-necessity for general timbering are the most important features in the general economy.

The values are fairly uniform throughout and approximate very closely the general averages. The Granby Consolidated, during the past financial year ending June 30, produced 858,432 tons; the values being gold, 0·0503 oz.; silver, 0·2865 oz.; and copper, 1·171 per cent per ton. In 1907, the Snowshoe mine yielded 0·059 oz. gold; 0·32 oz. silver, and 1·3 per cent copper per ton, of the 135,000 tons produced. During the past year the Granby Consolidated were working continuously on both sides

of the mineral zone. The premier mine of the district is situated on the west side, with workings extending through the Knob Hill and Ironsides claims, into the Ætna and Victoria. There are three outlets for the ore, namely No. 2 tunnel; No. 3 tunnel; and the Victoria shaft, through which is raised all the ore mined on the 200, 300 and 400 ft. levels. On the west side the workings are on the Gold Drop claim and the Curlew fraction, which lies between the Snowshoe and Rawhide claims. All the ore passes through the Curlew tunnel to the loading bins.

Both the Great Northern and the Canadian Pacific railways have spurs to the mines, and afford ample facilities for the transportation of the ore to the Company's smelter at Grand Forks, some 20 miles distant.

The tonnage mined this year will be the largest in the history of the Company and up to December 20, amounted to 1,006,659 tons.

The Consolidated Mining and Smelting Company of Canada resumed operations in August on the Snowshoe and War Eagle. The former, which is operated under lease from a London company, has, up to December 20, produced 37,989 tons. The ore is shipped partly to the Company's smelter at Trail, and partly to the British Columbia Copper Company's smelter at Greenwood. The main tunnel is the avenue of outlet for the greater part of the ore, which this season has been won chiefly from the big glory hole. A connexion has also been made with the old workings, with a view of more economically handling the ore mined in the reserves on the northern half of the claim.

On the War Eagle claim of the Phœnix Amalgamated group, development work has been carried on and sample shipments of about 400 tons have been sent to Trail. The shaft is down 100 feet, and up to the present about 1,200 feet of drifting have been done. The mine has no railway connexion, and the ore has to be hauled by teams to the nearest point on the Canadian Pacific, which is about three-quarters of a mile distant.

The Dominion Copper Company operated the Brooklyn and Rawhide mines during the summer. The mines, however, were closed down early in September, and so remain pending a reorganization of the Company. The ore mined up to August 8, amounted to 15,220 tons, which was shipped over the Canadian Pacific railway to the Company's smelter at Boundary Falls.

The Stemwinder and Idaho, belonging to the same company, were not operated during last season. The ore body of the latter is continuous with that of the Brooklyn, and the workings of the two mines are connected under the town of Phœnix.

The Rawhide ore body is continuous with that of the Gold Drop, and lies below and to the east of the latter. It has been opened up by a series of glory holes and six tunnels.

SLOCAN DISTRICT.

The month of October was spent in the Ainsworth and Slocan mining divisions of the Slocan district. Brief examinations were made of as many of the working and idle properties as was possible in the limited time. Among those visited were the Whitewater mine, Whitewater Deep, Rambler-Cariboo, Payne, Mercury, Last Chance, Surprise, Noble Five, Reco and Richmond-Eureka. This examination is only preliminary to a detailed survey which will be undertaken next season.

It is proposed to make a topographical and geological map of about 260 square miles in the above divisions. The north and south boundaries of the map will be so situated as to include the claims in the Whitewater basin as well as those in the basin of the south fork of Kaslo creek. The east and west boundaries will be Kootenay and Slocan lakes, respectively. Considerable development work has been done this year on many of the older properties, as well as on several claims which have hitherto

attracted but little attention. An increasing interest in this silver-lead district seems to indicate, if not a general resumption of mining, at least a larger shipping list, and tonnage output in the near future.

The principal shippers up to November 22 of this year were the Whitewater, Richmond-Eureka, Standard, Rambler-Cariboo, Last Chance, Idaho, Ruth, Vancouver, Reco, Slocan Star, Hewitt, Sunset, Slocan Sovereign, Canadian Group, Alpha and Rio, with a total output of about 23,300 tons.

TOPOGRAPHICAL WORK AT ST. BRUNO, QUE., AND PHŒNIX, B.C.

(W. H. Boyd.)

Acting under your instructions to make a topographical map of St. Bruno mountain, Chambly county, Quebec, I left Ottawa for that locality on April 28, accompanied by Messrs. F. H. MacLaren, H. Matheson and W. A. Johnston of this office.

The area covered comprises the main portion of the mountain, and the work occupied about three weeks.

The methods employed were transit and stadia traverses with accompanying sketches. A line of instrumental levels was run from the G.T.R. station, along the road, to the foot of the mountain. The publishing scale is 800 feet to one inch, with 20 foot contour intervals. The map was compiled on my return to Ottawa.

On June 30 I left for Phœnix, B.C., where the summer's work was to make a special detail map of that camp, similar to the one made of the Rossland camp; the scale being 400 feet to one inch, with 20 foot contour intervals. The area of the Phœnix map sheet is about 2 square miles and embraces the working mines and the town of Phœnix. Attached to the party were the following assistants: A. O. Hayes, W. E. Lawson, C. C. Galloway, M. Y. Williams, O. G. Gallaher and J. K. Workman. J. D. Galloway and E. E. Freeland were engaged in the field to complete the number of the party. All assisted in a willing and intelligent manner.

The methods employed were a triangulation control from a measured base on Ironsides avenue, with transit and stadia traverses to fill in all the detail. Sketches on 200 feet to one inch accompanied all traverse notes. The triangulation was computed, and the main traverses reduced in the field office to ensure results of the required accuracy being obtained, and also to eliminate, while still on the ground, any errors that might occur. The compilation of the map was started in the field. On August 20, Mr. A. Dickison, of this office, joined the party to assist with the compilation.

The work in Phœnix came to a close on September 30, after which I accompanied the Director and Mr. O. E. LeRoy into the Slocan country in order to look over, with them, the ground for the following summer's work. After spending a few days there, the Sheep Creek camp was next visited in company with the Director; some information was obtained of this camp to assist in making a sketch map to illustrate the report of the Director on that district. After leaving Sheep creek, a day was spent in visiting the cave at Ainsworth; after which I left for Ottawa.

THE BIG HORN COAL BASIN.

(G. S. Malloch.)

The Big Horn coal basin, situated between the Big Horn range and the first range proper of the Rocky mountains, and extending from the North Saskatchewan to its tributary, the Brazeau, was discovered by Mr. D. B. Dowling, of this 'Survey,' in 1906. Since then it has attracted considerable attention owing to its proximity to the lines of the Canadian Northern and Grand Trunk Pacific railways, for the use of which it offers an abundant supply of coal, much superior as a steam producer to the lignites found directly along their routes. During the past summer a photographic survey was made of this basin, and a contoured geological map will be published as soon as is practicable.

GEOLOGICAL SECTION.

The rocks of the basin are entirely of sedimentary origin, and the thirteen formations found are correlataed on stratigraphic and lithogical grounds with thirteen which have been described from the vicinity of the Bow river. These are as follows, beginning with the lowest:—

Palæozoic.

1. Intermediate beds: consisting of calcareous shales and impure limestones.
2. Lower Banff limestone.
3. Lower Banff shale.
4. Upper Banff limestone.
5. Rocky Mountain quartzite.

Triassic?

6. Upper Banff shale.

Jurassic.

7. Fernie shale.

Cretaceous?

8. Kootanie formation: the coal-bearing formation consisting of a succession of sandstones, and black shales.

Cretaceous.

9. Dakota sandstone: this also includes some shale.
10. Benton shale.
11. Cardium sandstone, and intercalated shales.
12. Claggett shales.
13. Judith River sandstones, and shales.

Of these, the first four were described by Mr. R. G. McConnell (1); the second four by Mr. D. B. Dowling (2); and the last five by Mr. D. D. Cairnes (3).

GENERAL AND GEOLOGICAL DESCRIPTION.

As defined above, the basin is roughly 35 miles in length by 8 in width and extends north-west from the Saskatchewan, in conformity with the general trend of the ranges. On the south-west it is bounded by the first range proper of the Rocky mountains.

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1 Annual Report, Geol. Surv. Can., Vol. II (N.S.), pp. 17-19 D.
2 Report on the Cascade Coal Basin, Alberta, by D. B. Dowling, B.A. Sc., 1907, pp. 8-9.
3 Moose Mountain District of Southern Alberta, by D. D. Cairnes, 1907, pp. 27-32.

This range offers a fine example of the fault block type, which is almost universal east of the continental divide. Enormous pressure from the south-west has tilted a block of strata perhaps 100 miles in length and forced it upward in a north-easterly direction, until Devonian strata at its base have overridden Cretaceous in the basin below. As in the other ranges, erosion has removed the younger formations from the back of this block, so that it is now composed entirely of Carboniferous and Devonian formations. These consist largely of thick-bedded limestones which offer considerable resistance to the further action of erosion. The general character of this range as a fault block is obscured by a number of minor crumplings of the limestone beds, developed by the pressure before it became strong enough to effect the break along the fault line. These crumples have accentuated the diversity in form, which would result naturally from the combined action of glacial plucking and of rock disruption, (due to sudden changes of temperature and to frost), both of which agents are efficient at the high altitude of the range. Consequently, in place of a simple scarped face on the north-east, a succession of cirques eaten back into the range to varying depths, and often exhibiting curved and branching axes, have given rise to protruding shoulders, precipitous cliffs, and extremely narrow ridges of fantastic irregularity. Nevertheless the range is remarkably straight when viewed as a whole.

On the south and north the Big Horn coal basin is bounded respectively by the Saskatchewan and Brazeau rivers, which cross the ranges in deep flat-bottomed valleys. The continuity of the first range is also broken by the valleys of two small streams which unite to form Big Horn creek. This flows east across the basin and at its south-east corner empties into the Saskatchewan. Near the north-west corner, Rocky creek heads in a particularly deep cirque, but fails to pierce the range entirely.

Unlike the first range to the south-west Big Horn range on the north-east of the basin does not extend beyond the Saskatchewan or Brazeau rivers, but is there represented only by a ridge of foothills of no greater elevation than their fellows.

These have been formed by the same pressure which developed the great thrust faults to the west, but which seems farther east to have chiefly affected the weaker strata which overlie the Palæozoic limestones of the mountains. Several exceptions occur, however, where these limestones have been folded and faulted so as to form outlying ranges, but which are much inferior both in length and elevation to the great fault blocks to the west. The Big Horn is the longest of these outliers, and near its centre where its elevation is greatest, it is essentially a fault block similar in all respects to the first range already described. Towards its ends, however, the throw of the fault becomes less and the direction of dip gradually changes to the north-west at that end of the range, and to the south-east at the other, and the Palæozoic limestones pass beneath younger formations. South of the Saskatchewan the range is represented by a sharp anticline in the Kootanie formation, the western limb being apparently slightly faulted over the eastern. To the north the Upper Banff shale forms the top of the ridge from about opposite the Brazeau gap through the first range, and finally north of that river the range is reduced to a simple anticline in the formations above the Kootanie.

The western slope of Big Horn range is comparatively gentle, being slightly lower in angle than the dip of the beds. Glacial erosion has been active here, but the cirques do not end in precipitous cliffs as on the eastern side of the first range, for the ice has acted on the upper and not the lower surface of the strata. The excavation of these cirques has given rise to a number of spurs which are usually flanked to a greater or less extent by the Upper Banff shale.

Cirques have also been developed on the eastern face of the range, and as a rule, the cirques on this side are much deeper than those on the west slope. In three cases they have broken entirely through the limestone strata, and have formed deep hollows in the soft, overlying formations behind, until checked by the hard beds in the Kootanie coal measures. Besides these three cirques, the Big Horn range is broken by three gaps occupied by streams draining the basin to the west. Beginning with the most

southerly, these are known as Grave creek, the South Branch of the Brazeau, and Trail creek. Inside the range all of them break into numerous branches whose positions are largely determined by the outcrops of the weaker formations.

Lying between the Big Horn range and the first range proper of the Rocky mountains on the west, the basin has a general elevation some 2,000 feet lower than that of the bordering ranges. This depression is partly due to the weaker resistance which the formations above the limestone offer to erosion and partly to the synclinal structure of the basin. The dip of the beds comprising the Big Horn range is sometimes as high as sixty degrees, but in accord with the synclinal structure, this decreases to the west until the axis of the syncline is reached. The western arm of the syncline is broken by the fault at the foot of the first range and more or less overridden by the fault block. Owing to the weight of the fault block the strata representing the western arm of the syncline have been overturned beneath it and dip to the east instead of to the west.

While the general elevation of the basin is some 2,000 feet lower than that of the ranges, it is by no means equal throughout, but shows differences of over 1,000 feet, or even 2,000 feet if we compare the height of the valley of the Saskatchewan or Brazeau with that of some of the higher ridges in the basin between them. These ridges are due to the resistance of certain beds to erosion, and with the intervening valleys they can be described best in connexion with the formations of which they are composed. We shall describe these in ascending order as they outcrop westward from the Big Horn range.

As stated above, the Upper Banff shales flank many of the spurs of this range and so produce few prominent topographic features. The succeeding Fernie shales are easily eroded and, therefore, occupy a depression just inside the range. This depression has been eroded chiefly by small tributaries of Grave creek and the other two creeks previously mentioned with it. The three cirques described as cutting through the Big Horn range, also produce hollows by widening out along the strike of this formation. Even on the divides between these cirques and the heads of the tributaries of Grave and the other creeks, the Fernie shale produces a depression of more than a hundred feet in depth.

West of the depression occupied by the Fernie shale is a line of hills formed of the harder beds of the Kootanie formation. These hills are sometimes less than 1,000 feet lower than the Big Horn range, but vary greatly in height. Owing to the composite character of the formation, these hills have been dissected into a large number of narrow and very irregular ridges by the action of erosion on the beds of shale which lie between the strong sandstones and conglomerates.

The Dakota sandstone offers less resistance to erosion than the Kootanie and usually outcrops on the western slopes of these hills, but gives rise to a few minor ridges where detached from them.

On the Dakota formation lie the Benton shales, which are of considerable thickness and very soft. As a consequence the lowest hollow in the basin, with the exception of the stream valleys, is situated on their outcrop. This hollow, though it contains some muskegs, is usually well drained by small tributaries of the larger streams.

West of the hollow occupied by the Benton shales is a ridge composed of the hard beds of the Cardium sandstone. In addition to the valleys of the Saskatchewan, Brazeau and Big Horn, the continuity of this ridge is broken only by the gaps occupied by two tributaries of Grave creek and three of the South Branch. On the whole, it presents a remarkably even crest line at an elevation of about 800 feet above the hollow east of it. It is notched, however, by several small streams on whose course it makes falls, and so protects the succeeding Claggett shale from being trenched by rapid erosion.

The outcrop of these shales produces another hollow parallel to that of the Benton shale, but probably 200 feet above it. The hollow is from 1 to 3 miles wide, and owing to the poor drainage it often contains muskegs. Along its western edge the strata

are usually buried under deposits of boulder clay, laid down by the glaciers descending from the cirques under the first range or from the high ridges capped by the remnants of the Judith River formation. This is the youngest formation represented, and its distribution can best be understood and described in connexion with further details of the tectonic structure of the basin.

As has been remarked this is synclinal. Along the Saskatchewan, the eastern limb dips at a low angle, but when the axis is reached, about 2 miles from the first range, the western arms turns up very sharply and near the fault line bounding the great fault block to the west has been slightly overturned. Just north of the river the Palæozoic limestone probably overrides the Upper Banff shale, but this is uncertain on account of a mantle of drift which conceals the contact. A little farther north, however, the Fernie shale was seen directly under the fault escarpment, while still farther on occurred the Kootanie sandstones. In order to explain this overriding of different formations, within short distances, by the same block of strata, it is supposed that the syncline existed before the development of the fault plane, and that its axis converged with the latter. When the block was shoved up, its weight would overturn the western arm of the syncline as far as possible and then truncate it, pushing the upper portion before it. Erosion would afterwards remove the broken portions and expose the upturned strata of the western arm in contact with the block and, owing to the convergence of the axis of the syncline with the fault plane, the exposed strata would be of successively higher formations in the direction of the convergence. Moreover, as the axis approached the fault plane there would be a smaller weight of overlying strata to resist the overturning of the arm. In agreement with this, as we go north, the dip of the eastern limb of the syncline becomes steeper and the western is farther overturned from the vertical. Finally, after the Dakota sandstone, Benton shale, Cardium sandstone and Claggett shale have been overridden in turn, and the axis of the syncline has approached to within half a mile of the fault, the dip of the beds in both arms is so nearly alike that both might be included in a section of the Judith River, should a geologist fail to note the sharply folded strata in the immediate vicinity of the axis.

Between the Big Horn and the Saskatchewan the Judith River caps a high hill in the form of a flat syncline. North of the former stream, however, the eastern limb of the syncline has a very considerable dip, and here it forms a ridge 5 miles long, which gradually rises and approaches the first range. From this point to the head of George creek, a tributary of the South Brazeau, the Judith River sandstones remain only as the capping of a few detached hills, but usually preserve the axis of the syncline. This gradually swings round and begins to diverge again from the fault plane, thus leading to a repetition, in the opposite order, of the structural features we have described. As its axis diverges, this syncline flattens also, and the Judith River sandstone on its eastern arm again forms a ridge, which becomes lower as it recedes from the first range.

To the south of Rocky creek, directly under the limestone of the main fault escarpment, the Kootanie sandstones outcrop, and some coal was found, but owing to the crumpled and fractured state of the measures it might be said to occur in pockets rather than seams. Its presence here is important nevertheless, for it furnishes a proof that the coal seams found on the eastern side of the basin probably extend across it, and it is to be noted in this connexion that, in every case in the areas south of the Saskatchewan where two sections can be compared from the same basin, or from two or more parallel basins, the more westerly section invariably shows more numerous and thicker seams.

SECTIONS OF THE COAL MEASURES AND ANALYSES.

In order to assist in the determination of the depth to which shafts will require to be sunk to reach the coal in different parts of the basin, a section was measured of the overlying strata to a point about half way up in the Claggett shale. This section

has not yet been worked out, but a section through the measures is appended. This was measured on Trail creek, and it is confidently believed that additional seams of coal could be exposed by the use of pick and shovel, for which task the demands of our topographic work left us no time. I therefore add two partial sections covering the most productive portion of the measures where they have been thoroughly examined. These have been very kindly furnished by Mr. J. McEvoy, lately of this 'Survey' and now in the employ of the German Canadian Development Company, which has purchased claims on the Big Horn and South Brazeau creeks. With a party of eight men he drove short tunnels into the various seams and secured carefully averaged samples, from which analyses were made by Milton Hersey, M.Sc., official analyst, Province of Quebec. We also publish these, and two analyses of specimens of coal from seams measured by our party. These were made by Mr. F. G. Wait. The following are the sections from the top downwards:—

1. That on Trail creek:—

1. Black and gray shale from the base of the Dakota sandstone..	131	feet.
2. Coal..	2·4	"
3. Shale..	2·9	"
4. Coal..	4·7	"
5. Black shale, with ribbons of coal..	161	"
6. Coal..	3·9	"
7. Sandstone..	2·5	"
8. Coal..	2·4	"
9. Black shale, and shaly sandstone..	127	"
10. Coal..	4·5	"
11. Black and brown shale..	131	"
12. Sandstone, shaly below, heavy bedded above..	54	"
13. Black and brown shales..	53	"
14. Coarse sandstone, weathers yellow..	37	"
15. Black and brown shale..	56	"
16. Heavy beds of sandstone..	22	"
17. Coal, with 0·6 foot shale two-thirds way up..	6·6	"
18. Coal seam not dug out, and black shale..	5	"
19. Siliceous sandstone..	8	"
20. Black shale, with seam not dug out..	179	"
21. Coarse gray sandstone..	7	"
22. Sandstones, separated by black shales..	56	"
23. Black shale..	33	"
24. Coal..	2	"
25. Sandstones, separated by black shale..	74	"
26. Black shale (fossil shells)..	154	"
27. Gray sandstone..	35	"
28. Black shale, and shaly sandstone..	133	"
29. Siliceous sandstone..	10	"
30. Black shale..	57	"
31. Massive gray sandstone..	59	"
32. Concealed, probably black shale..	85	"
33. Sandstone..	6	"
34. Sandstones, and black shale (crumpled) approximately..	100	"
35. Heavy bed of gray sandstone..	48	"
36. Black shale..	12	"
37. Heavy bed of gray sandstone..	32	"
38. Beds of sandstone, separated by black shale and ribbons of coal.	123	"
39. Black shale..	54	"
40. Siliceous sandstone..	6	"
41. Conglomerate bed, pebbles chiefly of black chert..	12	"
42. Shaly sandstones, separated by black shale..	38	"
43. Siliceous sandstone..	3	"
44. Black shale, and shaly sandstone..	103	"
45. Coarse gray sandstone..	14	"
46. Black shale, and shaly sandstone..	97	"
47. Siliceous sandstone..	2	"
48. Black shale, and shaly sandstone (shows contemporaneous erosion)..	110	"
49. Succession of black shale, and shaly sandstone with 3 ribbons of coal, 0·6, 1·4 and 0·3 feet, respectively..	76	"
50. Siliceous sandstone, weathering blue..	3	"
51. Black shale, and shaly sandstone, with 2 ribbons coal..	126	"
52. Sandstones, with 2 ribbons coal..	6	"
53. Siliceous sandstone..	8	"
54. Black shale, with 3 ribbons coal under 1 foot..	109	"
55. Sandstone, with ripple marks and impressions of rain drops..	21	"

56.	Siliceous sandstones, separated by black shale	68	feet.
57.	Gray, siliceous sandstone	50	"
58.	Black shale	42	"
59.	Thin bedded sandstone, with fossil plants	40	"
60.	Black shale, with one thin bed of sandstone	47	"
61.	Siliceous sandstone, weathers red	37	"
62.	Concealed, probably black shale	158	"
63.	Heavy bed of sandstone	30	"
64.	Concealed, probably black shale	33	"
65.	Sandstone: gray on fracture, but weathering brown	9	"
66.	Black shale	74	"
67.	Gray sandstones, with partings of black shale	173	"
68.	Gray sandstone	5	"
69.	Black shale, with ribbons of sandstone	75	"
70.	First heavy sandstone bed above Fernie shale	10	"

Mr. McEvoy's section measured on George creek is as follows:—

	Coal	0·5	feet.
	Rock	70	"
No. 1.	Coal	0·3	"
	Rock	1·5	"
	Coal	1	"
	Rock	40	"
No. 2.	Coal and shale	5	"
	Rock	60	"
No. 3.	Coal, with three bands shale	3	"
	Shale	0·5	"
	Coal	4	"
	Rock	110	"
	Coal	0·8	"
	Rock	240	"
No. 4.	Coal, with three bands of shale, 1 inch each	10·6	"
	Rock	110	"
No. 5.	Coal, dirty at outcrop	3	"
	Shale and coal	6·3	"
	Coal, one band of shale, 2 inches	4·3	"
	Rock	80	"
	Dirty coal	1·7	"
	Coal	1·5	"
	Shale	0·5	"
No. 6.	Coal, with band of shale, 2 inches	6·7	"
	Rock	30	"
No. 7.	Coal	1	"
	Rock	40	"
	Coal	0·5	"
	Shale	2	"
No. 8.	Coal, with 3 inch shale band, seam locally reduced in thickness	5	"
	Rock	220	"
No. 9.	Coal	8	"

Undetermined thickness of rock, and possibly other seams:—

No. 10.	Coal, locally reduced by a crumple	1	feet.
	Rock	100	"
	Coal	1	"
	Shale	1·5	"
No. 11.	Coal	9·5	"
	Rock	90	"
No. 12.	Coal	12	"
	Shale	0·2	"
	Dirty coal	2	"
	Rock	200	"
No. 13.	Coal	3	"
	Rock	150	"
No. 14.	Coal	3·2	"
	Rock	about 1,000	"
	Rock, with 7 small seams, 2 feet and under	125	"

The section on Big Horn creek includes only the upper part of the measures. It is as follows:—

Seam A	Coal	5	feet.
	Rock	7	"
Seam B	Coal	4·5	"
	Rock	8	"
Seam C	Coal	7	"
	Rock	250	"

Seam D	Coal	13	feet.
	Rock	130	"
Seam E	Coal	2	"
	Rock	140	"
Seam F	Coal	2	"
	Shale	0·8	"
	Coal	2·2	"
	Coal and shale	3	"
	Coal	6	"
	Rock, with several seams of coal under 2·3 feet	700	"
Seam G	Coal	8	"

The following are Dr. Hersey's analyses of Mr. McEvoy's samples from a number of seams in these sections; those numbered being from the Brazeau, while those designated by letters are from the Big Horn:—

Mark.	Moist.	Vol. Comb. Mat.	Vol. Mat.	Fix. Carb.	Ash.	Coke.	Sulph.
3	·28	29·04	29·32	64·52	6·16	70·68	·68
4	·90	27·60	28·50	60·08	11·42	71·50	·46
6	·50	20·10	20·60	49·62	29·78	79·40	·56
8	·36	26·72	27·08	62·35	10·57	72·92	1·21
12	·56	22·82	23·38	70·30	6·32	76·62	·69
14	1·46	24·04	25·50	67·93	6·57	74·50	·70
A	·38	22·62	....	68·85	8·15	77·00	
B	·20	22·95	.....	69·78	7·07	76·85	
C	·32	19·51	.....	71·47	8·70	80·17	
5	·34	25·28	.....	68·13	6·25	74·38	
9	·30	24·58	.....	62·95	12·17	75·12	
11	·20	24·33	.....	69·34	6·13	75·67	

Nearly all of these samples formed firm coherent cokes, while large samples tried by Mr. McEvoy in a small coke oven on the Big Horn produced an excellent coke.

Three natural exposures of coal were found on Grave creek, and were measured. No. 1 gave the following result: coal 9·3 ft., shale 1 ft., coal 2·2 ft.; No. 2: coal 5·2 ft.; No. 3: coal 5·4 ft. Analyses of the 5·2 ft. seam here, and the 6·6 ft. seam (No. 17 in the section) on Trail creek, gave the following results:—

Seam.	Moisture	Volatile Comb. Matter.	Fixed Carbon.	Ash.
5·2	·96	30·80	64·88	3·36
6·6	1·04	22·61	68·89	7·46

Both yielded firm coherent coke.

STEAM COALS OF THE CASCADE BASIN. LIGNITE AREAS OF ALBERTA AND SASKATCHEWAN. PRODUCTION OF COAL IN ALBERTA AND SASKATCHEWAN.

(D. B. Dowling.)

The examinations of the summer extended over a wide field, and included short visits to two localities in the Cascade basin, where prospecting operations have been carried on. A more detailed examination was made of the coal measures of the Edmonton district—for which a special report will be prepared—and several visits made to points in Saskatchewan, where prospecting has been carried on in the hope of finding coal. As these different visits were not to contiguous areas, fuller details will be given in this report of the outlying ones than of the Edmonton district, since the latter entails the preparation of a map.

STEAM COALS OF CASCADE BASIN.

At present the only mines in operation are at Canmore and Bankhead, but during the past season, several parties have been prospecting for coal as far south as the Kananaskis river. One locality visited at Canmore was on an area north-west of the property controlled by the Canadian Anthracite Company, and the openings made are on sec. 1, tp. 25, R. 2, west of 5th meridian.

At the time of my visit the prospect holes had fallen in and the examination was not at all satisfactory. Two seams had been discovered and openings made. There appeared to be a workable seam with at least 4 feet of clean coal. Below this seam, a series of coal and slate, 8 feet thick, may contain another workable seam, but the prospect hole was considerably fallen in and needed cleaning out. Although there are but few exposures, the measures appear to be on the strike of those at Canmore, and there is a possibility that the folding found there may not be as sharp in the area to the north-west. The seams probably belong to the upper series as found in the Canmore mine, judging from the analysis of the coal, which shows it to be a steam coal of the Canmore grade.

Analysis by F. G. Wait:—

Water	1·80
Volatile combustible matter	14·71
Fixed carbon	76·77
Ash	6·72
	100·00

This analysis appears to indicate a coal a trifle softer than the average of the Canmore seams and it is, no doubt, a good steam coal.

Prospecting has also been carried on in the sections to the south, near Wind mountain, and several seams have been opened, but the operations were confined mainly to the rocks along the slope of the measures, hence the whole section was not proved. Most of the seams found are on sec. 29, tp. 23, R. 9, west of 5th meridian.

On the Kananaskis slope a very complete examination of the measures was possible, as most of the seams had been discovered and opened by private parties during the present season. The work of prospecting the area was not difficult, as gullies, cutting across the measures, afford good facilities for the examination of exposures and give ready access to the seams. The lower portions only were hard to examine, owing to the greater accumulation there of loose material from the higher slopes.

The examination proved that the formation contains more coal than was found at the old Marsh mine, in the gully on sec. 12, tp. 24, R. 10, west of 5th meridian. This might be expected, however, since the whole thickness of the formation was not included in the examination at that point. The upper part of the measures, omitted before, was explored this season near Ribbon creek, a branch of the Kananaskis crossing sec. 3, tp. 23, R. 9. This makes a nearly complete survey of the coal seams to be found in the measures; the upper part was apparently complete, the only possible gap left uncovered being a band of measures about 400 feet in thickness at the bottom, thickly covered by debris and which might contain a few seams.

List of Seams in Measures.

For a complete section of the measures it is necessary to consider the exposures disclosed at three localities.

At the first locality, on a small gully in section 3, running to Ribbon creek, the upper measures are exposed with coal seams which were dug into with a view of showing their character and thickness. The coal seams in descending order are as follows:—

Coal seam,	No. 1	4′–0″	
"	No. 2	4′–6″	
"	No. 3	2′–6″	
"	No. 4	2′–0″	
"	No. 5	4′–0″	
"	No. 6	4′–6″	Two bands of shale, 4″ and 2″, near centre.
"	No. 7	4′–6″	Fairly clean.
		7′–0″	Dirty.
"	No. 8	2′–0″	Too small to mine.
		1′–6″	
"	No. 9	7′–0″	Clean.
"	No. 10	9′–0″	Fairly clean.
"	No. 11	15′–0″	Bright.

Below seam No. 11, when followed along the strike of the rocks north to a small draw running down the face of the hill, another set of seams was exposed.

Continuing the list of seams from above:—

Coal seam,	No. 12	2′–0″	
"	No. 13	3′–0″	
"	No. 14	12′–0″	Streaks of shale in seam.
"	No. 15	3′–6″	Clean.
"	No. 16	3′–0″	
"	No. 17	4′–6″	
"	No. 18	4′–0″	
"	No. 19	9′–0″	Hard and bright.

There is then an interval not prospected, but on the face of the hill about 2 miles north, on section 16, or near its north boundary, a seam supposed to be No. 14 seam of the last section, or at least a similar seam in about the same part of the measures, was found. At 500 feet below this exposure several seams were found and probably are those given above. The following seams appear to be additional:—

Coal seam,	No. 20	10′–6″	8 feet clean.
"	No. 21	4′–0″	Clean.
"	No. 22	3′–0″	Bands of shale in coal.
"	No. 23	9′–0″	

As remarked before, there may be a few covered seams below this, but the section as shown above contains about twenty seams which might all be mined; sixteen of them are certainly thick enough, having an aggregate thickness of 89 feet of coal.

Character of Coal.

The few analyses I have seen of outcrop samples show that these coals can be classed with the Canmore coals, which are of great value as steam producers. A few only of the seams, away from the outcrop or in the vicinity of the fault, may prove harder; but none of them, apparently, go higher than semi-anthracite in grade; the

exceptions being purely local. In this respect the Canmore seams show the same variation, since a sample from No. 3 Canmore was classed as anthracite. Even if a few seams do run to anthracite, the market will not be over supplied. The greater portion of this coal will serve for steaming and should be better for gas producer use than anthracite. Using the ratio between fixed carbon and volatile constituents as a standard, the analyses of eight samples of the seams show that three of them are softer and higher in volatile combustible matter than any of the Canmore coals. These samples were from seams Nos. 5, 10 and 9.

Of the rest all can be compared with the Canmore upper or softer seams, as follows:—

No. 17 can be classed with No. 6 Canmore.
No. 7 can be classed with No. 5 Canmore.
No. 18 can be classed with No. 5 Canmore.
No. 19 can be classed with No. 4 Canmore.
No. 11 can be classed with No. 2 Canmore.

The Canmore coals have been in steady use on Canadian Pacific Railway locomotives.

No. 11 is the hardest coal among the samples, though about the same in grade as No. 19. This result is very gratifying, since on the main line of the Canadian Pacific railway, the Canmore mine, capable of producing only 600 tons per day, was thought to be the only mine in the district that could supply steam coal. If the measures near the Kananaskis are mined, the long haul from the mines on the Crowsnest branch will be saved, and this area become one of the large producers.

Quantity of Coal.

The number of seams discovered, as well as the undisturbed position of the measures, assure a very large total of mineable coal. The block which starts at the Three Sisters and continues past the Kananaskis, is raised quite high at the watershed between the Bow and Kananaskis, but can be mined from either side. There is a slight syncline in the top measures, but the lower measures dip to the fault, so that a large part is gently dipping to the south-west. On the block behind the Marsh mine the measures become nearly flat, but to the south-east assume a greater dip toward the mountains, and a narrow belt only, near the fault, will be broken up. There is also a probability that where there is folding, as in the Canmore mine, the coal will be characterized by increased hardness.

Assuming that where the whole thickness of measures is present there is an average of 90 feet of coal capable of being mined, the available coal amounts to 150,000 tons to the acre, or 90,000,000 tons to the square mile. For the average of the area as mapped, allowing for dirty seams and coal left in the mine, approximately 65,000,000 tons per square mile should not be an excessive estimate.

Access for Mining.

On the slope to the Bow river, a stream, heading in a cirque north of Wind mountain, gives a workable grade down to the large open valley eroded out to the limestone range and making an excellent site for a colliery. The measures on each side of this valley can be attacked, and several gullies descending from the higher ground give access to the measures toward the height of land.

On the Kananaskis side the valley of this stream is wide close to where the coal measures cross it, hence there is ample room and an excellent site for a town. The measures are cut nearly to the level of this valley by a small stream coming from north of Mount Kidd, so that there are four points from which the measures may be mined: two from either side of Ribbon creek, the stream noted above, and the other two from the Kananaskis valley.

The largest and most important field is that lying north of Ribbon creek. Here there is a natural terrace on which to erect the necessary buildings in the vicinity of the tunnels. It might also be noted that this coal area being above the level of the river can be mined from the level entry, as at Bankhead, affording natural drainage and very easy haulage for mine cars.

The Bankhead mine, having its coal above the river level, and therefore capable of being mined from the level of the entry, has a great advantage over the Anthracite mine, which was above the coal. Similarly, the area south from Three Sisters mountain to past the Kananaskis should have a measure of superiority over that to the north at Canmore, which is being mined by means of a long slope. The fact that this new area contains steam coal, also assures cheap mining, as it is not necessary to separate the small coal from the lump. And it is probable that run of mine can be used, if care is taken to separate the slate from the clean coal; otherwise the slack will have to be washed.

The new area thus added to the steam coal producing class may roughly be estimated at about 15 square miles, of which 6 to 8 square miles north of Ribbon creek is proved to have about 500,000,000 tons of available coal.

LIGNITE AREAS OF ALBERTA.

The principal mining centre for the production of lignite is at Edmonton, where the population is densest. Over a great part of the coal belt passing through this district, there are numerous small mines from which the statistics of output could not be easily obtained, as the coal is used for a purely local market. The Edmonton mines, including those on both sides of the river, produced in 1907, 112,558 tons. This amount was all disposed of in the immediate vicinity, very little of it being shipped any distance by rail. The mines which will be called upon for a larger output for towns along the Canadian Northern railway and Grand Trunk Pacific, outside the coal belt, will naturally be those connected with the railway lines. With the advent of the two railways above mentioned, several companies have turned their energies towards sinking shafts near the railways. Of these the Parkdale, in Edmonton, was the first to start shipping by car. This mine is raising coal from 200 feet below the surface; mining the continuation of the Clover Bar seam which here is between 4 and 5 feet thick. This is the only mine in this vicinity in which any gas has been discovered, necessitating the exclusive use of safety lamps.

A new mine, the Twin City, situated alongside the railway spur connecting Strathcona with Edmonton, has only recently sunk a shaft, and the installation of boilers and winding machinery is being hurried. At a depth of 135 feet the Clover Bar seam was reached, but it had a clay parting. The shaft was continued to a depth of 161 feet, to another seam which has a firmer roof, although similarly split by clay partings. On the property lying east of this shaft, several borings have been made, and there is reason to believe that the clay partings will disappear in that direction. Tunnels on both the seams are under construction and mining will soon commence. Another mine which is being connected with the railway is the Clover Bar, situated on the west side of the river just above the Grand Trunk Pacific bridge. The old opening was on the river bank, and coal is still being hauled to Edmonton by teams. A point selected for a shaft, chosen with a view to the construction of a switch from the Grand Trunk Pacific railway, showed, when the coal was reached, a cover of 100 feet. In a depression between this shaft and the river an air shaft showed only 35 ft. cover. Operations are now in progress to connect these openings with the old mine. The seam in the old mine runs from 7'-9" to 8'-4" in the northern part of the old workings, and is about 8 feet thick at the new air shaft.

The other mines, which are very numerous on both banks of the river below Edmonton, are all supplying the local market, drawing the coal by team to town. Some are being equipped with steam hoists, and all appear to be working the Clover

Bar seam, with the exception of the White Star and Strathcona mines, south of Edmonton, which appear to have a higher seam.

The following mines during 1907 yielded the output indicated. Those opened during the present year have not made returns, and no returns appear for several that are known to be producing; so that the output for the district is greater than that given in the schedule.

Name of Mine.	Locality.	Seam.	Thickness.	Output, 1907.
			Feet.	
White Star Mine	5 miles S. of Strathcona	Probably Strathcona	5'-8"	12,000
Strathcona	Strathcona	Strathcona	5 ft.	18,368
Humberstone	Clover Bar	Clover Bar	8 ft.	8,665
Milner Coal Co	"	"	7 to 8 ft.	2,000
Clover Bar	"	"	8 ft.	13,281
Parkdale	Edmonton	"	4 to 5 ft.	3,800
Standard	"	"	4'-6" to 6 ft	21,200
Fraser & Freeman	Clover Bar	"	6 ft.	5,500
Daly	"			4,700
Keith & Fulton				4,294
Byers	Clover Bar	Clover Bar	7 ft.	2,010
Ottwell	"	"	7 ft.	9,025
Davkins				580
Lindsay	Namao	Probably Clover Bar	4 to 5 ft.	2,191
Smith & Steffos		" "	5 to 7 ft.	1,190
Cardiff	Morinville	" "	10 to 15 ft	Large output at present developing
Alberta	"	" "	10 to 15 ft	
Twin City	Strathcona	Clover Bar and Twin City		
Rosedale	Edmonton	Clover Bar	4 to 5 ft.	
Namao Coal Co	Namao	Probably Clover Bar	5 ft.	
United Collieries	Edmonton	Clover Bar	6 ft.	
Frank Coal Co	"	"	4 ft.	
Dawson	"	"	6 ft.	
Rupert's Land Coal Co	Oliver	"	8 and 6 ft.	

On the Grand Trunk Pacific railway, east near Beaver lake, a mine is being opened at Tofield on an 8 foot seam.

On the Wetaskiwin branch of the Canadian Pacific railway there are small mines near Camrose, and from the Battle river coal is being drawn to other stations on the line. In the vicinity of Bawlf a few seams are found south toward the Battle river, and at Hardisty there appears to have been a 3 foot seam discovered. On the Calgary and Edmonton line, near Hobberma, pockets of coal just beneath the boulder clay have been discovered, and may soon be mined. The short branch east from Lacombe, crosses a very important coal horizon, but as yet no drillings have been made, although coal is being mined on the banks of Red Deer river, and east of Tail creek at Nevis, a 4 foot seam with a good roof is being mined.

In the Kneehills country, which as yet has no railway facilities, four mines are operating for local trade; two on Threehills creek, one on Ghost Pine creek, and one at Carbon on the Kneehills creek. Two or three mines, not in continuous operation, are also located in this vicinity. Other mines supplying lignite south of the main line of the Canadian Pacific railway are those at Crowfoot, and smaller ones near Medicine Hat.

The general output of lignite for Alberta for 1907 is given in the provincial report as 639,335 tons. This includes the mines of Lethbridge, Taber, Magrath, Woodpecker, Lundbreck, High River and Pincher Creek, a total of thirty coal producing mines. Their product should be called lignitic coal, and thus separated from the true lignites.

As the principal mines at Lethbridge and Taber produced 350,000 tons, it is probable that there should be deducted from the total as given above, about 400,000 tons, leaving an output of lignite amounting to approximately 240,000 tons. Of this, Edmonton and vicinity produces more than half, for Edmonton alone reported for 1907, 112,588 tons. Morinville mines are now large producers. The small mines along the Wetaskiwin and Lacombe branches do not give returns, but if added to that from Red Deer river, Kneehills creek, Crowfoot and Medicine Hat, would augment the coal production of Alberta considerably.

LIGNITE AREAS OF SASKATCHEWAN.

Eagle Hills Creek.

The country through which the Moosejaw-Lacombe branch of the Canadian Pacific railway has been surveyed is mostly bare prairie, and the difficulty in settling this part, lying north of the Saskatchewan, is largely due to the want of fuel. A small seam of coal having been found by boring on sec. 14, tp. 32, R. 21, west of 3rd meridian, the Saskatchewan government spent considerable money in prospecting work. A shaft was sunk to the seam, and a drift run parallel to the face of the hill. The enterprise was abandoned, however, because enough coal was not found. The exposures in the vicinity show that the measures are part of the Judith River (Belly River) formation, but as they are apparently well down in the beds there is no very great chance of finding other seams below. The hills on the south side of Eagle Hill creek, as far east as range 17, west of 3rd meridian, contain practically the same rocks, with outcrops of small streaks of coal.

On sec. 18, tp. 31, R. 20, at a spring, a bore-hole was put down without finding coal. In the hill behind the spring, practically the west bank of the valley of Eagle Hill creek, a streak of brown sand with plant remains and a few streaks of coal seems to represent the same horizon as on sec. 14, tp. 31, R. 21, where 18 inches of coal was found. East of this, in a coulee crossing sec. 5, tp. 31, R. 17, west of 3rd meridian, several prospect holes have been put into the hillside. Nothing, however, but brown sandstone with streaks of coal were found.

The higher country which lies to the west of the latter place may have more of the upper beds, and there is a slight chance of finding seams in the upper part of the formation. The area will necessarily be small, as these hills are not of any great extent.

The question of fuel for this part will be solved only when railway connexion is made to the west, and the coal belt in the vicinity of Alex and Nevis is crossed. This coal field appears to be able to supply the country east, for even at present, coal is being mined there, though not to the extent that will soon be called for.

Inasmuch as the provincial government deemed it necessary to make some effort to find coal across the Saskatchewan, a visit was made to the north bank above the ferry on the Swift Current and Battleford trail. The top of the Judith River (Belly River) formation runs beneath the Pierre on the western edge of range 15, west of the 3rd meridian, at the Saskatchewan river, and the continuation of the coal seam of Medicine Hat should be found in the banks in that vicinity. Where slides have occurred in the banks a few exposures of parts of coal seams have been found, and at one of these, viz., sec. 14, tp. 20, R. 16, west of 3rd meridian, the indications are that the seam from which these pieces had slidden was of the following section:—

Clay roof.	
Lignite	2′–0″
Black slate	1′–6″
Lignite	2′–0″
Black shale	0′–6″
Soft sandstone floor.	

The Saskatchewan government was advised that boring should be done on the plateau behind, with a view of locating the seam away from the slides, before any

attempt was made to open a tunnel or sink a shaft to strike the seam. The coal contains a high percentage of woody matter, and is evidently not a high grade of lignite. The analysis of this coal, an average of the two parts, gave:—

Moisture	16·05
Volatile matter	55·05
Fixed carbon	22·35
Ash	6·55
	100·00

Dirt Hills.

South-west from Rouleau in tp. 12, R. 24, west of the 2nd meridian, several exposures of the Laramie rocks are seen, on the north-west face of the Coteau. The exposures that are visible from a distance occur on sections 22 and 27, and include many thin seams of lignite, up to 1 foot in thickness. The general appearance of these exposures, however, leads to the conclusion that they are all more or less slides, hence none of these seams can be described as in place.

On the eastern edge of the township and at the foot of the hill, coal in greater thickness has been found. On the south half of section 26, farmers have uncovered a 2 foot seam of inferior lignite. This has been taken out by stripping the surface, but this method cannot be carried on economically after the gradually increasing thickness of the cover becomes considerable. On the north-west quarter of section 24, in the side of a small gully, coal has been found with less cover, and several of the farmers have taken out fuel for home consumption. Southward the cover should amount to 50 feet, and the roof be of clay, so that mining will be difficult:—

The seam shows at the top	1′–4″
Clay parting, varying up to	0′–6″
Solid lignite, lustreless	2′–0″
Actual thickness of coal in seam	3′–4″

The grade is poor, as shown by the following analysis:—

Moisture	21·30
Volatile matter	38·05
Fixed carbon	16·09
Ash	24·56
	100·00

On the section to the south, No. 13, a small seam of about 6 inches was found, but although of much better grade, it is unfortunately too thin to mine. The following is the analysis of a sample taken from this seam:—

Moisture	18·10
Volatile matter	47·54
Fixed carbon	25·31
Ash	9·05
	100·00

NOTES ON THE PRODUCTION OF COAL IN ALBERTA AND SASKATCHEWAN.

The output of the mines of these two Provinces, as gleaned from census and provincial reports, shows a very great increase over the past. The coal production in the north-west for the four years ending 1906 is as follows:—

Production of Coal, in Tons.

—	1881.	1891.	1901.	1906.
Alberta	1,590	174,131	280,000	1,385,000
Saskatchewan			40,909	170,582
	1,590	174,131	320,909	1,555,582

The rapid rise in the rate of production suggests that it must be due to increase in population, extension of railways and introduction of manufacturing industries. This is borne out by the population returns covering the same period:—

Population.

—	1881.	1891.	1901.	1906.
Alberta	18,075	26,277	68,376	185,412
Saskatchewan	19,679	40,522	90,564	257,763
Manitoba	62,260	152,506	255,211	365,688
	100,014	219,305	414,151	808,863

The above table shows that the coal consumption is increasing at a much more rapid rate than the population of the three provinces; but as Manitoba is partly supplied from eastern markets, the population of this Province should not all be considered as consumers, and only the population of Alberta and Saskatchewan need be used in the statistical comparison. On this view, the coal production follows more closely the increase in population. In considering, therefore, the future needs of the north-west provinces, it is quite evident that if the present mines are working to nearly their full capacity, others must be opened in the near future. The first need of the population is domestic fuel. This is being supplied mainly from local mines in the lignite belt. The next demand is for facilities for the shipment of produce to market, and this means increased consumption of coal by the railways. Following increasing settlement is always the building of towns and establishment of factories, mills and other power-using works and institutions; so that not only domestic fuel, but coal for steaming and power will be in increasing demand.

This seems to be a manifest reason why the added population calls for a comparatively greater per capita consumption than when the density of population is less. The coal available in Alberta is of all grades, from anthracite to lignite, and mines producing each kind have been opened. In Saskatchewan the lower grades only are to be found.

Output of Anthracite.

Up to the present time the output of anthracite in Canada has been confined to one locality, namely, the Cascade basin in the Rocky mountains. Mining operations have been carried on at two mines. The first, at Anthracite near Banff, having worked out a small part of the area controlled, announced that the supply was exhausted. This led to the opening of a new mine on the adjoining property at Bankhead. A record of this may be read in the tabulated output of the two mines. The one at Anthracite closed down in 1903, and the new mine at Bankhead started the following year.

That the demand for anthracite was not satisfied by the previous mine is shown in the rapidly increased output that followed the completion of the installation of the new mine:—

Output of Anthracite.

	Tons.
1898	23,000
1899	22,000
1900	17,549
1901	14,742
1902	16,587
1903	5,185
1904	23,363
1905	43,653
1906	235,597
1907	305,700

The market has been extended through the west by the rapid growth of the towns, and the evident preference for hard coal for heating purposes. The source of power most in favour in these towns is the gas producer.

Owing to the trouble that the virtually inexperienced operators have with tarry matter from the softer coals, the small-sized coal from Bankhead is in common use. Larger plants are being installed, such as the power plant for the electric railway at Edmonton. This will mean a large consumption of coal. Presumably the local coal will be used as far as possible, but an admixture of anthracite will probably be found necessary. The town of Wetaskiwin is operating its electric lighting plant by means of gas producers, using anthracite exclusively.

Steam Coal.

The use of coal for the production of steam power in railway transportation is divided between the low grade bituminous and lignitic coals, and the harder bituminous that are not distinctly coking. Some of the latter, such as the Canmore coals, approximate to the anthracite class. The coal supply for locomotive purposes is derived from all the Rocky Mountain mines, except the anthracite mines, as well as from those in the vicinity of Lethbridge. In submitting statistics of output, we are compelled to make an approximation only, because the Lethbridge coal has, in some of the reports issued, been included in the returns from lignite mines.

From the table of total output, it will be seen that in 1881, with a total production of 1,590 tons, very little could have been used for railway purposes, and probably all coal used for this purpose was imported. In 1891 the total output was 174,131 tons, of which about 50,000 tons were probably used for domestic purposes. In 1901 the estimated output was 192,000 tons; for 1906 the steam coal output for the mountain areas was 546,623 tons; while it is estimated that 362,780 tons of lignite coal were also used. Between the last two dates several mines were opened on the Crowsnest branch of the Canadian Pacific railway.

The output of steam coal used in the country shows the increased production necessary to meet the demand caused by the increased mileage of the railways. The completion of the Grand Trunk Pacific railway will call for a further advance in output within a year, and it will probably be necessary to open new mines to meet the demand.

The approximate tonnage used, as noted above, is as follows:—

Year.	Local Coal Used.
1881	
1891	124,131
1901	192,000
1906	908,403

Coking Coal.

The coking coals are confined to the areas in the vicinity of the Rocky mountains. The coals of the Cascade basin are generally too hard to coke. The mines, therefore, on the Crownest branch and the areas north and south of these, are at present the only producers of coke.

Coking coal of the best grade has, however, been found north of the Saskatchewan, and when railway connexion has been opened, the market for northern British Columbia will be supplied. The production of coke in Alberta is of recent date, hence the tonnage used for this purpose is given for three years only:—

Year.	Tons.
1905	71,292
1906	103,936
1907	112,887

Lignite.

As the production of this coal altogether depends on the demand in the domestic market it should show an increase commensurate with the growth of population. That

this is the case may be seen from the following table. Manitoba being within reach of the eastern market, does not depend on the local supply to the same extent as the other provinces, consequently, a certain percentage of the coal used in Manitoba as well as in Alberta is imported. The figures are, however, in harmony with the general statement that increased population means a proportionate increase in the consumption of local coal.

Population.

	1891.	1901.	1906.
Alberta	26,277	68,376	185,412
Saskatchewan	40,522	90,564	257,763
	66,799	158,940	443,175
Manitoba	152,506	255,211	365,688

Lignite Mined—In Tons.

	1891.	1901.	1906.
Alberta	30,000	81,682	240,000
Saskatchewan	20,000	40,909	170,582
	50,000	122,591	410,582

According to this estimate, the production increases in proportion to the increase in the two larger provinces, and if this is maintained some forecast of the future output may be obtained. On the assumption that the population will become as dense as in Manitoba, it seems within the bounds of probability that a population of three millions may, within a decade or two, be found between the boundaries of Ontario and British Columbia. Assuming then that the local coal is mined as needed, there should be a maximum annual output of 2,600,000 tons of lignite and the cheaper grades of coal. The distribution of this amount, according to the needs of the respective areas, may be allotted as follows:—

	Tons.
Manitoba	150,000
Saskatchewan	1,650,000
Alberta	800,000
	2,600,000

As before remarked, Manitoba imports coal from the east and firewood from the north, while Alberta is partly supplied with a better grade of coal from the mountains.

Taking the character and value of these different coals into account, that from the Souris will supply about one-fourth of Saskatchewan and part of Manitoba, leaving three-fourths of Saskatchewan for the Alberta coals. This means that the output of the Souris mines may reach a maximum of 550,000 tons per annum.

The Alberta coal, to a maximum of 2,000,000 tons per annum, if distributed by railway lines eastward, might be adjusted under the following amounts:—

	Tons.
From Edmonton district	720,000
" Wetaskiwin district	350,000
" Lacombe district	400,000
" Kneehills and Crowfoot	350,000
" Medicine Hat	250,000
Totals from Alberta	2,070,000
Totals from Saskatchewan	550,000
	2,620,000

The main difficulty in keeping up with an increased demand is due to lack of transportation facilities, since, when coal is needed in the autumn, the railways are congested with wheat which has to be moved in the same direction as the coal. Another drawback is due to the apathy of dealers and consumers who neglect to store coal during the slack times, before the wheat shipments commence. This coal does not keep well unless stored in closed sheds, but if so treated, could be kept over summer. The loss of moisture causes the lumps to crack, so that if stored in a cool place, preferably below ground, in cellars for example, little evaporation can take place and the coal will not slack.

EXPLORATIONS ON THE CHURCHILL RIVER AND SOUTH INDIAN LAKE.

(William McInnes.)

INSTRUCTIONS.

My instructions for the past summer's work were to examine geologically and survey as much of the unexplored part of the Churchill river, including South Indian lake, as could be covered in the available time, to make certain geological examinations in the vicinity of Cumberland House, Saskatchewan, and to examine the reported mineral occurrences in the neighbourhood of Lac la Ronge, north of Prince Albert.

DESCRIPTION OF ROUTE FOLLOWED.

I left Prince Albert for Cumberland House by the Hudson's Bay Company's steamboat, on June 29. The water in the Saskatchewan river being high, little difficulty was experienced in navigating it, and we were able to follow the old channel to Cumberland, a course that can only be taken at very high water. This old channel formed, until about twenty-five years ago, the main course of the river, and is still to be preferred when the water is high enough to allow of its use. The new channel, which broke through at a time when the water in the main river was dammed back by an ice-jam, now takes more than half the water across to Sturgeon river and Cumberland lake, entering the lake by a number of small tortuous channels, none of which afford easy passage for steamboats. The water of Cumberland lake, excepting in the most northerly bays, is rendered quite murky by this sediment-laden inflow, the lake bottom is being gradually silted up and the fish, once plentiful, are being driven away. A dam at the point of outflow of the new channel would largely remedy these evils, and would be a great aid to the navigation of this part of the Saskatchewan river.

After a day at Cumberland House, the commonly used canoe route up Sturgeon-weir river was followed to Pelican narrows. Although the strength of the current makes poling or tracking necessary for a part of the way, and also occasional portages, the route, on the whole, is an easy one.

On Cumberland lake the banks were submerged in most places, and no outcrops of hard rocks were seen until Whitey narrows was reached, where low exposures of magnesian limestone, probably of Trenton age, outcrop. Other exposures of hard, yellowish-buff, magnesian limestone or dolomite, with dark brown thread-like markings and unidentifiable casts of brachiopodous shells, were seen on the shores of Namew lake. At a short rapid, a quarter of a mile above the junction of Goose and Sturgeon-weir rivers, yellowish-buff dolomites outcrop, very similar in general character to the upper beds exposed at Cormorant lake. The shores from this point to just below Amisk lake are made up of silt and clay, forming generally narrow ridges along the immediate banks, with low flat land behind.

Along the south-west shore of Amisk lake are almost continuous exposures of flat-lying or gently undulating, heavy bedded magnesian limestone, underlain by thin bedded dolomites. The more rapid disintegration of the lower, thin bedded strata causes the formation of cliffs that rise two or three chains back from the shore to heights of from 20 to 40 feet. These are often flanked with outstanding, detached, tower-like masses, while the intervening space is covered by a very rough talus of large, angular blocks from the cliff face.

The lithological resemblance of these rocks to those which, at Cormorant lake, hold Trenton fossils, and the fact that recognized Silurian forms have been detected only in the rocks at the southern end of Cumberland lake, leads to the belief that, all the sedimentaries north of the south shore of the lake should be included in the Trenton, the line of separation between them and the overlying Silurian probably traversing Cumberland lake in a nearly east and west direction just north of Cumberland House.

The cliff above referred to continues in a northerly direction up Sturgeon-weir river, forming the right bank of the stream as far as the first portage, while black and white biotite gneisses, nearly vertical in attitude, are exposed at intervals in low, rounded ledges, on the east bank. The same gneisses, the finer black predominating, cut by occasional sheet-like intrusions of coarse white biotite gneiss approaching a pegmatite in character with fairly uniform north-westerly dips, at angles varying from 45° to 80°, are exposed here and there along the river, to Pelican narrows.

At Heron lake, the next below Pelican narrows, Sturgeon-weir river was left and one of its tributaries ascended easterly through Waskwei and Attiti lakes, for a distance of about 30 miles to Kakinagamak lake. Thence Nemei river was followed for about 40 miles to the Churchill river, which it enters where the old Sturgeon House post of the Hudson's Bay Company was situated.

Biotite gneisses, striking generally north-westerly, form low ridges, occasionally partly sand-covered, between Heron lake and the divide. The forest growth is for the most part small, and the land rocky or sandy.

Kakinagamak lake has a length in a north and south direction of about 20 miles, lying in a narrow trough between low hills of gneiss. It empties northerly by a short stretch of river into Nemei lake and thence by a larger river course into Churchill river.

On Nemei lake and river the sand ridges are replaced by clay, which as the valley of the larger river is approached, covers the lower land between the gneiss ridges, to depths of from 20 to 30 feet.

Churchill River.

The Churchill river, from where Nemei river enters, to Pukkatawagan lake, is a succession of lake-like expansions connected by short stretches of swift water and rapids.

Banded, fine to medium-grained biotite gneisses, invaded by sill-like sheets and irregular masses of coarse white biotite gneiss, and by coarser pegmatites composed mainly of orthoclase feldspar and quartz, are well exposed at many points along the river. Their general strike swings to about east, with a northerly dip, at angles of from 40° to 70°, although showing minor crumpling. Certain bands in the finer gneiss are highly garnetiferous.

Pagato and Loon rivers, draining large lakes of the same names, enter the Churchhill river from the north, at the elbow where it turns eastward, directly north of Sisip lake.

From Pukkatawagan to South Indian lake (the lake of the Southern Indians) the river preserves its character as a chain of lakes, with short connecting links of rapids and falls. The land on either side as the river is descended becomes somewhat lower, and the islands and lower parts of the mainland are covered with a good mantle of light brown, friable clay, presenting considerable areas of good, cultivable land.

Biotite gneisses, similar in a general way to those occurring along the river above, are seen in the ridges or projecting from beneath the overlying clay, all along this part of the valley. Pegmatite intrusions are common, and the strata generally, although preserving in a broad way the same trend as above, are more contorted and crumpled. They include hornblende phases at a few points.

South Indian Lake.

A track survey checked by noon latitudes was made of the route followed from Pelican narrows to the entrance of South Indian lake, and a micrometer survey of the

lake itself. It was found to have a length of about 90 miles, an extreme width of about 15 miles, and owing to its deeply indented and irregular outline, a length of shore-line, disregarding bays and points of less extent than half a mile, exceeding 700 miles.

It is comparatively shallow and dotted with islands—the positions of 800 were approximately fixed—with areas varying from 25 square miles to quite small. The water of the lower half of the lake is turbid like the water of the Churchill river, while the upper part, above the outflow of the Churchill, is quite clear, like the water of the Muskwesi, a river of considerable size that empties into one of the northerly bays. About the southern end and the bays on the south-eastern side, the valleys, between low ridges of gneiss, are covered by a light brown friable lacustrine clay that is, with little doubt, continuous with that of the lower Burntwood River area and, like it, the result of deposition in ice-dammed, glacial waters. Adjoining the clay covered area on the north is a sand covered area, that apparently marks the rim of the old lake basin in which the lacustrine clays were laid down. The north end of the lake and the long bays on the west side extend into a flatter country, with less relief, where low ridges of gneiss, the flanks sparsely covered with sand, rise from extensive areas of black spruce and tamarack muskeg.

The rocks exposed about the lakes are for the most part banded biotite gneisses, varying in character from mica schists to granite gneisses and cut by numerous intrusives, including coarsely porphyritic red granites, fine red granites and pegmatites. These later rocks occur as intrusive masses of sometimes great extent, as sheets or sills, and as dikes or areas penetrating the gneisses. The gneisses, which are generally banded and stratiform in aspect, vary in dip from north-west to north-east and in angle from about vertical to horizontal, influenced largely by the intrusive masses that cut them. Fresh water-worn surfaces 4 feet above present high water level, on which the lichen and mosses are only beginning to grow, as well as accumulations of old drift wood, indicate an older high water level perhaps 50 years old, when the volume of water carried by the river was greater than now. The wide extent of smooth, clean rock surfaces that are thus exposed both on South Indian lake and along the Churchill river, offers a good opportunity for the study of the gneisses and associated rocks.

Upper part of Churchill River.

On the completion of the micrometer survey of South Indian lake, the Churchill river was ascended to the mouth of Nemei river and the track survey continued to Stanley, although for the portion above Frog portage a micrometer survey by Fawcett was available. The 60 mile stretch of river between the mouths of Nemei river and Reindeer river was the only bad piece of water encountered during the summer. In this distance a number of rapids and falls, including the Wintego, a rather bad, crooked rapid at the foot of Wintego lake, make eleven portages necessary and the ascent of the river somewhat tedious. For the whole distance of 70 miles intervening between Reindeer river and Stanley, the lake-like character of river channel before described is repeated. The shores are generally rocky, with here and there a thin cover of sand and gravel or sandy clay. At Frog portage the waters of the Churchill overflow to the south in a stream of considerable volume—large enough for the passage of York boats, excepting at the rapids—and make their way by Pelican narrows and Sturgeon river to the Saskatchewan river at Cumberland.

Between Nemei river and Stanley, with the exception of a few exposures of quartzose mica schist at Grand and Key rapids, that are possibly highly altered phases of Keewatin rocks, occurring as infolded bands in the gneisses, all the rocks exposed are biotite gneisses, varying from coarse to quite fine and schist-like.

Lac la Ronge.

From Stanley the route by Three Portage brook was followed to Lac la Ronge. Fine black and coarser, white biotite gneisses with narrow bands, never more than a few chains wide, of highly altered chloritic mica schists, and quartz schists occur all along the route to the lake and down its shores to near the southern end, where sand and boulders, without exposures of hard rock form the shores. The narrow schistose bands are probably infolded, highly metamorphosed Keewatin rocks, and possibly represent the tapering ends of a broader belt of these rocks, projecting from beneath the sedimentaries that overlie the country to the south.

The schist bands have been extensively squeezed and crushed and are, to a greater or less extent, impregnated with sulphides of iron and copper, the former often in considerable quantity, but the latter as far as observed, in comparatively small quantities.

On these bands, that in places weather to a gossan almost, numerous mineral claims were located during the summer; at Long point, near Moose portage, on a large island in Sucker bay known as Mineral island, and on a number of smaller islands.

With the exception of a few shots on some of the ledges, no work had been done on any of the properties at the time of my visit, and their probable value could be judged only from surface indications. The assays detailed below were of specimens collected, in the absence of prospectors or claim owners to act as guides to their properties, from locations on the lake shores, and thought to represent average samples from some of those showing the best surface indications.

1. Locality—Long point, Lac la Ronge, Sask.
   Gold.. .. .. Nil.
   Nickel.. .. .. Trace.
2. Locality—Mineral island, Lac la Ronge, Sask.
   Gold.. .. .. Nil.
3. Locality—Mineral island, Lac la Ronge, Sask.
   Gold.. .. .. Nil.
   Nickel.. .. .. Trace.

These results are, to say the least, not encouraging. No assays were made of material from the copper claims, as chalcopyrite was not seen in sufficient quantity on any of them to be economically promising.

Country south of Lac la Ronge.

Time did not permit of a further examination of the country to the south of Lac la Ronge, and the route followed to Prince Albert by way of Montreal river and lake afforded no exposures. It seems probable, however, from the occurrence at a number of places on the south shore of Lac la Ronge of beaches and points made up almost exclusively of angular debris of a yellowish, hard, magnesian limestone, and the absence of exposures of other rocks *in situ,* that a rim of Trenton rocks is in place beneath the drift deposits. The undoubted occurrence of outcrops of lignite coal on some of the streams flowing into the southern end of the lake indicates that the overlapping edge of the Cretaceous is at no great distance south from the lake shore.

ECONOMIC GEOLOGY.

With the possible exception of the mineral occurrences in the neighbourhood of Lac la Ronge, referred to on another page, and of lignite coals in the Cretaceous rocks south of that lake, no minerals of commercial importance are known to occur in economic quantities in the area covered this summer.

I was shown specimens in the possession of Indians at Pukkatawagan lake, of gray copper and molybdenite, that they claimed, probably with truth, were found at points not far from the main Churchill river.

On the east shore of South Indian lake a large, angular boulder of impure hematite ore was found. Although certainly not derived from the rocks in its immediate

neighbourhood, it is of interest from the fact that it is improbable that a large angular block of ore would be carried for a very long distance from its point of origin.

GLACIAL GEOLOGY.

Evidences of glacial action in the form of polished and striated rock surfaces, erratics and morainic and other accumulations of ice borne material, are well displayed over most of the region.

Striae all about South Indian lake are very well marked, showing ice movement in two principal directions, viz., S. 48° W. and S. 64°, with many deviations as much as 10° from each of these directions.

FORESTS.

The forest growth is not large anywhere in the region traversed, although the occurrence of white spruce of good size in small stands and as scattered single trees, indicates that if forest fires could be prevented the valleys, at least, would support a valuable growth of white spruce.

The higher land and the greater part of the valleys now show only second growth forest from 60 years to only a few years old. Aspen and Banksian pine are the most numerous among the trees gorwing up, but white birch, the three varieties of spruce, and balsam poplar are included.

FISH AND GAME.

Sturgeon, whitefish, doré and pike are plentiful in the larger lakes and streams throughout the district, the two first named being particularly large and fine in the Churchill where, however, the distribution of sturgeon is confined to the waters east of Kettle fall. Lake trout were caught in Lac la Ronge and Attiti lake, and are known to occur in many other clear water lakes in the region.

Moose are fairly plentiful in the country north of Cumberland, between the Saskatchewan and Churchill rivers, also along the last-named river to about the southern end of South Indian lake, and are particularly abundant in the low land bordering the Montreal river. Wapiti are found in considerable numbers to the south of Montreal lake, and woodland caribou in the northern part of the moose country. Barren ground caribou in their winter migration cross South Indian lake in large herds, leaving it at a point about three-quarters down its western side, travelling towards Reindeer lake. Jumping deer have been reported recently in the country immediately north of Cumberland.

ARABLE LANDS.

The lacustrine clays that cover a large part of the region lying between the head of Pukkatawagan lake and the outlet of South Indian lake form practically the only cultivable soils in the area. They are well developed on the long bay extending southerly from South Indian lake towards Burntwood river, and probably cover a large part of the country lying between the Churchill and the lower Burntwood river.

Many large tracts along the Churchill lying within the clay area are apparently well adapted for settlement. At Pukkatawagan lake, where the Indians have a few log houses, small fields of potatoes are cultivated, and on September 3 excellent potatoes were obtained from the Indians at that place. Barley, I was informed, had been successfully grown there. At Stanley, which was established in 1851, and abandoned in 1893, as a principal district post of the Hudson's Bay Company, a cleared flat of clay land was once cultivated, and grain of various sorts successfully grown. In the garden now maintained most of the common garden vegetables as well as potatoes were growing on September 16, and no frost had been experienced up to that time.

Outside of the lacustrine clay basin most of the land is either rocky or too sandy to be attractive, excepting that extending from Montreal lake to the Saskatchewan, where are large areas of alternating heavy clay and light, sandy clay well adapted for cultivation.

Mr. Chester P. Brown, a student in science at Toronto University, who acted as my assistant in 1897, filled the same position during the past season. His work was satisfactory in all respects.

Additional samples from the Lac la Ronge district were received during the winter from the Board of Trade, Prince Albert, through the Bureau of Information and Statistics, Department of Agriculture, Regina.

Assays of these gave the following results:—

(1) Pyrrhotite—	
Gold	0·08 oz. per ton
Silver	0·35 oz. per ton
(2) Chalcopyrite—	
Copper	8·10 per cent
Gold	trace
Silver	0·25 oz. per ton
(3) Chalcopyrite—	
Copper	8·50 per cent
Gold	trace
Silver	trace

The above assays, it will be observed, give results quite in accord with the earlier ones published in this report.

The results of the assay of a sample of crushed pyrite received from the same source as the above, are not given, as the Department makes it a rule, in cases of this kind, not to deal with crushed or concentrated samples, but only with those received in their original condition.

SURVEY OF THE SOUTH COAST OF HUDSON BAY FROM THE SEVERN RIVER TO CAPE HENRIETTA MARIA.

(Owen O'Sullivan.)

ROUTE TRAVERSED.

On May 23 I left Ottawa for Winnipeg, where I secured the services of Mr. Jos. de Lorimier, who was with me in 1905. I took passage on the steamer *Premier*, from Selkirk to Warrens landing, reaching Norway House by the Hudson's Bay Company's tug, on June 5.

At Norway House I engaged two canoemen for the whole trip, and on June 9, left with three canoes and seven men for York Factory, via the Nelson and Hayes rivers. We arrived at York Factory on June 27, and here learned that the ice of Hudson bay was still fast to the shore, making the navigation of the coast impossible, even with canoes. Upon the advice of Mr. Learmouth, the gentleman in charge of York Factory, we proceeded to Severn post by an inland route, leaving York Factory on July 1. We accordingly went up Hayes, Shamattawa and Sturgeon rivers, through Sturgeon lake, and, following a small creek, arrived at a portage about 2 miles long, which brought us to Castorum river, a branch of the Severn. Following the Severn downwards, we arrived at Severn post on July 16, after a journey of over 300 miles. A track survey was made of the route.

On July 18, we resumed our survey eastward to Cape Henrietta Maria, arriving there on September 12, after traversing a distance of over 300 miles.

This summer's work completes a continuous survey of the coast from Point Comfort, on the south shore of James bay, to York Factory on the west coast of Hudson bay, a distance of nearly 1,000 miles. The whole of this survey was made by myself with the same micrometer, under the same conditions, and was checked by astronomical observations.

PHYSICAL FEATURES.

Only two rivers of any importance flow into this part of Hudson bay. The Winisk, at the 125th mile from Severn post, is the larger of the two. It was surveyed and reported on by Mr. McInnes in 1903. The other, Trout river, enters the bay 200 miles from Severn post. This stream was surveyed and reported on by Messrs. Dowling and Boyd in 1901. The mouths of both of these rivers are quite shallow. The Winisk has a main channel, but the Trout river widens to a shallow estuary on entering the bay. There are several other streams flowing into Hudson bay, principally between the Severn and Trout rivers, but they all could be waded at half tide.

The coast between the Severn and Cape Henrietta Maria is of very much the same character as between the Severn and York Factory. The high tide line, which I attempted to follow, runs from Severn post eastward with but few irregularities for a distance of 230 miles. From there it is broken by points of limestone running out to sea in a north-easterly direction, and forming bays and points at intervals along the coast to Cape Henrietta Maria. The shore is low and flat, and in places the tide runs out a distance of 4 miles, leaving mud flats with many exposed boulders. There are many of these boulders between the Severn and Winisk, and they become still more numerous as one goes eastward to Cape Lookout, 184 miles from Severn post. Beyond Cape Lookout to Cape Henrietta Maria, many irregular reefs of boulders were observed reaching nearly to high tide water, and running out to sea as far as the eye could reach.

Between high tide and tree line, old beaches made up of sand and gravel running nearly parallel to the present high tide line, were noted. These ridges are more regular in the first 200 miles than in the last 100 miles. They sometimes run for a distance of 5 or 6 miles without interruption. As a rule they are about one or two chains wide, with an elevation of from 1 to 10 feet above high tide. Generally four prominent ridges could be seen between high tide and tree line. Dry mud flats, grassy flats, salt marshes and fresh-water ponds or lakes occupy the spaces between these ridges, which run parallel with one another at distances of from a few yards to over a mile.

FLORA AND FAUNA.

The country inland appears to be swampy and moss-covered. It is thinly wooded with low black spruce and tamarack having an average diameter of about 5 inches. In the first hundred miles from Severn post, the tree line is from 1 to 3 miles from high water mark. It then takes a south-easterly direction to the Opinnagan river, flowing into James bay, leaving the area northward to Cape Henrietta Maria open, barren and moss-covered, with numerous fresh-water lakes and ponds, the largest lake seen measuring about 3 miles long by 2 wide.

The trees come closer to the coast at the mouth of the Winisk and Trout rivers. A black spruce bluff was noted opposite a place 165 miles from Severn post. A fringe of willows and juniper bushes was generally found before reaching the tree line.

Ducks in thousands were seen late in August. The most common were pintails, teals and mallards.

ICE.

From July 21 to September 12, floating ice was constantly in sight. Large fields of ice could always be seen at about 3 or 4 miles from high tide. This ice was driven inshore by strong north winds during August and September. On two occasions, August 26 and September 8, it was necessary to portage outfit and canoes on account of the ice being shoved up on reefs near high tide mark, and on the first of these occasions, one stranded block was seen having a thickness of over 10 feet.

RETURN JOURNEY.

Our homeward trip was made southward, via James bay. We arrived at Fort Albany on October 1, and left on October 5, following the Albany river up to a point where the English river joins. We went up this branch as far as Long lake. Leaving Long lake on October 29, we crossed over to the head of the Pic river. During the night of October 29, a severe frost froze all the small lakes and still water of the stream, but by breaking the ice it was still possible to continue the journey. Another frost on November 7, however, rendered further canoeing impossible. Heron bay, on the Canadian Pacific railway, was reached on November 11.

THE REGION IN THE VICINITY OF LAKE NIPIGON, THUNDER BAY DISTRICT, ONTARIO.

(Alfred W. G. Wilson.)

In accordance with instructions received in May last, the writer, assisted by Mr. Robert Harvie, jr., has been engaged in obtaining information required to complete the two standard map sheets which cover the area in the vicinity of Lake Nipigon, District of Thunder bay, Ontario. We were occupied in field work from the first of June until the end of October. During the first portion of the season Mr. Harvie and the writer worked together in making a micrometer survey of the Blackwater and Sturgeon rivers to the east of Lake Nipigon. During about half the period devoted to the field work Mr. Harvie was employed on general mapping in parts of the area, while the writer was engaged on similar work in other parts for the same map sheets.

Only a small portion of our time had to be devoted to strictly topographic work, this information having already been compiled from the work of members of the Geological Survey staff in previous years, and from the various land surveys and railroad surveys that have traversed the district in all directions. Because of the extent of these surveys we were able to pay closer attention than usual to the geological mapping, and in the prosecution of this work we made numerous sections into the hitherto unexplored areas lying between the courses of the principal streams tributary to Lake Nipigon. The data which we have obtained will enable us to compile both these map sheets with very considerable detail.

The work of the summer was largely a review, compilation and extension of the previous work of members of the staff, including the present writer, in 1901, in the same field, and while it has resulted in an increased knowledge of the detailed geology there are few additional data of economic importance to be noted here.

In the south-west quarter of the area, between Black Sturgeon lake and Nonwatin lake, when the writer visited the locality in 1901, there was said to be an iron range of considerable extent, and during that and the succeeding season numerous claims were located along the supposed range. The results of the detailed examination made this summer, largely the work of Mr. Harvie, show that there is no iron range in the sense in which that expression is generally used. On many of the claims specular hematite occurs in small, more or less ramifying veins in a granite and in a schist, the hematite being very pure. It occurs also as a cement between the fragments of a breccia, these fragments being either granite or schists. The exposures showing ore occur along a north-west and south-east line running between Nonwatin and Black Sturgeon lakes, at the foot of a strong escarpment. There are reasons for believing that this escarpment represents an old fault line, the cemented breccias being fault breccias which have subsequently become impregnated with the pure hematite by infiltration. We saw no large masses of ore, the several diamond drill holes that have been put down on some of the properties do not seem to have disclosed any large bodies of the hematite, and I feel justified in stating that the geological conditions are such that it is extremely improbable that any bodies of ore of commercial importance occur in this locality, at any rate none have been discovered.

With reference to the iron ranges at Poplar Lodge and east of it, on the east shore of Lake Nipigon, they were partially investigated by several mining corporations between the years 1901 and 1903; during the seasons of 1906 and 1907 detailed geological studies were made for the Ontario Bureau of Mines by Dr. A. P. Coleman and his assistants. Under the circumstances we did not consider it either necessary or

advisable to attempt to make further examinations of the ranges, since the time could be more profitably employed elsewhere.

In the northern part of the area, in the vicinity of Round lake on the Mud river, about 6 miles north of the location of the National Transcontinental railway, other iron ranges are said to occur. As this district was being explored in detail by Mr. S. E. Moore, for the Bureau of Mines, during the present season, we did not attempt to do additional work in the area.

North-west of Lake Nipigon, in the north-west corner of the area under review, extending beyond the boundaries of the present map sheets, and including also practically all the country between the Mud river and Caribou lake, is a large area of Keewatin rocks that appear to the writer as possibly worthy of the attention of prospectors. No minerals of economic importance were found in the locality by us. In 1906 Mr. Collins noted the occurrence of some very small areas of iron ore in the vicinity of Caribou lake which are not of economic importance.[1]

We also noted some very narrow patches of a conglomerate that may probably represent the Upper Huronian conglomerate of the Poplar Lodge iron ranges. Other basic rocks similar to those at Poplar Lodge occur east of Caribou lake, and small patches of diabase, so widely distributed in the areas east of Port Arthur are also found here. While the results of the exploration of the two localities in which hematite has been found in the Lake Nipigon district have been largely of a negative character, and while this third area, still unexplored by the prospector, seems to be of very similar nature, its true value cannot be known until further work has been done.

Prospectors informed us that some finds of a nickel-bearing pyrrhotite had been made to the north-east of Lake Nipigon, not far from Marshall lake, but no specimens were submitted for examination and we were not able to confirm the information.

[1] W. H. Collins, Report on a portion of North-western Ontario traversed by the National Transcontinental railway, Geological Survey, 1908. No. 992, p. 21.

SIMCOE SHEET, ONTARIO.

(W. A. Johnston.)

During the past field season the topographical and geological mapping of the Simcoe sheet was continued according to instructions.

FIELD WORK.

On June 22, I proceeded to Orillia, Ont., where I was joined by Jas. Hill, M.A., B.Sc., of Stratford, Ont., Bert. A. MacKay, of Cornwall, Ont., and R. L. Junkin, of Toronto, who acted as my assistants during the season's work, which lasted until October 26.

While the mapping of the Simcoe sheet was being carried on by my assistants, I spent about seven weeks in midsummer with Mr. F. B. Taylor and Dr. Goldthwait, in leveling the Algonquin and Nipissing beaches in Ontario, and in studying the drift deposits of south-eastern Ontario.

The topographical work on the Simcoe sheet has been extended to the west side of Lake Simcoe, and during the past season portions of the townships of Mara, Rama, North and South Orillia, Oro and Vespra were mapped. In connexion with this work transit and chain lines were run along the railways, forming a basis of control for road traverses, which were made by compass and odometer. Instrumental levels were taken over all the roads traversed and contours at intervals of 25 feet put in. The precise levels taken by the Department of Public Works in connexion with the Georgian Bay Ship Canal survey along several railways in the Simcoe district, form an excellent basis for our levels.

GENERAL GEOLOGY.

One of the most important points in connexion with the geology of this part of Ontario is the determination of the age of the basal members of the Palæozoic series of limestones, shales and sandstones, which rest unconformably upon the Pre-Cambrian rocks. This has been a matter of dispute and uncertainty ever since the first work of the "Survey," in 1852, by Mr. Alexander Murray, in the district lying between Kingston and Lake Simcoe.

Mr. Murray describing the section of Marmora, Ont., which is similar to the section at Langford noted below, says:[1] The upper beds of the previous section are evidently part of the Birdseye formation, but in what part of the 80 feet to draw a line as its base, it is not easy to say.

The lowest fourth of the section is supposed to belong to the Calciferous sand rock, and it may be the case that the second quarter, including the beds marked by the intersecting lenticular crystals of calcspar, may belong to the Chazy, but there is as yet no satisfactory way of proving it."

Regarding the same section it was later stated:[2] 'In this section there appears to be such a passage from the arenaceous beds at the bottom of the compact limestones which become fossiliferous at the top, as to induce the supposition that the whole belong to the formation named (Birdseye and Black River), notwithstanding the two Chazy species found at Vanluvins Mills.' The section at Vanluvins Mills is also described and a list of fossils from the lower portion of the section is given, regarding

1 Report of Progress, Geological Survey, 1852-3.
2 Geology of Canada, 1863, p. 182.

which the following statement is made:[1] '*Leperditia Canadensis* ranges from the Chazy into the Birdseye and Black River, but the presence of *Pleurolomaria pauper* and *Bathyurus Angelini*, in the upper portion might lead us to refer this to the Chazy, notwithstanding the occurrence of *Tetradium fibratum*, which has not hitherto, in other places, been found lower than the Birdseye and Black River formations; unless indeed some of the perforations taken for *Scolithus*, in the Potsdam, be not rather impressions of that fossil.'

On the Madoc map sheet prepared by Mr. Eugene Coste, in 1886, the lowest Palæozoic sediments are mapped as Birdseye and Black River, but later[2] Mr. Coste refers the basal arenaceous beds to the Calciferous. On the Bancroft map sheet (1905) outliers of similar character are referred to the Black River.

Wilson and Graham[3] regard the sandstone at the base of the limestones in central Ontario, west of the Frontenac axis, as the basal arenaceous member of the Lower Black River.

Throughout this area the limestones dip gently to the south or south-west, away from the old land to the north, and generally present a steep escarpment at or near their contact with the Pre-Cambrian crystalline rocks. This escarpment varies from a few feet to upwards of a hundred feet in height, and can be traced more or less continuously all the way from Kingston to Georgian bay. Numerous quarries have, of late years, been opened along this escarpment, affording good sections of the limestone, shales, etc., from the base of the Trenton down to the Pre-Cambrian.

The Trenton limestones, generally consisting of thin-bedded, blue to black, somewhat shaly and nodular limestones, everywhere abounding in fossils, underlie the greater portion of the district. They pass downward into the limestone of the Black River formation. This formation, although only about 20 feet in thickness, is remarkably continuous and uniform in character, both lithologically and palæontologically. It consists of massive dark coloured limestone, containing a great abundance of characteristic large fossils, such as *Columnaria Halli, Stromatocerium rugosum*, etc., and forms an easily recognizable horizon. These coral beds form what is understood to be the Black River formation proper, that is, not including the Birdseye. The Black River beds are evidently continuous across the Frontenac axis from the Ottawa basin to the western or Ontario basin, except where they have been removed by erosion. In the Ottawa basin, a bed of fine-grained, dove-coloured limestone a few feet thick at the base of the Black River proper, is not sharply delimited from the Black River above nor the Chazy below, and for this reason, though formerly referred to the Birdseye, it was later included in the Black River, and the term Birdseye dropped altogether. Mr. Walter R. Billings of Ottawa still holds, however, that these beds should be referred to the Birdseye.[4]

West of the Frontenac axis, the dove-coloured limestones attain a considerable thickness and show a marked contrast, both lithologically and palæontologically, to the overlying Black River strata. In the district lying between and to the north of Lake Simcoe and Balsam lake, the Black River limestone has been eroded, exposing the underlying beds; hence, in the areal mapping of the district, the determination of the age of these local limestones, shales, etc., becomes more important.

In the last Summary Report these beds were doubtfully referred to the Birdseye (Lowville) and were thought to represent a formation deposited in Upper Chazy time, but in a basin separated from the Ottawa basin by a land barrier at the Frontenac axis. Further interest has been created in this subject and considerable light thrown upon it by the work during the past year of Messrs, Cushing, Ulrich and Ruedemann,

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1 Geology of Canada, pp. 177-178.
2 Report of Bureau of Mines, Ontario, 1906.
3 Canadian Record of Science, Vol. IX., p. 132, Bulletin Geological Society of America, Vol. XVII., p. 584.
4 Ottawa Naturalist, Sep., 1908.

in the north-western portion of New York state, a district also lying to the west and south of the Frontenac axis, where apparently similar formations are exposed.[1]

In north-western New York, according to Mr. Cushing,[2] the first formation below the Black River is the Lowville (Birdseye), having a thickness of 60 to 75 feet, and consisting of blue or dove-coloured fine grained limestone, with beds of thin, shaly limestones, which constitute nearly one-third of the formation. Regarding this formation he says:[3] 'The Lowville limestone, while typically developed on the south and west sides of the region, is but thinly developed in the Champlain valley, and is not sharply delimited from the formation above or below, as in the Mohawk and Black River valleys.'

Below this comes a closely related formation which Mr. Cushing has provisionally named the Pamelia. It consists of[4] 'blue and dove limestone, with intercalated magnesian limestones, and in the upper half of the formation, much whitish, impure limestone, and some yellow water-lime; a thin basal sandstone and overlying shales,' and has a thickness of from 40 to 140 feet.

Regarding this formation he says:[5] 'The Pamelia represents a formation deposited in Chazy time, but in a wholly separate basin.' He regards it as equivalent to the whole or a part of the upper division of the Stones River formation of the western basin. Beneath this formation and separated from it by an unconformity, both by erosion and overlap, lies the Theresa formation, supposed to be equivalent to the lower portion of the Beekmantown (Calciferous), and the Potsdam sandstone forms the base of the series. The maximum thickness of the formations below the Black River in north-western New York, as given by Mr. Cushing, is 375 feet, whereas in central Ontario the greatest thickness of the series below the Black River, seen in any of the sections, is only about 80 feet.

At the Longford quarries on the west side of Lake St. John, in Rama township, county of Ontario, a very good section is exposed. The north and east sides of the lake are occupied by the Pre-Cambrian granites and gneisses. Along the west side, an escarpment in the limestone is developed, in the face of which a number of quarries have been opened. The beds exposed along the shore have a slight dip towards the south-west, but near their contact with the crystalline rocks, are tilted up at a high angle and are apparently faulted, while the actual contact is concealed by drift. In the quarries, about 4 feet of the Black River limestone are exposed at the top in two heavy beds, containing an abundance of the characteristic fossils of the Black River, such as *Columnaria Halli, Stromatocerium rugosum,* etc., and a 6″ bed at the bottom is a mass of *Tetradium fibratum.* Below this are 12 feet of fine-grained blue and dove-coloured limestone, containing great numbers of *Leperditia,* but comparatively few other fossils.

These beds become somewhat shaly and impure toward the base, and weather white. Below these are about 30 feet of impure magnesian limestones, weathering brownish to pink, interbedded towards the base with thin-bedded blue to dove-coloured fossiliferous limestones. The base of the series, seen a short distance to the north-west of this locality, consists of about 20 feet of red and green, calcareous and arenaceous shales, with a few feet of coarse sandstone or arkose resting on the eroded surface of the Pre-Cambrian.

No breaks have been detected in any of the sections in central Ontario, and the whole series of formations from the Trenton down appear to be perfectly conformable.

It is possible that the thinned shoreward edges of some of the formations found below the Black River by Mr. Cushing, in north-western New York, are represented in this section, and that the true solution of the difficulty which has been experienced

1 Bulletin of the Geological Society of America, Vol. XIX., pp. 155-176.
2 Op. cit., p. 159.
3 Op. cit., p. 172.
4 Op. cit., p. 159.
5 Op. cit., p. 172.

in determining the age of these limestones, etc., in Ontario, in the absence of definite fossil evidence, is found in the assumption that they were laid down in a basin, separated from the Ottawa basin by a land barrier, at or near the Frontenac Pre-Cambrian axis. If this is so, the limestones, etc., below the Black River in central Ontario should be more easily correlated with the formations of the western basin.

A number of fossils have been obtained from the limestones towards the base of the section above-mentioned, which have not been determined, and until this is done nothing definite can be said regarding their age. It is probable, however, that neither the Calciferous (Beekmantown) nor Potsdam, are represented in the district at all, as there is no sign of any unconformity at the base of the limestone and the basal sandstone, or arkose, is always local in character and distribution, while occasionally beds of pure limestone, similar to the limestones higher up, are interbedded with the arenaceous beds down to the very base of the series.

The critical locality with regard to the question as to whether a land barrier existed separating the Ottawa basin from the western basin during the deposition of the sediments prior to the Black River is the Brockville-Kingston area, which has long been known as the Frontenac axis. This district has been described by Mr. Ells in the Summary Report for 1901, and later in a second paper[1] where he notes the difference between the relative succession of the several formations between the Potsdam and the Black River, on the two sides of the Frontenac axis. Regarding the limestone series about Kingston, on the west and south side of the axis, he says: 'Unless it is possible to correlate the lower 100 feet of this limestone series with the Chazy of the Ottawa basin it is necessary to extend the Black River formation downward to a very much greater thickness than is found anywhere else in eastern Ontario, since the true Black River strata, with the characteristic fossils of the Ottawa River basin, occupy only the upper portion of the formation.' Limestones similar to those found at Kingston occur beneath the Black River, throughout central Ontario, but so far as known no typical Chazy fossils have been obtained from them, hence the difficulty of referring them directly to the Chazy. The alternative seems to be to assume that these limestones, if they belong to a separate formation, were laid down in a separate basin and represent the shoreward edge of a formation of the south-western basin.

A few miles up the Rideau from Kingston Mills, a considerable thickness of sandstone, which is apparently conformably overlaid by Black River limestone, is exposed. This sandstone is regarded by Mr. Ells as Potsdam in age, representing the western extension of the Potsdam-Calciferous area of the Ottawa basin, since he states[2] that the sandstone has been traced by numerous outcrops up the Rideau to Westport, at the summit level of the canal, where it passes upward through the Calciferous and Chazy formations into the Black River limestone. If the sandstone exposed along the Rideau above Kingston Mills is Potsdam in age, the conformity with the overlying Black River limestone is only an apparent one as both the Chazy and Calciferous are lacking near Kingston Mills.

On the above supposition the Frontenac axis must have been affected by differential elevation during Cambro-Silurian time, and this is also borne out by the peculiarities of deposition in the Kingston district, by which at the same level and apparently in the same basin, different formations were laid down. Regarding this Mr. R. W. Ells says:[3] 'It would seem that in this portion of the Province of Ontario, as also in a part of the strata of New York adjacent on the east, the regular sequence of these formations has been affected by causes not directly observable at the present time, by which certain members of the geological scale have been omitted. Such gaps have not been caused by faulting, but are due rather to local differences in elevation which have affected certain portions of the area in question, since practically on the same

1 'Notes on some interesting rock contacts in the Kingston district,' Trans Royal Society of Canada, 1903.
2 Op. cit.
3 Op. cit.

present general level, and within a comparatively limited space, we find different formations ranging from the Potsdam to the Black River, constituting the lowest beds which rest upon the Archaean floor.'

The base of the limestone series at Kingston and westward throughout central Ontario appears to be everywhere similar in character, consisting of sandy and calcareous shales and grit or arkose, generally quite thin and rarely more than a few feet in thickness. In the Simcoe district the shales have a thickness of 20 feet, and seem to show the gradual thickening westward of the lower part of the formation. The logs of numerous borings made in Ontario, show the occurrence of similar sandstone or arkose at the base of the column. For example, in borings at Belleville there was reported to be found at the base immediately above the Archaean, a thickness of 4 to 8 feet of sandstone or arkose; at Whitby, 8 feet; at Toronto, 10 to 20 feet; at St. Catharines, 27 feet; in Peel township, Wellington county, 51 feet; and in Osprey township, Grey county, 47 feet. The coarse conglomerate commonly found at the base of the Potsdam in the Ottawa basin is almost entirely wanting, and the sandstone differs from the Potsdam in that it is always more or less calcareous.

It would therefore appear to be possible that the area lying to the south and west of Kingston was above the sea during or prior to the time of deposition of the sandstone of the Rideau district, and formed a land barrier shutting off the waters of the south-western sea from those of the Ottawa basin, until by its gradual subsidence the encroaching waters deposited the sandstones, shales and limestones found below the Black River in the Ontario basin. Not until Black River time was the submergence complete and the limestones laid down continuously across the Frontenac axis. If this was the case the limestones, etc., below the Black River in the Ontario basin should be the near shore equivalent of either the Lowville (Birdseye) or Stones River of the western basin, and a comparison of their respective fossils should determine this.

To recapitulate: While in the Champlain valley the Lower Palæozoic measures form a complete unbroken series from the Potsdam to the Trenton, in the Ottawa basin the formations from the Chazy to the Trenton have been described as following one another conformably and without a break, though by some the Lowville (Birdseye) is not recognized. The Black River and the immediately underlying few feet of dove-coloured limestone, extend from the Ottawa basin across the Frontenac axis into western Ontario, where they pass down into an assemblage of beds quite unlike those east of the axis and whose age is in question. These lower beds in the western basin rest directly on the Pre-Cambrian. In north-western New York state, in a district also west of the Pre-Cambrian axis, the Potsdam is succeeded by the Theresa formation of Lower Beekmantown age, then comes a break unrecognized in Ontario, above which appears the Pamelia of Chazy age, grading up into the Lowville, in its turn followed by the Black River.

ECONOMIC GEOLOGY.

In the northern portion of the Simcoe district there are numerous exposures of the magnesian limestones of the lower portion of the series. One of the best localities is on the south side of Lake St. John, in Rama township, where the beds have only a thin covering of drift over them. Some inquiries have been made regarding magnesian limestones in that portion of Ontario, but it is doubtful if these beds are sufficiently pure for the purposes required. Over the greater portion of the district, however, there is a heavy mantle of drift. Especially is this the case on the west side of Lake Simcoe, where the drift hills rise to a height of 500 to 600 feet above the lake, and no exposures of hard rock occur.

PLEISTOCENE GEOLOGY.

One of the most interesting points in connexion with the Pleistocene geology of the district is the Algonquin beach, which has now been traced almost continuously on both sides of Lake Simcoe for over 50 miles and accurately mapped and leveled.

The leveling has confirmed beyond a doubt, the uplift of this beach towards the north-east. The area covered so far in the Simcoe district has been too small to attempt any general description of the drift deposits of the district.

APPENDIX.

Since going to press a list of the fossils which were collected by the writer from the above-mentioned quarries at Longford, Ont., and from the vicinity of Uphill, Ont., and sent to Mr. E. O. Ulrich, of the United States Geological Survey, has been received. The following is the list of fossils as determined by Mr. Ulrich:—

FOSSILS FROM BED I.

Rafinesquina minnesotensis, Winchell.
Strophomena filitexta, var. (Lowville var).
Crytodonta sp. undet.
Liospira progne, Billings.
Liospira vitruvia, Billings.
Leperditia fabulites, Conrad.
Isochilina armata, Walcott.

FOSSILS FROM BED II.

Tetradium cellulosum, Hall.
Phytopsis tubulosum, Hall.
Strophomena cf. filitexta.
Gyronema sp. undet.
Leperditia fabulites, var.
Isochilina armata, Walcott.
Bathyurus extans, Hall.
Bathyurus spiniger, Hall.

The fossils from bed I were collected from the lowest fossiliferous limestones as described in the above-mentioned section at the Longford quarries, and the fossils from bed II were collected from the fine-grained, dove-coloured limestones immediately underlying the dark-coloured, heavy beds at the top of the section, which latter beds have been referred to the Black River limestone.

Mr. Ulrich states (letter March 9, 1909), that these fossils are all of Lowville (Birdseye) species. With regard to the shales, arkose, etc., at the base of the section, he says: 'What the basal 20 feet of red and green shales, thin sandstones, and arkose may be I do not like to decide at this distance from the outcrop. I strongly suspect, however, this variable bed is merely the initial deposit of the Lowville. Just such sediments are to be expected whether it is the Lowville or the Pamelia that first overlaps the old Pre-Cambrian land.'

FIELD WORK ON THE PLEISTOCENE DEPOSITS OF SOUTH-WESTERN ONTARIO.

(F. B. Taylor.)

On account of previous arrangements for other work only a part of the season was available for this investigation. Work was begun at Sarnia on July 4, and closed at Grimsby on September 30, 1908.

WORK OF THE LEVELING PARTY.

Five weeks (July 7 to August 11, inclusive) were spent in leveling with a wye level the Algonquin and lower beaches, chiefly along the border of Lake Huron, the south side of Georgian bay, and around Lake Simcoe and Balsam lake. The work was done under my direction by Prof. J. W. Goldthwait, of Dartmouth University, Hanover, N.H., with Mr. Roy C. Jacobson, of Geneseo, Ill., as assistant. Mr. W. A. Johnston of the Canadian Geological Survey joined me in the field work on July 12 and remained until about the middle of September.

In the leveling work lines were run from the Algonquin beach to the present lake shore wherever that was within reach, otherwise to some other datum of known, accurately determined altitude. Lines were run at intervals of 5 to 10 miles where possible, but in some places, as around Kirkfield, at much shorter intervals. Prof. Goldthwait's summary report on the leveling is appended.

OBSERVATIONAL STUDIES DURING THE LEVELING.

During the leveling operations as much time as could be taken from that work was given to the study and mapping of the Pleistocene features of the region traversed by the party. In this Mr. Johnston joined, and a large amount of information was gathered, but it is somewhat fragmentary, owing to the fact that observational work was for the time subsidiary to the leveling.

The chief studies related to the character, strength, variations, etc., of the Algonquin and Nipissing beaches. These two beaches are the greatest old shore lines of the region studied. As far as Kirkfield the Algonquin beach is a magnificent feature, but in the broken, thinly drift covered and forested Archaean region to the north, it is much harder to follow.

Lake Algonquin had its outlet east of Kirkfield into Balsam lake, and thence down the Trent river. In his later writings Dr. J. W. Spencer has thrown some doubt upon the existence of this outlet, although he had pointed it out at an earlier time. I spent some time studying the region of the outlet, in October, 1907, and it was studied again this season. Not only was it proved that there was a great outlet here, but much evidence was found showing that it endured for a relatively long time. The Algonquin beach keeps a remarkable degree of strength far into the outlet head, among islands and crooked channel ways where wave action must have been greatly reduced. It could not have been formed in such strength in such a situation, except by prolonged action of waves of small size. The beach is a strong feature on the east side of Balsam lake, a mile or more west of Baddow. It is quite clearly marked on the west side of Cameron lake, about 3 miles north-west of Fenelon Falls, and still better near the south-east corner of this lake, 1 mile west of Fenelon Falls.

From Balsover to a point a mile north of the station at Kirkfield the beach rises more than 5 feet per mile. North of Orillia there is a short interval in which it rises more than 5½ feet per mile. The rate in both localities decreases rapidly towards the south-west.

RESULTS OF FIELD STUDIES.

Areas Studied.

After the leveling party had finished, Mr. Johnston joined me in a general study of the Pleistocene deposits. Work was carried on for nearly four weeks, chiefly in the Lake Simcoe area, which was then being surveyed for both topography and general geology, by a field party under Mr. Johnston's direction. The work was done chiefly on the country surrounding Barrie and Orillia, with less extended studies around Bradford, Aurora, Tottenham, Orangeville and Acton. During the last two weeks in September, I worked alone on the Niagara peninsula between the Niagara river and Hamilton. In July, before the assembling of the leveling party, three days were spent studying the region around Wyoming, and between there and Sarnia.

Earlier Independent Work in Ontario.

In past years I have made quite extensive studies of the Pleistocene deposits of Ontario, working on an entirely independent basis. These studies were made during occasional excursions between 1893 and 1907, and have touched more or less upon the deposits of nearly every county in the Province. Some of this work was of the character of hurried reconnaissance, but in other places, especially in some parts of south-western Ontario, careful mapping was done, and much attention was given to details. In this way three or four areas of considerable extent were brought to a fairly complete state, and are ready to be reported upon at an appropriate time.

All of this work relating to southern Ontario is still unpublished, although between 1893 and 1897 seven papers relating to the earlier reconnaissances in northern and Central Ontario were printed.[1] Two maps showing on very small scales some of the recessional moraines of the continental ice sheet, and contemporary lines of drainage along the border of the ice in south-western Ontario, were published in 1899[2] and 1901,[3] in connexion with contexts relating to other subjects, but no description of the features in Ontario accompanied them. Two or three papers were read before scientific societies on subjects in this region, but only the briefest abstracts were published.

The most important area previously studied is one extending northward from Lake Erie past the west end of Lake Ontario, through parts of Norfolk, Oxford, Brant, Wentworth, Waterloo, Halton, Wellington, Peel and Dufferin counties. The area extends from the vicinity of Port Rowan and Port Dover northward to Hillsburgh, Caledon and Caledon East. This area was examined in considerable detail, thirteen weeks being spent upon it in the summer of 1899.

A magnificent assemblage of Pleistocene glacial and lake forms was found in this area. Several strong terminal moraines of the Lake Ontario lobe of the ice sheet run through this area from north to south, and their formation was accompanied by the flow of a great river along the edge of the ice in the same direction. The present season's work joins this area, and extends it both to the north and east.

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1 Bull. G. S. A., Vol. 5, 1893, pp. 620-626; Am. Geol., Vol. XIV., Nov., 1894, pp. 273-289; Vol. XV., May, 1895, pp. 304-314; Vol. XVII., April, 1896, pp. 253-257; Vol. XVIII., August, 1896, pp. 108-120; Vol. XX., August, 1897, pp. 111-128. Am. Jour Sci., IV. ser., Vol. 3, March, 1897, pp. 208-218.

2 Am. Geol., Vol. XXIV., July, 1899, Pl. II.

3 U. S. Geol. Survey, Monograph XLI., 1901.

Wyoming.

The Port Huron moraine, which is one of the most important in eastern Michigan, crosses the St. Clair river into Ontario at Moore, and runs north-east. It is deeply waterlaid, and is for that reason very faint for about 10 miles. But at this distance, about 6 miles south-west of Wyoming, it rises above the level of the Warren (Forest) beach. Wyoming is on the moraine, slightly above the level of the beach. The beach is a strong one. Less than a mile south of Wyoming station its altitude is 708 or 709 feet A. T. Three miles north of the station it occurs again, skirting the back or inner border of the moraine. It comes down from Forest through Uttoxeter, and extends to a point about 2 miles south-east of Mandaumin. Here the moraine is cut away severely, the bluff back of the beach being about 45 feet high. The moraine must have been cut back a mile or two, for its prolongation is marked by a very bouldery belt. The beach runs south-east across the moraine, and skirts its front back toward Wyoming. The moraine near the bluff has a quite rugged topography, with a number of drainless basins.

Faint gravelly ridges were found near Mandaumin and 4 miles west of there, probably representing the Grassmere and Elkton beaches of Michigan, respectively. The Algonquin beach in and near Sarnia was also examined in some detail.

The Lake Simcoe Region.

The region for 8 or 10 miles around Barrie, between Barrie and Craighurst and Orillia, with a narrow strip running seven miles north of Orillia, was studied in considerable detail. A brief reconnaissance around Barrie, in 1897, showed the presence of great bulky ridges of Pleistocene sediments, partly water-laid, running south from Lake Simcoe, curving gradually westward, and with marked depressions between them. These ridges are from 2 to 4 or 5 miles broad, and 100 feet to 200 feet high, and the valleys between are usually a mile or more in width. Four of these ridges seem clearly defined, two lying west of Cooks bay and two east of it, with a fifth, but lower ridge, apparently one of the same group, farther north near the shore of Georgian bay. These ridges were then regarded as terminal moraines of the Georgian Bay lobe of the last ice sheet.

The recent more detailed studies, however, seem to make it clear, that while they may be in part terminal moraines of a Georgian Bay ice lobe, the bulky ridges are not moraines of the last, or late Wisconsin ice sheet. If they are terminal moraines at all, it seems certain that they belong to an earlier epoch of the ice age.

The reason for this conclusion is that, with a few exceptions affecting only small areas to be mentioned below, this whole region from Tottenham, Schomberg, and Aurora on the south, to Orillia and Craighurst on the north, is what may be called, after Fairchild, a 'drumlinized' region. That is to say, the last action of the ice sheet in fashioning the surface was one of sculpturing and moulding, under the pressure and slow movement of relatively deep overriding ice, shaping the surface more or less perfectly into those remarkable hills known as drumlins.

The heavy ridges referred to form a well arranged system concentric with the shore of Nottawasaga bay, just as would be expected if they were terminal moraines of a Georgian Bay lobe moving from the north-west. But the drumlins, which cover a large part of the region, and record the direction of the last ice movement, trend mainly north-east to south-west, or, in a general way, parallel to the ridges and transverse to any ice movement which may have come from Georgian bay.

Most of the region between Orillia and Barrie is more or less drumlinized, and the drumlin forms continue in a belt 4 or 5 miles wide, down the west side of Cooks bay and the Holland River swamp, to the high ground east of Tottenham. The country east of Cooks bay, for several miles south of the shore of Lake Simcoe, has many drumlins, some of them very perfect forms.

Other parts of the area are not drumlinized, but gently undulating, nearly flat surfaces. They may be classified as ground moraines, or 'till plains,' and are quite distinct from the usual forms of terminal or marginal ice deposition. Some parts of this region have forms like table lands, although composed entirely of drift to depths much below the local stream valleys. The mesa-like mass west of Barrie is the most prominent of these. It derives its table-like form mainly from effects of erosion. It was heavily undercut along its west side by the waves of Lake Algonquin; its south side forms the north bank of the Barrie-Colwell channel, and its north side is the south bank of the Little Lake blind valley. It thus appears to have been carved out of a more extensive, high plain. The country south of Allandale, and around Thornton as far as Cookstown, is of the same character—a high till plain, with a flat or gently undulating surface.

The great ridges east and west of Newmarket and Aurora look like massive moraines, yet their surfaces show occasional drumlin forms, with north-east-south-west trend, as though they had been overridden from the north-east.

North and east of Orillia the drift is relatively thin, but west and south-west it becomes quite thick. In the northern part of the township of Oro some of the gravel hills rise to an altitude of nearly 1,300 feet. While the depth to rock is not known, it seems certain that the drift here is at least 500 to 600 feet thick. From Barrie south to the county line the drift is said to have an average depth of 300 feet or more.

Throughout this area of deep drift a considerable part is made up of water-laid or lake sediments, as distinguished from glacial or ice-laid deposits. Locally, as in the case of the high mass west of Barrie, a large part is water-laid—chiefly stratified sands and clays. But ice-laid drift is generally dominant. This is shown by the general prevalence of true, stony till to a considerable depth over the surface, and by the great quantities of boulders which the waves of Lake Algonquin have collected from the cliff cutting along its shore.

Three valleys in this area deserve particular mention, although their origin and relations are not yet understood. One of these is the so-called Barrie-Colwell channel. This valley extends westward from the head of Kempenfeldt bay to the valley of the Nottawasaga. It is about 6 miles long, nearly 2 miles wide at its east end, and 3 miles at its west end, and slopes gently westward. It appears to be in some sense a continuation of the long narrow depression occupied by Kempenfeldt bay. It is sharply cut through the high ground, and its banks on either side are steep and over 200 feet high.

Another remarkable valley is associated with Cooks bay. This is the valley occupied by Holland river and the great marsh. The marsh is about 2 miles wide, and extends the depression of Cooks bay about 16 miles to the south-west from the present bay shore.

The third channel-like valley is occupied in part by Little lake, 2 miles north of Barrie. This valley extends south-east from Midhurst for about 8 miles, curving gradually around to the north, after passing Little lake. Northward from its east end a broken depression connects with another narrower valley, running back to the north-west past Dalston and opening out on the low ground about 3 miles north-east of Midhurst.

The origin and history of these valleys has not yet been worked out, but the studies of this season show conclusively that they are older than formerly supposed. Evidences were found which seemed to show clearly that each of these valleys was in existence before the advent of the last ice sheet. In its eastern part, where it curves to the north, the Little Lake valley is broken, and interrupted by imperfect drumlin hills, showing ice movement from the east. Two small drumlins, of very perfect pattern, rise from the floor of the Holland River marsh a mile and a half south-west of Bradford. These forms prove that these valleys were occupied by the moving ice sheet after they were made by other agencies.

According to Kivas Tully, Kempenfeldt bay is deeper than most parts of Lake Simcoe, the deepest part of the lake being at the mouth of this bay. If the depression of this bay and its westward extension, and the depression of Cooks bay and the Holland River marsh were in existence at the advent of the last ice sheet, the ice might have adapted its movement, with but slight deflexion, to the course of these deep depressions, and thus have kept them open, if indeed it did not deepen them. But it is not so easy to apply this suggestion to the Little Lake valley, the main part of which trends west-north-west, and which has its open end in that direction.

If any terminal moraines attributable to the retreat of the last ice sheet occur within this area, they would probably be laid down in water, and would be very faint forms. Around Kempenfeldt bay, and along the shore towards Orillia, there are faint suggestions at a number of places of a marginal moraine about 100 to 150 feet above the lake, but these evidences are regarded as very uncertain. The sloping floor of the channel west of Allandale suggests an ice mass resting in Lake Simcoe, and discharging detritus westward through the channel. On the western border of the area investigated, west of Cookstown and Beeton, prominent ridges were seen at a distance, which looked like terminal moraines, but they were not examined further.

The most remarkable exception to the prevailing ground moraine surface of this area is in the northern part of the township of Oro, where a cluster of sand and gravel hills, the highest rising to nearly 1,300 feet in altitude, occupies an area 8 or 9 miles long east and west and half as wide. Its topography is characterized by high knobs and ridges and deep basins, and it is trenched by many steep-sided ravines. Much of the mass is composed of gravel and sand in horizontal beds, but there are also many morainic knolls of sandy, stony till, especially in the highest central ridge and along the south side. The north side is lower and more sandy, and much of it duney. Through the western half there is a drainage valley running south-west, and a large river evidently flowed in that direction through it at a late stage of the hill formation.

This deposit appears to be a combination of outwash, kames and moraine, and to have been made during the retreat of the last ice sheet. The north-west part has not been examined.

In the Lake Simcoe area the Algonquin beach was traced, with almost entire continuity, from a point on the county line about 2 miles north-east of Schomberg to a point 3 miles north-east of Ardtrea. Near Schomberg its altitude is 724 feet A. T., and at the northernmost point 883 feet, a rise of 159 feet in about 52 miles on a straight line. It is interesting to note what would happen if the land were depressed back to the relative attitude it had when the Algonquin beach was made. The surface of Lake Couchiching, 3 miles north-east of Ardtrea, would be about 20 feet below the surface of Georgian bay, and almost all of Lake Simcoe would disappear. Scugog lake would disappear entirely.

Southward from the western border of the area just described, recent studies about Aurora, and earlier studies around Toronto, show the same sort of country—deep drift, largely lake sediments, as shown by Coleman near Toronto, and nearly all the surface drumlinized. The Oak Ridges, extending from Jefferson and Bond lake north-east for 8 miles (as far as examined), are a strong, complex, land-laid terminal moraine laid down along the north-west margin of the Lake Ontario lobe of the last ice sheet. Between this ridge and the lake the surface is drumlinized by ice moving towards the north-west from the basin of Lake Ontario. There is no outwash from the south-eastward face of this moraine, but there is a large amount of it—gravel and sand—from the north-westward face. The whole surface of the country between Vandorf and Ballantrae is covered with this outwash. The south-east side of the moraine is nearly all till, with undulations dying out towards the drumlinized plain to the south-east. The drumlin forms between Lake Ontario and the Oak Ridges moraine have axes trending north-west and south-east, showing that the ice moved up the slope towards the north-west—about at right angles to the drumlin axes in the region around Lake Simcoe.

The Escarpment Area.

A few days were spent studying the region around Orangeville and Caledon. The same grand features—moraines and old drainage lines—found farther south in earlier studies were found to continue northward. Three strong moraines were found east of Orangeville. The western, or earliest one, runs about north-west from a point 1 to 2 miles east of Caledon, where it is cut off by a late stage of the great ice border river, to a point 2 to 4 miles north-west of Orangeville. At this place it abuts upon an earlier bed of the old river. This moraine is 2 to 3 miles wide. and rests on the high ground about 2 miles back or west from the edge of the escarpment. The next later moraine rests against the face of the escarpment near its top, and towards Mono Mills rises slightly above the cliff and overlaps a little on the plain. It follows the escarpment in a broad curve, from a point south of Caledon to and beyond Mono Mills. An old river channel follows the same course in front of the moraine. The moraine is banked up against and upon the face of the escarpment, and a minor drainage line appears to mark its lower limit, and at the same time the front of a third moraine which rests on the lower part of the slope.

The great river channel which passes just east of Orangeville lies in a deep, crooked valley, entirely removed from any possible exposure to wave action. Its gravel bars are prominent, and are distinctly river bars—demonstrably so from their shape, position and composition.

A very pronounced line of drainage from the ice front westward occurs at Mono Mills and is marked by a great moraine-headed gravel train, remaining now as a great terrace facing eastward over the lower country, but with its surface sloping westward, or in the direction that the river flowed. This drainage line was also in operation when the ice front rested on the next earlier moraine; for a great, broken esker runs west through the moraine east of Orangeville, bending south towards Melville. This culminates in an enormous kame on the west side of the river 2 miles south of Orangeville, where the crest rises to an altitude of about 1,620 feet A. T. (aneroid).

The old river bed was followed about 5 miles north of Orangeville, and nearly to Cataract on the south.

West and north-west of Orangeville there is an area of drumlins.

The Niagara Peninsula.

The last two weeks of the season were spent on the Niagara peninsula. It was, of course, impossible to cover the peninsula thoroughly in so short a time. What was done is, therefore, more of the nature of preliminary work, and the results are fragmentary. But they are very satisfactory as far as they go.

Three terminal moraines had previously been traced by me through the region around Buffalo, in New York—one down to the shore of Lake Erie at a point 4 miles south of Buffalo; another into and through the city of Buffalo, to Fort Porter on the bank of Niagara river, and a third to the bank of the river about a mile and a half west of Tonawanda, N.Y. The first of these moraines reappears on the Ontario shore of Lake Erie at Crystal beach, and was traced in faint form to a point about 9 miles west of Port Colborne; the second enters Ontario at Fort Erie, and was traced 5 miles west of the river.

The moraine which passes Tonawanda probably continues in faint form across Grand island, but has not been traced. A moraine which appears to be a continuation of it was found on the Canadian side at Niagara Falls (south centre). This moraine has been heavily cut away by the rapids above the falls. The highest place on the bluff at Falls View marks its crest. South-east of this point the crest is gone, but a remnant of the front slope runs on towards Chippawa.

The Crystal Beach moraine was traced this season 2 or 3 miles farther west, but grows much fainter westward, and becomes lost or obscured, first in the marshes north of Lowbanks, and farther on in the sandy plain to the north-west.

The Fort Erie moraine is much stronger than the Crystal Beach ridge, and is a conspicuous feature as far west as a point about 2 miles north of Ridgeway. Thence to the high ground west of Fonthill, the moraine is almost too faint to be traced, and some further study will be required to make sure of its course.

The Niagara Falls moraine, beginning at the high bluff overlooking the Horseshoe falls, runs north-west to Lundys Lane, the monument, cemetery, church, and observatory being on its highest knoll. Thence it runs west about two and a half miles, with Lundys Lane upon it, and then turns slightly to the south-west in a direct line to the village of Fonthill. Beyond this it was not traced, but appears to bend around the north side of the high hill west of the village, and then starts off north-west, probably passing North Pelham.

The Escarpment or Vinemount moraine is in some respects the most remarkable found thus far on the Niagara peninsula. It runs along the top of the escarpment near its edge. This moraine is narrow, but rises in sharp relief from the flat plain south of it, and is a conspicuous feature in the landscape. It is finely developed at a point 2 miles south of Beamsville, and runs with the same strength, and with only three slight breaks, to a point 3 miles west of Vinemount. Beyond these limits it was not traced.

Back of the escarpment, south and south-west of Hamilton, fragments of three moraines were found. The first one passes just south of Ryckmans Corners; the next passes through Glanford, and the third just north of North Seneca. They all trend north-west to south-east at these places, and converge somewhat north-westwards towards Ancaster. The first and third of these ridges are fairly strong, but the middle one is rather faint. The drainage, and the contours as given on the Grimsby sheet of the topographic map, seem to show very clearly the courses of all three of these moraines for some distance south-east from the places named. The two north specially seem very plain. The Ryckmans Corners moraine bends southward a little around the Mount Albion embayment in the escarpment, and passes Alfrida, and a little south of Tapleytown, Tweedside and Grassie. The Glanford ridge seems quite clearly indicated in a straight course from Glanford past Binbrook, and a little north of Abingdon and Caistor Centre. The North Seneca ridge seems indicated in a course passing south a mile west of Tyneside, to a point two and a half miles east of Caledonia, and thence 3 or 4 miles south-east.

If the Ryckmans Corners moraine takes the course indicated by the map, then it is an independent individual, not to be confounded with the Vinemount or Escarpment moraine. Thus, four distinct moraines forming a consecutive series have been identified thus far in the western part of the peninsula, and three in the eastern.

The moraines all seem to grow fainter in the middle part of the peninsula, and while, with one or two exceptions mentioned above, the fragments described are all very clear, the work of the present season was not complete enough to make possible the correlation of the eastern and western fragments.

The moraines of this peninsula are all water-laid. They were built at the front or edge of the ice sheet while it paused for a time, standing in water 100 to 200 feet deep. This circumstance greatly modified their character and surface expression. Moraines laid down in deep water are generally so broad and low and smooth that they are barely, if at all, perceptible to the eye as ridges. Still, they sometimes control the local drainage in a remarkable way and their course is often clearly indicated by the plan of the smaller streams. Being all water-laid, it is surprising that such considerable parts of the moraines of this peninsula as have already been observed are so strong and easily traced.

The drainage system of the Niagara peninsula is quite remarkable—evidently very different from what it was in pre-glacial times. Only one point can be touched upon

here. This relates to the features that control the upper part of the drainage basins of Twenty-mile creek and Welland river; the former above St. Ann, and the latter above Wellandport. These two drainage basins show in a wonderfully perfect way how it is that faint waterlaid moraines can control local drainage. The Mount Albion embayment in the escarpment must have received the drainage of a considerable area in pre-glacial times. Its drainage area now is limited by the morainic ridge which passes Ryckmans Corners. A careful examination of the Grimsby topographic sheet shows that a low ridge runs eastward, parallel with the escarpment, to and beyond Grassie, and that this ridge forms the divide, or boundary, between the hydrographic basin of the escarpment streams in the north and that of Twenty-mile creek on the south. This ridge is the continuation of the moraine which was traced from Ryckmans Corners to the escarpment a mile north-east of Ancaster. The headwaters of Twenty-mile creek are on concession 4 of Ancaster, aout 3 miles south of the escarpment, and 5 miles west of Hamilton. Only two or three lots farther west, and about half a mile north of the hamlet of Southcote, are the extreme headwaters of Welland river. The low morainic ridge running north-west from Glanford divides the waters of Twenty-mile creek from those of Welland river, and this ridge finds a continuation in a very flat, low divide, which runs eastward past Binbrook and Abingdon; and although it divides the hydrographic basins of these two streams, it becomes so low and flat that no ridge, or divide, is visible to the eye.

The south rim of the Welland hydrographic basin is defined in the same way by the moraine which passes North Seneca. Although these streams rise so close to the west end of the Lake Ontario basin and within a mile of each other, they flow in parallel courses many miles towards the south-east and east, between these controlling morainic ridges, before they are able to find a way of escape.

The configuration of the moraines near Hamilton, Buffalo and Niagara Falls, so far as now made out, is controlled not by geological structure, but by the topographic forms near by to the north, especially by the basin of Lake Ontario and the course of the Niagara escarpment. Given an ice mass overflowing the flat plain south of the escarpment from the basin of Lake Ontario, the arrangement of the moraines is just such as would be expected.

Outcrops of limestone are common along the south shore of the peninsula, and for a few miles inland, and also along the Niagara escarpment between Niagara and Queenston, but exposures of bed rock are comparatively rare in the interior, where the moraines referred to control the drainage. Neither the courses of the moraines nor of the streams in the area south-west of Hamilton are controlled by the form of the rock surface beneath them.

There are a few swampy areas containing peat in considerable quantities, the largest being in Wainfleet and Humberstone townships. The township of Moulton, and the north-west part of Wainfleet, are covered with fine sand, which has been considerably modified by wind action. The soil over nearly all the peninsula is clay, generally rather heavy, and with few stones—characters which seem to be due largely to its deposition in lake waters.

Two, or possibly three old shore lines were found. One, in the village of Fort Erie, has its crest about 15 feet above Lake Erie. This beach occurs in fragmental form along the shore, at least as far as Lapp point. At Fort Erie and Port Colborne it appears to be a little above the modern storm beach. It is a conspicuous feature at Lowbanks, and most of that littoral village is built upon it. Here it is slightly lower, rising not over 8 or 10 feet above the lake, and is distinctly lower than the modern storm beach. It shows considerable evidence of age, being weathered much more than the modern beach.

On the top of the moraine running west for about 4 miles from Fort Erie, there is a very well defined ridge of gravel, which probably is the Lundy beach of Spencer, and the Dana beach of Fairchild. Its altitude, determined by aneroid, is about 640

feet A. T., or about 65 feet above Lake Erie. Another fragment of this beach runs 6 or 7 miles north-east from Ridgeway along the crest of a low limestone escarpment. Other bars and small island fragments of this beach were found farther west. A beach—probably the same—occurs at Lundys Lane; it is not very well defined, but has an altitude of 675 to 680 feet. Only faint suggestions of this beach were found around the east and south flanks of the great hill west of Fonthill, but no doubt it is present there.

PRELIMINARY REPORT ON MEASUREMENTS OF ALTITUDE OF THE ALGONQUIN AND NIPISSING SHORELINES IN ONTARIO. JULY 6–AUGUST 11, 1908.

(J. W. Goldthwait and R. C. Jacobson.)

(In this report are embodied also eight measurements made later in the summer, by F. B. Taylor and W. A. Johnston.)

The relation of this region to others previously studied in the United States is discussed in a paper by one of the authors, published in the *Journal of Geology*, July, 1908. The ideas there expressed as to correlation have been confirmed by the summer's work.

The Algonquin shoreline in Ontario corresponds in present altitude and warped attitude with the same shoreline in the region at the north end of Lake Michigan, and around the Straits of Mackinac, for which complete data are at hand.

The newly collected data in Ontario fully confirm the preliminary correlation in which the United States data were correlated with those of Spencer.

By the measurements here summarized, the area in which the attitude of the upwarped water plane of Lake Algonquin is known is just about doubled; for the isobases can now be extended across Lake Huron and the Province of Ontario, as far as the divide between Lake Algonquin and Lake Iroquois, south and east of Lake Simcoe. The facts gathered on this five weeks' survey thus mean a long step forward towards the understanding of the extent and exact nature of those differential uplifts which changed the altitude of all northern North America, at the close of the ice age, and which raised much of south-eastern Canada out of the sea.

THE MEASUREMENTS.

The Algonquin shoreline was measured with the wye level at over fifty distinct localities, distributed as follows:—

About	6	localities on the east shore of Lake Huron.
"	10	" around Georgian bay.
"	18	" " Lake Simcoe.
"	15	" east of Lake Simcoe, near the Kirkfield outlet.
"	4	" in the Archaean highlands farther north, viz., Bracebridge, Huntsville, Trout Creek and North Bay.
"	53	

In many places the Nipissing shoreline was also measured. In a few places intermediate beaches, or higher ones, were measured.

RECONSTRUCTION OF THE WARPED ALGONQUIN WATER-PLANE.

The altitude of the Algonquin shoreline, in feet above sea level, is shown in ink figures on the large maps (*a*) U.S.L.S. chart of Great Lakes, and (*b*) a tracing from standard topographic sheets of the Canadian Government.

Measurements at Sarnia, Kettle point and Grand Bend, fix the Algonquin water-plane in a horizontal position, at about 606 feet A. T. At the southern end of Lake Huron, as in the middle and southern parts of Lake Michigan, this water-plane shows no sign of differential uplift such as affected the more northerly districts.

Measurements from Bayfield (613 feet A.T.) northward along the east Huron shore indicate a rising of the plane to the north-north-east, at a rate that increases, first slowly (less than 1 foot per mile) and then rapidly (becoming 5 feet per mile over Georgian bay and the north end of Lake Simcoe). This is shown by the spacing of the isobases as will be explained.

In this region, where the plane has been unwarped to a slanting position, it is possible to draw a set of isobases, or lines of equal deformation of the water-plane. For instance an isobase connecting points where the plane now stands 780 feet A.T. can be drawn very satisfactorily with reference to these observations: Wiarton 776; Hogg 778; Meaford 783; Allendale 782. Likewise a 770 foot line, if drawn parallel to the 780 foot line, harmonizes with the stations: Clarksburg, 769 feet; Collingwood, 767; Colwell, 774; and Lefroy, 775. It must be kept in mind, however, that a beach or a shore terrace was not level when first constructed, but varied a few feet; consequently a variation of say 5 or 6 feet in the measurements need not be taken as a disturbing factor in drawing isobases. Slight discordances must be expected.

The direction of these isobases along the south shore of Georgian bay is north 68 degrees west. If extended across Lake Huron in this direction, or rather with a slight curvature southward, the 770 feet and 780 feet isobases pass not far south of the Straits of Mackinac, the district where the Algonquin beach stands at just that altitude (770-780 feet). The correlation, therefore, seems undeniable. It is strengthened by a comparison of the rate of southward inclination of the water-plane in the two widely separated regions.

The direction of steepest inclination (or dip) of the warped plane here (in south-western Ontario), is south 22 degrees west; while over the north end of Lake Michigan it is about south 15 degrees west.

Isobases for 760 feet, 750 feet, 740 feet, 730 feet, etc., etc., if drawn parallel to these, and at wider intervals towards the southerly limit of deformation, lie harmoniously with the several measured localities where the Algonquin beach is best developed, viz., Port Elgin, 710 feet; Kincardine, 666 feet; Bayfield, 613 feet; Owen Sound, 748 feet; and in the Simcoe basin, Holland Landing, 752 feet; Bradford, 749 feet; Beeton, 729 feet. In other words, the inclined plane flattens rapidly southward, and becomes horizontal somewhere between Bayfield (613 feet) and Grand Bend (607 feet).

In the Simcoe basin, stations are comparatively close together, and the Algonquin beach can be traced almost continuously from the south end (749 feet at Bradford), to the north end (883 feet north of Ardtrea). The rate of northward ascent is as follows:—

Over the greater part of Lake Simcoe, 3 feet per mile. Along the south shore of Georgian bay, about 4 feet per mile.

South of this, as computed from Owen Sound, Port Elgin and other stations on the east side of Lake Huron, and from a few at the extreme south end of the Simcoe basin, 2 feet per mile.

Farther north, as shown by stations north of Orillia in the Simcoe basin, the rate of ascent increases somewhat abruptly, to over 5 feet per mile. It is doubtless a significant fact that just beyond, the Archaean border appears.

Between Lake Simcoe and Balsam lake, at the head of the old Trent outlet of Lake Algonquin, the same steep tilt rate of over 5 feet per mile is shown around Balsover and Kirkfield; and observations on the north side of the Kirkfield outlet, nearby, support the idea that this steep uplift continues northward.

Just east of Kirkfield, measurements south of Victoria road, at points on Balsam lake and on Cameron lake, at Fenelon Falls, place the Algonquin plane distinctly below that of the district just west of Kirkfield; although one would expect to find it higher, because of the easterly component of uplift expressed by the diagonal trend of isobases. This is believed to mean either that there is locally a great irregularity of uplift, a condition unknown over the wide region around Lakes Michigan and

Huron where detailed studies have been made; or that the basins of Balsam and Cameron lakes were on the slope of the old Kirkfield outlet, and that the sill which controlled the level of Lake Algonquin, while this outlet was running, was at Kirkfield, and not at Fenelon Falls, or any other point south-east of Kirkfield.

The Archaean area north of the Simcoe region, and bordering the Great Lakes on the north-east, has a fragmentary record, and is not readily accessible for leveling. Measurements at Bracebridge, Huntsville, Trout Creek, and North Bay, on a well marked beach, which may well be the Algonquin, suggest that the Algonquin plane there is either dislocated or very irregularly warped, in strong contrast to its wonderful uniformity over the whole middle and southern parts of the Great Lake region.

In view of visible faults in the limestone near Kirkfield (exposed at the surface), and of the possible function of the Archaean area as the seat of repeated and irregular uplifts, this contrast is not regarded as an objection to the correlation of beaches at Trout Creek, North Bay, etc., which F. B. Taylor made some 15 years ago. An interesting field of inquiry is thus re-opened.

MONTREAL RIVER DISTRICT.

(W. H. Collins.)

In anticipation of the continued westward progress of prospecting activity in the Timiskaming region, the writer was directed to conduct the field work of 1908 in the area between the east and west branches of Montreal river. This work was commenced on July 1 and continued up to the end of September.

Hitherto this area has not been carefully mapped, and no accurate surveys have been made in it except the Algoma-Nipissing boundary line run in 1897 by Alexander Niven and the exploratory line of 1867 by Sinclair. Before the summer was well advanced, an influx of prospectors had begun and the need of reliable topographical information became very apparent. Considerable time was, therefore, occupied in making a micrometer and compass survey of all the waterways within the area explored. Information concerning remote ponds, small brooks, and the conspicuous hills was obtained by rapid chain and compass traverses.[1]

ROUTES TO DISTRICT.

The most favourably known route to this area begins at Latchford, a station on the Timiskaming and Northern Ontario railway, 93 miles north of North Bay. From here the Montreal river is navigated up-stream for 56 miles, daily trips being made by a line of small steamers. Elk lake, the northern terminus, a village of several hundred inhabitants, has sprung up during the past eighteen months, coincidently with the needs of the country. It forms the real headquarters and point of departure for Montreal River prospecting parties, being already equipped with stores, a post office and a mining recorder's office. From Elk lake various canoe routes extend to the east branch of the Montreal river, the best known being a chain of portages called the Bloom Lake route, which leads from the main river 11 miles above Elk lake directly west to the East branch. From the East branch numerous good canoe routes connect with the West branch and Duncan lake. The construction of a winter road directly to Gowganda lake from Elk lake is anticipated.

TOPOGRAPHY.

The country drained by the East and West branches of the Montreal river differs only in detail from the typical Archaean peneplain. The surface is everywhere irregular and hilly, differences of elevation being, as a rule, under 200 feet. But, at intervals, are more conspicuous hills reaching to heights of 300, 400, and, in one case, 550 feet above the general level. Most of the surface is thickly forested, hindering ready comprehension of its character. But, from the top of any of the higher hills, a long succession of rocky elevations and swampy depressions is visible, the latter commonly containing small lakes. Soil is not abundant and is usually collected in the lower levels; it consists mainly of glacial sand and gravel, sometimes forming plains of notable extent, as, for instance, at the north end of Duncan lake. Comparison of various parts of the area indicates a tendency to the development of parallel ridges extending in a direction varying from north and south to north-east and south-west. The water courses are to some extent governed by this feature, but in addition exhibit

[1] It is proposed to have a preliminary geological report and map of the district ready for field use in the coming spring.—DIRECTOR.

a remarkable tendency to diverge sharply in directions at right angles, producing, as emphasized in recent reports upon the neighbouring region published by the Bureau of Mines, two sets of courses, the one extending about north-east and south-west, the other about east and west.

GENERAL GEOLOGY.

The details of the geology of the area are somewhat complicated, but its general features are readily apparent. The region is characterized by a few distinct rock systems separated by discordances due to enormous gaps in the geological succession. The basement of the whole area consists of a complex of Keewatin and Laurentian rocks. This complex possesses a hummocky eroded surface developed during Pre-Huronian times, and upon it the younger Huronian system rests unconformably. The complex consists entirely of crystalline rocks—either dark schists or gneisses—characterized more particularly in the case of the schists by highly tilted attitudes and well-developed secondary foliation. They are with very slight exception igneous rocks more or less metamorphosed.

The Huronian series lies directly upon this very much older surface, with which it is in striking contrast. All its members are sedimentary and lie horizontally or inclined at comparatively low angles. Conglomerate, greywacke slate, quartzite and arkose are its constituent rocks. This series, which no doubt once entirely covered the underlying crystalline complex, has been subjected to erosion which has locally worn it completely away, exposing the base upon which it rests. The relations of the Huronian to the Keewatin and the Laurentain may be compared with that of a badly worn carpet, through holes in which portions of the floor are visible.

There are no other sedimentary rocks in the district, but all the preceding groups are intruded by the now well-known Post Middle Huronian diabase. This rock has already been frequently described in reports of the Geological Survey and Bureau of Mines; moreover, it is not readily confused with any other rock in the Montreal River district. Its freshness, dark colour, and unmistakeable crystalline, igneous character are sufficient criteria for its determination.

AREAL DISTRIBUTION OF FORMATIONS.

Boundaries between the Huronian sedimentary series and the underlying Keewatin and Laurentian complex are irregular but definite. Small isolated patches of slate and conglomerate may lie scattered over an area of the latter as well as enclosing it; but there is never any difficulty in distinguishing them and deciding where they terminate. Also contacts between Post Lower Huronian diabase and the other rocks are capable of sharp definition. Between the Keewatin and Laurentian, however, much more difficulty exists, the older schists being, at their contacts with the gneiss, frequently caught up in varying proportion by the latter. In such cases, a wide zone of intermingled materials from both formations represents the contact, and a dividing line can be drawn only arbitrarily.

Keewatin and Laurentian.

Considering both formations at once, two considerable areas are distinguishable:—

(1) An area occupying the country north of Obushkong lake between the East and West branches with extensions southward between Obushkong and Firth lakes, and westward to Duncan lake. That portion north of Obushkong is composed of biotite gneiss varying locally in texture and degree of gneissification. Hornblende granite-gneiss is less widespread. Patches of hornblende gneiss, probably representing absorbed Keewatin material, occur frequently. To the south, between Obushkong and Firth lakes, the gneiss gives place to Keewatin green schists and altered eruptives.

The former are chiefly the metamorphosed products of old porphyries and allied igneous types which have been squeezed into chlorite and hornblende schists. They stand almost vertically and strike, in general direction, north-east and south-west. Associated with these is a fresher, less compressed diabase, and a basic rock, of coarse grain and rich in olivine, which in places has been altered to serpentine. The same green schists and old pyrite-bearing diabase, together with some hornblende granite-gneiss, form a triangular area reaching from the West branch north-westward to the middle of Duncan lake.

(2) An area lying west and south of Pigeon lake.

This consists, so far as examined, chiefly of Keewatin, the rocks being, as before, steeply inclined and striking in the same general direction. Much fractured, weathered diabase occurs rather abundantly along the west shores of Pigeon lake; it resembles some contact phases of the Post Lower Huronian diabase and might be confused with it. So badly fractured is this rock in some places that it exhibits a brecciated structure, the spaces being filled by a network of calcite veins. A much fresher dike rock, probably a hornblende-lamprophyre, occurs frequently in this area. The abundance of small rod-shaped hornblende crystals distinguishes it from the Post Lower Huronian diabase. In this area the Laurentian is represented by a small body of somewhat gneissified hornblende syenite, lying less than half a mile to the south-west of Pigeon lake.

Huronian.

The major part of the area is covered by Huronian sediments. These rocks, considering their age, are remarkably well preserved and show only local indications of severe disturbance. In general, they lie at angles up to twenty-five degrees; in the neighbourhood of a diabase intrusion they are sometimes much more steeply inclined and are shattered so as to simulate certain Keewatin forms. The general dip is to the east, the strike north and south to north-east and south-west. The basal member is a conglomerate sometimes possessing a breccia structure and remarkable for the irregular distribution and frequently enormous size of its included boulders. This grades upward through greywacke into finely laminated slate and quartzite, followed in turn by an upper conglomerate. Arkose, referred in other localities to the Middle Huronian, occurs on Duncan lake, and more extensively around Obushkong and Gowganda lakes.

Post Lower Huronian Diabase.

The diabase takes the form of dikes, sills, and possibly, stock-like masses, the form being apparently dependent upon the character of the formation into which the material was intruded. When enclosed by Huronian sediments it appears frequently as thick sills extending along the bedding planes. When the Huronian is thin, or the Laurentian or Keewatin is exposed, dikes are more common. The larger bodies may be stocks.

The dikes are of ordinary diabasic character, but in the larger bodies very notable differentiation of the original rock material has taken place. Within small limits the texture may vary from that of a medium grained diabase to a coarse gabbroid type. In mineral composition the average rock is a quartz diabase, but this type often grades into a more acid one of syenitic composition and of characteristically coarse grain and reddish colour. Basic masses, almost black in colour, are less numerous. All phases of the diabase are cut by dikes or veins of a pinkish rock known in the field as aplite. There is good reason to believe these dikes to be of the nature of pegmatites and representative of late stages in the differentiation and solidification of the molten material which produced the diabase. After much of this material had already consolidated and contracted, developing fissures in itself, the residuum, grown aqueous and acid, rose in the fissures and solidified to form the aplite

veins or dikes. These bodies, as a rule, are less than 2 feet wide, though in one observed case considerably more. They are finer textured than the ordinary diabase, light pink in colour and, therefore, not to be readily confused with the diabase, much less with the Laurentian gneiss, although such mistakes have been made by newcomers unacquainted with the rocks of the district.

ECONOMIC GEOLOGY.

Silver.

A widely circulated and seemingly reasonable opinion, holds the diabase responsible for the valuable silver-cobalt deposits of the region. The testimony of the Montreal River district, as yet known, supports this belief.

Early in August, a discovery of native silver was made just west of Gowganda lake, and recorded at Elk lake early in September. Up to that time only a small number of prospectors had been at work in this locality, but immediately following the news of discovery came an influx of several hundred men. In a few days all the promising country for a distance three miles west of Gowganda had been staked, and search instituted for mineral deposits sufficient to validate the claims. The results on the whole have been highly satisfactory. At the time of his leaving the district the writer knew of four bona-fide silver discoveries. At that time systematic prospecting had scarcely begun, the country was everywhere forest-covered, and exploration was impeded, even rendered somewhat hazardous, by the presence of forest fires, so that an intimate acquaintance with the area and its possibilities was very difficult to obtain. However, something has been learned concerning the geological structure and the mineral possibilities as visible at the surface. Westward from Gowganda lake the formation is Huronian, traversed in a north and south direction by three elongated bodies of diabase. The more easterly occupies the peninsula between the two long northerly bays of the lake and extends thence northward for about a mile. It has a maximum width of 60 chains. A central mass 7 miles long and about 40 chains wide extends parallel to the west bay and at a distance inland of less than half a mile. A westerly body of about equal dimensions extends from Elkhorn to Firth lake, being traversed by the chain of lakes used in travelling from Gowganda to the West branch. Various fingers and dikes extend from each of these bodies, but are of subordinate importance.

In the easterly body, up to the end of September, no silver had been found although a considerable number of mineralized veins were being examined by trenching. These veins occupy fissures in diabase and vary in width from a few inches to 2 feet. The largest of these was reported by the owner, Mr. McLaughlin, to be continuous for a quarter of a mile. The vein matter is, peripherally, quartz with a central filling of calcite, the relative proportions of the two minerals being quite variable. Chalcopyrite occurs, often abundantly, in all of them, pyrite less frequently. Cobalt bloom is largely in evidence, and on the property of Mr. O'Reilly smaltite was being obtained in small amounts, together with native bismuth. In one vein the calcite was strongly impregnated with minute crystals of magnetite.

The central diabase body has already been proved to be, judging from surface indications, richly silver-bearing. On a group of four claims owned by Messrs. Mann, Milne and associates, a vein was seen in which native silver occurs plentifully. The calcite gangue had been weathered out, leaving, in a diabase bluff, a crevice about 5 inches wide filled with decomposed earthy matter. Silver formed a more or less continuous vertical sheet as far as the vein had been uncovered, the average thickness of this sheet being about one-quarter inch. The lower undecomposed portion of the vein had not been exposed. At other points on these properties native silver, small quantities of argentite, and a 1″ vein of solid smaltite had been found.

Bloom, chalcopyrite, and galena were widely distributed. Farther south, native silver had been obtained in good quantity at the surface by Mr. Dobie and his partner. At the extreme south end of the mass F. A. McIntosh was surface stripping upon a group of seven claims, but at that time without important result. Subsequent to the writer's departure from the field valuable silver veins were discovered on this property. Silver had also been obtained in the western mass by W. H. Margueratt, the deposit occurring on Margueratt lake near the middle of the diabase body.

Native silver has, therefore, been demonstrated to exist at points distributed over an area of about 10 square miles, in much the same mineral association as at Cobalt and neighbouring camps. In this case all the finds yet recorded are within the diabase. The Huronian, however, has not been proved to be unmineralized, prospecting having been confined almost wholly to the diabase areas. The aplite dikes have not yet been proved to carry more than a little disseminated smaltite and chalcopyrite, although in James township, not far away, they are ore-bearing. Although not valuable in themselves, in the Gowganda area they may have a positive significance with regard to the existence of mineral deposits. They seem to occur most abundantly where differentiation of the diabase magma has proceeded farthest, and where, if the supposed relation between the diabase and the silver-cobalt mineralization does exist, conditions for the formation of mineralized veins would be most favourable.

The intimate connexion between silver deposits and diabase at Gowganda lake naturally draws attention to other diabase bodies in the neighbourhood. Of these the most extensive is a great sill-like mass which, beginning on Duncan lake at about 3 miles from its north end, follows that body of water, more or less closely, to its junction with the West branch; thence southward to where the West branch turns sharply east; thence east, crossing Wapus creek 1 mile from its mouth, and from there north-eastward for about 5 miles, beyond which it could not be traced. In width it varies from 10 to 60, or more, chains. Very little work had been done on this body during the summer of 1908, although results of search had not been distinctly negative. Very thorough and well directed work was being done on Wapus creek, under the supervision of Mr. Robert Lett, with the result that numerous veins and aplite dikes had been exposed and, in cases, had yielded small quantities of bismuth and disseminated smaltite, also abundant bloom and chalcopyrite, but no free silver. The evidences of extensive differentiation at this point are promising signs. Bloom, chalcopyrite and galena are also to be found throughout the diabase body as seen along Duncan lake.

Two masses of diabase, each about 2 miles long and 40 chains wide, lie immediately north-east of Firth lake, in Huronian and Laurentian formations. A presumably extensive diabase area lies between Duncan lake and the West branch, extending in a north-east and south-west direction, and most readily reached from a point on Duncan lake 3 or 4 miles from its north end. Little or no prospecting seems to have been done on these bodies.

Iron ore.

Hematite is known to exist in considerable amount on the west side of Nest lake, an expansion of the East branch, a few miles north of the area here under consideration. In small quantities it was observed near the head of Kenisheong lake, and on Duncan lake 5 miles above its junction with the Montreal river. In both cases the hematite fills interstices in Lower Huronian conglomerate.

A Keewatin iron formation occurs about half a mile to the north-east of Gowganda lake, on which a number of claims have been staked by Mr. Cryderman. Magnetite is present in the usual banded form, but, so far as can be determined from surface appearances, not in sufficiently concentrated condition to be of value.

Asbestos.

Small bodies of serpentine occur at a number of points in the Keewatin area between Obushkong and Firth lake. On the east shore of the latter body just opposite the central group of islands, one of these serpentine bodies is traversed by numerous seams of asbestos. Some of the largest are 3 or 4 inches in width, but the material is coarse-grained and brittle. In many smaller ones less than half an inch in width, the asbestos is of good quality.

In conclusion, the writer desires to thank Messrs. Thomas Firth and J. R. Marshall for their intelligent and ready assistance in advancing the summer's field work.

LAKE OPASATIKA AND THE HEIGHT OF LAND.

(Morley E. Wilson.)

The field season of 1908 was spent in that part of the Province of Quebec lying north-east of Lake Timiskaming and adjacent to the interprovincial boundary; attention being more especially directed to the vicinity of Lake Opasatika and the height of land.

In the absence of an accurate and detailed map of the district, a considerable part of the summer was necessarily devoted to topographical work, the Rochon micrometer and surveyor's compass being employed for the purpose. Surveys were made of Lac des Quinze, Barrière lake, the Lonely river and Lake Opasatika, all of which form part of the Timiskaming-Abitibi canoe route. The remainder of the time at our disposal was spent in making a geological examination and survey of the country adjoining the north end of Lake Opasatika; the area investigated extending to the Kekek hills on the east, to Island (Obadowagashing) lake on the north, and to the interprovincial boundary on the west.

PHYSIOGRAPHY.

The country north-east of Lake Timiskaming presents, in general, the characteristically monotonous, low relief of the Laurentian-Keewatin peneplain; a feature further accentuated throughout a great part of the district by the large flat areas of clay which have filled in the depressions in the uneven rock surface. There are, however, a number of very prominent elevations extending along the divide between the waters of the Ottawa and those flowing into James bay. The most westerly of these, known as Shiminis, occurs immediately east of the interprovincial boundary; a second prominence—the Swinging hill—is situated between Opasatika and Island lakes; while the Kekek hills form a third and more extended portion of the series farther east. These have an elevation of from 500 to 700 feet above the surrounding country, and form very conspicuous topographical features in a country otherwise comparatively flat. They all consist of Huronian quartzite or conglomerate and represent residual or monadnock portions of these rocks which the forces of erosion have failed to remove.

The typical Pre-Cambrian hydrographic features are characteristic of the district. The lakes are numerous and irregular in outline, while the streams either meander through muskeg or abound in rapids and waterfalls. The muskeg type of creek, however, owing to the lack of elevation and the predominance of Pleistocene deposits, is much more in evidence, even the smaller streams being navigable by canoe throughout the greater part of their course.

The drainage of the area is almost exclusively into Lake Timiskaming, either by way of the Blanche river (or Rivière), and Lac des Quinze.

GEOLOGY.

Geologically, the area presents the same formational succession, and to a large extent, the same rock types as are found elsewhere in the Pre-Cambrian of the Timiskaming district. Arranged in descending order, the geological succession may be outlined as follows:—

Pleistocene.

Post-glacial: clay and sand.
Glacial: boulder clay, gravel and sand.

PRE-CAMBRIAN.

Post-Huronian.

Diabase, gabbro, granite porphyry.

Lower Huronian.

Conglomerate, greywacke, slate, quartzite.

Laurentian.

Granite, gneiss, pegmatite, aplite.

Keewatin.

Mica schist, green-stone, green schist and dolomite.

It is of interest to note the similarity between the rocks of this area and those described by Mr. R. W. Brock, in the adjoining Larder Lake district. There is this difference between the two localities, however, that while on Larder lake mica schist is a minor Keewatin rock, on the Quebec side of the boundary it becomes the dominant member of the series.

Keewatin.

The Keewatin formation is represented in the area by a complex of both igneous and sedimentary rocks, all of which have reached a more or less advanced stage of metamorphism. Although mica schists predominate in the vicinity of Lake Opasatika, farther north beyond the Huronian hills and the 'height of land,' there are large areas of more basic Keewatin rocks, to the majority of which the general names greenstone and green schist are applicable. The latter usually contain a considerable percentage of lime carbonate, which frequently occurs interlaminated with the schist or as a network of seams traversing the greenstone.

At the base of the Keewatin, and hence, intervening between the acid igneous intrusives of the Laurentian and the upper members of the series, is a remarkably uniform biotite schist. On the weathered surface the rock presents a decidedly rusted appearance, owing to the decomposition of the iron pyrites which it contains. It varies in dip from horizontal in some localities, to nearly vertical in others, and possesses a very decided bedding-like cleavage, the definite and uniform character of which suggests that it owes its origin to sedimentary deposition.

The upper and more basic portion of the Keewatin consists of a great variety of rocks of which chlorite and amphibole schists are the most abundant, but basalt and diabase are also very common. The latter are probably volcanic, sometimes possessing an amygdaloidal structure and frequently showing spheroidal markings and other irregularities in the surface weathering. The green schists are found to occur in the vicinity of the Laurentian granite and gneiss. They comprise chlorite schist, hornblende schist, tremolite schist, and amphibolite, and are evidently products of dynamic metamorphism.

Laurentian.

The rocks of this age in the area are of the typical Laurentian character, the predominating varieties being biotite, gneiss and granite, throughout which, irregular, ill-defined masses and dikes of pegmatite and aplite are distributed. The parallelism in the arrangement of the mineral constituents of the gneiss, while sometimes most

pronounced, is frequently scarcely perceptible. The biotite in the decidedly gneissoid rocks is sometimes segregated into bands varying from minute laminæ up to several inches in width. In a number of localities hornblende was observed to replace the biotite as the ferro-magnesia constituent of the gneiss and granite.

Huronian.

The uneven, denuded surface of the Laurentian-Keewatin complex just described, formed the floor upon which the Huronian clastics were deposited. These, however, owing to later erosion, have been largely removed from the area and are now confined to the series of hills and ridges which parallel the height of land.

The basal member of the Huronian series is a conglomerate, consisting of a fine-grained quartzose to slaty matrix, enclosing numerous pebbles and boulders of granite, greenstone, green schist, chert, quartz, jasper and other rocks. The included fragments are well rounded and are usually small, but in a few localities boulders up to 12 inches in diameter become rather abundant.

While there appears to be considerable variation in the development of the various Huronian rocks in different parts of the area, the same general succession usually prevails. The conglomerate passes upward by a gradual transition from greywacke into slate, which in its turn is succeeded by quartzite. This succession can be observed in a vertical section in both the Swinging hill and Shiminis; the Kekek hills on the other hand, although they reach an elevation nearly as high as either of the former, consist wholly of conglomerate. All of these rocks, wherever the bedding can be observed, appear to be nearly horizontal, the dip rarely exceeding 10°.

Post-Huronian Intrusives.

At a number of points throughout the district diabase or gabbro dikes of Post-Huronian age occur, cutting the Keewatin and Laurentian rocks. A dike of porphyry also occurs between Ollier and Reneauld lakes, intruding Huronian conglomerate. These dikes vary in width from a few inches up to 200 yards, and can sometimes be traced continuously for several miles.

Pleistocene.

The Pleistocene deposits of the area consist largely of stratified clay and sand of post-glacial age, but in some localities gravel and sand, or boulder clay of glacial deposition are to be found. The post-glacial clays and sands are very extensive, especially eastward and southward from Lake Opasatika.

ECONOMIC GEOLOGY.

A considerable amount of prospecting has been carried on during the last few years in the vicinity of Lake Opasatika, which has resulted in the location of a large number of quartz veins throughout the locality. The majority of these, however, are not auriferous, although some of them contain considerable quantities of sulphides, such as chalcopyrite, bornite, pyrite, and sphalerite.

The mining locations of the Pontiac and Abitibi Mining Company, situated about 2 miles north-east of the head of Lake Opasatika, are of special interest because of the similarity of one of the prospects to the gold-bearing rocks of Larder lake. On the shore of Fortune lake an exposure of dolomitized porphyry occurs, which is traversed by veinlets of dolomite and quartz containing sulphides of iron and copper in small quantities. Assays of specimens from this occurrence have yielded high values in gold, but no attempt has been made, as yet, to determine the extent or average value of the deposits.

A GEOLOGICAL RECONNAISSANCE ALONG THE NATIONAL TRANSCONTINENTAL RAILWAY FROM THE ST. LAWRENCE RIVER TO THE INTERPROVINCIAL BOUNDARY BETWEEN QUEBEC AND NEW BRUNSWICK.

(J. A. Dresser.)

In the month of April, 1908, I was instructed to make a preliminary examination of a reported discovery of gold at Marsboro, near Lake Megantic, in the county of Compton, Quebec; and spent nearly two weeks in examining the locality and writing a preliminary report thereof, which has since been published by the Geological Survey. A sketch map, and some valuable observations were contributed to the report by Mr. E. R. Faribault.

In connexion with this published Report No. 1028 (French No. 1032), it should be mentioned that an assay reported by Mr. J. Obalski, Superintendent of Mines of the Province of Quebec, was erroneously quoted as being 'considered by him an average of 17 feet,' whereas Mr. Obalski's was only a hand specimen from a body of rock of that width.

On June 22, I received further instructions to make a reconnaissance survey along the route of the National Transcontinental railway from the St. Lawrence river to the interprovincial line between New Brunswick and Quebec; giving special attention to the economic possibilities, the timber and agricultural resources of the district, and the relations of the Quebec group to the other rocks of this region. After purchasing tents and blankets in Montreal, and engaging men at Three Rivers, I went to Quebec, where the rest of the outfit was procured.

There I was joined by Messrs. A. MacLean, B.A., and R. Randal Rose, a senior student in applied science at the University of Toronto, who acted as assistants throughout the season. It is a pleasure to acknowledge the very efficient services rendered by both these gentlemen.

I would also acknowledge the assistance and many courtesies received from the officials of the National Transcontinental railway, and from many of the contractors, especially Mr. G. W. Bartlett, of Quebec, who aided us in various ways throughout the summer.

Inasmuch as a portion of the section of the National Transcontinental railway from Quebec bridge to New Brunswick was covered by Mr. R. W. Ells' map and report on N.E. quarter sheet of the Eastern Townships map (Geological Survey of Canada, 1887), that part was traversed quickly; only sufficient time being taken to familiarize ourselves with the geological structure, in order to correlate our later observations with Mr. Ells' work, and to note the present economic conditions. The line of the National Transcontinental railway for the first 120 miles being approximately parallel to the strike of the rocks, it was found advisable to carry on our reconnaissance by a series of cross traverses, rather than working altogether parallel to the course of the railway. Accordingly, traverses about 30 miles in length were made along seven lines transverse to the line of the railway; and the intervening country—especially near the railway—was also covered as closely as was found advisable. The length of the section followed was 203 miles. It is known officially as District B of the National Transcontinental railway, and crosses the counties of Lévis, Dorchester, Bellechasse, Montmagny, L'Islet, Kamouraska and Temiscouata.

The country is sparsely settled in the northern part of the section, but it was always found possible to move camp by teams. Except in the vicinity of Pohenaga-

mook, and Long lakes, there are no waterways in this district suitable for canoes, and, owing to the extreme low water of the past season, not even the rivers connected with these lakes could be used for travel.

The camp was broken up September 23, when a day was spent examining the exposures about Lévis and Orleans island; and another day by Messrs. MacLean and Rose at Montreal, completing the material for a map.

DISTRICT.

Location.

This part of the Province of Quebec is chiefly that narrow portion between the St. Lawrence river on the north-west and the State of Maine on the south-east. Throughout the greater part of its length it is between 30 and 40 miles wide, but towards the south-west it widens out with the more southerly deflexion of the International Boundary Line. It is approximately 120 miles from the Etchemin river to the St. Francis river. This gives an area of about 3,600 square miles in the district, but this investigation has been mainly confined to parts of it that have been previously less known, principally along the line of the National Transcontinental railway.

General features.

Bordering the St. Lawrence there is a narrow strip of low land, generally from 4 to 6 miles in width. This is usually between 100 and 200 feet above sea level, and is a narrow extension of the St. Lawrence lowland, which continues from the Lower St. Lawrence to Lake Huron. At the south-east limit of this belt, the land rises in an abrupt escarpment from 600 to 800 feet, and maintains a general elevation of upwards of 1,000 feet for a distance of 15 to 20 miles farther to the south-east. There are many small, deep valleys cutting this area, both lengthwise and crosswise. It, however, preserves a somewhat uniform rolling surface for a breadth of 15 to 20 miles. A series of hills then appears rising to a height of from 300 to 700 feet above the adjacent country, beyond which the surface slopes rather evenly, although with some interruptions, to the St. John river, in the State of Maine, some 20 miles east of the International Boundary.

Drainage.

The district is drained by tributaries of the St. Lawrence on the north-west, and of the St. John on the south-east. The principal rivers which empty into the St. Lawrence are the Etchemin, Boyer, Sud, Ouelle, Kamouraska and du Loup. Those flowing into the St. John are the Daaquam, Noire and the St. Francis. All these streams take their rise in the high central portion of the district. Those flowing towards the St. John are usually larger streams, with more tributaries, and flowing less swiftly than those which empty into the St. Lawrence.

GEOLOGICAL STRUCTURE.

The geological formations represented in this district are arranged parallel to the St. Lawrence river, and are in a broad way successively younger towards the south-east. The oldest consists of a series of quartzites and conglomerates on, or near the St. Lawrence lowland. Above these are the slates and sandstones which form the greater part of the central upland and a part of the lowland along the St. Lawrence. Overlying these are the graphic slates and sandstones along the boundary, which are of still later age. Fossils have been found along the river front in conglomerates interbedded with the quartzites, and their determination, which has not yet been made, is necessary to a more detailed discussion of the geological structure of the district.

ECONOMIC POSSIBILITIES.

Minerals.

With two exceptions the rocks of this district are sedimentary, slates, sandstones and quartzites. The slates are of three different horizons, in two of which they are much shattered. In the latest formation, however, there are beds that appear in every way suitable for roofing and other uses to which slates may be applied. The best of these is on the south-west side of Long lake, in the county of Temiscouata, a quarter of a mile north-west of the point where the Transcontinental railway crosses the lake. Here, the slate in a railway cutting is fine and even-grained, free from pyrite, and splits easily in thin, even laminae, of 3 or 4 feet in dimension. It is very favourably situated, both for quarrying and transportation. Similar occurrences may be found for a short distance along the lake, farther to the south-eastward.

Much of the sandstone is of the green and reddish varieties common to the Sillery formation in which it occurs. This is largely used in Quebec city for building stone. It may be obtained at many points throughout this district when economic conditions bring it into demand.

The quartzite is best exposed in the vicinity of the St. Lawrence river, especially near Kamouraska bay. It is often nearly white in colour and exceptionally free from iron rust, or other stains. It is occasionally used for building stone, and an attempt to employ it for glass manufacture seems to have failed only from adverse market conditions at the time.

Igneous rocks occur at several small hills of diabase in the county of Bellechasse, north-west of the village of St. Lazare; and in larger areas of diabase and serpentine in the south-western part of the counties of Bellechasse, Montmagny, and L'Islet.

The diabase at St. Lazare seems to form an interbedded sheet and occasionally shows a few grains of chalcopyrite. As similar rock under like conditions, to the south-west of this district, at Nelson, St. Flavien, Drummondville, Wickham and Roxton, has produced certain amounts of rather high grade copper ore, these hills were examined carefully; but no copper was found.

The diabase serpentine areas promise to become more important. The diabase, at least, has been intruded through the sediments (Sillery) at the north-west of it, and so is of later age. In range V of Talon, in the county of Montmagny, there is a considerable body of serpentine, probably a mile in width. Asbestos of short fibre was seen in it, but no detailed examination could be made in the time at our disposal. The country is densely wooded, making the extent of this igneous belt difficult to determine; but the area that it seems most important to prospect is one about 12 miles long, by 2 or 3 in width, lying largely between the L'Islet and the Montmagny roads. This is chiefly in ranges V and VI of Rolette, III, IV and V of Talon, and I and II of Leverrier.

Besides this, there is a series of detached hills continuing in the same general trend for 15 miles farther to the south-west, in the vicinity of St. Fabien and St. Magloire.

Copper pyrites was found in loose blocks of diabase having the lithological character of the rock of much of these areas, but it was nowhere found in place.

This entire series of eruptive hills lies to the south-east of the second ridge mentioned in the early part of this report, hence is not easily accessible from the National Transcontinental railway. The projected extension of the Quebec Central railway from St. George de Beauce by way of St. Justine, will probably pass through the length of this area.

Aside from the above there are no indications of any metallic values in the district, save some deposits of bog iron ore which are probably of no great extent. A reported deposit of galena in the township of Woodbridge, near St. Paschal on the Intercolonial railway, does not seem to give promise of any importance. It was thus

described by Mr. J. Obalski, Superintendent of Mines for the Province of Quebec, who saw it when it was probably in better condition to examine than at present: 'There is a small vein of sulphate of baryta, with a little calcite of two to three feet in thickness which may be followed for a distance of an acre and in which an opening of some 15 feet has been made. A little galena in fine grains is disseminated through the mass, but in too slight a proportion to be worked industrially as it represents not more than ten per cent of the mass.' A picked specimen of this galena was assayed by Dr. M. L. Hersey, with the following results:—

Galena=45·2 per cent; silver=traces.

Except for some peat bogs in the north-western part of Kamouraska, no other mineral products of possible economic importance are known in the district.

Timber.

The lowland along the St. Lawrence has long been settled, and no forest remains. But the middle upland, and the south-easterly slope of the St. John valley, are generally well wooded, especially in the northern part of the district. The valleys and low lying land are timbered by spruce; the hills by a mixed growth of spruce, and occasionally of hemlock, with maple and birch. In the northern part of Kamouraska, pine appears in some quantity.

Much of the land is under lease for lumbering purposes and some of the limits are evidently carefully treated; the cut being regulated to allow of a succeeding forest growth. In others less care is taken.

Logs and pulpwood are driven, when possible, in the various streams to mills situated near the St. Lawrence, and down tributaries of the St. John, generally to Fredericton, N.B.

In the middle upland the streams are often too small to carry log drives. Consequently, much of the timber that is cut in clearing the land for settlement is burned on the ground. This waste will, however, cease when the Transcontinental railway, the course of which follows this belt of the district, is completed.

Agriculture.

In the older settled land along the St. Lawrence, better conditions of agriculture prevail. But in the settlements of the upland, which are confined to a small portion, generally along the Taché road which runs parallel to and a few miles south-east of the National Transcontinental railway, the farming is on a small scale and of a primitive character. The live stock here raised is of the poorest type and dairying is only partially organized. The lack of easy access to a railway has been the main cause of these conditions. Although the Provincial Government has built roads from the St. Lawrence lowland nearly or quite to the Maine boundary, at intervals of 10 to 20 miles, and has connected these by means of the Taché road during the past 50 years, the settlements have advanced very little. The escarpment dividing the lowland from the upland, makes the hauling of supplies or produce a heavy tax on the farmer's resources, in fact, on some of the roads, a prohibitive one.

The soil on the upland is light and is often heavily covered with boulders. Yet excepting a belt two to five miles in width along the north-west margin of the upland, which is little but a glacial moraine on a rock shelf, this section when cleared will be well suited for dairying and, with railway communication, much of it will admit of small mixed farming under favourable conditions. The land on the slope of the St. John valley is much better. The soil contains more clay and less boulders.

I found the idea prevalent amongst many people not native to the district that, many farms had been abandoned owing to the impossibility of the owners gaining a livelihood. But a careful investigation does not show this to be the case. Many so-

called abandoned farms are homesteads begun in leased timber berths, which the holders of the berths have bought in order to protect their limits against mutilation and the danger of fire. In other cases, land seems to be taken ostensibly for colonization purposes, the minimum of settlement duties being performed, and the land stripped of its timber for pulpwood. When this is done, the land is abandoned for taxes and considered an abandoned farm.

When, however, all its possibilities are considered, this district may be considered, unless for a slightly shorter season, very similar in its agricultural possibilities to the counties of Megantic, Arthabaska, Richmond or the hilly portion of Shefford and Brome, where mixed farming has been successful, and dairying pre-eminently so for many years.

SUMMARY REPORT ON A DISTRICT NEAR BATHURST, N.B., AND ON THE REPORTED OCCURRENCE OF GOLD IN THE TOBIQUE COUNTRY, VICTORIA CO., N.B.

(G. A. Young.)

INTRODUCTION.

Mining operations having been commenced on a large body of iron ore lying near the Nipisiguit river at a point about 21 miles south-west from the town of Bathurst, New Brunswick, the writer received instructions to begin work on a topographical map and to study in detail the geology of an area extending sufficiently far inland from the sea to include the ore deposit. The boundaries of this proposed sheet lie within the confines of two geological sheets known as 3 S.E. and 2 N.E., of the regular series of geological maps of New Brunswick, published on a scale of 4 miles to one inch, by the Geological Survey, and of which the two referred to were prepared by Mr. R. W. Ells.

TOPOGRAPHY.

Owing to various causes the topographical work progressed slowly, and during 1908 field work was confined to the northern portions of the sheet where it fronts on Chaleur bay, between Belledune river on the west and Tetagouche on the east. The part of the district already examined may be described as a tilted plain gradually rising from the sea, until at distances of between 5 and 10 miles inland, it attains elevations of 500 to 600 feet. Four main streams cross the area and occupy marked depressions affording many rock exposures, but elsewhere bed-rock is largely concealed, either by deposits of soil, sand and gravel or by glacial debris.

GENERAL GEOLOGY.

The greater part of the district is underlain by sandstones, shales and slates, probably for the most part of Silurian age; but near Belledune, and again near the Tetagouche, younger igneous rocks outcrop over considerable areas, while dikes of dark basic varieties are everywhere common. Younger than the above are certain limited patches of conglomerate, sandstone and calcareous beds virtually confined to the coast and supposed to be of early Carboniferous age.

The igneous rocks, while apparently all intrusives, vary widely in composition and appearance; at times they are light coloured and approach the granites in appearance, but more commonly they are dark, basic porphyrites and diabases. In the neighbourhood of Belledune the igneous varieties occupy almost exclusively an irregular area a number of square miles in extent, and at times are intricately associated with gneissic and schistose derivatives of the sedimentary beds. To the south, approaching the Tetagouche, dark basic rocks, probably diabases, form a number of relatively wide, dike-like bodies.

The sedimentary strata, which occupy by far the larger part of the district, have a general strike of about east and west. Different lithological varieties have a tendency to occur in bands paralleling the strike, so that along the coast between Belledune river and Elmtree river, where the shore has a general easterly trend, the beds consist largely of sandstones with associated shales, limestones and heavy conglomerates, while inland these are succeeded by a group of sandy measures that appear on

or near the coast east of Elmtree, where the shore pursues a southerly course. A third zone, inland and south of that occupied by the sandstones, is composed largely of black shales and slates. These form a wide band extending to the eastern boundary of the sheet.

The strata appear to lie in a series of close folds, at times, at least, overturned; while faulting is prevalent and some of the dislocations are of considerable magnitude. The individual beds are frequently much deformed, are frequently contorted, broken and pulled apart, while locally they often assume a schistose condition.

The limestone beds of the northern portion of the district are fossiliferous, and from a preliminary examination of several collections Mr. H. M. Ami has pronounced the beds of Silurian age, and to be probably from a horizon about equivalent to the Clinton of the New York series. In the field all the sedimentary strata appeared to compose one conformable series with the fossil-bearing limestones in the lower portion of the column. Considering the complexity of the geological structure, the number of exposures within the area examined was very limited, and it is possible that when the work is completed and compiled, the evidence may be interpreted differently. Beds bearing Ordovician graptolites are known to occur south of the district, and it is not impossible that at least a portion of the strata now believed to be of Silurian age may prove to belong to the Ordovician over some such area as shown on the original map of the district.

ECONOMIC GEOLOGY.

The sedimentary rocks of the interior of the country, and more particularly the dark slates, are in many places very rusty weathering as the result of the presence of iron pyrites, either in the form of small grains or occasional larger crystals. Quartz veins, usually narrow, are exceedingly numerous and are especially common in zones in the more rusty weathering bands of the dark slates. Frequently these veins are composed solely of milk-white quartz, but at times they contain small amounts of iron pyrites or occasional grains of galena or zinc blende or both together. On the Elmtree river, at a point about 3½ miles above its mouth, there occurs a zone some 6 feet wide of shattered and altered slates, richly impregnated along veins, seams and in patches with galena and zinc blende accompanied by much iron pyrites and some quartz and calcite.

A deposit of iron ore occurs on the eastern side of a brook flowing into the Millstream at a point about 9 miles above its mouth. The ore body is situated about 1½ miles up the tributary which flows south into the Millstream. The deposit forms the side of an abrupt rise in the ground of about 50 feet, and is imperfectly exposed at intervals over a distance of about 1,200 feet, with at one point a maximum breadth of about 30 feet. The ore seems to form a very flat, lense-like body conforming in strike and dip with the neighbouring sedimentary beds which have a general east and west strike, while they dip at high angles of between 60 and 90 degrees towards the north.

The deposit where it seems to attain its greatest width has been stripped and there shows a symmetrical development from the sides towards the centre. The country rock is almost entirely concealed, save in the immediate neighbourhood of the ore body, where it appears to represent hardened, silicified, sandy shales and fine sandstones, and those near the ore body contain irregular streaks and bands of pale greenish, finely granular garnet. At the margin of the ore body, short streaks and lines of fine granular magnetite appear lying in a garnetiferous matrix, the whole having a distinctly banded appearance. In a general way the amount of iron oxide gradually increases towards the centre of the mass, but bands, largely of garnet, reappear at intervals. Towards the centre of the body the ore consists very largely of magnetite, but with much feldspar and garnet. Through the whole mass iron pyrites is abundantly though irregularly disseminated, either in small lense-like patches, with some quartz,

or in large and small aggregates of grains, or in single grains. Besides the abundant garnet, vesuvianite, actinolite, epidote and altered chalcodite occur sparingly.

The general relations of the deposit with the surrounding strata, viewed in connexion with the possible Silurian age of the measures, pointedly suggest that the ore body formed at the same time with the enclosing sedimentary beds, and that originally it was of the same general character as the beds of manganiferous hematite of the Silurian of the St. John River valley and the bordering State of Maine. The sulphide probably originated in the same fashion as the widely distributed pyrite of the country rocks of the whole district. The garnets, in part at least, are younger than the pyrite grains, since the latter are sometimes enclosed in individual crystals of garnet.

The garnet, vesuvianite, etc., minerals essentially of metamorphic origin, need not necessarily have been produced at the time the iron oxide first was localized, but may have been due to local causes, perhaps connected with the neighbouring igneous dikes, which, both large and small, are very numerous in the district. Possibly, however, the ore body should be classed as a true metamorphic contact deposit and be considered as having formed later than the enclosing strata, since nowhere else in the district are the sedimentary beds so highly changed, nor were secondary minerals like the garnet and vesuvianite seen anywhere else.

The ore body lies near the eastern limits of the map sheet, and just beyond the borders of the area fragments of similar ore were observed over a distance of several miles. Though not seen in place, this float material seemed to point to the existence in their neighbourhood of other like deposits of iron ore. Since no indications of specially favouring conditions were observed, it is not impossible that other bodies of iron ore occur within the area already examined, though if such are present they are probably concealed from view by drift.

TOBIQUE COUNTRY.

At the close of the season's field work in the Bathurst district, a brief visit was paid to the Tobique country in Victoria county, N.B., in connexion with the reported occurrence of gold in that district. Through the country various stories are current regarding the finding of gold in the district twice during a period of over half a century, but all versions agree in stating that in neither case did the supposed discoverer reveal even the approximate locality from which he had procured his gold specimens. The general consensus of opinion locates the supposed discoveries in a territory over 100 square miles in extent, lying in the angle formed by the Serpentine river and the headwaters of the Nipisiguit, and one possible reason for this general belief may be due to the fact that a few colours can be recovered from the gravel bars of the Serpentine river. From time to time the mining rights to certain tracts of land in this district have been granted, but as far as the present writer is aware, no systematic prospecting has ever been done.

The country is not one favourable for prospecting in nor for rapid geological work, since even in the beds of streams and on steep hillsides bed-rock is but rarely exposed, while the district being still unsettled and thickly timbered, the finding of rock exposures is largely a matter of chance, unless unlimited time is afforded for a systematic search. The district, however, by reason of lumbering operations, is readily accessible, and its general geology is not unfavourable to the occurrence of mineral deposits, perhaps including gold. The country lies between the large areas of granite, presumably Devonian in age, of the interior of the Province, and the Silurian sediments and associated igneous rocks, both intrusive and extrusive, that occupy so wide a territory in the St. John River valley and in Maine. This territory is partly underlain by schists and gneisses which previously have been assigned to the Ordovician and Pre-Cambrian, though possibly they are metamorphosed equivalents of the Silurian.

BITUMINOUS SHALES OF NOVA SCOTIA AND NEW BRUNSWICK: WITH NOTES ON THE GEOLOGY OF THE OIL-SHALES OF SCOTLAND.

(R. W. Ells.)

The first part of the season, or from the end of May to the middle of August, 1908, was spent partly in an examination of the oil-shales of Scotland, with a view of comparing them with those of New Brunswick and Nova Scotia, and of making an investigation of the oil-shale industry of that country, which is very large and important; and in superintending the distillation of a shipment of oil-shale amounting to between 40 and 50 tons, which had been sent from Baltimore, Albert county, N.B., to Glasgow in March, 1908, in order that a commercial test should be made to ascertain the economic value of the material, especially as related to the contents in crude oil and sulphate of ammonia.

This work was successfully carried out in the experimental retort belonging to the Pumpherston Oil Co., located at Mid Calder, about 12 miles west of Edinburgh. The detailed report by the chief chemist of the company has been handed to Dr. Eugene Haanel, Director of Mines, and will appear in the Annual Summary Report of the Mines Branch for the fiscal year 1907-8.

THE GEOLOGY OF THE OIL-SHALES IN SCOTLAND AND CANADA.

The geological position of the Scotch oil-shales, when compared with those found in New Brunswick and in Nova Scotia, corresponds very closely. Those from which the oil is now produced are apparently on the same horizon as the Albert shales of New Brunswick, while the horizon on the Torbane Hill mineral, once worked in Scotland, is apparently identical with that of the Stellarite of Pictou county in Nova Scotia, belonging to the Middle Carboniferous, or base of the Coal Measures proper.

The position of the oil-shales and their associated rocks in both countries is below the Lower Carboniferous marine limestones, and above the recognized Devonian in Scotland. In eastern Canada they are unconformably beneath the limestones, and appear to form an upper member of the Devonian, belonging to the Perry formation of New Brunswick. In Scotland the formation is known under the name Calciferous Sandstone series.

In Scotland these oil-bearing rocks are well developed to the west and north of Edinburgh on both sides of the Firth of Forth, and mining operations have been carried on in many parts of the field. In general character the shale formation resembles closely the same formation in New Brunswick—in the frequently brownish or chocolate colour, the texture and association of ochreous dolomitic or iron stone bands, and in the presence of the remains of fishes which in certain bands are very abundant. The oil-bearing bands in the Scotch shales differ from those found in the New Brunswick shales; for while both are high in oil and ammonia contents, the Scotch bands are chocolate brown and softer than the containing shales. They can be readily cut with a knife, being practically free from gritty matter, but have the characteristic bituminous odour; while the New Brunswick oil bands are much darker, often a dark brownish black, more massive and harder than the ordinary shales, tough, and break with a marked conchoidal fracture. Like the beds of the Scotch shales they vary in oil contents as well as in sulphate of ammonia in different bands, and even in parts of the same bed. In the freshly mined rock the New Brunswick shale is

much more massive than the Scotch shale or even than the main mass of the associated shale, which often has a thin and papery structure; but is nevertheless a shale, as can be seen on weathered surfaces of the oil-bands, and this shaly character is also developed to some extent in the retorting. Owing to this generally more massive character the Scotch experts were at first inclined to the view that the New Brunswick material furnished for the test was not a true shale, as compared with the material with which they are familiar.

The New Brunswick oil bands ignite easily in splinters kindling readily from the flame of a match, burn freely in the grate, producing a long yellow flame with great heat, generate steam quickly under boilers; but yield a large percentage of ash which unfits the material for a good fuel, so that, except for experimental purposes, it has, as yet, been but little employed for economic use. With the exception of the large percentage of ash in composition, however, it should be available in many cases as fuel. It burns like cannel, giving off gas spurts in the grate, and was for a time regarded as a variety of this coal.

The Scotch shales used for oil are known by the terms 'plain' and 'curly.' The associated or less bituminous portions are known under the name of 'Blaes.' All these varieties are found in the New Brunswick deposits. Of these the kind known as curly is regarded as the most valuable, being as a rule much richer in oil than the plain. Both varieties sometimes occur in the same bed, and the yield of oil varies from point to point in the working. In the curly variety, possibly the greater percentage of hydrocarbons may render the material softer and more easily crumpled than the stronger but poorer bands associated with them.

These Scotch oil-shales are, as stated, almost entirely free from gritty matter, do not dull the edge of the knife, and can be readily tested by the teeth. The Blaes varieties, on the other hand, show the presence of gritty material very perceptibly, do not shave easily, and on weathering crumble readily, and pass into muds. The rich shale, however, resists weathering, and practically remains unchanged by exposure to the weather on the dump for some years with but small loss of oil contents. It will be seen, therefore, that the physical characters of the New Brunswick shales are somewhat different from those used in the Scotch industry, though there is a general resemblance between the two formations.

The great value of the Scotch shale does not, however, depend entirely upon the percentage of the contained oils, as now mined, but largely on the presence of other substances, such as paraffin, sulphate of ammonia, etc., while the resulting oils from the retorts are fractionated into various grades of burning, lubricating, and fuel oils; naptha, tars, etc. The percentage of crude oil now obtained from the Scotch shales has materially decreased in recent years, and now rarely exceeds 25 to 30 gallons per ton; but shales low in oil are used somewhat extensively, since the industry has shown that, often the shales poor in oil contents are richer in sulphate of ammonia. This is a very important point in estimating the scale of profits, owing to the importance sulphate has obtained through its extensive employment as a fertilizer in agriculture. The yield of paraffin is also an important factor.

The thickness of the workable beds varies very materially in the same field, and even in different parts of the same bed. They range from a few inches to sometimes 6, 8 and even 10 feet, and at one place a thickness of 15 feet is recorded.

Like the New Brunswick shales, the strata are often thrown into folds which bring different portions of the oil bands to the surface at various points, and they are also affected by numerous faults. Some of the Scotch workings have been mined to a depth of over 1,000 feet; the mining being carried on much after the fashion of mining beds of bituminous coal. All the workable areas have been proved by systematic borings, usually with the diamond drill; the cores from which are carefully logged and kept for reference. In all attempts to prove the number of beds, their thickness and extent, this method of core drilling is considered most important as regards future development, and is one of the first things attended to. In the New Brunswick areas,

where the shales are concealed over large areas by drift or by overlying newer formations, such preliminary work is an absolute necessity to obtain suitable locations for plants, or a correct estimation of the economic value of the several portions of the field.

In a folded and faulted area, the actual position and extent of the several seams cannot be ascertained from limited and scattered outcrops alone, and estimates of quantities made under such conditions will be merely conjectural. In the case of the Scotch drillers, so carefully have the logs of the numerous holes been kept, and so well are the positions and nature of the several oil shales known, that in many cases any particular seam met with can be readily recognized, and its horizon established. It is greatly to be regretted that in all the borings made on these shales in New Brunswick no such careful recording of the drillings has ever been attended to.

OIL-SHALES OF NOVA SCOTIA AND NEW BRUNSWICK.

After my return from the shale tests carried out in Scotland, nearly two months were devoted to a careful examination of the shale deposits of Nova Scotia and New Brunswick, in order to ascertain more closely their probable economic values in oil and sulphate of ammonia; and several deposits, other than those already known to exist, were located.

On these up to the present time little work has been done. At several points, as at Lake Ainslie and McAdam lake, in Cape Breton, boring for native oils has been carried on in a desultory manner for some years, but without much apparent success, and the sites even of most of the borings have been obliterated. At Stellarton, in Pictou county, on the discovery of the mineral stellarite some 50 years ago, its value as a producer of crude oil was ascertained, and a quantity, stated to be about 4,000 tons, was raised and shipped for treatment abroad, part of which went to the United States; the value of the material at that time being stated as $8.35 per ton at the place of shipment. Owing to its high yield in gas this material was evidently largely employed as an enricher of bituminous coals in the process of gas making. Work on this area was discontinued shortly after the finding of the native oils of western Ontario.

In the examination of the several shales, the simple tests by ignition, and by the knife, were applied with varying results, some portions kindling readily from a lighted match; and certain portions in both Provinces were found to be excellently adapted for distillation on a large scale. For this purpose it may here be said that practically the greater part of the rich shale areas in eastern New Brunswick has been secured by a company, and arrangements are already being made to establish a plant in this Province to work these shales on a commercial basis.

In New Brunswick the belt of bituminous, or as they are generally styled, Albert shales, is well exposed in that part of Westmorland county between Memramcook river, near Upper Dorchester, and Petitcodiac river, between Dover and Beliveau.

Crossing this river into Albert county these shales are at first concealed by Lower Carboniferous rocks, in which gypsum is very abundant, but they reappear at the Albert mines, about 5 miles to the west of Hillsborough. They here lie against the flank of Caledonia mountain, and can thence be traced, with several gaps, to the western limit of the county near Elgin. Beyond this they continue through Kings county south of the Intercolonial railway for some miles, being well seen at a number of points to the south of Sussex and Norton, but disappear between Apohaqui and Hampton.

In Nova Scotia the shales are somewhat different in character, the brown bituminous beds being apparently represented by black and dark coloured beds. The beds richest in oil belong to a higher horizon, and form a portion of the Coal Measures, or Middle Carboniferous. The black shales are well exposed in Hants county, between Hantsport and Avonport, on Avon river, and on the coast from Cheverie to beyond Walton on the south side of Minas basin. They have often a jet black colour, but do

not readily ignite; no analyses have been made to determine the percentage of hydrocarbons. The shales occur in great quantity at several points, and reports of their capacity for oil have been given in a paper by Mr. J. Campbell, in How's Mineralogy of N.S. (1868). In this, Mr. Campbell states that 'the bituminous beds appear to be divided into two groups, the lower of which appears to be about 70 to 80 feet in thickness, 20 feet of which may be regarded as good oil shale, including 5 feet of curly cannel rich in oil. The upper band, which lies in immediate contact with the limestone, cannot be much short of 150 feet in vertical thickness of strata, containing a large percentage of oil. Of this great bed of oil-batt, about 30 feet will in all probability yield from 20 to 25 gallons crude oil to the ton. The 5 foot seam of curly cannel will yield at least 40 gallons crude oil to the ton, and the 15 feet of the best section of the oil-batt will yield at least 20 gallons to the ton.' On the assumption that these figures are reasonably correct, the amount of oil obtainable from this great body of shale is of great importance, and the area is well worthy of careful testing. The basin in this part should contain some 50 feet of strata rich in oil. It may be added that no attempt has yet been made to ascertain the actual value of these oil-bearing strata.

In the vicinity of, and a short distance north of Truro, Mr. H. Fletcher reports the presence of large bodies of these black shales, but no attempts have yet been made to establish their percentages of oil, or sulphate of ammonia.

Farther east, in Pictou and Antigonish counties, large deposits of black shales occur. As regards the deposits near Stellarton, reference has been made to them in How's Mineralogy. Some statements there given are worthy of careful consideration, and may be reproduced since this volume is out of print and copies are rarely to be found.

Of the oil-coal at this place, Dr. How remarks:—

'I believe this material was first examined and described by myself in a paper published (Silliman's Journal and Edinburgh Phil. Journal), in 1860, soon after it had been opened up by Mr. Fraser. It has been called the stellar coal from the fact of 'stars of fire' dropping from it when it has been held to a flame and removed. The seam in which it is found is called the stellar seam. As the well known minerals analogous to it, in the leading property of furnishing much oil, have been distinguished from coals by the special names torbanite and albertite, this might be designated stellarite. It occurs with bituminous coal in a seam 5 feet thick, of which 1'-10" are stellarite, 1'-4" bituminous coal, and 1'-10" bituminous shale: the composition of the three bands is shown by my analysis to be as follows:—

	Coal.	Stellarite.	Shale.
Volatile matter	33·58	66·56	30·65
Fixed carbon	62·09	25·23	10·88
Ash	4·33	8·21	58·47
Moisture	0·23		
Sp. gr.	1·103		

The oil-coal, or stellarite, has been examined abroad with quite analogous results; the mineral improves towards the east, while the overlying McGregor coal deteriorates in that direction. Other analyses have given the following results, the No. 2 is probably the shale, No. 1 being stellarite:—

	No. 1.		No. 2.	
Moisture	·20	·32	·80	·60
Volatile combustible	67·26	68·38	34·16	38·69
Fixed carbon	24·03	22·35	12·30	8·26
Sulphur	·11	·05	·74	·25
Ash	8·40	8·90	52·00	52·20
	100·00	100·00	100·00	100·00
Sp. gr.	1·069	1·079	1·612	1·568

On a further comparison of these shales with cannel coals, Dr. How gives the following results, the ratio of carbon to hydrogen for the following minerals being:—

Cannel coal, from Wigan	100 to 5·65
" " Leshmahagow	100 to 8·71
" " Capeldrae	100 to 10·05
Torbanite, Scotland	100 to 12·43
Albertite, New Brunswick	100 to 10·85
Stellarite, Pictou, N.S.	100 to 12·43

and he says that 'theoretically they should be excellent oil-coals, as is abundantly proved by experience. For the following amounts of oil, yielded by various materials, I am indebted in part to Mr. Poole, formerly manager of the Fraser Oil-coal Works, where the stellarite was used, and in part to Mr. Hoyt. I have myself tried none of them for the production of oil.

Union oil-coal, of West Virginia, affords	32	gals. crude oil per ton.
Elk River oil-coal, of West Virginia, affords	54	" "
Kanawha oil-coal, of West Virginia, affords	88	" "
Leshmahagow cannel, Scotland, affords	40	" "
Albertite, New Brunswick, affords	92 to 100	" "
Torbanite, Scotland, affords	116 to 125	" "
Stellarite or Stellar coal affords	50	" "
Stellarite or Stellar coal No. 2, affords	50, 60¾, 63, 65, 74	" "
Stellarite or Stellar coal, No. 1, affords	123 to 126	" "

Picked samples gave, in Boston, 199 gals.

'Some of these are the amounts yielded by careful experiments on a small scale. When oil was made at the Fraser mines, in 1859, the practical result was about 60 gals. crude, and from 30 to 35 gals. fine clarified oil to the ton.'

By reference to the recently published map of the Pictou coal field, by Dr. H. S. Poole, issued 1904, the presence of this oil-coal may be seen noted at a number of widely divergent points, so that it is evident that the material must occur in large quantity. The mining of the mineral was stopped on the discovery of the abundant supplies of mineral oil in the United States, about 1860.

In view of the great prospective value of the stellarite, or oil-coal of this district, the following data, taken from Dr. How's paper in Silliman's Journal (1860), may be added:—

'The oil-coal found near Pictou, N.S., was first met with by persons residing in the neighbourhood, early in 1859, and its exact locality is called Fraser mine. It occurs in the Coal Measures. I am indebted to Henry Poole, Esq., manager of the Fraser mine, for the following particulars relating to the geological position, etc., of the substance.

'The lowest measures, about 60 yards, on the surface, short of the distance where the oil-coal outcrops, are composed chiefly of strong bands of sandstone, actual thickness not yet proved; then shales with bands of ironstone, and stigmaria roots with sigillaria stems, and a few detached fern leaves in such soft shale that I have not been able to preserve any good specimens. Immediately above the oil-coal is a seam of bituminous coal about 14 inches thick. Where we commenced to open a mine by driving a slope, the oil-coal was 14 inches thick, but at 200 feet down, at the bottom of the slope, the oil-coal was 20 inches thick; it has a smooth regular parting at the top next the coal, as also at the bottom next the oil-batt below, but throughout its entire thickness it is of a curly twisted structure; many of its fractures look like the casts of shells, and the sharp edges are polished, of a slickensided character. No fossils that I am aware of have yet been found in the curly oil-coal. The oil-batt next below is nearly 2 feet thick, of a homogeneous character with a slaty cleavage of various thicknesses. In this band two or three varieties (species) of lepidodendron beautifully preserved have been found, also leaves about one-fourth of an inch wide and in lengths of from 4 to 6 inches, which have undergone so little change, that when the damp shale was fresh split they could be removed, and were so elastic that

they could be bent considerably without breaking. At the bottom of the slope another thin seam of curly oil-coal has appeared of a few inches in thickness, but it is not worked at present. In the roof-coal were found pieces of decayed wood very little changed, which I consider a great curiosity. On McLennan brook, shale is above the oil-coal and oil-batt below, in which have been found lepidodendra, and apparently molar teeth with three fangs, flattened modiola shells, and spines or small fish teeth. The oil-batt has been found in several places without the curly band or so-called oil-coal. Two thousand tons of oil-coal have been raised (December, 1859), at the Fraser mine.

'The oil-coal varies in colour from brown to black, is dull where not polished as just mentioned, has a reddish-brown, lustreless streak, its powder is dark chocolate coloured, it is very tough and breaks at last with a hackly fracture, its specific gravity in mass, after the vessel of water containing it had been in an exhausted receiver, is 1·103. It takes fire very readily, and when removed from the lamp, still burns for some time with a brilliant smoky flame, and flaming melted fragments continually drop from it in a truly characteristic manner. Ignited in coarse powder, in an open crucible, it gives off abundant smoke and flame, then seems to boil quickly, and a coke is left of the bulk of the original material, showing, when turned out, a complete cast of the interior of the crucible. The ash of the coke is grey, and consists mainly of silicate of alumina; at least no lime, or a mere trace, is dissolved by acid, while some alumina is taken up, and a great deal of solid remains undissolved. The powdered oil-coal, digested with benzine and with ether, does not more than sensibly colour these fluids, but some residue remains on evaporation, in each case.

'The bituminous coal occurring with the oil-coal has the usual characters belonging to the species; it is black, brilliant, and very brittle. The proximate analyses of the two are placed side by side; and it will be obvious at once that they contrast very strikingly.

	Oil-coal.	Bitum. coal.
Volatile matters	66.56	33.58
Fixed carbon	25·23	69·09
Ash	8·21	4·33
	100·00	100·00

'The following is the ultimate analysis of the oil-coal, for which I am indebted to Mr. Slessor, assistant to Prof. Anderson, of Glasgow, whose aid I requested from want of the necessary apparatus:—

Carbon	80·96
Hydrogen	10·15
*Nitrogen (by loss)	0·68
Ash (as above)	8·21

'The oil-batt appears to be decidedly a shale, and a specimen from Bear brook, Fraser mine, gave the following results: —

Volatile matters	30·65
Fixed carbon	10·98
Ash	58·47
	100·00'

The practical yield of oils will vary according to the manipulation, the perfection of the manufacturing processes, and the quality of samples employed, but the following statement of the comparative amounts of oil afforded by some of the above may be taken as a good illustration.

In Scotland the Leshmahagow cannel coal gives 40 gallons crude oil and 32 gallons rectified oil per ton.

The Fraser oil-coal at McLellan brook gives 40 gallons crude oil per ton.

The Fraser oil-coal and oil-batt at Coal brook, together give 53 gallons per ton.

* With oxygen and sulphur?

The Fraser oil-coal at McCulloch brook gives 77 gallons per ton.

The Albert coal, or albertite, gives 100 gallons crude oil per ton.

The Torbane Hill coal gives 125 gallons per ton.

It will thus be seen that in Pictou county, where these shales outcrop at several points, and in large extent, the possibilities of successful development are such as to merit careful experimenting.

Going east to Antigonish county, Dr. How, in the paper already quoted, reports a 5 foot seam of curly cannel which will yield at least 40 gallons of crude oil to the ton, and 15 feet of oil shale which will yield at least 20 gallons.

In the recent examination of these areas, near Big Marsh, about 9 miles north of Antigonish town, extensive outcrops of very black shales were seen, with others grey and reddish. With these black shales are beds of coal, somewhat impure, yielding a large percentage of ash. The black shales do not all kindle readily, but some portions burn freely, and should contain sufficient hydrocarbons to be of value for distillation. These are probably the shales referred to by Mr. Campbell, already noted. They have not been tested, but are similar in character to those of Hants county, and are worthy of careful examination.

In Cape Breton also, similar shales, black and supposed to be oil-bearing, are found at several points. They have been bored for oil around the north end of Lake Ainslie, and at McAdam lake, the latter about 12 miles west of Sydney. Though no success has yet attended the oil-borings, the character of the black shales, and their ready ignition at certain points, indicates a prospective economic value, and certain of these deposits are worthy of being tested as soon as provision is made for this kind of work.

Various reports and papers have been written relative to the value of these deposits, but prior to the recent test in Scotland, nothing specially definite could be stated as to their actual value. In New Brunswick, as in Pictou county, N.S., attempts to utilize certain of these deposits at Baltimore were made about the same time as the opening of the stellarite beds, or between 1860 and 1864. A plant was erected at Baltimore, which was in operation for several years, and produced, even with the crude plant of that early date, a good quality of oil, the reported yield by the retort being given as 60 gallons per ton.

Unfortunately all records of the works at that time have been lost, some of them in the St. John fire of 1877, while the plant has long since been entirely removed. Several thousands of tons of the rich oil-shales from the Taylorville area in the eastern portion of the field were also shipped to the United States, at an early date, for distillation, but with the crude appliances of that time they could not successfully compete with the great supplies of native oil produced in the United States and Canada. The enterprise was, therefore, soon abandoned as being unprofitable, but even with the somewhat crude plants and methods of 50 years ago, an excellent quality both of burning and lubricating oil was produced and found a ready market.

At that date also it may be said that the Scotch industry was only passing through the experimental stage, and numerous failures of companies engaged in the business are recorded.

The investigations of the past season on the oil-bands have shown these to be numerous and of great prospective value as a source of supply for crude oil and sulphate of ammonia, as well as for paraffin wax. In New Brunswick, of the principal areas examined, the most readily accessible at the present time are at Baltimore, Albert Mines and Taylorville, the latter on the shore of Memramcook river, in Westmorland county.

In all these places the several outcrops of oil-shale were uncovered, with the following results:—

At Taylorville, the area of shales exposed is somewhat limited, owing to overlying beds of later date, including the Lower Carboniferous and Millstone-grit. About 45 years ago a considerable quantity of the oil-shale was mined, aggregating several

thousand tons, and shipped to the United States for distillation or for gas making, the records of which are not now to be had. Recently the area was examined by Mr. James Robertson, of Albert Mines, on behalf of this Department, and the Albertite Oilite and Cannel Coal Co., and four beds of very fine quality were uncovered. Of these two measured 22 inches each in thickness, the third 36 inches, and the fourth 60 inches. These equally in character the best found in the Albert County areas. Being all situated close to water, and within a mile or so of the Intercolonial railway, they are easily accessible, and should be of great value for future operations.

At the Albert mines, which were formerly the seat of the great albertite industry, the oil-bands outcrop along the course of Frederick brook. These were also opened by Mr. Robertson, under our direction, and at least six were uncovered in a distance of about a fourth of a mile along the stream. Of these No. 1, the most easterly, was opened some years ago, in a small quarry, along the old line of railway connecting the former Albertite mine with the Harvey and Salisbury railway. The exposed thickness of this band is 6½ feet, largely of the curly variety, rich in oil. It has not been tested for sulphate of ammonia. A few yards to the north-east, on the brook itself, apparently the same bed is disclosed, and was opened by blasting. It has a similar thickness of 6½ feet, with a north-west dip at an angle of about 7 degrees. It apparently continues down the stream for some distance, until overlaid above by conglomerates of Lower Carboniferous age, which are unconformable.

Going west up this stream from No. 1, 430 feet, bed No. 3 is seen at a small fall, with a thickness of 5 feet of good shale, but not so curly as the first, and showing a slaty structure on weathered surfaces. On the north side of the brook, bed No. 2 was uncovered on the side of the ridge, with a thickness of about 3½ feet, and is also of excellent quality, with numerous black streaks of carbonaceous matter. These two seams dip south-west at an angle of 8 degrees.

Bed No. 4 lies 150 feet west of No. 3. It has a thickness of 4½ feet, and a dip similar to the last; the shale is of good quality but not of the curly variety. About 290 feet west of this is bed No. 5, consisting of laminations of brownish shales with thin beds of oil shale. It is situated on the bank of the brook, has a south-west dip of about 20 degrees, and is not so massive as the others. Some 650 feet farther on is bed No. 6, which was uncovered on the face and showed a solid front of 6 feet, most of which is of good quality. The dip here is also south-west, at an angle of 10 degrees.

These beds are all easy of access. The contained strata show an anticlinal structure a short distance north, and they are probably repeated in that direction. Faults, however, occur in this part of the field. As newer formations cover the surface to the north and south, their distribution cannot be ascertained except by boring. It may be said, however, that the shafts of the Albert mine were carried down to a depth of 1,400 feet in close proximity, and from the material on the dumps, other bands of the oil-shale were apparently passed through, the positions of which were not recorded, since the search at that time was for albertite only. None of these beds have as yet been submitted to a careful test for either oil or sulphate of ammonia, by this Department.

West of the Albert mines the bituminous shales are concealed, for several miles, along the north flank of Caledonia mountain, by Lower Carboniferous sediments, to within about a mile of Baltimore, where they again reappear on the headwaters of Weldon creek. On the upper part of the east branches of Turtle creek, on Forsyth and Baizley brooks, they are well seen, and on the latter show beds of very rich oil-shale of the curly variety.

These were opened up many years ago to supply the oil works at this place (1862-4). The old drift was cleared out and the bed measured. This bed is numbered, No. 7, or Baizleys. The thickness of the black curly portion is 4 feet, with a lower portion from 2 to 2½ feet of black and rich oil-shale, of the plain variety, the foot and hanging shales being easily recognized. This seam is traceable to the west for nearly half a mile past Rosevale corner and post office. Several other beds of this shale

evidently occur running in a similar direction to the Baizley seam, and can be recognized by the ridgy nature of the surface, due to the greater resistance of this material to weathering.

Bed No. 8 is about 75 yards north of E. Stevens' house, at the summit of the road leading across to the west branch of Turtle creek. It has been opened by a drift driven for 80 feet on the dip of the bed, which is north at an angle 20-25 degrees, and shows a measured thickness of 5 feet clear of very fine oil-shale, mostly of the black curly variety.

To the south of the road, 100 yards in front of Mr. E. Stevens' house, is bed No. 9, also opened by a drift to a depth of nearly 100 feet, the dip being north like the last. The shale is a very rich curly variety, and the thickness at the face of working is reported as 7 feet. A large quantity of this shale, amounting to some hundreds of tons, which had been mined several years ago and left on the ground, was recently set on fire by some one and entirely consumed. The drift at this place is now fallen in, so it could not be entered.

No. 10, or Irving's seam, lies to the north of the main road, and about 1,000 feet east of E. Stevens' opening. This is the bed from which the shale shipment to Scotland was taken. It is opened by a drift for about 75 feet, and at the inner end shows a thickness of about 6 feet. The seam varies in quality, being generally massive, but sometimes with small black streaks, though with small indications of the curly variety. It is certainly inferior in quality to that from the Baizley or Stevens seams. The dip of this bed is north, 20-25 degrees.

The outcrops of several other seams were observed in the vicinity of the corner by Rosevale post office. These had been uncovered some years ago, but the openings were entirely filled up, and the thickness could not be measured. It seems probable, therefore, that at least two other seams or beds, other than those described, should occur in this area.

On the west branches of Turtle creek, about 2 miles west of Rosevale corner, the shales are well exposed and show oil bands at several places. On the first of these branches, near the school house, several bands cross the stream, somewhat greyer in colour than the oil-bands already described. One of these, at the old road crossing to Stewart's, has a thickness of not far from 15 feet, apparently, though this has not yet been opened, the measurements being taken on the bank of the brook.

On the west branch, ¾ of a mile to the west of this, is a bed of what is styled grey shale, which, from the facility with which it ignites and its oily streaky character, appears to be very high in hydrocarbons. The exposed thickness, where opened by a short drift, is about 3½ feet, with the usual north dip, at low angles. Other bands occur on the stream, but lack of time prevented their being opened at the time of our visit.

About 4 miles farther west, on Hayward brook, a branch of Prosser brook, and near the foot of the mountain, three other bands of brownish oil-shale were partially opened up. This shale is soft, resembling in character much of the Scotch oil-shale. The thickness of the first bed was measured as 5 feet, and the other two, though not well displayed, seem to be about the same size. The present comparative inaccessibility of these beds, as compared with those already described, is against their immediate development. Like the Baltimore beds, these shales have been tested for oil and sulphate of ammonia.

Farther west, in Coverdale, Mapleton, and at Elgin corners, these Albert shales are well seen in several streams. They were bored to some extent for oil thirty years ago, without success, but no recent detailed examination for oil-bands has yet been attempted, though several were observed during the examinations of that time. They are well worthy of a careful search along these lines. Several well located borings with a good core drill, under careful supervision, should be able to settle this point.

Large samples of the several beds disclosed from Taylorville on the east to Hayward's on the west, were collected during the past season. These were duplicated,

and one set was sent to New York for determination in the laboratory of Dr. Charles Baskerville, Dean of the Faculty of Science in the College of the City of New York, who has installed a small plant where all these can be carefully tested and their values in crude oil and sulphate of ammonia can be determined. This test will be of the greatest practical value, and with the exception of the large test made recently in the Pumpherston works, Scotland, will be practically the only thorough test to which these shales have as yet been subjected. From the high standing of Dr. Baskerville as a chemist, and of his assistant, Mr. W. A. Hamor, who was present during the whole of the Scotch tests on the New Brunswick shales, and is, therefore, thoroughly conversant with the methods employed in that country, these tests when completed may be regarded as thoroughly reliable. This course is at present necessitated by the fact that the apparatus designed for testing various Canadian shales by the Mines Branch of the Department of Mines, is not yet installed; owing to the contemplated changes in the laboratory, due to the removal to the new Victoria Museum in Ottawa.

The results of a number of these analyses recently made by Dr. Baskerville are by his permission inserted. They serve to show the large values of these shales, both in crude oil and in sulphate of ammonia.

Locality.	Imperial gallons of crude oil per ton.	U. S. gallons of crude oil per ton.	Specific gravity of oil.	Sulphate of ammonia in lbs. per ton.
Shale retorted in Scotland from Irvings opening	40	48	0·92	77
Geo. Irvings, by Dr. Baskerville, N.Y	39	47	0·895	76
Baizley's farm, Baltimore	54	65	0·895	110
E. Stevens, Baltimore	49	59	0·892	67
Hayward brook, Prosser brook	30	35	0·895	75
Adams farm, Taylorville	43	51	0·90	93
A. Taylor's farm, Taylorville, No. 1	48	58	0·91	98
A. Taylor's farm, No. 2	37	44	0·925	110
Sample of 85 lbs., run in 1907, Baltimore	51	61	0·91	111

All that can be definitely stated in the present practically undeveloped condition of the several districts in which oil-shales are known to occur in eastern Canada, is that all these areas are well worthy of being tested in the most thorough manner, and by all available means, especially by careful core drilling at several well selected points; in order that the whole series of beds may be located, their thickness ascertained, and a careful analysis of the several beds drilled through in the sections should be carried out; since in the folded and faulted nature of much of the ground, their actual positions in depth and values cannot otherwise be ascertained.

As regards the Baltimore shale bands several reliable analyses have already been made from time to time. Among the most valuable of these, two may be cited.

One of these analyses by Mr. Hislop, a chemist of known repute connected with the gas works at Paisley, Scotland, was made on one ton of shale from Baltimore, the exact location of the bed from which the sample was taken not being known, and gave:—

Lubricating oil	11 gallons.
Burning oils	25 "
Paraffin wax	48 pounds.
Sulphate of ammonia	72 "

Another test of Baltimore shale made in the laboratory of Dr. Baskerville, New York, by Mr. W. A. Hamor, his assistant, gave:—

Naptha	6 gallons.
Lubricating oil	9 "
Burning oil	11 "
Paraffin oil	5 "
By-products, containing tars, sulphur compounds, creosote, etc	31 "
	62 "

The actual position of this sample is also unknown, but possibly it may represent the Baizley seam at that place.

It may, therefore, be stated that in general character and value, both as regards the contents of crude oil and sulphate of ammonia, the shales of New Brunswick compare favourably, and in some cases undoubtedly surpass, those distilled in Scotland. These two substances should render it possible to utilize at the present scale of prices, certain of these deposits at a fair profit, while the bonus recently granted by the Dominion Government of 1½ cents per gallon on oils manufactured from shales, or the same as that taken from wells, should practically offset the supposed greater cost of mining the crude material. The actual cost of this item is not yet ascertained.

While the greater part of the main vein of albertite was supposed to be worked out at the time the mining of this material was abandoned, this is by no means regarded as actually correct; since portions of the original vein are confidently stated by those familiar with the structure and history of this mine to yet remain in certain parts of the old workings. Recent investigations on this area have also disclosed the presence of other veins of albertite, which by careful testing may make the property as a whole much more valuable than once supposed. The high yield of this substance in oil and paraffin as known by tests at various times should render the average yield of oils from this part of the field much larger than would be obtained merely from the retorting of the shale bands alone; while the immense dumps at this place, aggregating over 100,000 tons, in which large quantities of albertite are known to be embedded, are worthy of consideration, in the event of future operations being commenced.

REPORT ON A PORTION OF CUMBERLAND COUNTY, NOVA SCOTIA.

(Hugh Fletcher.)

I left Ottawa on June 30, under instructions to continue the survey of the district in Cumberland county comprised principally in sheet 78, but also partly in sheets 77 and 79, lying west of Philip river, and the sheets already published, or between Oxford junction and Amherst on the Intercolonial railway and the shores of Northumberland strait and Baie Verte. My assistants were Messrs. M. H. McLeod and John D. MacKenzie. The latter leaving on September 17, one of Mr. Faribault's assistants, Mr. J. M. Cruickshank, was engaged to work until the close of the season.

A general description of the district is given in the Report of the Geological Survey for 1903, also in previous reports by Messrs. Scott Barlow, Walter McOuat and R. W. Ells, mentioned on the map of the Springhill coal fields, No. 812, which was printed in the Summary Report for 1902. In these reports is emphasized the difficulty of defining the various groups of rocks, particularly the conglomerates and grey sandstones, without assistance from their fossil contents, even on a section as well exposed as that of the Joggins shore. It is believed that considerable progress has been made in this direction, and it is confidently hoped that the maps, when issued, will make several points clear that are now obscure. At present the general results only of the season's work will be briefly stated; details of structure being reserved for the maps now in course of preparation.

Beginning at Rossendale and Mount Pleasant, most of the branches of Little river, the Shinemicas, Nappan, Laplanche and Tidnish rivers, also several branches of the Little Forks and Black rivers were surveyed. These afford outcrops belonging to the following geological formations: Carboniferous Limestone or Lower Carboniferous, Millstone-grit, Coal Measures and Permian or Upper Carboniferous. The general character and distribution of these formations are shown in Mr. Ells' report for 1885, Dawson's Acadian Geology, and other publications.

The Carboniferous Limestone, with its characteristic beds of gypsum and limestone, is found in a more or less continuous belt from Mount Pleasant to Minudie, on the Joggins shore. At Rossendale, it is exposed in Philip Fahey's fields, in several branches of Little river, on the Leicester road, at Brookdale, and in the Lime-kiln brook and other branches of Nappan river.

The limestone, gypsum and associated marls and sandstones of the north branch of Little river extend also down the main river below the forks to within a short distance above the mouth of Bear brook, where they are overlaid by gray, and rusty sandstones, probably Permian, or Coal Measures. North of the road at West Leicester, broken land and pits seem to indicate gypsum or limestone, an extension of the Lower Carboniferous of the quarries of East Leicester; as at other places, salt springs indicate the presence of these rocks.

The Lime-kiln brook near its mouth shows gypsum, succeeded by a thick band of limestone which follows the brook up-stream in the most remarkable manner, crossing and recrossing it several times, then turning to the quarries at Shipley's from which 12 tons of pyrolusite were extracted. [1]

The gypsum found in bore-holes at the Routledge farm, and marked also by large pits, is probably continuous with that to the westward, as shown on the map of Springhill.

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[1] Geological Survey, Summary Report, 1898, p. 147.

A comparison of Mr. Ells' map of 1885 with that published by the Nova Scotian Institute of Science in 1908 will show that in his subdivision of the rocks of the Joggins section, Mr. Ells has included Division 7 and the lower part of Division 6 in the Lower Carboniferous instead of making it the base of the Millstone-grit, as in Dawson's grouping.[1] Mr. Ells' point of separation is certainly the more convenient, being that at which the red sandstones and shales of Division 6 are overlaid by greenish and gray sandstones, with black carbonaceous shale and concretionary limestone, near Dogfish reef;[2] and this horizon seems to be recognizable also in the country to the eastward; for, using the line between the red flags and gray sandstone south of the Leicester road as a guide to define the structure, Mr. J. D. MacKenzie traced it from Little river through Salem and Fenwick to the Maccan river, thence to the Joggins shore, where it passes near a mill at the head of Downing cove; which would agree with the boundary given above. The gray sandstone forms a high ridge for a great part of its course and large blocks mark its position even where there are few outcrops.

The Millstone-grit as thus defined occupies a zone nearly parallel with the Leicester road, and at the Styles mine has at its summit 1,500 feet of gray conglomerate and coarse sandstone, underlying the coal, and well exposed in Styles brook immediately above the Gould road, and also for some distance east of Stanley.[3] Thus far small seams of coal have been traced. It has been generally assumed, as on the map of the Springhill coal field, that this is the equivalent of the thick conglomerate that extends from Holt's mill on Little Forks river westward to the fork of the Stewart and Westchester (Post or Economy) roads. The unbroken line of the boundary between the red and gray rocks traced by MacKenzie seems to limit the north and south fault necessary on the above assumption to indicate the equivalence, and the apparent wide distribution of the conglomerate east of the old Westchester road seems to render it possible that there the conglomerate may represent rather the so-called Upper Carboniferous rocks which overlie the Coal Measures at the Aberdeen slope, and thus represent the gray sandstone of Ragged reef. The resemblance of this conglomerate and associated gray sandstone to certain Upper Carboniferous sections to the eastward, makes the determination of its exact horizon of the highest importance in relation to the extension of the coal basins. The beds overlying it in Chase brook and elsewhere, are not like Coal Measures, and the Upper Carboniferous of Pictou harbour includes large masses of gray sandstone.[4]

The copper ore of Amos Blenkhorn and the manganese of Salem have been described.[5]

Coal Measures clearly extend from the Joggins shore to the Stanley mine at the Westchester road, and small seams of coal were traced by Mr. James Baird for a mile farther east, but the question of their further extension to the eastward is the question of the equivalence of the rocks of Styles brook with those of Chase brook, which it is hoped the surveys of this season will conclusively settle. As no coals have been found to overlie the conglomerate of Holt's mill, these strata will be included for the present with the Upper Carboniferous.

The Permian or Upper Carboniferous may then be subdivided into two distinct groups, a lower gray sandstone series, and an upper red soft series growing finer towards the top, and lying on both sides of an east and west anticline which passes south of the Leicester road: the southern outcrops extending from Mount Pleasant to Oxford and Saltsprings station; the northern and larger occupying most of the country north of the Leicester road. The presence of the gray rocks on most of the sections will be observed.

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1 Acadian Geology, p. 178.
2 N. S. Inst. Sc., Vol. XI., Part 3, p. 488.
3 Geological Survey, Summary Report, 1901, p. 214.
4 Geological Survey, Vol. 2, 1886, pp. 93-98 P.; ibid Vol. V., ;1889-91, pp. 121-141 P.
5 Geological Survey, Summary Report, 1897, p. 101.

The ledges of gray sandstone of Rossendale and Mount Pleasant succeed the Carboniferous limestone and seem to have as their base a gray grit associated with concretionary limestone-conglomerate. They are best seen in Dickson and Simpson brooks with a considerable thickness of overlying red rocks; but the grey series was not found to occur on the north side of Dickson brook, although one of the whitish overlying beds south of Dickson brook seems to be identical with a slickensided rock at Havelock Carter's near the Leicester road. If there is no unconformity here, the disappearance of the gray sandstone, and a steep southerly dip along the Dickson brook may indicate an east and west fault by which the sandstone is concealed. A higher conglomerate, overlying rusty grits and pebbly flags, was traced for some distance by McLeod across the Simpson brook.

The so-called coals of Mount Pleasant consist only of coal pipes and patches in coarse sandstone. In Dickson brook veins of barite, similar to those of Hodson in Pictou county, and beds containing chalcocite have been worked to a small extent.

Reference has already been made to some of the rocks of Little river. At and near the mouth of Bear brook, the more gritty variety, containing a large proportion of conglomerate, is well exposed and occupies the river nearly to its confluence with Philip river. The rocks of the eastern branches of Chase brook, those of the rocky barrens north of Black river, and of the ridge near the Doncaster Meadow road, are all Upper Carboniferous. Near Hunsley's mill on Little river, the gray and reddish sandstone of the branch from the northward—recorded on McOuat's maps—includes patches of pea and nut-conglomerate, probably Millstone-grit, and resembling certain bands traced eastward from Baird's pits. In the main river up-stream, flags and blocks seem also to denote Millstone-grit, while along the south bank extends a gray and reddish, massive grit and conglomerate, which follows Little river to its head, is continuous with the conglomerate of Little Forks river, seems to be at the base of an unconformable group and is overlaid by whitish and cream-coloured sandstone. At and beyond Hunsley's mill this conglomerate, mentioned as extending from the Post road where it is widespread, is well exposed, and was followed along the adjoining branch of Little Forks river past Holt's mill and down to the Post road. This conglomerate, as already stated, may be Permian; but it is not yet clear that it is not the mass underlying the coal, traced as far as the Baird pits north of the river. Its continuity to the eastward is unbroken until it reaches the neighbourhood of Mount Pleasant.

A good section of Permian rocks is seen on Black river and Chase brook. The spotted red and white rocks immediately above Keiver's bridge[1] at Saltsprings station, are like the Permian of Little river below the mouth of Bear brook and the spotted rocks of Mount Pleasant road. They are associated with conglomerate and grit of Permian aspect. The gray, massive sandstones, blackish-red sandstone, and the spotted rock of the lower bridge are probably identical. In the cliffs down-stream, certain coarse Trias-like varieties resemble Permian rocks of the Nappan, and Shinemicas rivers. A conglomerate near Glenville brook yields pebbles as large as cocoanuts, while somewhat lower down, a red stone resembles that of the Amherst quarries. Up Chase brook these Trias-like beds and others resembling the Amherst red stone are exposed as far as the branch from a meadow on the left. Above this branch, greenish and gray grit and fine conglomerate contain pyritous coal pipes, underlaid by purple marl, and interstratified with thin flags, underlaid in turn by gray and rusty conglomerate and sandstone with fine, calcareous bulls-eyes, resembling rocks of the Doncaster Meadow road, and succeeded up-stream by reddish, brownish and gray flags and shales, sandy, argillaceous and calcareous, towards a mill and camps. Sandstones in thick layers with red argillaceous shales extend to Chase lake, near which gray fine sandstone is abundant. The rocks of the branches above show a descending section as far as the grit of Little river.

[1] Geological Survey, Summary Report, 1898, p. 146; ibid Summary Report, 1903, p. 163.

Further examinations were made in the neighbourhood of Springhill, and from Stewart's meadow north-eastward and south-westward, to correlate this work with the results shown on the map of 1901. These examinations may slightly modify that map, but need not here be presented since they require confirmation and careful investigation of such differences of opinion as those expressed previously.[1]

On the north side of the anticline, one of the best sections is that of Edgett brook, which crosses the Leicester road at Mansfield. The rocks suggest that there is possibly an unconformity between the Permian and all the underlying rocks, including the gray sandstone; but this may again be due to faults. Near the head of Edgett brook the red rocks of Logan's Division 6 are in contact with the gray sandstone of the upper part of that division, dipping southward at a very high angle; while down-stream, below the Leicester road, separated by a long concealed interval, these Lower Carboniferous rocks are succeeded by red and chocolate crumbly flags and sandstones of Permian aspect, no grey rocks being seen on this side. At West Leicester, on the other hand, and north of the road, there occur conglomerate and grey sandstone resembling those of Simpson brook and Little river, and a great thickness of the grey rock is found also on the Westchester road, and in branches of the Nappan river. Here, grey and rusty, coarse and fine sandstones succeed red Lower Carboniferous marls, dip away from them to the northward, and are overlaid by red rocks which include the stone worked at the quarries in Amherst. On the road to Hastings, a short distance from Brookdale, conglomerate and reddish-gray grit of Permian texture succeed Lower Carboniferous limestone, which has been quarried on the west side of the Westchester road, as already mentioned. Permian red rocks then cover the roads from Hastings to Truemanville, and thence to Amherst head and Tidnish; being well exposed in the Nappan river at Hastings.

The Low Brook coal has already been described.[2] Another of the small impure coal groups of the Upper Carboniferous upon which large sums of money have been wasted, but which gives no promise of improvement in size or quality upon development, is found on a little brook running into Blair lake south of Amherst, on the road to Nappan. Here, three openings have been made into a bank of heavy drift soil on the right or west bank of the brook. One of these runs west as a level for about 45 feet, then turns square to the right on a coal seam dipping northward at an angle of 20°. Another tunnel about 50 feet north of the first, also near the level of the brook, was driven in about 65 feet; a third is higher up the bank. In the first tunnel a band of coaly shale, 10 inches thick, with more or less lenticular layers of good coal, is underlaid by a few inches of grey, soft clay shale, succeeded by grey crumbly fine sandstone. Among the coal and in the roof are small layers of coherent limestone and ironstone. All the rocks are very pyritous, and adhering to the coal in some places are fine aggregations of pyrite. In the brook, reddish coarse Permian grit and conglomerate dip north at an angle of 18°, but at one point 42°, including layers of red concretionary limestone-conglomerate, like that of Duck creek on Philip river. These openings were made by Mr. Harry Davis of Amherst, who has also traced the coal into a little brook adjoining to the westward.

Permian rocks are well exposed on the shores of Northumberland strait, both in cliffs and low water reefs, from the mouth of Tidnish river to Northport, and also on the low shore as far east as the mouth of Philip river. They consist of red shale and massive sandstone, showing but little variety, undulating in flat folds, with the dip always low so that the same beds follow the shore for a great distance. A sandstone quarried at Black's quarry, and again at Myers' quarry on Coldspring head, resembles the Amherst red stone. These quarries have been worked only to a limited extent. Inland there are few outcrops; but bore-holes and wells have usually cut

1 Geological Survey, Vol. I., 1885, p. 25 E.
2 Geological Survey, Summary Report, 1898, p. 147.

shaly or thick-bedded sandstone at no great depth, and blocks of the characteristic red limestone-conglomerate are not infrequent.

Around the head of Baie Verte, for some distance west of Tidnish, there are no outcrops, but the debris indicates rocks similar to those described above. From Port Elgin to Cape Tormentine, the frequent exposures of reddish and gray sandstone all have a very low dip, and on the cape bend over a broad anticline.

BORING FOR COAL.

As in previous years, owing to the great activity in the mining districts of the Province, and the demand for geological information by explorers, I was often taken from the field of systematic work.

In the boring at Pettigrew with the calyx drill,[1] the first core was obtained at 2,347 feet; the boring was then continued to 2,518 feet, where, after fishing a month for broken rods, it was given up in conglomerate and sandstone, loose and friable, mostly brought out as gravel and sand, so that out of 120 feet only 10 feet of good core was recovered. No coal debris was found in boring. In connexion with this work, Mr. H. B. Pickings, of the Nova Scotian Department of Mines, came to Springhill on September 26, to discuss the advisability of boring other holes with a cable drill by contract. Two locations have been suggested to the government as worthy of trial; Clam cove west of Shulie, and the Maccan river near Southampton. Other places have also been mentioned, on some of which more light may be thrown by the surveys of last summer and by the government bore-holes in Prince Edward Island.

METAMORPHIC ROCKS OF KINGS COUNTY.

Early in July, and again about the first of August, a few days were spent at Whiterock with Mr. E. R. Faribault, who was studying the relations of the quartzites there to the gold-bearing rocks;[2] and from September 7 to 12, the superposition of the fossiliferous Silurian of New Canaan and South Alton upon the underlying slates was followed with Mr. W. Malcolm.

Mr. R. W. Ells, on his return from Scotland, examined the black shales of Antignoish,[3] Pictou and Cape Breton, as to their capacity for producing oil; and wishing also to compare those of Avonport, Cheverie, Walton and other places with the rich bituminous oil-shales of New Brunswick, I accompanied him to the last named places in October. In the course of this examination a remarkable deposit of reddish, greenish and mottled metamorphic rocks resembling the flinty quartzite-flags and the slates of the Millbrook at Kentville, sometimes supposed to be Devonian, was pointed out by Prof. Ernest Haycock, on low-water reefs west of Avonport pier. These rocks lie nearest the base of the section west of Horton bluff, but are more like rocks of the upper part of the Horton series, those of the west side of Walton river and near Tennycape mines, while the agate-like markings on the bedding planes of the flags are strikingly like those of Coldbrook. At all these points the metamorphic rocks unconformably underlie the Triassic, which in cliffs and reefs presents points of great interest in the alternations of coarse and fine sediments, resembling those from the bore-holes near Fullerton lake, beds of conglomerate extending far upward from the contact, and containing pebbles of pyrolusite derived from the older rocks in which it is now mined. The rocks near the bridge at Tennycape resemble the Horton of Crowell creek and the shore towards Hantsport, containing beds of blackish sandy shale and reddish coarse grit among finer beds which, in common with those of Cheverie, afford fine examples of contorted, crumpled and faulted strata, worthy

1 Geological Survey, Summary Report, 1907, p. 7.
2 Geological Survey, Summary Report, 1907, p. 4.
3 Geological Survey, Summary Report, 1907, p. 10.

to be compared with those of the neighbourhood of Whiterock. Further comparisons of the various sections of the Horton remain still to be made; the grits, sandstones and dark shales can probably be correlated throughout the entire district; for sections are numerous, as in Harding (Angus) brook, in which, as already described, [1] these rocks from their unconformable base upon the *Dictoyenema* slates give a thick, regular, ascending sequence. The presence of *Lepidodendron* and other plants, together with the fish remains collected and examined by Mr. Lawrence M. Lambe, may be expected to fix definite horizons.

In this connexion it may be mentioned that at Cheverie, another bore-hole said to be 1,000 feet deep has been drilled for oil in Johnston point, north of the other two. The dark shales of this neighbourhood are like those of North river above Truro; of Riversdale, Curry brook and the Gaspereau river; none of which are regarded with favour by Mr. Ells as a source of oil when compared with the albertite and oil shales of the Albert mines, supposed to be of the same geological period of formation.

PERMIAN ROCKS OF PRINCE EDWARD ISLAND.

With Mr. Ells, between October 12 and 21, another interesting excursion was made to Prince Edward Island, to compare the rocks there with those of the adjoining shores of Cape Breton, Nova Scotia and New Brunswick, the Dominion Government having undertaken to test the existence of coal in the island by a number of deep bore-holes. The first of these, at Gallas point, located by Mr. Ells some years ago, was visited by us, in conjunction with Mr. F. H. Stover, the contractor. It has now reached a depth of 1,900 feet, but has cut no rocks different from the red soft sandstone, shale and impure concretionary limestone of the cliffs along the seashore in the vicinity, rocks precisely like those of the opposite shore between Cape Tormentine and Philip river, described in this report as Permian or Upper Carboniferous. These rocks were again met with at Summerside—also visited with Mr. Stover—and at many other intervening places.

On returning from Prince Edward Island, Mr. Ells and I drove to Lower Rockport, to examine recent workings by Messrs. E. N. Jones and H. A. Ripley, upon two small coal seams, regularly interstratified in belts of argillaceous shale and resembling lower coals of the Joggins among the thick gray sandstones of the Millstone-grit. Levels along the coal have been driven for more than 100 feet into the cliff, but the seams are too small to be profitably worked even at their thickest. Underlying these gray rocks are the red shales and flags of Pecks cove.

COMMISSION ON SUBMARINE MINING.

About the middle of August, I accompanied Messrs. T. E. Forster, W. G. Scott, and Hiram Donkin, members of a government commission on submarine mining, to point out and explain the character of the different materials composing the roof and pavement of the coal seams of the Sydney coal field; visiting the mines at Lingan, Glace Bay and Port Morien, as well as typical outcrops along the shores. A week later I went with these gentlemen to some of the collieries in Inverness county, and subsequently to the Joggins mine in Cumberland county, now worked by the Maritime Coal, Railway and Power Company, where the new slope[2] on the shore of Cumberland basin near the pier is now 2,400 feet deep, with levels broken off at 1,800 and 2,300 feet, hence has practically all its workings beneath the sea.

On August 25, I joined Mr. Faribault, and other members of the Mining Society of Nova Scotia, in an excursion to Sydney, but left next day for Inverness.

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1 Geological Survey, Summary Report, 1898, p. 180.
2 Geological Survey, Summary Report, 1907, p. 10.

EXAMINATIONS IN CAPE BRETON.

Early in November, by request of the manager, Mr. M. S. Beaton, several days were again spent at Inverness mines to examine the section of a cross-cut through strata, overlying the main seam as far as the so-called 13 foot seam, and to compare it with other sections exposed in the district, or cut through in pits and bore-holes recently sunk in preparation for extensive operations on the large seam. The tunnel had been driven the distance at which the 13 foot seam should have been encountered, without finding coal of the full thickness of that seam on other sections.

Late in November, my services were again sought by the company that has done so much in the exploration of the Richmond coal field, and I subsequently spent several days with Mr. L. O. Mellinger and the drillers in that field.[1]

On November 13, I visited, with Mr. William Routledge, a deposit of hematite at Coxheath near Sydney, along the contact of a Lower Carboniferous limestone with conglomerate and older rocks, shown on the 'Survey' maps of this district, similar in mode of occurrence to the hematite at Big Pond, Boisdale, Goshen, Newton Mills, and other places;[2] and to the limonite and other metalliferous ores of Bridgeville, Brookfield, Stewiacke and other contacts. Here a small quantity of ore has been taken out of shallow pits, and boring has been begun in search of a larger quantity.

1 Geological Survey. Summary Report, 1902, p. 388.
2 Geological Survey, Summary Report, 1904, p. 297.

SOUTHERN PART OF KINGS AND EASTERN PART OF LUNENBURG COUNTIES, N.S.

(E. Rodolphe Faribault.)

GOLD IN QUEBEC.

On April 29, 1908, in company with Mr. J. Obalski, Superintendent of Mines for the Province of Quebec, and Professor E. Dulieux, the writer made an examination of a recent discovery of gold at Marsboro, on the west side of Lake Megantic. Visible, free gold associated with chalcopyrite, pyrite and galena occurs in small reticulated veins of quartz cutting through shattered dikes of aplite, which generally lie along the cleavage planes of sharply folded slates of Cambro-Silurian age. The slates resemble in some respects the gray slate of the upper division of the gold-bearing rocks of Nova Scotia. A sketch plan has been made showing the location of the gold discoveries and the probable structure of the rocks. This has since been published in a special report on the district by J. A. Dresser.

FIELD WORK IN NOVA SCOTIA.

My instructions for the past season were to continue the geological and topographical survey of the southern part of Kings county, and the eastern part of Lunenburg county, in order to secure the data necessary to complete for publication the Gaspereau sheet, No. 85, the New Ross sheet, No. 86, the Chester Basin sheet, No. 87, and the Mahone Bay sheet, No. 88. This has been accomplished, excepting that on the last named sheet, more work is still required in the western part.

My assistants for the season were Messrs. W. Malcolm, M.A., J. McG. Cruickshank and H. R. Mader, all of whom acquitted themselves well in the work entrusted to them.

Mr. Malcolm's time was devoted chiefly to the study of the geology and mineralogy of the field, and the plotting of surveys made during the season. Messrs. Cruickshank and Mader were engaged, the first part of the season, in working out the structure of the gold-bearing rocks lying to the south of the Gaspereau river, and the greater part of August, September, and until October 24, in taking barometer readings to determine elevations through the region included in the Gaspereau, New Ross and Chester Basin sheets. Railway profiles and the instrumental leveling of the roads made last summer with the stadia and transit by Mr. F. O'Farrell, were used as a base for this latter work.

GOLD-BEARING ROCKS IN KINGS COUNTY.

The first two and one-half months were spent in making a detailed revision of the geological structure of the group of slates and quartzites extending along South mountain from Wolfville and Kentville southward to the granite region. The area has been surveyed and mapped in much detail on a scale of 20 chains to 1 inch by Mr. Hugh Fletcher, who has reported on the district in the Summary Reports for the last three years.

Mr. Fletcher, referring to the age and structure of these rocks, says,[1] 'the slates 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 the folds can be distinguished. In an estimate of the thickness and geological age of these

[1] Summary Report, Geological Survey, for 1906, p. 141.

slates, the few fossils being 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 20 chains to 1 inch, to confirm the evidence collected from the dip of the slates; but there is still much that is obscure and requires further elucidation.'

Last season's work was, therefore, to determine with more detail and greater precision, if possible, the geological structure of these rocks, in order to finish the Kentville sheet for publication. The surveys were plotted in the field, and fitted on Mr. Fletcher's map as the work progressed. The results obtained may be briefly given here, before the map is published, subject to revision.

All the sedimentary rocks to the south of Wolfville and Kentville, with the exception of the Horton, the Triassic and the small area of fossiliferous Silurian south of New Canaan, form what appears to be a continuous series of argillaceous and siliceous slates, overlying conformably the lower whin rock, or Goldenville division of the gold-bearing series. The whin rock is exposed in different parts of the field; the line of division between it and the overlying slate and two beds of quartzite which outcrop very conspicuously at Whiterock, form two well defined horizon markers by which to work out with certainty the geological structure and the true order of succession of the different slates of the region.

These great series of whin, slate and quartzite, have been sharply folded into three main anticlines and synclines, the axes of which extend in a north-east and south-west direction.

The North Anticline.

The north anticline runs south-westerly from Kentville along the crest of Green hill, crosses Tupper lake where the slate is succeeded by the underlying whin rock which spreads out in a broad fold, and extends 2 miles west to the granite on Sharpe brook. It shows again 6 miles farther west, on the Aylesford road to the south of Morristown, where the whin rock has a width of 2 miles. This anticlinal fold pitches east along its whole length. It has several small crumplings along its apex, with a few quartz veins which do not, however, look promising for gold.

The South Anticline.

The south anticline crosses Black river half way between the first and second bridges, where the whin rock is exposed for a width of a quarter of a mile, and extends south-westerly to the south of Sunken lake, where it is cut off by the granite. From Black river this anticline extends north-easterly, passing between the Union Street post office and Schofield corner, and crossing the headwaters of Halfway river and Duncanson and Harding brooks, beyond which it is concealed by the Horton series. It forms a sharp fold with an eastern pitch, and shows the whin rock along its course as far east as Union street, where it is overlaid by slate. Gold-bearing quartz was discovered, it is said, on this anticline in 1868, but the district has received very little attention from prospectors.

The Middle Anticline.

The middle anticline crosses the Deep Hollow road three-quarters of a mile north of Whiterock post office, and extends easterly along the north side of the Ridge road to where it is overlaid by the Horton series opposite Wolfville. South-westerly it crosses the road leading from Whiterock to New Canaan at its junction with the Highbury road beyond which the two bands of Whiterock quartzite curve around on a westerly pitch. A little farther west the slates are concealed by the Silurian rocks already referred to.

This anticline is also composed of several small crumplings, but unlike the other two, it pitches to the west and does not bring the whin rock to the surface. It shows a few small quartz veins, which may be auriferous, but have no economic importance.

Synclines.

The north syncline crosses the Deep Hollow road half way up and the Canaan road at Johnson hollow, while the middle syncline follows the valley of Gaspereau river, almost to the granite. These two synclines occur one-third of a mile on each side of the middle anticline, and like the latter, they pitch to the west. They are made up of several small undulations, which are conspicuous along the Deep Hollow road, where the two bands of Whiterock quartzite form subordinate, but prominent anticlinal folds pitching west and standing up in bold relief. The structure is rendered still more intricate by the presence of several transverse faults.

The south syncline is seen a short distance south of the Greenfield sawmill on Halfway river, and on Pencil brook it is well exposed. A small crumbling occurs on the south side of this fold, and auriferous quartz float reported to have been found to the south of Etna post office, probably comes from veins occurring along the anticline of this subordinate fold, which, however, could not be closely located on account of the covering of drift.

Faults.

After the folding took place the whole of this region was extensively faulted, like the gold-bearing rocks along the Atlantic coast, by an extraordinarily regular system of step-faults running obliquely to the axes of the folds in a south-easterly direction, with horizontal displacements on the north-east side, almost invariably toward the south-east. These are appropriately called right-hand faults by the gold miners of the Province. In tracing out the two prominent beds of Whiterock quartzite, it was possible to locate and determine the extent of most of the faults, with a fair degree of precision. Some of them could be followed by surface indications, such as straight, narrow depressions and swamps, and by the clear cold springs which abound along their course. The horizontal displacements vary from a few feet up to 900 feet; but the vertical displacement could not be determined, except in a few cases.

Thickness of Total Section.

A detailed section of the slates measured along Black river from the whin rock to the two bands of Whiterock quartzite, and along Elderkin brook from the same quartzites to the highest slates in the syncline, gives a total thickness of about 14,500 feet of strata. Of this thickness, the lower 11,700 feet correspond in character and thickness to the upper or Halifax division of the gold-bearing series of the Atlantic coast, and the remaining 2,800 feet, from the base of the two bands of quartzite, are probably a sedimentary series not represented along the coast. If we add to this thickness the 16,000 feet of whin rock, that is, the Goldenville division as exposed at Moose river, we have a total thickness of 30,500 feet for the whole.

Geological Age of the Strata.

The slates immediately overlying and underlying the Whiterock quartzite differ much along the contact, both in aspect and colour, even at points not widely separated. For this reason the conformity of the two has been doubted. The changes in the character of the slates might, however, be explained by local causes not involving an unconformity. For example, in the case of the slates which at Whiterock falls, Gaspereau river, are dull red to fawn coloured, and on Black river, three-quarters of a mile west, are blue-black, shiny and quite unweathered, an examination of the inter-

vening exposures seems to show that the change in colour is a gradual one. In one brook in the interval, the change is only partial, the slates presenting a mottled appearance with the red colour confined mostly to lines of cleavage and joints, the more solid portions retaining their blue-black colouring. There can be little doubt that this change in colour is due to weathering or to the infiltration of iron leached from overlying rocks, perhaps the Horton.

The red colouring of the slates farther down Gaspereau river and up Duncanson and Harding brooks, is probably due to the same cause. The section on Black river and that on Sharp brook reveal similar changes in the slates. On Black river the whin rock is overlain mostly by quite unweathered, blue-black, clay slates heavily charged with iron pyrites, succeeded by gray argillaceous and siliceous, banded slates with a micaceous, shiny lustre; while on Sharp brook the whin rock is overlain by the same blue-black slates, the lowest beds of which are metamorphosed into knotted, crystalline slate by the neighbouring granite. These are followed, higher in the series but lower down the brook below the Prospect road, by gray and red banded slates in which the thin siliceous layers are coated with films of red hematite. Dictyonema fossils were found by Mr. Fletcher in these red slates near a 20 foot fall on this brook, and in other brooks in the vicinity, also on Moore and Elderkin brooks near Kentville, in all cases at approximately the same horizon, about 5,000 feet above the whin rock.

If the sequence be conformable, the Dictyonema slates here occupy a horizon in the upper division of the gold-bearing series about 4,000 or 5,000 feet above the whin rock. The lowest palæontological horizon of Dictyonema is Upper Cambrian or Lower Cambro-Silurian, while the gold-bearing slates everywhere else are barren, and many geologists classify them as Pre-Cambrian, on which assumption many thousands of feet of fossiliferous Cambrian must intervene between them and the Dictyonema horizon, as in Cape Breton, New Brunswick and Newfoundland. It is best, therefore, to defer judgment as to their definite age until they have been more carefully studied farther west in connexion with the Nictaux and Torbrook iron-bearing series.

Diabase Dikes.

Numerous dikes of diabase or diorite, from a few inches to several yards wide, are intruded in these slates and the Silurian rocks, generally occurring in continuous bands along the bedding or cleavage planes. The small dikes are generally quite schistose, while the larger ones have a more coarsely crystalline texture. The adjacent slates are often altered for a few inches from the contact.

Origin of Gaspereau River Valley.

The writer finds no evidence of a great fault along the Gaspereau river above the Whiterock falls, as has been reported. The narrowness of the valley is probably due to the presence of the middle syncline of soft slate, flanked on both sides by the two bands of Whiterock quartzite, which resisted denudation and formed the two steep banks of the deep valley. Below this barrier the valley widens out and loses its youthful appearance. The valley in which the Deep Hollow road lies at Whiterock shows evidence of having been an old river channel, through which the Gaspereau and Black rivers probably discharged their waters into the Cornwallis river, until with the aid probably of regional tilting, the obstructing quartzite at the falls below Whiterock was removed by erosion and allowed the river to follow the syncline farther east along its present course to the Horton basin.

This region presents one of the most interesting fields for the student of structural geology. It is easily accessible and its picturesque beauty, enhanced by the weird, rugged scenery of the Black River falls and the gorges, pot holes and cauldrons of Hell Gate, make it a most attractive resort for the summer tourist.

NEW ROSS DISTRICT.

Part of September was spent at New Ross, Lunenburg county, revising the geology of the granite and the gold-bearing areas of that region, to complete the New Ross sheet. A survey was made of the pegmatite and aplite dikes in the granite which contain minerals of tin, tungsten, molybdenum, bismuth, lithium and other important metals.[1]

No work worth recording has been done since last season at the King tin deposit, or on any of the other dikes.

Dr. H. W. Cain's manganese mine has been idle since the spring of 1904, but it is rumoured that work will be resumed shortly.

E. Turner, of Mill Road, has opened an important vein of manganese in the granite 2 miles north of Dr. Cain's manganese mine, on the height of land between Wallaback and Dean-and-Chapter lakes. Two pits have been sunk, one of which is 30 feet deep and the other 25 feet deep. The vein is vertical and has been traced by float about a thousand feet; its course lies about N. 70° E. It is of much the same character as Dr. Cain's vein; at the surface it is composed chiefly of botryoidal hematite, with some ochre and a little pyrolusite; at the depth of 26 feet the pyrolusite begins to increase, and at 30 feet the vein is 14 inches thick and composed of 5 inches of good manganese ore and 9 inches of mixed iron oxide and crushed pyrolusite and granite. The country rock is a light reddish-gray porphyritic biotite granite, somewhat crushed along the walls of the vein. Drift manganese has been found at many places in this section of country, lying between Wallaback, Dean-and-Chapter, Porcupine and Baptist lakes, as much as five barrels having been found in one spot. This would indicate the presence of several veins not yet discovered, and should encourage prospecting in this promising field.

E. Turner has also opened a vein in the granite, on the west side of the Wallaback stream, half-way between Camp and Harris lakes, carrying tin and tungsten ores, in the form of cassiterite and scheelite, associated with copper pyrites and zinc blende. Several dikes of quartz-porphyry, aplite and quartz have been located in this vicinity, some of which show molybdenite, chalcopyrite, etc. Several blocks of quartz carrying molybdenite in fair quantity have been observed 3 miles east of New Ross on the south side of the new Windsor road, on Harden Russell's farm, and also on the south-east side of Whalen lake.

A survey has been made of the outlines of the two areas of quartzite and slate of the gold-bearing series occurring in the granite, a short distance to the north of the new Windsor road between New Ross and Vaughan. The western area is 12 miles long by about a mile wide, and extends from the Kentville road in a north-easterly direction across De Adders, Camp, Wallaback and Grassy lakes, where it curves to the eastward across Smith river and the north end of Lower Canoe and Little Island lakes. From there it extends to Leminster, where the upper slate division overlies the whin rock. Free gold has been discovered by E. Turner in a few quartz veins, and in drift on the east side of Wallaback lake in a cove opposite a small island. The veins occur on an anticlinal fold running north-easterly on the north side of Grassy brook and south-westerly across Wallaback lake to the outlet of Camp lake. Some interesting contacts with the granite are well exposed on the eastern shore and islands of Wallaback lake.

The eastern area of gold-bearing rocks lies directly north of Vaughan post office, and extends 3 miles towards the north, between the Windsor road and the Avon river.

Lack of railway communication is a handicap in the exploration and development of the mineral resources of this part of the Province. The construction of a railway through the district would not only give an impetus to the mineral industry, but

[1] Summary Report, Geological Survey, for 1907, pp. 80-83.

would tap a great forest area and probably lead to the development of much of the water-power that is now going to waste.

CHESTER BASIN DISTRICT.

The first part of October was spent in tracing the boundaries of the Lower Carboniferous limestone and gypsum areas in the vicinity of Chester Basin and East Chester. Limestone is exposed at several places, but gypsum could not be observed anywhere. Along the eastern shore of Chester basin and up the Middle river the ground is much broken, and shows a great number of symmetrical, circular, funnel-shaped sink-holes, often attaining 20 feet in depth. These are characteristic of the presence of gypsum rather than limestone, underlying the drift. Some of the sink-holes are very recent, for the gradual formation of two of them has been witnessed by inhabitants of this section now living.

TUNGSTEN DEPOSITS OF MOOSE RIVER GOLD MINES.

The discovery of the tungsten-bearing mineral scheelite, in the Moose River gold district, Halifax county, early in the summer of this year, promises to be of considerable economic importance. In November, 1907, a quartz boulder carrying a small amount of a bright canary-yellow powder was found by John A. Reynolds and W. S. Currie, about 2 miles west of Moose River Gold Mines. In May, 1908, this was placed in the hands of A. L. McCallum, B.Sc., chemist and analyst, Halifax, who, along with Prof. Walker, of Toronto University, determined it to be tungstite, although later analysis by Mr. McCallum proves that it is a mixture of tungstite and scheelite.[1]

Prospecting was then begun under the direction of Mr. Reynolds and was prosecuted so systematically that within two weeks scheelite *in situ* was discovered. The original tungsten-bearing boulder was found 300 feet east of Stillwater brook, not far from the mouth of a small tributary. Both of these brooks have a southerly direction. By a thorough examination of the coarser drift found in the small brook, and of the fine scheelite got by panning, the debris was traced up stream to its northern limit, and here in the bed of the brook a scheelite vein was found. Westward about 700 feet on the strike of this vein and on Stillwater brook, another vein was found, and further prospecting in the neighbourhood of these two brooks has revealed the presence of several veins.

On October 8, the writer and Mr. Malcolm, in company with Messrs. Reynolds and Currie, made a survey of the locality. A plan has since been plotted on the scale of 250 feet to 1 inch, a copy of which was furnished to the property owners, with notes on the structure of the veins for the use of the operators in their development work. The Moose River sheet, published in 1898, shows the location and general structure of several quartz veins on the anticline crossing Stillwater brook, some of which correspond to the tungsten veins; and the special plan of the Moose River gold mines published the same year gives the detailed structure of that district, which closely resembles the structure of the tungsten area situated only a short distance farther west.[2]

The only rocks exposed in this section are those of the gold-bearing series, consisting of heavy beds of bluish-gray quartzite, with interbedded black graphitic slates. They are the lowest strata of the whole series known in the Province, brought up along the Fifteen-mile Stream and Beaver Dam anticlines which converge as they approach the Moose River district from the east and join some distance west of Stillwater brook. The immense strain and pressure accompanying the meeting of these two folds have greatly disturbed the measures, and caused many flexures and faults which probably gave vent to tungsten-bearing, deep-seated emanations at the

1 The Canadian Mining Journal, September 15, 1908.
2 Summary Report, 1897, Vol. X., pp. 113-114 A.

time of the granite intrusion. A cross-section of the rocks exposed along Stillwater brook shows that within a distance of 525 feet the strata have been folded into three small anticlines and two synclines, which have a general east and west course and pitch west at low angles.

Fourteen veins bearing scheelite have so far been uncovered by Messrs. Reynolds and Currie, all of which occur in slate bands interstratified between beds of quartzite and dip north at angles of 60° to 75°. They are comprised in a well defined zone 200 feet wide, limited on the north by the north syncline and on the south by the middle anticline. In depth these veins will probably be found to terminate at the syncline, but being of deep-seated origin they are undoubtedly underlaid by a succession of other veins which should offer a promising field for deep mining. Further exploration will probably disclose scheelite veins outside that zone, especially south of the middle anticline, where the rocks are more crumpled and fractured, but the veins may not be so well defined and continuous. Several large interbedded quartz veins are exposed on the north side of the south anticline 200 feet south of the west bend on the brook. One of these is 10 feet thick, and forms a prominent saddle of white quartz, pitching west on the anticline. These veins have more the characteristic of the gold-bearing veins and do not appear to carry scheelite.

The structure of the rocks indicates that there is probably a cross-country fault immediately east of the first trench on the east side of Stillwater brook, with a horizontal displacement of about 150 feet to the north on the east side of the fault. This would explain why the course of the tungsten veins on Stillwater brook is so different from that of the veins farther east along the small brook.

In some places the slate exhibits incipient recrystallization, the presence of numerous small black specks showing a tendency towards the formation of a knotted phyllite. Both the slate and the quartzite adjacent to the veins are much altered, and carry a great deal of white, scaly mica, probably sericite, the slate being changed to a sort of chloritic schist, and the quartzite to a quartz schist. These rocks are much rusted by the weathering of an iron-bearing mineral. Unweathered portions of the slate are found to carry numerous well-formed crystals of arsenopyrite about $\frac{3}{16}$" long, commonly surrounded by a narrow zone of white mica, with the scales at right angles to the surface of the mispickel. The quartzite, or quartz schist, is dotted with smaller rusty specks, many of which are lenticular and were probably arsenopyrite.

The vein matter consists of mispickel, scheelite, and translucent, white quartz in varying proportions. The scheelite is coarsely granular, shows distinct cleavage, is translucent, and is honey-yellow to pale brown in colour. Scattered throughout the veins are patches of fine, white, scaly mica with a silky lustre, and embedded in the scheelite and the quartz are needles of black tourmaline. The scheelite seems to have crystallized before the quartz, for many veinlets of the latter are seen cutting the former, generally in a direction perpendicular to the walls of the veins. The mispickel also is probably of later deposition than the scheelite, and is intimately connected with the quartz. The veins have as yet been exposed only in prospect pits, which have been dug in the drift, but it can be seen that some of them are quite uniform in width, especially those in which quartz predominates. Those that are richer in scheelite are commonly in lenses averaging a foot or more in length. They are from 1 to 14 inches thick, dip at a high angle, and many of them show the rolls that are so common in the gold-bearing veins. The rolls pitch westward, run about parallel with the axes of the anticlines, and may indicate, as in the gold vein, the general pitch of the ore shoots.

Although no igneous rocks have yet been found in the neighbourhood of these deposits, they probably resulted from the intrusion of granite, which is exposed in a large mass about 7 miles to the south and south-east and, no doubt, underlies this area.

Several assays for gold of the ore from different veins were made by Mr. McCallum, with negative results in every case. The tungsten veins differ materially from the gold veins of the district and are probably of different age and origin.

The extent of the mineralized area is not known, but veins enough have been exposed to show the importance of the deposit from an economic point of view. That the area is much larger than might be supposed from the veins exposed by Messrs. Reynolds and Currie is shown by the fact that scheelite was found in drift in a line extending 300 yards west from Stillwater brook, and in an isolated boulder a mile and a quarter west. Some was found *in situ* about half a mile east, in a vein 20 feet south of the Johnston shaft, also in a vein just east of the main road at Moose River Gold Mines, as well as on the dump at Kaulbach's last vertical shaft. Scheelite has, therefore, been found over a space of 3 miles along the Moose River anticline. Further systematic prospecting along this anticline should reveal other veins, and the fact that those thus far found are of the regular bedded type, should be of much assistance to the intelligent prospector in the pursuit of his work.

Scheelite has about the same hardness as apatite and can be cut with the knife, specific gravity about 6, i.e., over twice the weight of ordinary rock; colour, white, pale yellow, brownish, greenish and reddish and is transparent to translucent. Its composition when pure is: lime 19·4 per cent, tungstic acid 80·6 per cent. Other important ores of tungsten are wolframite and hübnerite, the former being a tungstate of iron and manganese. Although scheelite is richer in tungsten than the others, it was for a time considered less desirable, owing to the difficulty of its metallurgical treatment, but the modern method of reduction, in the electrical furnace, has rendered it fully as desirable.

The following table of production of tungsten concentrates in the United States, taken from Vol. XVI., of *The Mineral Industry,* gives some idea of the value of the mineral:—

Year.	Production in Short Tons.	Value.	Average per Ton.
1900..	46	$ 11,040	$240
1901..	179	27,720	155
1902..	184	33,112	180
1903..	292	43,639	149
1904..	740	184,000	249
1905..	834	257,463	308
1906..	1,096	443,150	404
1907..	1,468	715,031	487

A concentrate that runs 70 per cent tungsten trioxide is worth in the neighbourhood of $11 per unit, or $770 per ton.

Tungsten minerals are known to occur at three other places in Nova Scotia. At Emerald, on Murphy brook, a tributary of Big brook, about 9 miles by road from Margaree Forks, Inverness county, a boulder of quartz was found, carrying three to five hundred pounds of hübnerite, associated with a little chalcopyrite and hydromica. This boulder lay on a lenticular vein of similar quartz, about 3 feet wide, through which was irregularly scattered a small amount of hübernite. The vein occurs in Pre-Cambrian gneissic, or granitic rock. Scheelite of a light, smoky gray colour was found associated with pyrite and arsenopyrite in a quartz vein intersecting the Middle Rabbit lead at the Ballou mine, Malaga, Queens county. All three minerals, wolframite, hübnerite, and scheelite, have been found very sparingly in pegmatite dikes in the neighbourhood of New Ross, Lunenburg county.

At the time of going to press, Mr. McCallum reports the discovery of an important vein of scheelite in a slate belt in Halifax county, 1 mile north of Waverley, halfway between Perry lake and the old Cobequid road. The vein was opened up for gold about ten years ago by some Indians, who on being shown a small piece of scheelite lately recognized it to be the same mineral which they had found and which has since been identified by Mr. McCallum. Mr. F. H. Mason, chemist, formerly of Halifax, informs me that he has often found traces of scheelite in the tailings from the lake-

lode at Caribou gold mines. It is very probable that scheelite occurs in other gold mining districts of Nova Scotia, but owing to its non-metallic lustre, it has not attracted the attention of the miner. A systematic search for it over the old dumps of gold mines may be rewarded by other important finds. It may easily be mistaken for calcite or siderite, which often occur in the auriferous veins, but may be recognized by its weight, which is about twice that of the others.

WATER AND BORINGS BRANCH.

(E. D. Ingall.)

Early in March, at the request of the Director, I turned my attention to the general question of borings, etc.

Acting in the light of the general instructions received, the object kept in view has been to inaugurate a division for the collection of records of all bore-holes made throughout the Dominion. Incidentally, data will accrue regarding water supply, especially of underground water, natural gas, mineral oil, salt, etc., or other useful minerals encountered in the bore-holes of which logs can be obtained.

Evidently the investigation of water supply is to a certain extent dependent upon the results obtained in borings made, from which, interpreted in the light of the local geology, opinions might be formed as to the best places to look for water in any given locality.

The work of such a branch naturally falls into two main divisions, viz.:—

A. The collection of as many records as possible of bore-holes put down in various parts of the Dominion.

B. The technical study and interpretation of all this material, with a view to rendering it valuable for the use of the public in reports to be issued at frequent intervals.

The first (A) resolves itself largely into the problem of getting and keeping in touch with the contracting drillers operating in Canada; in persuading them to co-operate with the Department by sending in complete and careful logs of wells put down, together with samples of drillings from the various strata encountered. This information, when acquired, must be carefully filed and prepared for further study and correlation. A system for doing this is essential, as is also a permanent staff, the members of which can by practice become so familiar with the routine that the records constantly coming to hand will be filed ready for examination and reference without any chance of confusion and consequent loss.

The system of accomplishing this, as followed by the United States Geological Survey, was found, with a few adaptations, to be suitable for our purpose, and was, with the Director's sanction, adopted.

Circulars explaining the scope of the proposed work and its value to the 'Survey,' the public, and the contracting drillers, etc., were sent out to a number of firms owning drilling rigs, soliciting their co-operation.

A copy of this circular is inserted below, and is, at the same time, explanatory of the work undertaken:—

"Circular.

Subject: Well Records and Samples.

Department of Mines.

Geological Survey of Canada.

Ottawa, Ont.

SIR,—'The demand for information regarding wells has become so great that the Geological Survey has decided to issue a yearly publication, giving briefly an account of the wells bored in the preceding year. This report is to be published as near the beginning of each year as practicable, and will be sent to all who apply for it. It will

contain the names and addresses of persons doing well work, and will summarize the work done by them in the preceding year.

'In order that no portion of your work may be overlooked in this report, you are requested to inform this office from time to time of the progress of your work, and to forward records and samples of the materials penetrated in your wells.

'That the foreman of the outfit, or the person visiting the wells may not be burdened with a great number of bulky bottles or cans, and an evergrowing accumulation of samples, small canvas bags have been prepared (one of which is enclosed), in which samples may be transmitted through the mails without the payment of postage. As these samples can be mailed as often as the men visit the post office, there is no danger that they will accumulate and become burdensome. For the keeping of a log a convenient pocket memorandum book has been prepared, and will be sent with the sample bags.

'In order to keep in touch with you, and your foreman, a card like the enclosed will be mailed at stated intervals. This will not only serve as a reminder, but will save you some clerical labour.

'This work should enlist your co-operation, for the following reasons:—

'First. Your name and work will be kept before a class of readers interested in well drilling.

'Second. Records of your work will be carefully filed in this office, and will be readily available to you at any time, so that in case your notes are lost they can be duplicated.

'Third. You will aid materially in the study of the geological structure of Canada, a knowledge of which cannot fail to benefit you as a well driller.

'In some cases, where it is requested that the records should be regarded as confidential, the information will be carefully guarded, and used only under the conditions which you stipulate.

'I shall be glad to hear from you regarding this work, and will be grateful to you for any suggestions.

'Very respectfully,

'R. W. Brock,
'Acting Director."

The line of work designated (B), will comprise studies not only of the boring records and their interpretation, lithologically and stratigraphically, but their correlation with others in the same district, and with the geological data otherwise established.

This work will need a wide general knowledge of the geology of the country on the part of the technical officers connected with the branch, for elucidating more special points and details; recourse being had to the literature of the subject and to the help of the various geologists of the staff.

The system of collecting boring records has already been established, and has resulted in the collecting of a number of valuable sets of drillings, which have been duly recorded and filed.

A number of drilling firms have responded to the solicitation of the Department, but it will take some time yet to establish co-operation with the majority. It is believed that the issuance of a first report, which will illustrate the value of such work to the drillers themselves, will go a long way towards ensuring their continued help. For this publication there is a considerable amount of information to be gleaned from various sources. A good deal has already been done in the direction of searching out and indexing this information, as well as in investigating and straightening out the unpublished logs and drillings already in the Department. Much yet remains to be done in the way of searching for and acquiring logs of important wells drilled in past years, where such have been kept by the operators. This will require

time, and entail considerable correspondence, but it is believed that most of this important information can, in time, be recovered.

Acting under instructions, I left for western Ontario the middle of August, and returned the end of September. During this trip a number of those interested in drilling for gas, oil, etc., throughout the district visited, were seen, and investigation made of the whole question of the best way to carry on the work of the branch for the future, and of where information might be available as to borings made throughout these districts in the past. It was found that the latter class of information was practically lost, except in so far as certain people resident in the districts for many years had kept careful records for their own information. Dr. Fairbanks and Mr. McIntosh, of Petrolia, The Imperial Oil Co., and Mr. Jas. Kerr, of Sarnia, and others, were seen, and have promised to render every assistance.

It was intended that the delimitation of the proved limits of the gas and oil pools should have been attempted by local inquiry and the locating of wells by traversing the roads. It was found, however, that apart from the data collected in private hands, as mentioned above, nothing adequate could be obtained for the delimitation of the pools, so that the co-operation promised as above mentioned had to be relied upon.

The possible co-operation of the officials of the local governments in collecting this information has been kept in mind, and a commencement was made by interviewing Mr. Gibson, the Director of the Ontario Bureau of Mines.

About the middle of June, Mr. J. A. Robert, of the Geological Survey staff, was instructed to assist, and with his co-operation the work has been carried on since that date.

Thanks are due to the various members of the staff of the Geological Survey for information and assistance rendered. Mr. H. M. Ami especially has co-operated in the work in determining horizons from the fossil evidences contained in the drillings and in placing at the disposal of the branch his accumulated records and general knowledge of the geology of the country.

Besides the routine of collecting and filing of drillings, the division has already, in a number of cases, performed its promised function of investigating questions sent in for answer, and in getting together the data required, and preparing memoranda for a number of inquirers.

The establishment of complete working relationships with drilling contractors at large will take some time, but already for the time and money available, a most encouraging beginning has been made; and continued effort will doubtless meet with a wider response as the division proves its usefulness to them.

In this line much can be done by the technical officers connected with the work, if the clerical routine can be so arranged to leave them free to keep themselves posted as to the geological data available and bearing upon any districts where important drilling operations are in progress.

They will thus be in a position to promptly meet the needs of operators during the progress of the work, as well as to intelligently interpret the data coming to hand, and to publish in the report of the branch all that is necessary to make it useful to the public.

As the work becomes established, doubtless many questions of interpretation of the borings data will arise which will call for field studies by the officers of the branch. Foor instance. in districts where many holes have been put down, leveling to connect them with a fixed datum would probably result in the delimitation of folds, etc., of the strata having an important bearing on economic questions.

An immense amount of valuable geological data has been lost in the past, but it is hoped that the inauguration of a properly equipped division will prevent such loss in the future.

SECTION OF MINERALOGY.

(Robt. A. A. Johnston.)

As anticipated in the Summary Report of last year, a large share of attention has been paid to the development and improvement of the collections of minerals and rocks which the Department is issuing for the benefit of the educational institutions of the country. Formerly the study of mineralogy in its different aspects was confined, so far as institutions of learning were concerned, to the courses of instruction furnished in the universities and colleges. Of late years, however, as the systems of education in the different provinces have been extended, this subject has been embraced in the curriculum of institutions of lower grade. As a natural result of this, the requirements of the case have become more exacting, and collections of a high order of excellence have been demanded. Through the accession of large quantities of new material this year, the forthcoming collections have been much improved over those issued in previous years; changes will no doubt suggest themselves from time to time, and advantage will be taken of any opportunities to implement these, where they seem to be for the betterment of the collections. The standard collection to be issued this year consists in all of one hundred and fifty specimens, one hundred and five of which are minerals, and forty-five rocks; the arrangement of the rock-division has been supervised by Mr. G. A. Young.

In addition to the demand for the standard collections, there have been lately many requests for small specimens for prospectors' reference, for class use in blowpipe practice, etc. These requests are being met, so far as available material will permit, from chips and small fragments accumulated during the cutting and trimming of specimens for the standard collections. In a few instances special collections of minerals and rocks have been arranged to meet the needs of special cases. The preparation and despatching of these collections has been performed by Mr. A. T. McKinnon, who has devoted the greatest care and energy to the work.

Since writing the last Summary Report, collections of minerals and rocks have been issued as follows (unless otherwise noted it is to be understood that the full 1908 collection of one hundred and forty-five specimens has been sent):—

Province of Alberta:—

Collegiate Institute, Calgary.
High School, Vegreville.
Other institutions: Edmonton Board of Trade, Edmonton.

Province of British Columbia:—

Columbian College, New Westminster.

Province of Manitoba:—

High Schools: Killarney; Melita.
Public School, Stonewall.
Other institutions: College of St. Boniface, St. Boniface; Manitoba Educational Institution, Portage la Prairie.

Province of New Brunswick:—

High School, Salisbury.
Other schools: Summer School of Science, Riverside; Consolidated School, Hampton; 9th Grade School, Kouchibouguac (34 specimens).

Province of Nova Scotia:—

Academy, Amherst.
High Schools: Goldboro; Sherbrooke.
Other institutions: Sacred Heart Convent, Halifax.

Province of Ontario:—

Collegiate Institutes: Fort William; Vankleek Hill; Galt.
High Schools: Oshawa; Essex; Weston; Belleville; Cayuga; Madoc; Brussels; Mount Forest; Plantagenet; Alexandria; Rockland; Williamstown (18 specimens).
Public Schools: Ancaster School, Carluke; Macdonald Consolidated, Guelph; Milverton.
Other institutions: Rideau Street Convent, Ottawa; Hamilton Model School, Hamilton; English and French Training School, Ottawa; Ontario Agricultural College, Guelph (full collection and 45 specimens extra); Queen's University, Kingston (20 small collections for class work); Toronto University (3 specimens); Huron Institute, Collingwood (7 specimens); Mines Branch, Department of Mines, Ottawa (full collection and 22 specimens extra); Department of Agriculture, Ottawa (4 specimens); Immigration Branch, Department of the Interior, Ottawa (72 specimens).

Province of Quebec:—

Schools, colleges, etc.: Couvent de la Congregation, Sorel; St. Eustelle Congregation de Notre Dame, Huntingdon; Academy, Lachute; Notre Dame Convent, Joliette; Les Freres de la Charite, Longue Pointe; Macdonald College, Ste. Anne de Bellevue; St. Frederick's College, Drummondville; Couvent de Ste. Anne, Lachute; Arthabaska College, Arthabaskaville; Academy of the Sacred Heart for Boys, St. Romauld d'Etchemin; Convent, Beauport; Ecole Polytechnique, Montreal (full collection and 159 specimens extra); Redemptorist College, Ste. Anne de Beaupre; St. Elizabeth College, Montreal; Des Freres Marciles High School, St. Hyacinthe; Retraite St. Benoit Joseph, Longue Pointe; Couvent de la Congregation, Victoriaville; Couvent de L'Assomption, St. Germain de Grantham; Couvent de la Presentation, Drummondville; Academy, Knowlton; Sœur Marie de Ste. Amelie (6 specimens); Trappist Agricultural College, Oka.

Province of Saskatchewan:—

High School, Qu'Appelle.
Public School, Grenfell.
Other institutions: Graton Roman Catholic School, Regina.

Collections otherwise distributed:—

Prospectors' reference collection of 16 specimens: V. S. Steffanson, New York; J. G. McMillan, Toronto; Rev. W. J. Wood, Smiths Falls, Ontario.
Other collections: G. S. Mathey, Cooper Institute, New York (54 specimens); Baird & Tatlock, London, England (37 specimens).

The collections for blowpipe practice included 47 varieties of minerals put up in cotton bags and neatly labelled. These were distributed as follows: School of Mining, Kingston; McGill University, Montreal; Ecole Polytechnique, Montreal; University College, Toronto; Dalhousie College, Halifax; McMaster University, Toronto; Ottawa College, Ottawa; Bishop's College School, Lennoxville; University of New Brunswick, Fredericton; Summer School of Science, Riverside, N.B.

The following materials have been secured during the past season for use in the various collections, and for purposes of exchange:—

Donations:—

White Pass and Yukon R. R. Co., per Hon. H. E. Young, Provincial Secretary of British Columbia:—

	Lbs.
Hydromagnesite, Atlin, B.C.	1,000
Granby Consolidated Mining, Smelting and Power Co.:—	
Copper ore, Phœnix, B.C.	1,500
The Mineral Range Iron Mining Co., Limited:—	
Magnetite, Mayo, Ont.	2,000

Collected by officers of the Department:—

Charles Camsell:—	
Chalcedony, Aspen Grove, B.C.	200
Axinite, Nickel Plate mountain, B.C.	200
Dunite, Tulameen, B.C.	500
Pyroxenite, Tulameen, B.C.	500
O. E. LeRoy:—	
Andesite, Phœnix, B.C.	1,000
D. D. Cairnes:—	
Epidote, Whitehorse, Yukon	1,000
R. L. Broadbent:—	
Hematite, Dunham, Que.	1,600
Granite, Stanstead, Que.	800
Syenite, Mount Johnson, Que.	800
Chlorite, Chester, Que.	300
Chloritic schist, Chester, Que.	200
Slate, New Rockland, Que.	300
Red slate, Acton, Que.	1,000
Steatite, Sherbrooke, Que.	900
Specularite, Shefford, Que.	200
Chromite, Coleraine, Que.	500
Scapolite (pink), Coleraine, Que.	200
Steatite, Broughton, Que.	500
Red granite, Rivière à Pierre, Que.	1,000
Gray granite, Rivière à Pierre, Que.	300
Iron sands, Moisie, Que.	600
Ilmenite, Baie St. Paul, Que.	700
Garnetiferous gneiss, Baie St. Paul, Que.	400
Muscovite, Pied des Monts, Que.	100
Gray granite, Halifax, N.S.	1,000
Granite, Nictaux, N.S.	800
Copper ore, Antigonish, N.S.	200
Specularite, College Grant, N.S.	900
Manganite, New Ross, N.S.	200
Limonite and hematite, New Ross, N.S.	300
Quartz breccia, New Ross, N.S.	600
Gypsum, St. Anns, N.S.	500
Sandstone, Sackville, N.B.	800
Limonite, Brookfield, N.S.	400
Amygdaloid, Morden, N.S.	500
Basaltic trap, Morden, N.S.	400
Magnetite, Clementsport, N.S.	700
Mica-diorite, Welsford, N.B.	1,000
Stibnite, Prince William, N.B.	200
A. T. McKinnon:—	
Dolomite, Ross, Ont.	1,000
Anorthosite, Horton, Ont.	1,000
Beryl, Calvin, Ont.	200
Quartzite (pink), Dryden, Ont.	2,400
Pyrite, granular, Helen Mine, Ont.	1,000
Siderite, Helen Mine, Ont.	1,000
Hematite, Helen Mine, Ont.	2,700
Pyrrhotite, Creighton Mine, Ont.	1,000
Quartzite (white), Waters, Ont.	1,600
Chalcopyrite in quartz, Cobden, Ont.	1,200
Olivine-diabase, McKim, Ont.	1,500
Tuff, Dowling, Ont.	1,000
Andradite crystals, Tudor, Ont.	1,200
Gabbro, Limerick, Ont.	1,300
Garnetiferous schist, Cardiff, Ont.	2,000

	Lbs.
Marble, Faraday, Ont.	3,000
Nepheline-syenite, Dungannon, Ont.	1,500
Pyroxene crystals, Herschell, Ont.	450
Pyroxene crystals in calcite, Herschell, Ont.	500
Feldspars, Herschell, Ont.	2,000
Diopside, Cardiff, Ont.	500
Arsenopyrite, Marmora, Ont.	500
Arsenopyrite in feldspar, Marmora, Ont.	500
Quartzite, Elizabeth, Ont.	500
Granite, Gananoque, Ont.	1,000
Quartz-porphyry, Vaudreuil, Que.	500
Syenite, Vaudreuil, Que.	1,000
Nepheline-syenite, Outremont, Que.	1,000
Hornblende granite, Staynerville, Que.	1,000
Apatite, Templeton, Que.	1,870
Idocrase, Templeton, Que.	200
Rutile, Templeton, Que.	50
Garnetiferous gneiss, Hull, Que.	1,000
Pyroxene crystals in calcite, Hull, Que.	500
Garnetite, Onslow, Que.	400
Diorite, Wakefield, Que.	1,000
Strontianite, Nepean, Ont.	600
Fossiliferous limestone, Hull, Que.	500

During the year extensive and interesting additions have been made to the Museum collections, as will be seen by the following list:—

DONATIONS.

Mr. Geo. E. Valleau, Ottawa, Ont.:—Coal from the Nicola Valley Coal and Coke Company's mine, Middlesboro, Yale district, B.C.

Mr. L. H. Chaperon, Murray Bay, Que., per R. L. Broadbent:—Muscovite crystals from Bergeronnes, Saguenay county, Que.

Mr. G. E. Barnet, Murray Bay, Que., per R. L. Broadbent:—Biotite and muscovite from Pied des Monts, Charlevoix county, Que; samarskite from Maisonneuve, Que.

Mr. A. L. McCallum, Halifax, N.S., per R. L. Broadbent:—Scheelite from Moose River, Halifax county, N.S.

Dominion Coal Co., Glace Bay, N.S., per R. L. Broadbent:—Three blocks of coal from the Dominion colliery, Glace Bay, Cape Breton county, N.S.

Victoria Gypsum Company, St. Anns, N.S., per R. L. Broadbent:—Two blocks of gypsum from St. Anns, Cape Breton county, N.S.

Nova Scotia Steel and Coal Company, Sydney Mines, N.S., per R. L. Broadbent:—Three blocks of coal from the Sydney Mines, Cape Breton, N.S.

Intercolonial Coal Mining Company, Waterville, N.S., per R. L. Broadbent:—Three blocks of coal from the Drummond colliery, Waterville, Pictou county, N.S.

Mr. E. H. Gladwin, Truro, N.S., per R. L. Broadbent:—Scheelite from the Torquay gold mine, Halifax county, N.S.; limonite from Brookfield, Colchester county, N.S.

Canadian Antimony Company, Lake George, N.B., per R. L. Broadbent:—Stibnite from Prince William, York county, N.B.

Cumberland Railway and Coal Company, Springhill, N.S., per R. L. Broadbent:—Three blocks of coal from Springhill mine, N.S.

Mr. William Ahearn, Ottawa, Ont.:—Micanite prepared from the phlogopite of the Laurentide mica mine, Kingsmere, Wright county, Que.

Mr. Edward Ardley, Montreal, Que.:—Native arsenic from the corporation quarry, Montreal, Que.

Dr. A. E. Barlow, Ottawa, Ont.:—Native silver from the Ruby mine, Bucke township, Nipissing district, Ont.; argentite and native silver from the O'Brien mine, Cobalt, Ont.; native silver from the Downey location, James township, Nipissing district, Ont.; native silver (mossy) from the Timagami reserve, Toweganda lake, Nipissing district, Ont.; Cobaltite crystals from the Columbus mine, Coleman township, Nipissing district, Ont.; native silver from the Big Pete mine, Cobalt, Ont.; native silver from the Crown Reserve mine, Cobalt,Ont.; native gold in quartz from the 77 mile post, T. & N. O. R'y, Nipissing district, Ont.; corundum crystal from Craigmont, Renfrew county, Ont.

Captain Bernier, Quebec, Que.:—Native copper and almandite from Albert harbour, Baffinland. Lignite from Salmon river, near Albert harbour, Baffinland.

Canadian Mining Journal, Toronto, Ont.:—Corundum crystal in nephelite from Craigmont, Ont.

Mr. S. Cohen, Cobalt, Ont., per Mr. Arthur A. Cole:—Argentiferous tetrahedrite from the Crown Reserve mine, Cobalt, Ont.

Mr. Patrick C. Cunningham, Sedgewick, Alberta:—Selenite crystals.

Dr. Danby, Richmond, Ont.:—Pyrite crystals from Larder lake, Ont.

Mr. J. Draper, Woodstock, N.B., per Mr. R. W. Ells:—Native gold in quartz from the Cobbler-Sexton mine, Carleton county, N.B.

Mr. C. L. Hansen, Port Arthur, Ont.:—Argentite from Silver Mountain, Thunder bay, Ont.

Mr. Charles Keddy, New Ross, N.S.:—Quartz crystal from Lake Ramsay, New Ross, N.S.

Mr. J. D. Rice, Barrows, Sask.:—Melanterite from township 44, range 28, west of 1st initial meridian, Manitoba.

Mr. F. Soues, Clinton, B.C.:—Natron from Goodenough lake, Lillooet, B. C.; waterworn mass of volcanic rock from Bonaparte river, six miles east of Clinton, B.C.

Mr. E. T. Smith, Prescott, Ont.:—Phlogopite from North Burgess township, Lanark county, Ont.

Mr. J. M. Turnbull, Moyie, B.C.:—Galena from St. Eugene mine, Fort Steele, B.C.

Mr. C. W. Willimott, Ottawa, Ont.:—Tourmaline crystals and lepidolite from Wakefield, Ottawa county, Que.

Specimens collected by officers of the Department:—

H. M. Ami:—Group of apatite crystals showing curved distortions from Carp, Carleton county, Ont.

R. L. Broadbent:—Hematite from Dunham, Missisquoi county, Que.; specularite from Shefford, Brome county, Que.; chalcocite from Chester, Arthabaska county, Que.; bornite and chalcopyrite from Acton, Bagot county, Que.; calcite, fluorite and sphalerite from east side of Baie St. Paul, Charlevoix county, Que.; manganite, limonite, hematite and stilpnomelane from Wallaback lake, Lunenburg county, N.S.; bog iron ore from Macdonald brook, Schooner pond, Cape Breton county, N.S.; specularite and chalcopyrite from College Grant, Antigonish county, N.S.; siderite, chalcopyrite, and pyrite from Copper lake, Antigonish county, N.S.; chalcocite from Tatamagouche, Colchester county, N.S.; magnetite from Clementsport, Annapolis county, N.S.; stibnite from Prince William, York county, N.B.; a series of specimens

from a vein on the Dominion Chrome Company's property, near Little lake, St. Francis, Megantic county, Que.

R. W. Brock:—Pyrrhotite and chalcopyrite from the 100 foot, 300 foot, 600 foot, 1050 foot, and 1200 foot levels, LeRoi mine, Rossland, West Kootenay, B.C.; silver ore from the Mountain Consolidated mine, Slocan, B.C.; sphalerite and galena from the Right of Way mine, Cobalt, Ont.

Charles Camsell:—Axinite from Nickel Plate mountain, Osoyoos mining district, Yale, B.C.; hübernite from Cathedral mountain, Ashnola river, Yale, B.C.

D. B. Dowling:—Anthracite from Bankhead mine, near Banff, Alberta; anthracite coal from the Sedlock seam, Canmore, Alberta; lignite coal from Prairie creek, Athabaska river, Alberta; coal from Coal creek, North Saskatchewan river, Alberta; coal from opposite Big Horn range, North Saskatchewan river, Alberta; coal from Big Horn river, North Saskatchewan river, Alberta; coal from south branch of the Brazeau river, Alberta; coal from Panther river, Red Deer river, Alberta; coal from section 14, township 20, west of the 3rd meridian, Alberta; lignite from Kneehills creek, Alberta; briquets of lignite made from coal from the Alberta Coal Company's mine, Morinville, Alberta; black slate from Dominion creek, Yellowhead pass, Alberta; marl from the Saskatchewan river above Edmonton, Alberta.

R. W. Ells:—Oil distilled from Baltimore shales, Albert county, N.B.

E. R. Faribault:—Beryl crystal, manganese ore, molybdenite, limonite and hematite from New Ross, Lunenburg county, N.S.; scheelite from Moose river, Halifax county, N.S.

E. D. Ingall:—Chalcopyrite and pyrite from the Eustis and Capelton mines, Ascot, Sherbrooke county, Que.

Joseph Keele:—Native copper from White river, Yukon; galena from Little Twelve-mile river, Klondike, Yukon; cassiterite from Hunker creek, Klondike, Yukon; scheelite from Dublin gulch, Duncan, Yukon; ferro-nickel from Pelly river, Yukon; yellow travertine from Athabaska river.

L. M. Lambe:—Gypsum from Hillsborough, Albert county, N.B.; albertite from Albert Mines, Albert county, N.B.

O. E. Leroy:—Calcite crystals from the Granby mine, Phoenix, B.C.

B. Matheson:—Albite crystals from Porter mountain, twelve miles south of Tantalus, Yukon.

A. T. McKinnon:—Limonite from the Helen mine, Michipicoten district, Ont.; diopside from Cardiff township, Haliburton county, Ont.; large magnetite crystal (438 lbs.) from Faraday township, Hastings county, Ont.; arsenopyrite from Deloro, Hastings county, Ont.; beryl from Calvin township, Nipissing district, Ont.; strontianite from Nepean, Carleton county, Ont.

W. J. Wilson:—Erythrite from Cobalt hill, Cobalt, Ont.

PURCHASES.

Specimen of silver ore from the City of Cobalt mine, Cobalt, Ont.

Specimen of silver ore from the Coniagas mine, Cobalt, Ont.

Large specimen (435 lbs.) of dyscrasite-bearing ore from the Crown Reserve mine, Cobalt, Ont.

In addition to the above, the following accessions have been made to the collection of foreign minerals:—

DONATIONS.

His Excellency, the Right Honourable Earl Grey, Governor General of Canada:—Stalactite from Crystal cave, near Hamilton, Bermuda.

R. L. Broadbent:—Sphalerite and calcite from Joplin mines, Missouri, U.S.A.; rubellite and lepidolite from San Diego county, California, U.S.A.; bauxite from Georgia, U.S.A.; cuprite with malachite from Mexico; rose quartz from Black hills, South Dakota, U.S.A.; cinnabar from Tertinqua, Brewster county, Texas, U.S.A., cinnabar from Waitahuna Heights, New Zealand; calamine from Marion county, Arkansas, U.S.A.; zoisite in chalcopyrite from Ducktown, Tennessee, U.S.A.; scheelite from Otago, New Zealand; cassiterite from New South Wales, Australia; limestone from Oamaru, New Zealand; magnetite (lodestone) from Magnet cove, Arkansas, U.S.A.

D. B. Dowling:—Aluminium products from the Pittsburgh Reduction Company, Massena, N.Y., U.S.A.; cassiterite and associated granite from the Dolcoath mine, Canbourne, Cornwall, England.

H. B. Wright, Detroit, Michigan, U.S.A.:—Octahedrite from Burke county, North Carolina, U.S.A.

Since writing the last report, 180 letters have been received, 234 have been despatched; and 316 mineral specimens have been examined and reported on either by letter or through personal interview.

Attention is directed to the following mineral occurrences, most of which are new:—

Albite. Some fine crystals of albite—two of them, Carlsbad twins—from Porter mountain, Yukon, have been brought in by Mr. H. Matheson, Geological Survey.

Axinite in large dark hair-brown crystals and crystalline masses from the contact between monzonite and sedimentary beds on the western slope of Nickel Plate mountain, Osoyoos mining district, Yale, B.C., submitted by Mr. Charles Camsell, Geological Survey.

Beryl. A small translucent blue crystal of this mineral was found in material from New Ross, Lunenburg, N.S., submitted by Mr. E. R. Faribault, Geological Survey. It was also observed in small grains in some sands from Quesnel river and 111-mile creek, Lillooet district, B.C., submitted by Mr. F. Soues, gold commissioner, Clinton, B.C.

Calcite. Five groups of calcite crystals have been brought from the Granby mine, Phœnix, B.C., by Mr. O. E. LeRoy.

Cassiterite. A specimen consisting mainly of quartz holding small quantities of copper and iron pyrites and zinc-blende from a vein in granite on the farm of Henry Winston, near the head of Mill road, north of Gold river, Lunenburg, N.S., submitted by Mr. Ernest Turner, was found to contain about 4 per cent of cassiterite, and about the same amount of scheelite.

Enstatite. Good cleavable masses of enstatite, from Ste. Adele, Terrebonne, Que., were sent in for examination by Mr. A. Groulx, Ste. Adele.

Ferro-nickel. This name is now given provisionally to some fine particles of metallic material found in the sluice boxes of Hoole canyon, Pelly river, Yukon, the examination of which is not yet completed; it contains over seventy per cent of nickel and over twenty per cent of iron; its true origin is a matter of uncertainty, but a few particles have been noted, enclosed in the original gangue, and the examination of these may throw some light on this point. This material has been submitted by Mr. Joseph Keele.

Hübnerite. A small specimen of hübnerite from Cathedral mountain, near the head of Ashnola river, Yale district, B.C., has been brought in by Mr. Charles Camsell, Geological Survey.

Lodestone. In the course of separating the ferro-nickel mentioned in a previous paragraph from associated minerals it was observed that some grains and rolled pebbles of magnetite were strongly attracted to the steel forceps that were being employed for this purpose. Further examination of these showed that they adhered with great tenacity to any iron instrument, and that the larger pebbles were capable of sustaining a very considerable weight, by the force of magnetic attraction alone.

Melanterite. Good crystals of melanterite have been received from Mr. J. D. Rice, Barrows, Saskatchewan, who states the locality of occurrence as township 44, range 28, west of the 1st initial meridian, Manitoba.

Monazite.. This mineral was noted as a constituent of some black sand from Quesnel river, Lillooet, B.C., submitted by Mr. F. Soues, Clinton, B.C.

Platinum. Native platinum was noted in some black sands from Quesnel river, Lillooet, B.C., submitted by Mr. F. Soues, Clinton, B.C.

Pyrochlore? A mineral from Wakefield, Wright county, Que., submitted by Mr. C. W. Willimott, may prove to be this species.

Scheelite. The occurrence of this mineral, in association with cassiterite and other minerals, has already been noted at the head of Mill road, Lunenburg, N.S.; it has also been recently discovered at some of the gold workings on Moose river, Halifax, N.S.;some fine specimens from this locality were exhibited at the Industrial Exhibition, in Toronto, in September of this year (1908); good specimens have also reached the Survey recently from this locality.

Tetrahedrite. A specimen of dolomite carrying tetrahedrite from Lavant, Frontenac county, Ont., has been submitted by Mr. R. W. Brock.

Tourmaline. Fine red and green tourmalines have been brought to the Survey from Wakefield, Ottawa county, Que., by Mr. C. W. Willimott.

In accordance with instructions from Mr. R. W. Brock, Acting Director of the Geological Survey, I left Ottawa on August 29, for the purpose of joining the excursion of the Canadian Mining Institute, at Sherbrooke, Que. On arrival at the latter place, however, it was found that a change in the plans of the Institute would necessitate my going to Quebec, but advantage was taken of the opportunity while in Sherbrooke, to visit, along with Mr. R. L. Broadbent, the residence of Mr. Thomas Houle, some miles out of the city, where it had been reported to the Department there might be seen a specimen showing impressions of human feet. On arrival there Mr. Houle displayed to our view a slab of rock measuring 30″ × 36″, carefully mounted in cement, resting on a low four-wheeled carriage. The specimen proved to consist of the ordinary altered sediments common to the district. On the upper surface were a number—some three or four altogether—of depressions, which showed a curious resemblance to the imprints of a moccasined foot. They were clearly the result of the action of running water whereby some of the soft concretionary-like masses in which the rock abounded had been eroded.

During the year some important changes have been effected in the arrangements in the Museum. At the suggestion of Mr. G. A. Young, he was given permission by Mr. R. W. Brock, Director of the Geological Survey, to engage in a rearrangement of the specimens in the lithological section. The arrangement according to age, which has been heretofore more or less closely followed, has been, to a large extent, abandoned, and the specimens are now arranged petrographically and territorially, a change which has been very favourably commented upon by students and others visiting the Museum. In this work Mr. Young was assisted by Mr. D. S. McIntosh.

During the winter and a large part of the summer, up to the time of his going to the field, Mr. R. L. Broadbent's time has been taken up in rearranging the economic collection, as far as space would permit; the addition of twelve new table cases provided for the installation of over three hundred new specimens. During the latter part of the summer and early autumn, Mr. Broadbent was engaged in collecting material for the Museum, and for the educational collections, in Quebec and in the Maritime Provinces.

Mr. Broadbent wishes here to record his thanks to the following gentlemen for courtesies and assistance rendered during his itinerary: Messrs. Greenshields, Black Lake, Que.; Mr. J. Fraser, New Rockland, Que.; Dr. J. F. Yeats, Dunham, Que.; Mr. G. McIntosh, Beebe Plain, Que.; Mr. H. C. Bosse, Quebec; Mr. John Kline, Halifax, N.S.; Mr. G. H. Duggan, Glace Bay, N.S.; Mr. Chas. Mitchell, No. 6 Colliery, Cape Breton, N.S.; Mr. John Fraser, Sydney Mines, N.S.; Mr. Geo. J. Ross, Antigonish, N.S.; Mr. J. Floyd, Westville, N.S.; Mr. E. H. Gladwin, Truro, N.S.; Hon. A. T. Dunn, St. John, N.B.; Mr. C. N. Crowe, Lake George, N.B.; Mr. Stewart, Springhill, N.S.; Mr. W. McIntosh, St. John, N.B.

During the winter season, and through the summer, until July 23, Mr. A. T. McKinnon's time was devoted to the assembling and shipping of the educational collections. After that date Mr. McKinnon spent about a couple of months collecting in central and northern Ontario and western Quebec. He also superintended the Geological Survey exhibit at the Central Canada Exhibition held at Ottawa in September of this year. He wishes to here express his appreciation of the assistance and advice accorded him by the following gentlemen: Mr. A. P. Turner, Sudbury, Ont.; Mr. R. W. Seelye, Sault Ste. Marie, Ont.; Mr. L. B. Howland, Baptiste Lake, Ont.; Mr. Wm. Hambly, Creighton Mine, Ont.; Mr. James H. Reid, Dean Lake, Ont.; Messrs. Thomas Morrison and Archibald Riddell, Bancroft, Ont.; Messrs. D. B. Wright and James A. Lambe, Deloro, Ont.; Mr. R. E. Cushman, Kingston, Ont.

I must here record my appreciation of the assistance given by Mr. J. J. Lyon in having the specimens and cases in the Museum cleaned and put in proper order.

PALÆONTOLOGY AND ZOOLOGY.

(J. F. Whiteaves.)

PALÆONTOLOGY.

Considerable progress has been made with the preparation of the systematic and annotated list of the fossils of the Corniferous limestone of Ontario, which was commenced in 1907, and referred to in last year's summary report. In this list the term Corniferous limestone is used in the sense in which it was used by Billings and Nicholson, to include all those rocks that intervene between the Oriskany and Hamilton formations; and the word Ontario to that part of the Province which Prof. E. J. Chapman calls the Erie and Huron district. That portion referring to the corals proper has been re-written throughout. It gives the names, with references and a full list of localities, of 67 more or less well known species of Anthozoa, and 8 of Hydrozoa from the Ontario Corniferous. The part which includes the Brachiopoda and Pelecypoda of that formation, has been written during the year 1908. It gives the names, etc., of 63 species of Brachiopoda, and 23 of Pelecypoda. Among the Brachiopoda there are no very striking novelties, but 9 of the species of Pelecypoda are described as new, and these, it is hoped, will soon be figured. These portions of the list are by no means mere compilations, and have necessitated the re-examination and comparison of a large number of specimens. During their preparation the writer has been indebted to Dr. W. A. Parks for the loan of several specimens of Corniferous fossils from the museum of the University of Toronto.

A paper entitled 'Notes on the Pelecypoda or bivalve mollusca of the Chazy formation in Canada, with descriptions of one new genus and four new species from the Chazy sandstone at Hogs Back, near Ottawa,' has been written and published in the *Ottawa Naturalist* for September, 1908. The introductory part of this paper consists of a few notes on the four species of Pelecypoda that were previously known to occur in the Chazy limestone of eastern Canada, and the part which follows is a description of seven species, four of which are new, and one new genus, of this class, from the Chazy sandstone and shale at Hogs Back, collected by Mr. Walter R. Billings, mostly in 1906 and 1907. The paper is illustrated with one full-page plate, with 16 figures.

Another paper, entitled 'Notes on some fossils from the Cambro-Silurian rocks of the Albany River drainage system in north-western Ontario,' has been written, to form an appendix to Mr. W. J. Wilson's forthcoming 'Report on a part of north-western Ontario, in the districts of Algoma and Thunder bay.' The fossils referred to in these notes were collected at several localities on the Kabinakagami river, by Mr. Wilson, in 1903; on the Little Current and Nagagami rivers, by Mr. Wilson and Mr. O. O'Sullivan, in 1903; on the Drowning river, by Mr. O'Sullivan, in 1903; and on the Pagwachuan river, by Mr. Wilson, in 1904. All of these streams are tributaries of the Albany. These fossils seem to indicate two different geological horizons in the Cambro-Silurian system, and two in the Silurian. The Silurian Stromatoporoids in these collections have been either determined or described by Dr. W. A. Parks, who has published a short account of them in the *Ottawa Naturalist* for April, 1908.

A third paper, on some fossils from three localities on the Nordenskiold river, Yukon Territory, collected by Mr. D. D. Cairnes, in 1908, has been written for publication as an appendix to Mr. Cairnes' report. These fossils, which are neither so

numerous nor so perfect as one might wish, are all clearly Jurassic or Cretaceous. They seem to indicate a geological horizon that may be synchronous with part of the Queen Charlotte Island formation of Dr. G. M. Dawson.

A few fossil Brachiopoda from the Gravel river, Mackenzie, which are apparently of Devonian age, have been determined for Mr. Keele, and a few fossils from the Guelph formation of Ontario have been examined for Dr. Parks.

ZOOLOGY.

Two short papers, descriptive of some zoological specimens of special interest, that have recently been added to the 'Survey' collection, have been written for the *Ottawa Naturalist.*

The first of these papers consists of some notes on a specimen of the Olympic Vole *(Microtus macrurus)* from Metlakatla, B.C.; and on an egg of the Rhinoceros Auklet *(Cerorrina monocerata)* from Lucy island, near Metlakatla; both presented by the Rev. J. H. Keen, of Metlakatla. It was published in the *Ottawa Naturalist* for December, 1907, which, however, was not issued until January 23, 1908.

The second consists of notes on a specimen of the Least Weasel, or Bangs' Weasel *(Putorius rixosus,* Bangs) collected by Mr. Keele on the Ross river, Yukon Territory, in January, 1908; on a specimen of the Alaskan Lemming Mouse *(Synaptomys wrangeli)* from Metlakatla, and on a male bird of the Rhinoceros Auklet, from Lucy island, both presented by Mr. Keen, in 1908. This paper is now in the printer's hands.

A number of recent shells, from various localities, have been named for the museum of the St. Laurent Convent, near Montreal.

EXECUTIVE.

Up to November 1, 1908, the duties of Acting Deputy Minister were performed by the writer. During the absence of Mr. Brock, in the field, from August 14 to October 28, 1908, the office work of the Director, also, was performed by the writer. The additional duties necessitated by the appointment of the writer to the position of Acting Deputy Minister, on May 28, 1907, have taken up much of his time, and added greatly to his official responsibilities.

ADDITIONS TO THE PALÆONTOLOGICAL AND ZOOLOGICAL COLLECTIONS IN THE MUSEUM OF THE 'SURVEY.'

The following specimens were received in 1908, either from members of the staff, or from employes of the 'Survey' :—

Fletcher, Hugh:

Collection of fossils from the Dictyonema shales of Kings county, N.S.

McConnell, R. G.:

Six fossils from the Cretaceous rocks at Texada island, on the west coast of British Columbia.

Lambe, L. M.:

Collections of fish and plant remains from the Albert mines and Belliveau, N.B., and from Horton Bluff, N.S. Also a collection of plant remains from Taylor village, N.B.

Wilson, W. J.:

A large collection of fossil plants, etc., from several localities in southern New Brunswick.

Two slabs of *Archæozoon* from Green head, narrows of St. John river, N.B.

Ami, H. M.:

About 100 fossils from the Lowville and Pamelia formations at Barriefield hill, Portsmouth quarry, and other localities in the Kingston district, Ontario.

One hundred and fifty fossils from the Black River, Lowville and Pamelia formations, near Clayton and Watertown, in the State of New York (for correlation purposes and comparison).

One hundred Cambro-Silurian fossils from localities near Ottawa.

About 300 specimens of Carboniferous marine invertebrata from Black Rock, West Bay shore, Parrsboro, N.S.

One hundred specimens of fossil plants, etc., from Pleasant Valley coal pits, Antigonish county, N.S.

Eighty specimens of fossils, plants, etc., from Big Marsh coal pits, Antigonish county.

Fifty specimens of fossil plants from shaft at Curly Dan's (Macdonald), near Big Marsh P.O., Antigonish county.

Eighty specimens of fossil plants, etc., from the dump, Acadia coal mine, Westville, Pictou county, N.S.

Two hundred and fifty fossiliferous concretions from the Pleistocene clay at Besserer, near Ottawa.

Five hundred specimens of marine invertebrata from the Pleistocene deposits at Les Grandes Bergeronnes, below Tadousac, Quebec.

O'Sullivan, Owen:

Small collection of Palæozoic fossils from the Shamawatta and Severn rivers, and from the south coast of Hudson bay.

Johnston, W. A.:

About 150 specimens of Cambro-Silurian fossils from various localities in central Ontario, including some fine specimens of crinoidea, cystidea and starfishes.

Cairnes, D. D.:

A small collection of Mesozoic fossils from three localities on the Nordenskiold river, Yukon Territory.

Malloch, G. S.:

Forty-four specimens of fossil plants and shells from the coal-bearing Kootanie formation, and from strata underlying and overlying it in the Big Horn coal basin, between the North Saskatchewan and its tributary the Brazeau. Also 4 specimens of fossil shells from the end of the first range south of the Saskatchewan river, and one specimen of a Brachiopod from the fourth range south of the Clearwater river.

Keele, Joseph:

A few Palæozoic fossils from various horizons on the Ross river, Yukon Territory, and Gravel river, Mackenzie.

One Mink, one Kit Beaver, and a specimen of the Least Weasel *(Putorius rixosus)* from Ross lakes, Yukon Territory.

Winter skin of porcupine, from the Stewart river, Yukon Territory.

Skull of grizzly bear, from Ross river, Yukon Territory.

Skull of white whale, from Beaufort sea. (Presented by Major Jarvis, of the N.W.M.P.)

Camsell, C.:

Clutch of two eggs, of the Calliope Humming bird *(Trochilus calliope)*, taken at Princeton, B.C., in June, 1906.

McInnes, W.:

A few specimens of fresh-water shells from various localities on the Churchill and Sturgeon-weir rivers, in the Province of Saskatchewan and the North West Territories.

Young, Charles H.:

Pair of each of the Red-Eyed Vireo, Palm Warbler, Maryland Yellow-throat, Chickadee, Tree Swallow, Great Crested Flycatcher, and Wilson's Thrush, with nest and eggs, from near Ottawa.

Large collection of recent marine sponges from the coast of British Columbia.

Over 150 starfishes, 195 crabs and Hermit crabs, 30 cirrhipedes, 50 mollusks, and about 45 bottles of marine fishes, in alcohol, from Departure bay, Vancouver island.

The additions to the palæontological and zoological collections in the Museum during 1908, from other sources, are as follows:—

By presentation:—

A.—Palæontology.

Grant, Colonel C. C., Hamilton, Ont.:

Thirteen fossils from the Niagara chert at Hamilton; two Silurian fossils from Grimsby, and five from the Cambro-Silurian drift at Winona.

Macrae, Stewart, St. Andrews, Manitoba:

Two Cambro-Silurian fossils *(Orthis proavita,* W. and S.*)*, and cast of interior of a *Murchisonia,* from Bear rock, near Fort Norman, Mackenzie river, collected by Mr. Joseph Hodgson.

Specimen of fossil coral *(Cyathophyllum),* picked up on the surface of the ground about 30 yards from edge of bank of Red river, at St. Andrews, about a mile above the rapids.

Five fossils broken out of a block of limestone lying about 100 yards from the west bank of the Red river, a mile and three-quarters above the rapids at St. Andrews.

Nicol, Prof. W., Queens University, Kingston:

Specimen of a fossil coral *(Tetradium Saffordi),* collected at Kepler, near Elginburg, Frontenac county, in September, 1907.

B.—Zoology.

Keen, Rev. J. H., Metlakatla, B.C.:

Female of the Olympic Vole *(Microtus macrurus).* Skin, with skull. Animal captured at Metlakatla, August 28, 1907.

Alaskan Lemming Mouse *(Synaptomys Wrangeli).* Taken at Metlakatla, November 2, 1899. Skin of male, with skull.

Rhinoceros or Horned Auklet *(Ceratorhina monocerata).* Skin of adult male, taken at Lucy island, near Metlakatla, April 24, 1907. Egg of a bird of the same species taken at Lucy island in June, 1907.

Boutellier, R. S., Sable island, N.S.:—

Nest and set of four eggs of the Ipswich Sparrow *(Ammodramus princeps),* from Sable island.

Taylor, Rev. G. W., Wellington, V.I.:

Specimen of a marine sponge *(Aphrocallistes Whiteavesianus,* Lambe*),* brought up on a cod hook near Nanaimo, in December, 1907.

Tufts, R. W., Wolfville, N.S.:

Set of four eggs of the Oven-bird or Gold-Crowned Thrush *(Seiurus aurocapillus)* from Black river, Kings county, N.S.

Fletcher, Dr. James, Ottawa:

Two specimens of a Pecten *(P. hastatus)*, from Departure bay, Vancouver island, one encrusted with a sponge *(Myxilla parasitica,* Lambe).

By purchase:—

One egg of Cassin's Auklet *(Ptychorhamphus Aleutieus)*, from Santa Barbara island, California.

One egg of the Greater Shearwater *(Puffinus major)*, from Chatham island, South Pacific.

Clutch of two eggs of the Pomarine Jaeger *(Stercorarius Pomarinus)*, from Point Barrow, Alaska.

Clutch of three eggs of the Kittiwake *(Rissa tridactyla)*, from the coast of Newfoundland.

Clutch of six eggs of the Harlequin Duck *(Histrionicus histrionicus)*, from Peel river, Mackenzie.

Clutch of eight eggs of the Pacific Eider *(Somateria v-nigra)*, from the mainland opposite Herschell island, Arctic ocean.

Clutch of two eggs of the Little Brown Crane *(Grus Canadensis)*, from the Red Deer district, Alberta.

Clutch of two eggs of the Sandhill Crane *(Grus Mexicanus)*, from near Yorkton, Assa.

Clutch of four eggs of the Black and White Creeping Warbler *(Mniotilla varia)*, from Nova Scotia.

Clutch of four eggs of the Parula Warbler *(Compsothlypis Americana)*, from Nova Scotia.

Clutch of four eggs of the Blackburnian Warbler *(Dendroica Blackburniæ)*, from Nova Scotia.

Female wolf, from the Gatineau valley.

VERTEBRATE PALÆONTOLOGY.

(Lawrence M. Lambe.)

ALBERT SHALES FISH FAUNA.

Early in January, 1908, a study was begun of the Albert shales fish fauna of New Brunswick, with a view to reporting on the genera and species of Palæoniscidæ of which it is composed. Since 1851, when Dr. Charles T. Jackson described a number of species of palæoniscid fishes from the Albert mines, near Hillsborough, Albert county, New Brunswick, little has been done toward the description of this interesting fauna as a whole, although it was known that the shales of this locality held large numbers of exceptionally well preserved specimens. In the autumn of 1907 the Geological Survey received two large collections of fishes from the shales of the Albert mines: one made by Mr. R. W. Ells of this 'Survey,' the other by Mr. James Robertson, of the Albert mines. The material in the 'Survey' Museum, from the typical locality, and from the north-eastern extension of the Albert shales area across the Petitcodiac river, had previously consisted of specimens obtained by Mr. R. W. Ells, in 1876, by Dr. F. D. Adams, in 1877, and by Mr. James Robertson, in 1891.

Field Work.

Acting under instructions, the latter half of July and the month of August, were spent in New Brunswick and Nova Scotia, with the object of making further collections from the Albert shales area, and from certain supposedly correlative beds in Nova Scotia, with a view of definitely establishing, if possible, the geological age of the beds in question—on palæontological evidence.

Some weeks were spent at the Albert mines and in visiting the outcrops of the Albert shales to the south-west as far as Elgin corner. Between this place and the mines an examination of the beds was made at Rosedale, Baltimore, Turtle Creek, and Mapleton, as well as at exposures seen in brooks and near the road. A large collection of fish remains was obtained at the Albert mines, principally from beds exposed on the western branch of Frederick brook, from which exposure the two collections received last autumn were also made. By searching the dump a number of specimens, brought from a low level, were also found. A few plant remains were obtained.

In a north-easterly direction from the Albert mines, across the Petitcodiac river, at Belliveau, and at Taylor village on the Memramcock river, the same shales are found. Putting up at the last named place, where some days were spent, Belliveau was reached by road. At both of these places numerous outcrops of shales occur, from which collections of fossils were made. At Taylor village there is a low cliff extending some distance along the river front. This cliff is mentioned by Sir J. William Dawson in his Acadian Geology, as constituting the best exposure of Albert shales seen by him. The collection from Taylor village consists of plant remains only.

The shales at Belliveau and those of Albert mines have a flora and fish fauna common to both. In each, the plant remains are few in number and represent only two or three species. At Belliveau, not far from the old shaft, in readily splitting shales, similar in appearance to those of the Albert mines, a species of *Lepidodendron,* probably referable to *L. corrugatum,* Dawson, was found.

The shales of Albert mines and Belliveau are similar in character, and their fossil remains are preserved in a like manner; in fact, the Beliveau area between the

Petitcodiac and Memramcook rivers is a continuation to the north-west of the larger Albert mine area. At the Albert mines are found six or more species of Palæoniscid fishes belonging to three typical Lower Carboniferous genera. They belong to the same genera as, although differing specifically from, the fish described by Dr. Ramsay H. Traquair, from the Lower Carboniferous rocks (Calciferous sandstones series), of Eskdale, Scotland. All the species of fishes that have been found so far at Belliveau are included in the Albert mines fauna; the plant remains also, though few in number, apparently represent a flora common to both localities.

After leaving Taylor village, a short time was spent collecting at Horton bluff, Kings county, N.S., from beds exposed in cliffs on the shore at the mouth of Avon river. These beds were placed by Sir William Dawson, on the evidence of their fossils, in the Lower Carboniferous, at about the horizon of the Albert shales, and for many years were so regarded, but lately their assignment to the Lower Carboniferous has been questioned by some geologists, who prefer to place them at the top of the Devonian, hence it was thought desirable to secure further evidence, if possible, of their true position in the geological scale; especially as their age appears to have a direct bearing on that of the Albert shales, the Carboniferous age of which has also been questioned. Accordingly, fossils were collected here.

At Horton bluff plant remains predominate; but the remains of fishes also occur, principally in the form of scales, not in place, as in the beautifully preserved Albert mines and Beliveau specimens, which show the contour of the fish, with the exact shape and position of the fins, but detached and scattered or brought together in considerable numbers, as aggregations. Many of these scales are recognized as belonging to some of the Albert mines and Belliveau species.

A fish bone of considerable interest, as it throws additional light on the age of the beds at Horton bluff, was obtained at this locality during last summer's visit. This bone was sent to Dr. L. Hussakof, of the American Museum of Natural History, New York, who has kindly given it his attention. He pronounces it to be the right clavicle of a Crossopteryian, probably belonging to one of the Rhizodontidæ. Separate teeth, referable to the genus *Strepsodus,* were also found here during the past season. A species of *Strepsodus* found in these rocks has already been described by Sir J. William Dawson, from teeth, scales, and part of a lower jaw with teeth in place, under the name *Rhizodus hardingi,* and is, according to the author of the species, allied to *R. gracilis,* McCoy, from the Carboniferous shales of Gilmerton, Scotland. It is most probable that the clavicle of this year's collection belongs to Dawson's species. The genera *Rhizodus* and *Strepsodus* differ but slightly from each other, and both are known from the Lower Carboniferous of Great Britain, and include characteristic Carboniferous forms. Neither of these genera occur in the Devonian.

Two of the most common species of plants at Horton bluff are *Lepidodendron corrugatum,* Dawson, and *Cyclopteris acadia,* Dawson, both of which have been considered to be typical of the Lower Carboniferous. As mentioned above, a species of Lepidodendron—presumably *L. corrugatum*—was found during the past season at Belliveau. Dr. Jackson in his Report on the Albert Coal Mine (1851), mentions having found remains of Lepidodendra in the shales of the Albert mines, but none were obtained last summer.

It is desirable that an exhaustive study should be made of the fossil flora of the above-mentioned localities, in the light of present palæobotanical knowledge.

The conclusion drawn from the past year's work on the fossils of the shales of the Albert mines and Belliveau areas, and of the Horton Bluff beds, is that these rocks are of Lower Carboniferous age; special reliance being placed on the evidence of the fishes. On palæontological grounds, also, it is believed that the Horton Bluff beds are nearly, if not quite, synchronous with the Albert mines and Belliveau shales.

Considerable progress has been made with the manuscript for my report on the fossil fishes of the Albert shales, begun during the year, and a number of drawings for the illustration of the report have been completed.

My thanks are tendered to Dr. Charles R. Eastman and Mr. Samuel Henshaw, of the Museum of Comparative Zoology, Cambridge, Mass.; to Mr. Charles W. Johnson, of the Boston Society of Natural History; and to Dr. Frank D. Adams, of McGill University, for the loan of available types and figured specimens of Albert shales fishes, described by Dr. Charles T. Jackson and Sir J. William Dawson.

OFFICE WORK.

A number of fossil corals, collected by Mr. Joseph Keele during the past summer, from four localities on Gravel river, North West Territories, have been determined, and notes supplied as to their structure and the geological horizons indicated by them.

A catalogue of the fossil vertebrata, in the possession of this 'Survey' at the present time, was commenced during the year. So far, it records all the genera and species represented, of the six classes of the vertebrata, with the exception of the Agnatha and the Batrachia, which will be added when time permits. The collection includes many types and figured specimens, and has greatly increased in value in the last few years, by the addition of many species: some of which are new to science, while others had not previously been found in Canada. Of fishes, there are thirty species, belonging to nineteen genera; of reptilia, forty species, of twenty-nine genera; of birds, one species, of one genus; and of mammalia, ninety-five species, of sixty-three genera. This catalogue will be of use in numbering the collection, when it is placed on exhibition in the new museum building. It may also serve as a basis for a descriptive and illustrated guide to the fossil vertebrata in the Museum, if, at any time in the future, it is thought desirable to issue such a publication for general reference.

This year, plaster casts were purchased of the skulls of *Mœritherium lyonsi,* Andrews, and *Palæomastodon beadnelli,* Andrew: primitive Proboscidea from the Middle, and Upper Eocene, respectively, of the Fayum, Egypt. These species are the earliest known members of the family of which the elephants of the present day are the representatives. They were made known to the scientific world through their discovery by British and Egyptian government expeditions of recent years. These skulls are for exhibition in the new museum, as part of a series intended to show the development of the Proboscidea. This series, particularly if the skulls of the two living species of elephants are added, should prove most instructive to students, and of great interest to the public generally.

A few additions have been made to the osteological collection; which, it is hoped, will continue to grow. At present, well mounted, articulated skeletons, representing all the orders of existing vertebrate life, would form a decided acquisition to the Museum.

In May, 1908, a Bibliography of Canadian Zoology for 1907 (exclusive of Entomology) was—with the Director's permission—presented at the annual meeting of the Royal Society of Canada, for publication. This report is now being printed, and separates of it will, it is hoped, be ready for distribution by the Geological Survey before the close of the year.

INVERTEBRATE PALÆONTOLOGY.

(H. M. Ami.)

An appendix covering the palæontology and chronological geology of the area embraced by the Cornwall-Ottawa sheet was prepared for Mr. R. W. Ells' report on this district.

A preliminary examination was made for Mr. Joseph Keele, of the Geological Survey, of a number of fragmentary specimens of graptolites from the Ross and Pelly rivers, Yukon Territory. The fossils are of Ordovician age, the most easily recognized form appearing to be a variety of the almost ubiquitous *Orthograptus quadrimucronatus*, Hall. More slender forms also occur resembling *Leptograpti* or some dicellagraptid.

A small though interesting series of fossils from the Donjec river, Mount St. Elias range, Yukon, obtained by Mr. R. G. McConnell, of the Geological Survey, was examined, and indicates an Upper Carboniferous horizon.

A collection of about fifty specimens obtained by Mr. R. W. Brock in 1906, from the neighbourhood of Rossland, B.C., appears to represent six species which may possibly be referred to the Upper Carboniferous.

Fourteen collections of fossils obtained by Mr. R. A. Daly, geologist of the International Boundary Commission, from the neighbourhood of the 49th parallel in western Alberta and British Columbia, have been examined. These include fossils from the Flathead valley of British Columbia, and various localities in the vicinity of the Tobacco plains. The results obtained lead to the separation of the collections into two main groups: (1) Those referable to the Carboniferous; (2) those referable to the Devonian. The former appear, for the most part, to be closely related to, if not identical with, the fauna of the Madison limestone of the United States geologists; while the Devonian materials are correlated with the Jefferson limestone of Idaho, The bulk of the fauna examined are corals, together with a number of brachiopods and other invertebrates which frequent or inhabit shallow, but clear water seas. I am under special obligation to Drs. G. H. Girty, and E. M. Kindle, of the United States Geological Survey, for valuable assistance in the determination of the material from the Daly collections.

A collection of fossils belonging to the Banff museum, Banff, Alberta, was determined.

A small collection made by Mr. D. B. Dowling, of the Geological Survey, in 1906, from the 'top of the red beds' near Red Deer river, Rocky Mountain park, reveals the presence of strata which have been referred to the 'Permo-Carboniferous' of the Wahsatch section in the United States. These are intermediate between the Upper Carboniferous limestone and Weber quartzite, and underlie the Trias. Dr. Girty, of the United States Geological Survey, examined the material with me, and is satisfied that in Canada the same succession of strata occurs as across the border.

Some progress was made during the past year in connexion with the preparation of a report on the Silurian faunas and formations of the Arisaig shore in Antigonish county, Nova Scotia. Through the kindness of the Director of the American Museum of Natural History, New York city, I was permitted to examine the original specimens described by Professor James Hall, from the same locality.

The manuscript for the 'Bibliography of Canadian Geology and Palæontology for the year 1907,' was prepared for publication, as customary, in the Transactions

of the Royal Society of Canada. A catalogue was also prepared for the Canadian Mining Institute of the various Geological Survey publications relating to the different mining districts of Canada visited by the Canadian Mining Institute in connexion with the mid-summer excursion of 1908.

Acting under instructions from the Director, a visit was made to Vinal Haven, Maine, to confer with Mr. Bailey Willis, of the United States Geological Survey—under whose direction a geological map of North America is now being prepared—concerning questions of correlation and the mapping of Palæozoic formations as developed in Canada.

In August, a few days were spent at Les Grandes Bergeronnes, Quebec, examining the condition of the clay banks; three small slides having occurred subsequent to Mr. McInnes' visit in the spring. A number of fossils were collected from the boulder clay and stratified marine clays and sands.

Acting under instructions of date August 15, the writer proceeded to Clayton, N.Y., to visit, in company with H. P. Cushing, of Western Reserve University, R. R. Rudemann, of the New York State Geological Survey, and E. O. Ulrich, of the United States Geological Survey, typical exposures of Lower Palæozoic rocks, for the purpose of comparing the formations there recognized with those found north of Lake Ontario. While in the district, specimens of the rocks and fossils were collected. Afterwards the party visited certain exposures in the neighbourhood of Kingston, Ontario.

At the localities visited in New York State, the order of succession of the various formations as given by Mr. H. P. Cushing,[1] is as follows:—

Trenton. (Black, somewhat shaly limestones, etc.).
Black River. (Massive black limestones).
Lowville. (Blue, or dove coloured, thin, shaly limestones).
Pamelia. (Blue, and dove coloured limestones, with thin basal sandstones and overlying shales).

Unconformity—

Theresa. (Sandy dolomite).
Potsdam. (White, yellow, and red quartzose sandstone).

Unconformity—

Pre-Cambrian.

The above generalized section applies well to the strata examined near Kingston, where also the general thicknesses of the beds as estimated, appear to vary but little from those in New York State. The strata corresponding to the Pamelia are possibly more arenaceous near the summit of the formation.

There is no doubt that the sedimentary formations, as they occur in the Ontario Palæozoic basin, were formed in a basin distinct from that to the east of the Frontenac axis and its continuation, the Adirondack massif, so that the geological formations of Ontario west of the axis are more closely linked in their nature and origin with those of northern and central New York State than they are with those of the St. Lawrence-Ottawa, and Lake Champlain districts.

THE COAL FORMATION IN ANTIGONISH COUNTY, NOVA SCOTIA.

Since in the minds of some of those interested in the locality there was some doubt as to whether certain areas of Carboniferous rocks in Antigonish county, N.S., had, as the result of former work by members of the Geological Survey, been assigned to their true horizon, I was instructed by the Director to make an independent palæontological investigation. The results obtained corroborate the earlier determina-

[1] Bulletin, Geol. Soc., Amer., vol. 19, p. 159.

tion, and show that in the vicinity of Big Marsh post office and the Pleasant Valley region, there are no Coal Measures proper, and that the strata are of Lower Carboniferous age, and more closely related to the Horton formation of Nova Scotia, and the Albert formation of New Brunswick. Previous experience has shown that, in such lower divisions of the Carboniferous, coal occurs only in rather limited quantities, and of rather impure character.

The characteristic fauna and flora peculiar to the coal areas of Sydney, Stellarton, and Springhill, appear to be entirely absent in the coal-bearing horizons of this portion of Antigonish county. From the strata examined in the immediate neighbourhood of the coal pits at Big Marsh, as well as at Pleasant valley, a species of *Lepidodendron,* resembling *L. corrugatum,* Dawson, as well as fragments of *Cordaites?,* and narrow leaves or stipes associated with scales and other remains of fishes were gathered, and indicate a horizon much lower than that of the Coal Measures.

A considerable amount of prospecting for coal along the outcrop of the coal seam at Pleasant valley near Macgillivray's mill and Big Marsh has been carried on during the past forty years, and more recently bore-holes have been put down and other work done with the help of machinery and of funds from the Nova Scotia legislature.

A thickness of some 4'–6" has been assigned to the coal seam at Big Marsh coal pits, which forms the most promising exposure examined: consisting of an admixture of coal, coaly shale, and other impurities.

A few days were spent in the Stellarton region, Pictou county, and near Parrsboro, Cumberland county, N.S., securing further palæontological material.

During the past year various collections of fossils have been examined and some time was spent in preparing collections of palæontological and ethnological material for the new museum.

ARCHÆOLOGY AND ETHNOLOGY.

The following accessions to the Museum were made during the year:—

Moberley, Frank:

One stone adze or skin scraper, MacDougall chute, intersection of the Timiskaming and Northern Ontario railway with the National Transcontinental railway. This point is now called Matheson station.

Ells, R. W.:

Two rock masses, consisting of indurated Cretaceous shale or argillite, from quarry where the Haidas or aborigines of the Queen Charlotte islands obtain the material for their carved stone implements. Collected on Graham island in 1905.

Low, A. P.:

Half-size models of three Kinipitu kyaks, with paddle (double ender), etc., used for hunting on inland lakes, northern Hudson bay, 1904.

Abrahamsen, Johan:

Stone spear-head (?) found by shantyman near Massey station, Canadian Pacific railway, Ontario. Collected in 1907. Per H.M.A.

Pierce, E. H. (per Collingwood Schreiber, Esq., C.M.G., Ottawa, Ont.):

Skull of chief of the Skeena River Indians, from the Skeena river, about 53 miles above Prince Rupert, British Columbia. Collected by E. H. Pierce, Esq., Government Inspecting Engineer, Western Divisions of the National Transcontinental railway.

By purchase:—

Newcombe, Dr. C. F.:

Nine Chilcotin baskets of various designs. Chilcotin, British Columbia.

Goodwillie, Rev. J. M.:

Goodwillie collection acquired August 6, 1908, consisting of 714 specimens, including skulls of aborigines, bone implements, Wampum strings and beads, skin scrapers, arrow and spear heads, etc., from various localities in the Province of Ontario, including Craigleith, near Collingwood mountain, Newmarket, Chatham, Thames river, Thorold, Bosanquet, Amherstburg, etc., all collected by the Reverend J. M. Goodwillie, M.A., now of Metcalfe, Ontario.

Price, D. H., Aylmer, Ont.:

Very extensive collection of archæological remains from various localities in Ontario, comprising some 8,215 specimens as per catalogue of specimens prepared by Mr. Price and accompanying the collection. The bulk of this collection was received at the Geological Survey Department in 1904; a number of bone implements were received later and are included in the collection. Catalogue No. 3314, Division of Archæology and Ethnology.

SUMMARY REPORT DEALING WITH THE FIELD WORK IN CONNEXION WITH THE COLLECTION OF PALÆONTOLOGICAL MATERIAL FROM THE DEVONIAN AND LOWER CARBONIFEROUS OF NEW BRUNSWICK.

(W. J. Wilson.)

INTRODUCTION.

My instructions for the past summer's work were to make a collection of fossils, particularly fossil plants, from the Devonian and Lower Carboniferous of the southern portion of New Brunswick, with the object of definitely fixing the geological horizons of the formations found there.

On the Geological Survey maps, the Devonian is shown as occurring in irregular areas, from Point Lepreau to Musquash harbour; at St. John, from Courtenay bay to near Cape Spencer and inland, and over a large area in Charlotte and Queens counties, extending from the St. Croix river to the St. John. The Lower Carboniferous is shown on the same maps: at St. Andrews, Point Lepreau, Emmerson creek to Melvin beach, St. John county, also from Point Wolf to Cape Enrage, Albert county. In the two last places there are areas along the shore mapped as Middle Carboniferous. Inland the Lower Carboniferous rocks are shown in large areas; from Kennebecasis bay to Indian mountain in Westmorland county, and north of the Devonian area already referred to in Charlotte and Queens counties.

Mr. R. W. Ells of the Geological Survey examined these localities in 1906-7, and in the Summary Reports for those years, describes most of the former Lower and Middle Carboniferous areas as Devonian. It has, therefore, been considered advisable to get from these rocks a collection as complete as possible, of the plant remains and other fossils, with a view of determining their exact geological horizon.

Fossil plants have been known to occur at the Fern Ledges, St. John, for a long time; and since 1860, systematic collections have been made at different periods from these rocks and others in the vicinity. The first collections were made by Dr. Geo. F. Matthew and Prof. Chas. F. Hartt, and their specimens were examined and described by Sir J. W. Dawson. Later, collections were made by the writer and others, so that the flora of the Fern Ledges is fairly well known. Within the past three years, collections were made at Kennebecasis island, by Messrs. Ells and Matthew.[1] In the report on the geology of southern New Brunswick by Messrs. Bailey and Matthew, Sir J. W. Dawson gives a list of nine species of fossil plants from Gardner creek, St. John county, which were submitted to him for identification.[2] Besides the above, no systematic work has been done towards making a careful study of the fossil evidence contained in these rocks, especially as regards the plants.

FIELD WORK.

Collections were made during the past summer at St. Andrews, Kennebecasis island, Moosehorn brook in Kings county, McCoy head, Gardner creek, Tynemouth creek, Alma, Cape Enrage, and New Horton, and an examination of the rocks was made at St. Martins, Waterside, Albert county, also on the Nerepis stream at the contact between the Devonian and Carboniferous formations.

1 Geological Survey Summary Report, 1906, p. 132.
2 Geological Survey Report of Progress, 1870-1, p. 210.

At St. Andrews, the southern part of the peninsula was carefully examined, and parts of Ministers and Hardwood islands. At Brandy cove, a few indistinct plant remains were found, and at Joe point distinct branching fern stems were collected. At Indian point, near the end of the railway track, a fern frond showing indistinct pinnules was found in place. Some fairly well preserved stems, etc., were found off this point. Plant remains were common in places, both on the mainland and islands; but not much determinable material was secured.

The next place examined was Kennebecasis island, near St. John. The rocks forming the western part of this island are gray sandstones, grits, and shales: dipping N. 20°, W. at an angle of 58°. The shale is mostly fine-grained, greenish-gray, breaking in places into irregular conchoidal pieces. These shaly beds contain many fern stems, cordaites, lepidodendra, fronds of ferns and separate pinnules in a good state of preservation. The lepidodendra are especially abundant, and many good specimens were obtained.

A few days were next spent collecting along the shore of Courtenay bay; but very little good material was found. A day was spent with Dr. Matthew examining the rocks for sponge-spicules, in the vicinity of Green head; and another day at Drury cove. The material collected at these places has not been examined carefully, but it does not look promising.

A fortnight was spent at Moosehorn brook, in Kings county. This brook enters the Kennebecasis river about 2 miles below Norton station on the Intercolonial railway, and for over 5 miles, reveals a good section across the rocks under consideration. Red sandstone and conglomerate occur for over a mile down the brook from Campbell settlement. Some of the finer beds contain plants, but none of much value. In descending the brook, to the mouth, gray sandstone and fine dark shale are met with. In some places the beds are vertical, in others they dip at various angles. In two places well preserved plant remains were met with in abundance. A more careful search would probably reveal other similar beds. One good collecting ground is about 5 chains above the wagon road, near the mouth of the brook. The rocks are vertical, and the prolific beds are 4 feet wide. They contain long, round plant stems, small fronds, and separate pinnules of ferns; also good specimens of lepidodendra, cordaites, and branching fern stems. The second locality is from 1½ to 2 miles from the mouth of the brook, and a few chains below the driving dam. At this place the plants are splendidly preserved and consist of fern stems, pinnules, and a delicate plant with very fine thread-like leaves. The water was very low in this stream at the time of my visit, affording an exceptional opportunity for collecting, as the beds near the dam could not have been examined if the water in the stream had been at its ordinary height.

The next place examined was on the shore of the Bay of Fundy, between Emmerson creek and Gardner creek, including McCoy head. All along this coast there are steep cliffs, 100 to 200 feet high, the strata dipping at various angles, mostly from 50° to vertical. Good specimens were obtained at various places, and a large variety of species was collected. Cordaites is very common, and plants which belong to the following genera were found: annularia, aneimites, pecopteris, neuropteris and calamites, besides others which will be described later. Fern stems and tree trunks are common, and *Cardiocarpum crampii,* and other fruits were collected. Just east of Gardner creek, estuarian shells of the naiadites, or anthracomya type, were found in considerable numbers.

A few days were spent in St. Martins and vicinity, especially at Macomber brook, but no fossils were found.

A short time was spent at Tynemouth creek. The rocks along the shore at this place are reddish sandstone, with occasional gray bands and beds of fine shale. They dip S.W. at an angle of 20°-30°. A rich flora was obtained from the finer beds, the genera being similar to those found at McCoy head, and Gardner creek, with some additional species.

An animal track was noted east of the mouth of the creek, on a smooth rock surface below high tide level. The track consists of two parallel slightly curving lines, about 10 inches apart. The depressions are partly obliterated by erosion.

From Tynemouth creek I went to Alma, in Albert county, and examined the shore from Point Wolf to Cape Enrage. Good collections were made from a few points. The rocks between Point Wolf and Matthews head are coarse reddish conglomerates, with very little fine material. No fossils of any kind were seen. Part of this shore was not passable on foot, and while I was there, the wind prevented landing with a boat, so that only a portion of the shore at either end was traversed. Between Alma and Herring Cove, the rocks are well bedded, gray sandstones, dipping S. 30° E. at an angle of 8°-15°, with occasional bands of fine shale. Near Herring cove there are beds of reddish shale interbedded with the gray. Many of these beds contain an abundance of plant stems, poorly preserved, but some good calamites and cordaites, and one small fern frond were found. Eastward from Alma, along the shore, the usual coarse plant stems occur, and many tree trunks were noted in the cliffs. Most of the trees show woody structure and should be easily determinable. East of the breakwater at Alma there is a very fine dark shale, in which were found fish scales and good specimens of ferns of different genera, also a spirorbis in considerable abundance. About a mile and a quarter east of Alma, in a band of black shale, there were many shells in a good state of preservation. These shells are probably the same as those found at Gardner creek, but they have not yet been specifically determined. Fern leaves were found in the same beds.

About half a mile east of Alma, there are marks resembling the track of an animal, on a large block of gray sandstone which has fallen from the cliff. There are three parallel grooves. The two outer ones are over 8 inches wide, and an inch and a half deep. The middle groove has somewhat regular depressions and heights. The extreme length of the track is 19 feet, and from outside to outside it is 32″ wide. This is evidently the track referred to by Dr. L. W. Bailey.[1]

A short time was next spent examining the soft, red sandstones at Waterside, but no fossils of any kind were seen. Then Cape Enrage was examined. Here there is a high, steep cliff of gray sandstone, with numerous bands of fine shale. These rocks are nearly vertical and contain many plant stems and trees. North of the lighthouse steps there is a wide band of fine, fissile schist, in which there are splendidly preserved ferns, but the shale is so soft that it crumbles into small pieces on exposure to the air. In this bed I found *Sphenopteris marginata,* alethopteris and annularia, also calamite, cordaites, and fern stems, almost covered with a spirorbis.

At New Horton, good specimens of coarse stems and tree trunks abound. The last place examined was on the Nerepis river at Clones, where the Devonian and Lower Carboniferous are shown as coming in contact. No fossils were found in either formation, but unfavourable weather prevented an extended examination.

The time at my disposal did not permit of an exhaustive collection from any locality, and I was not able to reach several places mentioned in my letter of instruction. I tried to get a fairly representative collection from as many places as possible, so that when the fossils are studied, and named, a fair knowledge of the age of the rocks may be acquired. I was much surprised at the great variety and perfect state of preservation of the plants in most of the places examined, and there is no doubt that future careful work will be richly rewarded.

Until the fossils are studied I am unable to offer a definite opinion as to the age of the rocks from which they were collected.

I desire to acknowledge my indebtedness to Dr. D. P. Penhallow, of McGill University, and Dr. G. F. Matthew, of St. John, N.B., for much valuable assistance in the prosecution of my work.

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1 Geol. Survey, Annual Report, Vol. XIII., p. 29 M.

SUMMARY REPORT OF THE NATURALIST.

(John Macoun.)

Between the date of my last summary report and my departure for Vancouver island, my time was chiefly occupied in revising the manuscript and reading the proofs of the Catalogue of Canadian Birds. As soon as I was informed that I was to spend the summer on Vancouver island, I began work on a list of the plants known to grow there, and completed this before going to the field. The routine work of my branch increases annually, and a very considerable portion of my time is, of course, devoted to it.

My assistant, Mr. J. M. Macoun, worked chiefly at botany, as there are still many thousand sheets of botanical specimens to be named and placed in the herbarium. The re-arrangement of the matter in the Catalogue of Birds is also in his hands. Mr. C. H. Young has been an invaluable assistant, and during the winter months, in addition to the entomological work for which he was specially engaged, he re-labelled all our mammal and bird skins. Miss Stewart has, as in former years, proved an efficient assistant, and the greater part of the labelling and sorting of botanical specimens has been done by her. The work of my office is in her charge when my son and myself are in the field. During the winter months, 3,141 sheets of botanical specimens were distributed, and 1,732 sheets mounted and placed in the herbarium. Mr. J. M. Macoun had leave of absence for five months, but has now resumed work as my assistant. Owing to his absence, and the unusual amount of report and catalogue work we have had to do during the year, our correspondence was much less than usual, only 593 letters having been written.

As soon as it was decided that my field of labour for the season of 1908 should be Vancouver island, I immediately began to put the knowledge acquired in the summers of 1887 and 1893 in proper shape. When this was done I saw that our knowledge of the birds and small mammals, as well as of general botany, was very extensive. Having conceived the idea that one or two seasons more would enable me to write up the whole natural history of the island, I obtained permission to attempt it. In addition, we had in view specimens of the forest trees of Vancouver island for the new museum, and of the fauna and flora of the sea in connexion with the biological station recently established at Departure bay. Having these various projects in mind, I had Mr. William Spreadborough, who has done such good field work for so many years, commence work at Victoria, on April 1. Here he collected flowering plants, listed all the migrating birds, and obtained the nests and eggs of twenty-four species. Nineteen specimens of rare birds were collected, and 146 eggs. I was able to reach Victoria on May 29, and we immediately commenced to collect the fauna and flora of the sea. We were very successful, and obtained much material.

On June 22 we went to the biological station at the head of Departure bay, and owing to the excellent arrangements there were able to work very successfully. Mr. Spreadborough ranged the country for miles around, and listed birds, collected plants, and selected the various species of trees we desired to obtain. I was employed in collecting from the sea, especially seaweed, which was the chief object of my living at the station.

On July 17, Mr. Spreadborough and I returned to Victoria, to finish up the collecting of plants, and he here selected and obtained some of the rare trees we wished to obtain from the island.

I arranged in the spring for Mr. Charles Young to go to Vancouver island to experiment on the preservation of starfishes and other sea forms which were needed for the new museum. I received word that he would reach Nanaimo on August 1, and going from Victoria to Nanaimo, met him there and took him to the biological station. Through the kindness of Mr. G. W. Taylor, who has charge of the station, we had the use of his boat and dredging apparatus, and were thus enabled to do more exhaustive work than would otherwise have been possible. Our work at the station was inexpensive, as we had food and lodging, and every accommodation, free of charge. Mr. Taylor's library was also put at our disposal. These facilities, combined with the opportunities for discussion with the trained investigators located at the station, made it possible for us to accomplish a great deal more than was expected.

Before leaving Ottawa, I was directed to visit Rossland, for the purpose of examining into the cause of the rotting of mine timbers; so leaving Mr. Young and Mr. Spreadborough to finish the work on Vancouver island, I left Victoria on September 1, and proceeded to Rossland. I descended the Centre Star mine to the 1,600 foot level, and obtained specimens of four species of fungus, which belonged to the genera *Trametes* and *Polyporus,* groups which are noted for their injurious action on timber above ground.

In conversation with the manager of the mine, I suggested painting the posts, as the spores of the fungus must enter the wood to produce injury. I mentioned the methods adopted in the United States, and spoke of creosote, but really all these methods mean the same thing, the keeping of the spores out of the wood, because there can be no rot without fungus, or algoid spores.

Since my return, the Director has mentioned a statement made by Mr. Watson, one of the mining engineers from Europe, that timber used in mines there has been preserved by immersing for a time in a strong saline solution before being used underground. This I consider a complete solution of the difficulty, as no fungus is known by me to grow on trees or other woody matter which is found lying on the seashore. All wood on the seashore is sound, and all wood on the borders of lakes or rivers is rotten. A detailed description of the method referred to above, follows:—

The Treatment of Timber for use in Mines.

A method of treatment of timber, known as the Henry Aitken method, is now used at many collieries. In this process the idea is to soak the timber in water, raised to a temperature of from 190° to 200° Fahr., containing enough common salt to form a thoroughly saturated solution.

The timber should be free from bark, fairly well seasoned, and thoroughly dry.

Any tank, either wood or iron, of a size suitable to contain the timber to be treated will do, and the water should be heated by exhaust steam, or otherwise.

The time necessary for completing the process largely depends on the nature and size of the timber, but two days will, in general, be sufficient.

By sawing off a small part of the timber being treated, it can be seen whether thorough penetration by the salt has been obtained.

When the timber is removed from the treating tank it is soft, and not in a condition for immediate use.

It is dried by being put into a covered shed, or stacked in the open air.

The cost for treating timber by this process averages in Great Britain, about one penny per cubic foot.

Some of the managers of the largest collieries in Scotland, who have adopted the process, write as follows:—

Mr. Maevie, manager Cadzow collieries, Hamilton, regarding the Aitken process for treating the timber for use in mines, states that in his five years' experience he had never seen the least indication of decay in any timber so treated. About four years ago, gears (every alternate one treated) were put in the main return airway of

the No. 3 Pit Ell coal seam, Cadzow colliery. About a year ago, all the untreated gears were replaced, owing to decay. The treated timber is still in use, and in good condition. As regards the contention that the Aitken process reduces the strength of the timber, he had never seen anything to make him think this was the case. Indeed, he had stopped using larch timber, and now used treated Scotch, or foreign fir.

Mr. Ferguson, manager Benarty colliery, Fifeshire, writes that the Aitken process has been in use at the Lochore and Capledrae collieries for upwards of six years, and during that time it has proved a great saving, not only in wages renewing broken timber, but also in the price of wood used, which is now nearly all foreign timber. The treated wood had stood in the return airways for six years, and was quite sound. If this wood had not been treated it would have been replaced twice during the above period. No tree which had been treated had shown the slightest decay during the six years.

Mr. Carlow, managing director Fife Coal Company, Leven, Fifeshire, writes that the Aitken process has been in use for four years.

The following experiments have been made with the process: Two pieces of ordinary fir, 3½″ in diameter and 3 feet long, both weighing 10 pounds before being treated, were selected. One of the pieces was treated by the salt process and the other was not. After being treated it weighed 12 pounds. Both were taken underground and placed in a return air-course, and after eleven months were examined and re-weighed. The untreated timber then weighed only 5 pounds, whereas the treated one weighed 12 pounds, being exactly the same weight as when it was put in. They were put back into the mine and allowed to remain eleven months longer, with the result that the untreated timber weighed 6 pounds, and the treated timber weighed 11¾ pounds. They were again replaced in the mine, and after an exposure of three years they were examined, and while the treated piece was sound, the untreated one was decayed. Besides these tests, observations were made on the treated timber put into main roads, beside other timber not treated. The treated timber remained damp and fresh, while the untreated crown-trees were dry and soft on the outside, showing that decay was in progress.

The amount of salt that timber will absorb depends on the firmness of the wood, and its dryness at the time of treatment. Norway fir absorbs from 15 to 50 per cent of its weight, that is, it becomes 15 to 50 per cent heavier after treatment, while larch crown-trees absorb only 10 per cent.

The cost is about one penny per cubic foot for salt, and one farthing for labour, a total cost of about 1¼ d. per cubic foot.

WORK OF MR. C. H. YOUNG.

Mr. Young reached Nanaimo on August 1, and worked two months at the biological station, leaving there September 28. His day's work commenced with a collecting trip; the remainder of the day being taken up with the preparation of specimens, which often kept him employed far into the night. When necessary I assisted him to collect specimens, and very soon he had a large series of shore species. During the last month he was ably assisted by Mr. Spreadborough, who soon learned to manipulate and prepare the various forms.

While dredging off the head of Newcastle island in August, the dredge brought up, from a depth of 25 fathoms, at one haul, over 60 specimens of a hexactinellid sponge, *Rhabdocalyptus Dawsoni,* (Lambe), a species which had previously been taken at two localities by Dr. G. M. Dawson, while dredging in the Strait of Georgia, one specimen being taken off the mouth of Qualicum river, Vancouver island, in 40 fathoms, and two specimens in the Strait of Georgia, near Comox, in 40 fathoms. Dr. Dawson obtained the type specimen, nearly a foot in length, in 1885. The species has also been collected by Mr. Taylor. None have been taken anywhere else, until last

August. Many other rare and beautiful sponges were taken, and will be named when time permits by Mr. Lambe, and placed on exhibition.

WORK OF MR. WILLIAM SPREADBOROUGH.

Reference has already been made to the work done by Mr. Spreadborough. He was employed from April 1 to the last of September. During April and May he collected plants, listed the migrating birds, and searched for nests and eggs. In all of this work he was very successful. In June, July, and August he continued collecting, and at the same time procured for the new museum specimens of seventeen species of trees native on Vancouver island. The specimens selected are all 5 feet long, varying in diameter up to 2 feet; although the species may attain to a larger diameter. While at the biological station, Mr. Spreadborough assisted Mr. Young in collecting and preparing the starfish, crabs, etc., in that vicinity, when he was not otherwise employed. Both men were indefatigable, and I cannot speak too highly of their work.

COLLECTIONS.

The collections made in August, and September, by Messrs. Young and Spreadborough, comprise:—

One hundred and fifty-six starfishes.
One hundred and ninety-five crabs of various kinds.
Over one hundred sponges of various kinds.
A fine collection of barnacles.
Over fifty bottles filled with specimens in spirits, and a very large collection of marine shells.

Each evening Mr. Young went out with a lamp and net and caught moths and beetles. This collection alone numbers over 600 specimens.

The botany of the island was chiefly my work, but Mr. Spreadborough gathered the greater number of the flowering plants. The collection embraces over 1,100 species of flowering plants, about 400 species of cryptograms, and nearly 150 species of seaweeds. The latter collection was chiefly made at Victoria, and Departure bay.

It will be seen by the above that we made an excellent beginning, and another season's work will enable me to write an exhaustive report on the whole fauna and flora of the island, provided I have the assistance of Messrs. Spreadborough and Young.

Since our return to Ottawa, Mr. Young and myself have been employed arranging the various specimens collected, all of which have turned out well.

A few days since I sent down 21 species of starfish to Prof. Verrill, of New Haven, Conn. In a letter received from him three days ago he says, in part:—

'Have looked over the starfish rapidly. I think there are some among them that I do not know, and some are represented by larger or better specimens than I have had before, and I may wish to figure some of them by photography.'

The collecting of the starfishes was only an experiment; but it is gratifying to be able to report that it has proved an unqualified success.

Since my return, besides attending to the routine of the office, I have named large numbers of plants from Guelph, Galt, St. Thomas, Truro, Winnipeg, Calgary, and from the Experimental Farm. Birds, and small mammals are occasionally received for identification.

In the intervals between this routine work I am engaged on the flora of Ottawa. This work has become a necessity, as the new museum must take a local as well as Dominion position. The local botanists will give their assistance, and we will make as complete a catalogue as possible. The other work I am engaged upon is the identification of the specimens obtained on Vancouver island.

A PRELIMINARY REPORT OF AN ETHNOLOGICAL INVESTIGATION OF THE MACKENZIE DELTA.

(V. S. Steffanson.)

The following is submitted as a preliminary report: the statement of facts in which may be amplified and the conclusions modified after the completion of the field work now in hand. Although this report is of work done under the auspices of the Geological Survey during the summer and autumn of 1908, it is inevitable that it should include to some extent, the results of observations made during a stay in the Mackenzie delta and neighbourhood, from July, 1906, to August, 1907, at the end of which period I began the work which the Geological Survey desired to have continued under its direction.

THE ROUTE.

The Mackenzie delta may be reached by two practicable routes, either by boats down the rivers of the Mackenzie system from Athabaska Landing, Alberta, or by whaling ships from San Francisco, U.S.A. The Mackenzie route is the easier for passengers, but the more difficult for the transportation of freight. For this reason, we had certain supplies shipped from San Francisco to Herschel island, while Dr. R. M. Anderson, a geologist, and myself took the river route, reaching the Mackenzie delta early in July.

THE PEOPLE.

The upper portion of the delta may be considered to be occupied by Loucheux Indians of the Athabaskan stock, while the lower portion belongs more strictly to the Eskimo. Formerly there was but one group, the people who may be called the Mackenzie River Eskimo, but now there are immigrants from the interior of Alaska behind Kotzebue sound, the so-called Nunatamas, and from almost every coast settlement between Cape Nome and Herschel island. It seems probable that in 1889, when the first whaling vessels began fishing off the delta, there were rather more than 2,000 Eskimo between Herschel island and Baillie island, inclusive of the former and exclusive of the latter. At present, 1908, there are less than 400, half of whom are immigrants from the west.

Reasons for Decline in Population.

The chief reason for the decline in population has been the introduction of white man's diseases. These, placed in the order of their destructiveness, are as follows: measles, scarlet fever, syphilis. A number die every year from consumption and ptomaine poisoning, as well as from various diseases not named. Altogether the causes of death in the order of their fatality, may be arranged as follows: measles, scarlet fever, consumption, ptomaine poisoning, gonorrhœa (sp?), syphilis, etc. As is well known, the manifestations of syphilis are so various that its positive determination is difficult, and even medical men would, therefore, differ as to its prevalence where histories of each case are difficult to get.

Among the Eskimo, as everywhere among American races, measles are more fatal than is the bubonic plague among Europeans. Instances have occurred within the

last ten years, where ten out of thirteen individuals in a single house have died in one week; strong men sometimes dying within thirty hours from the appearance of the first symptom. Consumption is not nearly so fatal in these Eskimo communities as among the Indians. It is said that at Fort Wrigley, on the Mackenzie, the number of Indians has been reduced in six years from two hundred to twenty hunters, chiefly by tuberculosis, whereas, among about four hundred Eskimo there have been only eight deaths from this disease in two years. Rheumatism is not uncommon, and spinal tuberculosis is occasionally met with (two cases among four hundred people); while blindness and weak eyesight is rather common among elderly people, chiefly among the men, probably in consequence of frequent snow blindness, as they themselves believe.

Apart from epidemics, the death rate of the Eskimo cannot be considered very high, except as compared with the birth rate. They are, however, an extremely unprolific people. I have never heard of more than four children in a family, and have never seen more than three, while one child or none, is more common than two or three. The death rate among children is not excessive, but it is evident that even were there no deaths in infancy, population must decrease from year to year.

ESKIMO VILLAGES.

Eskimo houses were at various times in the past built at virtually every point of the coast between Herschel island and the Mackenzie river, but the first place west of the Mackenzie river recognized as a regular village site is Escape reef, located about 15 miles west of the most westerly mouth of the Mackenzie. From this place, going eastward, one crosses the entire delta before coming to the next recognized village site, near the south end of Richard island. Although there were doubtless a considerable number of people in villages west of the Mackenzie, three-quarters at least of the population must have been east of the delta proper. The largest villages were on the river between Richard island and the mainland, namely, Kopuk and Kittegaryuit, although to the east along the coast, and southwards to the Eskimo lakes, were numerous and populous towns whose ruins are rich in archæological material.

PHYSICAL CHARACTERISTICS.

At Herschel island, at certain seasons, are gathered together several hundred Eskimo, and a corresponding number of white whalers. The general impression one gets from this mixed assembly is that the whites and Eskimo are of the same average stature, though measurements indicate that the whites average a trifle taller, the general smallness of certain tribes reducing the average. Other tribes, however, such as the Nunatamas, fully average the stature of northern Europeans.

In general, the features of the Eskimo become more Mongolian in type as one goes west through Alaska. The Mackenzie River people proper, have a head tending in general to narrowness of skull, the eyes level or with a suspicion of the Mongol slant, noses of as varied types as Englishmen, high cheek bones, a greater tendency to lobeless ears than Europeans, and stiff black hair. The hair is worn cut level with the eyebrow in front but hanging to the shoulders behind, and the crown of the head is tonsure cut. The men are well proportioned, agile, and walk with a swing approaching the English cavalry stride. There is a greater difference in the stature of the sexes than among whites, the women being considerably smaller than white women.

Head form being in general the most important somatological character racially, there is appended a tabular summary of head measurements of three groups of Eskimo, and also of some Loucheux Indians.

78 KOGMOLLIKS.	84 NUNATAMAS.	15 PT. BARROW.	59 LOUCHEUX.
No. of Individuals.	No. of Individuals.	No. of Individuals.	No. of Individuals.
Index 66—1	Index 66—	Index 66—	Index 66—
67—	67—	67—	67—
68—1	68—	68—	68—
69—1	69—	69—	69—
70—3	70—	70—	70—
71—2	71—	71—	71—
72—2	72—	72—	72—
73—10	73—	73—	73—
74—8	74—1	74—	74—2
75—7	75—	75—3	75—2
76—14	76—2	76—	76—0
77—9	77—6	77—4	77—4
78—10	78—5	78—2	78—6
79—3	79—8	79—2	79—5
80—5	80—10	80—	80—6
81—1	81—7	81—2	81—10
82—1	82—10	82—1	82—6
83—	83—6	83—1	83—5
84—	84—5	84—	84—5
85—	85—6	85—	85—3
86—	86—6	86—1	86—1
87—	87—3	87—	87—2
88—	88—5	88—	88—1
89—	89—2	89—	89—1
90—	90—1	90—	90—
91—	91—	91—	91—
92—	92—	92—	92—
93—	93—1	93—	93—

RELATIONS WITH INDIANS.

Both east and west of the Mackenzie we know of cases of protracted friendly contact and trade relations between Eskimo and Indians, but in recent times at least, there was continuous hostility between the Mackenzie Delta Eskimo and the Loucheux Indians. It seems that in general the Eskimo were the more aggressive and now and then made incursions far into the Indian country, and it is certain that, in recent times, the Indians have been in much greater fear of the Eskimo than the Eskimo of the Indians. After the establishment of the Hudson's Bay Company's post at Macpherson, on the Peel river, attempts were made by its officers to establish peace between the two races, in order to facilitate trade. Although comparatively timid in open battle, hostilities were again and again precipitated by the treachery of the Eskimo.

The last pitched battle occurred in the sixties, when a party of Eskimo, all able-bodied men and women, attacked a much larger band of Loucheux Indians, consisting largely of old men, women and children. None of the Eskimo were killed, but only two of the Indians escaped.

After this fight the Company called together all the relatives of the slain Loucheux, upon whom rested the duty of blood-revenge, and paid them in trade goods what was considered a fair blood-price. The Eskimo were then informed that no revenge would be taken, and although distrust existed for many years, both tribes have since then, each year, traded at Macpherson and no deeds of violence have occurred. The two races are now on perfectly friendly terms.

COMPARISON OF INDIANS AND ESKIMO.

While on a journey by a whaleboat from Fort Macpherson to Herschel island, I had a good opportunity to compare the Indian with the Eskimo under identical con-

ditions. Both were receiving the same remuneration for their work, but the way in which they carried it forward was markedly different. The Indians were lazy, shirking and complaining of even the little they had to do, and always eager to go ashore and camp. They whined about their uncomfortable beds on board our boats, although they seemed able to drop asleep at any time and to sleep on indefinitely. On the other hand, the Eskimo, Memoranna, worked hard during the day, stayed up at night to keep the boat in the current, and took the greatest interest in our progress and the greatest pains to see that everything went on well. At one time he was over fifty hours without sleep, and throughout the entire trip got his sleep irregularly; and yet was ever the soul of good humour, while some of the Indians were sulky even while they were eating.

The status of women among the two races may be said to be diametrically different. Among the tribes I have had the opportunity of observing, the Indian women are considered inferior to the men and seem to recognize themselves as such. Walking between camps they will follow at some distance behind the men, speaking little and then only to each other and the children. When a discussion is going on in the tent, they never venture an opinion unless spoken to; their whole attitude is one of sheepish inferiority. With the Eskimo the story is different. Their women are more nearly the equal of the men than women are among the white people, for there is none of the affected superiority and real depreciation which is their lot amongst most European nations. An Indian considers it a degradation to have to do any sort of women's work; to eat with them or assist them under ordinary circumstances; but among the Eskimo of the mouth of the Mackenzie, men and women habitually eat together. An Eskimo man will sew cloth, tan skins, prepare food, tend the baby, or in fact, do anything that comes to his hand, while the women will, in time of necessity, do man's work of any kind.

Perhaps the most salient point of difference between the two races, however, is that an Indian tries to appear dignified under all conditions, while apparently an Eskimo never takes pains to vary his conduct to impress others. When one approaches an Indian village, a few women or boys may come out to meet the stranger, but ordinarily the men, and especially the more important men, will await one in the tent, receiving one with dignity and what might be called formality. If a strange boat approaches an Eskimo village, all the inhabitants not only manifest the liveliest interest, but the most prominent men are the first to wade into the water to help pull the boat ashore.

In energy and resourcefulness there seems to be a no less marked difference. An experience of Mr. Daniel Cadzow, a trader at Rampart House, on the Porcupine river, will illustrate this. Indians of various tribes had traded with Mr. Cadzow, but no Eskimo until the winter of 1906-7, when exceptionally hard hunting conditions in the mountains northward forced some of the inland Eskimo to follow the deer far south into the Indian country in the neighbourhood of Mr. Cadzow's trading post. Almost starving, some of the Eskimo came to the store asking that food be given them on credit until they could pay for it in furs and deer meat. To the surprise of Mr. Cadzow, when food was dealt out to the Eskimo, they loaded it on their sleds and started off. Indians, under similar conditions, would have made a great feast, eaten up all that had been given them and then have come back whining for more. In fact, that was precisely what a large crowd of Indians did do at this very time.

Seeing the difference between the two people, Mr. Cadzow went to the Indians, gave them a few days' rations, then practically drove them away, saying that he would give them nothing more to eat unless they hunted like the Eskimo. The Indians went off, but in about three weeks sent messengers asking for more food, saying that they had been unable to hunt on account of the excessively cold weather. Later on it developed that they had gone only a few miles from Rampart House and had kept in camp until all their food was eaten. About this time the Eskimo returned to the

trading post, but instead of asking for more food, they now brought their sleds loaded with deer meat and valuable furs.

The incident reported from Rampart House is typical of the experience of everyone I know who has dealt with both Indians and Eskimo.

HONESTY OF THE ESKIMO.

Nothing more clearly illustrates the general honesty of the Eskimo than their practice of storing household goods, often including valued articles easily carried off, in unprotected places. These are seldom disturbed, excepting in the case of food, when it is an unwritten law that anyone who is in need may openly help himself. In the old days apparently no restitution was made, but since the Eskimo began to acquire ideas of private ownership from the whites, the custom of making payment for food taken from abandoned stores is becoming established. Though the character of everyone is well known, only two natives of the Mackenzie delta are publicly recognized as thieves, and one of these is the only known murderer now living in the community.

CONTACT WITH WHITES.

Although Franklin, Richardson, Pullen, Hooper and others, saw groups of Mackenzie River Eskimo at various times between the twenties and sixties of the last century, it is probable that the influence of the white man upon their lives and habits was small up to the time of the cessation of Loucheux hostilities and the beginning of continuous trade relations with the Hudson's Bay Company. Even then the change must have been slow. In the late sixties, Roderick McFarlane made his first trading trip to the Anderson River district, east of the Mackenzie. After trading peaceably with an encampment or two of Anderson River natives, he was robbed of all he had by a party of delta Eskimo who had been told of his expedition by Hare River (or Loucheux?) Indians. Subsequently, McFarlane, acting for the Hudson's Bay Company, succeeded in establishing a trading post on the Anderson river, and maintained it for a few years until an epidemic killed off most of his customers.

At Fort Macpherson, on the Peel river, trading with the Mackenzie Eskimo practically began in 1872, when the present factor, Mr. John Firth, took charge. For many years the Eskimo came only in large armed parties, and established what might be described as a belligerent camp in the Peel bottoms a quarter of a mile from the fort. They were admitted to the post only in small groups, and sent beyond the walls when the trading was done, while the stockade was barred at night and guards set. Evidently trade relations of this sort could have no very rapid culture influence upon the natives.

In 1889 a new influence came into the field when the first whalers began their fishing around Herschel island, and since then the change in manners and customs has been rapid. Some of the natives have taken service aboard the ships, and speak English tolerably well; a considerable number of the native women have lived for years with white men, afloat and ashore; and considerable dependence has come to be placed on imported foods and trade wares. All this applies, however, much more largely to the people living west than to those living east of the river mouth.

RELATIONS OF WHALERS TO ESKIMO WOMEN.

Among the Eskimo no ceremony is necessary to constitute marriage, the desire and consent of the parties concerned being all that is required, and divorce is equally easy. When an Eskimo couple are married they remain married as long as suits the convenience of both parties, and the union may be dissolved by either without the consent of the other, and without prejudice to the social standing of either. The same rule applies to the relations between whalers and Eskimo women, though in this case the divorced Eskimo woman has the advantage of having acquired knowledge of white

men's ways, hence is more desired as a wife by the Eskimo men, who appreciate the value of a wife who can give competent advice in matters of trade with the whalers. The woman, therefore, rises in social standing by having been the wife of a white man. Besides this, she usually acquires wealth, for the tents and camping outfit which were used jointly by herself and husband are left behind by the whaler when he goes south. She has, therefore, for the purpose of her second marriage, acquired increased social standing and a substantial dowry.

While not advocating the continuance of the conditions now prevalent, I do consider that the matter should be approached calmly, and it should be definitely recognized that, from the point of view of the Eskimo, no atrocities are being committed in the north. Things that are wrong are wrong from our point of view, and it is with this understanding that we should proceed to rectify them.

THE ESKIMO OF HERSCHEL ISLAND.

Previous to the first coming of the whalers in 1889, there were probably few Eskimo immigrants in the Mackenzie River country. There are traditions of occasional visits, perhaps one only, from Point Barrow. A middle-aged man named Memoranna told me that when he was young, a crew of Point Barrow natives in an umiak, came one autumn to Herschel island. They were on what might be called a voyage of exploration, though the Mackenzie River and Point Barrow men met yearly for trading purposes at Barter island, Collinson point, or some neighbouring place, and were, therefore, more or less familiar with each other. The Herschel islanders had a very bad reputation for turbulence, dishonesty, and even treachery, and the Point Barrow people, therefore, left their wives, children and property behind in the neighbourhood of Coldville delta.

The visitors, however, were well received at the island, were entertained for a while, and then began a sort of triumphal march eastward, going from village to village with a large company of followers, finally penetrating as far east as Baillie island. Here the leading man of the Point Barrow party married a Kogmollik woman, who became his second wife. In the latter part of the winter the party returned to Herschel island, and when navigation opened, proceeded to Point Barrow. It is manifest, therefore, that there was some intercourse and intermarrying between the Mackenzie River Eskimo and others.

Shortly before 1889, the first Nunatamas or inland Eskimo, arrived at Herschel island. People who were used to dealing with the Point Barrow Eskimo, and found no trouble in understanding their language, understood at first scarcely a word of the dialect spoken by the inlanders. After being together for a week or so, however, they found little difficulty in conversing; but it seems that the Nunatama dialect differs more from that of the Herschel islander than does the Point Barrow dialect from either.

With the first whalers, and practically every year since, there have come Eskimo immigrants from the islands in Bering sea, and from various points as far west as Point Barrow or the mouth of the Yukon. Sometimes they have merely landed, or they may have stayed a year or so, but not infrequently both men and women have taken up permanent residence at Herschel island or farther east. A large number of the Nunatamas have come either overland by themselves, or eastward from Point Barrow or from Kotzebue sound as passengers on whaling ships. The result is that the population in the Mackenzie delta is becoming mixed in blood, has already been deeply influenced in its culture characteristics, and has taken up many strange words into the spoken language. A few of these borrowed words are English, an occasional one Indian, but most of them are forms of Eskimo words, which previously were not in current use at the mouth of the Mackenzie.

It seems that these people, collectively known to the whalers as Kogmolliks, always had a feeling of solidarity, although they had no common word to designate themselves as a group, the inhabitants of each village being known by the name of their dwelling place. They had a certain territory which they recognized as theirs; and although a man seldom lived in the same place two winters in succession, he was very unlikely to build his house beyond the regular ranging ground of his people. Their western limit seems to have been pretty definitely placed at the east end of the long lagoons coming down from Barter island and ending some 30 or 40 miles west of Herschel island. What their eastern limit was is less certain, though it is evident they recognized themselves as a different people from those of the neighbourhood of Baillie island. Their south range was even more indefinite, for there they were on the frontier of an actively hostile people. In summer they hunted far up the Anderson, and in armed parties ascended the Mackenzie, occasionally to the neighbourhood of Fort Good Hope. Their permanent houses in the Mackenzie delta were probably never built farther south than Point Separation, some 20 miles north of the present site of Fort McPherson.

MATERIAL WELL-BEING.

It is commonly assumed that the Eskimo occupy the least desirable portion of the American continent, and have been crowded into it from more favourable localities by a more powerful people (the Indians) to the south. This generalization is not only incorrect as a whole; but tacitly assumes as true or evident several things which may appear evident but are not true.

Is the country immediately to the south, from which the Eskimo must have come if crowded from anywhere, superior to the coast? The temperature in the Indian country, say at Fort McPherson, falls below 70° F., while on the coast it has never been known to go below 55° F., therefore, the coast is evidently considerably warmer in winter. Fuel is, anywhere between Point Barrow and Cape Barry, as abundantly supplied by drift-wood as it is to the south by trees, although, as a matter of fact, the Eskimo use wood for fuel in summer only. The same game animals, with unimportant exceptions, that abound in the Indian lands are hunted under similar advantages by the Eskimo, who, in addition, have the animals peculiar to the sea, viz., the various seals, whales, and polar bears. Fish are as abundant in a river's lower reach as they are in its upper and are of better quality, and, in addition, there are the salt water fish. The net result of the comparison shows a balance of opportunity for well-being decidedly in favour of the Eskimo. If then, they are not in the least favourable locality, it is not probable they have been crowded into it since little force is needed to compel a shrewd people to occupy the best localities. Further, it is evident that both now and when first seen by whites, the Athabaskan Indians are, and were, incapable of driving the Mackenzie River Eskimo anywhere. There is no case known of their having done anything of the kind, but instances of the reverse are definite, if not numerous.

The Mackenzie Eskimo live (from the food-gathering point of view) in a good country, and they have the disposition to make use of their opportunities. On the other hand, the Loucheux Indians to the south of them starve most years, and almost every winter lose a number of their dogs through hunger. There is not a case of starvation, within the memory or tradition of the Mackenzie Eskimo, nor within the record or present knowledge of whites. Their winters of great hardship are those when the supply of blubber so nearly gives out that they have to save it for food and are forced to use wood to heat their houses.

That they lived well in the past is a matter of tradition and in the memory of old men living; that they live well now is a fact to be seen by all who visit them. My first meal in an Eskimo house (near Herschel island) comprised bacon, fresh deer and seal meat, fresh and dried fish, good yeast bread and butter, tea and coffee with

sugar and canned milk, dessicated potatoes, cheese and syrup—most of it purchased for deer meat and furs from whalers and from Capt. Amundsen's exploring vessel *Gjoa*. The whole was cooked on an air pressure kerosene stove, in a tent that would be considered presentably clean for a holiday camper. In a Loucheux tent, 200 miles to the south, one feast of dark trade flour a year, tea two-thirds of the year, with deer, fish, rabbits and starvation alternating, is the typical condition. The meal described above was, it must be allowed, unusually varied in its menu, even for an Eskimo house of the best class. Its owner was not a Mackenzie native but an immigrant from near Kotzebue sound. Besides various household articles, he owned half a dozen good rifles, a whaleboat, and a quarter share in a forty ton sailing schooner. He was not a Christian, and spoke not much more than a dozen words in English.

The typical Indian likes to smoke in silence, or chat idly with his neighbours while his women folk do the work; on the contrary, an Eskimo is never idle. If he wants to go to a neighbour's house for a chat, he takes his work with him, a net to be made or mended; a gun to be cleaned; a set of dog harness to be braided or sewn. In hunting or fishing he is equally energetic and persistent; going out for game and taking fish out of a net, when an Indian under like conditions stays at home, because it is too cold to hunt. And with it all, the Eskimo is thrifty.

When an Indian goes to a trading post he takes with him all his fur, and he invariably sells it all. If the trader does not have in stock what he wants, he will buy something else, whether he wants it or not. The trading goods carried in stock by the Hudson's Bay Company for Indians show pretty well what they want; tobacco, tea, ammunition, bright cloth, ribbons, beads, sleigh bells, canned meats and fruits, candy, chewing gum, sweet biscuits, sauces, extracts, patent medicines, even English plum pudding. I have seen an Indian trade 12 fish averaging perhaps 3 pounds each, for a pound tin of canned salmon, when he had been starving the week before, and had nothing to eat the next day.

For the Eskimo, the goods on sale are in general different; tea, tobacco, ammunition, carpenter's tools, copper kettles, and first quality woollen blankets. If the trader does not have the exact article wanted he does not get the fur. I have known Eskimo to go 250 miles from Herschel island to buy at Macpherson, tea at $2 a pound because they did not like the tea they were getting from the whalers at 50 cents a pound. Often they treasure up silver fox skins for years to buy whaleboats, or small steam launches, or tug boats. The Indians whenever they can, will buy loaded cartridges, but the Eskimo always load their own, thus saving perhaps two-thirds of the price.

Although the Eskimo buy only staple goods, the traders at Macpherson and Arctic Red river, prefer to deal with them rather than with Indians; largely for the reason that an Indian always wants more than he can pay for, and then frequently defaults payment; while an Eskimo rarely even buys to the full extent of his present catch of fur, preferring to keep a few valuable skins for a rainy day.

A striking demonstration of the qualities that must keep the Eskimo comparatively well off, so long as there are even moderate resources in his country, was afforded by their manner of trading at Macpherson in the summer of 1908. Deerskins were scarce both with the Indians and Eskimo, but the Indians sold all they could muster at $2 each to the trader, who immediately resold them to Eskimo in exchange for fox, mink and marten. Of these deerskins, the Eskimo will this year make clothes to keep them warm hunting and working.

To sum up, while the condition, in general, of most Indians in the northern Mackenzie valley is wretched, in my opinion the Eskimo of the delta live at a higher average of level of material comfort than do the white men of any city with which I am familiar.

GAME IN THE MACKENZIE DELTA.

The upper part of the Mackenzie delta, towards the mouth of the Peel, is generally covered with a fairly thick forest, consisting mainly of spruce, but towards the

ocean this thins out and the more northerly islands show only Arctic willow or no tree growth at all. Even to the ocean edge, the footprints of moose and black bear are occasionally seen, but the animals are more abundant farther up the river. They are most numerous near the middle of the delta, midway between the hunting ground of the Eskimo and that of the Indians from Fort Macpherson.

In the neighbourhood of the delta, black, silver, cross, and red foxes, as well as mink and marten are found. In some years lynxes are numerous, and rabbits, here as elsewhere, vary from year to year. The Arctic hare is not ordinarily seen west of Cape Bathurst, and the musk ox in recent years is not found west of the Anderson river. Polar bears are now scarce along the coast, their decrease being due not only to the introduction of modern and highly efficient firearms among the Eskimo, but to the occasional poisoning by whalers of whale carcasses, etc. The Eskimo too, occasionally use poison, although as this is against the law, they are somewhat restrained through fear of the Mounted Police.

Last winter our household at Tuktuyaktok, near Cape Brown, secured four white bears, and some of our neighbours secured one or more. At Baillie island the animals are more numerous. East of Cape Parry, the Eskimo say that bears are so numerous that one may occasionally see from ten to twenty at one time from the top of a high hill.

FIREARMS AMONG THE ESKIMO.

In guns, as in everything else, the Eskimo are anxious to get the best. They had no firearms until long after the Indians south of them were supplied with muzzle-loaders by the Hudson's Bay Company. But when whalers began to winter at Herschel island, the Eskimo soon secured modern American rifles, and are now so particular about their quality, that 44 calibre guns and others of low power, are practically without value among them. Some own Krag-Jorgensen, Lee-Enfield, and other similar high-power rifles, and if it were not for the greater cost of the ammunition, these guns would doubtless entirely replace the American-made rifles, for the Eskimo keenly values lightness of ammunition and high power of the rifle.

ESKIMO METHODS OF DEER HUNTING.

When a herd of deer is discovered the usual mode of procedure among the Eskimo is as follows: The news is passed around to as many men as are within reach, and careful preparations are made. Perhaps the hunters will even take time to cook or eat a good meal before starting. Then begins an attempt to surround the herd, involving many hours and sometimes the larger part of a day. Commonly they succeed in surrounding the band, and I have known cases where sixteen, twenty, or even thirty deer were killed, to the last one.

CLEANLINESS.

Much has been written about the filthiness of the Eskimo, but mostly by travellers who have seen them only from the point of view of tourists living in comparative luxury in their own houses or ships. Some of them even pride themselves on a sensitiveness that prevented their entering the 'wretched hovels' of the natives. In marked contrast is the testimony of C. F. Hall, Nansen, Hanbury, and, as far as I know, of all who have lived with the Eskimo in their houses, and hence are entitled to express an opinion based on their own experience.

One element of house cleanliness is ventilation. In an Eskimo house this is provided for according to the number of inhabitants and the abundance of fuel; and the abundance of fuel must necessarily be the determining factor in any cold country, for most people prefer inadequate ventilation to freezing to death. In the Mackenzie district there is, practically speaking, only one outlet for the indoor air, viz., a chimney in the roof; for the house is otherwise approximately air-tight, and the door will let

in cold air practically no faster than the chimney lets out the warm air. When fuel is abundant, this chimney is three or four inches in diameter for a house accommodating twenty or thirty people. But when it is remembered that the fires within doors keep the temperature between 60° F. and 85° F., while the winter temperature outside ranges from −20° F. to −55° F., it will be seen that the current of warm air rushing up through the chimney will be very rapid. In fact, on the naked hand, one feels it like a blast, and the column of steam formed in contact with the outer air rises in calm weather like a pillar of smoke above the house.

The Eskimo house is generally not evil-smelling, for the six or eight seal or whale-oil lamps burn, when properly trimmed, without odour or smoke. At meal-times a mess of gamey venison or fish may be a trifle malodorous, but not more so than certain cheese that is occasionally admitted into our own dining-room.

It is true that many an Eskimo goes from year to year without a bath; but so does many a white man, and apparently with no very serious results in either case.

FOOD.

With a few unimportant exceptions, such as berries, leaves and roots, the diet of Mackenzie River Eskimo is of fish, sea mammals, land mammals and birds—named in the order of abundance and consequent importance. Fish, in summer, is eaten preferably cooked, but occasionally raw. For winter use some of it is smoke-dried, or wind dried, but not much, since the climate is damp. Most of it, however, is put in caches on the surface of the ground and covered with logs. This becomes more or less high towards winter, depending upon whether it is put up in the spring, summer, or autumn. In winter, fresh fish only is cooked, and that not always; while the rotten fish is always eaten raw and usually frozen. Of the total amount of fish eaten, perhaps three-quarters is eaten raw. The blubber of seals and white whales (beluga) is usually put up in sealskin bags, but occasionally, if very abundant, white whale blubber is cached in the ground, like fish. Seal meat is similarly cached for winter use, and white whale meat is also cached, or else dried. The bowhead whale, which formerly was frequently killed, has now been driven out of the land waters by the American whaling ships, though an occasional carcase drifts ashore, and in early autumn is cut up in blocks and piled like cordwood for winter use.

Meat in general, except the skin of the bowhead, is eaten cooked, if the means for cooking are at hand. Bear meat I have never seen eaten raw under any circumstances. Deer, if killed in summer and not immediately needed, are ground-cached, or dragged, with the skin on, into a pond; but if killed in winter they are placed on elevated platforms near the house. Birds and eggs are usually eaten immediately after they are secured, and usually boiled. Eggs are eaten at any stage of incubation.

It may be worth recording, that after trying the Eskimo diet for several consecutive months, during a time when we had no civilized food whatever to vary it with, I fully agree with the Eskimo taste in the matter of preparing it. During some two or three months of fish diet, unvaried by meat, I found it most agreeable to eat two or more meals a day of raw fish and one of cooked. And when it is raw, I prefer, as do the Eskimo, high fish to fresh.

The foregoing outline of the Eskimo diet is more true for the past than the present, for in ordinary years they now have various articles of civilized diet, even east of the Mackenzie, where the whaler's influence is least. But during the winter of 1906-7, for the first time since 1889, there was no whaling vessel in the Beaufort sea from which supplies could be bought for use in the winter. In my case, that was a fortunate circumstance, since it threw the natives upon their own resources and into their old ways of food-getting and food-preparing. This summer (1908) no ships' goods have been secured, hence everyone is again on a fish diet, though vessels are expected to come in from the west in August.

CLOTHING.

For summer wear, the Mackenzie Eskimo now prefer cotton and woollen clothing, but formerly they wore sealskins, or any old, nearly outworn clothes left over from the previous winter. For coat and trousers, the sealskin is tanned with the hair on, but for water-proof boots, knee or high boots, the hair is removed. These boots, with legs of common seal and soles of ground seal or white whale skin, last for three or four months and are perfectly water-tight, while they weigh not one-fourth as much as rubber boots.

In winter the clothing is usually deerskin, though muskrat or other small fur is occasionally used for underwear, and bird or even fish skins will tide over a bad season. The typical suit is made up as follows: undershirt, with hood and knee-drawers of young, summer-killed deer, with the hair turned towards the body; coat with hood, and knee trousers of older, summer-killed deer, with the hair turned out. Socks of deerskin with hair inwards; boots with deerskin legs and soles of long-haired deer, the boot leg with hair outside, the sole with hair inside. Two pair of deerskin mittens, the inner with hair inside, the outer with hair outside, and either or both with gauntlets. This suit is so warm that it may be considered cold-proof, and when well made, weighs ten to twelve pounds. Eskimo garments are two and a half to four times as light, a great deal more pliable, and much warmer than European garments, no matter what their weight. Eskimo clothing has, therefore, been adopted *in toto* by Peary, Amundsen and others, even to the exclusion of woollen or silk underwear and socks.

The warmth of an Eskimo suit is clearly indicated by the procedure of the natives when caught in a blizzard away from their houses and under conditions prohibiting the building of a snow house. They then make no attempt to reach their homes, since they would probably become tired and wet with perspiration without gaining any advantage; instead they take off their mittens, place them on the ground, kneel on them, and slip their arms out of the coat and shirt sleeves, that they may fold them on their bare breast. In this way, squatting on their haunches in some elevated spot where no snowdrift will collect, they sit for one, two, or even three days, awaiting the cessation of the storm; complaining of hunger only when the weather finally clears and they can get home.

SUMMER TRAVEL.

The Mackenzie Eskimo, like most primitive races, generally confine their summer movements to the water routes, and utilize the one-man kayak and the open, capacious umiak. One essential difference in their use of these, from that of the Eskimo farther east, is that the umiak is not so strictly a woman's boat as in Greenland, where it is said to be an ineffaceable disgrace to a man, unless decrepit with age, to travel in the umiak. In the delta, however, although all the women travel in the umiaks, so do some of the men, and without dishonour.

When possible, the Mackenzie kayak is constructed of the skin of the ordinary hair seal, while the umiak is preferably of white whale, but occasionally of ground-seal skin. The umiaks are made of from five to nine or ten seal, or beluga skins, and carry one to four tons of freight. They are a fairly seaworthy boat when equipped with sealskin floats along the gunwales to act as an outrigger. They are easily paddled in smooth water, but are too light to make headway against a stiff breeze. This quality of lightness makes them easily portaged and hauled ashore. Their chief disadvantage is that they must be hauled ashore every three or four days and dried, to prevent rotting.

In summer the people travel light, leaving most of their belongings in caches, unless they intend moving to an entirely different section of the coast.

WINTER TRAVEL.

Winter travel is by means of dog sleds. The Mackenzie sled is from 3½ to 4 feet wide, with solid runners about 4 feet long and 1½" to 2" wide. These runners are commonly shod with ice, though whalebone is used if it is intended to draw them over bare spots. The ice shoeing is made by stirring dry snow and chopped moss together, then mixing in water enough to make a sort of slush. These runners glide with greater ease than those made of any metal, and need looking after only on starting each morning, providing one does not cross bare ground or glare ice.

The Mackenzie dog team, as I have seen it, varies from one to eleven dogs. They are not hitched by single traces, as by the eastern Eskimo; nor tandem, as is the Indian custom; but on short branch traces, joined to a main one that runs direct from the sled to the leading dog. This system may be said to combine most of the advantages of other systems, for it allows the dogs to pull straight, one behind the other as when hitched tandem; while it also allows almost as much individual freedom among rough ice as does the Greenland system, but without the corresponding danger of dogs going either side of a snag and forking the traces.

The Eskimo's object in winter travel is not speed, but comfort. He, therefore, takes along most of his belongings. This makes his sled heavy. A moving family in winter will not average more than 8 to 12 miles per day.

In spring and autumn, when the weather is not very cold, the Eskimo ordinarily sleep in tents, but in mid-winter they prefer snow houses. One large enough to accommodate a family can ordinarily be built by two men in an hour. When once built, it will stand a blizzard that would blow away almost any tent, and can be kept warm by one or two blubber lamps. As a matter of personal testimony, I may say that I much prefer a fairly good snow house to the most elaborately designed tent. I have never seen water freeze over night, and one can keep his foot-gear and bedding dry in a snow-house, but I think cannot do so in a tent that has no stove or fire. Peary, Hanbury, and all the white men I know of, who have tried both snow-houses and tents in the Arctic mid-winter, much prefer the snow-house.

Camping in snow-houses and travelling slowly, the Eskimo with their families keep moving during seasons which keep the ordinary explorer indoors, excepting the few who have adopted Eskimo methods and clothing.

MARRIAGE AND MARRIAGE CUSTOMS.

There are literally no ceremonies connected with marriage among the delta Eskimo. The mutual desire of the two parties to the arrangement is sufficient, though it is customary to secure the formal consent of the bride's parents. The young man makes the advances, asking first the father, then the mother, then the girl. If all parties are pleased with the marriage, the young couple usually live with the bride's parents, if she is an only daughter or the last one married, but if there are unmarried, grown sisters, the couple will live with the groom's parents if desired, or else put up their own house.

Divorce is equally simple. Either one may leave the other without an explanation to anyone. Doubtless the person thus left is often ill-pleased, but it seems to be a matter of etiquette not to show it. Out of a good many divorces, I have not seen a case where either party showed grief, or a feeling of injury.

In divorce, no blame or disgrace usually attaches to either party. I have known only one case that caused unfavourable comment, so much indeed, that the man feared for his life. The matter was this, that when his wife told him she wanted to cease living with him, the husband told her that she would have to go away without dogs as he wanted to use his team on a trip in the opposite direction to that in which she wished to go. Accordingly she struck off alone, got her feet wet, and froze her toes badly before reaching a house. People said that the husband should either have taken her where she wanted to go, or have lent her the dog team.

BURIAL CUSTOMS.

The Mackenzie River Eskimo put the body of the dead person on the ground, sometimes on hills, but more frequently on sand spits where driftwood is abundant. The body is then covered with logs, the sled on which it was hauled to the burial place is broken up by the side of the grave, and a number of articles that the dead man had used, or owned, are left beside him. A few articles of great value, such as labrets of rare stone, ordinarily pass to the descendants of the dead man. If, however, the man had owned several pairs, one or more may be buried with him. A woman's most valuable possession, her false hair, is, however, usually buried with its owner. This accounts partly for the fabulous price at which false hair is held, for the value of a good set is computed at from one to two white whale skin umiaks.

Whalers assert that very often now-a-days, an old, inferior gun is substituted for the better weapon owned by the dead man. This, however, the Eskimo deny, and I am uncertain where the truth lies. They admit that the custom is growing into disuse, and at certain recent burials no property at all was left beside the grave. In general, the Eskimo seem to have the idea that the articles left with the body are useful to the dead. Sometimes, however, these take a curious form. For instance, one man told me that as he could not bury both a blanket and a rifle with the deceased relative, he buried two blankets and no rifle. He said that the dead man could use one of the blankets as a rifle in the future life. As I met this Eskimo at a time when my command of the language was as yet very limited, I could not make out clearly whether he expected his relative to trade off one of the blankets in the future life for a rifle, or whether he thought of the blankets merely as an indefinite equivalent for the gun.

Food is often placed in the grave with the dead, and it was formerly a custom to occasionally replenish this store for two or three years after the individual's death. Only small quantities were put on the grave, however, a year's supply of food for the dead man rarely being equal to a square meal for the living. Sometimes articles placed on the grave were deliberately broken and the food occasionally burned, or otherwise handled so as to be unfit for the use of the living. From my investigation of the older graves I concluded that such articles as kayaks and sleds were almost invariably broken; while smaller things were buried in good condition. All the Eskimo agree that the labrets were not left in the man's lips, but were placed at the side of his head in the grave. Some say invariably at the right side of the head.

Eskimo from Point Barrow, and along the north coast of Alaska, told me that the only proper way to bury a man was with his head to the east, but the excavation of graves showed, as a matter of fact, no such uniformity. It was difficult, in some cases, to determine the original position of the body, because the graves had been disturbed by dogs, wolves, or polar bears. In fact, the body is ordinarily devoured within a day or a week of its interment. It is said that if the dead had been recognized by the community as a man of importance, more pains were taken to preserve his body, and the Eskimo frequently remark, on seeing a carefully covered grave, 'a good man must be buried there.'

DISTRIBUTION BRANCH.

During the twelve months from December 1, 1907, there were distributed 112,816 publications, comprising reports, parts of reports, bulletins and maps; of these 76,544 were distributed in Canada, 22,370 in the United States, 10,468 in England, and 3,434 in foreign countries.

The sale of publications during the year, including maps and reports, amounted to $354.

The number of letters received in connexion with the distribution of maps and reports was 3,928, besides 12,000 acknowledgments from exchanges and individuals.

The number of letters sent out was 3,502.

THE LIBRARY.

Publications to the number of 3,275 were received as donations or exchange, including besides periodicals, maps, reports and publications of foreign Geological Surveys, memoirs, transactions and proceedings of societies of both Europe and America. The number of volumes purchased was 138, while 230 volumes were bound.

The number of letters sent out relating to library work was 289, besides 656 acknowledgments for publications received.

There are now in the library 16,650 volumes, besides a large number of pamphlets on various subjects. The library is open from 10 a.m. to 4 p.m. for persons wishing to obtain information in regard to scientific matters.

PUBLICATIONS.

The following reports and catalogues have been published since January 1, 1908:—

No.

947. Summary Report, 1905. *French translation.*

959. Summary Report, 1906. *French translation.*

961. Reprint Part H., Vol. XIV., Report on the Nickel Deposits of Sudbury, Ont. By Dr. A. E. Barlow. Published November 10, 1908.

962. Reprint, Part I., Vol. X., Report on the Geology and Natural Resources of the area included by the Nipissing and Timiskaming map sheets. By Dr. A. E. Barlow. Published November 10, 1908.

965. Report on the Nickel Deposits of Sudbury, Ont. By Dr. A. E. Barlow. *French translation.* Published August 13, 1908.

968. Report on the Moose Mountain area. By D. D. Cairnes. Published January 1, 1908.

970. Report on Niagara Falls. By Dr. J. W. Spencer. Published January 15, 1908.

972. Descriptive Catalogue of Minerals and Rocks. By R. A. A. Johnston and G. A. Young. Published February 28, 1908.

974. Report on the Copper Deposits of the Eastern Townships of Quebec. By J. A. Dresser. English edition. Published April 7, 1908.

975. Report on the Copper Deposits of the Eastern Townships of Quebec. By J. A. Dresser. *French translation.* Published April 7, 1908.

982. Report on the Conrad district, Yukon. By D. D. Cairnes. Published July 28, 1908.

983. Report on the Geology and Mineral Resources of New Brunswick. By R. W. Ells. Published December 10, 1908.

984. Report on the Mineral Pigments of Canada. By C. W. Willimott. *French translation.* Published February 15, 1908.

986. Report on the Similkameen district. By C. Camsell. Published September 20, 1908.

988. Report on the Telkwa valley, B.C. By W. W. Leach. Published May 22, 1908.

992. Report on a portion of North-western Ontario traversed by the National Transcontinental railway between Lake Nipigon and Sturgeon lake. By W. H. Collins. Published April 30, 1908.

996. Report on the Nanaimo and New Westminster districts. By O. E. LeRoy. Published June 19, 1908.

998. Report on the Pembroke sheet. By R. W. Ells. *French translation.* Published January 1, 1908.

1000. General Index. By F. J. Nicolas. Published May 1, 1908.

1013. Report on the Tertiary Fossil plants of British Columbia. By Prof. D. P. Penhallow. Published June 8, 1908.

1016. Report on gold values in the Klondike High Level Gravels. By R. G. McConnell. *French translation.*

1017. Summary Report for 1907. Published January 13, 1908. Second Edition published December 26, 1908.

1021. Report on Explorations in Nova Scotia (Summary Report.) By Hugh Fletcher. Published July 3, 1908.

1028. Report on a Recent Discovery of Gold near Lake Megantic, Que. By J. A. Dresser. English Edition. Published July 17, 1908.

1030. Report on the Landslide at Notre-Dame de la Salette, Lièvre river, Quebec. By R. W. Ells. English Edition. Published July 17, 1908.

1031. Report on the Landslide at Notre-Dame de la Salette. Lièvre river, Quebec. By R. W. Ells. *French translation.* Published August 1, 1908.

1032. Report on a Recent Discovery of Gold near Lake Megantic, Que. By J. A. Dresser. *French translation.* Published August 1, 1908.

SPECIAL REPRINTS.

Report on the new Crocodilian Genus and Species from the Judith River Formation of Alberta. By L. M. Lambe. Trans. Royal Society Canada, Vol. I., Section 4.

SESSIONAL PAPER No. 26

Report on a collection of Fossil Woods from the Cretaceous of Alberta. By D. P. Penhallow.

Report of Bibliography of Canadian Zoology for 1907, exclusive of Entomology. Trans. Royal Society of Canada, Vol. 2, Section 4.

FRENCH TRANSLATION SECTION.

(M. Sauvalle.)

The following work has been executed during the year. Translating and editing the following reports:—

No.

829. Annual Report (New Series) Vol. XII, 1899.

1031. Report on the Landslide at Notre-Dame de la Salette. By R. W. Ells.

1032. Report on a Recent Discovery of Gold near Lake Megantic, Que. By John A. Dresser.

1034. Report on Mineral Resources of New Brunswick. By R. W. Ells.

1038. Report on a portion of North-western Ontario traversed by the National Transcontinental railway. By W. H. Collins.

1052. Report on Wells of Island of Montreal. By F. D. Adams and O. E. LeRoy.

1069. Report on an Exploration of the East Coast of Hudson bay. By A. P. Low.

1070. Report on the Geology of the Basin of Nottaway river. By R. Bell.

MAPPING AND ENGRAVING.

(C. Omer Senécal.)

The following is a report of the work carried out under my supervision since December 1, 1907:—

STAFF.

The number of assistants in the mapping division has remained stationary during the past year, while the work is ever on the increase. Demands for maps of newly opened mining or prospecting areas, requiring to be promptly issued to the public, are met only with extreme difficulty and at the cost of other important work which is thereby delayed for lack of sufficient assistance and accommodation in the office; while the routine work has to be carried out.

Photographic appliances were a few years ago installed in the office for mapping purposes, but have not, so far, been fully taken advantage of, for want of a qualified assistant to operate them.

The staff of this division of the Geological Survey is at present composed of the Geographer and Chief Draughtsman, eight draughtsmen, and a typist who is also keeper of records.. These assistants have been painstaking in their work, and have generally rendered excellent service. In two cases, however, the help rendered was of little value; owing to the meagre and irregular attendance at the office, due to sick leave, or otherwise.

To cope with the increasing work which devolves on this office, especially during the autumn and winter months, and in view of the fact that, revised editions of a large number of indispensable geological maps, the stock of which is now exhausted, demand the earliest attention, two or three first-class map compilers and letterers, at least, and a photographer accustomed to line work, are required.

ROUTINE OFFICE WORK.

The routine work of this office, which includes the plotting of geographical projections; computation of astronomical observations; correction and revision of map proofs; making photographic negatives and prints; tracings of all descriptions for office and field use; supplying information to the librarian and others; writing memoranda referring to the reproduction of maps, and on other subjects relating to map-work, was distributed among the staff, and attended to.

ASSIGNMENT OF WORK.

The principal work of the office was assigned as follows:—

Mr. L. N. Richard compiled a large map of the upper Lake Timiskaming district extending in Ontario and Quebec, on the scale of 1 mile to 1 inch, and partly traced the same for engraving. The colour copies and revision of the proofs of the new edition of the Lake Nipissing and Timiskaming sheets were also entrusted to him. Mr. Richard is at present engaged on the examination and testing of field instruments, and preparing lists of repairs.

Mr. A. Dickison traced for engraving and prepared the colour copies of the several maps of the Rossland mining district, B.C., which are now in the engravers' hands. He also drew a number of illustrations for a report on that district. On

August 14, Mr. Dickison received instructions to proceed to Phœnix, B.C., and there to report himself to Mr. W. H. Boyd, and assist him in his mapping of this mining centre. He returned on October 21, and resumed the compilation of a map of the upper Winisk River region, which he had begun last year.

Mr. H. Lefebvre compiled a map of part of north-western Ontario, showing the country traversed by the National Transcontinental railway between Lac Seul and Lake of the Woods, on the scale of 4 miles to 1 inch, and traced and lettered the same for engraving. He compiled additional surveys on the preliminary map of Telkwa River valley, B.C., and constructed several map projections.

Mr. O. E. Prud'homme drew a series of nine maps of portions of Whitehorse Copper Belt, Yukon Territory, on various scales, for engraving and photolithographing; prepared the colour work on sheet 2 of the map of Lièvre River valley, Quebec, and a map of the vicinity of Lake Megantic, Quebec, for printing. He also made sundry reductions of surveys for maps under construction, zinc cut illustrations, and drawings of a few fossils for reports.

Mr. G. Aitken drew for photolithography, a map of eastern Ontario, to illustrate a report on raised ancient shore-lines (publication deferred). He traced for engraving, and prepared colour copy of a preliminary map of lower Lake Laberge and vicinity, Yukon; traced for engraving, sheets Nos. 11 and 17, north-west Ontario (Lake Nipigon); and compiled a map of the Chromite and Asbestos mining areas near Thetford mines, Quebec. The engraver's tracing of this sheet is nearly finished.

Mr. R. B. Yorston traced for engraving and prepared colour copies of several Nova Scotia serial geological sheets, namely: Halifax sheet No. 68; Waverley sheet, No. 67; Aspotogan sheet, No. 70; St. Margaret Bay sheet, No. 71, and Windsor sheet, No. 73. He assisted Mr. E. R. Faribault generally on Nova Scotia mapping. He is, at present, preparing a map of the routes between Lac Seul and Cat lake, North West Territories (Keewatin).

Mr. F. O'Farrell was again attached to this division on July 6. He has in hand a general index map of the Dominion, showing all the maps published by the Geological Survey to date.

Mr. J. F. E. Johnston is making reductions of railway plans for intended maps of British Columbia. He traced a number of boundary plans for records, made lists of repairs of instruments, etc.

Mr. J. J. McGee, Jr., kept the record of the stock of plans and maps belonging to the Geological Survey; attended to typewriting and to general office work. A catalogue of a large number of railway plans, hitherto not listed, is being prepared by him.

MAP WORK BY FIELD OFFICERS.

The following maps are also under construction by field officers from their respective surveys:—

Exploration of Pelly, Ross and Gravel rivers; Yukon, and North West Territories, scale 8 miles to 1 inch, by Mr. J. Keele.

Whitehorse Copper Belt, Yukon Territory, general map, scale 40 chains to 1 inch, and central portion of same, scale 400 feet to 1 inch, by Mr. F. H. MacLaren.

Coal areas between Tantalus and Whitehorse, Yukon Territory, scale 1 mile to 1 inch, by Mr. H. Matheson.

Big Horn coal basin, Alberta, scale 1 mile to 1 inch, by Mr. G. S. Malloch.

Canoe route between The Pas and Split lake, Saskatchewan and North West Territories, scale 8 miles to 1 inch, by Mr. Wm. McInnes.

Tract of land in Abitibi district, Quebec, traversed by the National Transcontinental railway, scale 4 miles to 1 inch, by Mr. W. J. Wilson.

Lake Simcoe topographical and geological sheet, scale 2 miles to 1 inch, by Mr. W. A. Johnston.

City of St. John and vicinity, N.B., by Mr. J. A. Robert.

Bathurst and vicinity, N.B., by Mr. G. A. Young.

Albert county, etc., N.B., by Mr. S. Ells.

Final revision of Gaspereau sheet, No. 85, New Ross sheet, No. 86, and Mahone Bay sheet, No. 88, Nova Scotia series, by Mr. E. R. Faribault.

The eastern sheet of the Dominion geological map, on the scale of 50 miles to 1 inch, and the Ontario serial sheets, Nos. 111 and 112, Kingston district, scale 4 miles to 1 inch, are in the hands of the geographer of the Department of the Interior.

INSTRUMENTS.

A large number of new instruments were purchased and, where necessary, old instruments were, as usual, overhauled and repaired.

GEOGRAPHIC BOARD.

The meetings of the Geographic Board of Canada were regularly attended, and place names given on our maps submitted for approval. Lists of approved names are published in the Annual Report of the Board, and from time to time, in the *Canada Gazette*.

CORRESPONDENCE.

Some 380 letters, memoranda, specification sheets, etc., relating to the work of this office were sent out; while 450 were received.

MAP EDITIONS PUBLISHED.

There are, at present, seventeen maps in the hands of the King's Printer, several of which will be issued shortly. A list of the editions received during the period covered by this report, is appended herewith.

Catalogue Number.	Title.	Approximate area in sq. miles.
1042	Dominion of Canada—Minerals—Scale 100 miles to 1 inch.	
1011	Yukon Territory—Auriferous gravels on Bonanza and Hunker creeks, Klondike Mining district—Scale 40 chains to 1 inch.	
991	Yukon Territory—Sketch geological map of vicinity of Tantalus and Five Fingers coal mines—Scale 1 mile to 1 inch. . .	60
990	Yukon Territory—Geological and topographical map of portion of Conrad and Whitehorse Mining districts—Scale 2 miles to 1 inch.	400
1033	Yukon Territory—Preliminary geological and topographical map of Lower Lake Laberge and vicinity—Scale 1 mile to 1 inch.	240
1001	British Columbia—Special map of Rossland, topographical sheet —Scale 400 feet to 1 inch.	1·9
1003	British Columbia—Rossland Mining camp, topographical sheet— Scale 1,200 feet to 1 inch.	7·2
997	British Columbia—Geological map of part of Nanaimo and New Westminster Mining divisions—Scale 4 miles to 1 inch.	500
989	British Columbia—Sketch geological map of Telkwa river and vicinity, Omineca Mining district—Scale 2 miles to 1 inch.	400

987	British Columbia—Geological and topographical map of Princeton and Copper Mountain Mining camp, Yale district—Scale 40 chains to 1 inch..	110
791	British Columbia—West Kootenay sheet. Economic minerals and glacial striae, second edition—Scale 4 miles to 1 inch.	6,000
1009	North West Territories—Geological map of canoe route between Split Lake and Fort Churchill—Scale 16 miles to 1 inch.	
1010	Alberta, Saskatchewan and Manitoba—Coal areas—Scale 35 miles to 1 inch.	
993	North-western Ontario—Geological map of country traversed by the National Transcontinental railway, between Lake Nipigon and Sturgeon lake—Scale 4 miles to 1 inch..	1,300
599	Ontario and Quebec—Lake Timiskaming geological sheet, No. 138, second edition, revised to date—Scale 4 miles to 1 inch.	3,456
606	Ontario and Quebec—Lake Nipissing geological sheet, No. 131, second edition, revised to date—Scale 4 miles to 1 inch.. ..	3,456
1029	Quebec—Geological map of Lake Megantic and vicinity, Compton county—Scale 2 miles to 1 inch..	200
1005	Nova Scotia—Elmsdale geological sheet, No. 66, Halifax and Lunenburg counties—Scale 1 mile to 1 inch..	216
1036	Nova Scotia—St. Margaret Bay geological sheet, No. 71, Halifax and Lunenburg counties—Scale 1 mile to 1 inch..	180
1043	Nova Scotia—Aspotogan geological sheet, No. 70, Halifax and Lunenburg counties—Scale 1 mile to 1 inch..	70
1012	Nova Scotia—Plan and sections of Brookfield Gold district—Scale 250 feet to 1 inch.	

ACCOUNTANT'S STATEMENT.

The staff of the Geological Survey Branch at present employed numbers sixty-six.

During the year the following changes have taken place in the staff:—

Death—

Dr. Robert Chalmers.

Superannuations—

Dr. Robert Bell.
Mr. C. W. Willimott.

Appointments—

Mr. R. W. Brock, Director.
Mr. O. E. LeRoy, a technical officer.
Mr. Alex. Young, a junior second-class clerk.

Promotions—

Mr. W. H. Boyd, a technical officer, vice Dr. Robt. Chalmers, deceased.

The funds available for the work and expenditure of the Geological Survey Branch for the fiscal year ended March 31, 1908, were:—

Details—	Grant.	Expenditure.
Civil list appropriation..	$ 75,525 00	
General appropriations..	152,050 00	
Civil list salaries..	.....	$ 70,558 01
Explorations and surveys..	.....	46,733 62
Experimental borings for gas, oil, etc..	.....	6,730 45
Experimental coal tests..	.....	17,455 93
Wages of temporary employes..	.....	39,020 02
Printing, engraving and lithographing..	.....	23,834 03
Books and instruments..	.....	2,965 04
Chemicals and apparatus..	.....	570 81
Specimens for Museum..	.....	3,552 81
Stationery, mapping materials, etc..	.....	2,834 49
Ottawa Exhibition, 1907..	.....	110 00
Incidental and other expenses..	.....	3,578 54
Advanced to field explorers in 1907-8, to be accounted for 1908-9..	.....	1,067 35
Unexpended balance civil list appropriation..	.....	4,966 99
Unexpended balances general appropriations..	.....	3,596 91
	$227,575 00	$227,575 00

JOHN MARSHALL,
Accountant, Dept. of Mines.

GENERAL CONCLUSION.

In concluding this annual Summary Report it may be restated that, the publication of the *English* editions of Geological Survey reports in the form of annual volumes was discontinued with the issue of Vol. XVI., and the *French* with Vol. XII. In place thereof the individual reports are now published separately in pamphlet form and thus get into the hands of the interested public much earlier than was possible under the annual volume system. Moreover, the fact may be recalled that, on pages 204, 205, 208 and 209, are lists of the reports and maps issued during the past year; and it is an opportune time to announce that, a revised Catalogue of Geological Survey reports and maps—1843 to 1909—is now in the press. Applications for the publications of the Geological Survey—addressed to the Director—will be promptly attended to.

I have the honour to be, Sir,
Your obedient servant,

(Signed) R. W. BROCK,
Director.

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