GEOLOGICAL SURVEY OF CANADA
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SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1901

BY

THE DIRECTOR

OTTAWA
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OTTAWA, January 1, 1902.

The Honourable CLIFFORD SIFTON, M.P.,
Minister of the Interior.

SIR,—Having requested me to take charge of the Geological Survey Department immediately after the lamented death of Dr. G. M. Dawson, which took place on March 2, 1901, it now becomes my duty under the Act governing the department, to report to you on al matters connected with its administration during the calendar year just closed. I have, accordingly, the honour to submit the following Summary Report on the affairs of the Survey for the above period. This report, besides being what may be termed a short business statement of the work performed by the Survey during the year, contains, in the various subordinate reports, of which it is partly composed, an epitome of the principal scientific results which have been achieved. It embraces the statements of the various officers who were entrusted with the field operations, and also of the gentlemen engaged in carrying on and supervising the several divisions of the indoor work. Nature of report.

Care has been taken to give prominence to any discoveries which may have an economic bearing. This is done in response to the general desire for early information on all points which may be of immediate value to the public, although the scientific discoveries may ultimately prove of greater practical importance. For the above reason some of the accompanying reports on field-work are fuller than usual, although the work they represent may not have been any greater than where the reports are shorter. In the latter case the results will be given at greater length in the detailed annual reports, which are to follow as soon as the field notes can be worked up, and the maps or other illustrations can be prepared. Of such reports, volume XI., containing nine individual sections of this character, with maps, etc., has been pub- Economics.

lished (in cloth covers) during the past summer. Some of these constituent parts had been already issued as "separates."

Published in 1901.

The following are the publications of the department in 1901 :—

Summary report of the Geological Survey for 1900, pp. 203, part A., vol. XIII.

Report on the Topography and Geology of Great Bear Lake and of a chain of lakes and streams, thence to Great Slave Lake, by J. Mackintosh Bell. Part C., vol. XII., pp. 36.

Report on the Atlin Mining District, by T. C. Gwillim. Part B., vol. XII.

Report on the Iron Ore Deposits along the Kingston and Pembroke Railway in Eastern Ontario, by E. D. Ingall. Part I., vol. XII., pp. 91.

Report of the section of Chemistry and Mineralogy, by G. C. Hoffmann. Part R., vol. XII., pp. 64.

Section of Mineral Statistics and Mines, Annual Report for 1899, by E. D. Ingall. Part S., vol. XII., pp. 144.

Report on the Geology of Argenteuil, Ottawa and part of Pontiac Counties, Province of Quebec and of portions of Carleton, Russell and Prescott Counties, Province of Ontario, by R. W. Ells. Part J., vol. XII., pp. 138.

Report on the Geology and Natural Resources of the area included in the map of the City of Ottawa and vicinity, by R. W. Ells. Part G., vol. XII., pp. 77.

Annual Report, vol. XI., new series, 1898, English edition, pp. 853.

Annual Report (new series), vol. X., French edition, pp. 1,117.

Special Reports published in 1901.

Altitudes in the Dominion of Canada, by James White, pp. 266.

Catalogue of the Marine Invertebrata of Eastern Canada, by J. F. Whiteaves, pp. 271.

The maps, sections, profiles, diagrams, etc., published by the Survey during the year are enumerated in the accompanying report by the geographer and chief draftsman of the Department.

Field Work.

The great feature of the operations of the department for the year is, of course, the amount of field-work done, as most of the other proceedings of the Survey depend upon this. During the past summer 31 parties were out, as against 13 employed the previous season, and the amount of work accomplished is believed to have far exceeded that of any previous year in the history of the department. The average number of field-parties for the last ten years has been 14 or 15. Besides sending out all the men qualified for field-work belonging to the regular staff, a sort of contract system was adopted, by which the temporary services were secured of a number of competent geologists, principally college professors, who could only devote the summer season to this work. A lump sum was paid for the field-work, together with all maps and reports thereon. While this plan happened to suit these gentlemen, it was also a very economical and advantageous one for the department, since a large amount of field-work was secured at much less cost than by employing officers for the entire year. Under this system, the gentlemen so employed in the field agreed to plot their work and write their reports at their own homes, thus relieving, without cost for rent, heating, &c., our congested offices at headquarters. They send in their map-work from time to time at different stages in its progress for inspection by the Geographer of the Department.

31 parties in field.

Contracts.

Advantages.

All the gentlemen who were employed in field-work have given in reports on their labours, and statements covering the year's operations have also been furnished by the Chemist and Mineralogist, the Mining Engineer, the Geographer, the Palæontologist and Zoologist (and his two assistants), the Botanist and Naturalist (and his assistant), the (Honorary) Entomologist and the Librarian.

In former years the Summary Reports of most of the officers of the department were run together under the name of the Director, but in the present volume a distinct heading as to subject is given to the report of each member of the staff and it is published under his own name. In this way the reader may more readily find what he is looking for, and each writer will be more likely to receive the credit due him for his own work.

Individual reports.

As all the more important points in connection with the various operations of the Survey during the year 1901 are set forth in the individual reports, which explain themselves, it will be unnecessary for me to give more than the following convenient summary of the field-work accomplished, the order being from north-west to south-east.

Field officers and their work.

Field officers and their work—*Cont.*

Mr. R. G. McConnell, assisted by Mr. Joseph Keele, worked in the Yukon district. Mr. McConnell's investigations were connected with the mode of occurrence of gold, both alluvial and in veins, and the investigation of new districts as well as those which he had visited in previous years. Mr. Keele was engaged during part of the time on an investigation of the copper deposits of the White Horse district, which were also visited by Mr. McConnell.

Mr. R. W. Brock continued his investigations in British Columbia, in the Boundary Creek district, in West Kootenay, particularly in the neighbourhood of Greenwood and on the north fork of the Kettle river. In addition to tracing out the geographical distribution of the formations, he paid particular attention to the nature of the rocks themselves and to their relations to the ore deposits, and he has written a pretty full report on these subjects.

Dr. Reginald Daly, formerly Instructor in Geographic Geology in Harvard University, became connected with the Survey in May, 1901, and during the past season was employed on the western part of the International Boundary, from the Pacific ocean eastward into the first range of mountains.

Mr. J. M. Macoun acted as Botanist and Zoologist to the Canadian Commission in connection with marking the same boundary.

Mr. W. W. Leach, assisted by Mr. T. Denis, of the Survey staff, was employed in the Crow's Nest Pass coal-fields, in continuation of the work heretofore performed by Mr. James McEvoy, who has left the Service and become connected with a coal mining company operating in the Crow's Nest Pass region. The result of the investigations of Mr. Leach and Mr. McEvoy is to show that there is an enormous aggregate thickness of coal in the main basin in the neighbourhood of Fernie, divided amongst a great number of seams of convenient thickness for working. He also investigated the southern part of the Green Hills coal-fields, lying about thirty miles north of the main field. Here also there is a vast amount of workable coal, which, like that of the main field, is of excellent quality.

Mr. Lawrence Lambe, one of the assistant palæontologists of the Survey, was engaged with a party collecting fossils on the Red Deer river, to the north of Medicine Hat. He brought home a fine collection of the remains of Upper Cretaceous reptiles, and since his return has described two species of tortoises, these descriptions, with illustrations, being included in his report.

Field officers and their work—*Cont.*

Mr. William McInnes continued his surveys between Lakes Superior and Manitoba, in which region he has now mapped out all the more important Huronian belts and described the characters and structure of the rocks which they comprise.

Mr. D. B. Dowling, assisted by Mr. W. H. Boyd, of the Survey, was sent to the country lying to the south-west of Cape Henrietta Maria, on the western side of Hudson Bay. The limits of the different formations within this district had never before been mapped out. The great region lying on this side of the bay is of a generally low and level nature, but behind Cape Henrietta Maria a hilly country was known to exist. On the older geological maps this was represented as Laurentian, but I had predicted that it would more likely turn out to be of Lower Cambrian age and to consist of rocks like those of the Manitonnuck formation on the east side of Hudson bay, which is equivalent to the Animikie of Lake Superior. This prediction was fully confirmed by Mr. Dowling's investigations. The party surveyed the west coast of James bay from Moose Factory north to the above mentioned cape, and they also made an instrumental traverse of the Equan river and a track-survey thence northward by way of Sutton Mill lake to the main bay.

Dr. Alfred W. G. Wilson made a detailed geological survey of the country lying immediately west of Nipigon river and lake, at the same time mapping out all the geographical features which had not been laid down by myself when surveying the lake in 1869.

Dr. W. A. Parks, assistant professor of geology in the University of Toronto, was employed during the summer vacation in making a topographical and geological survey in the country lying to the eastward of Nipigon lake and river. It is expected that the work of these two gentlemen when combined with my own in one sheet, will give a very accurate representation of both the geology and topography of this whole region.

Mr. W. J. Wilson, of the regular staff, assisted by Mr. Thomas Davies, was engaged in defining more accurately the boundaries between the Laurentian and Huronian rocks in the region lying around and to the westward of Abitibi lake and river. His work is shown upon the accompanying preliminary map.

Mr. Frank Johnson did similar work in the country to the east and south-east of the same lake, and his results are also indicated on this map. In both cases topographical surveys were made simultaneously with the geological examinations, and a complete geological map of the whole of the Abitibi country is now being constructed.

Field officers and their work—*Cont.*

The writer spent part of the summer and autumn in geological researches from Kippewa lake to Grand lake and in the region to the northward of the latter, in continuation of surveys and explorations which he had made in that district in previous years. These researches showed the existence of several alternating belts of Huronian and gneissic or granitic rocks.

Dr. Alfred E. Barlow was engaged in the Sudbury nickel and copper district in tracing in greater detail some of the rock-formations in the same area which he had assisted me to investigate in 1887-90 and which are represented on the geological map, published with my report on the district in 1890. One of Dr. Barlow's principal objects was to ascertain whether or not the relative richness in nickel of the pyrrhotite ores was in any way related to the composition or other characters of the different eruptive country-rocks in which they occur.

Prof. Frank D. Adams continued his investigations in the Haliburton district, lying to the north-east of Toronto, where he and Dr. Barlow have now completed a geological survey of a large area of highly interesting rocks belonging mostly to the Upper Laurentian system.

Mr. L. N. Richard was in the field a portion of the season, making some topographical surveys in the western part of the area covered by the Bancroft map, which were required by Dr. Adams in order to enable him to lay down accurately his geological lines in that part of the sheet.

Prof. John Macoun, botanist and naturalist to the Geological Survey, while pursuing investigations in his own Division around the north shore of Lake Erie and the east shore of Lake Huron, also made additions to our knowledge of the surface geology of these regions. He made a special investigation as to the fruit-growing capabilities of the districts examined.

Dr. Robert Chalmers carried out during the summer an extensive reconnaissance survey of the superficial deposits of the interlake peninsula of Ontario, together with some investigations into the results of boring for petroleum, gas, salt and water within the same region. Previous to Dr. Chalmers' work the superficial geology of this region had been more or less investigated for the Survey by myself in the early sixties and later by Dr. J. W. Spencer, Mr. F. B. Taylor, Prof. Gilbert, and others, as amateurs.*

* Dr. Chalmers' investigations included the country around London, Ontario. After his return in the autumn he was requested by the city engineer and water commissioners of that city to return and give them the benefit of his opinion as to the best means of securing a large and reliable supply of good water. He acceded to this invitation and his advice will, no doubt, prove of value.

Field officers and their work—*Cont.*

Dr. Henry M. Ami was instructed to perform in the province of Quebec, westward of the city of the same name, and in part of the Ottawa valley, work similar to that assigned to Dr. Chalmers in Ontario.

Mr. E. D. Ingall, mining engineer to the Survey, in addition to his usual duties in connection with mines and mineral statistics, completed his report on the iron ores of Eastern Ontario and Western Quebec, and it has lately been printed for the department. He also visited some of the iron mines in these districts.

Dr. R. W. Ells was again engaged in a geological survey of the district around Kingston and thence east and west, and has collected sufficient data to map out the boundaries of the various palæozoic formations in that part of the country.

Principal J. A. Dresser, of St. Francis College, Richmond, P.Q., was engaged during his vacation in making a petrographic study of Brome mountain, east of Montreal. In previous summers Principal Dresser had made similar studies of some of the other isolated intrusive masses in the province of Quebec, and these, together with the studies of Mr. LeRoy and Professors Harrington and Adams, complete our knowledge of the lithological character of all the isolated mountains in the remarkable chain extending from Rigaud on the west to Brome on the east.

Prof. A. Osann, of Mülhausen, Germany, has completed a highly interesting report on his petrographic studies, both in the field and laboratory, in regard to a variety of crystalline rocks occurring east, west and north of Ottawa city. This report, which is well illustrated, is now in press.

Prof. Laflamme, of Laval University, carried out a further geological examination of the Island of Anticosti, in the mouth of the St. Lawrence, on behalf of the Geological Survey. In doing this he has added considerably to our general and geological knowledge of this large island, and has brought home a collection of the fine fossils which occur there in the Middle Silurian rocks.

Prof. L. W. Bailey, of the University of New Brunswick, made further researches, on behalf of the Survey, into the geology of southern New Brunswick, and also did some work on the Carboniferous of the northern part of the province.

Prof. H. S. Poole, of Dalhousie University, Halifax, was requested to investigate the whole coal problem in New Brunswick, with a special view to determining whether or not workable coal seams might

Field officers and their work—*Cont.*

be found by boring in any part of the wide distribution of the Carboniferous rocks in the north-eastern part of the province. In performing this work Mr. Poole was assisted for a part of the time by Dr. L. W. Bailey.

Mr. Lawrence W. Watson, of Charlottetown, P.E.I., undertook certain scientific researches in the Province of Prince Edward Island, in which but little official geological work had heretofore been done. The results of Mr. Watson's investigations promise to lead to interesting results in some of the lines he took up.

Dr. George F. Matthew continued field-work in connection with his palæontological studies in Cape Breton. He is preparing a general report (which will be illustrated) as to the palæontological results of several years work in the lower provinces.

Mr. E. R. Faribault, who has made geological surveys of most of the gold mining districts in Nova Scotia, continued his investigations in this direction during the whole season. Mr. Faribault has now been enabled to demonstrate the true history and origin of the gold-bearing veins of these districts.

Mr. C. O. Senécal was engaged part of the season in Nova Scotia in running base lines with a view to connecting the gold district plans prepared by Mr. Faribault, and also to securing accuracy of position as to certain geological work heretofore done by the Survey in Nova Scotia.

Mr. Hugh Fletcher continued the work in Nova Scotia in which he has been engaged during the last thirty years. He has now nearly completed his geological survey of the coal-fields and was more particularly occupied this summer in Cumberland County. Mr. Fletcher has finished ten map-sheets, showing details of the geology, especially in the north-eastern half of Nova Scotia, as the result of his labours during the latter part of the above period. These have been engraved and it is expected they will be published during the present winter.

Mr. C. W. Willimott was in the field all summer, engaged in collecting supplies of minerals and rocks to be used in meeting the demand from educational institutions for specimens for illustration in teaching mineralogy and geology. The collections of good specimens which are sent by the Survey, under certain conditions, to universities, collegiate institutes, academies and schools, all over the Dominion, constitute a very important adjunct in the teaching of mineralogy. Mr. Willimott, who has had much experience in collecting and knows the best localities to go to for the minerals required, worked in the provinces of Ontario, Quebec, New Brunswick and Nova Scotia. He sent in a large supply

of good material for the above purpose and also many fine specimens suitable for exhibition in our own museum. The results of his labours are given more fully in Dr. Hoffmann's report. We are indebted to several managers and owners of mines, quarries, &c., for sending us generous quantities of material, thus saving Mr. Willimott the necessity of going himself for it. Field officers and their work—*Cont.*

Mr. R. L. Broadbent made some trips to the field for the purpose of obtaining mineral specimens required for the museum as well as for the educational collections. His work is also referred to in Dr. Hoffmann's report.

We are indebted to Mr. Henry O'Sullivan, P.L.S., of Quebec for tracings of his surveys on the southern and eastern shores of James bay; and we expect to receive a good deal of interesting geographical and geological information from several persons not connected with the department who have been travelling in some of the northern parts of the Dominion. Some of the former members of the staff have also kindly promised to contribute their geological observations over wide areas which will always help to fill in the geological map. Among these are Mr. J. B. Tyrrell of Dawson, Mr. A. P. Low and Mr. J. Mackintosh Bell. Outside aid.

Mr. A. P. Low resigned from the Survey early in 1901 in order to accept a position offered him by a syndicate of United States capitalists. He proceeded to the eastern coast of the Hudson bay, in order, amongst other things, to locate mining claims on the extensive manganiferous iron deposits which were discovered by me on the Nastapoka islands, in that region, in 1877 and described in my report of the same year. Before leaving, Mr. Low promised to try to send to the Survey reports and maps showing the geological information which he might incidentally acquire in connection with his present work. Mr. A. P. Low.

Mr. J. Mackintosh Bell, who had accompanied me, as assistant, to Great Slave lake in 1899 remained at that lake during the following winter in order to proceed on an exploration of Great Bear lake and the surrounding country the next summer. Returning in the end of 1900, he completed a map and report of his work for the Survey, after which he accepted a position as explorer and geologist, offered by Mr. F. H. Clergue of Sault Ste. Marie. He worked, aided by two assistants whom he detached separately from his own party, between Lake Superior and the east side of James bay. It is expected that Mr. Clergue will ultimately give the Survey the benefit of Mr. Bell's purely geological results in the above region. Mr. J. M. Bell.

Primary object of the Survey.

The primary object for which the Geological Survey was instituted and for which it is being carried on is to aid in the development of the mineral resources of Canada, and the constant aim of those engaged in its work is to carry out this object in the best possible way and by methods approved by intelligent men who have a knowledge of how the end in view can be best attained. This is not by an indiscriminate search for individual "mines" without regard to the nature of the rocks, but by scientific and systematic methods based on knowledge and experience gathered by educated men all over the world.

Distribution of formations.

Among the first things which a geological survey requires to do, is to trace out the geographical distribution of the various rock formations, some of which carry economic minerals, while others do not. It is important to point out where such minerals are not to be found as well as where they may be looked for with success. In the case of metals and their ores, the conditions and modes of occurrence are studied by our field geologists, so that the efforts of the prospector may be properly directed and his attention confined to the most promising parts. A study of the conditions of occurrence of any ore which may be found in a particular formation will enable us to judge intelligently as to the probability of the discovery of such ore in workable quantity or otherwise.

Non-metallic minerals.

In the case of economic minerals of a non-metallic character, such as coal, petroleum, salt, fire-clay, etc., a knowledge of the structure, composition, geological age and other matters in regard to a rock formation may enable the geologist to pronounce upon the probable occurrence of such minerals, their depth from the surface at any given point, or as to any other circumstance in connection with them, with an accuracy which would be impossible to a person who had not this geological knowledge. The information obtained by the joint labours of large numbers of geologists during a long period and in all parts of the world, has been brought together by a free interchange of knowledge in a scientific spirit. It has become the common property of all and may be utilized by anyone who has been trained to understand such subjects. The above two examples of the utility of a geological survey are given, out of many that might be cited. But surely in this enlightened age, it should not be necessary to defend the valne of scientific knowledge and experience in connection with such investigations as are entrusted to the Geological Survey. I wish, however, to call attention to the eminently practical character of all the branches of work carried on by the department.

Practical character of the Survey's work.

As the nature of the various operations of the Survey above referred to, seems to be imperfectly understood by many, a few words of expla-

nation may not be out of place. These operations may be divided into field and home work. The former consists in obtaining original information in various parts of the country, collecting specimens for further examination, etc. This work is done almost entirely in the open season. The elaboration of this information is carried on mostly at headquarters in the winter by the same men, with help from the draughtsmen, chemists, lithologists, palæontologists, or other members of the indoor staff.

Topographical surveying.

Much of our work being prosecuted in unsurveyed and even unexplored territory, topographical surveying becomes a prominent part of our duty. It would, of course, be of little use for our officers to do geological work in previously unexplored districts, if, on their return, they could not represent it in its proper geographical position. Each field man, therefore, requires to be a topographical surveyor, as well as a geologist. It will thus be seen that the qualifications of a field geologist in Canada must be of a much wider and more varied character than would be required in an older country, where the topography is already well represented on the maps. Our geographical work embraces surveying of all kinds, from accurate measurements of base lines to track surveys and mere explorations. It includes triangulation of lakes, sea coasts and mountainous regions, surveys on land by transit and chain, odometer, pacing, etc.; on water by micrometer telescopes, boat logs and time reckoning. Observations for latitude and longitude require to be made at frequent intervals, especially in the more distant regions. Altitudes should be taken everywhere, either by barometer or spirit level. When working on the water, soundings are made as often as possible. Sooner or later all such facts prove valuable, and they can be noted by an energetic man in connection with working out the geology. In order to be able to carry on work in the wild or uninhabited parts of the country, the geologist requires to understand the selecting of suitable men for the work, the equipment and management of a party under varying conditions, far from civilization, methods of travel, of finding food in wild regions, etc. Unforeseen difficulties often arise which require patience, skill and endurance to overcome. The geologist in charge of a party in remote regions must, therefore, be a man of energy, resources and experience.

Various kinds of surveys.

Geologists qualifications.

Geology being the prime object of these surveys and explorations, the man in charge of one of our parties requires, in addition to the topography, to attend constantly to recording a variety of observations as to the nature of the rocks, their distribution, dip or strike, the run of veins, joint and cleavage planes, dykes, etc., glaciation or

other surface conditions, the superficial deposits, etc; he requires also to collect and label specimens of rocks, minerals and fossils. Particular attention is directed to the occurrence of useful minerals and rocks of any kind in new districts and to the examination of any discoveries, and to workings by prospectors and miners, with a view to his forming a correct estimate of the outlook for mining or quarrying in such districts.

Useful minerals.

Variety of observations.

While working in new territory we also take advantage of the opportunity to obtain heights of banks or cliffs, hills and mountains and comparative levels of waters, grades and depths of streams and lakes, records of the temperature of the air and water and of other meterological observations as indications of climate, notes as to the kinds and characters of the forest trees and on the flora generally; also as to the fauna, the collection of zoological and botanical specimens, making notes on the nature of the surface of the country, whether hilly or level, rocky, swampy or covered with soil, the character of the land, and on various other matters. We also enquire from the natives as to the topography, etc., of regions beyond our own explorations. Photographs are taken to illustrate the geology, scenery, the character of streams, etc. All these duties being carried on by the same person, in addition to his general management of the party and pushing on of the work, require constant attention and labour and they often involve danger and privation, as well as discomfort from the weather, the plague of mosquitoes and various other insects, and are unaccompanied by any of the comforts and advantages enjoyed in civilized parts.

Work at headquarters.

Among the numerous and varied branches of work prosecuted by the staff at headquarters is map-drawing in all its departments, supervision of map-engraving, the preparation of reports giving the results of the different kinds of work being done, looking after the printing and illustration of these reports, testing, assaying and analysing ores, rocks, coals, clays, sands, waters and mineral substances generally, the business of the Section of mines and mineral statistics, petrographic work, preservation, determination, description and utilization of the fossils collected and the illustration and publication of the results of palæontological research, lapidary work, the preservation, determination and mounting of zoological specimens, studies in connection with the fauna of our vast country, including entomology, the mounting, naming, cataloging, classification and the description of new species and varieties of the plants collected, the study of the economic results of botanic researches in the field, the supplying of good named and catalogued collections of specimens of minerals and rocks to edu-

cational institutions of various grades, from elementary schools to universities, after we have collected these from widely separated parts of the Dominion, work connected with the archæological collections, with the accountants' branch, with the care and increase of the library, the sale and distribution of the maps, reports and other publications of the Survey, the care of the different departments of the museum, the varied duties of the secretary, photographic work, attending to daily personal enquiries on a great range of subjects, and the correspondence connected with every branch of the service.

Subject of correspondence.

The correspondence of the office covers a wide range of topics of the most varied character, embracing enquiries on almost every subject connected with geology, geography, mapping, rocks, ores, minerals and materials of all sorts, mines, mining, markets and statistics of mineral products, chemistry, metallurgical questions, forests and timber, flora, fruit-culture, fauna, protection of game and fish, hunting, fishing and travelling in wild parts of the country, engineering, surveying, exploring, characters of wild and settled regions, sub-division of land, health resorts, information for proposed visitors and immigrants, climate, mineral statistics, the naming of specimens and of whole collections, questions in geology, palæontology, biology and nearly all the natural sciences, as to aboriginies, surveys and instruments, values and uses of economic minerals, as to text-books, requests for information on a great variety of scientific subjects. Many of the letters refer to matters altogether foreign to any branch of our work. One of the more numerous classes of letters is that asking for our reports, maps and other publications, which now number 657 titles, of which 607 are enumerated in the last List of Publications of the Survey, which is sent free to applicants. A nominal charge is made for these publications to prevent an indiscriminate demand from persons having no real need of them. The above example will serve to illustrate the main features of the correspondence carried on. The letters and enquiries received relate to almost every scientific subject except electricity. Some of the demands are far-reaching and elaborate, and require voluminous answers, the preparation of which consumes the time of the higher officers of the Survey. In fact, the department seems to be considered a bureau of free information on all subjects such as those which have been mentioned. All letters are answered promptly; and we are frequently thanked by the correspondents for the pains we have taken to satisfy them.

Good results.

The supplying of all this information, both by letter and to personal applicants, as well as the numerous other services rendered in the various ways above indicated, must be of great assistance to the appli-

cants, and it constitutes an important means of promoting the progress of the country. Having the necessary information on the above subjects, together with the extensive personal knowledge of the remoter parts of the Dominion, possessed by various members of the staff enables the Survey to give valuable and reliable information to inquirers both at home and abroad on almost any subject relating to Canada.

Maps.

Maps collected.

The value of accurate maps in connection with the delineation of geological formations was fully appreciated by the late William Logan from the beginning of the Survey and was dwelt upon by him in the earlier reports. He collected assiduously all charts and maps, whether printed or in manuscript, relating to Canada and secured any desirable collections which could be obtained by purchase. In this way large numbers of maps were acquired from surveyors and others which it would be impossible to obtain at the present day. Copies were made of all serviceable maps and plans in the Crown Lands Offices of both Upper and Lower Canada and the surveys which were carried on for geological purposes were often the means of making important corrections in these.

Plans preserved.

Later on in the progress of the country, when explorations and surveys were being made for railways, boundary lines, lumbering operations and other purposes, tracings of the resulting maps and plans were secured as soon as possible. It was in this way that copies of a large proportion of the plans of the government survey of the Canadian Pacific Railway were preserved at the time the offices of this survey were burnt and the originals destroyed at Ottawa in 1872.

Topography of Canada.

But above all, the extensive surveys and explorations which have been made by the geological staff itself, year after year, throughout the comparatively long period during which its operations have been carried on, have been the means of mapping out the principal part of what is known of the topography of Canada. The maps, plans and charts in our collection, not counting those of small areas, now number about 20,000. It is safe to say this is the largest and most valuable collection of such documents in the Dominion, and it constitutes the most precious part of the property of the department. The Survey is now in the sixtieth year of its existence and the necessary topographical surveys, incidental to the geological investigations, are being prosecuted more vigorously than ever and over a much wider range than in the earlier years, when only two provinces claimed attention, instead of half a continent.

It may be said that the Geological Survey is the only distinctly topographical branch of the public service and that the large number of maps which it has produced from time to time have always been recognized as the most accurate obtainable in regard to topography, to say nothing of their primary object—the geology which they represent. Our published maps already number about 350, while considerable additions are in various stages of preparation, and we have on hand the data for the construction of many more. The cost of producing these maps, from the original survey by the officers of the staff, the drafting, compiling, etc., up to the finished engraving, has been extremely small in comparison with their utility and value to the country. An immense amount of work has still to be done before the remainder of even the habitable parts of the Dominion are mapped out, but with the increased facilities now at the disposal of the department, this work can be prosecuted even more rapidly and economically than before.

Accuracy of maps.

Small cost.

The process of carrying on a geological survey of such a vast, and for the most part, unsurveyed country as Canada, must necessarily be entirely different from the methods employed in well surveyed and comparatively small countries. The geology of Canada has been already outlined with more or less completeness in the older parts of the country, that is, in regions where the lands have been divided up and settled, although even here, much remains to be done in some districts, but in the greater part of the area of the Dominion the need of surveys for other than geological purposes has not been sufficiently pressing to justify the great expenditure which would be required to make topographical or cadastral surveys far in advance of immediate requirements.

Methods differ.

It has, therefore, remained for the Geological Survey to do its topographical work simultaneously with the geological, and thus the country has had the benefit of both at a remarkably small cost. The Survey has thus been a most useful institution for the general progress of the country, and as no better method could be employed, the same topographical system must continue if we are to have the whole country mapped out at all, and as the geological work adds little or nothing to the cost, we might as well have it done at the same time.

Simultaneous work.

The long experience of sixty years which the Survey has had in carrying on these combined surveys in all parts of British North America, from Nova Scotia to the Yukon and Lower McKenzie, and from Vancouver Island to Baffinland, has developed a very efficient system for the execution of this work, both as regards accuracy and rapidity on the one hand, and economy of expenditure on the other.

Sixty years' experience.

The methods pursued, and the results obtained, have always met with the highest approval from all impartial persons capable of judging.

Whether the particular survey to be made be one requiring instrumental accuracy, or one of those carried on by rougher methods in previously unexplored regions, where long distances or large areas are covered in a short time, the officer in charge of the party and his professional assistant work together at both the topography and the geology.

Map-making. On returning to winter headquarters, the plotting and preliminary work on the map are done, mostly by the assistant, but partly by both, with perhaps the assistance of a draughtsman, and the compilation of the map, on the scale adopted for publication, is proceeded with and carried to completion under the supervision of both the geographer and the geologist or his assistant. When the compilation is sufficiently advanced, the geologist writes his report, which he could not do without the map. All the geologists being engaged in a similar way, a number of valuable original maps, combining topography and geology, are wholly or partly constructed every winter, and the field geologists and their assistants are ready to go back again to the outdoor work as soon as the season comes round. During summer, when the geologists are away in the field, the geographer and his assistants, being relieved of much of the work of compilation, can devote more time to the drawing for the engraver of such maps as have been completed, correcting proofs of new maps, and otherwise facilitating their final production.

United work necessary. It will thus be seen that the topographical and geological map-work must necessarily be done in the same office. The geologist must confer constantly with his assistant and both with the geographer and chief draughtsman in order to produce the best possible map from the materials obtained in the field, and he must lay down the geology at the same time as the topography. The presence of a number of geologists and topographers under the same roof is mutually beneficial and promotes an *esprit de corps*. The men take a pride and an interest in their work, and they regard the professional credit which it may bring them, if well done, as of more importance than the pecuniary remuneration they receive.

Control of map-work. Under the existing system, which was inaugurated nearly sixty years ago by the late Sir William Logan, the department has, so far, secured the services of a superior class of scientific men, who would not give up their time and talents unless they obtained full credit for all branches of this work. Geological surveys in all countries control the issue of their own maps. The mapping of the topographical and geological work of the gentlemen only temporarily connected with the

department, which has been already referred to, could only be done under the immediate control of the Survey, and it works in well with our organization, which includes a number of skilled draughtsmen who do no field-work themselves.

A system of map-making, differing from the above, was tried for a time with less success in the Geological Survey office. It consisted in attempting to construct the map from the field data, independent of the geologists and assistants who had done the field-work. But this method has been abandoned as unsuited to our requirements. The present system, which is conservative of both time and energy, has been evolved in all its details after a very long experience in the various branches of the work, and it has proved to be the best that can be followed.

Unsuitable system abandoned.

The department aims at the systematic division and arrangement of the work. The geologist must have constant access to all maps which may refer to the region he is working upon. Our maps, being constructed from surveys under our own control, with the addition sometimes of other reliable data, are always up-to-date and contain the newest and most accurate information. These maps, together with the Summary and Annual reports, are given to the public at the earliest possible moment, but a certain amount of time is, of course, required for the drawing and engraving of good maps. From the fact that they show both the geology and the topography as accurately as they are known, our maps have come to be regarded as the best guides for travellers and prospectors, especially in new regions, and they constitute a distinct advance in the proper mapping of the country.

Early issue of geological maps.

Since the department requires to construct the best possible maps in order to lay down its geological work on various scales, and as it already possesses the largest and richest collection of maps extant, referring to all parts of the Dominion, and which have been obtained largely by its own labours, its base-maps of the whole country or of any portion thereof, on such scales as may be required, could be utilized both on account of their accuracy and for the sake of economy, as well as to save duplication, in the future production of reliable maps for the special purposes of any of the other Departments.

Other uses.

The first large general geological map of Canada was published in 1866. In order to show the relations of the geological formations of Canada to those of the United States, it includes a large part of that country and extends from Newfoundland westward to the Qu'Appelle river, in what is now the province of Manitoba. It is on a scale of 25 miles to an inch and is very finely engraved on steel. The next

General geological maps.

general map issued, shows, in a less detailed manner, the geology of the Dominion from the Atlantic to the Pacific, but it extends north only to Newfoundland in the east and Great Slave lake in the west. It is on a scale of 43 miles to an inch and was produced by lithography.

New geological map of the Dominion.

A map on a scale of 50 miles to an inch, to show the geology of the Dominion, as far as known up to 1902, is now in the engraver's hands, and it is expected that the western half of it will be ready for distribution the present winter. It is done on stone and shows the country as far north as Hudson Strait on the east and Great Bear lake on the west.

ANALYSES, ASSAYS AND EXAMINATIONS OF MINERALS.

Chemical laboratory work.

The report of the Chief Chemist and Mineralogist for the year just closed, in regard to the work of his Division, shows the great importance of this branch of the Survey. Dr. Hoffmann and his two assistants have been engaged principally in the examination, assay or analysis of the specimens received from the field geologists. Some of these were of geological and some of economic interest. They embraced mineral fuels of all kinds, ores of iron, copper, lead, nickel, silver, gold and other metals, mineral waters, rocks required for various purposes, graphite, clays, marls, shales, sands, ochres, etc., and of many of the rarer species of minerals. But in addition to this work, these gentlemen examined during the year 705 samples of minerals which were brought by visitors to the museum or sent by express or through the mails by miners, prospectors, explorers and others from all parts of the Dominion for identification or information regarding them. Dr. Hoffmann furnished a written report on most of these examinations or analyses. During the past twelve years the numbers of specimens thus examined, identified, described or reported upon, as given in the Summary Reports were as follow :

Samples sent and analysed, etc.

Year.	Specimens.
1890	558
1891	705
1892	697
1893	463
1894	694
1895	573
1896	697
1897	985
1898	861
1899	1,017
1900	663
1901	705

For 12 years, 8,618, or at the average rate of 718 a year. The rules of the department require that the locality of occurrence of all specimens be given before they can be examined or analysed in the laboratory.

The minerals for which information was sought during the year, either by personal application or by correspondence, included the following:— Minerals inquired about.

Albertite, asbestus, barytes, borax, cement, clays, celestite, chromic iron, coal, copper ores, corundum, fire clay, fuller's earth, gas (natural), gold, graphite, granite, gypsum, infusorial earth, iron ores, kaolin, lepidolite, limestone, magnesite, manganese, marble, marl (shell), mica, mineral waters, molybdenite, nickel, ochres, peat, platinum, pyrite, salt, selenite, silver, soapstone, sulphur, talc, tugsten, zinc ores.

In connection with these inquiries, the Survey has been the means of putting parties requiring these minerals, etc., in communication with the producers or owners of properties where they occur, thus promoting the development of various resources and increasing the business of the country. Service thus rendered.

The value of the mineral output of the Dominion is increasing very rapidly. In 1900 it amounted to $64,448,037, while in 1886 it scarcely exceeded $10,000,000. The figures for 1901 are not yet available, but there has been a further increase under most heads, and the working of mines and utilization of the various mineral resources of the country are rapidly taking a foremost place in the great industries of Canada. Value of miners output.

COAL-BEARING LANDS OF THE CROW'S NEST PASS REGION.

According to the provisions of Chapter 5, 60 and 61 Victoria, 1897, the Director of the Geological Survey is required to state in writing his opinion as to what are coal-bearing lands within the areas which were granted by the government of British Columbia to the British Columbia Southern Railway Company, its successors and assigns for ever, as subsidy earned by the Canadian Pacific Railway Company under an agreement with the former company and the Dominion of Canada in the construction of the Crow's Nest Pass Railway. On the 15th of October I was requested by the Minister of the Interior to report, according to the requirements of the above mentioned Act, and my return, illustrated by a geological map, was furnished on the 17th of the month. Coal lands of Crow's Nest Pass.

Surveys of coal field.

In 1900, by direction of the government, a topographical survey of the region was made by Mr. H. O. Wheeler, and a geological survey of it was also made the same year by Mr. James McEvoy, assisted by Mr. Joseph Keele. The latter survey was continued in 1901 by Mr. W. W. Leach, assisted by Mr. T. Denis, and by the month of October we were able to define the coal-bearing lands with sufficient accuracy. These lands consist of two separate areas, the more southern and larger one containing about 230 square miles, or 147,200 acres, and the smaller one, which lies in the Green Hills, at a distance of nearly 30 miles north of the other, containing about 6·75 square miles, or 4,320 acres. There had been rumours of the occurrence of coal elsewhere within the lands belonging to the Canadian Pacific Railway Company, but on investigation by Mr. Leach these were not confirmed.

Immense quantities of coal.

Mr. McEvoy reported that in a total section of 4,736 feet, at right angles to the strata, which he measured in the main, or Crow's Nest Pass Coal Field, there are no fewer than twenty-two seams of coal, with the enormous aggregate thickness of 216 feet, of which, at least, 100 feet may be considered as workable coal. This section was measured at Morrissey siding, and it is all above the level of Elk river. The Canadian Pacific Railway Company has had two borings made near their track, south-east of Michel station. The logs of these borings have been kindly furnished to this department. They both show the existence of numerous seams of coal, and these have been correlated, by Mr. Leach, with those of the section measured by Mr. McEvoy at Morrissey siding. Their relations to one another are described in Mr. Leach's report in this volume and illustrated by the sections which accompany it.

Green hills coal-field.

In the portion of the Green Hills coal-field within the railway company's grant, Messrs. Leach and Denis measured a section of coal-bearing strata of 3,387 feet, containing twelve seams of coal, having a total thickness of eighty-nine feet. Seven of these seams are of workable size, with an aggregate thickness of seventy-nine feet. The section is not complete, as the rocks are covered up or concealed in many places, leaving room for the occurrence of more seams of coal. The sections in Mr. Leach's report, drawn to a scale, show the position, thickness, etc., of each seam in both of the above coal-fields.

GEOLOGICAL MAPS OF NOVA SCOTIA.

Geological maps of Nova Scotia.

The publication of ten geological map-sheets of the north-eastern portion of the mainland of Nova Scotia, prepared in great detail by Mr. Hugh Fletcher of this department, from his painstaking topo-

graphical and geological surveys, extending through a period of more than twenty years, was suspended, owing to a difference of opinion, which had been held by some, as to the age of certain geological formations of that part of the province. As Mr. Fletcher's conclusions on this subject have not changed since the publication by the Survey of his previous geological maps in accordance with these views, and as he has given his unremitting study and labour to the correct elucidation and representation of the geology of the region in question, having no object but the truth to maintain, it is not considered desirable to longer withhold from the public these valuable maps, and they will accordingly be published as rapidly as possible. They are already engraved and the colour-stones are being prepared, so that it is expected the printing can be done during the present winter.

MINERALS OF CANADA AT INDUSTRIAL EXHIBITIONS.

Canadian minerals at exhibitions.

Through the efforts of the Geological Survey, the minerals of Canada have been well represented at all the international industrial exhibitions which have been held, from that of 1855 in London to those of last year. These collections and the descriptive catalogues prepared by the Survey to accompany them, have never been excelled by those of any other country. The fine collection which had been got together under the control of the Survey for the Paris exhibition of 1900 was transferred entirely to that held in Glasgow in 1901, and in both cities it served to make known, in a striking manner, the great mineral wealth of Canada.

Zoological specimens exhibited.

At the request of Mr. Wm. Hutchison, the Canadian Commissioner to the Pan-American Exhibition, held in Buffalo last year, the department loaned some zoological specimens, including a fine wood buffalo. These specimens were the means of attracting much attention to the country, and, owing to Mr. Hutchison's careful management, they have been safely returned to the museum.

The collections which were at the Paris and Glasgow exhibitions, are to be shown during the winter in London, and in spring are to be divided between the exhibitions to be held in Cork and Wolverhampton respectively.

ZOOLOGY, BOTANY, PALÆONTOLOGY, ETHNOLOGY, ETC.

Other scientific work.

Dr. Whiteaves' catalogue of the Marine Invertebrata of Eastern Canada, published during the year, is the result of the studies of an

Scientific works.

expert for many years and is a very important contribution to zoological literature. Other work which he has accomplished last year is mentioned in his own report. It will be seen by this report that a considerable number of zoological specimens have been added to the museum. Professor Macoun's botanical work in Ontario, which is described in his report, shows that he made very large collections of plants and a variety of interesting zoological observations in the southern part of the province. He is now engaged in preparing for the press the second part of his *Birds of Canada*. Mr. James Macoun and his assistant did good work with the International Boundary Commission in collecting botanical and zoological specimens and in working out the natural history of the south-west corner of the Dominion bordering on the Pacific ocean. Mr. Lawrence W. Watson has been working on the botany and zoology of Prince Edward Island and has sent some interesting specimens to the museum.

In addition to the palæontological work performed by our own staff, we are greatly indebted to Professor Samuel H. Scudder, of Harvard University, for another valuable voluntary contribution to Canadian palæontology, being part 2 of vol. II. of his *Canadian Fossil Insects*, containing 92 pages and 10 plates, published by the Survey during the year. The figures were drawn by Dr. A. D. Hopkins, of Morgantown, West Virginia. Professor Penhallow, of McGill University, has written and illustrated a report on Osmundites from Queen Charlotte island, which will be published as soon as possible. Several additions have been made to the archæological and ethnological collections, among the latter being a carved totem pole about 40 feet high, obtained for the Department in British Columbia by Dr. C. F. Newcombe. This and four other totem poles from the Pacific coast, which we had on hand, have been erected in the court-yard of the museum.

Totem poles.

VOYAGEUR WHO WAS LOST IN THE FAR NORTH.

In connection with the survey of Great Bear lake, it was mentioned in the Summary Report for 1900, that one of Mr. J. M. Bell's men (Charles Bunn) had been lost near the Arctic sea. Mr. Bell and all his party did their best to obtain some trace of the missing man, but without success. They spent a number of days searching for him on the Barren Lands between the north-east angle of Great Bear lake and the Coppermine river, not far from Coronation gulf, when time was very precious, as too little of the season remained for their own return before the setting in of winter. After the party had been obliged to give up the search, Mr. Bunn fortunately wandered to a

Return of lost voyageur.

camp of Indians on Great Bear lake. These people treated him hospitably and helped him to reach Fort Norman on the McKenzie river. From this post he accompanied parties of Hudson's Bay Company's men to Fort Simpson and thence to Fort Resolution, where Mr. Bell had engaged him. He pushed on southward up the Great Slave and Athabasca rivers and finally arrived safely at Edmonton, where he was paid by this Department for all his time and expenses.

OFFICERS' REPORTS.

The Yukon District.

Mr. R. G. McConnell.

Yukon district.

During the past season the writer, assisted by Mr. Joseph Keele, who acted as topographer and geological assistant, was occupied principally in an examination of some of the smaller placer camps in the Yukon Territory. I left Ottawa on June 16, joined Mr. Keele, who had preceded me a few days, at White Horse on June 26, and after outfitting there, we proceeded at once to the Salmon river gold-field. The party consisted, besides Mr. Keele and myself, of two camp hands, who were engaged at Sault Ste. Marie.

Salmon river Gold-field.

Salmon river gold-field.

The Salmon river gold-field is situated east of the South fork of the Big Salmon river. It can be reached by ascending the Big Salmon river to the South fork, a distance of about forty miles, and then continuing up the latter to the mouth of Livingstone creek, a further distance of about twenty-five miles. These streams are, however, swift and difficult to ascend, and the route generally adopted is to descend the Lewes to the mouth of the Teslin, and ascend the latter to Mason's Landing, a distance of about twenty miles. From Mason's Landing, a pack trail, fifteen miles in length, has been constructed across the ridge bounding the Teslin valley on the east, to the valley of the South fork of the Salmon, and branch trails continue on to the various creeks. The trail follows a wide depression in the ridge mentioned above, at the summit of which it reaches an elevation of about 1,700 feet above the Teslin valley. A wagon road, following nearly the same course across the ridge, could easily be constructed and would be a great boon to the district.

Topography.

Topography.

The topography of the district is simple. A ridge about five miles in width where crossed by the trail, separates the Teslin river at this point from the valley of the South fork of the Salmon. The ridge is traversed by several deep depressions and is fairly regular in outline as a rule, but in places is surrounded by rocky peaks, some of which attain an elevation of 5,000 feet.

South fork.

East of the Teslin ridge is the great valley of the South fork of the Salmon, a huge depression some thousands of feet in depth, and where crossed by the trail, nearly two miles in width. The valley-bottom consists of a wide, partly forested gravel plain, broken in places by low benches and terraced along the sides up to an elevation of about 500 feet. The South fork itself is a shallow stream, seldom exceeding thirty yards in width, flowing rapidly along a boulder-paved channel. It rises in a range of granite mountains to the south and has a length, measured along the valley, of about sixty miles. Its grade at the mouth of Livingstone creek averages forty-five feet to the mile.

East of South fork.

The valley of the South fork is bordered on the east by a steep slope, about 2,000 feet in height, beyond which is a strip of plateau-like country, four to five miles in width, surmounted by low rounded hills, the summits of which have an elevation of from 2,000 feet to 2,500 feet above the valley. The plateau-strip is terminated on the east by a high mountainous district, worn into sharp peaks and bold projections, on some of which the snow lies throughout the season. The plateau-strip bordering the valley constitutes the gold-field of the district. The larger creeks cut back through it into the high mountain region beyond; the smaller ones rise in the lower foreground and descend rapidly, often in a series of cascades, to the level of the valley of the South fork.

Timber.

The valleys and the slopes of the plateau, up to a height of about 2,000 feet above the valley of the South fork, are partially forested. The principal trees noted were the Banksian pine, the white and black spruces, the aspen, the rough-barked poplar, the balsam fir and a species of birch. The trees, as a rule, are small and the quantity of serviceable timber in the immediate vicinity is limited. A few groves of white spruce were noted, some individuals of which attained a diameter of fully eighteen inches, but trees of this size are rare.

Geology.

The geology of the district can only be briefly referred to here as the rocks have not been studied. The oldest beds in the district

consist of hard micaceous quartzites, passing into mica-schists. These rocks are exposed along the eastern slope of the mountains referred to above, as bounding the auriferous plateau on the east. They are interbanded towards the top with crystalline limestones and are overlaid by green chloritic schists, probably representing crushed diorites or diabases. The green schists are followed in ascending order by gray quartz-biotite schists, white and light gray sericite schists, ressembling the gold-bearing schists of the Klondike series and probably like them of igneous origin, lead-coloured argillites, a second series of green rocks, mostly tuffs, above which is a wide band of hard cherty limestone forming the western edge of the plateau. The schists and associated quartzites and limestones have a nearly north and south strike and dip steadily to the west at angles of from 20° to 50°. Character of rocks.

The high narrow plateau bordering the valley of the South fork on the east, in which most of the gold streams of the district have their sources and which all of them traverse, is thus seen to be built almost entirely of micaceous schists of various kinds, and from these rocks the gold of the district undoubtedly originated. The schists are partly of igneous and partly of clastic origin and resemble in a general way the gold-bearing schists of the Klondike district. Origin of gold

The ridge between the South fork of the Salmon and the Teslin river is built of comparative recent volcanic rocks consisting largely of andesites, augite-porphyrites and allied varieties. Basalt occurs at the base of the western slope, and tuffs and agglomerates on the eastern slope.

The schists east of the South fork are cut, south of Mendocina creek, by some dykes and a couple of small bosses of gray biotite granite. This rock is not conspicuous in the district, but is apparently widely distributed further to the south, as the wash in the South fork is largely granitic. Granite.

Gold-bearing Streams.

Gold has been found in some quantity on all the streams traversing the high plateau, previously described as occurring east of the South fork, along a stretch about twelve miles in length extending from Sylvia creek to Mendocina creek. The schists which underlie this portion of the plateau continue on both to the south and to the north and it is probable that the field will be extended as prospecting continues.

The most productive stream so far discovered is Livingstone creek. This creek has a total length of ten miles. Its general course is Livingstone creek.

westerly, but four miles above its mouth it enters an old longitudinal valley which cuts off a segment of the plateau, and turns abruptly north for two miles before crossing the flats to join the South fork. It is a fair-sized stream, measuring about fifteen feet in width at ordinary stages of the water, where it leaves the hills. The current is very swift, as the grade is steep, exceeding 400 feet to the mile in some places.

Character of rocks.

The valley of Livingstone creek differs considerably in character from that of the Klondike creeks. In its upper part, it is a deep, rounded depression, evidently modified by glacial action, terminating in a steep-sided amphitheatrical basin. Farther down, the valley narrows in and becomes a canyon bounded by steep rocky walls separated at their bases by a narrow flat from 50 to 100 feet in width. The canyon portion of the valley has a length of about three-quarters of a mile and ends abruptly at the old valley previously referred to, which the creek enters after leaving the plateau.

Gravels.

The workings on Livingstone creek so far have been confined principally to the canyon portion of the valley. Discovery claim, on which the most work has been done, is situated near the head of the canyon. The gravels here and along the canyon generally are quite shallow, seldom exceeding three feet in depth, and in places the bed-rock is bare. They are, unlike the Klondike gravels, only partially derived from the rock exposed along the valley, and include much foreign glacier-borne material, largely of a granitic character. Boulders are numerous and are often of large size, some of them measuring six to eight feet or more in diameter. The heavy grade of the valley renders hydraulicking practicable, and on Discovery claim the water is flumed along the bank until a head of about fifty feet is gained and it is then used to ground-sluice the light wash in the bed of the stream. The heavy boulders are removed, when necessary, with a derrick.

Character of gold.

The gold is found principally on bed-rock or in the crevices of the rock and as a rule is very coarse. A third of the gold obtained from Discovery claim consisted of nuggets over an ounce in weight, and none of it, I was informed by the manager, could be called fine gold. The largest nugget obtained was valued at $304, and the second largest at $295, assuming the gold to be worth $16 to the ounce, the ordinary price. The assay value of the gold is stated to average $18.20 to the ounce. A few of the nuggets show a rough surface and include fragments of quartz, but as a rule they are worn quite smooth. This is probably due largely to the attrition of the sediment in the stream, as it is impossible that gold of this character could have been carried for any considerable distance.

Discovery claim is stated to have produced $11,000 in 1900, and a small amount in the preceding year. The product of the present season was not ascertained, but the 'clean up' which was made at the time of my visit was very satisfactory and the output for the season will probably be considerable. The ten claims below Discovery claim and extending from it down to the foot of the canyon are very similar in character to Discovery claim. They are owned by a company and preparations are being made to work them on a extensive scale during the coming season.

Claims above canyon.

Very little work has been done on Livingstone creek above the canyon, as the ground is much more difficult to prospect. The gravel is much deeper, and as it is not frozen except in sheltered spots, work on the shafts has mostly been stopped before bed-rock was reached by the inflow of water. The claims will require to be drained before they can be worked and this can only be done by a company owning several of them, or by a number of the claim owners combining and working their properties in common.

Below the canyon, the creek, as stated before, enters an old valley and runs for some distance at right angles to its former course. The gravel in this portion of the valley proved to be very deep. A number of shafts have been sunk, one of them to a depth of over seventy feet, without reaching bed-rock. Work on most of these shafts was stopped by water before any results were obtained.

Summit creek.

Summit creek, two miles north of Livingstone creek, and running parallel with it, is a much smaller stream, scarcely measuring six to eight feet in width where it leaves the hills. It heads in the plateau and, after a course of less than three miles, cascades down into a longitudinal valley, which here follows the base of the hills and runs north to Cottoneva creek. Its valley, where it leaves the hills, is narrow and canyon-like in character, but above the cascade it gradually widens out and assumes the form of a broad rounded and comparatively shallow depression.

Discovery claim, on this creek, is situated at the foot of the cascade. The gravels here are shallow and include, as on Livingstone creek, numerous granitic boulders. The claim is worked by ground-sluicing, water for this purpose being easily and cheaply obtained from the cascade. About $1,200 was taken out in 1900. The gold is similar in character to that from Livingstone creek. The claims above the cascade have not been prospected, although some work has been done. The gravels deepen rapidly in ascending the valley, and work on the few shafts which have been started, has been stopped by water before bed-rock was reached.

Lake creek.

Lake creek, a mile north of Summit creek, is about equal in size to the latter and its general character is very similar. Discovery claim on this creek, is situated above a cascade, which occurs, as on Summit creek, near the brow of the plateau. The gravels at this point, and for a few claims above, are comparatively shallow, averaging from four to eight feet in depth and can be easily worked. Work had only begun at the time of my visit, but some gold was being taken out and the miners appeared to be very hopeful in regard to the future of the creek.

Cottoneva creek.

Cottoneva creek, three miles north of Lake creek, is a much larger and longer stream and it has cut a more uniform grade down from the plateau. A canyon, half a mile in length, occurs about a mile from the point at which it leaves the hills. Above the canyon the valley is wide with gently sloping banks. The first discovery in the district was made on this creek in 1898, but the yield has been small and at the time of my visit no work was being done. The gravels are reported to be deep and difficult to work above and below the canyon, and in the canyon, where they are shallow, they do not appear to be productive. Besides the creeks briefly described above, good prospects have been obtained from Martin and Sylvia creeks, south of Livingstone creek, and from Little Violet and Mendocina creeks north of Cottoneva creek, and on the opposite side of the valley some work was being done near the mouth of St. Germain creek, a stream heading in the range west of the South fork.

Production of field.

The total production of the Salmon river gold-field up to, but not including the present season, was estimated at $20,000, the greater part of which has been obtained from Discovery claim on Livingstone creek. Work in the district has, however, barely commenced, notwithstanding the fact that gold was discovered as early as 1898. The field can only be considered of moderate richness and the fame of the Klondike creeks drew most of the miners to that section. The outlying camps are now, however, receiving more attention and it is expected that work in the future will be more vigorously prosecuted.

Yukon River.

Rocks along Yukon valley.

After leaving the Salmon river gold-field we descended the Lewes and Yukon rivers in a Peterborough canoe, and a few days were spent in making an examination of the geological section exposed along the Yukon valley below Fort Selkirk. Only a brief reference to this work will be made here. The rocks at Fort Selkirk and down the Yukon valley for fifteen miles consist mostly of diabases, coarse tuffs and

agglomerates. These rocks are underlaid by a highly altered clastic series consisting largely of quartz-mica-schists, quartzites and crystalline limestones. The clastic series, in a more or less altered condition, occurs at intervals along the valley down to the mouth of Forty-mile river and probably beyond. It alternates in broad bands with igneous schists and gneisses, derived mostly from granites, quartz porphyries and diorites. The granite gneisses have been regarded as the oldest rocks in the Yukon valley, but positive evidence was obtained during the course of the exploration that they are really younger than the altered clastic series and have been intruded through them. The old igneous schists, and to a less extent the clastic schists, are very important from an economic standpoint, as they constitute the gold-bearing rocks at all the camps so far examined. They are broken through at numerous points along the valley by intrusives of various kinds and are overlaid in places by more recent rocks, but a description of these does not come within the compass of this report.

Thistle Creek.

Thistle creek enters the Yukon from the east about eight miles above the mouth of White river. It is about eighteen miles in length and towards the mouth from fifteen to twenty feet in width. The valley is flat-bottomed in the lower stretches, the flats varying in width from 150 to 400 yards, but towards the head it narrows into a V-shaped gulch. The bordering hills have a general height above the valley of 1,000 feet to 1,500 feet, but in places slope up to sharp peaks and ridges very much higher. Terraces occur at intervals, but do not form continuous lines. The grade of the valley increases gradually towards the head. Six miles above the mouth it amounts to 50 feet to the mile, and at twelve miles to 100 feet to the mile. Thistle creek. Valley.

Discovery claim on Thistle creek is situated about six miles above the mouth. The creek was staked in 1898, but the work done on it up to the present has been inconsiderable. At the time of my visit some work, chiefly of a prospecting character was being done on claims 17 and 19 below and 9 above Discovery on a terrace opposite 9 above, and at the mouth of Edas gulch which comes in opposite 12 below. The gravels on Thistle creek resemble those on the Klondike creek. They consist principally of flat schistose pebbles, imbedded in coarse sand, and include occasional boulders of quartz and granite. They have a thickness in the vicinity of Discovery claim of from four to six feet and are overlaid by a layer of muck, usually from 8 to 10 feet in thickness. The terrace gravels are coarser than Work done. Gravels.

those in the creek and have a thickness at the rim of the bench opposite Discovery claim of 25 feet.

Gold.

None of the Thistle creek claims yet worked have proved very rich. The gold is irregular in its distribution and so far has been found principally along the left limit of the valley close to a well defined terrace which extends from claim No. 9 above Discovery down stream about three miles. The gold is found principally on or in bed-rock and occurs in coarse grains and nuggets. The largest nugget reported came from claim No. 1 above Discovery and was valued at $96. The total product of the creek is estimated at $10,000.

Henderson Creek.

Henderson creek.

Henderson creek enters the Yukon from the east about three miles below the mouth of the Stewart. It is a longer stream than Thistle creek and carries considerably more water, but is very similar in general character. It occupies a flat-bottomed valley of the usual type, bordered by fairly steep, mostly wooded, banks which are, in places, interrupted by irregular disconnected benches, but the banks are not conspicuously terraced.

Rocks.

The rocks exposed along the valley consist, as on Thistle creek, mainly of granite-gneisses and other igneous schists. At the Forks, three miles above the mouth, inliers of white crystalline limestone associated with quartz-mica-schists and quartzite were noticed, and andesites occur in a group of high rounded hills near the head of the creek.

Work done.

Only one claim was being worked on Henderson creek at the time of my visit. The creek was hurriedly and inadequately prospected in 1898 and since then has been practically abandoned. The claim which is being worked is situated about fourteen miles above the mouth of the creek and just below the junction of the main branch with Sixty-mile creek. It is owned by two Australian miners who have worked it partly by drifting and partly by the open-cut method for several seasons, and are apparently quite satisfied with the result. The gold is finer than on Thistle creek and is not concentrated near bed-rock, as is the case on that creek, but extends, like the Bonanza creek gold, upwards into the gravels for several feet. It is unlikely that this claim is the only one containing pay gravel in this portion of the valley and systematic prospecting on some of the adjoining claims would probably lead to equally good results.

Sixty-mile District.

The gold creeks of the Sixty-mile district are situated near the Alaskan boundary, about forty miles directly west from Dawson. They can be reached by ascending Forty-mile river, a western tributary of the Yukon, to the mouth of Moose creek a couple of miles west of the International boundary, from which point a good trail about twenty miles long leads to the principal creeks; or by a pack trail from Dawson, 56 miles long which follows the divide between Swede creek and the Yukon, or by ascending Sixty-mile river. The latter route is seldom used, owing to the shallowness of the stream, and the numerous bars and rapids which interrupt its course. All these routes were traversed in the course of the present exploration. The writer reached the district by Forty-mile river and the Moose creek trail, and descended Sixty-mile river on the way back in a small canvas boat which was portaged across from Forty-mile river for the purpose, while Mr. Keele travelled by the overland route and made as careful a survey of it as time permitted.

Routes to Sixty-mile district.

Geology.

The rocks in the Sixty-mile district are similar to those occurring on the Yukon valley above Dawson. The beds have a general east and west strike, and a section across them from Forty-mile river south to the Sixty-mile shows two broad bands of dark quartz-mica schists, quartzites and crystalline limestones, similar to the rocks described by me in a former report as the Indian river series, separated by a band of igneous schists four to five miles in width. The latter consist partly of gray granite-gneiss, and partly of light-coloured sericite schists derived mostly from quartz-porphyries. The schists are replaced near Sixty-mile river by andesites and are overlaid on Moose creek by a small area of conglomerates, probably of Cretaceous age.

Character of rocks.

Gold-bearing Creeks.

Coarse gold was discovered in the Sixty-mile district in 1893, and from that time up to the discovery of the Klondike creeks in 1896, it was one of the principal producing camps in the Yukon country. It was practically abandoned in 1897, but lately the miners have been returning to it. At the time of my visit, about forty men were at work.

The principal creeks are Miller and Glacier* creeks on the Sixty-mile slope, and Moose creek, a tributary of Forty-mile. Moose creek is a

Moose creek.

* A detailed description of Miller and Glacier creeks, by J. E. Spurr, is published in the eighteenth Annual Report of the U. S. Geological Survey, pages 320-326.

large stream, about twenty feet wide at its mouth, and about fifteen miles in length. Its valley is about 200 yards wide in the lower reaches, but gradually contracts towards its head into a narrow gulch. Gold in small quantities is found all along the valley, but only a short stretch, barely a mile in length, commencing about ten miles above its mouth, contained claims rich enough to work. The gravels had a depth of from two to four feet, and the gold occurred in a narrow pay streak in the centre of the valley. The total amount produced is given at $5,000 only.

Glacier creek.

Glacier creek is a tributary of Gold creek, and joins the latter a mile above its mouth. It is a small stream, from two to three yards in width, and less than seven miles in length. The grade is steep, amounting to about 100 feet per mile in the lower part of the valley, while further up it becomes much steeper. The valley conforms to the usual type. The upper part is a narrow gulch, but in descending, it gradually widens, and towards its mouth has a breadth of 200 yards. It has been worked from claim No. 28, above Discovery, down almost to its mouth, a distance of about five miles. The pay streak from No. 21 above, down to No. 17 above, is reported to have been very continuous but quite narrow, less than twenty feet in width. Farther down it widened out and became more spotty. Claim No. 18 below is stated to have been the best claim on the creek. The valley gravels have a thickness of from six to ten feet and are overlaid, as on the Klondike creeks, by a varying thickness of black muck. They have been mostly worked over, but a few claims, too low in grade to pay in the early days, still remain, and some gold was also being obtained from a few of the richer claims which had been imperfectly or only partially worked.

Terraces.

The terraces on Glacier creek were neglected up to the last year or two, but are now being worked at several points. Well defined benches occur on the left limit, opposite claims 10 and 12 above, and on the right limit opposite No. 6 below and down the valley for some distance farther. The bench opposite No. 10 above, is interesting in as much as the workings, consisting of three shafts, one 62 feet deep, prove the existence of an old channel, separated from the present creek channel by a rock ridge 27 feet high and about 200 feet in width. The old channel has an elevation of 75 feet above the present one. Pay was found in one of the shafts, and the owners expect to work the claim from a tunnel which they are driving through the rock ridge. At claim No. 6 below, good pay has been struck on a terrace on the right limit 40 feet above the valley bottom. The gravels here have a thickness of about 50 feet.

The terrace gravels of Glacier creek are ordinary stream wash, deposited before the valley had been sunk to its present depth, and they have no resemblance to the enigmatical quartz drift or white wash of Bonanza and Hunker creeks.

Miller creek

Miller creek, west of Glacier creek, empties into Sixty-mile river. It is somewhat shorter than Glacier creek, about equal to it in size, and its general character is very similar. Miller creek was considered a very rich stream in early days, and for two or three years after its discovery, it ranked as the chief producer in the Yukon country; but it is now nearly exhausted so far as the valley gravels are concerned.

Terraces.

Terraces occur on the left limit from No. 2 below, down to about No. 20 below. They were only discovered recently and are still practically unworked. A terrace claim opposite creek claim No. 17 below, is stated to have yielded $18,000 during the past season. The terrace here has an elevation of fifty feet above the creek bottom and the gravels have a thickness of about fifteen feet near the rim, but evidently deepen considerably, farther back.

Other creeks.

Other creeks in the district are Poker and Davis, both of which head in the Yukon territory, but have their principal productive portions in Alaska; and Gold creek, Twelve-mile creek and California creek, tributaries of Sixty-mile river from the north, all of which show prospects, but up to the present have afforded no paying claims. The total production of the Sixty-mile creeks is difficult to estimate at this late date, but was probably less than half a million dollars.

Derivation of gold.

The gold on Miller and Glacier creeks is derived, in large measure, directly from the quartz veins and silicified schists of the district, but some evidence was obtained in the course of the exploration, serving to show that some of it has been deposited from solution. A boulder was found in one of the workings on Miller creek, the upper surface of which was partially covered with specks and scales of crystalline gold. The crystals were arranged in dendritic forms, and while some of them were firmly attached to the rock, others separated easily from it. The angles of the crystals were sharp and showed no wear of any kind, while the boulder itself, an autoclastic quartz-mica schist, was well rounded. The gold evidently did not belong to the rock originally, and the only explanation of its occurrence under the peculiar conditions stated, seems to be, that it was taken up by some solvent and redeposited on the surface of the boulder in the position in which it was found. A number of specimens of unworn crystalline gold in filiform and dendritic shapes have been found on Eldorado and other Klondike creeks, which were probably formed in the same way, although no direct evidence of this has hitherto been obtained.

Sixty-mile River.

Sixty-mile river.

A track-survey was made down Sixty-mile river from the International boundary to its junction with the Yukon. This stream heads in Alaska and has a length, after crossing into Canadian territory, measured along the valley, of about 70 miles, and following the windings of the stream, of about 125 miles. Its fall, measured roughly with the barometer, from the boundary to the Yukon, amounts to 1,425 feet, and the average grade of the valley to a little over 20 feet to the mile.

Size of stream.

Sixty-mile river, at the Boundary, is a rapid winding stream averaging about 50 feet in width and interrupted at frequent intervals by steep bars covered with only a few inches of water. The upper portion of the river from the Boundary to California creek can hardly be considered a navigable stream even for small boats. Below California creek the volume of water increases and the descent becomes less difficult, but bars and rapids continue almost to the mouth and no part of the river is easy to ascend. The tributary streams are small, as a rule, but two large streams, one draining the country to the west and the other to the south, come in within four miles of each other, nearly opposite Indian river and these branches nearly double the volume of the main river. Towards its mouth Sixty-mile has an average width of from 40 to 50 yards.

Valley.

The valley of Sixty-mile is generally flat-bottomed, the flats varying from a couple of hundred yards to nearly a mile in width. The sides are usually terraced and in places, the stream for long distances, has cut a secondary rock-walled channel, similar to that noticed on Indian river and the Stewart, through the bottom of its old valley. The country bordering Sixty-mile river forms part of the Yukon plateau, a highland worn into rounded hills and long zigzag ridges, but containing no well defined and continuous mountain ranges. At several points, high hills usually built of andesite, project a few hundred feet above the general level.

Geology.

Sixty-mile river affords a very good geological section, but only the salient points of this can be given here. At the Boundary and down the valley to Bed-rock creek, the rocks consist principally of igneous schists of various kinds, largely granite-gneisses, with which are associated some quartzites and other clastic schists. These schists constitute the gold-bearing rocks. They are replaced below Bed-rock creek by andesites which continue down to a point a mile and a half below the mouth of Gold creek. The andesites extend up Miller creek nearly three miles and up Gold creek over seven miles. Their distribution

south of Sixty-mile river is not known, but they apparently cover a considerable tract of country in that direction.

Rocks of Sixty-mile.

Below Gold creek the granite gneisses and associated igneous and clastic schists reappear and are exposed along the valley down to a point five miles below the mouth of Ofa creek. The schists, in this stretch, are cut by numerous intrusions of newer granite, and quartz veins are fairly abundant. They are succeeded by andesites, basalts and other volcanics, and these rocks, alternating with basins of sedimentary strata consisting mostly of conglomerates, agglomerates and shales, probably of Cretaceous age, continue down the valley for twenty miles. Below that point the granite-gneiss and included clastic schists and crystalline limestones appear again and outcrop along the valley down to the mouth of the river. The gold-bearing rocks, it will be seen, occupy the upper and lower parts of the valley but are covered up along the central portion by more recent and, so far as known, barren rocks. Some bars were worked in early days on Sixty-mile river, but so far as could be learnt, none of them proved very rich and at the time of my visit no work of any kind was being done.

Quartz Veins.

Quartz veins.

Considerable prospecting for quartz has been done in the Klondike district and in other parts of the Yukon country during the past season, and numerous discoveries of more or less importance have been reported. The old igneous and clastic schists referred to previously as the gold-bearing rocks and which have such a wide distribution along the Yukon valley, are cut everywhere by quartz veins and in places these become so abundant as to constitute a considerable proportion of the whole rock-mass. The majority of the veins follow the planes of schistosity or cut them at a small angle. They are narrow and non-persistent as a rule, but occasionally swell out into lenses of quartz six to eight feet or more in width. These veins often give fair assays and in places show free gold, but except in rare instances they are too small singly to make mines. The discovery of a zone of small auriferous quartz veins closely grouped together, and capable of being worked together, is however possible, and in a region so highly silicified as the Klondike district, even probable.

New Bonanza and Lone Star claims.

Before leaving Dawson, a visit was made to the New Bonanza and Lone Star claims at the head of Victoria gulch, a tributary of Bonanza creek. The development work done on these claims consists of a few shallow shafts or pits, none of which reach any considerable depth. At one of these openings on the New Bonanza, a kidney of quartz,

Gold in quartz.

over six feet in width has been uncovered for a few feet, one end of which is studded with grains and nuggets of gold. A second opening, 200 feet to the south-east, has been sunk in a smaller quartz vein, also carrying free gold. A specimen of quartz from this vein, in which no free gold could be detected with the naked eye or an ordinary magnifying glass, was assayed in the laboratory of the Survey and gave 2.625 ounces of gold and 3.267 ounces of silver to the ton. The country rock, mostly sericite schists, adjoining the vein, also proved to be auriferous. Other small veins occur to the north-west, following the same south-east and north-west strike as those above mentioned. The work done on these claims is insufficient to base an opinion on as to their ultimate value, but the prospects are certainly encouraging enough to warrant further investigation.

The existence of a group of quartz veins at the head of Victoria gulch, carrying free gold in such quantities, is interesting from the fact that the pay streak on Bonanza creek practically stops at the mouth of this gulch. Victoria gulch itself is gold-bearing, and the gold obtained near its head is rough and unworn and looks as if it had just dropped out of its original matrix. It is not inferred from this, of course, that all the gold on Bonanza creek originated from this source, as the coarse gold found along this stream could not have travelled any distance, but that some of it came from this point seems beyond question.

Quartz veins on Sixty-mile river.

Quartz veins are prominent in places along Sixty-mile river and a couple of specimens collected proved to be auriferous. A vein about four feet wide cuts the granite-gneisses about a mile below Twelve-mile creek, in the upper portion of the river. A specimen from this vein was assayed in the laboratory of the Survey and yielded 0·058 ounces of gold to the ton. A vein was also found about six miles above the mouth of the river, on a bluff 200 feet above the level of the valley, a specimen from which assayed 0.117 ounces or nearly $2.50 to the ton. This vein consisted of light brown drusy quartz and at the point examined it was fully eight feet in width. It apparently belongs to a different class from the ordinary small gash veins of the districts, and is worth a closer examination, as the proportion of gold usually varies along the strike and portions of this vein may be rich enough to work.

Quartz veins occur in the schists of the Salmon river country, but the only specimens assayed from this district proved to be barren. Specimens from a vein on Fish creek, a tributary of the South fork, which carried iron and copper pyrites and gelena were shown to the writer. The vein is stated to be of large size, but it was not examined.

River Dredging.

Dredging at Cassiar bar.

The dredging operations at Cassiar bar, on the Lewes river, in 1900 proved a failure. About 50,000 cubic yards of gravel were washed, and the average yield, so I was informed by one of those interested, averaged only five cents per cubic yard. The bar has been abandoned and the plant transferred to a claim on Bonanza creek, where it is reported to be doing satisfactory work. Cassiar bar was worked in early days by the miners, and was supposed to offer exceptional facilities for dredging. The failure there has, on this account, led to an impression that a like result would attend dredging operations in any part of the district. This opinion, it seems to me, is not well founded.

Character of river gold.

Cassiar bar is situated a long distance from the source of supply and, as a consequence, the gold is very light, and is confined, as is usual in such circumstances, to a thin layer of gravel immediately beneath the surface. The conditions are entirely different on streams or portions of streams, near to, or cutting the rocks from which the gold originates. The grains in the latter case are heavier, are less easily moved, and the gravels increase in richness, as a rule, towards bed-rock. The bars on Forty-mile river, a stream cutting the gold-bearing schists throughout nearly its whole course, afford a good example of this. The gold on the auriferous bars on this stream is much coarser than that obtained from Cassiar bar and the best pay occurs near bed-rock. The gravels on the Klondike river below the mouths of the gold-bearing creeks has been proved to be auriferous to some extent down to bed-rock, and gold, in grains much coarser than the ordinary flake gold of river-bars, has been found in the bed of the Stewart, and also on the bars of the Big Salmon. Whether dredging would pay on any of the streams mentioned, is a question which can only be answered by careful prospecting or actual work, but it is obvious that the result of a single experiment cannot be accepted as settling the matter in the negative for the whole district.

Gold coarser near sources of supply.

The Geology of the Region adjoining the Western Part of the International Boundary.

Dr. Reginald A. Daly.

Geologist to Boundary Commission.

The government having decided to send a geologist, as a member of the Canadian Commission appointed to co-operate with the United States Commission in locating the International Boundary, which was to begin operations at the western extremity of the line last spring, I

was asked to name a suitable person for the position. I recommended Dr. R. A. Daly, a Canadian, who was instructor in geology in Harvard University. He was appointed and entered upon his duties in the end of June. He reports as follows upon the season's work :—

Instructions.

On June 29 I left Ottawa to join the Boundary Commission party which was under the direction of Mr. J. J. McArthur, D.L.S. The axemen of Mr. McArthur's party had already been some five weeks engaged in cutting trails to Chilliwack lake and beyond, where the monuments of the 1859-61 Commission were to be examined and vistas cut through the forests on the line of the 49th parallel of latitude. My instructions were to use the commission camp as headquarters and to work out the geology of as broad a belt north of the International Boundary as could be reached from that camp.

A brief stay at Banff and another at Field enabled me to get a glimpse of the Canadian Cordillera and, especially of the Carboniferous, Devonian and Cambrian members of the system. While awaiting the steamer from New Westminster to go up the Fraser, I made a short visit to Victoria, where I was particularly impressed with the remarkable traces of glaciation near that city. Returning to the mainland, I arrived at Chilliwack village on July 9, but, on account of difficulties of the trail, did not reach camp at the upper end of Chilliwack lake before July 14.

Length of season.

I remained in the field until October 29, and returned to Ottawa three weeks later, by way of San Francisco, Salt Lake City and Denver. Believing that even a rapid railway trip could aid one greatly in bringing into sharper relief the contrasts and similarities of structure and of form in the mountains of Canada and the United States, I chose this roundabout route. The North American Cordillera will be understood, as a whole, only after Canadian and American cross-sections are correlated, a treatment which, for this orographic system, stands among the more pressing desiderata of present day research.

Correlation of American and Canadian geology.

The tracing along the strike of the different mountain belts from the one country to the other, offers related problems of the highest importance. Examples are to be found in the search for the equivalent, in Canada, of the Basin Ranges, as these disappear under the vast lava cap of Oregon, Washington, and Idaho, and again, in the study of the zone of transition between the physiographic type of the Canadian Rockies and the quite different type represented in the Big Horn mountains of Wyoming or the Colorado Front range. It was, therefore, with peculiar interest that, for the first time, I saw, even fleetingly, the Cascades with their associated volcanoes, the Sierra Nevada

fault-block, the ranges of the Great Basin, the shore-lines of Lake Bonneville, the canyons of the Eagle, Grand and Arkansas rivers, some of the Colorado ranges and a typical Rocky Mountain 'park.' A more prolonged study was made of the classic section near San Francisco, from which the proofs have come of the extraordinarily recent origin of the Coast range of California; in making this excursion, I was directed by Professor A. C. Lawson, formerly of this Survey, and by Mr. Calkins, assistant geologist in the American staff on the International Boundary Commission. A day was spent among the modern gold-mining plants of the Cripple Creek district; a second, in visiting smelting and chlorination plants at Colorado City and Denver.

My outfit and the expenses of the season were supplied by the Department of the Interior, through Mr. King, our Chief Commissioner. I secured an excellent assistant in Mr. F. Nelmes, of Chilliwack, who helped me greatly at all times, but particularly during the more difficult climbing. Until September 17, we remained in direct communication with the main camp, but, thereafter, until October 18, we employed a small independent pack-train and camping outfit.

Conditions of work.

While the month of June had been characterized by almost continuous rain, our party was fortunate in having extraordinarily fine weather until September 1, and indeed, the meteorological conditions for field-work were favourable even as late as October 15. We were assured by the ranchers of the Fraser and Chilliwack valleys that so long a period of fair weather had never been recorded there before. Offsetting this good fortune to a large extent, work was seriously interfered with during August and part of September by a heavy pall of smoke borne into the mountains from forest-fire or ranch-clearing by the prevailing westerly winds. The smoke was usually so thick as to make photography, sketching and even intelligent mapping of outcrops either impossible or of indifferent success. The burning of the bridge across the Chilliwack river was a further cause of interruption in the progress of the work.

Difficulties.

The excessive ruggedness of the belt traversed, coupled with the well-known luxuriance of the dense Coast Range forest, its brulés, windfalls, devil's club, vine-maple and other underbrush offered, however, the greatest impediment in carrying on the work of the summer. Even under the able leadership of Mr. McArthur, our large party of axemen barely succeeded in opening the trails required to give access to the whole number of boundary monuments, before the bad weather of the autumn forced me to relinquish work in the mountains.

Construction of sketch-map.

The existing topographic maps of the region investigated were found to be entirely inadequate as a basis for geological plotting. For this reason, much time was spent in making a sufficient number of sketches, photographs and barometric readings, and in carrying on a rough triangulation, to suffice for the compilation of a 250-foot contour map of the area, on the scale of one and one-half miles to the inch.

Area covered.

The area covered during the summer includes an east-and-west belt of country eighty miles in length, parallel to, and limited on the south by, the 49th parallel of latitude, with a breadth of 10 miles north of this line. It stretches from the Gulf of Georgia at Point Roberts to a meridian running about four miles east of Chilliwack lake. Approximately the eastern half of this belt is mountainous, lying entirely within the western versant of the Coast range. The western half covers the flats of the Fraser delta and the waters of Semiahmoo bay. The first mentioned division comes within the drainage system of the Chilliwack river, and includes Chilliwack lake, the deep canyons of Middle (or Nesaquatch), Slesse, Tamihy and other creeks tributary to the river. The intervening mountain ridges, with part of the lofty Cheam range and the isolated Sumass and Chilliwack mountains rising out of the Fraser valley alluvium, claimed most of my attention for the season. The relative accessibility of the western half of the area, the simplicity of its formations and the absence of important outcrops of bed-rock, warranted a comparatively rapid study of the flats.

Geological conclusions

The following remarks are not intended to be so much a summary of results, as a preliminary statement of certain general conclusions which will receive amplification when the topographic sketch map is completed, the plotting of geological observations accomplished, photographs developed and specimens examined in the laboratory.

Considering the whole length of the transmontane section that lies before the geologist of the commission, this season's work was disappointing as to the amount of ground covered. The lack of trails on the eastern slope of the Coast range forbade my carrying the section farther east this year. The enforced concentration of field-work on the area actually covered was, however, a great advantage in reaching final conclusions as to the structure and age of the rocks within it.

The staple rocks of the Coast range are metamorphic. In the earlier reports of this Survey they bear the general name of the 'Cascade Crystalline Series.' Among the localities where metamorphism has least affected the rocks, allowing original structures and organic remains to persist in recognizable form to the present day, the long section of tilted shales and limestones briefly described by Bauerman, in the Chilli-

wack River Valley* seems to promise more information concerning the geological history of the southern portion of the range than any other section yet discovered. It was, however, only after seven weeks of search that the first fossil was found, and toward the end of the season that the most important faults and folds were determined in a satisfactory way. The more open country of the Skagit valley and still farther eastward will, I believe, permit of much more rapid reconnaissance.

Scenery of the belt.

By a curious accident, the International boundary line, roughly speaking, divides the Coast range into two parts of contrasted scenic quality. In Washington the summits are the higher and more peaked, the ridges the more serrate, while all are dominated by the majestic cone of Mount Baker; on the Canadian side the massifs are somewhat lower, are more rounded and less abundantly supplied with a perennial snow-cover. While this is true, the panoramas along the Chilliwack river are, nevertheless, most imposing. The inaccessible horn of Slesse mountain, 7,700 feet in height, is the loftiest peak of the belt, and the average height of some fifty other summits, determined barometrically, is over 5,500 feet. They win impressiveness in rising either from the floor of the Fraser valley, a few score of feet above the sea, or from the deely incised tributary valleys. The slopes flanking the canyons may be those of almost sheer precipices, 500 to 2,000 feet in height, or the usual ones of about thirty-five degrees.

Origin of the relief.

All indications point to the fact that erosion is responsible for the existing form of these mountains. No constructional surface, other than those slopes assumed by moving rock-waste have been recognized in the belt; no fault-scarp or fold recent enough to have preserved any of its original form, even in a damaged condition, has been observed. Vigorous dissection by denuding agencies has removed a vast volume of rock from the structurally complex range. Yet the existing *diversity* of relief cannot be far from the maximum due to the cycle of degradation through which the mountains are now passing.

Glacial erosion.

A special cause for their ruggedness is found in the erosive activity of now vanished local glaciers, for the sierras and horns have been developed in harmony with the growth of numerous high-lying cirques, amphitheatres, cols, and deep reëntrants which appear in all parts of the region. The latter forms are believed to have been formed, or at least greatly enlarged, from once shallower depressions by local ice sheets of glacial times. The glaciation of the belt does not seem to

*Report on the Geology of the country near the Forty-ninth Parallel of North Latitude West of the Rocky Mountains, from observations made in 1859-61. Published in the Ann. Rep. of this Survey for 1882-4.

Denudation.

have been general at any time. The restoration of the rock material which has disappeared from corrie or col or deepened valley, would afford much more rounded contours and profiles than those now existing. We should probably have something approaching the full, swelling outlines of the unglaciated, deeply decayed, granitic mountains of Colorado, smooth slopes mantled with graded rock-waste. If those slopes were attacked by valley glaciers, as the glaciers of Switzerland and Alaska are now working, not only removing the pre-glacial cover of disintegrated rock, but deepening and lengthening valleys, heightening and driving backwards the head walls of ravine and corrie, there would result in Colorado a serrateness of topography perhaps as great as that over much of Washington or British Columbia.

Cirques.

Many of the corries in the belt are of extreme picturesqueness. Below magnificent head-walls and lateral precipices, one to two thousand feet in height, are to be found in several cases, rock-basin lakes or tarns; above are perennial snows capping the surrounding peaks which stand in pleasing contrast to the rich and heavy masses of evergreen forest in the tree zone. At the southern end of Chilliwack lake, I found a fine example of what may be called 'tandem cirques.' In this case two stately amphitheatres occupy the same valley, one above and *en axe* with the other. The upper one holds a true tarn; the lower is drained by a series of cascades into the lake. Another and a finer association of this kind was examined with ease from a trail between Slesse and Middle creeks, and leading to a gold property now being exploited by Mr. G. O. Pierce, at an elevation of 5,000 feet. Here three tandem cirques of considerable size succeed each other through head-wall descents of 1,000 and 300 feet. Two of them are occupied by rock-basin lakes.

Observations were made which warrant further inquiry on the question, whether the excavation of corries by glaciers is in any necessary relation to a combination of definite jointage and massive structure in the underlying rock, or at any rate, whether excavation leading to the peculiar forms of corried mountains, be not much facilitated by that combination. The best, if not all, the well defined cirques of this belt, were found either in the massive granite or massive diorite, which in both cases, seem to offer an overriding glacier much advantage in *plucking* out the joint blocks. The process of plucking undoubtedly plays an important part in all glacial erosion; in the formation of cirques it may thus assume special prominence.

Mountain tarns.

Nothing is more striking in connection with the tarn-basins than the plain evidences that in the development of each one, the respective glacier moved uphill over the lip of the basin and with enough live

energy to score and groove deeply its *moutonnée* surface. The smallest tarn visited was less than 300 feet in diameter, and from the size and position of its corrie, the glacier responsible for both must have been very small. Yet it moved with grooving power for a distance of fifty feet up a twenty-eight degree slope forming part of the lip of the basin. Similar observations were made elsewhere.

The elevation of the summits within the belt is not sufficient to permit of the flourishing of large glaciers at the present time, though a goodly number of fair size are to be found among the jagged peaks just across the boundary line. None in the belt is more than a quarter of a mile in length.

Origin of Chilliwack lake.

One of the most noteworthy constructive effects of the former glaciation is seen in Chilliwack lake, which owes its origin to a heavy morainal dam. Though only five miles in length and a little over one mile in breadth, this sheet of water must, for the grandeur of its setting, rank among the finest in the Dominion. It has some resemblance to Lake Lucerne, but, in the larger features of colour and form in forest, crag and glacier, the panoramas of the Canadian lake are certainly the superior. Some day, perhaps not far distant, it should be a favoured objective point for tourist travel. The moraine holding in the waters at the lower end of the lake, is a faintly crescentic accumulation of large granite boulders without any considerable intermixture of finer materials. It rises steeply from thirty fathoms of water to a rather even crest, 100 feet above the lake-level. Its length is about 2,000 yards, its breadth 500 yards, though it may be said to merge into the less definite deposits lower down. The moraine was built at a late stage in the history of a great west-flowing local glacier, the scorings of which were observed on both sides of the Chilliwack valley, at all elevations up to 5,200 feet above the sea. This thick tongue of ice may have been a distributary of the Cordilleran ice-sheet shown by Dawson to have covered the interior plateau in glacial times.

Description of Chilliwack Lake.

The lake is deep. Forty-four fathoms of water were found not far from the shore. Owing to a lack of sufficient line, I was not able to complete enough soundings to give either the maximum depth or the shape of the bottom. It is hoped that this, with a similar study of certain of the tarns, may be accomplished next season. Strong deltas at two of the inflowing streams and numerous alluvial cones about the lake, show that it is being rapidly filled. The lake is about 1,850 feet above the sea; the granite walls surrounding it rise steeply and abruptly from the water's edge 3,000 to 4,500 feet higher. If we may judge from the truncation of spurs lying between the tributary gulches, glacial erosion seems to have given its present fiord-like character to

the valley. What originally fixed the axial trend of the valley, may, perhaps, never be told, yet there is a marked parellelism between it and a system of master-joints in the granite, which suggests an adjustment analogous to that of a subsequent stream on a belt of soft rock in a tilted sedimentary series.

River terraces.

Excellent land for farming purposes occurs on broad heavily timbered benches extending from the lake dam, or a little below it, to the Fraser flats. The bench form is due to the terracing of glacial gravels, sands and clays by the torrential river. The material thus removed from the valley, together with similar products from side valleys, have been carried through a narrow 'iron gate' or rock-gorge, where the river debouches from the mountains, and there built into a flat alluvial fan. The apex of the fan is about seventy-five feet above the flooded Fraser, and its radii extend five miles or more to Sumass mountain. The size of the fan recalls the still larger fan of the Bow River and the finely mapped examples on the flanks of the San Bernardino mountains, California. By the vigorous growth of the Chilliwack fan, several small streams flowing northward between Vedder and Sumass mountains have been dammed up and Sumass lake is the result. Although possessing in time of high water, an area of about fifteen square miles, this lake is in all parts usually under ten feet in depth, excepting in the channels of inflow and outflow. In late summer, the maximum depth decreases to less than six feet and the area diminishes accordingly. A plan to drain the lake and, by suitable dyking, to reclaim not only its bed but enough of the surrounding land subject to freshets to make a total of thirty thousand acres, has been developed and needs only capital to bring it to a successful issue. The engineering difficulties can be evercome with an expenditure that is small compared to the great value of this particular land. The latter is probably as rich as any part of the Fraser valley, and needs no clearing, since it is either prairie or lake bottom to-day. The tract further enjoys the advantages of proximity to growing markets and of being part of the limited farming land of British Columbia. Capitalists will do well to examine the project with experts on the ground. One of the chief hindrances to the successful prosecution of the scheme, is the strong flooding of the Chilliwack, which obeys the law of streams on their alluvial fans of periodically shifting its bed from one to another radius of the fan. The expense of securely dyking in the river could, however, be partly compensated for by the cheapness of the water-power for pumping, dredging or other purposes; some forty feet of fall in the river may be secured for turbines and would furnish a great store of energy.

Fan of the Chilliwack river.

A fortnight was spent in a rapid study of the Fraser delta, utilizing the river-banks, the sea-cliffs near Blaine and at Point Roberts, the

Yale wagon-road, and the railroads intersecting the belt. The chief result was to show that the delta is compound in nature. At Huntingdon, at 'Mount' Lehmann, at Point Roberts, across the river from New Westminster and elsewhere, are broad flat-topped plateaus of washed gravels and sand with associated local patches of typical till. The average height of the plateaus is about two hundred feet. They are considered as remnants of a great accumulation of débris, partly alluvium, partly ice-laid drift, spread out over the lower part of the Fraser valley in glacial times, after the manner of delta-growth in front of Alaskan glaciers at the present time. Post-glacial uplift has enabled the powerful distributaries of the river to cut to pieces the original delta, so that now but small portions of its surface are to be seen. The process is thus related to the strong terracing of the upper part of the Fraser valley. The prairies about Ladner's Landing are situated on the newer delta which is now advancing rapidly into the Gulf. Fraser delta.

For reasons already stated, this report must be particularly brief with respect to the geology of the fundamental rocks or in any discussion of the mining prospects of the belt. What appears to be the oldest formation in the area is represented in a series of coarse and finer-grained, plicated quartz-hornblende gneisses associated with diorites. They occur along the western base of Vedder mountain in the form of a narrow band of rock, limited on the north-west by the alluvium of the flats. Overlying the gneisses—doubtless unconformably—is an extremely complex group of feldspathic sandstones, grits, conglomerates, shales and quartzites, the last being of a characteristic green colour on exposed surfaces. They have as yet yielded no fossils, but the somewhat peculiar nature of the sandstones and quartzites suggests the correlation of the series with a much greater development of similar rocks outcropping abundantly in the walls of the Tamihy Creek canyon. These latter beds, too, have afforded no fossils. They underlie unconformably a third series of rocks, consisting of black and gray shales and bluish-gray, semi-crystalline limestones aggregating over 2,500 feet in thickness. Both shales and limestones have furnished organic remains. Bed-rock geology.

The shales in the upper part are abundantly charged with molluscs, brachiopods and crinoids in so poor a state of preservation that they prove as yet simply the Palæozoic age of the strata. The overlying limestones, some 800 feet in thickness, hold the same or closely allied species. They are filled in certain zones with thick concretionary knots, lenses and reticulate masses of chert which may possibly yield microscopic forms of interest. No closer determination Fossils.

of the age of these beds can be announced until the specimens have been examined in Ottawa. Topographically, the heavy limestone is the most important member of the series; it has a tendency to form strong ridges, scarps or bluffs, wherever it crops out in the belt.

Folds.

This limestone composes the summit, 6,500 feet above the sea, of the so called Black mountain (really whitish), a conspicuous peak between Slesse and Tamihy creeks. With the underlying shales and green metamorphics, it has been flexed into a rather regular S-shaped fold similar to an Appalachian zigzag. The pitch of the axes is directed due east. The nose of the anticline is found at the point where Slesse creek empties into the Chilliwack and the river flows westward for some nine miles in the unroofed anticline. The unexpected discovery of such an axial direction for these great folds may throw some light on the determining cause for the east and west course of the broad Fraser valley from Hope to the sea.

Faults.

The northern limb of the anticline composes part of the thick monoclinal series described by Bauerman in his section up the river. The remainder of the section is made up of the same shales and limestones repeated some four times by north-west and south-east step-faults with downthrows to the south-west. Abundant large crinoidal stems, similar to those occurring on Black mountain were discovered in the crystalline limestone at Thurston's ranch opposite the mouth of Slesse creek. It was the five-fold occurrence of this thick, easily recognized bed which at length pointed to a series of parallel faults as responsible for the duplication of beds in the twenty-mile monocline of the river valley. Duplication by overthrown folds proved to be highly improbable. In some cases planes of slipping were actually seen. The great thickness of 24,000 feet, given to the series by Bauerman, is believed to be very much in excess of the real strength of the beds. A careful, close estimate cannot be made until the map is completed and observations are plotted, but the total thickness must be less than four thousand feet.

Indications of gold and silver.

A small patch of mineralized ferruginous schists and saccharoidal crystalline limestone was discovered in contact with intrusive granite in the extreme eastern portion of the belt. It is possible that they represent the altered equivalents of the Palæozoic beds above described. There are indications of the occurrence of both silver and gold east of Chilliwack lake, and that portion of the belt can be especially recommended for exploration by prospectors. Until our trails were this summer cut through to the lake, almost no prospecting had been done in the upper part of the valley. Through July and August, a few men advanced eastward beyond the granite, and also reported the

country to be worthy of close examination. The re-opening of the old Boundary Commission trail would make the latter possible. It is to be hoped that this tract, which is specially interesting to the geologist, will be rendered accessible next year by means of a suitable pack-trail.

Structures south of the Chilliwack river.

The long monoclinal section is confined almost entirely to the north side of the Chilliwack river. From that stream to the boundary line, the structures are more complex. The shales are represented by phyllites and slates, often impregnated to a remarkable degree with pyrite and other minerals; the sandstones are altered to quartzites and schists. All the sediments exhibit a degree of induration and mineralization much in excess of that displayed north of the river. This difference is to be explained partly by more intense local crumpling, and partly by the contact metamorphism of intrusives.

Eruptive rocks.

The shales and limestones are cut by a considerable number of eruptive rocks, all intrusive with the exception of an amygdaloidal lava which appears in small patches on the rugged peaks west of Tamihy creek. The latter rock, with associated tuffs, is possibly contemporaneous with the shales. The most important intrusive from the standpoint of area covered, is an extensively developed hornblende biotite granite, already noted by Bauerman, in the eastern part of the section. Its contacts were located throughout the area, and its intrusive character clearly proved. Its numerous basic segregations, the accompanying aplitic and lamprophyric dykes and metamorphic aureole well deserve detailed study. Quartz veins of good size are comparatively rare, either in the granite or in its contact zone, but coarse pegmatites are common there.

Occurrence of gold.

The granite is also intrusive into an irregular mass of variable diorite occurring between Sleese creek and the lake. The exomorphic zone of the diorite is still more interesting than that about the newer eruptive. Observation seems to show that the concentration of gold in the quartz leads, now being developed in the region, may be referred chiefly to that zone. Free gold in paying quantities, according to samples, has been found several miles from any visible granite contact, but never, to my knowledge, at any great distance from the intrusive diorite. Igneous dykes cutting the diorites, together with others among the sedimentary rocks of the belt, will be microscopically examined in Ottawa.

A few years ago, great excitement was created among mining men by the discovery of the 'Lone Jack' gold property on Red mountain, and about four miles south of the point where Slesse creek crosses

Mount Baker. the boundary line. The net result has been to give the Mount Baker mining district a greater reputation than it at present deserves, if we may judge by the amount of production yet achieved. A small amount of free-milling high grade ore and a large quantity of low grade ore distributed in many narrow veins, is now in sight in the large number of claims staked off on the United States side of the line. On the Canadian side, only one property, that of Mr. Pierce, already noted, is being developed with an annual expenditure greater than the assessments. Mr. Pierce's assays average over forty dollars to the ton of the free-milling metal. Not only has he a tolerably rich quartz lead, but his property includes an extensive belt of an interesting auriferous rock which I take to be an altered limestone. This rock will undergo detailed study in the laboratory. A further encouragement to Mr. Pierce's enterprise is an abundant supply of water-power on the ground. Numerous other claims were visited, but, either on account of the small quantity of ore in sight, or because of its low grade character, none of them seemed so promising as this one. The strongly mineralized rocks, such as appear in the vicinity of the 'Lone Jack' mine, extend but a short distance (from one to three miles) into Canada; we must, therefore, not expect many important discoveries of the precious metal within the ten-mile belt explored this season. A ten-feet bed of magnetic iron is reported to have been found at the close of the season on Red Mountain, a few hundred yards north of the line, but I had no opportunity of reaching it in its remote position from any trail.

Plant bearing beds. No stratified bed-rock formation later than the Palæozoic series appears in the belt except a small patch of coal-bearing shales, sandstones, grits and conglomerates, probably Cretaceous, occurring on Sumass mountain, and on the opposite ridges to the north and south of the Chilliwack river. The thickness is considerable—1,500 feet—but the area is small, not more than five or six square miles. A few fossil leaves were found *in situ*, and better specimens were presented to the Survey by Mr. D. G. Gray and Mr. M. McArdle. Mr. Gray is the manager of a boring plant which has already sunk one hole 530 feet deep in the search for coal and is continuing operations on the southeast side of Sumass Mountain. The thickest coal-bed known to me here measures thirty inches. The logs of the borings are not yet accessible to the Survey; they may show the presence of a heavier deposit. The quality of the coal is at least fair, as some of it has been successfully used for blacksmithing purposes. In this case, also, the exact age of the beds cannot be made out until the fossils have been determined, but the similarity to the Cretaceous rocks of Nanaimo is strong. The measures lie at the base of the series which has everywhere gentle

dips and repose unconformably on contorted gray quartzites and hard sandstones composing much of Sumass Mountain. The latter are cut by a fine-grained diorite which is associated, in the form of a remarkable flow-breccia, with a newer granite. The coal measures overlap the breccia.

Summary of bed-rock geology.

The following is a provisional summary in descending order of the different formations in the belt, the nomenclature of which must not, however, be considered as that which may be adopted in the fuller final report:

Glacial and recent deposits.
Cretaceous (?), plant-bearing beds with overlying beds conformable with them.
Intrusives of Sumass Mountain.
Fossiliferous Palæozoic beds with others conformable with, and underlying them.
Green quartzite series.
Vedder Mountain gneisses.

Ages of dykes.

The ages of the large number of dykes in the area and of the intrusive granite and diorite of the mountain tract, are not yet known with a degree of confidence that would warrant their assignment to definite geological epochs. Using only the information to be derived from this particular region, they are to be referred to the long interval between the Palæozoic stage represented and the glacial period. The bearing of the facts ascertained by field-study this season on the question of dates of the various epochs of mountain-building in this part of the Coast range, will be discussed in the final report.

The Boundary Creek District, British Columbia.

Mr. R. W. Brock.

The winter and early part of the summer were spent in Heidelberg, Germany, in studying, microscopically, rocks collected during preceding seasons in West Kootenay, B.C. On returning, I reached Ottawa on August 9, but was delayed until the 12th in getting the necessary supplies for field-work. On this date I left Ottawa with instructions to extend the work into the Okanagan map-sheet from the western border of the West Kootenay sheet, where work was left off last season. Mr. Leach, who had charge of the topographical work in West Kootenay, having been transferred to the coal-fields of the Crow's Nest Pass, I was this season without a topographer, and progress in the work was necessarily slower.

Start for field.

Areas examined.

Greenwood was selected as headquarters and work was confined to portions of the Grand Forks and Kettle river mining divisions of the Boundary district. Commencing field-work at Grand Forks, Hardy creek was ascended to Hardy mountain, and the country between July creek and the North Fork of the Kettle river to the international boundary line was examined. From here the work was extended northward to Summit camp. From this point the area between Brown creek and the North Fork was examined. Moving southward, the district between July creek and Boundary creek was examined a short distance south of Wellington camp. From Wellington camp, July creek was descended and camp was moved to Grand Forks. From Grand Forks, a trip was made up the main North Fork of the Kettle river, to examine the rocks in which coal had recently been discovered.

On returning to Grand Forks, work was extended from July creek to Boundary creek, south of Wellington camps, to the boundary line, including Central and Attwood's camps. A traverse was then made of the Columbia and Western railway, between Midway and Grand Forks, the railway cuttings affording fine exposures of the rocks of the district. Ordinary field-work was suspended on October 23, the remainder of the season being devoted to an investigation of the ore-bodies of the district examined, together with some of the representative ones of Deadwood and Copper camps. I returned to Ottawa on November 13.

Physical features.

The district between the North Fork of the Kettle river and the main stream south of Pass creek, while mountainous, is lower, less rugged and more open than the country to the east. The mountains take the form of comparatively even rounded ridges, scarcely exceeding 5,000 feet in height, often with broad summits and rather gentle slopes. The northern slopes, where they have escaped forest fires, are always well wooded, and the eastern slopes generally so. Southern slopes, as a rule, are open and grassy, and the western, either grassy or park-like. To a large extent the country is drift-covered, with knees and elbows of rock protruding. North of Pass creek the mountains are higher, rising in pyramidal peaks to a height of about 7,500 feet, and the country is less open and more rugged.

The climate is drier than that of West Kootenay. This, with the lower altitude of the mountains, the consequent lighter snowfall and more rapid melting in the spring, makes the water supply less copious and reliable, although the district is still fairly well watered. The valleys, as a rule, are large and wide, affording, in a number of instances, good ranching lands. The valley of the main North Fork, as far as the junction of the East Branch, was described in the

Summary Report of last year. From this fork northward, the valley is narrow and for the most part V-shaped, but widening at intervals with a small flat or swamp in the river bottom. July creek has a short deep valley with an even gradient.

Boundary creek occupies the principal longitudinal valley between the North Fork and the main Kettle river. Along its lower stretch it is a wide U-shaped valley, with good grazing land on its lower slopes. The transverse valleys are short and steep but still larger and older looking than the corresponding valleys in West Kootenay. The topography, as a whole, is that of an older mountain district.

Timber.

Most of the valleys are or have been well wooded. The timber of the North Fork is the largest and most valuable, both for mining and building purposes. The vegetation is similar to that of West Kootenay outlined in the last Summary Report. The open hillsides are usually clothed with bunch-grass, and sage-brush was observed at one or two localities.

Geoligical description.

Although this district may be traversed with less difficulty than West Kootenay, geological work is not much easier, as the covering of drift in many places conceals the rocks and good exposures are found with difficulty, if at all. Frequently the critical points, such as contacts, are entirely drift-covered. While prospect pits are usually to be found, these are not altogether satisfactory for geological purposes, for mineralization obscures the original structure, as it alters the original character of the rocks. After a few words on the nature and distribution of the rocks, a short account of the occurrence of ores in them will be given. As in the Kootenay district, the geology is complex and diversified.

Rocks observed.

Eruptive rocks (greenstones, granites, various intrusive dykes, tuffs and lavas, etc.) have the widest distribution. Sedimentary rocks, such as limestone, generally crystalline, argillites, quartzites, together with metamorphic rocks including serpentines, are met with in almost all parts of the district, but do not have very large dimensions in any one place, being caught up as inclusions in the intrusive eruptive rocks. The oldest rocks recognized in the district are the sedimentary and crystalline ones.

Crystalline schists.

On Observation mountain near Grand Forks and on the rounded hill a little south of west of this and some of the hill-sides on Newby's ranch, are crystalline mica and hornblende schist with a few bands of crystalline limestone. These highly altered rocks resemble lithologically those of the Shuswap series (Archæan), but may only be the argillites and limestones found elsewhere, in a more metamorphosed form.

Sedimentary rocks.

The argillites, in places altered to schists and hornfels, limestone, usually crystalline, often highly so, quartzite, the latter occurring only sparingly, together with serpentine which occurs in many portions of the district associated with these, form a groups which closely resembles the Cache creek series described by Dr. Dawson* and assigned by him to the Carboniferous. In the Boundary creek sedimentary rocks no fossils have been found, but they are probably of about the same age as similar rocks occurring to the north and west, and may, on this ground, be provisionally classed as Carboniferous. Owing to their mode of occurrence their strike is not uniform. It may be in any direction but most frequently perhaps it approaches north and south.

Greenstone.

Somewhat newer than the sedimentary rocks, but probably with no very great lapse of time intervening, are the greenstones, which have the greatest development of all the rocks in the southern portion of the area examined. These rocks in the district under discussion appear much altered. When the structure can be plainly seen it seems to be an augite-porphyrite, similar to that found in so many portions of the West Kootenay district. In many places it, like the West Kootenay rock, appears to be an agglomerate. Usually it is massive, but under pressure it has in places become more or less schistose, and difficult or impossible to distinguish microscopically from some of the included argillites. It cuts and holds inclusions of the older sedimentary rocks. Indeed, in most of their occurrences, these latter appear simply as islands of greater or less size, caught up in this greenstone. In places, particularly near a contact with limestone, it is almost filled with small fragments of the rocks through which it has cut.

Occurring with it, as at Summit City on the east road to Eholt and at Phoenix are areas of a tuff-like rock. The material is green, resembling the porphyrite, the fragments, which are usually angular often with protruding corners, are of limestone (crystalline) cherty quartz, red and black argillite, and are usually tumultuously arranged. They vary greatly in amount and size. Sometimes they form almost the entire rock. In these rocks are fine-grained bands resembling volcanic ash. Before these rocks have been studied microscopically it is impossible to draw a line between the greenstone filled with inclusions of the older rock and these bands of apparent tuffs. At one or two points, such as near Mile-post 72 on the Columbia and Western railroad, is a massive looking rock, full of pebble-like fragments which might prove when studied microscopically to be an associated conglomerate. Whilst, therefore, at some points there is doubt as to the

* Annual Report, Geol. Surv. Can., vol. VII., (N.S.), Part B, pp. 37-49.

nature of the 'pudding-stone' like rock, at most points it is probably greenstone filled with inclusions, with, in places, associated tuffs.

Gray granite.

Newer than and cutting the greenstone is a gray hornblende-biotite-granite which has an important development on Boundary creek at Greenwood. Small intrusions of it occur in Wellington camp and on Hardy mountain. Near its contact with the greenstone and where its mass is small it is often coarse-grained, more basic, (as if it had absorbed basic material from the older rock) and inclined to be pegmatitic. Owing to differentiation, facies of this rock also occur which are not, strictly speaking, granite. Granite porphyry dykes from it cut the older rocks for a considerable distance from the parent masses. A crushed porphyry dyke on the south fork of McCarren creek and at Central and Attwood camp may belong to this series of dykes. It will probably prove to be the same rock as the Nelson granite of West Kootenay* and about Jurassic in age.

Near Central camp are exposures of a gray monzonite-like rock and dykes of a similar rock occur in the gray granite near Greenwood and in the greenstone at the Ruby claim. Whether this rock is related to the Rossland monzonites and therefore newer than the gray granite, or whether only facies of the grey granite and its dykes, has yet to be determined. A pinkish acid granite newer than the gray and belonging to the rock largely exposed on the divide between the East Branch and the main North Fork of the Kettle river, occurs on the latter about 10 miles above the fork of the East branch. On the North fork of the Kettle river there also occurs a still newer rock, a reddish porphyritic granite similar in appearance to the Rossland granite.

Younger granites.

Dyke rocks.

Dykes of a reddish or yellowish porphyry with a fine-grained granular ground-mass and rosette-like phenocrysts of feldspar, with some of biotite, are common, especially in the neighbourhood of ore deposits. On the Carbonates claim this reddish porphyry is seen as a contact facies of a coarse porphyry similar to those observed east of the North fork and in the Rossland district, where the dykes are from the Rossland granite. So it would appear that the porphyry dykes of the Boundary district hold the same genetic relationship, although it has yet to be proved that they have no connection with the recent Tertiary volcanic rocks. Besides the porphyry dykes are others of dark lamprophyric rocks and some of a dark brownish basalt-like rock. On account of their somewhat limited occurrence and the lack of exposures at critical points, the relative age of these rocks with respect to that of the porphyries could

*Summary Reports, 1896 to 1900.

not be determined, but from analogy of similar rocks in the Kootenay district one might expect them to prove to be newer.

Volcanic rocks.

The recent volcanic rocks occur in numerous localities as outliers, remnants of a sheet of volcanic rocks which once covered the entire country, but which have been largely eroded away. The series consists of coarse and fine tuffs and ash beds, some shales and sandstones in which coal is found in places, sheets of andesites, basalts, pitchstone, and probably other volcanic rocks. These volcanic rocks often have phenocrysts of feldspar and are locally known as 'birds-eye porphyry.' Similar rocks have been found and described by Dr. Dawson in the country to the west and are largely represented in the areas embraced in his Kamloops and Shuswap sheets. From stratigraphical and fossil evidences he assigned them to the Tertiary. A few fossil plants, which have not yet been determined, were found in these rocks on the North fork of the Kettle river.

Distribution of the rocks between July creek and the North Fork.

Owing to the intrusive nature of most of the rocks, their distribution is complex and only a small area need be examined to form the acquaintance of most of the rocks of the district. Without going into details their occurrence is roughly as follows: In the country lying between North fork and July creek the rock is mainly greenstone, but with several important and many minor inclusions of sedimentary rocks. Of the latter, limestone, which is usually crystalline, is the most important. Near Badina Hill at the southern end of the ridge, is a thin bedded quartzite. Here also the limestone is replaced by silica forming a cherty quartzite-like rock. Dr. Dawson mentions a similar rock as characteristic of the Cache creek (Carboniferous) formation.

A belt of crystalline limestone is fairly persistent on the range near July creek, passing west of Eagle mountain, Hardy mountain and the head of Deer creek. Limestone is also exposed in Summit camp almost to Mineral Monument XVIII. The band is not wide, and owing to coverings of drift it is impossible to prove that it forms one continuous band. Smaller bands are found at various other points along the railway line on the North fork of the Kettle river, at the head of Lime creek, on the ridge between the B.C. mine and Rathmullen creek and other points. Argillites, more or less altered, occur in the greenstone on Hardy mountain, near the Majuba claim, and near them is a large mass of apparently very pure serpentine. To the north of these rocks is a 'stock' of the gray granite, very basic, holding inclusions of the greenstone and impregnating it.

Argillites.

Argillites occur near the mouth of Fisherman creek. They are black and in some parts appear to be highly carbonaceous. On the

Laurier claim, for example, is a prospect tunnel in a black coal-like rock, having the appearance in places of anthracite, but it is probable that it is highly silicious. On Hoffmann mountain, near the head of the East fork of July creek purplish argillites are caught up in the greenstone.

Volcanic rocks.

The summit of the range between Deer creek and Fisherman creek consists of the Tertiary volcanic series. Overlying the greenstone and associated rocks, are coarse and fine-grained tuffs, and above these are andesites and other volcanic rocks. The eastern portion of the range between Fisherman creek and Lime creek is also capped by this volcanic series. It extends southward almost to Fisherman creek. At their northern end, near Lime creek, these rocks are cut by a reddish porphyry, which becomes somewhat granitic in the centre of the mass. On the railroad, about a mile east of Eholt, is another exposure of the volcanic rocks. They extend north to Loon lake, westward to the hill across the B.C. wagon road, and east to about Rathmullen creek. On the railroad about a mile east from the edge of the volcanics are several large dykes of monzonite or essexite-like rock.

Rocks at Summit camp.

At Summit camp, on the Emma and Oro Denoro claims and extending north from the latter, is a small boss of gray granite. The hill to the north-east, on which is Mineral Monument XVIII., consists of a large basic dyke between limestone on the east and the greenstone on the west. It looks as if it might be a larger, coarser, more highly crystallized form of the dark basaltic dykes. The reddish and yellowish porphyry dykes are common about Summit camp, B.C. mine, Rathmullen, and other points where important mineralization has taken place. The basaltic dykes are frequently met with about Eagle mountain. Other dykes are found, but space can not be given for particulars regarding these in the present preliminary report. In the district between July and Boundary creeks the greenstone is still, perhaps, the dominant rock, but the areas of sedimentary rocks become more frequent and important, particularly on the Boundary creek slope, although they are still cut by and included in the eruptive rocks. Argillites, often highly altered, and the cherty altered limestone are common, but so mixed are the rocks in this area that it is impossible to give the occurrences of the rocks without going into a detailed description of the whole district.

Rocks between July and Boundary creeks.

Greenstones.

In Phœnix camp, north of the town, occur greenstones filled with inclusions, (or the greenstone tuff,) bands of limestone with some argillites, dykes of gray granite and porphyry. To the south of the town the greenstone and greenstone tuff is more massive, having fewer inclusions of the sedimentary rocks. Near the station and on the hill

to the north-east, and on the ridge above the Gold Drift, the tertiary volcanic rocks overlie the older formation. In Wellington camp, on the Winnipeg claim and on the hill north-east, a mass of the gray granitic rock cuts up through the greenstone. A large inclusion of serpentine is also found here. On the wagon road toward the Athelstan claim a band of yellowish or brown weathering rock, locally known as dolomite is encountered, which extends through claims north-east and south-west. This rock, while made up of a certain amount of calcium and magnesium carbonates with some iron, is somewhat silicious and has probably been formed from serpentine. May creek and the head of McCarren creek are in massive greenstone.

In Central camp and on the ridge where No. 7 mine is situated, are considerable areas of more or less altered argillites. In Central camp serpentine is also largely represented. In places the latter is altered to a yellowish rock resembling that found near the Althelstan claim. Squeezed and altered dykes of granite porphyry are also common, together with masses of the monzonite-like rock. Similar mixtures of greenstone, argillites, limestone, serpentine, together with the numerous dykes are found on the slopes near Boundary creek. Around Midway, extending around the boundary line for a couple of miles, and northward across Norwegian creek to McCarren creek and west of Boundary creek to about Boundary falls is an important development of the Tertiary volcanic series.

Rocks on Boundary creek.

On Boundary creek, beginning at Anaconda and extending to the railway bridge above Greenwood is a mass of the gray granite. From Anaconda, the eastern boundary of the granite runs north-easterly to the Last Chance and Lake claims and then north-west to the mouth of Providence creek. The hills to the west of Boundary creek between these points are gray granite. This granite is found along the north side of Eholt creek to about Mile Post 84 on the railroad, and here greenstone reappears.

West of the North Fork between Brown's and Pass creeks the rock is essentially greenstone, but much cut up by porphyry and other dykes. From Pass creek north to a point opposite Rock Slide creek, the red granite obtains. Between this point and the forks of the river at Bunch Grass mountain, the west side of the river has not yet been examined. On the main North fork, above the forks of the East branch, gray granite predominates for the first six miles though extensively cut by pink acid granite and porphyry dykes from the red granite. Some red granite comes in above this point, but the main rock from here to the Coal Fields camp (about twenty-four miles by trail from Bunch Grass hill) is the pink acid granite. At the creek

from the west, half a mile below Coal Fields camp, the Tertiary volcanic series comes in and extends to the camp. The rock exposed by the river cutting east of and opposite to the camp and for about one mile north is the acid micaceous granite. Here the volcanics are again exposed near the river for at least one mile. On the west bank of the river, the volcanic series, including the tuffs and shales, seems continuous. The main portion of the divide between the East Branch and the main North Fork is granite, and it is not probable that the area of Tertiary rocks will be found to have a strong development east of the main river nor for any great distance up the stream.

Glaciation.

None of the mountains in the area examined, are of sufficient altitude to support glaciers or snow-fields. But here, as elsewhere in Southern British Columbia, glacial phenomena due to the former Cordilleran glacier are everywhere strikingly evident. The rocks when protected from weathering are polished, striated and fluted. The average direction of striation, where uninfluenced by local causes is about S. 30° E. Transported boulders, often of large dimensions, occur scattered all over on the summits and ridges, as well as on the lower levels. Boulder clays are not common but re-sorted glacial material, such as silts and clays, is abundant. This drift material, when it occurs in a protected position, shows marked and persistent terracing. The terraces are very numerous, rising in tiers at intervals of from ten to one hundred feet to a height of about two thousand feet above the valleys. In the larger valleys, such as that of Boundary creek, the numerous terraces are a marked feature in the landscape. A detailed study of these terraces, with those already observed in West Kootenay and the Kamloops and Shuswap districts, would yield very interesting results. The glacial phenomena in this district are in accord with those observed in other portions of the west, once covered by the great Cordilleran ice-sheet.

Ore-bodies of Boundary creek district.

The ore-bodies of the Boundary district are, for the most part, large in size and low in grade. This is their striking characteristic. Development work has proved them to be much larger than at first supposed, and they have proved to be surprisingly well adapted for smelting, no fluxing or roasting being necessary, but on the other hand the values have proved lower than the assays from early samples had indicated. In many respects these ore-bodies resemble the ore-bodies of West Kootenay. They are in what are sometimes known as composite or shear zone veins, formed by mineralizing solutions traversing the country rock, principally along fissures or zones of fissures, in which they deposit the economic minerals, and from which they replace with their mineral contents, particle by particle, sometimes only

partially, sometimes completely, the original material of the country rock.

Their form

As might be inferred from their mode of formation, they resemble the West Kootenay bodies in being of irregular form, often with no well-defined walls. The country rock in the neighbourhood being mineralized to a greater or less distance from the ore body, the line between the two is often merely a commercial wall. As in the Kootenay the ore occurs in the veins in shoots of various forms. Sometimes several of these occur, often roughly parallel. Sometimes veins with similar filling cross one another at various angles, and small stringers leading from the main vein are of common occurrence. The intersection of veins, so far as observed, while sometimes increasing the size, has produced no marked enrichment in the ore body. The ore occurs in all rocks except the newest, the latter being the porphyry and basic dykes, the acid granite, the red granite and the Tertiary volcanic rocks.

Country-rock.

So far as yet found mineralization is confined to districts which show evidences of recent disturbance, especially where the older rocks are cut by the newer dykes. Limestone, in such a district, seems favourable for the deposition of ores. In some cases the ore occurs in the limestone itself, but more frequently it is found in a rock along its contact with limestone, which forms a clean-cut wall to the deposit. Thus in the greenstone, where the latter holds large inclusions of limestone, the ore occurs in the greenstone along its contact with the limestone, while the latter may show little or no mineralization.

Causes of mineralization.

The lack of mineralization of the limestone itself in such cases is due to the fact that under pressure the limestone, instead of fracturing, flows and forms lenticular masses, which furnish no channels for the mineralizing solutions. If attacked and replaced by them it must be along the contacts, and from the pureness of the limestone this will take place easily, leaving a clean-cut unmineralized wall. That the contacts between the limestone and other rocks should be favourable, may in part be due to the chemical influence of the limestone in precipitating the mineral contents of the mineralizing solutions, but it is also due to lack of firm cementing between the limestone and contact rock, thus leaving a free channel, which the solutions have used as a highway and basis for their operations. But while such contacts are favourable, mineralization is by no means confined to them, in fact in the largest deposit yet found in the district (Knob Hill, Ironsides), with the exception of an insignificant island of it in the intermediate level, limestone is conspicuously absent, although it occurs at numerous unmineralized points in this vicinity. While most of the deposits of ore are in greenstone, limestone, or in contacts between them, they also occur

in the other older rocks, notably in the serpentine, argillites and gray granite.

Relationship between the dykes and ore-bodies.

The porphyry dykes which are associated with the ore-bodies, are usually to be found in close proximity to the ores, sometimes, as at the No. 7 mine, the ore occurs parallel to the dyke along the contact, or in the immediate neighbourhood. At the B. C. mine, Mother Lode mine and others, the dykes lie almost horizontal, running through the ore-body and intersecting it at right angles. The ore is found on both sides of the dykes, but, as far as known, it is not faulted by them, nor is the ore in any way altered by them, as might be expected if the dykes were newer and had been erupted through the ore, but in some cases the ore seems richer in the neighbourhood of the dykes.

That the dykes themselves show so little signs of mineralization and that the salband extends unbroken across the contact with the ore cannot be taken as proving that the dykes are subsequent to the ore formation, for the same phenomena are observable in West Kootenay where such dykes are known to be prior. If this is also the case in the Boundary district, the mineralization in such cases has taken place along fractured zones or fissures or contacts joining parallel dykes of porphyry. If mineralization has taken place in this way and a genetic relationship exists between the porphyry and ore (which in the Boundary district cannot be taken as yet proved) it would account for the enormous dimensions of the ore bodies. In the Mother Lode mine, where these conditions are found, development work, so far, has exposed an ore-body 1,180 feet long, 160 feet wide and 500 feet in depth.

Size of ore-bodies.

The Knob Hill-Ironsides lead, is of as yet unknown dimensions. It extends through the greater part of the length of both claims and probably into the Gray Eagles, the lowest slopes being 700 feet below the highest point of the vein, and diamond drilling has proved the vein to a depth of 800 feet. Its known width is said to be 400 feet. On the second level, three ore shoots are said to occur, one of 150 feet, one of 100 feet and a third of 200 feet in width. These with the mineralized rock between the shoots would make a total width of 800 feet. One stope, said to be 100 feet by 200 feet, is all in ore. While the above figures may be only approximately correct, they are sufficient to show the extent of mineralization. Some of the less developed properties also have very large ore-bodies. There has been considerable movement since the ore was deposited, numerous slips often with gangue or with secondary filling traverse the ore-bodies. This broken nature of the ground, coupled with the original irregularity in the form of the ore-body makes the exploitation of the smaller masses difficult and precarious. The slips so far encountered have not been sufficiently

large to have seriously affected the greater ore bodies. The serpentine is particularly full of slips, some prior but many subsequent to the formation of the ore bodies, which make it probably the most unsatisfactory country rock in the district.

Mineral contents of the veins.

The mineral contents of the veins, arranged according to their prominence, are magnetite, pyrrhotite, chalcopyrite or marcasite, arsenopyrite, specularite (micaceous hematite); galena, zincblende and molybdenite occasionally occur, especially in the smaller veins. Tetrahedrite, ruby silver, argentite, native silver, native copper and the various oxydized copper minerals are reported from a few localities, for the most part in the smaller veins. When the ores consist largely of pyrrhotite and chalcopyrite they resemble some of the west Kootenay ores. The occurrence of large masses of magnetite in the ores is peculiar. It seems to take the place of the pyrrhotite, for so far as I could observe, where magnetite is prominent, pyrrhotite is absent, though in one or two cases it was present but only very sparingly. The pyrrhotite and magnetite appear to have been the first minerals of the ores to be deposited, though their period of formation extended into the period at which chalcopyrite and pyrite were formed. This is shown by the fact that while the latter are usually found as veinlets or small points or irregular masses scattered through this pyrrohotite and magnetite, they also occur in places interbanded with them.

Formation of magnetite.

The reason for the formation of magnetite in this manner would seem to be a deficiency in sulphur in the mineralizing solutions. That they were poor in sulphur is shown by the formation of pyrrhotite rather than a higher sulphide of iron. Where magnetite occurs they would appear to have been still poorer; the greater part of the iron could not obtain sulphur, all available sulphur being first seized upon by the copper, the remaining sulphur which the iron obtained being only sufficient to furnish the chalcopyrite. Oxygen would also be scarce, so hematite could not be formed and the iron appeared as magnetite. Later when the copper had been supplied the little iron remaining received enough sulphur to form pyrite. In some places the double sulphide of iron appears to be marcasite, being lighter in colour and more easily decomposed, leaving a cellular structure, but no crystals of marcasite have been seen. Arsenopyrite occurs only at one or two points, as in the Winnipeg and Morrison mines, and not in any great quantity. The specular iron which occurs in scales, often rosette in form, appears to be an oxydation product from the magnetite. It does not occur in very great quantity.

Gangue minerals.

Quartz and calcite are the common gangue minerals. Magnetite may often be considered to also play this role. Garnet, green and red

(probably hessonite and almandine) and epidote, both well crystallized and massive, are very abundant in the veins often interbanded with the ores. They are probably largely alteration products of the country rock. This process can be observed at many points in all stages of development. The garnet and epidote are not confined to limestone, but are also abundant when greenstone and gray granite are the country rock. In the Mother Lode mine, where limestone seems to be the country rock, while these minerals are developed, the chief mass of the altered rock is made up of felt-like aggregates of short fibres, apparently actinolite. Silicification of the country rock to a cherty or quartzite-like material is a common phenomenon in the neighbourhood of a vein.

In the large deposits the values are principally in copper and gold with subordinate silver. In some of the small quartz veins carrying galena, zincblende, with tetrahedrite and silver minerals, silver is the principal value; in others, as No. 7, when pyrite likewise occurs, gold is also of economic importance, the galena and blende carrying silver and the pyrite gold. In the large deposits, further study is required in order to formulate the laws governing the distribution of the gold values. Generally the magnetite and pyrrhotite, when occurring alone, are almost barren of gold, but this is not always the case. On the Seattle claim the pure magnetite is said to carry good gold values. Specimens for assay have been taken to test this. What appears to be pure pyrrhotite in the Winnipeg carries as high gold values as have been obtained in the mine, but at other points in the same mine the pyrrhotite appears barren. As a general rule throughout the district the best values occur when the pyrrhotite or magnetite are mixed with chalcopyrite. An increase in the amount of copper seems occasionally to lessen the value of gold. This obtains in the Mother Lode, where about two per cent copper carries the highest gold values, but in the British Columbia mine on the other hand the values seem to be confined to the chalcopyrite; pyrrhotite and pyrite appearing to be almost barren. The chalcopyrite although segregated in places, is, on the whole, remarkably evenly distributed through the large ore bodies. Away from the chief centres of mineralization, although pyrrhotite or magnetite are sometimes found in considerable masses, gold and copper appear to be only sparingly present.

Values.

The actual value per ton and the cost of mining and smelting have not been made public.* The values are low, but the cost of smelting is also low and the management state that the mines are at

* The Dominion Copper Company's ores yield a gross value of copper 1·95 % au. ·119 oz., ag. ·44, or a net value (with copper at 10 cts per lb.) of $5.72.

present working on a paying basis. It is generally admitted, that many of the properties can only be worked profitably by mining companies owning smelters. For this reason a union of the smaller properties, or at least the building of a union smelter, is being agitated. The larger properties, such as Knob Hill, Ironsides and Mother Lode, are now mining by large quarries or 'Glory holes,' from which the material will be loaded directly into ore cars. On the Knob Hill, this will be done by a steam shovel. On the Mother Lode, the large blocks will be first put through a gigantic crusher capable of manipulating blocks a yard square and with a daily capacity of 800 tons. With this cheapening of the costs of mining and with double smelting capacity, which will be ready shortly, in both the Greenwood and Granby smelters, there should be an appreciable increase in the profits. The small quartz veins are said to yield high assays in places, but of these, the No. 7 vein was the only one being mined at the time of my visit. This ore probably runs from $12 to $15 per ton in gold and silver.

Lack of surface oxydation.

A striking feature of these deposits is the lack of surface oxidation. A few feet below the surface, the ore has the same character as exhibited in depth. The soil overlying the deposit is often quite unstained, affording no indication of the underlying deposit, and consequently adding to the difficulties of prospecting. Often the surface of ore even retains the glacial polishing. The explanation of this feature is probably to be found in the glaciation to which this region has been subjected. The old oxidized and probably enriched surface has been cut off by the Cordilleran glacier, and since glaciation, the surface has in great measure been protected.

Ores of Copper camp.

An apparently and at first sight different type of deposit occurs in Copper camp, of which the King Solomon affords the bsst example. This deposit is found at a contact between porphyry and crystalline limestone. Wedge-shape little tongues of the porphyry extend from the main dyke into the limestone. Both the limestone and the porphyry are much broken up and traversed by little slips. The fractures cut the limestone into little blocks. In the fractures in the limestone, and to a less extent in the fractures in the porphyry near the contact, are deposited various oxidation products of iron and copper and also native copper. These little blocks of limestone include red earthy hematite and yellow limonite, crystallized and massive malachite and azurite, a black amorphous substance probably a mixture of copper oxide and perhaps amorphous chalcosite, cuprite, often well crystallized in transparent crystals, native copper, chrysocolla, and the impure chrysocolla known as copper pitchblende. The edges of the little limestone blocks

have often been dissolved and the copper ores then occur as encrustations surrounding a core of limestone. The main fissures are filled with the hematite and all the copper minerals; the smaller fractures principally with the copper. In the porphyry it is only the fractures which contain a thin film of the copper ores, the rock itself remaining fresh and unaltered.

About 650 feet north of the main working on the King Solomon is a small vein. The rock here is not so badly shattered. A few feet below the surface pyrite and chalcopyrite occur, although on the surface they have oxydized to sulphates and from the sulphates the green and blue carbonates of copper have been formed. What can be seen taking place on a small scale on this little vein is probably what occurred on the King Solomon ledge proper, on a much larger scale, so that the King Solomon is probably an oxydized and secondarily enriched form of a sulphide deposit similar to the other sulphide deposits of the Boundary district and due to oxydation and concentration by surface waters. The iron of the iron sulphides has been removed or left as red hematite or yellow limonite, the copper has been more or less concentrated as carbonates, oxides and native copper, probably black sulphide and other copper minerals. At a greater depth, the unaltered iron and copper sulphides will presumably be found, although between the oxydized minerals and unaltered sulphides it is quite probable that a zone of enriched sulphides will be met with. That this zone of oxydation and enrichment should be found in Copper camp and not in other parts of the district, is in part explained by the local topography and the broken nature of the country rock, but a cap of volcanic rocks which covers the hilltops all around and extends almost to the King Solomon ledge, has been, in all probability, a factor. This capping in glacial times is likely to have extended a little farther, in which case it would have protected the deposit from the scouring effects of the ice-sheet which has been shown above to have covered this area. Again the contact between these volcanic rocks and the older rocks is likely to be a natural water-way.

Chemical changes.

Some of the practical deductions from the study of the ore deposits may be summarized as follows:—

Since, with the exception of certain deposits in Copper camp there is no zone of oxydation and secondary enrichment in these deposits, no loss of values is to be expected in depth, while the present general conditions remain unchanged. On account of the irregular form of the ore-bodies and the complex nature of the rock-formation, a careful and detailed geological study of the ground in the neighbourhood of the mine would be of great practical value in the exploitation of the ore bodies.

Practical deductions from a study of the deposits.

For the same reason development work must always be kept well ahead of the actual mining. Crosscutting must frequently be done to determine the limits of the ore-body and to prove the existence or non-existence of parallel ore shoots. What appears a barren wall may often prove a barren zone between two ore shoots. The limits of the mineralization must be actually proved; and similarly only that ore can be reckoned on which has been actually blocked out.

Diamond drilling.

Diamond drilling can with advantage be used for prospecting and exploiting the ore-bodies. Magnetic surveys would also be of great value in locating them under the covering of drift, and also in testing for masses of ore in the mine workings themselves. Especially would this be the case in the magnetite deposits. In pyrrhotite deposits also, in other parts of the world, magnetic methods have proved successful. The pyrrhotite and magnetite should always be assayed, as barren looking material sometimes carries good pay values. The conditions where pay ore occurs, and the minerals in the ore should be carefully studied with the view of ascertaining which carry the values and what are the causes which produce the enrichment. The limestone contacts in mineralized districts should be carefully prospected. The limestone wall can often be used for following the ore, it being kept in mind that the ore does not always strictly follow the limestone contact, and that this rock may pinch out without causing the ore to likewise give out.

Districts which show evidences of disturbance through vulcanism manifested by heavy dyking are promising fields for prospecting. The porphyry dykes themselves may in places prove auriferous, as in twelve assays of porphyry dykes from West Kootenay, one-half yielded colours of gold. In a specimen of a dyke from Valkyr mountains examined last winter, free gold was visible even with the naked eye.

Mines at present working.

Besides ordinary prospecting, fourteen properties were being worked in the Boundary district at the end of the season, and of these ten were shipping ore. In Deadwood camp, the Mother Lode, Sunset and Morrison were working, the two former shipping ore. Some ore was also being shipped from the King Solomon in Copper camp, but work on the claim was at a standstill. In Greenwood camp, the Knob Hill Ironsides group was shipping heavily, and some work was being done on the Lake mine. The Brooklyn has just been closed down, in response to an order from head-quarters in Toronto, althongh the mine was reported to be looking promising. In Wellington camp, the Snowshoe was being developed and sending out small shipments. This was also the case with the Winnipeg. Work was also being resumed in the Golden Crown. The Athleston was closed down. In

Summit camp the B. C. was working and shipping, but the R. Bell, Rathmullen, Oro Denoro and other properties were closed down. On the North Fork of the Kettle river the Humming Bird was being worked on a lease and was making occasional shipments. The Jewel in Long Lake camp (which was not visited) was shipping. No. 7 mine in Attwood's camp was working and shipping. In Central camp the City of Paris, which shipped during the winter, was closed down, but it is expected that work will be resumed in the spring. Some development work was in progress at the Ruby in Smith's camp. In other parts of the district prospecting was being carried on. This is the case in the district south of Summit camp between July creek and the North Fork. In this area, while mineralization has taken place at a number of places, no large deposit of pay ore has as yet been encountered, although a fair showing of ore occurs on the Little Betts and Seattle claims.

As an indication of the progress of mining in the Boundary district the shipments of ore for the month of October might be quoted :—

	Tons
Old Ironsides and Knob Hill group	20,722
Mother Lode mine	8,730
B. C. mine	3,750
King Solmon	490
Snowshoe	330
Jewel	290
Winnipeg	190
No. 7	120
Sunset	50
Total	34,762

The total ore shipments for the year will approximate 385,000 tons. Smelters.

The Granby smelter at Grand Forks has been working steadily since it was blown in a year ago. It has at present a daily capacity of about 670 tons. Two new furnaces to double its capacity are being added and are expected to be ready to blow in at the beginning of the new year. A converting plant to refine the math to blister copper was also being installed. With the completion of the railroad from Republic, Wash., it is expected that a large quantity of Republic ore will be treated at Grand Forks. The mines of the Granby Company at Phoenix can easily supply the enlarged smelter, as their output is practically limited only by the smelting facilities. The British Columbia Copper Co.'s smelter at Greenwood has also been running steadily with a daily output of about four hundred tons. Another furnace to double its capacity is also being installed. The Pyrite smelter at Boundary falls has remained idle since its completion.

North Fork coal.

Last summer a prospector, acting on information from the writer that Tertiary rocks occurring in the neighbourhood were likely to be coal-bearing, prospected new ground on the main branch of the North Fork of the Kettle river, which resulted in the locating of a small seam of coal. Following his lead a large number of claims have been staked, but of these only a limited number cover coal-bearing rocks, the remainder being in granite. The New Coal Fields, as they are locally called, are situated about twenty-four miles above the forks of the East Branch on the main North Fork of the Kettle river, or about fifty-two miles from Grand Forks. Here, as above mentioned, a Tertiary outlier lies on the granite. The Tertiary rocks consist of tuffs, ash rocks, and a little shale overlaid by basalts and other volcanic rocks. The first exposure of coal on the west bank of the river occurs in a coarse tuff filled with fragments of volcanic rocks, and crystals of minerals belonging to volcanic rocks. Above this tuff is a thick bed of another filled with boulders from the granite of the surrounding country. In the tuff are little lenses of carbonaceous material, the remains of plants of which the form is sometimes preserved, and a thin seam (about an inch) of argillaceous material and coal. The tuffs have been somewhat squeezed. The strike is about N. 20° E., angle of dip 45° W.

Wiseman's discovery.

About one mile and a quarter up the river on the east bank is Wiseman's discovery. Here a band of shale twelve feet thick lies between two big beds of tuff. Interbanded with the shale are one or two thin ash beds. The shales are exposed for about 200 feet along the river bank. Their strike is S. 19° to 34° W., dip 30° to 40° E. At the upper end of the exposure the shales are contorted, and at this point the coal is found. The pressure has broken the seam and probably increased its width. At the widest point it approximates one foot. Only about twelve feet of the seam are exposed, but as the upper end disappears under drift, nothing could be ascertained of its extension in that direction. The extent of coal-bearing rocks is not large as they are overlaid by the unproductive volcanic flows and immediately underlaid by granite which is exposed on the east bank for the greater part of the distance between the two exposures of coal. Nor have they a wide areal extension, as the granite boulders in the river and tributary creeks testify. All the divide between the main North Fork and the East Branch is granite. No work had been done on any of the claims at the time of visit, and the trail to the fields was not completed. This, coupled with bad weather and lack of provisions, prevented a careful examination of the whole Tertiary area.

Colonel N. E. Linsley, of Spokane, who examined the district after my visit, reports having discovered four seams of coal on the lower (Gilpin's) claim. Of these, the upper (seven inches wide) was the largest

and was separated from the lowest by 150 feet of tuffs. He also found the area of coal bearing rock to be extremely circumscribed. The coal is of very fair quality, coking easily and well.

Possibility of the occurrence of platinum.

The recent increase in the use of platinum has created a strong demand for this metal, and it is now as valuable as gold. Its principal source is in alluvial sands where it occurs with garnet, magnetite and gold and other heavy minerals. As sand, it is sometimes very fine and of a brown or lead color. Treated with nitric acid it shows a white colour. It has been found in the Similkameen district and is known to occur at many points in the Western States. When found in place it has been principally confined to serpentine, and when found in sands it is usually in the neighborhood of serpentine. Consequently streams draining masses of serpentine, in particular should be prospected for platinum. Serpentine, as above noted, occurs at a number of points in the district examined this summer, as on July Creek, Hardy Mountain and Central Camp. It also occurs on the range east of Cascade.

In conclusion I wish to thank the mine managers one and all for their unfailing courtesy, attention and assistance.

Crows Nest Coal Fields.

Mr. W. W. Leach.

Work by Mr. W. W. Leach.

On June 3, I left Ottawa with instructions to continue the examination of the Crow's Nest Pass Coal-fields, begun by Mr. McEvoy last year. Mr. T. C. Denis, B.A.Sc., accompanied me during the season. I returned to Ottawa on October 24.

Assistance by Mr. McEvoy.

On arriving at Fernie, some days were spent in becoming acquainted with the Cretaceous coal-bearing rocks of that neighbourhood. Mr. McEvoy, formerly of this department and now with the Crows Nest Pass Coal Company, very kindly accompanied us on several expeditions into the surrounding hills, assisting us very materially with his knowledge of these rocks, gained during the previous season.

On June 15, instructions were received to examine immediately two reported outlying coal areas, separate from the main or Crows Nest area, or such parts of them, that, being included in the lands earned by the Canadian Pacific Railway Company, might be taken into account when the selection of Government coal lands was made.

Of these two areas, the Northern or Green hills area was mentioned by Dr. Dawson in his report on 'that portion of the Rocky Mountains between latitudes 49° and 51° 30′ (see Annual Report, 1885, vol. I., page 109 B.); while the southern one was reported to Mr. McEvoy last year by Mr. Phillips of Tobacco Plains. It was considered advisable to examine the Northern area first, it being the more easy of access at that early season. Considerable difficulty was experienced in reaching the field of operations; the trail, following the valley of the Elk river, then in flood, being under water in many places.

This area is situated on the east side of the Elk river, the southern edge of it being about twenty-four miles above the mouth of Michel creek. It extends northwards an unknown distance.

Green Hills coal area.

Generally speaking the attitude of the Cretaceous rocks of this locality is that of a wide, flat syncline, the upturned edges resting conformably on the flanks of two high limestone ranges of Devono-Carboniferous age, one on the west side of the Elk river and the other on the east side of Fording river.

In that part of the area examined, the upper beds of the Cretaceous rocks, represented in the Crows Nest area by coarse sandstones, conglomerates and brownish and yellowish shales, have been entirely eroded away and with them some of the coal measures, but further to the north it is probable that these upper beds will be represented at least partially. The coal-bearing lands, within the boundaries of lot 4,588, group I., (the property of the Canadian Pacific Railway Company), are, roughly speaking, of triangular shape, about 4½ miles in length and 1½ miles in average width, with the apex of the triangle to the south, and occupy the summits of the Green hills, which form the watershed between the Elk river to the west and Fording river to the east. Fording river being a tributary to Elk river, with a course approximately parallel to it. The general direction of the summits of these hills being about N. 20 W., with a maximum elevation of about 7,200 feet.

Coal seams.

The coal seams noted, twelve in number, outcrop along the crest of the ridge. The lowest one seen coming to the surface, just south of the most southerly point of the ridge, striking here nearly east-and-west and dipping at about 60° north. From this point northwards, in a distance of about 1½ miles, the strike gradually swings round to about N. 30 W., with a dip of 26° N.E. This strike and dip remains fairly constant as far northward as was noted.

An attempt was made to measure a section across the coal measures, but, as the time was limited and the rocks much covered, it must be

considered as open to revision on more detailed work. The result attained is as follows, given in descending order:

	Feet.	Section.
1. Sandstone	103·0	
2. Shale	67·0	
3. Coal	4·5	
4. Shale	5·0	
5. Sandstone	55·0	
6. Shale	8·0	
7. Coal	1·75	
8. Shale	5·0	
9. Coal	35·5	
10. Black shale	5·0	
11. Sandstone	46·0	
12. Shale	24·0	
13. Arenaceous shale	35·0	
14. Coal	3·0	
15. Shale	7·0	
16. Sandstone	18·0	
17. Coal	0·75	
18. Shale	42·0	
19. Sandstone and arenaceous shale	54·0	
20. Coal	7·0	
21. Sandstone	114·0	
22. Covered	365·0	
23. Shale, sandstone and covered	261·0	
24. Sandstone	7·0	
25. Coal	2·5	
26. Shale	15·0	
27. Coal	8·0	
28. Shale	158·0	
29. Coal	8·0	
30. Covered with shale outcrops	300·0	
31. Black shale	40·0	
32. Shale and thin bed of sandstone	275·0	
33. Covered	1,010·0	
34. Shale	15·0	
35. Coal	2·5	
36. Shale	23·0	
37. Coal	8·0	
38. Shale	10·0	
39. Covered	210·0	
40. Coal	8·0	
41. Shale	20·0	
42. Sandstone		
Total	3,386·5	
" thickness of coal	89·5	

It is quite probable that there are other seams which were not seen, and it is also possible that some of the seams may appear twice, as the measurements were not continuous, but an attempt at compilation of several partial sections. Immediately below the base of the section

the ground is heavily drift-covered with a few exposures of hard gray sandstone, leaving room for other seams.

Beds underlying coal measures.

The lower beds of the Cretaceous rocks in this neighbourhood show a wide variation from those noted by Mr. McEvoy in his section measured last season near Morrissey, whereas he shows these beds to consist of black and brownish shales, sandy argillites, shaly limestone and calcareous shales (see Summary Report, 1900, page 89), here they are composed almost entirely of hard, light-coloured, rather fine-grained sandstones with a few thin beds of gray shale. The rocks included in the coal measures consist principally of black and gray shales, dark-coloured sandstones and a few thin beds of impure dolomite.

Faulting.

On the east side the coal measures are cut off by an overthrust fault of large dimensions, the line of faulting being nearly parallel to the axis of the ridge, the upper beds of the Devono-Carboniferous limestones and quartzites being lifted to the surface and having the appearance of overlying the coal-measures. Crossing these limestones and quartzites in a northeasterly direction the lower Cretaceous beds (sandstones) are again encountered overlying conformably the Carboniferous rocks. These continue across the valley of Fording river, still dipping to the north-east at decreasing angles, till the coal measures are again met with on the eastern slope of a line of hills which lie between Fording river and the main limestone range to the east. The summits of these hills conforming approximately to the axis of the syncline of the Cretaceous basin. Besides this large fault there are evidences of a number of minor disturbances, but the limited time at our disposal made it impossible to trace them out in detail.

Quality of coal.

No analyses have been made of any of the coal from this area, but in general appearance it is very similar to the coal from the Crows Nest area. The quality of the coal in the various seams does not seem to differ to any great extent, though it is probable that the seams numbered 27 and 29, in the above section, contain a slightly better quality of coal than the remainder.

Means of access.

This area is, at present, very difficult of access, but the Elk river valley presents an easy route for a railway from the Crows Nest Branch of the Canadian Pacific railway at the junction of Michel creek and Elk river to the base of the Green hills. That part of the coal area visited, however, is situated at an elevation varying from 2,800 feet above the valley of the Elk at its southern extremity, to about 2,000 feet above the valley at the northern boundary of lot 4,588, group I, the slope from the valley to the summit of the ridge being very steep. Within these limits there are no transverse valleys of sufficient size to afford a practicable grade from the Elk valley to the coal measures. It is probable, however, that further to

the north the coal measures outcrop in the valley of Elk river and may possibly cross it to the west side.

A rough topographical survey was made of the southern part of this area, a base line having been measured with the Rochon micrometer, angles read with prismatic compass and elevations with the aneroid barometer.

Timber.

The greater part of the timber in this part of the Elk valley has been destroyed by fire, though patches of good spruce (*Picea Engelmanni*) and tamarack (*Larix occidentalis*) remain.

Sulphur spring.

There is a remarkable sulphur spring on the Elk river trail about 17 miles above the mouth of Michel creek. The river valley here is rather wide, open and prairie-like. This spring is situated immediately at the foot of the eastern slope, and occupies a basin about 75 feet long, 40 feet wide and 9 feet deep. The water is strongly impregnated with sulphuretted hydrogen gas, which bubbles up from the bottom in four or five places; the characteristic odour of the gas is noticable for upwards of a mile from the spring when the wind is from that direction. The water is warm and beautifully clear and of a bright green colour. An analysis made by Dr. Hoffmann, of specimens from the deposit at the discharge of this spring gave the following results: 'A mixture of carbonate of lime, with a small quantity of sulphate of lime, a very little carbonate of magnesia and a small quantity of free sulphur.'

Reported southern coal area.

On returning to Fernie, preparations were made to leave for the Wigwam river, where the southern coal area was supposed to be situated. Leaving Fernie on July 16 we travelled down the Elk river to the Kootenay valley, thence south to the Tobacco Plains, where I interviewed Mr. Phillips, who, as before stated, had first mentioned the existence of this supposed southern coal area to Mr. McEvoy. Having been furnished by him with a sketch-map of the district, we returned northwards about twelve miles to Desrosier's, where the trail for the Wigwam river leaves the main road. This trail, following an easterly course, crosses the Galton range, which separates the Kootenay river from the Wigwam, at an elevation of about 6,100 feet, coming down to the Wigwam river about twelve miles above its mouth. Crossing the river here, we ascended Bighorn creek, a large tributary from the east, camping about four miles up this stream. Some days were spent here examining the rocks in the vicinity. These consisted chiefly of quartzites with some dark quartzose argillites and micaceous schists. Similar rocks had been crossed all

Rocks of Bighorn creek.

the way from Desrosier's to the Wigwam river, referred to by Dr. Dawson as the 'Quartzite Series' of Cambrian age.*

The attitude of the Cambrian strata is here considerably disturbed, the axes of the folds being, generally speaking, along north-and-south lines. These rocks are overlain by a great thickness of limestones of Devono-Carboniferous age, which were also met with on Bighorn creek, about half a mile east of our camp and they apparently extend eastwards to the head of the creek, forming the backbone of the Macdonald range, a high and extremely rugged group of mountains which forms the divide between the Flathead and Wigwam rivers.

Return to Tobacco Plains.

Being satisfied that there were no coal-bearing rocks in the basin of Bighorn creek, I returned to Tobacco Plains to obtain, if possible, further information, Mr. Denis remaining at Bighorn creek continuing the topographical work of that neighbourhood. On arriving at Tobacco Plains, I visited Mr. Phillips again. He stated that coal existed further up the Wigwam river, near the international boundary, and offered to send his son with us to point out the locality. The following day I started back for Bighorn creek with the understanding that Mr. Phillips, jr., would overtake us before evening. However, he did not put in an appearance; so, after waiting two days at our old camp on Bighorn creek, it was decided to move on up the Wigwam without him. This river here flows nearly due north and occupies a rather wide, flat-bottomed valley. There being no trail, progress was necessarily slow, but advantage was taken of the low state of the water, which enabled us to keep in the river bottom, crossing and recrossing from one bar to another, except in places where the valley narrowed to a gorge, compelling us to cut a trail on the hillside. In this manner the river was ascended to the international boundary.

Ascent of Wigwam river.

Camps were made at several points in the valley and from them the country was explored on either side, but nowhere were any Cretaceous rocks found, the hills on both sides being composed of Cambrian strata, chiefly quartzites. Time was not available to make any complete section of these rocks, the structure generally being somewhat complicated with evidences of much faulting and folding. The upper beds are composed chiefly of rather thin-bedded white quartzites. These are underlain by altered greenish and grayish argillites, usually highly siliceous, some thin beds of gritty silicified sandstone followed by massive red quartzite and impure dolomitic limestones. Near the summit of the Galton range, about five miles north of the boundary, a very hard dark-green intrusive rock was seen cutting the Cambrian

*See Annual Report, Geol. Surv., Can., 1885, (N.S.), vol. I, page 78B.

strata; this was the only intrusive rock noted in place, though in the drift of the river and its tributaries in the vicinity of the boundary there were many fragments of a dark very hard amygdaloidal trap. These Cambrian rocks extend from the river westwards at least to the summits of the Galton range and eastward about five miles, when the Devono-Carboniferous limestones of the Macdonald range are found overlying them.

The ground covered, included practically all of the Wigwam basin, from the mouth of Bighorn creek to the international boundary, and within these limits it is fairly certain that no coal-bearing rocks exist. A few days before returning to Ottawa, however, I was informed that coal was reported to have been found between the head of the Wigwam river and Tobacco Plains on the west slope of the Galton range. If there is any truth in this report, the area must be very limited in extent.

Timber.

The valley of the Wigwam river is well wooded throughout with timber of fair size; spruce, (*Picea Engalmanni*), and black pine, (*Pinus Murrayana*) being the predominant trees of the lower levels, while on the higher ridges *Pinus Albicaulus* and *Abies Subalpina* are most abundant.

Game.

Deer are very plentiful, and this valley appears to be one of the few remaining places in this part of British Columbia where beaver are to be found in any numbers.

As the object of our exploration was to search for coal, any detailed topographical work was not attempted, but enough was done to compile a preliminary map of this section.

Arrival of Mr. Pearce.

When we returned to Fernie on August 17th instructions were received to await Mr. Wm. Pearce and co-operate with him in the selection of coal lands that he was to make for the Government. In the meanwhile a few days were spent in preparing a sketch-map and short report of the Green Hills area. Mr. Pearce arrived on the 21st and until August 27th we were engaged with him in examining the various openings that had been made on the coal seams of the Crows Nest Coal Field.

A trip was then made to Marten creek and the South Fork of Michel creek with the intention of defining the eastern outcrop of the coal measures, but work had hardly been begun there when a message was received from Mr. Pearce, requesting us to return to Fernie to meet Messrs. Taylor and Turriff who had arrived there from Ottawa to undertake with him the selection of the Government coal lands.

About ten days were occupied in going over the ground with these gentlemen, after which we returned to Marten creek. The lateness of the season with the presence of snow prevented us from continuing our work in the higher mountains, so the remainder of our time was spent in measuring a section of the coal measures on this, the easterly outcrop of the basin as well as examining the upper valley of the South fork of Michel creek with reference to its suitability as a site for mining operations.

Localities suitable for mining operations.

Mr. McEvoy, in his report of last year, mentions five localities from which the coal measures are easy of access, two of these, Michel and Coal creeks, as well as the north side of Morrissey creek are already occupied by the Coal Company, while on the south side of Morrissey creek some prospecting has been done by the Canadian Pacific Railway Company. No important development work has as yet been done at either of the remaining localities—Lodgepole creek and the South Fork of Michel creek. The first of these was visited by Mr. Pearce, while we directed our attention to the latter.

South fork of Michel creek.

The coal measures outcrop in the valley of the South fork of Michel creek, at a point about 10½ miles above the 'loop' of the Crows Nest Branch of the Canadian Pacific Railway, and at an elevation of about 900 feet above the railway. This valley would thus afford a comparatively easy grade for a branch line, and, as it is fairly wide and flat-bottomed, there would be ample room for coke ovens and other necessary structures. As stated by Mr. McEvoy, there are two faults running parallel to the valley, one on each side; the eastern being the most important. This fault was not traced northwards farther than the branching forks of the South fork. To the south, it continues nearly parallel to the stream about a mile to the eastward, to near the summit, when the valley swings round to the east, meeting the line of fault which continues across the summit and down the valley of a branch of the Flathead river. This fault is probably an overthrust from the east, the rocks to the west of it in the valley being chiefly conglomerate and gritty sandstones with some beds of brownish and yellowish arenaceous shales, characteristic of the beds overlying the coal measures.

Western fault.

The western fault lies generally below the outcrop of the coal seams on the face of the escarpment, and dies out about one mile and a half south of Marten creek. The structure here is difficult to trace out as the hillsides are heavily drift-covered and densely timbered, exposures being very scarce. However, it is possible that this is also an overthrust fault, the movement in this case being from the west. If so, the area lying between these two faults in the valley-bottom

must be underlain by the coal measures, but further information is necessary before the attitude of these beds is made entirely clear.

The section given below was measured at a point on the west side of the creek, about two miles and a half south of the mouth of Marten creek. The lower seams are not included, as they outcrop in the valley-bottom where the covering of drift is so deep that it was impossible to uncover them in the time available. The strike here is generally about N. 9° W., dip about 25° to the west, gradually flattening towards the west. This dip remains fairly regular to the north for about a mile, when the western fault mentioned above is met with. To the south the coal seams gradually disappear beneath the bed of the creek, which is here rising rather rapidly, till the summit is reached, when they are cut off by the eastern fault and do not outcrop again for some miles down the Flathead river.

The section which follows, measured by Mr. Denis, is given in descending order:

Measured section.

	Feet.
1. Gray arenaceous shale with occasional narrow bands of black shale	46·2
2. Sandstone	61·5
3. Gray shale	24·9
4. Coal	4·2
5. Gray shale	30·0
6. Black shale	3·2
7. Coal	2·8
8. Black shale	3·2
9. Gray shale with narrow bands of black shale	89·3
10. " "	9·2
11. Black "	10·0
12. Sandstone	0·7
13. Gray and black shale	8·4
14. " shale	47·5
15. Coal	2·0
16. Gray shale with narrow bands of carbonaceous shale	5·7
17. "	82·7
18. Coal with shale parting	3·6
19. Gray shale	9·4
20. Black "	3·0
21. Gray "	7·7
22. Coal	0·8
23. Gray shale	64·7
24. Coal with shale parting	7·3
25. Gray and black shale with a little coal	8·7
26. " shale	25·0
27. Coal	1·5
28. Black shale	4·6
29. Gray "	7·2
30. Coal	13·0
31. Black shale	0·8

32. Arenaceous shale with thin beds of sandstone	31·0
33. Gray shale with a little coal	73·5
34. Carbonaceous shale and coal	1·6
35. Gray shale	8·2
36. Coal	2·1
37. Shale	16·1
38. Covered	32·0
39. Sandstone	8·2
40. Arenaceous shale with narrow bands of black and carbonaceous shale	32·0
41. Black and carbonaceous shale with thin seams of coal	24·4
42. Coal with shale parting	7·1
43. Black shale with thin seams of coal	46·1
44. Dark grayish shale	15·6
45. Coal with shale parting	25·2
46. Black shale with thin seams of coal	10·0
Total	921·8
" thickness of coal	69·6

A comparison of this section with that measured by Mr. McEvoy last year near Morrissey, gives the following results :—

Correlation with section near Morrissey.

On South Fork of Michel Creek.		*Near Morrissey.*	
Seams numbered,	Feet.	Seams numbered.	Feet.
24 Coal with partings	7·3	50 Coal	7·0
Intervening beds	47·0	Intervening beds	35·0
30 Coal	13·0	53 and 55 Coal with parting	14·0
Intervening beds	115·1	Intervening beds	154·0
36 Coal	2·1	58 Coal	3·0
Intervening beds	112·7	Intervening beds	120·0
42 Coal with partings	7·1	61 Coal	10·0
Intervening beds	61·7	Intervening beds	140·0
45 Coal with partings	25·2	63 Coal (upper 10 feet impure)	36·0

It will be seen from the above table that the coal seams are fairly persistent, considering the fact that these two points are about ten miles apart. The intervening beds, however, show a wider variation with a decided tendency to thin out in the lower part of the section at least.

The Crows Nest Pass Coal Company are operating mines at three points, Michel, Coal creek and Morrissey creek. At present Coal creek is their principal point of supply, producing over 1,600 tons a day. During the past summer extensive improvements have been made and new machinery installed, two Robb engines of 250 horse power each, one 200 horse-power compressor, and a new ventilating fan with a capacity of 250,000 cubic feet of air per minute, as well as a new tipple for the No. 1 mine having been added to the plant at Coal creek. With these additions in operation it is expected that the output will be very largely increased before long.

Mining operations.

At Michel the output has been about 200 tons a day, won chiefly in the course of development work. Mining at this point is attended with more difficulties than at either Coal or Morrissey creeks, several faults having been encountered, the structure generally being more disturbed, and the coal more sheared and friable.

Railway construction.

No shipments have been made as yet from Morrissey but preparations are well under way and it is expected that before long the output from this point will equal or even exceed that from Coal creek. A spur line is now nearing completion from the Crows Nest Southern Railway to these mines. This railway, at present under construction, runs from Fernie to Tobacco Plains, there connecting with the Great Northern Railway, and will afford an outlet to the south for a large output of coal. Six seams have been opened up at Morrissey which correspond to seams numbered 61, 63, 71, 73, 75 and 81 in Mr. McEvoy's section (see Summary, 1900).

The Crows Nest Pass Coal Company have now in operation at Fernie 424 coke ovens, of which 112 have been built during the past summer, producing about 850 tons of coke a day. At Michel, a battery of 212 ovens is now under construction, while at Morrissey the company is contemplating building 50 more.

Prospecting by C.P.R.

As before mentioned, the Canadian Pacific Railway Company has done some prospecting work on the south side of Morrissey creek. In addition to this, some work has been done by this company on the South fork of Michel creek, several seams having been uncovered here. In most cases, however, sufficient work was not done to show the thickness of the seams and, on account of the disconnected nature of the work, the relationship of the seams in the various openings was not clearly shown. Two bore holes were sunk with a diamond drill by this company near Michel, both immediately alongside the railway, the first (No. 1) about 1·4 miles, and the second (No. 2) about 2 miles south-east of the station. Copies of the records of these borings, kindly furnished by the company, are given below.

No. 1 Drill Hole.

Drill holes at Michel.

	Feet.	In.
1 Sand and gravel	7	6
2 Hard gray sandstone	41	6
3 Conglomerate	23	0
4 Hard sandrock and conglomerate	16	0
5 Soft black sand	2	0
6 Slate	21	6
7 Coal and slate	1	6
8 Coal	3	0
9 Slate	15	0
10 Coal	3	

	Feet.	In.
11 Slate	15	0
12 Sand shale	26	6
13 Coal	0	6
14 Soft black slate	1	6
15 Coal	2	0
16 Sand shale	73	6
17 Coal	5	0
18 Coal and slate	20	6
19 Sand shale	22	6
20 Gray sandrock	20	0
21 Slate	13	6
22 Coal	3	9
23 Soft slate	0	9
24 Coal	2	3
25 Soft slate	1	0
26 Coal	3	3
27 Soft slate	0	9
28 Coal	1	3
29 Soft slate	1	0
30 Coal	2	0
31 Soft slate	0	9
32 Coal	2	0
33 Slate	6	6
34 Coal	7	0
35 Sand shale	10	0
36 Dark hard sandstone	94	0
37 Coal	4	0
38 Slate and coal	2	0
39 Sand shale	13	0
40 Black slate	25	9
41 Coal	5	6
42 Slate and coal	4	9
43 Sand shale	11	0
Total	536	0

No. 2 Drill Hole.

	Feet.	In.
1 Sand and gravel	6	0
2 Gray sandrock	75	0
3 Gray sandrock and conglomerate	12	0
4 Slate	18	6
5 Coal	2	6
6 Slate	18	0
7 Slate and coal	1	0
8 Coal	5	0
9 Slate and coal	3	0
10 Slate	7	0
11 Coal	2	0
12 Slate	23	0
13 Shale	119	0
14 Dark gray sandrock	23	0
15 Slate and coal	10	0
16 Coal	8	0

		Feet.	In.	Section.
17	Slate	0	6	
18	Coal	0	6	
19	Slate	0	3	
20	Coal	7	3	
21	Slate	1	3	
22	Coal	0	6	
23	Slate	7	6	
24	Coal	8	9	
25	Slate	0	9	
26	Coal	6	3	
27	Slate	0	9	
28	Coal	0	6	
29	Slate and coal	5	9	
30	Coal	2	0	
31	Sand shale	10	0	
32	Dark gray sandrock	58	0	
33	Black slate	10	3	
34	Coal	2	6	
35	Sand rock, shale and slate	39	9	
36	Slate and coal	1	0	
37	Hard gray sandrock	13	0	
	Total	510	0	

It will be noticed that there is no mention of the dip of the strata in either case, so that it is probable that a deduction from the above figures should be made, as it is not likely that the strata here are horizontal. It is evident that the sections shown by these two bore holes are at the same horizon, although the coal seams show a wide variation in the two holes, one seam, No. 17, shown in bore hole No. 1, not appearing in No. 2 hole. This may be due to local thinning out. These sections hardly afford sufficient information to attempt a correlation with Mr. McEvoy's section near Morrissey. It is possible, however, that the seams from Nos. 22 to 34 in bore hole No. 1 and from Nos. 16 to 30 in bore hole No. 2 represent the seams included between Nos. 77 and 81 in the Morrissey section.

Fossils.

The following fossils were collected during the summer, both from the coal-bearing rocks and the underlying limestone, all of them, as yet, being undetermined: Seven fragments of belemnites and one impression of an ammonite from the shales underlying the coal measures near Fernie; one fossil plant from lower shales at Hosmer, two fossil plants from coal seams at Morrissey, eighteen fossil plants from coal seams at Green Hills, four corals and several spirifers from top of Devono-Carboniferous limestones of the Green Hills.

Red Deer River, Alberta.

Mr. Lawrence M. Lambe.

The second part of 'A Revision of the Genera and Species of Canadian Palæozoic Corals' was issued early in May. This report, referred to in last year's Summary as being then in the press, forms part II of volume IV of 'Contributions to Canadian Palæontology' and is descriptive of the Madreporaria Aporosa and the Madreporaria Rugosa. The two parts of this report on fossil corals together comprise two hundred pages of text illustrated by eighteen plates.

Cretaceous vertebrates.

The study of the vertebrate remains from the Laramie and Belly river series of the Cretaceous of the North-west Territories was continued during the past year, and considerable progress has been made therein, the object in view being the production of an illustrated report, descriptive principally of the Dinosaurian, Chelonian and Crocodilian remains found so admirably preserved at many localities in our North-west. The material available for study consists, for the most part, of collections made by myself on the Red Deer river, Alberta, in 1897 and 1898, to which has been now added a large collection made during the past summer in the same locality. Additional to these collections are specimens previously obtained from the same horizons, at a number of localities in the North-west, by officers of the Survey, viz: by Dr. G. M. Dawson in 1873, 1874 and 1881; by Professor John Macoun in 1880, by Mr. R. G. McConnell in 1882, by Mr. T. C. Weston in 1883, 1884 and 1889 and by Mr. J. B. Tyrrell in 1884.

Collection of Dinosauria.

Field-work.

Over two months, viz., July, August and part of September were spent in the field this year. Acting under instructions to supplement the collections of 1897 and 1898, by spending another season in the Red Deer river district, I left Ottawa on July 2 and proceeded direct to Medicine Hat, Assiniboia, where provisions, etc., were procured. The Red Deer river was reached by trail from Bantry, a flag station on the Canadian Pacific Railway, about sixty-five miles north-west of Medecine-Hat.

In the extensive area of 'bad-lands,' exposing the rocks of the Belly river series of the Cretaceous, on the Red Deer river between the mouth of Berry creek and Dead Lodge canyon, where I remained in camp until the end of the first week in September, I was successful in securing a large collection of Chelonian, Dinosaurian, Crocodilian, fish, primitive mammalian and other vertebrate remains of considerable

scientific value. This collection is of importance in working out the material already on hand, as it throws much additiona llight on some of the problems relating to the generic and specific affinities of the animals represented in the collections of former years. It also adds to our knowledge of Cretaceous vertebrate life generally, indicating at the same time the richness of the palæontological field in the north-west and the possibilities there for further research. Importance of collection of 1901.

I was assisted in the field by Mr. Heber Cole, of Montreal, who contributed materially in every way to the success of the expedition. After returning from the west, until the end of the year, my time was almost entirely occupied in a preliminary study of the newly acquired material from the Red Deer river.

A short paper on *Adocus variolosus*, Cope (sp.), one of the turtles represented in the collections from the Red Deer river, was issued in June last. This report appeared in the 'Ottawa Naturalist' under the title 'Notes on a turtle from the Cretaceous rocks of Alberta' and is illustrated by four plates. Cretaceous turtle.

The following notes are descriptive of some interesting turtle remains collected last summer :—

ON TRIONYX FOVEATUS, LEIDY, AND TRIONYX VAGANS, COPE, FROM THE CRETACEOUS ROCKS OF ALBERTA.

By Lawrence M. Lambe.

(With four plates.)

During the past summer whilst engaged, on behalf of the Geological Survey, in making a collection of vertebrate remains from the Cretaceous of the Red Deer river, Alberta, to supplement the material obtained in two former years, the writer was fortunate enough to secure two almost complete carapaces of turtles, one referable to *Trionyx foveatus*, Leidy, the other to *T. vagans*, Cope. In the Red Deer river district, referred to, the remains of these two species are abundant and are found associated with a number of other species of Chelonia, of which one is *Adocus variolosus*,* Cope (sp.), remarkable

*Proceedings of the Academy of Natural Sciences of Philadelphia, vol. XXVIII, p. 257, 1876 (Cope), and Ottawa Naturalist, vol. XV, p. 63, plates iii, iv, v and vi (Lambe).

alike for its size and the strikingly rugose character of the sculpture of its shell. The rocks holding these remains belong to the Belly river series of the Cretaceous brackish water deposits underlying the Pierre Fox-Hills formation, by which they are separated from the still higher Laramie series.

Trionyx foveatus† was originally described in 1860 by Leidy from small fragments of costal and sternal bones from the Judith river beds of Nebraska.

The Red Deer river specimen of *T. foveatus* consists of the carapace, in which the nuchal plate is missing, without any part of the plastron. Sternal plates, probably referable to this species, were found not far distant, but further reference will not be made to them here.

The carapace (Plate II, fig. 2) is a little less than one-fourth broader than long, and is only slightly convex. The eight costals of the left side are practically entire, but the first right costal is wanting. Five neural plates are preserved with part of another that lay principally between the first costals, its posterior end being between the front inner borders of the second costals. If this neural were as long in proportion to its breadth as the plate immediately following it, its front margin probably effected a sutural union with the nuchal plate, and its outline was presumably as is shown by the dotted lines in the figure.‡ Neurals two, three and four are six-sided, neural five is oblong, and neural six, lying for the most part between the sixth costals, is shield-shaped, coming to a point behind. The seventh costals are suturally united at their inner ends, where they develop a breadth sufficient to separate the eighth costals from each other. These latter are subtriangular in shape, with three convex sides. The nuchal plate was evidently small, as the lateral termination of the suture (*a* in the figure) between it and the left first costal indicates a side extension scarcely past a point in advance of the mid-length of the first costal. Small, shallow, rounded depressions mark the surface of the neurals and the inner ends of the costals. In the latter, as the distance from the neurals increases, the depressions gradually grow larger and more decided, becoming often reniform or

†Transactions of the American Philosophical Society, vol. XI, p. 148, pl. xi, figs. 1 and 2. Extinct Vertebrata from the Judith river and Great Lignite formations of Nebraska.

‡Since the above was written some misplaced fragments have been added to the anterior end of this carapace; they reveal the fact that the first costals are in reality separated by a divided first neural. The writer wishes here to express his indebtedness to Professor Osborn and Dr. Hay, of the American Museum of Natural History, for the loan of the type of *Trionyx vagans* and the opportunity thus afforded him of making a direct comparison of the type with the Red Deer specimen.

oval, and frequently coalescing, until in the distal ends of the costals a few more or less continuous furrows are formed parallel with the outer margins of the plates. These furrows are a conspicuous feature in the sculpture; they are not so well marked on the posterior margin of the carapace, but they are well developed near the front edges of the first costals. In the neurals and inner halves of the costals there is a narrow, smooth strip devoid of sculpture bordering the sutures. The rib-heads are well developed.

Measurements :

	M.
Estimated length of carapace along median line ($6\frac{7}{10}$ inches)....	·170
Distance from front margin of first costal to back margin of seventh costal (slightly over $6\frac{1}{2}$ inches).....	·167
Maximum breadth of carapace ($8\frac{4}{10}$ inches).....	·214
Length of second neural.	·023
Maximum breadth of second neural.....	·017
Thickness of fourth costal at centre near inner end.....	·005
Thickness of fourth costal at centre near outer end.....	·005
Thickness of eighth costal at centre.....	·005

Trionyx planus,* Owen and Bell, a British Lower Eocene species, described from the posterior half of the carapace, bears a strong general resemblance to *T. foveatus* as regards the sculpture and also in the absence in both species of the seventh and eighth neurals accompanied by a similar curtailment of the sixth neural. The strong development of the seventh costals found in the Red Deer river carapace resulting in a reduction of the eighth pair of costals may be an irregularity of growth of no specific importance.

The second species of *Trionyx* represented by an almost complete carapace is referred to *T. vagans*, Cope, first described by that authority in 1874† from 'a number of fragments of costal bones and perhaps of sternals also,' from the 'Lignite cretaceous of Colorado; near the mouth of the Big Horn river, Montana; Long lake, Nebraska; found at the last two localities by Dr. Hayden.' Later, in 1875, in 'The Vertebrata of the Cretaceous Formations of the West' the same description appears; this time with figures of two fragments of costal bones. Dr. O. P. Hay, of the American Museum of Natural History, New York, has kindly compared part of a costal plate from the Red Deer river with fragments labelled *T. vagans* by Professor Cope in the New York collections. Owing to the insufficiency of the published

* Monograph of the British Reptilia of the London Clay, part I., p. 58, tab. XIXC, 1849, Palæontographical Society.

† Bulletin of the United States Geological Survey of the Territories, 1874, No. 2, p. 29.

description and figures of this species, the writer could scarcely judge whether the Canadian specimens were or were not referable to *T. vagans*, but Dr. Hay writes that he thinks they probably are.

The carapace (Plate IV, fig. 4) is broader than long, the breadth exceeding the length by more than one-sixth and it is only moderately convex. In outline, as seen from above, it is flat behind with the sides curving broadly to the front margin, at the centre of which there is a shallow concavity. The shell protrudes where the ribs pass outward from beneath, causing the lateral margin to be sinuous, the sinuosity being most marked toward the front in the first, second and third pairs of costal plates. Of the eight pairs of costals, the first costals are the broadest at the inner ends, whilst the fifth are the broadest distally. The seventh costals are extremely narrow throughout their length and the eighth pair is well developed. The first costals increase in breadth rather suddenly at their outer ends and are separated by a divided first neural plate. The neurals gradually decrease in breadth to the fifth, their sides being not so nearly parallel to each other as those of the corresponding plates in *T. foveatus*. The sixth and last neural is very much reduced in size and is irregularly oval in outline. Of the protruding rib-ends, all the six of the left side were secured, in a fair state of preservation, except the one belonging to the first costal and it was obtained in part. The rib-heads are well developed. In the figure, the nuchal plate is represented as entire. Of the carapace under consideration, the central part only of the nuchal plate, extending from the margin in front to the suture behind, was found, but fortunately the left end of a nuchal, of another individual of similar size, showing the left front margin and the suture between the plate and the first costal with part of the latter adherent, supplied the deficiency. The sculpture consists of a network of narrow ridges ramifying and inosculating so as to enclose small, sunken areæ of irregular shape and size, the areæ being generally wider than the ridges are broad. The frequent confluence of a varying number of areæ results in a more open pattern, the ridges at times shewing a tendency to run in parallel lines. The sculpture is not so distinctly defined near the sides of the carapace as it is toward and at the centre and anteriorly, but in the hinder part it is more decidedly rugose, the ridges being here higher and the enclosed areæ larger. Near the intercostal sutures, more particularly in the inner halves of the costal bones, the sculpture is partially effaced and consists of low, poorly defined parallel ridges at right angles to the sutures, forming a distinct border, with a maximum breadth of about ·5 centimeters. A smooth border, broadest at the sides of the carapace and narrowest in front, extends along the whole of the peripheral edge.

As regards a divided first neural in species of this genus, it is interesting to note that Lydekker in describing *T. melitensis*, from the Miocene of Malta, in 1891, (Quarterly Journal of the Geological Society, vol. XLVII, p. 37, fig. 1) mentions the occurrence in the Miocene species of a divided first neural and remarks (p. 37) that 'all the fossil species hitherto described, of which the entire carapace is known, agree with the normal type in having but a single long neural between the first pair of costals.'

Measurements :

	M.
Length of carapace along median line (18½ inches)	·470
Maximum breadth of carapace (23$\frac{2}{10}$ inches)	·590
Breadth of first costal at inner end	·075
Thickness of same near inner end	·009
Thickness of same at outer end	·012
Breadth of fifth costal at outer end	·119
Thickness of same at outer end	·013
Breadth at mid-length of seventh costal	·036
Thickness at centre of eighth costal	·010
Maximum breadth of neural 1	·056
Maximum breadth of neural 1a	·039
Length of same	·043
Thickness of nuchal plate at left end	·018
Length of vertebral centrum	·045

EXPLANATION OF PLATES.

PLATE I.

FIGURE 1. Upper surface of the carapace of *Trionyx foveatus*, Leidy; from the Cretaceous of Alberta. One-half natural size. The sinuous lines indicate the sutures between the bones; the dotted ones parts restored; NU, nuchal bone; N 1, 2, &c., neural bones; C 1, 2, &c., costal bones.

FIGURE 1*a*. Outline of the transverse curve of the upper surface of the carapace.

PLATE II.

FIGURE 2. Upper surface of the carapace shewn in plate I; from a photograph. Considerably over one-half the natural size.

PLATE III.

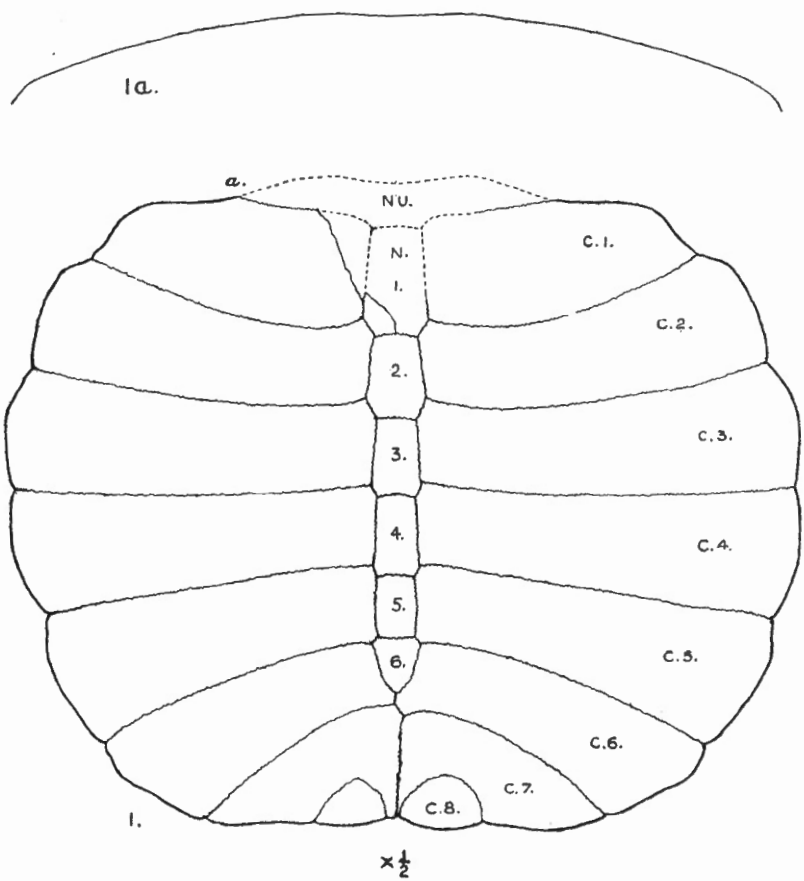
FIGURE 3. Upper surface of the carapace of *Trionyx vagans*, Cope; from the Cretaceous of Alberta. One-eighth the natural size. Lines and letters as in figure 1 of plate I.

FIGURE 3*a*. Outline of the transverse curve of the upper surface of the carapace.

FIGURE 3*b*. The sculpture of part of the upper surface of the same carapace; from a photograph. Natural size.

PLATE IV.

FIGURE 4. Upper surface of the carapace shewn in plate III; from a photograph. Slightly less than one-fourth natural size.


1a.
a.
NU.
N.
I.
C.1.
C.2.
2.
C.3.
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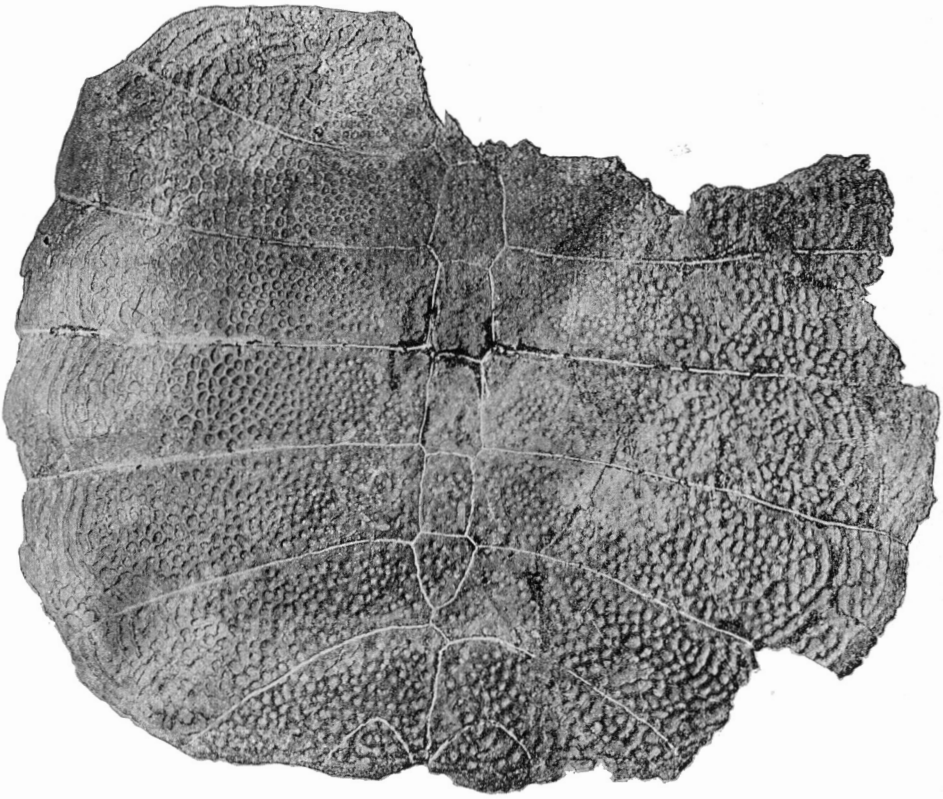

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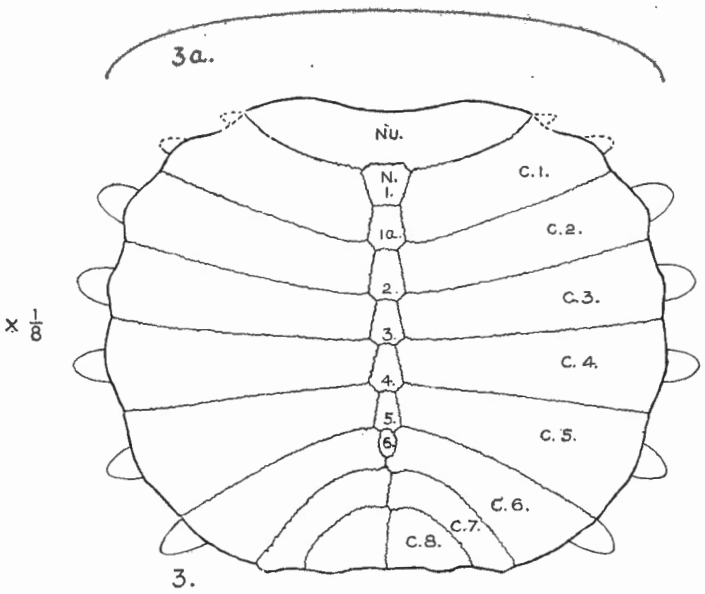
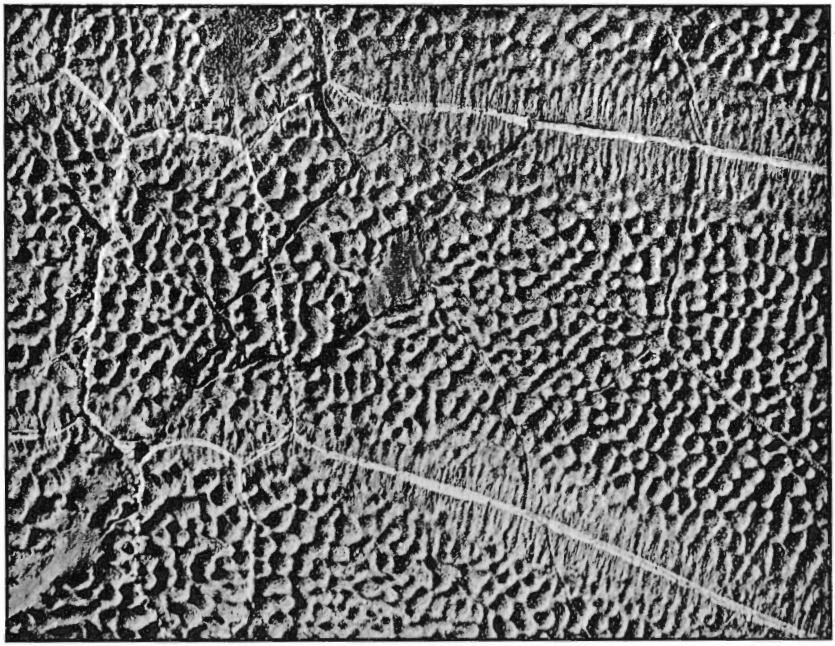
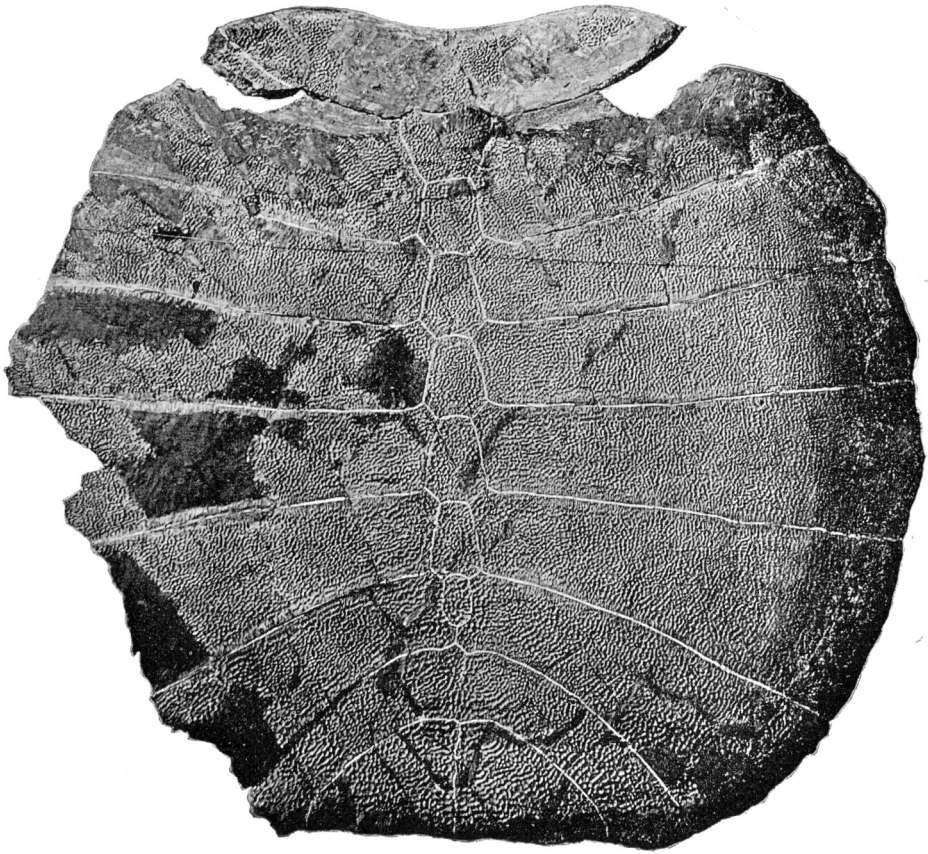




3b.



Region South-east of Lac Seul.

Mr. William McInnes.

The winter of 1900–1 was spent at Ottawa in office work and was chiefly given to the supervision of the compilation of the Manitou sheet and to the preparation of a report to accompany that and the Ignace sheet.

Scope of work.

Pursuant to instructions, the work of the past summer was directed mainly to the completion of the geological and topographical details necessary for the compilation of the geological map-sheet lying to the north of the Ignace sheet. I was accompanied from Ottawa by Mr. A. E. G. Mackenzie, of Campbellton, N.B., who had been appointed as my assistant for the summer. Mr. Mackenzie proved most willing and capable and his services during the summer were of value.

Assistant.

Canadian Northern Railway.

While waiting for canoes at Port Arthur I was enabled, through the courtesy of Mr. Mann, to make a trip to the end of the track on the Canadian Northern Railway, where part of the Atikokan iron belt was examined. At locations 138x and 139x two bands of magnetic iron ore were seen, not apparently of high percentage and shewing considerable sulphur in the form of pyrite. These belts lie about 200 yards to the north of the right-of-way and their outcrop on the hill is perhaps 100 feet above it. This favourable situation led to some exploratory work being done later in the season that resulted, I am informed, in shewing up a band of much cleaner ore. These deposits form part of the Atikokan iron-bearing belt and do not differ genetically from the others that have been described in earlier reports.

Area covered.

The primary object of the season's work was to trace with greater accuracy the Sturgeon lake gold-bearing belt and to work out, as well as possible, the geology of an area of 3,456 square miles lying to the south and east of the eastern half of Lac Seul. A micrometer survey of Sturgeon lake made during the previous summer by James Robertson, P.L.S., for the Ontario Crown Lands Department, was of great assistance and rendered a further topographical survey of that lake unnecessary. In other parts of the area, boat-log and track surveys were carried on concurrently with the geological examination. Starting from Dinorwic station the part of Minnitaki lake not already examined and of which no detailed map was available was first gone over.

Gold-bearing belt.

This lake lies entirely within the Huronian belt that has now been

traced continuously from Whitefish bay on Lake of the Woods to the Albany river, having gold-bearing veins at intervals for the whole distance. About the lake, typical Huronian (Keewatin) rocks everywhere occur, the greater proportion consisting of basic eruptives and their derived schists, with a considerable development of more acid eruptives of quartz-porphyry types and of altered sedimentaries. Work was being done on two of the numerous gold locations on the lake, viz., on Twin lakes, near the inflow of English river and at Grassy Narrows.

Conglomerate at Abram lake.

Continuing through Abram chute to Abram lake, the belt is crossed nearly at right angles to its general trend, and a good section of the rocks is afforded. At Abram lake, an interesting conglomerate, noted by Dr. Bell in 1871, is strongly developed, outcropping in a striking way to form a chain of islands that, with projecting points on either shore, nearly cut the lake in two. This conglomerate is made up of pebbles, from quite small to two feet or more in diameter, enclosed in a felspathic green schist matrix, the pebbles being well-rounded and water-worn, like beach pebbles. They include granite and granite-gneiss (in greatest proportion), fine banded gneiss, schist, flinty quartzite, diorite, and white vein-quartz.

Conglomerate belt.

The strike of these outcrops is N. 60° E., and they may be traced on this course to Little Vermilion lake to the west, where both conglomerates and associated quartzites are well exposed, and up the Sturgeon river to the east. Continuing towards Lac Seul, the northern edge of the Huronian belt is reached at the northern side of Pelican lake, and from this point northward, biotite granite-gneisses are continuous, striking N. 60° E. with minor, local variations. At Abram lake a number of locations for gold have been taken up, but little work has yet been done.

English river.

The descent of the English river between Minnitaki Lake and Lac Seul, estimated by barometric readings, is in the vicinity of twenty-five feet, the main drop occurring at the lower end of Pelican lake, where, by a fall and rapid, the river descends about eighteen feet. A small rapid at the entrance to Abram lake, one at the outflow and another below the forks, are the only other breaks in the continuous smooth navigation to Lac Seul.

Falls and rapids.

Fork of English river.

At nineteen miles above the lake, the river divides into two channels, emptying into the lake at points fifteen miles apart and forming an island about 100 square miles in area. The shores of Lac Seul were followed in a westerly direction only as far as the Hudson's Bay Post, biotite gneisses occurring all along with a uniform trend about N. 60°

E. Many of the islands and the north shore of the lake are drift-covered, the drift consisting of clay with overlying stratified sands containing boulders and pebbles of gneiss, of various types of Huronian rocks and of limestone, dolomite and flint holding fossils of Devonian age that probably indicate a glacial origin from the Devonian areas near James bay. The shores of Lac Seul were examined to its head at the falls on the Watap or Root river. The same biotite gneisses occur all along. They are in many places garnetiferous, the crystals of garnet in some of the coarser pegmatitic beds reaching a fair size—a quarter of an inch in diameter. Only at one point, on the south shore above Vermilion river, is there any marked change from the prevailing Laurentian type of rock. Here, though still gneisses, the finer, black bands increase in volume and show many of the features characterizing an approach to the schists of the Huronian. Though no rocks unmistakeably Huronian were seen, there is good reason to infer their presence at no great distance.

Lac Seul drift area.

Huronian.

The drift area already referred to extends easterly for some distance along the north shore, shewing at a number of places, well-marked terraces rising about thirty feet above the lake level. No veins carrying valuable minerals in any quantity were seen about the lake. The principal feeders flowing into this half of the lake are the Watap at the head of the lake, the Vermilion from the south-east, and the Wapessi, a large river entering the lake from the north above the eastern narrows and draining a number of lakes of good size.

Terraces.

Returning towards the railway, Vermilion lake and Little Vermilion lake were examined. The Huronian band of Minnitaki extends westerly beyond these lakes, petering out however before reaching the English river again. This westerly extension of the belt has been prospected for only a short distance west of Vermilion lake, owing largely to the fact that a considerable thickness of drift is reported to overlie the greater part of it.

Vermilion lake.

Vermilion lake is a large body of clear water about 9 miles long by a mile and a-half wide, and varying in depth from ninety to a hundred and twenty feet. Besides the common fish of the district it abounds in maskinongé of good size. Typical Huronian rocks occur all about the lake, including a considerable thickness of quartz porphyry. At the eastern end of the lake a deposit of fine granular iron pyrites of considerable size outcrops at the shore. Its exact extent could not be determined, owing to the covering of drift, but a width of over ten feet was seen at the outcrop. A deposit of red oxide derived from this, colours the beach pebbles for some distance and gives the lake its name of Wunnummini (Vermilion) lake.

Iron pyrites.

Conglomerate at Little Vermilion lake.

On Little Vermilion lake the schist-conglomerate of Abram lake is again seen evidently forming a persistent band between the two and associated with thick beds of quartzite similar to that of Sturgeon lake and the Matawin river. Three portages, aggregating a little over a mile and a-half in length lead, by way of two small lakes, to the south-western arm of Minnitaki lake.

Sturgeon river.

After laying in a further supply of provisions at Sandy lake, Sturgeon river was ascended to the lake. From its outlet into Abram lake, the river is a succession of lake-like expansions, as far as the first fall and portage, a distance of ten miles. For this distance it follows the Huronian belt, the southern edge of the gneiss lying from half to three-quarters of a mile to the north all along and cutting some of the northerly expansions, the immediate contact being in low land without outcrops. About a mile below this first portage, development work has been commenced on a vein, four to five feet wide where exposed at the shore, in a mineralized quartz-schist band, a fissured and crushed form of the banded quartzose felsite. A shaft, sunk on this band close to the vein, was filled with water. The dump showed principally schist with irregular lenses of bluish quartz impregnated with iron and copper-pyrites. This vein is claimed to carry good gold values.

Dog river.

Just above the portage, a large tributary comes in on the right bank carrying perhaps a third of the water of the river. This branch of the river is known to the Indians as Dog river (Annim-o-sibi). For the first nine miles from its mouth, the river lies in the granite-gneisses when it crosses an arm of Huronian felsites, diorites and schists which is probably a continuation of that crossing the Sturgeon river at the portage.

Portages.

Above this band the gneisses again come in. There are in all fourteen portages on the Sturgeon river, aggregating about two miles in length and showing a rise between Abram and Sturgeon lakes of about 160 feet.

Survey of Sturgeon lake.

On Sturgeon lake, the survey made by James Robertson, P.L.S., in 1900, was used, and attention was given only to the geology and to surveying tributary lakes and streams. The outlines of the gold-bearing Huronian were found to be irregular in the extreme and could only be fixed by traversing all the smaller lakes and streams in the neighbourhood.

Prospecting for gold.

Much prospecting work was done during the summer and many gold claims were located. On only about half a dozen of these had any development been done. On one location, owned by a St. Catharines syndicate, with the precipitancy so characteristic of the earlier years in the district, a five-stamp mill was erected and worked during part of the summer with good results in the amount of gold

extracted. Development was not, however, sufficiently forward and it was wisely resolved by the present manager, Mr. Smaile, to close down the mill and give all attention during the winter to sinking a shaft and further proving the property. Sturgeon lake mining Co.

On the location lying to the east of that on which the mill is situated, a vein has been partly uncovered in the schists. It has been traced at intervals by large bunchy outcrops of quartz for a considerable distance, in a direction about 15° E. of N. One of these bunches has proved phenomenally rich in nuggety gold at the surface. Owing to disputed ownership, only a little preliminary stripping has been done. Gold locations.

Another property on which extensive surface development has been done is the St. Anthony Reef, lying near the contact between the Laurentian and Huronian, a little south of the Dawson property, above referred to, and between Sturgeon and Couture lakes. There is here an arm of highly altered intrusive granite which, though not as far as seen, connected with the main body of granite-gneiss, is probably genetically the same. Along the contact, a broad zone of shattered rock, upwards of 200 feet wide, is filled with secondary quartz in the form of small veins, lenses and stringers. Where an open cut has been made from the contact westerly into the crushed zone in the granite it is seen to be made up largely of quartz with the included minerals, zinc-blende, galena, chalcopyrite and pyrite occurring segregated in quite distinct coarsely crystalline masses. A pay streak with very high values has been partially traced out, and it is claimed that the whole mass is milling ore. In the schists, the vein contents are more evenly distributed and less coarsely crystalline. The contact between the green schists and the granite mass follows a very irregular course, and the vein, with a general strike nearly north, breaks away into the granite to the north and into the schists to the south, where the contact abruptly changes its direction. Sinking is being prosecuted, and the property is provided with engine house, power drills, &c., with the necessary buildings for the accommodation of the workmen and staff. St. Anthony Reef. Contents of vein.

A little further down the shore, Mr. Symmes was doing development work on a vein that seems to be really a crushed band in the granite-gneiss close to the contact. The vein is generally narrow but swells into large pockets of mineralized quartz, seven or eight feet wide. Argentiferous-zinc blende and galena, with pyrite and free gold, occur in the vein, the narrow, more vein-like portions being exceptionally rich. Locations.

Between the two last noted localities and near the same contact, on location 694 are seen veins running about N. and S. and E. and W. Location 694.

They occur in a somewhat felspathic green schist and have the lentic ular character so common. Sufficient work had not been done to afford information as to their extent. They show visible free gold and native copper in small quantity. At location 207, the property of the Anglo-Canadian Gold Estates, considerable stripping had been done under the supervision of Mr. Girard on a vein running N. 10° E. through green schists, near their contact with an arm of highly altered granite. The vein is lenticular in character and varies in width from seven or eight feet to quite a narrow streak, and is in places rich in visible free gold. It follows partly the line of contact, but is better defined where it has the green schists on both walls. Pyrite, chalcopyrite and a little native copper also occur in this vein. On the opposite side of the Huronian belt, at Belmore bay, a number of properties have been taken up and some work has been done in the way of stripping and showing up the veins.

Location 207.

Belmore bay.

With the object of tracing further the Sturgeon lake gold-bearing belt, a northerly route was followed to the Albany river. Leaving the northerly arm of Sturgeon lake by a small brook entering ten miles north of the outlet and ascending the brook for two miles, a portage of two miles led to a lake about a mile in length. From the head of this lake a portage of thirty-five chains took us to a long narrow lake extending north for over four miles, from which the large lake known to the Indians as Musipomigut and roughly indicated on existing maps under the name Savan lake, was reached by a quarter of a mile portage. A log-survey of the lake proved that there was little or no resemblance between the real lake and its representation on the existing maps. We found it to be a little over twenty-three miles in length in a direction about N. 20° E., having a central portion forming the main lake eleven miles long by five miles wide, with a number of bays of considerable length branching from it. The Huronian belt of Sturgeon lake was found to be continuous almost to the foot of the lake, the two arms, one running northerly to the outlet and the other north-easterly, extending into the granite-gneisses on either side of the central belt.

Route to Musipomigut lake.

Huronian belt.

The lake is characterized by many shallow bays that are divided from one another along the shore-line by long and irregular rocky points, and at their heads, by areas of swamp. The central part of the the lake shows wide expanses of deep water, while the narrower parts and the bays are for the most part exceedingly shallow, long stretches having only a few inches of water covering a bottom of slimy mud. The forest growth is for the most part of small size and consists principally of black spruce, poplar and white birch, with occasional red and

Description of lake.

white pine. This is the highest latitude (about 50° 35') in which I have observed the white pine in this district.

The Huronian rocks are of the usual kinds, with a large proportion of massive igneous types, and include a considerable thickness of schists, conglomerates and quartzites, similar to those that occur in the same belt at Sturgeon, Abram and Vermilion lakes. A drift-covered area or basin similar to those occurring in other parts of the district, occupies part of the shores and islands of the central part of the lake. The close resemblance of this drift area to that at Lac Seul makes it probable that they are similarly derived. That at Lac Seul seems to have been laid down at the foot of a glacial barrier which cut off the drainage to the north, and so formed a lake-basin between it and the higher land to the south. Pebbles in this drift contain fossils that seem to be of Devonian age and are probably derived from strata of that age, occurring to the north near Hudson's bay. The derivation of the drift about this lake is the more interesting as colours of gold have been obtained from it. A number of pits near the shore of one of the islands showed the work of the alluvial prospector during the summer. I could not learn authoritatively that more than a few colours had been obtained.

Drift basin.

Traces of alluvial gold.

Many smaller lakes were visited and surveyed during the summer, including a chain lying between the western end of Sturgeon lake and Sturgeon river. Of these the largest is known to the Indians as Kashapwaweigamok (Straight route lake), as it affords a short and easy route from Sturgeon river to English river and the railway. The lake lies within the granite-gneiss, only its extreme south-western bay reaching down into the Huronian, where it approaches the northern end of Jarvis lake on English river. This Sturgeon lake area was visited by a great number of prospectors during the summer, some of whom extended their field north to some distance down the Albany river, following the same belt of rocks.

Straight route lake.

Prospecting parties.

A well marked iron-bearing belt was noted to the north of Sturgeon lake, extending from the lake to the south of Musipomigut for some distance up that lake. No deposit of commercially valuable iron ore was seen, the outcrops being confined to very narrow bands of magnetite in the schist or very fine gneiss.

Iron belt.

Active work is being continued during the winter at the Shore property on King bay, at the Sturgeon Lake Mining Company's and at St. Anthony's Reef, as well as, probably, on a few others.

Mining in progress.

The Country West of Nipigon Lake and River.

Dr. Alfred W. G. Wilson.

Nomenclature of rivers and lakes.

In naming lakes or rivers in this report, as far as possible, an English translation of the name by which the water-body is known to the Indians has been used. At present there is much confusion in regard to the names of many of them, because different surveying or prospecting parties have given different names to the same body of water, without any regard to those used by the natives of the district. For example, on the field-map received from the Geological Survey office at Ottawa, there is a small sheet of water just east of Black Sturgeon lake, named Pike lake. On the map published by the Ontario Goverment this summer, the same lake is called McKee lake. To the Indians, the lake is known as Kawawata or Northern Light lake, and the latter name is used in the present report. Again, the lake just east of this is Fraser lake of the Ontario map, Kahwahzehbemegog of the field map and the natives, and the Indian name is here translated Pleasure lake; Lake Elizabeth of the field map is called Susie lake on the Ontario map, and as the Indians have no name for this lake, priority holds and the lake is referred to as Lake Elizabeth in this report.

Work by Dr. Wilson.

On receiving a letter from the acting Director of the Geological Survey, dated June 17, 1901, intimating that I had been appointed to make a geological survey in the district south and west of Lake Nipigon, I reported to the Department personally in Ottawa on June 21st. Leaving Ottawa on June 26, I joined Dr. W. A. Parks in Toronto. Together we proceeded to Port Arthur, reaching that place on July 1, our steamer having been delayed by a storm on Lake Superior. After procuring the bulk of our supplies for three months, and engaging two canoemen in Port Arthur, we went to Nipigon station on the Canadian Pacific railway, where our canoes and camping outfits already awaited us. At Nipigon, Mr. Thomas M. Fyshe of Montreal, who was to act as my assistant during the summer, reported to me.

Assistant.

Parties separate at Lake Emma.

Moving into camp at the foot of Lake Helen on July 3, we commenced our ascent of the river the next day. On July 5 and 6 we were somewhat delayed by rains, but reached Lake Emma on July 8 where I parted from Dr. Parks, he proceeding up the river while I turned to the west through Lake Hannah. After making a track-

survey of South bay from Lake Hannah and examining the rocks in that vicinity, we crossed the Flat Rock portage to Lake Nipigon. Three days were spent surveying some small streams which enter South bay from the south, and in studying the geology around the bay. On July 12 we started for Chief's bay on the southwest side of Lake Nipigon, noting the geology of the peninsulas lying on either side of McIntyre, Grand, and Black Sturgeon bays. While in the vicinity of the Indian Mission on McIntyre bay, our Indian canoeman deserted, causing however a delay of only a few hours, as we were fortunate enough to secure the services of a much more efficient canoeman at the Mission.

Poshkokagan river.

On July 16 we reached the mouth of the Poshkokagan river and commenced a track-survey of that stream, beginning at the head of the first rapids. On July 18, having reached a point about two miles above the foot of the long rapids, and about eight miles from Chiefs bay, I left Mr. Fyshe in camp and proceeded with the Indian to the point were the Canadian Pacific exploration line crosses the river near Poshkokagan lake. Returning a short distance, we proceeded up Lime creek, a tributary of the Poshkokagan from the south, for a distance of about six miles and then across country due east to the headwaters of Birch creek, another tributary of the Poshkokagan. Descending Birch creek we reached our camp on July 20. Returning to Chief's bay, a survey was made of several small brooks which enter that bay from the north. On July 25 we crossed to the Kabitotiquia and descended that river to Gull bay, studying the geology *en route*. On Gull bay, a survey was made of a small lake and brook lying to the south of the east arm of the bay. From here we proceeded to Nipigon House to procure further supplies and to secure another canoeman, as the man then with us declared himself unable to work longer on account of injuries received some time before while portaging a heavy canoe.

Short surveys made.

Leaving Nipigon House on July 29 we proceeded to West bay to examine the geology in that vicinity, and thence down the west shore of the lake towards Black Sturgeon bay, making a survey of Flat Rock Point bay and studying the geology at several points *en route*. After spending a couple of days in the country immediately to the east of Black Sturgeon bay, we crossed the portage to Black Sturgeon lake. On reaching this lake the canoeman from Nipigon House became sick and practically useless. He was permitted to leave with a prospector and two Indians, a message being forwarded to the manager of the Hudson's Bay Company's store at Nipigon station asking that another man be sent. The company's agent kindly secured a man to come from that post to our camp on Black Sturgeon lake, and he

Delayed at Black Sturgeon lake.

joined us ten days later. The interval was spent by Mr. Fyshe and myself in studying the geology and topography of the country around Black Sturgeon lake, more particularly in attempting to work out the relations of the Laurentian and newer rocks immediately to the east of the lake, a number of traverses being made across the Laurentian belt.

Work accomplished.

On August 15 we were joined by the canoeman sent by the Hudson's Bay Company from Nipigon, and immediately proceeded to the portage leading to the head-waters of a small river which enters Black Sturgeon lake about the middle of the west side. On August 24 we returned to the lake, having reached a point beyond the western boundary of the map-sheet and having mapped seventeen small lakes (and connecting streams) on this system, the largest of which, Circle lake, is about three square miles in area.

Ascend Nonwatin river.

Descending the Black Sturgeon river, we reached Nonwatin lake on August 26, and on the 27th started to ascend the Nonwatin river, a swift and shallow stream with many rapids, making a track-survey of it as we went along. Being delayed somewhat by rains, we did not reach Small Trout lake, near the southern boundary of the sheet, until August 31. From this lake, trips were made to the south-west, ascending the Upper Nonwatin to beyond the boundary of the sheet and to the north-west as far as Small Trout lake on the Spruce river. From the south end of Small Trout lake we made a section directly east to the Black Sturgeon river, surveying Sucker lake near the head of Sucker creek *en route*. Returning to Nonwatin lake on September 9, a day and a half was spent in examining the country to the east of the lake. On September 12 we started towards the Nipigon river over a portage route leading from the foot of Nonwatinose lake to Northern Light lake and thence through Pleasure lake, Lake Elizabeth and a few smaller lakes to Lake Maria on the Nipigon river. Surveys were made of a few small lakes, and the northern boundary of the Laurentian area, which lies between Nipigon and Black Sturgeon rivers, was mapped.

Assistant returns home.

On reaching Nipigon station on September 21, I paid off the canoemen and Mr. Fyshe, the latter returning home on account of an injury to his knee. After spending two days in refitting and in engaging four canoemen, on September 25 I left Nipigon by rail for Sprucewood siding, near the Black Sturgeon river. Commencing at the Canadian Pacific railway crossing, we made a micrometer survey of the Black Sturgeon river as far as Nonwatin lake, reaching the latter point on October 3, having been materially delayed by snow and

sleet storms. From Nonwatin lake we proceeded to Black Sturgeon lake and commenced a micrometer survey of the Spruce river (upper Black Sturgeon), carrying the line to about three miles above Muskrat lake, on the north branch of this stream. Above this point the river is very narrow, and a long portage leads to a small lake at the head-waters of this branch, but on account of the lateness of the season I did not think it advisable to ascend further. Returning to a point about three miles from Black Sturgeon lake, we portaged across to Small Sturgeon lake, on the south branch of the Spruce, and descended this river, which is chiefly a succession of rapids, to Black Sturgeon lake.

Micrometer survey of Spruce river.

After spending a day and a-half in visiting Tchiatangs bluff on the east side of Black Sturgeon bay, Lake Nipigon, to study the relations of the rocks in that vicinity, and a portion of the day in visiting the belt of iron-bearing strata near the south-east corner of the lake, we ascended the Spruce river to Small Sturgeon lake and commenced a micrometer survey of the upper part of the river, carrying the line up to and across the height-of-land and coming out on the stream which enters East bay of Dog lake from the northeast. The lateness of the season and a shortness of supplies rendered it inadvisable to attempt to reach Eaglehead lake and several other small lakes on the Eaglehead river, a small stream which enters Spruce river at a point about eight miles from Small Sturgeon lake. I determined to descend the Kaministiquia from Dog lake and reached Kaministiquia station on the Canadian Pacific railway on October 30. Returning to Port Arthur next evening, a day was spent there in settling accounts, and two days at Nipigon station in paying off the men and in packing up the outfit for the season.

Line run from Spruce river to Dog lake.

Geology of the Area.

The rocks of the country traversed during the season belong to the Laurentian, Huronian and Cambrian, the last mentioned being represented by the Animikie formation.

Geology.

Laurentian.—Beginning south of the southern boundary of the area, extending northward as far as Lake Maria, and reappearing from beneath the traps of the Animikie formation at several points (noted by Dr. Parks) above this in the valley of the Nipigon river, is a belt of Laurentian rocks, chiefly gneiss. The northern boundary of this belt curves south in the vicinity of Lake Maria, along whose western shore the gneiss occurs in a narrow belt. From the foot of Lake Maria it runs west and then northward to the foot of Lake Elizabeth. From

Area of Laurentian rocks.

here the boundary runs a little south of west, lying but a few chains north of the outlet stream from Pleasure lake. From near Nonwatinose lake a belt of Laurentian, varying from one to two miles in width, runs northward, appearing on the east shore of Black Sturgeon lake near the long point, outcropping east of the portage from Black Sturgeon bay, and reappearing from beneath the traps of the Animikie along the base of Tchiatangs bluff, which forms the eastern side of this bay. Similar rocks outcrop in a very narrow belt, about one mile in length, along the southeast side of Grand bay, and are also seen at Gneiss island in the passage between Grand and Black Sturgeon bays.

Western boundary of main area.

The western boundary of the main area of Laurentian is approximately marked by the Black Sturgeon river from Nonwatin lake to beyond the southern boundary of the sheet. The rocks consist of alternate belts of black micaceous schists and of pink to gray hornblende-biotite gneisses, moderately fine grained in texture. In the vicinity of Nonwatin lake and east of Black Sturgeon lake, there is an area of pink to gray hornblende granite which frequently becomes a granitoid gneiss. The relationship of the granite and older gneisses is very complicated, so much so that at times it is difficult or impossible to determine any line of demarcation between the two.

Area of biotite-granite-gneiss.

To the southwest of the sheet, around the headwaters of the Spruce river, the biotite-granite gneisses, so well developed in the area of the Shebandowan sheet, were found uncovered around the shores of a small lake to the north of Ell lake, the main area occurring in the vicinity of Ell lake and from thence southward. The strike of the foliation planes of the gneisses and schists in the region preserves a uniform direction of about fifty-five degrees east of north, with variations reaching a maximum of about thirty degrees on either side of the normal.

Huronian.

Huronian.—Within the boundaries of this portion of the sheet there is but one small area which may be considered to belong to the Huronian. Commencing near the south-east corner of Black Sturgeon lake and extending south-east to the vicinity of Nonwatinose lake, is a narrow belt of highly ferruginous quartzite of an average width, so far as could be determined, of about four hundred yards. On the north-east, this quartzite band, whose beds strike N. 20° E. and are nearly vertical, is cut off by the granitoid gneiss belt referred to above, while on the south-

Red hematite bands.

west it is overlaid by later deposits. About half a mile east of Black Sturgeon lake, the quartzites are interbanded with a red hematite, sometimes quite soft, in bands rarely over a foot in width. The outcrop at this point is small, but from the topographic features of the vicinity one would expect that a much larger body of soft ore would be found in the valley near the outcrops, which are on the side of a steep incline.

Further east, other small exposures of the ore occur, but the drift covering makes it impossible to determine their extent and value without considerable stripping. I understand that locations have already been taken up along this belt, although I was unable to find any claim-stakes in the vicinity of Black Sturgeon lake. Claims have been staked north of Nonwatin and east of Nonwatinose lake. No development work of any kind has as yet been undertaken, and the value of the belt has still to be proved. The ores which I have seen vary from a soft unctuous clay-like mass of bright red hematite to a hard ore, in which are frequently found small patches of sparkling blue-black hematite. I was informed that specular hematite in larger masses has also been found in this vicinity.

Claims said to be taken up.

Animikie.—The bed-rocks of the greater portion of the area belong to the Animikie formation. These rocks are of several types, that of greatest extent in the region I examined, being a deep red dolomite, frequently brecciated. It sometimes occurs in beds about 1 foot in thickness and then it is usually fine-grained and compact; at other times it is quite shaly and may then be coarser grained. Frequently it is yellow-spotted, owing to a partial reduction of the iron oxide, and occasionally small crystals of gypsum (selenite) are found. This dolomite is well exposed along the Black Sturgeon river below the lake of the same name, and along the Nonwatin river to beyond the borders of the map-sheet. Associated with these dolomites is a highly ferruginous dolomitic sandstone, best exposed along the valley of the Spruce river. This sandstone frequently carries large inclusions of quartz in angular masses. Both of these rocks occur in beds, which, near the Black Sturgeon river, are slightly inclined toward the south-west, and which, near the boundary of the sheet on the upper Spruce river, have a dip of five degrees to the east. Small outlying areas of the dolomites occur on the east shore of Black Sturgeon lake about two miles from the outlet, and also on the west and south shores of Northern Light lake. On the Upper Spruce river near the southern boundary of the sheet the red dolomites are conformably overlain by thirty-feet of a fine-grained greenish grey hard-shale, lacking slaty cleavage, and showing many fossil mud-cracks but no organic remains. This hard shale is capped in this locality, by fifteen feet of trap, and all three rocks dip to the east at an angle of five degrees.

Area of Animikie.

Associated ferruginous sandstone.

Outlying areas of dolomite.

A rock of very wide occurrence within the district is a fine- to coarse-grained extrusive, which, pending a microscopic examination, may be called trap. The trap rock, as it occurs in this region, is probably chiefly gabbro, though there are areas in which it shows a distinct diabasic structure. The trap frequently contains enough magnetite to

Large areas of probable trap rock.

seriously interfere with compass observations. The traps are found to cover the greater portion of the area between the Nipigon river and the Poshkokagan, and from Gull bay to the southern boundary of the sheet. To the south of McIntyre bay, the trap forms an almost continuous sheet. Westward in the vicinity of the Poshkokagan, Spruce, and Nonwatin rivers, it occurs in ridges and more rarely in isolated hills. Along the west side of the Black Sturgeon river, and near the upper Nonwatin and upper Spruce rivers, the trap, in a sheet varying in thickness from fifteen to three hundred feet, overlies the sedimentary beds, apparently conformably. In the vicinity of Grand bay and Black Sturgeon lake it is found to rest upon the Laurentian.

Modes of occurrence.

On the east side of the passage between Black Sturgeon and Chief bays and in the vicinity of Tchiatangs point on Chiefs bay are small exposures of a compact greenish dolomite in beds, varying in thickness from one to six inches and apparently resting conformably upon the trap, which is here very fine-grained at the contact. On the east side of Tchiatangs point, about two miles from the extremity, similar dolomites are found, apparently overlain conformably by a trap sheet which is here over one hundred feet in thickness. A lithologically similar dolomite is found in a position apparently overlying the trap and covering about six square miles on the southwest side of McIntyre bay.

Dolomite beneath trap.

In the front of the bluff along the south side of Grand bay is found a granophyric dyke, intrusive in the lower traps, but overlain by the traps which form the crest of the bluff. These two cases of trap sheets of considerable thickness, overlying other rocks closely associated with trap, suggest that there are at least two trap sheets of somewhat different ages in the region.

Two sheets of trap.

Along the southern part of Black Sturgeon bay and extending south as far as Black Sturgeon lake is a very narrow belt of sedimentary rock, chiefly sandstone. The lower beds at the south end of the belt are conglomeritic and contain a few fragments of the schists upon which they rest. At the northern end of the belt these sandstones are both overlain and underlain by trap. At the north end, where they are in contact with the trap, these beds dip at an angle of fifty-five degrees to the westward and strike N. 10° E. At the point of contact with the schists the dip is about thirty-five degrees to the south-west. In one place the sandstones in contact with the trap were found to stand at an angle of eighty degrees to the horizontal. On the eastern side of the Laurentian belt, which traverses this portion of the area, a somewhat similar sandstone occurs in positions varying from nearly horizontal to a dip of about sixteen degrees to the south-west. The sand-

Sandstones.

stones of this belt, which is nearly a mile in width, are almost free from iron oxide, are generally white, and are probably newer than the first extrusions Their aggregate area approximates eight square miles.

Dolomitic limestone.

In the valley of the Poshkokagan river, beginning at a point about eight miles from Chiefs bay and extending to within about four miles of Poshkokagan lake, are a number of exposures of almost pure white, occasionally reddish streaked and mottled, dolomitic limestone, readily sectile on the fresh fractured surface, but becoming hard on exposure to the air. The width of this belt is indeterminate on account of the covering of drift and forest, but from the topographic features, it is certainly five miles across and frequently somewhat wider. In the upper part of its course the Poshkokagan passes through a gorge about one hundred and forty feet in depth, cut chiefly in this dolomite.

Topography.

Dissected table-land.

From a physiographic standpoint, the country explored may be regarded as a partly dissected table-land. The best preserved portion of this table-land is found in the region south and west of McIntyre bay, where the flat-topped upland has a breadth of over three miles and consists largely of bare rock with a few small scattered areas of glacial sands, on which there is a growth of stunted jack-pine, black spruce or small poplar. In the west and south-west portion of the sheet, the dissection has proceeded much further, and the trap occurs in ridges and isolated masses between broadly open valleys. The trap caps the older sedimentary rocks, upon which it was extruded, and into which it has probably been locally intruded in the form of laccoliths. The more ancient depressions, now more or less blocked by glacial débris, have become the valleys of the present streams and lakes. The Black Sturgeon river, from the foot of the lake of the same name to within about three miles of the Canadian Pacific Railway crossing, flows along the front of a trap-capped cuesta formed by the dolomites and sandstones of the Animikie formation. On the east rise the older Huronian and Laurentian hills, occasionally capped by traps in the vicinity of Black Sturgeon and Nonwatinose lakes. The Nonwatin and Spruce rivers and their tributaries drain the cuesta outwards after the manner of insequent streams. These streams wander to and fro in broadly open valleys, occasionally cutting into bed-rock, but more frequently cascading over glacial boulders or meandering through glacial and alluvial sands. At the edge of the upland, the Spruce river descends nearly 400 feet in a long series of rapids over trap rock *in situ*, to the level of Black Sturgeon lake. The Nonwatin river, on

Character of valleys.

the other hand, descends from the upland over red dolomites. Both rivers, it will be noted, flow northward for the greater part of their courses, turning almost abruptly eastward when about four miles from the cuesta front.

Glacial deposits.

The valleys of the three principal rivers, the Black Sturgeon (and its tributaries the Nonwatin and Spruce), the Poshkokagan and Kabitotiquia, are more or less filled with deposits of glacial origin, either sands and gravels occurring occasionally as eskers or kame-like mounds, but more frequently as sand plains or extensive boulder plains. These latter, particularly in the valley of the Poshkokagan, cover an area more than 100 square miles in extent, forming a typical felsenmeer. Sometimes the boulders are found without a covering of any kind, but in the present case this occurs only in small areas. More frequently they are covered with moss and a dense growth of underbrush and spruce.

Economic Resources.

Farm lands.

There are a few small tracts, particularly in the valleys of the Nonwatin and Kabitotiquia, which are sufficiently free from stones and boulders to be considered fit for agricultural purposes. The areas are, however, small, scattered and difficult of access, and the region, as a whole, must be regarded as totally unfit for settlement.

Iron ore.

From an economic standpoint the country will prove to be valuable only for its timber and for the iron ores in the district near the Black Sturgeon lake and river. The uplands, for the most part, are bare or covered with jack-pine and spruce, or small birch and poplar, generally not large enough to be of any value. The valleys along the river are densely wooded, chiefly with spruce. In a number of areas, particularly on the higher ground and on glacial sand and gravel plains, we find poplar and birch and a few areas of jack-pine. In a narrow belt, rarely over a mile in width, along the valleys of the Poshkokagan and Spruce rivers, there are many very large white spruce trees. One of these, which I measured on the Poshkokagan, was eight feet in circumference three feet above the ground. There are small areas of red pine along the east shore of Black Sturgeon lake, and a few scattered white pines in the vicinity of the same sheet of water and the streams entering it from the west. Both the red and white pine trees are too few in number to be worth cutting except in connection with the other timber.

Timber.

Burnt areas.

In the valley of the Poshkokagan, a belt of timber about a mile in width and about ten miles in length was burned over last year, all the trees being killed. During the present summer there was a large fire

in the region west of the Spruce river. The extent of the burned area could not be ascertained. In all about one-half of the region is covered with timber, which will be of value for pulp-wood, or for ties and piles.

At present the district is the hunting ground of the Indians from the settlement on McIntyre bay. Large game (moose, cariboo and black bear) seem to be abundant. During the summer, members of our party saw, besides the above animals, otter, fisher, mink, beaver, muskrats and foxes. Marten and lynx are also taken by the Indians. Game.

The Country East of Nipigon Lake and River.

Dr. W. A. Parks.

My instructions as received from Dr. Bell were to complete as far as possible, the geology and topography of that part of the Nipigon sheet lying east of the lake and river. Owing to the limited time and the rather inaccessible nature of the country it was thought advisable to make track-surveys only, and to tie these to the various exploratory lines which had been run in connection with the location of the Canadian Pacific railway and to the shores of Lake Nipigon. The Nipigon sheet embraces an area of the usual size adopted by the Survey (forty-eight by seventy-two miles). This includes the southern part of Lake Nipigon as well as the Nipigon river to within a few miles of its mouth. Nipigon lake and river divide the sheet into two almost equal parts; the eastern half was assigned to me, while Dr. Alfred Wilson received similar instructions regarding the western division. Instructions. Region covered.

The first work in this region was executed by Dr. Robert Bell with the assistance of Mr. Peter McKellar during the summer of 1869. Dr. Bell triangulated the western side of Lake Nipigon from South bay to the northern extremity, filling in the details with measurements taken by the micrometer telescope, while Mr. McKellar carried out a compass and micrometer survey of the eastern side. Both gentlemen made geological examinations of the shores of the lake and of the lower portions of some of the rivers flowing into it. The resulting map, on a scale of four miles to the inch, was published in the report of the Survey for 1869. At a later date Messrs. D. B. Dowling and Wm. McInnes made a survey of parts of the shores and of those islands which had been omitted in the above survey, and also a compass and micrometer traverse of some of the tributary streams. It will be seen that this left a large amount of work to be done in the interior before a sufficient knowledge of the geology and geography inland had been acquired to justify the issuing of the map-sheet. First survey of lake Nipigon.

Assistant.

During the summer I had the assistance of Mr. Gordon O'Leary, of Lindsay, who proved in every way satisfactory. In company with Dr. Wilson I left Toronto on June 27 and arrived at Port Arthur on June 30. Here we spent a day in obtaining men and supplies and on July 2 proceeded to Nipigon, where we completed our equipment and were enabled to start up the river the following day. Mr. O'Leary had not arrived by this time, so I thought it better to leave word for him to follow, as I desired to lose no time before getting the supplies over the long portages. I parted from Dr. Wilson at the portage below Lake Emma on July 8 and arrived at Rabbit falls the same night. The next day I was joined by Mr. O'Leary and we proceeded at once to Poplar Lodge at the mouth of the Sturgeon river, which point we made our headquarters for some time. Here I purchased a small bark canoe, as the large cedar one with which I ascended the river was much too heavy and clumsy for inland work.

Getting to our field.

Poplar point.

A small stream enters Lake Nipigon a short distance north of Poplar point. In order to ascertain the eastern limit of the Mungo Park trap area and to map the stream referred to, it was ascended to a point beyond which it was found to be entirely unnavigable, Returning from this trip, I had the misfortune to suffer a slight accident which forced me to remain at Poplar Lodge for two days. During this time I sent Mr. O'Leary to make a survey of the large lake lying north of Mungo Park point. This he accomplished and found that the waters of this lake discharge into Lake Nipigon direct, and not into the Sturgeon river, as indicated on former maps.

Sturgeon river.

On July 19, I started up the Sturgeon river but considered it unnecessary to make a survey of its lower part, as this had already been done by Mr. McInnes. On entering Cameron lake, however, I began a track-survey which was carried through to the upper waters of the Sturgeon river. A similar traverse of the Windigokan lakes was also made at this time. On July 25, I left the Sturgeon river and portaged into a chain of lakes which finally brought me to the Blackwater river. On ascending this stream it was found to flow out of a lake about three miles long. A track-survey was made of the lake and of the river to its mouth in Lake Nipigon. The stream is not travelled by Indians and no portages were cut out, hence it took us a considerable time to make the traverse and we did not arrive back at Poplar Lodge until August 1.

Blackwater river.

Various Huronian rocks.

The region, from the Sturgeon to the Blackwater river and for a few miles on each side of these streams, is occupied by various Huronian rocks, including sericite and other schists, altered porphyrite and quartz-porphyry, slate and, more abundantly, diorite, both massive and

in different stages of metamorphism. Agglomerates also are found at a few places. The dividing line between the agglomerates and the rocks below them might be drawn from the mouth of the Sturgeon river to a point north of the Windigokan lakes. Particular attention is due to this region as it contains, in places, ranges of schists passing into jasper and hematite. The strike is somewhat north of east in all cases and the dip variable but always near the vertical. Within the limits of the sheet there are, roughly speaking, three ranges with indications of iron*; one just north of the Sturgeon river and two south of it. Many claims have been staked on these belts, chiefly by the Flaherty and Clergue syndicates, both of which are actively and systematically prospecting the region. Mr. Flaherty has had a diamond drill working during the past summer on the first range south of the Sturgeon (the Sand river range). The jasper rock is here 1,000 feet wide and is filled with narrow bands of pure hematite. Its strike is 22° north of east and its dip northward 76°. The drill was driven down 542 feet at an angle of 60° from the vertical to the south, thus crosscutting the deposit. The core revealed continuous jasper with narrow bands of hematite and at the bottom a passage into quartzite. This belt has been traced, with some interruptions, to Little Long lake, a distance of 70 miles to the eastward, at which Dr. Bell mentioned the occurrence of iron ore in his report for 1870. North of the Sturgeon, the strike is about the same, but the average width is difficult to ascertain as the deposit is covered by the silt at the river banks. Slaty hematite, giving 40 per cent iron has been found at different places on this range. I was able to work out the geological conditions of occurrence fairly well and will be in a position to write on this point when the various samples have been examined. Jasper was observed at one place on the Blackwater river and magnetite was found south of Blackwater lake.

Three iron ranges.

Jasper rocks.

Iron at Little Long lake.

On August 2, I re-ascended the Sturgeon river to the Long portage and made an overland trip north, a distance of four miles, in order to locate the northern limit of the large trap area. The following day I started with a month's provisions to examine the chain of lakes lying south of the region above described. Long and rough portages are encountered in ascending the 800 or 900 feet of difference in level between these lakes and Lake Nipigon. Massive hills of trap mark the limits of the Animikie formation and much assisted me in mapping these rocks. Their extent was at one time much greater than at present, as evidences of denudation are very manifest and outliers are numerous, sometimes at considerable distances from the main mass.

Large trap area.

Hills of trap.

* The iron ore of this region was discovered by Mr. Peter McKellar, assistant to Dr. Bell, in 1869. See Report Geol. Survey, for that year.

New lakes mapped.

It was found necessary to survey all the lakes of this chain, as existing surveys are extremely faulty and in places absolutely incorrect. Many trips inland were made and a large number of new lakes mapped. Particular attention was paid to locating the head-waters of the several rivers flowing into Lake Superior. The height-of-land between the Nipigon and Superior waters lies a short distance south of the above

Rapid descent.

mentioned chain of lakes. The streams flowing south have therefore, more than 1,000 feet descent in a distance of about 25 miles. This renders them very rapid and as the volume is small they are all quite unnavigable. The first ten miles of these streams lie on the uplands, hence lakes are more numerous and the canoe navigation facilitated thereby.

Pijitiwabikong.

On September 2 we returned to Poplar Lodge and removed our supplies to a point on Pijitiwabikong bay. The following week was spent in making overland trips in various directions from this place, the most interesting results, besides minor geographical features, being the locating of limestone under the trappean overflow at several places.

On September 9, I instructed Mr. O'Leary to engage an Indian and take the large canoe to Nipigon station, while, with one man, I returned in the small canoe to the most south-easterly point reached in the

Overland to lake Superior.

previous trip. From this place we forced our way southwards, discovering a number of small lakes and one of considerable size known to the Indians as Abamichegomog. We were finally forced to abandon the canoe and to make our way overland to the railway. This country is extremely hilly and rough and consists of Laurentian gneiss, but a fringe of Huronian schist is met with before reaching Lake Superior. This trip resulted in the mapping of the Gravel and Cypress rivers and in proving the existence of a large area of excellent spruce timber. On returning from this expedition I paid off the Indian who had been with us all summer.

Long narrow valley.

With Mr. O'Leary, I went to the north end of Lake Sally, from which point a trip was made northward to connect with the one previously made from the south end of Pijitiwabikong bay. This revealed the fact that a narrow valley has been cut through the trap from Lake Nipigon to Lake Helen, as gneiss is found all the way from Pijitiwabikong bay to the latter. In order to survey the Jackfish river, we went overland, due east, until a stream was encountered which we followed to the railway. This proved to be only a tributary of the Jackfish. Another expedition was therefore made along the line between concessions II and III of the township of Ledger and it was continued a mile beyond the borders of the township, where the river was again found and it is thus located at four points, namely on two trial lines of the

Canadian Pacific Railway, at the point just mentioned, and at the junction of the affluent above referred to. These various trips revealed a large area of sandstone, limestone and shale resting on the gneiss and covered by the massive trap. The Jackfish river occupies a wide valley, eroded through the trap and floored at both its northern and southern ends with gneiss, with a wide belt of sandstone and limestone in the middle. It appears to me possible that at some past time the waters of Lake Nipigon escaped from the great chasm at Pijitiwabikong bay and found their way to Lake Superior through the well-marked valley of the Jackfish river. Sandstone etc. under trap.

The lower part of the Jackpine river I was unable to explore, as my duties in Toronto demanded my return by the first of October. However, two streams were surveyed from the north end nearly as far as the southern boundary of the sheet. It is very likely that these two streams unite to form the Jackpine, as they lie in the proper place and would agree with the location of the river on the plans of the Canadian Pacific Railway. Jackpine river.

I wound up the business of the expedition at Nipigon station and Port Arthur and, accompanied by Mr. O'Leary, arrived at Toronto on September 30.

The West Side of James Bay.

Mr. D. B. Dowling.

In the Severn district of the Hudson's Bay Company, which has now become the southern part of the District of Keewatin, there is a large region lying to the south-west of Cape Henrietta Maria that had never been geologically explored, and in which we were consequently unable to lay down the boundaries of the formations, even approximately. As this region occupies a very conspicuous position on our geological map of Canada, in course of preparation, it had become necessary to ascertain as much as possible during the season in regard to the distribution of the rocks in these parts. In addition to this, the west side of James Bay had not been surveyed, and as it was desirable to represent this shore on our maps with some degree of accuracy, it was decided to send a party to make a geological reconnaissance of the above region and a track-survey of the sea-coast in going to and returning from Cape Henrietta Maria. Mr. D. B. Dowling was entrusted with this work and was instructed to make an instrumental survey of the Equan river, the largest stream in the Unexplored region. Instructions.

region above designated, and track-surveys of as many other streams as could be executed; also a similar survey of Sutton Mill lake. He was likewise to make notes on the timber, soil, fauna, flora, climate and other matters in regard to the district. He was assisted by Mr. W. H. Boyd, of the Geological Survey, and attached to his party were Messrs. J. L. Biggar, of Toronto, and T. M. Papineau, of Montreal. Mr. Dowling reports as follows on the season's work:—

Assistants.

I left Ottawa May 30 and proceeded to Missinaibi, on the Canadian Pacific railway, to which the canoes had been shipped. In order to forward our supplies a 'half-size' bark canoe was obtained and four Indians were engaged to go as far as Moose Factory. As Mr. A. P. Low was going down the river at the same time, we travelled in company, and arrived at Moose Factory on the 17th of June. While there I hired a small sail-boat to carry us and our supplies to the mouth of the Equan river. Heavy north winds, which carried a large ice-floe into the bay, delayed us several days, but we managed to reach the mouth of the Albany river in safety, although we were enveloped in fog and rain most of the time. As directed by your instructions, I looked for gypsum between Moose Factory and Fort Albany, and found some loose pieces of it in the vicinity of Nomansland. It is quite likely that this mineral occurs *in situ* in the vicinity. After our experience in sailing along a shallow uncharted shore, I determined on securing, if possible, a guide at Fort Albany who would know the shore to the north, especially that part near the Equan or Ekwan river. Many of the Indians trading at Albany were from the region we were going to visit, and much useful information was obtained from them. One of their number (Patrick Spence), who lived on the coast near the mouth of the Equan, was hired as guide. After about five days of fruitless endeavour against a head wind, during which we made only about ten miles, we had a day of fair wind from the east and south which enabled us to run to the Equan river, arriving on the evening of July 8.

Moose Factory to Equan river.

As the Indians of this district cannot obtain bark to build canoes, they were poorly equipped in this respect, and finding that no canoes could be had, we did not divide our party, but with our two wooden ones began a micrometer survey of the Equan. This was continued for about one hundred and fifty miles from the coast, or to the mouth of Washagami river, which I ascertained to be in latitude 53° 48′ 52″. We then ascended this branch to the first lake, from which, by a series of long portages eastward, we reached a small stream that carried us to the south end of Sutton Mill lake. This lake we found to be in a deep valley trending north and south, with an average width of little over

Survey of Equan river.

half a mile. It is divided into two sections by a ridge of rock, consisting of horizontal beds of Cambrian age surmounted by a heavy trap overflow, similar in general appearance to those of Lake Superior. Through this, by a series of parallel faults, a narrow chasm, nearly blocked up by detritus from the cliffs, allows a small stream to flow from the southern to the northern part of the lake. A log-survey of this lake was made, and while I remained to complete this work and examine the rocks, Mr. Boyd was sent down the stream draining from its northern end, called Trout river, to make a traverse of its course to Hudson Bay. While at its mouth, besides latitude observations, he took a series of barometer readings by which to check the elevation of the lake.

As the navigation along the Hudson bay shore from Trout river was reported difficult and dangerous, we both returned by the routes we had already traversed, arriving from the interior at the mouth of the Equan on August 22. Having but a short time to spend in this vicinity, I determined on making a quick trip northward along the shore as far as the weather would permit. A log-survey, checked by latitude observations, was made as far as the Opinnagow river. After being detained there by a storm from the north, and fearing a continuance of bad weather, we turned back on August 30, and arrived at the Equan again on September 3. Hiring our former guide, we started in the boat for Albany, but were detained by head wind at the southern mouth of the Attawapiskat river. A latitude observation which we took here confirms the position determined in 1886 by Dr. R. Bell which was questioned at that time, as it was much farther south than that given on the old maps and charts.

Traverse on shore of James bay.

On September 6, we entered the Albany river on our return journey and paid off our guide. A storm from the north set in just after we arrived there. When we were ready to start, it had expended much of its force and by the moderated wind we were carried about half way to Moose river. A period of calm weather with light south and south-west winds then set in and we reached Moose river on the evening of September 11. The tide was running out, so we waited till 9 p.m. for it to turn and then we beat in to the Inner Ships Hole by 10.30 p.m. In the afternoon we saw the barque 'Hans,' a chartered vessel, leaving on her run out of the bay. The Hudson's Bay Company's vessel, the 'Lady Head' was still at anchor in the river, ready to start, but she did not leave till about September 15.

The Moose river we found to be very low, but before we left for the south a heavy rain set in for three days, for which we were thankful, as the delay at Moose Factory would be balanced by an increase in the

Return by Moose river.

depth of the river which would facilitate our travelling. On the 18th, we left Moose Factory, but soon found that we were obliged to wade for long distances in the shallow water. Owing to the very dry summer, a forest fire had been raging in the valley during the latter part of August and up to the middle of September. This was found to extend from the mouth of the Mattagami river south-westward on the Missinaibie to the Skunk islands. My instructions directed me to make a track-survey, if possible, of the Opazatika river when on my way home; but as this stream flows through part of this burnt area it was especially shallow, and we were satisfied that our canoes could not be got up it without very heavy labour and a loss of more time than we could afford, so we returned by the Missinaibi, arriving at the railway on October 15.

General description of mouth of Moose river.

The delta at the mouth of the Moose river is divided into three channels which enter James Bay. The northern one runs from north of Middleboro island to the north-west of Ship Sands, but it is nearly dry at low water and is also impeded by large boulders, so that it is not used except by canoes and small boats. The southern channel is also reported to be shallow. The central channel which runs along the south edge of the Ship Sands, shoals to seven feet at low tide, and vessels pass at high water after being lightened to draw about twelve feet.

Moose river to Albany river.

Northward from the outer bar to North point, the water is very shoal but it deepens slightly to Nomansland. The low-tide flats are not very wide but the bars project from many of the points for long distances at Long Ridge point and Cockispenny point. At Halfway point, limestone fragments are pushed up along the shore from rock apparently *in situ* below tide. Long Ridge point is built up mostly of gravel with a few boulders showing on the surface. From Nomansland to Albany river the shore is very flat and at low tide the mud flats extend out for several miles.

Mouth of Albany river.

The Albany river, like the Moose, is divided at its mouth into three channels. The trading establishment and mission are situated on an island on the north side of the southern channel. North of this island is the broad opening called locally North river. This has at its mouth a long bar similar in position to the Ship Sands at Moose. The southern entrance to this is the larger, and its entrance seems to be much deeper than the channel going to the settlement. The small channel north of the bar is shallow at low water and has a bar outside on which we found a depth, at high tide, of very little over one fathom. Very shoal water, in which boulders appear, extends northward beyond Nottashay point and boats are obliged to keep nearly out of sight of

land to escape the shoals. Chickney river, which enters north of the Albany, is said to be another channel from the latter.

Coast northward.

Shoals were observed, well out from shore to near the Kaypuskow river. In the inner water between Akimiski ('Agoomska') island and the mainland there seems to be a maximum depth of about two fathoms. This shoals gradually to one fathom at a distance of three miles from either shore, as observed in tacking back and forth in latitude 52° 54′ 0″. The mainland here is generally without a beach and between the woods and the tide-line is a wide flat covered with grass. The north-western part of Akimiski island approaches the mainland much closer than is shown on the maps and a number of sboals are scattered from this point to the point south of the Equan river. The boat channel, according to our guide, runs to the west of the two islands which here lie off the shore. The position of the mouth of the Equan river according to several observations is in latitude 53° 14′ 0″.

Northward from the Equan, the shore, for a long distance, is flanked by high gravel bars, but at low tides a broad belt of mud extends out several miles, so that travelling along this coast with canoes is very unpleasant, should the time of high water be in the middle of the day or night. Landing on the beach without a long 'carry' through the mud is only possible at high tide.

Streams south of the cape.

The rivers that enter the bay between Equan point and Cape Henrietta Maria are not large and, as the former maps are mere sketches, it is difficult to locate those which are not known by a local Indian name. The first stream north of the Equan is a small channel said to be a branch from that river. It is marked by two gravel bars to the north about a mile from the beach. Swan river, which is perhaps Raft river of the map, enters in latitude 53° 36′. It is in a slight bay or curve in the shore line. In latitude 54°, the shore takes a curve to the west, forming a point and as the tree-line curves to the north-west from here, this is probably Point Mourning, the first wooded point south of Cape Henrietta Maria. Several small streams flow into the above bay. The first is called by the Indians, Nowashe river—the next Patchipawapoko — then the largest along this coast, the Opinnagow, followed by the last stream Nikitowasaki, fifteen miles north of the Opinnagow. The latitude of the mouth of Opinnagow river by observation is 54° 12′ 24″.

The bay to the south of Cape Henrietta Maria is shallow and muddy with wide mud flats, but near the extreme eastern end of the cape, the shore is reported to be bolder and limestone beds are said to outcrop

at high tide mark. These are probably continuations of those found on the Equan and Attawapiskat rivers to the south-west.

Timber.

The timber along the coast gradually becomes smaller as we go northward and the tree-line recedes from the shore, leaving it finally at the Opinnagow, so that the country behind the cape is more or less an open plain. The shore, where the trees are at a distance from the beach, is generally an even mud slope, covered above high tide with grass, followed by a wide belt of stunted gray willows which look somewhat like the sage bush of the western plains. Behind this, a few isolated spruces of small stature appear before the tree-line is reached. In sailing along this coast, it is impossible to know which way to steer so as to run parallel to the land as nothing is to be seen ahead by which to shape one's course.

Tides.

The tides along this narrow shore are not regular in their amount of rise and fall, which is determined, in a great measure, by the direction and strength of the wind. From Equan river northward, the high tide appears to be about six and a half hours after the moon's meridian passage—the flood and ebb running seven and five hours respectively, while to the south of the shallow ground between Akimiski island and the mainland, the flood comes from the south and is much earlier. High tide at Lowasky river occurs at between two and a half and three hours, and at Albany about the same. The flood tide at Lowasky river runs four hours and the ebb eight. At Albany the flood runs five hours and the ebb seven. At the outer bar at Moose river the tides are from half an hour to an hour earlier.

Equan river.

The general course of the Equan river, from the junction of the Washagami or Clearwater river is toward the east-south-east. It emerges from a plateau above the mouth of the Little Equan river, in a wide old valley and then flows eastward over a sloping plain to the sea. In the latter part of its course, it is cutting down a new valley through marine clays which cover the underlying rocks to a depth varying from twenty to fifty feet. From the lowest rock exposure to the sea, the current is swift and it is constantly moving a large quantity of gravel towards its mouth and into the bay, into which the stream empties. Shoals and gravel islands at its mouth bear evidence of this transportation. Nearly horizontal limestones are met at intervals in the section which lies between the fortieth and one hundredth mile from the sea. From a series of fossils collected in these rocks, it would appear that they are older than the Devonian and are probably of Silurian age.

Above the Little Equan, as noted before, the river issues into a wide valley from a higher plateau, but this valley gradually narrows before

the Washagami is reached, and cut-banks of clay, higher but somewhat similar to those in the river below, occur at many of the bends. These clays contain marine shells such as *Saxicava rugosa, Macoma calcaria, Mya truncata* and *Cardium ciliatum.* These were also found at the highest point at which the clays were seen, about 390 feet above tide. The fall in the river from the mouth of the Washagami, as given by our barometer readings, is about 290 feet. North of this to beyond Sutton Mill lake, is a plateau at an elevation of nearly 400 feet above tide, through which, in latitude 54° 20′ rounded or oval domes of trap protrude to a height of from fifty to one hundred feet. Through the plateau, a deep narrow valley has been eroded in a north and south direction, which is now occupied by the waters of Sutton Mill lake. At the lake, the surface of the clay plain is 390 feet above the sea and the surface of the water is 290 feet above the same level. Marine clay.

Soundings show that the bottom of the southern part of the lake is 310 feet below the plain and that of the northern part 250 feet below the same surface. It was known from the map published long ago by Arrowsmith that a tract of high and broken ground (compared with the generally level country) existed to the south-west of Cape Henrietta Maria. This tract had been assumed to be Laurentian and it was so coloured on former geological maps, but in my instructions from Dr. Bell he predicted that the rocks of this area would more likely prove to belong to the same series as those of the Manitounuck and Nastapoka islands, on the east side of Hudson Bay, which are of the same age as the Animikie of Lake Superior; and my examinations of the region proved this surmise to be correct. Elevation of marine plateau.

Silurian limestone is found on Trout river, draining Sutton Mill lake, as well as in the bed of this lake just north of the trap rocks The rocks at the narrows of the lake, described on the maps as 'high and romantic,' are cliffs one hundred and fifty feet in height of trap, capping horizontal beds of probably Animikie age. The trap overflow covers the uneven surface of these rocks, in much the same manner as at Nipigon bay on Lake Superior. The underlying rocks are dark slates impregnated with iron ore and interbanded with beds of jasper. Some of the beds seem to contain a high percentage of magnetite and hematite. On the east shore a section of about ninety feet of these jasper and iron-bearing slates is exposed above the lake, but on the west side they have been brought down to below the water level by a series of north and south faults and the exposures there are of the trap alone. These rocks form an east and west ridge reaching to the upper lakes on the Washagami and eastward to a large lake on a Rocks of Sutton Mill

Iron ores.

branch of the Trout river which, as before stated, drains Sutton Mill lake and runs to the north.

The slates and jasper, or jaspillite, beds form a long anticline, whose axis runs east-and-west and the majority of the beds exposed belong to the northern slope of the anticline. This ridge is terminated on the lake by a series of north-and-south faults with downthrow to the west of unknown amount. The overflow of trap appears to have been at a later date, as there seems to be some unconformity at the base of the trap, the flow having filled all the inequalities in the underlying surface. The cliff at the west side of the narrows is of trap, one hundred and fifty feet high, with none of the jaspillites showing beneath it. On the east side, however, ninety feet of these beds are exposed with a varying thickness of trap above them.

Section.

The following rough enumeration of the arrangement of the beds below the trap is given, but as no careful examination of the rocks has been made, it is to be considered as only provisional:

At the top, in contact with the under surface of the trap, is a series of black, gray, and greenish slates with many of the upper beds impregnated with magnetite. At eighteen feet down, red jasper streaks begin to appear and the first narrow band is quite crystalline, so much so, that it resembles an eruptive porphyry. In the next two feet, very thin beds or streaks of jasper are interleaved with the slates, but they become much thicker below. The jasper beds are seen to be made up of minute oval and rounded concretions of bright jasper separated by a matrix of chalcedonic quartz. As the colour depends on the percentage of these jasper pellets the colour of the beds ranges from light-red to brown. Thin bedded dark rusty rocks form the majority of the beds to about thirty feet down, where several heavy beds of jasper occur. Below this to forty feet, the beds are mostly of dark grayish and black semi-crystalline rocks with fewer red streaks, but they are more heavily charged with magnetite than those above, and some of the thin beds appear to be wholly of magnetite. A covering of talus conceals the slope to about seventy feet down, but, in this space, fragments which lie about, indicate dark iron-bearing slates or quartzites of high specific gravity. In the lower part of the section, the rocks are of a coarser crystalline apparance and the lowest bed, or that exposed at the water level, is heavy with magnetite.

Trout river.

The valley of Sutton Mill lake widens out at the north and its discharge flows at first in an old wide valley and then gradually forms a newer channel for itself. In going north, the timber gets small and disappears before the shore of Hudson bay is reached. The mouth of

this river is placed by several latitude observations by Mr. Boyd at 55° 16′ 09″.

Along the streams there is a narrow fringe of timber, but in approaching the tree-limit this becomes very small. Back from the immediate slopes of the rivers the surface is nearly level and moss-covered, with scattered groups of small spruce and tamarack. The greater part of the interior is reported to be muskeg (open bog). A small collection of about forty species of shore plants was made at the mouths of the Equan and Albany rivers. Interior.

The principal fur-bearing animals of this district are foxes, otters and beavers. Of the larger mammals, few appear to be obtained by the Indians. In the interior the game birds are all very scarce, the fall hunt for ducks and geese being confined to the shores of the bay. The rivers afford a small supply of whitefish. The streams running to the north into Hudson bay in this region are, at certain seasons, well stocked with speckled trout. Sutton Mill lake is well supplied with a slender variety of lake trout and at the narrows, speckled trout were also caught. Game.

Western Part of the Abitibi Region.

Mr. W. J. Wilson.

I beg leave to submit the following report of my explorations in the vicinity of Lake Abitibi, Nipissing District, Ontario, during the past summer.

I received instructions from you 'to determine the extent, etc. of the Huronian rocks to the north-west and north of Lake Abitibi, along the Abitibi river from the outlet of the lake downward as far as may be necessary, say to the Long Sault rapids or Frederick House river, southward of the lake to explore and make a survey of the Abitibi river which falls in southward of the Post, and of any natural features possible in that region, west as far as Night Hawk lake and south to the Height of Land or Round lake.' Instructions.

On June 10, I left Ottawa accompanied by Messrs. J. F. E. Johnston of this department, T. A. Davies and H. F. Lamb'art. We proceeded to Abitibi post by way of Temiskaming lake and the canoe route from Quinze lake to Lake Abitibi, reaching the latter lake on June 23.

Mr. Johnston, following your instructions, made an examination of he country lying to the east of the Interprovincial boundary, and he

will report directly to you on the result of his explorations. He was accompanied by Mr. Lambart.

After storing our supplies in the Hudson's Bay Company's warehouse which Mr. Robt. Skene kindly placed at our disposal, and securing a guide, I came south on the canoe route, over which I had just passed, for the purpose of examining the country south of Lake Abitibi. Maps of this region represent a river as flowing from the south-west and joining the stream flowing from Agotawekami lake, a short distance north of the latter. The Indians told me there was no river there, and subsequent investigation proved this information correct.

Abitibi river south of lake.

In passing along the canoe route, the opening looks exactly like the mouth of a river, but it is only a long winding arm, and has not even a small stream flowing into it. Abitibi river, therefore, flows directly from Agotawekami lake. It receives two small streams from the west, about three and five miles long respectively, but they are not passable for canoes except in very high water.

I learned from the Indians that there is a canoe route west from Obadowagashing lake through a series of rivers, lakes and portages round to Agotawekami lake.

Beginning at the north-west bay of Obadowagashing lake, I followed the river flowing from Labyrinth lake a distance of about four miles.

Canoe route west from Obadowagashing lake.

There are two short portages on this river and several exposures of a hard fine-grained greenstone containing, in most places, small grains of pyrite. There are also two small exposures of vitreous tuff. Close to the river, the banks are low and are composed of clay, but a short distance back the land rises in low undulations to a height of 50 to 100 feet.

Forest growth.

The country is thickly wooded with spruce *(Picea alba* and *P. nigra)*, poplar *(Populus tremuloides* and *P. balsamifera)*, balsam or fir *(Abies balsamea)*, canoe-birch *(Betula papyrifera)*, cedar *(Thuya occidentalis)*, tamarack *(Larix Americana)*, pine *(Pinus Strobus, P. resinosa, P. Banksiana)*, and numerous shrubs, as alder, willow, American yew, mountain maple *(Acer spicatum)*, rowan, sweet gale and a great variety of small flowering plants and ferns.

Labyrinth lake.

Labyrinth lake is irregular in shape, about four miles long and three broad. It contains numerous islands which are well wooded but rough and rocky, the rock being compact greenstone containing small quartz veins holding pyrite. Wherever the rock is exposed, especially near the water level, it is polished smooth and heavily striated. The course generally is south to S. 20° W., with stossing on the north. A few granite boulders were noted but no boulder clay. The Indian name of this lake is Kwaskonadaga.

Continuing the survey westward, I passed through a low marshy river for two miles, then through a small grassy lake called Waterhen lake, then for a mile and a half up a river where a portage of nearly a mile leads into a lake called Wawagoshe, and from this a portage of a quarter of a mile passes over the Height of Land to the head waters of the Blanche river. The elevation where the line crosses the Height of Land is about 980 feet above sea level (aneroid). In passing over the portage into Wawagoshe lake, I noted some comparatively large trees, especially spruce and poplar. Some of the spruce measured sixty-seven inches in circumference, but west of the middle part of Wawagoshe lake the forest is all second growth, the country having been overrun by fire about thirty years ago.

Height of land.

The branch of the Blanche river which forms a part of the canoe route is a very small stream near the Height of Land, but at a distance of a mile and a half it has become twenty feet wide and six feet deep. At a distance of four miles it expands into Snake Island lake, and a mile further into Misemikowish or Beaver House lake. This is a narrow deep lake extending west and north-west seven miles, with an arm running south six miles. The shores are high and rocky, the rocks consisting of massive diorites and schists with numerous small quartz veins holding pyrite. The rock itself contains considerable pyrite in disseminated grains.

Diorites and schists.

Structural lines which may represent the strike run nearly east-and-west with the dip ranging from 75° to vertical. In places, however, the lines run north-and-south. A ridge of dolomitic rock containing iron forms a dam across the south end of the lake, causing a fall of about five feet. The branch of the Blanche river flowing south from this lake is a stream of considerable size, and I was told by the Indian guide that it is twenty to twenty-five miles long. There is a canoe route westward from Misemikowish lake to Round lake, also one leading north across the Height of Land. I followed the latter over a portage of two chains into a narrow lake one mile and a half long, then up a small stream one mile long, two small lakes, a short portage and a lake two miles long to the Height of Land portage. As already noted on Wawagoshe lake the forest growth is all small, consisting chiefly of spruce, canoe-birch, poplar and Banksian pine, the latter eight inches in diameter. This is the character of the forest growth to the south end of the Height of Land portage, where the *brulé* ends, and west probably to Round lake.

Second growth.

A portage of half a mile crosses the Height of Land, then a number of small streams and lakes which form the head waters of the Isabemagussi river were followed for over three miles. Here the canoe route

leaves the main stream, which is blocked with driftwood, and a portage of two miles connects with another branch of the river. This I ascended for three miles, when a lake two miles long was reached. From near the north end of this lake a portage of three miles is necessary to again reach the Isabemagussi river, which is now flowing east to Agotawekami lake, about twenty-two miles distant. All the rocks along this route are Huronian, and consist of greenstone and schists, with an occasional band of chert and conglomerate. The latter was seen on the last long portage one mile from the south end; strike N. 70° E.

Huronian conglomerate.

The forest growth is generally heavy and was well seen on the long portages where there are swamps densely wooded with tall, clear spruce ranging from six inches to one foot in diameter. On the higher ground the soil is a deep clay loam and vegetation is very luxuriant. Spruce, twelve to twenty inches in diameter is common, and poplars measuring two feet were seen; canoe-birch and other trees grow to a fair size.

Isabemagussi river.

The Isabemagussi river at the north end of the Three-mile portage, is fifty feet wide and seven feet deep, but the marks on trees, etc., along the banks show that when the ice is moving out, the water is at least ten feet higher than at present, (July 10). The soil along its banks is a sandy bluish-gray, stratified clay, resembling that found everywhere south of Lake Abitibi. The water is muddy, but some of the numerous streams it receives are clear and cold. Very few rock exposures are seen, but wherever they do occur they show the same Huronian strata striking east-and-west. From the appearance of the soil and the luxuriance of the forest growth and vegetation generally, it is clear there is a large area of excellent land for agricultural purposes on this river and its branches, also considerable quantities of pulpwood and saw-logs.

I next made an examination of the country south of Lake Abitibi, going up the rivers for that purpose. The first river ascended falls into the lake about twelve miles west of the Hudson's Bay Company's post. It is called Madawanasaga because there are two main branches which meet near the lake. For the first five miles there are no rock exposures, the banks being low and in places marshy. The first rock seen in place is a purplish-gray, rusty weathering dolomite, and a short distance farther up the river there is a much altered greenish rock which is changing into serpentine. A similar rock was found four miles further south, and at a rapid where I turned back the ordinary greenstone of the country occurs. This river was surveyed for eleven miles, when it became too small for canoes, but the guide said it extends seven or eight miles farther flowing from the south-west.

Serpentine.

The next river that can be ascended by canoes enters the lake west of the large peninsula called by Mr. M. B. Baker, Cauliflower point. The stream he has named Lightning river, the Indian equivalent being Animikewabid. About six miles from its mouth the river divides into two branches of equal volume, but neither of these can be traversed for more than a mile, as they are blocked by numerous jams of drift-wood and fallen trees. The branches extend inland to the south-east about five miles. A little over two miles from the mouth of the river there is an exposure of greenstone holding pyrite in disseminated grains. Near the fork the rock is the ordinary greywacke.

Ghost river.

The last river examined on this shore empties into the lake in the south-west part and has been named Ghost river by Mr. Baker; the Indian name is Manitouskosi. This river is one hundred feet wide at its mouth and flows through a flat, clay country, as far as examined, about eleven miles. It continues several miles farther, flowing through more elevated ground. It also receives a large branch from the west. The only rock seen on this river is a small exposure of greenstone at its mouth. Like the other rivers examined on this shore of the lake, the banks are composed of well stratified clay which contains considerable quantities of sand, making the soil a sandy loam. Near the numerous streams this is of excellent quality, and from the appearance of the ground as seen from the surrounding hills there are large areas of good soil throughout the whole district. There are several hills rising to a height of four to five hundred feet above the level of Lake Abitibi and one or two probably higher, but the country generally is rolling and affords good drainage. Small poplar, spruce and fir are common on the lower ground and sides of hills, and scrubby Banksian pine on the top of the hills, but none of these are of much economic importance.

Stratified clay.

Abitibi river.

I next went down the Abitibi river, which was examined as far as the intersection of Niven's meridian line, below the Long Sault rapids. A micrometer survey was made of it from Niven's line to Speight's tie line, below the Iroquois fall, thus connecting with the micrometer survey made by Mr. Speight from that point eastward to Abitibi post in 1900. The first obstruction is four miles and a half from the lake at Couchiching falls, where the river passes over an altered greenstone in a succession of falls and rapids, the total descent being about 46 feet (aneroid). From this fall to the Iroquois fall there are numerous exposures of rock, all of Huronian age, consisting of greenstone, chloritic schists, and in one place an impure dolomite. These cause several rapids, which are passed by short portages. The strike varies considerably, but in a general way, is nearly east and west. At

the Iroquois falls the water has a perpendicular drop of 15 feet or more, and would make an excellent water power. The rock here is massive greenstone, which extends for a mile and a half below the falls; then for two miles it is mixed granite and gneiss, alternating with the more basic rocks. The contact between the Huronian and Laurentian is evidently in this vicinity, but, as in so many other places, there is no sharp line separating them. For the next five or six miles to Buck Deer rapids occasional exposures of granite and gneiss were seen, striking N. 70° to 80° W., dip. S. 10° to 20°, W. <50°-70°. From the Buck Deer rapids to the head of the Long Sault rapids, a distance of twenty-eight miles, there are no rock exposures, but there are numerous gneiss and granite boulders in the bed of the river and along its banks. Examinations were made on both sides of the river, but no rock was found. The Long Sault rapids are caused by ridges of gneiss which cross the river at this place, and good exposures are seen for over five miles. From this point to the crossing of Niven's meridian line no rock was seen.

Contact between Huronian and Laurentian.

The Abitibi river for the whole distance examined has low banks of stratified, sandy clay, rising above the water level from five to twenty-five feet, but in a few places, as at Buck Deer rapids, the banks are higher and somewhat rugged. The soil close to the river is of good quality, but back some distance it becomes in places wet and swampy. The forest is composed of spruce, poplar, balm of gilead, fir, cedar and numerous shrubs. Close to the river the trees are of a fair size, but soon become much smaller.

An examination was also made of the Mistoogo river, a branch of the Abitibi. It joins the latter from the north about ten miles above the mouth of Black river. Less than a mile from its mouth a ridge of chloritic schist, striking N. 80° W. and dipping N. 10° E. < 75°, causes a fall in the river of 18 feet (aneroid). This schist contains small veins of quartz, and Mr. R. W. Colthard says that a picked sample assayed in gold $2.20 per ton.* The low state of the water prevented my going far up this river, and the only rocks met with were schists and greenstone of Huronian age. A day's walk into the woods showed large areas of good soil covered with an abundant vegetation but no rock exposures.

Mistoogo river.

The water of Lake Abitibi is muddy during the whole summer. This is true of all the rivers flowing into it as far as examined, and of Abitibi river. The lake being very shallow, the whitish sediment carried down by the rivers or washed from its own clay banks does

*Survey and Exploration of Northern Ontario, 1900, p. 45.

not get time to settle, as the wind constantly agitates it. This adds a considerable element of danger to canoeing on any of these waters, as it is impossible to see boulders or other obstructions if only a few inches below the surface. By February the water in the lake becomes clear. Muddy water.

I next ascended the Black river, the largest branch of the Abitibi, above Frederick House river. Its mouth is twenty-nine miles below the lake and its water, being dark and comparatively free from muddy sediment, contrasts strongly with that of the Abitibi. A micrometer survey was made of this river for forty-nine miles and a track-survey for some distance farther. The river at its mouth is about three chains wide with little current and continues about the same width for about seventeen miles to the first fall. In this distance only two small exposures of rock are seen, both greenstone holding pyrite. About seven miles up the river a stream enters from the east. A portage from near what is called Old Woman rock on the Abitibi river, connects with this branch passing through a small lake. This route is only used by Indians when hunting, as the portages are very long. Nine miles from the mouth, the forest was destroyed by fire four years ago, and for about five miles there is nothing standing but dry stumps of trees, with an occasional clump of green trees along the river and in swamps. The burnt area extends eastward about ten miles, but I did not learn how far to the west. Black river. Burnt area.

The fall above referred to is over a massive greenstone with numerous veinlets of quartz and disseminated grains of pyrite. The total descent here is about fifteen feet and the fall would make an excellent water power. A half-breed family named McDougall have a neat house and small clearing at this point, where they have planted a patch of potatoes which promised an abundant crop. An average stalk measured forty-two inches in length and some of the potatoes were quite large.

The following is a report on soil collected at the above place. Latitude about 48° 38′ and Longitude about 80° 27′.

'A sandy loam of a dark grey colour and showing a considerable amount of vegetable fibre, from fragments of roots and bark chiefly. There are no pebbles and the soil appears to be in an excellent mechanical condition, due no doubt chiefly to its comparatively speaking, large proportion of vegetable matter. Analysis of Soil

Analysis of the above Soil (air dried).

Moisture	1·86
Organic and volatile matter	9·73
Insoluble residue (clay and sand)	79·96
Oxide of iron and alumina	7·67
Lime	0·45
Magnesia	0·44
Potash	0·36
Phosphoric acid	0·11
Carbonic acid, etc. (undetermined)	
	100·58
Nitrogen, inorganic matter	0·227

Available Constituents.

A determination of the amounts of phosphoric acid, potash and lime, soluble in a 1-per cent solution of citric acid, and consequently to be considered as more or less immediately available for plant use, yielded the following data:—

	Per cent.
Phosphoric acid	·0192
Potash	·0142
Lime	·376

This soil appears to be very well supplied in all the essential elements of fertility, save phosphoric acid—which latter is somewhat below the average found in our better and more fertile soils. In humus and nitrogen it may be said to be particularly rich, though no doubt much of the latter is not present in a condition immediately available to plants. Considered from the physical as well as the chemical standpoint, I should expect this soil would prove one of very fair productiveness, provided climatic conditions were favourable.

FRANK T. SHUTT, M.A., F.C.S.,
Chemist, Dominion Experimental Farms.

Huronian rocks.

In ascending the river for the next eighteen miles, there are many exposures of Huronian rock, mostly massive greenstone and schists. These rocks are generally pyritous, and they also contain many small veins of quartz and epidote. At the second portage there is a dyke-like mass of hornblende granite with green schists on both sides, and at the fifth portage, twenty-nine miles up the river, there is a mass of greenish breccia. These rocks frequently cross the river in ridges and cause falls and rapids, necessitating altogether eight portages in the first thirty-five miles. In this distance the rise is about 150 feet (aneroid). At the seventh portage, thirty-two miles up, there is a fall of forty-six feet, and thirty-five feet of this is an almost perpendicular

fall at the head of the portage. This could be utilized for a water power. At the eighth portage, three miles farther up, the descent is thirty-five feet, the chief part of this being over a series of cascades at the upper end of the portage. For seventeen miles above the eighth portage, the river flows through a flat country showing few rock exposures, and there is no further obstruction to navigation in that distance. Several branches of considerable size flow into the main stream in this stretch, and the river beyond becomes gradually smaller. Fifty-two miles from its mouth where we turned back, it is twenty-five feet wide but too shallow to float an empty canoe (August 29). It was also blocked at short intervals with fallen trees. The Indian guide informed me that the river continues eastward for about fifteen miles with numerous branches; also, that at about half this distance there is a perpendicular fall much higher than any we had passed.

The country round the head waters of Black river.

Near the fifty-second mile I ascended a bare hill 120 feet high, from which an unobstructed view of the surrounding country was obtained. To the north, north-west and west, it is comparatively level with an occasional hill rising 100 feet above the general surface. To the north-east, east and south, the country is much more rugged. There are several bare rocky hills within a radius of four or five miles, while in the distance, much higher blue peaks appear. All the rocks seen in these hills are Huronian greenstone, striking N. 45° E., dip S. 45° W. < 70°. The forest, as seen from this hill, is all second growth, except an occasional clump of trees that escaped the fire which swept over this region thirty years ago. The northern boundary of the burnt district crosses the Black river about thirty-three miles from its mouth, and extends southward beyond the Height-of-Land and eastward close to the head waters of the Isabemagussi river, and, I presume, connects with a similar second growth already mentioned as occurring on Misemikowish lake and vicinity. The Indians did not know how far the burnt area reached to the west, but said it was a long distance. Canoe-birch and poplar, from one to four inches in diameter, are most common, while small spruce, fir and many shrubs are abundant, with Banksian pine on the rocky hills and sandy ridges. Along the Black river the areas which escaped the fires are covered by a heavy growth of spruce and poplar, which will yield a large quantity of saw-logs and pulpwood. The soil along the river is a clay loam of excellent quality, and as far as could be learnt, it extends over portions of the lower part of the whole district. There are, however, many swamps and sand plains.

Good soil.

Route to Round lake.

The route south to Round lake leaves the Black river forty-one miles from its mouth and follows a winding branch, White Clay

river, to Kékékwabik lake and thence to the Height-of-Land through small streams, lakes and portages. The stream, which I have called White Clay river, is known by a long Indian name which means 'flowing through white clay.' The name is very appropriate, as the soil is composed of a whitish clay, mixed with a large quantity of sand. Three miles from Black river there is a fall of twenty feet over greenstone dipping S. 80° E. <10°–15°. The fall is passed by a short portage on the west side. There are two more portages before reaching Kékékwabik lake with exposures of rock of Huronian age. This lake is six miles south of Black river, in a straight line, but following the sinuosities of the stream, it is more than eight miles. On the west shore of this lake there is a steep rock composed of breccia-conglomerate. The matrix is of a dark green colour and the pebbles are granite, quartz and many small fragments much resembling the mass of the rock. They are angular, sub-angular and rounded, and vary from the size of a pea to 20 inches in diameter. Nearly half a mile south of the steep rock above referred to, a reddish-brown breccia-conglomerate occurs, and this gradually merges into the more common greenish variety. On the east shore near the north end the ordinary greenstone is seen and a little to the south, a beautiful quartzite or arkose rock occurs, and near the south end of the lake there is a reddish coarse felspathic agglomerate. On a small lake a few chains west of Kékékwabik lake and parallel to it, breccia-conglomerate again occurs similar to that already described at the steep rock. The dip is N. 70° W. at a high angle. On a small lake, a mile to the east, there is an exposure of a very fine black fissile slate. Strike N.W., dip vertical. Continuing south, the river for about a mile is deep and sluggish flowing through a marsh. Here a stream enters from the west draining Swan and Gull lakes. To the south the stream was so small at that season (Sept.) that we had to carry the canoes and luggage most of the way to the Height-of-Land. After crossing three portages and two small lakes, a branch of the Blanche river, flowing from Sasakinaka lake was reached. I followed this stream to Kinogami lake and thence to Round lake, making a track-survey to the former and a micrometer survey of the remaining distance. Between Kékékwabik lake and Kinogami, the rocks are all Huronian greenstones, schists and slates striking nearly east-and-west. The soil is poor, except some small areas along the river, and the forest growth is valueless from an economic standpoint, as it is all small second growth. Kinogami lake is over five miles long and one mile broad. Huronian rocks, consisting of a fine-grained greenstone, breccia-conglomerate and reddish quartzite, are seen at different points along its shores. Five miles east of Kinogami lake, in a straight line, or seven and a half by the river,

Breccia conglomerate.

Blanche river.

Kinogami lake.

at the first portage, there is an exposure of conglomerate containing jasper pebbles. There is also a band of dolomite fifteen inches wide, holding a considerable quantity of iron. Strike N. 75° E., dip vertical. A mile and a half farther down there is a lake a mile long known as Kapikokonaka lake. From this a portage of nearly a mile is necessary to avoid rapids and beyond this there is no further obstruction, except from fallen trees and driftwood. Three miles and a half north of Round lake, in a straight line, there is an exposure of a hard reddish syenitic rock composed chiefly of felspar and hornblende; the same rock is seen at several places farther down the river and the last outcrop is only a short distance above the lake. The dip is S. 10° E. < 60°. The river where it enters Round lake is a chain wide, and the lower part is comparatively straight with clay banks and some good land.

Syenitic rock.

I returned to the northern part of Otto township and made a track-survey of a small winding river flowing into the Blanche, seven miles north of Round lake. This stream drains a large number of lakes; the largest, called Anikojigami, is four miles from its mouth. The rocks up to this lake are greenstone and breccia-conglomerate, holding jasper pebbles. The latter rock is well seen at the fourth and fifth portages, where the matrix is of the ordinary dark-green colour and the pebbles are abundant and varied, being mostly well rounded. In fact some of the rock is composed chiefly of pebbles, with just enough of the matrix to hold them together. The pebbles consist of granite, quartzite, greenstone and jasper. On one small surface I counted seven jasper pebbles some two inches in diameter. The strike is N. 20° E.; dip vertical. The hills rise to a considerable height on both sides of this river, but slope gradually back. The banks, where not rocky, are composed of a whitish sandy clay. Anikojigami lake, as its name implies, is a collection of lakes joined together by narrow passages. It is more than eight miles long, with narrow winding arms. The shores are usually high and rocky, with a stunted second growth of poplar, canoe-birch, Banksian pine, etc. The rocks are the ordinary Huronian greenstone and schists, as are all those on a number of small lakes to the east and north. Eastward there is a canoe route to Misemikowish lake, which I followed four miles, making a track-survey. The last lake examined on this route is called Kaminamekoka, and is a beautiful sheet of water over two miles long. The height of land is one mile and a quarter directly north of Anikojigami lake, where there is a small lake from which the water flows both north and south. We followed the stream flowing north to Kawanaska lake, from which a stream flows directly to Black river.

Jasper conglomerate.

Height of land.

Coming back to the southern part of Anikojigami lake, a canoe route was surveyed to the west, coming out where we first reached the Blanche river on our way to Round lake. There are four lakes on this route and as many portages. The largest lake, called Sasakinaka, is three and a half miles long and full of islands clustered together. On the first small lake west of Anikojigami there is an outcrop of a granitic rock, and exposures of the same rock occur for nearly two miles west. The strike is N. 70° E. Huronian rocks are found elsswhere on this route. Some areas have escaped the fire of thirty years ago and these are covered with a heavy growth of spruce, poplar, canoe-birch, fir, red pine and red maple *(Acer rubrum)*. This is the only place I have seen the red maple in the whole district.

Sasakinaka lake.

I returned to Abitibi post and spent some time in trying to make an examination of the north shore of Lake Abitibi and the rivers flowing into it from that side, but owing to heavy storms and high winds, I found it impossible to accomplish much. This shore has, however, been examined and well described by Mr. Walter McOuat* of this Survey and others.†

Indian relics.

On Lower Lake Abitibi, at the east end of the portage, across the peninsula from the south, I found a number of interesting Indian relics. They were lying on the sandy beach, covered at ordinary high water, and consisted of several pieces of pottery, showing five or six different patterns of ornamentation, part of an arrow head, several knives and scrapers, gun flints, a stone axe and numerous flint chips. The pottery seems to have been made from the clay and sand contained in the bank at this point. Close to the bank there are hard baked, irregular masses four or five inches thick which seem to be of the same material as the pottery. Stone knives and scrapers were also found on Black river at the mouth of White Clay river and on a point in the southern part of Agotawekami lake, and a perfect arrow head on Kapikokonaka lake, in Otto township.

Glaciation.

The whole country examined shows evidence of heavy glaciation. This is seen in the transportation of boulders, the general rounded appearance of the hills, and especially in the smooth, polished and striated rock surfaces so frequently met with. The latter are best seen in the lakes, on the shores of islands and on rock exposures in the rivers at or near water level. When the rock is wholly exposed to atmospheric action the surface has been so changed by weathering that striæ are rarely preserved, but when the surface is covered for a por-

*Report of Progress Geol. Surv. Can., 1872-73, pp. 126, 127.

†Report of the Survey and Exploration of Northern Ontario, pp. 46-48

tion of the year, the glacial grooves and lines are very distinct. There are two general courses. The latest, which is by far the most common, varies from S. to S. 20° E. ast. and an older set runinng from S. 20° W. to S. 35° W. ast. That the direction of the ice movement was from north to south over the Height-of-Land, there is most conclusive evidence. The stossing is invariably on the north side, as is well seen on the islands in Abitibi and many other lakes. Many buff-coloured limestone boulders, similar in composition and colour to the rock occurring north of the Sextant rapid, sixty miles from Moose Factory, were found on Lake Abitibi, and also at the Long Sault rapids. These boulders contain typical Devonian corals and they were evidently carried by the ice from the above mentioned Devonian strata.

Boulders containing Devonian fossils.

The whole country examined is frequented by fur-bearing animals, which form a means of livelihood for the Indians. Each Indian has his own hunting-ground and it is said they are careful not to trespass on each other's property. A good hunter will secure furs to the value of $400 in one winter, but many do not exceed $200. The animals hunted are moose, caribou, Virginia deer, bear, fox, wolf, muskrat, marten, lynx, otter, weasel, beaver, mink, ermine, skunk, porcupine, fisher, and rabbit. Moose were very plentiful about the head waters of the Blanche and Black rivers, especially the former. Fresh tracks were frequently seen in the soft mud along the streams and their paths were common and well beaten through the bush. The Indians say that the wolves are increasing alarmingly fast, and they fear if their rapid increase is not checked they will exterminate the deer and other animals. They are sometimes successful in their attacks on the moose, especially the young ones. Fish of various kinds are numerous in all the lakes and rivers, and many species of birds were seen during the summer.

Game.

From my observations in this district, I am convinced that there are large areas of agricultural land of excellent quality, especially in the river valleys, the soil being in most cases a clay loam, free from stones and easily cleared. The climatic conditions also seem favourable for farming operations, and these would improve with the clearing and drainage of the land. Out of a collection of nearly seventy species of plants from this district, Professor Macoun says there is only one which indicates a cold climate and that was found in a peaty swamp. When it is remembered that Lake Abitibi is farther south than the southern boundary of Manitoba it will be seen that there is nothing in the latitude to prevent the successful cultivation of the soil, and further, it has been practically proved for many years that vegetables of all kinds can be successfully grown at Abitibi post.

Rich agricultural land.

Climate.

In the collection of plants above referred to, there is a black-fruited Crætagus, which is probably a new species.

Raspberries and blueberries were frequently met with, though they are not plentiful. High bush cranberries are common along the streams, and the Indians report several bogs where low bush cranberries are abundant. The tamarack is everywhere dead, and though an occasional tree has a few green leaves, I did not see a vigorous one the whole summer. In certain localities a considerable percentage of the spruce is also decaying, and I noted many cedars with the foliage from one-third to one-half dead.

Dead tamarack.

Mr. Skene gave me the following dates as the opening and closing of Lake Abitibi:

Opening.	Closing.
1898, April 11.	October 28.
1899 " 28.	November 11.
1900 " 30.	" 11.
1901 " 11.	(Not received.)

The first frost at the post this fall (1901) was on September 25.

I may state that Mr. T. A. Davies, who accompanied me the whole summer as assistant, did his work in a very efficient and satisfactory manner.

I have to thank Mr. O. E. Taylor, Mattawa; Mr. B. M. Miller, Ville Marie, and Mr. Robert Skene, officers of the Hudson's Bay Company, for much valuable assistance and many kindnesses, especially Mr. Skene, who did everything in his power to aid me in my work.

Eastern Part of the Abitibi Region.

Mr. J. F. E. Johnston.

Instructions.

In accordance with your instructions I left Ottawa on June 10, and proceeded in company with Mr. W. J. Wilson to the Hudson's Bay Company's post on Lake Abitibi, this point having been decided upon as the best depot from which to make a geological and topographical examination of that portion of the country lying to the east of the regular Hudson's Bay Company's route from Lac des Quinzes to Abitibi, northward to latitude 48° 45′, and east and south as far as could be got over in the time available.

The post was reached on Sunday, June 23, and the following day was spent in arranging outfit, securing guides, &c. One of the men hired to help us to get our outfit in from Quinze lake to Abitibi and who had been over a considerable portion of the country to be examined, was engaged to act as guide and canoeman. He found, however, that he would be unable to join us for eight or ten days. Accordingly, on the next day, with Mr. H. F. Lambart, of Ottawa, as assistant, and one Indian, I left for a short side trip to Agotawekami lake, to examine any brooks entering on the east side with a view to finding a practicable route into the lakes which had been already surveyed by Mr. John Bignell, P.L.S., of Quebec, on the south-eastern side of the height of land. A good sized brook, coming in one-third of the way down, was ascended to a point where it was found to be completely blocked with fallen timber, and had to be abandoned. I then struck across through the bush to the height of land, but did not find any way to get through with a canoe, nor were any rock exposures encountered. The timber consisted principally of excellent white spruce and poplar, the former having an average diameter of from nine to eighteen inches, while some of the latter was large, a few of the trees having a thickness of two feet near the butt.

Assistant.

Timber.

We then returned to Abitibi to meet the guide and, although we waited a couple of days over the time agreed upon, he failed to appear. We, therefore, secured a small bark canoe and two Indian boys (it being impossible to persuade any of the men to come) and started up the Amikitik or Whitefish river which enters Lake Abitibi at its north-east corner about four miles and a half from the Hudson's Bay Company's post. As this trip was to be over entirely new ground, a micrometer survey was made of the stream and of a good sized lake drained by it. The lake is situated about twenty-eight miles from the mouth of the stream.

Whitefish river is a sluggish, dirty brown stream five chains in width at its mouth and varying from three to five chains, up to Makamik lake at its head. It is about twenty-five feet deep at seven miles from its mouth and fifteen feet at two miles below the lake. It is fed by numerous good sized creeks and flows through a flat country. The shores are thickly wooded and low, and the soil along its banks is a good clay loam. In ascending the river, the first break in the smooth water occurs twelve miles up, where there is a chute and rapid with a total fall of about thirteen feet. Three-quarters of a mile further, there is a slight rapid falling one foot and in less than a quarter of a mile another chute and rapid occur with a fall of fifteen feet. Four miles and a quarter further on we came to the biggest rapid and chute on

Whitefish river.

the river with a fall of thirty feet. Two other small rapids occur within the next three miles and a half, with a total fall of about four feet and from this to the lake is dead water.

Huronian.

The first rock exposure met with on the Whitefish river occurs two miles from Abitibi lake and consists of Huronian biotite schist. Three miles higher up is a small exposure of biotite gneiss and from there till Makamik lake is reached, the only rocks met with are altered diabases and mica and chloritic schists, striking in a general way, about east and west. Ancient glacial action is very evident along the river and the striæ are well defined.

Makamik lake.

Makamik lake, at the head of this river, is approximately six miles and a half in its greatest length and its extreme width is about six miles. In general direction it lies nearly north and south with one large bay to the west and two to the east. The water is very shallow and although we sounded it in a good many places, the greatest depth we found was five and a half feet with clay bottom and the high water mark is only three feet above this. The shores are heavily wooded with white spruce, white and black poplar, balsam, white birch, a few black ash and near the water some excellent cedar.

It is fed by three fair sized streams, one of which enters the lake at the extreme southern end (which we afterwards ascended) and two others coming in close together on the eastern shore. The two latter are about 100 and 150 feet in width respectively and possibly are two mouths of the same river. There is also another brook entering the lake on the western shore, called by the Indians Ogassassan ; we examined this brook later on.

General course of Whitefish river.

Whitefish river, the outlet, leaves the lake at its most northerly point and flows, in a general way north-west for fifteen miles, then swings round and flows in a southerly direction to Lake Abitibi. The rocks on the northern shore of Makamik lake resemble those on Whitefish river, but on the southern side we found altered granite, biotite schist, granite and gabbro. The general strike is from about east-and-west to north-east and south-west with a northerly and a north-easterly dip respectively. Most of the rocks are well striated.

Guides desert.

The morning after completing the survey and examination of Makamik lake, we found on awakening that the two Indian boys had left during the night, taking the bark canoe and leaving us with one shallow 17 foot canoe to carry our whole outfit and three men. This of course prevented me from doing any further micrometer work, but as it was very desirable to reach the head waters of the Whitefish river it was decided to ascend the stream entering at the south end. A time

traverse was made of this river and the lakes at its head, carefully checked by astronomical observations for latitude. The magnetic variation was also observed as frequently as possible.

In ascending this river, which is about three chains wide at the mouth, we travelled almost directly south for nearly seven miles, south-easterly for nine miles, when we swung round and travelled a little south of west for over two miles. This brought us to the next lake, which is entered about the middle of its north shore. At the mouth of the river between Makamik lake and this one, there is a peat bog, but its extent is small. The river maintains the same width approximately, to within about three miles of the lake, when it gradually widens to about seven chains, narrowing again to about three chains where it leaves the lake. The water is very muddy at the mouth, but gradually becomes less so higher up and at the head it is comparatively clear. The bottom is clay and the soil on either side clay loam. The shores are well wooded with white spruce, white and black poplar, balsam, tamarack and black ash and a good deal of Banksian pine.

Peat bog.

Several brooks enter on either side, but they are all so choked up with fallen timber that it would be impossible to go up them in a canoe. The first rapid occurred about seven miles and three quarters from the mouth. It was about nine chains long and had a fall of twelve feet. Here there is an exposure of massive gray granite, well striated, and the same rock is seen at the next two rapids, the first of which is a little over a quarter of a mile farther up, falling about five feet and the second seven chains further still, with a fall of fifteen feet. One mile and a quarter more brought us to a fourth rapid falling about six feet and here the rock, which is very much disturbed, is an altered diabase. One more rapid has to be passed before reaching the lake and this is the one of greatest fall. It is about two miles and three-quarters above the last mentioned, and consists of a chute and a rapid about sixteen chains long with a fall, according to the aneroid, of thirty-five feet. The same altered diabase crops out again here. For the last three miles before reaching the lake, the shores are very marshy, covered with alder in places, and occasionally running back into tamarack swamps. Just before reaching the lake, however, the shores become tree-covered to the water's edge and the river narrows again. Our progress up this river was somewhat slow, as all our portages had to be cut out and, having only one Indian and my assistant, this took considerable time.

Exposure of massive gray granite.

The lake at the head of this river is a very pretty one. It is about two miles and a quarter long, half a mile wide, and lies almost exactly east-and-west. The extreme western end and the extreme eastern where the inlet occurs, are somewhat marshy, but the shores of the

rest of the lake are wooded to the water's edge with white spruce, white and balsam poplar and cedar. To the west and south-west the ground begins to rise almost from the water's edge, up into the low hills forming the height of land. The depth is ten to twelve feet and altered diabases, striking in a general way east-and-west, are the only rocks met with, except on a small island, a quarter of a mile from the inlet, where a volcanic breccia is exposed containing slate pebbles, pyrite and a pseudomorph probably siderite after pyrite.

Volcanic breccia.

Ascending the inlet, it gradually widens out into another lake of a marshy character for the first mile. It is on the same level as the last lake, and beyond the marsh it is a beautiful sheet of water with a total length of about eight miles and a half and an average width of from half a mile to a mile. Looking up the lake from its outlet the main axis would be a little south of east for seven miles, when it turns sharply to the north, in which direction it continues for a mile and a half further. About the middle it narrows to a quarter of a mile and is studded with islands, some seventy in number. Nearly every point on the lake shows rock exposure. The water is dark in colour but not muddy, and the average depth is about sixteen feet. As I was unable to find any Indian at Abitibi who knew these waters and consequently could get no name for them, we called the lake for descriptive purposes, Lake Lois.

Lake Lois,

There is an exposure of breccia near the western end, and all the other rocks seen are altered diabases and greenstones. The rock is everywhere rounded by glacial action and well striated. The strike varies from about north-east and south-west to east-and-west. The shores are well wooded with the same timber we had seen all along. Two creeks enter the lake at its eastern end and both of these were examined as far up as we could get, but a mile or so from the mouth of each, the water was found to become very shallow and the brooks choked with alder bushes and fallen timber. We then followed their courses by walking through the bush to see if there were any more lakes on this route, but they both seemed to rise merely in marshes or swamps. A quarter of a mile north of the long northerly arm, at the east end of Lake Lois, another small lake was found. Its longer axis trends north-east and south-west; it is a mile and a half long and one-eighth to one-quarter of a mile wide. A portage was cut to the lake, of which a traverse was made. The rocks and the timber on this lake resemble those on Lake Lois. It is ten feet higher than the latter lake and its outlet, which is at the north end, is a very small brook running in the opposite direction from Lake Lois. This satisfied me that Lake Lois is the source of the river emptying into

Makamik lake and is consequently one of the head waters of Whitefish river. We now returned to Abitibi post over the same route by which we came, and on our way examined Ogassasan brook, already mentioned, for a couple of miles, when it became completely choked with wood. One mile and a quarter from its mouth there is a chute falling three feet, and here chloritic schist, striking south-east, is exposed. Return to Abitibi post.

We reached the post on the evening of August 5, and as Mr. Wilson and myself had agreed to meet August 15, to arrange about going out together at the end of the season, I decided to use the interval in again trying to find a route into the lakes on the south-eastern side of the height of land. Two or three days were lost by very bad weather, but on the 9th we went up to Agotawekami lake and, after a careful search along the east shore we found a brook coming in about four miles above the one we had tried previously, and this proved to be the route required. It is rather difficult to find, as the mouth is hidden in marsh, and at twelve chains up, the brook widens out again into a very shallow marsh, in which the water was so low that we had to pull the canoe through by wading. We followed a number of sections of this brook alternating with marshes, portages and small lakes till we crossed the height of land into Lake Kajakanikamak, which is practically at the same level as the last lake on the Hudson bay side of the watershed. This lake is about one mile and three-quarters long in a general south-easterly direction from the end of the portage, and about one-eighth of a mile wide. A couple of exposures of greywacke were seen and about half way down, one of conglomerate. On completing the examination of this lake I returned to Abitibi to meet Mr. Wilson, and having arranged with him to meet again at Klock's depot on Quinze lake on October 15, I started back to Kajanikamak and continued the exploration to the eastward. Lake Kajakanikamak.

The lakes in this part to the east and south had been already surveyed by Mr. John Bignell, P.L.S., Quebec, so that the topographical work for the remainder of the season consisted merely of minor track-surveys up small brooks and between lakes previously located. Lakes surveyed by Mr. John Bignell, P.L.S.

Leaving Kajanikamak lake at its south-eastern end, a little over two miles of very bad brook travelling brought us to Kakameonan lake, which is about six miles in length and varies from half to three-quarters of a mile in width, lying in a general direction north-west and south-east and with a bay near the middle of the north-east shore running north-east for about a mile and a half, out of which it discharges. Kakameonan lake.

Like all the other lakes in this district, the shores of Kakameonan are well wooded with aspen and balsam-poplar, white spruce, balsam-fir, tamarack and an occasional pine. The rocks seen were greywacke, chert, a breccia with flinty felspathic quartzite pebbles, altered diabases and a hard, compact, light-gray Huronian rock. The brook which is the outlet, joins the west branch of the Kinojevis river about six miles above the junction of the latter with the east branch. Altered diabase is exposed a quarter of a mile up the west branch above the brook, and a mile and a half beyond this slate is seen. Below the outlet of Kakameonan there are no exposures on the west branch which flows over clay and is from sixty to a hundred feet wide. Ascending the east or main branch, which is from three to four chains wide, there is a swift current four miles up, and at five miles altered diabase was seen at a rapid.

Rock exposures.

Several exposures of slate and graywacke were seen before reaching Kabakwobia lake, a small expansion of the river about two miles long. A short stream fr m the south, a mile long, connects it with Kawbaswakaminikatay, a round marshy lake about a mile in length, and a badly choked creek connects the latter with Kawinakwisakwidaw about four miles to the south-west. About half way up the creek, between the second and third lakes, there is a fall of about eighteen feet with an exposure of chloritic schist. On Kabakwobia lake, schists, slate and greywacke are seen and the shore is well wooded with poplar, spruce, cedar and balsam.

Carcajou river.

In ascending the Kinojevis from the forks, we travelled in a general easterly direction as far as Kabakwobia, then northerly for about four miles when we swung round easterly again. On the river just above this lake there are a few elms, but for some distance after this the river runs through an old *brûlé* with second growth of small white birch and poplar. About twenty miles above Kabakwobia a small stream, known as the Carcajou river, enters from the north, and between Kabakwobia and this stream we passed two more small rapids, the first of which falls about twenty feet and the second two or two and a half feet. The rocks met with along this stretch are greywacke, greenstone and altered diabase holding considerable pyrite disseminated through it in small cubic crystals. We went about three miles up the Carcajou, which is a muddy stream, badly choked in places with fallen timber. Chloritic schist, striking about north-west-by-west is seen on this river at a small rapid. Returning to the Kinojevis, we found that three-quarters of a mile further up, the river forks into two large branches, one known as the Nawapitechin or North river, coming from the north, and the Kewagama from the south.

Forks of Kinojevis river.

The North river was examined as far up as we could get, a distance of about thirty-five miles. Twelve rapids, all small, varying in fall from one foot to six feet with a total descent of about twenty-seven feet, were passed in this distance, after which the river narrowed to a very small stream choked with alder. The soil is clay-loam and the shores are well wooded the greater part of the way. On the lower part of the river the timber consists principally of spruce and balsam poplar with some aspen. Further up, the poplar becomes scarce and spruce and jack pine are the principal woods. The river is very crooked and in ascending it, the general direction is nearly north-west for two-thirds of the way, when it swings round nearly south for five or six miles and then nearly west again till the end of canoe navigation is reached. North river.

The rocks on this river are somewhat varied, greenstone carrying some pyrrhotite and giving indications of the possible presence of nickel, occurring about five miles up the river, while two miles beyond an altered granite is exposed. Within the next mile and a half, greenstone is seen again and also chloritic schist. An outcrop of light-gray altered granite is seen at intervals for about two miles beyond this, and gives place to a very hard cherty rock containing small specks of chalcopyrite associated with greenstone, and further up the river, as far as we managed to ascend, greenstones were the only rocks seen. Rock exposures.

Having completed the examination of the North river, a return was made to its mouth and we proceeded up the Kewagama some five miles to a lake of the same name. This river flows over clay with good clay loam on its banks, which are well wooded with spruce, balsam and white poplar. There are two rapids, one, about four miles up, with a fall of about six feet, and another near the head falling about fifteen feet. At both of these there are exposures of a rusty, somewhat gneissic biotite schist, striking about north-east. Kewagama river.

Kewagama lake, which is much the largest of the different bodies of water examined during the summer, consists of two main parts, an eastern and a western, separated by a long point. The latter runs nearly south almost the whole length of the lake, leaving merely a narrows to join the two parts. The western part is again divided by a second narrows about half way up. The longer axis of the lake would be a line running east and west at its southern end and passing through the first narrows. This would be about eleven miles in length. The extreme width north and south would be about eight miles and a half for the eastern section and nine for the western. The width of the eastern is about six miles at the north end, narrowing to about one mile, half way down and then gradually widening at the Kewagama lake.

southern end to about six miles from the first narrows to the eastern shore.

Diorite, schists and syenite.

Following the shore-line from the outlet round the point dividing the two portions of the lake, a distance of four miles, we met with a coarse-grained diorite, chloritic and biotite schist, and a reddish syenite. A little further on, a soft chloritic schist is exposed, and, about two miles below this, there is a very quartzose altered granite intersected by numerous veins of white translucent quartz of various sizes. Of this quartz several specimens were broken off at random from the top. One of these carrying considerable iron pyrites was assayed under Dr. Hoffmann's direction and gave 0·117 of an ounce of gold to the ton of 2,000 lbs. Others, quite close carried molybdenite and bismuthite. The occurrence of bismuthite is very interesting, as it has previously been found, I believe, in only four localities in Canada.

Economic minerals.

Granite.

Granite is the prevailing rock till the first narrows is reached. There diorite is exposed, and this continues round the point to the second narrows, leading into the northern half of the western section of the lake, and for one mile and a half further. In places, associated with this, is a hard, compact rock carrying considerable pyrites. Quartzose granite is then exposed for some distance, and, about three miles from the head, hornblendic schist. A very marshy creek entering the northern end of this part of the lake, was ascended for about two miles to a small lake at the same level as Kewagama, but no exposures were found.

Returning to Kewagama lake and working along the western shore of this section, mica diorite was seen three miles down, and a quarter of a mile further, chloritic schist. From here to the south end of the lake the rocks are biotite, chloritic and hornblendic schists, with the exception of one point a mile below the narrows, where there is quartzose granite. At the south-eastern corner of this portion of the lake, a river one hundred to one hundred and twenty feet in width enters from the south-west. We ascended this stream for about six miles, passing a little rapid about two miles and a half up, where chloritic schist is exposed. Quite a number of white pine of fair size are seen about two miles up this stream. This brought us to Lake Kai-kaik, which is about four miles long and a quarter of a mile wide. The rocks on this lake are chloritic schists striking east and west, with some slates.

Lake Kai-kaik.

Returning once more to Kewagama we continued the examination of the southern shore, and in a quarter of a mile came to diorite. In the next mile there are several exposures of schist and then one of

diorite, then a mile and a half of schist. Beyond the narrows a porphyritic rock occurs, and from here, along the rest of the southern shore, which is very rocky, schist prevails. Along the eastern shore diorites and granites are the only rocks seen, but along the northern, hornblendic schist, granite, altered diabase and, just at the outlet, biotite schist occur. At the north-east corner of the lake, a small brook, about a mile and a half long forms the outlet of a marshy lake called Kapitagama, which is nearly round and about a mile and a half across each way. This lake was also examined, but no exposures were found.

Kewagama lake well timbered.

Kewagama lake is well timbered, fine white spruce and white poplar being very abundant, with a considerable quantity of balsam poplar and white birch. On some of the islands there is a fair quantity of red pine of medium size, and more particularly near the southern portion of the lake an occasional white pine is seen. At some of the narrows and near the mouths of some of the brooks entering the lake there is a considerable growth of small ash, and along the whole lake shore small cedar is seen close to the water.

On completing the examination of Kewagama we returned to Abitibi, as we were out of supplies and time would not permit us to prosecute the work any further to the eastward this season. A route exists from a long bay on the east shore of Kewagama via Lake Newagama over the height of land into a large body of water known as Seal lake.

Lower part of Kinojevis river.

Abitibi was reached September 14, and a day was spent in packing up part of our outfit which was to be taken to Quinze lake by the Hudson's Bay Company. We were further delayed by very bad weather till the morning of the 19th, when we started back to the forks of the Kinojevis, from which point it was intended to extend the work down to the Ottawa river. Proceeding down the river from the forks for thirteen miles, we came to a small lake, after passing two rapids, one being half a mile below the forks and falling about fifteen feet, while the other is about eight miles down and falls three feet. In this interval the general direction of the river is southerly, but it is very crooked.

Numerous exposures occur of chloritic schist, altered diabase, greenstone and a breccia containing flinty, felspathic quartzite pebbles. A number of these rocks carry considerable pyrite and some have very rusty surfaces. A brook enters the little lake from another lake some three miles in length, situated about a quarter of a mile to the west. On both of these lakes, the prevailing rock is greywacke with a nearly

Small lake expansions.

east-and-west strike, and the same rock occurs all along the river with about the same strike for the next seven miles, for four of which the river is flowing east and for three south-west, at the end expanding into another small lake a mile and a half long with a deep bay extending a mile to the south-west; and on this lake the same rock occurs on the upper portion and in the bay. On the lower part of the lake hornblende schist is exposed at intervals for about a mile. The river now runs in two channels for a mile and a quarter round an island, from three-quarters to one mile in breadth, the foot of this island being at the northern end of Lake Kinojevis. We came down the western branch to the lake and saw two exposures of greywacke still striking nearly east and west.

Kinojevis lake.

Kinojevis lake lies for about five miles a little east of south from its head when it makes a sudden turn to the south-west for about thirteen miles, the part below the turn being known as Crooked lake. At the turn the Kinojevis river, its outlet, leaves it and flowing in a general south-easterly direction for about sixteen miles joins the Ottawa river about twenty-one miles above Lake Expanse. Lake Kinojevis with Crooked lake is very narrow, averaging from a quarter to half a mile in width. At its head, on the western shore, a hard biotite schist occurs and on the opposite shore an altered diorite. One mile down, a bay runs for about a mile in a westerly direction and at its head a small creek enters. This we ascended for half a mile, when we came to a lake which is about two miles and a half long and of increasing width till, at the head, it is about a mile and a quarter across.

Lake Kekeko.

On this lake we found hard biotite schists, altered diorite, and greywacke. At the western end a brook comes in and going up this a little over two miles, passing an exposure of greywacke on the way, we came to Lake Kekeko. The latter is about six miles long, lies nearly east-and-west, and has two bays at the western end, one running to the north and the other to the south, giving the lake the general appearance of the letter T. Both this and the first lake are practically on the same level as Lake Kinojevis. The first exposure seen on Lake Kekeko is a dark coloured diorite two miles from the outlet and from the point to where the two bays turn off, the rock is entirely slate striking nearly east and west. At the entrance to the northern bay there is diorite, and higher up the bay on the east shore, chloritic schist. On the west shore greywacke and slate are the prevailing rocks. At the north end of the north bay a brook enters the lake and we went up it about five miles passing two chutes, one falling ten feet and the other fifteen feet, about one-eighth of a mile apart, and about

three miles from the mouth. Greywacke, greenstone and chloritic schists are the rocks on this creek. At the south end of the south bay, a small creek comes in from two lakes but the brook was quite impassable for the canoe owing to the abnormally low water. I walked up to the first lake but saw only greywacke. However, it was difficult to do any geological work here as it had been snowing for two days and the rocks were hidden.

Returning to Lake Kinojevis we proceeded along the lake and at two miles down found altered diorite, and one mile and a half further rusty biotite schist, and associated with it altered granite. Three-quarters of a mile further we found a hard, black, biotite schist and turning down into Crooked lake the same rusty schist. This rock continues down the lake shore but becomes more gneissic and three miles down is more of a schistose biotite gneiss, striking nearly east-and-west. For the next four miles the same rock occurs, very rusty and decomposed in places, and associated with it is a quartzose granite containing quartz and pegmatite veins. Eight miles down Crooked lake, opposite the mouth of a small stream known as the Kamshigamau river, the same gneiss occurs, in places very micaceous and associated with it everywhere is the same granite, intersected by numerous pegmatite veins carrying considerable muscovite, though from surface showings, only in small crystals. Crooked lake.

We now returned up the lake to the outlet at the bend and proceeded down the Kinojevis river. There are two small rapids between Crooked lake and the Ottawa with a fall of a few inches. Schistose biotite gneiss, similar to that seen on Crooked lake, was noted on coming down the river at intervals for about eight miles, after which there are no exposures till about four miles from the mouth, when gray granite, also similar to that on Crooked lake, outcrops. All exposures from this point to the Ottawa river are of granite. The Kinojevis river from Crooked lake down, has an average width of about five chains and the Ottawa river where the latter enters it is about seven chains wide. Descend Kinojevis to Ottawa river.

Having reached the Ottawa our work for the season was finished and we started at once for Klock's depot on Quinze lake. This was reached on the night of October 14, and Mr. Wilson arriving the next day, we left on the following morning and reached Ottawa on the 20th. During the whole season Mr. H. F. Lambart, of Ottawa, acted as assistant and performed the duties allotted to him very satisfactorily.

The general inference drawn from the rocks in the area examined this season is that the line of contact between the Laurentian and Huronian observed by the late Mr. Walter McOuat in 1872 as crossing Geological conclusions.

Lake Opasatika on the main Quinze-Abitibi route runs in a general way a little south of east, crossing Crooked lake about the mouth of the Kamshigamau river and thence in about the same direction to the Kinojevis river which it crosses about four miles from its mouth. East of this we had no opportunity of observing it. The most northernly rocks met with were Huronian and the northern limits of the Huronian are extended to cover the whole area examined, the granites mentioned as occurring at different localities being considered as intrusive. The whole area has been subject to glacial action and the rocks are nearly everywhere striated, the grooving being very clearly marked in most places.

Huronian.

Timber.

With regard to the timber—white spruce, aspen, balsam poplar, balsam, white birch, tamarack, Banksian pine, and cedar are the principal trees found. Spruce and aspen are by far the most plentiful and particularly on the northern portions on both sides of the height of land, excellent spruce for pulpwood is seen on the lake and river shores. Balsam-poplar, balsam fir and white birch are probably the next most plentiful, and tamarack is not far behind, but it is nearly all dead, particularly in the northern portion. Cedar is found scattered along the banks of some of the rivers and around the shores of nearly all the lakes. Small ash grows near the mouths of a good many brooks. Small elms are found in a few places and red and white pine occur from Lake Kewagama south, but not in sufficient numbers or of large enough size to be of importance.

Soil.

The soil over the greater portion of the area is a clay loam, changing in places to a somewhat sandy loam, and in some localities would probably make fair farming land if not too wet and cold. Along the river banks it is generally good, and, along the Kewagama river, very good. With reference to this, the conditions at Abitibi post may prove of interest. I was informed by Mr. Skene, the gentleman in charge, that this year the last spring frost at the post was recorded on May 25, and then only one degree. The highest temperature was on July 15, 92° Fahr. and up to September 16 there had been no frost. On June 8 there was a fall of snow, with the thermometer at 36° and in the interval between May 25 and September 16, rain fell on fifteen days.

Vegetables grown.

Mr. Skene has a small garden at the post and has met with complete success in growing the following vegetables, viz., potatoes, onions, cabbages, cauliflowers, beans, radishes, lettuces and cucumbers. They sowed timothy seed in the Company's clearing on May 21, 1900, which yielded an excellent crop of hay the following summer. Oats also gave a good crop.

At the Post the land is well cleared. We did not find the weather in the bush quite so favourable as it was there. Water left in the kettle over night was coated with ice on the morning of September 12. The weather broke this year on September 15, and from that date until we completed our work, on October 15, there were very few days without snow or rain. On Kekeko lake on October 4 and 5, we had a two days snow storm, the snow, twenty-four hours after it had ceased falling, having a depth of three inches. From June 15 till September 14 we found the weather delightful.

Game.

With regard to fish and game, I might say that all the lakes near the height of land on both sides were plentifully stocked with pike, pickerel and suckers. In Makamik lake, however, we found only suckers, while in Whitefish river we caught whitefish, in addition to those mentioned. Farther south black bass can be caught in Crooked lake, and possibly a little above it, but they are very scarce.

Of the larger game, moose are undoubtedly the most plentiful. We saw their tracks often quite fresh all over the area examined, and, although not looking for them during the summer, we saw four of these animals, one on the Carcajou river, two on the outlet of Lake Kai-kaik, and one on Lake Kekeko. We also heard them frequently during the calling season, and the Indians seemed able to go out and get a moose whenever they felt inclined. Caribou are not scarce, but we saw only one, and that had just been shot by an Indian. I saw a black bear on one of the small lakes off Kewagama, and a large lynx on the Nawapitechin river. Of the fur-bearing animals, beaver, otter, marten, muskrat, mink and fisher are common, and of these we saw many individuals. Ermine are rather scarce, but some skins are brought to the post. Rabbits were found to be comparatively abundant. Both the ruffled grouse and spruce partridge are very plentiful, but ducks are rather scarce.

The Sudbury District.

Dr. A. E. Barlow.

Microscopic examination of rocks.

The first part of the year before the commencement of field operations was spent by Dr. A. E. Barlow in a detailed petrographical examination of the various rock types exhibited in the suite of specimens collected to illustrate Mr. R. G. McConnell's work in the Yukon Territory during the seasons of 1898-1899 and 1900. Thin sections were also examined under the microscope of some of the rocks associated

with the iron deposits along the Kingston and Pembroke railway. The detailed description of these forms an appendix to Mr. E. D. Ingall's report which has just been issued. Many of the different rock species met with by Dr. Robert Bell and Mr. J. M. Bell in the Great Slave lake and Great Bear lake regions were also sectioned and studied, the results in detail being included in the report covering this work. A considerable amount of petrographic work was also done on the rocks from the Atlin district, the results being handed to Mr. J. C. Gwillim to be included in the final report on this area.

Resumption of work in Sudbury district.

This laboratory work being finished early in June, it was decided to send Dr. Barlow to make any corrections and additions found necessary on the map of the Sudbury mining district issued in 1891. The renewed activity in the mining of nickel in the Sudbury district indicated clearly that the present was a most opportune time to obtain a better knowledge of the nature and extent of those deposits. It was recognized that the geological map needed revision and correction, although its general accuracy and usefulness had never been questioned. Besides, the region had become more accessible by reason of occasional clearances, the opening of roads, and the development and extension of the various mines. Much additional information had likewise been secured concerning these occurrences of nickel, while the advance in geological knowledge due chiefly to the introduction of improved methods for petrographic and geologic research showed how desirable it was to undertake a more thorough study of the geology and petrography of this region. In carrying out this work, Dr. Barlow was materially aided by Dr. Ludwig Mond, of London, England, under an agreement by which the former was partially relieved from the Survey during the six months from July 1, 1901, to January 1, 1902.

Denison township.

Dr. Barlow was chosen to take charge, not only on account of his former connection with the work, but also because petrography would of necessity enter very largely into any detailed examination and study of these old crystalline rocks. The township of Denison was selected as the starting point, because the work done here in 1890 was more in the nature of a reconnaissance than a finished survey. With a headquarters camp on the west side of Ethel lake, the whole township was carefully and systematically explored, so that the lines of demarcation between the various rocks, as now ascertained and mapped, are very nearly accurate. A month was found necessary to complete the work in this township, after which a move was made to McCharles lake, to the east in the township of Graham. From this base of operations the work was gradually extended over the town-

ship of Graham and the southern part of Creighton. The southern limits of the nickel-bearing eruptive was also determined in the township of Snider, and the season was brought to a close in September by certain corrections of a minor nature in the geology of the township of Garson.

Nickel-bearing eruptive.

The investigations of the past summer have shown conclusively that the unaltered normal or type-rock with which the deposits of nickeliferous pyrrhotite and chalcopyrite are associated, possesses rather exceptional character and interest. It belongs to the general family of gabbros, but has nearly always traces of a broad ophitic or diabasic structure, which, although rude at times, is generally quite distinct. The abundance and occasional preponderance of hypersthene or enstatite justifies its classification and description as a norite, while the presence of a considerable quantity of original quartz makes it a rather exceptional rock type.

Mineralogical composition.

In general, the rock is made up of plagioclase (labradorite or bytownite), hypersthene or enstatite, augite, biotite, hornblende and quartz, with much smaller quantities of apatite, titaniferous magnetite, pyrrhotite, chalcopyrite and pyrite as accessory constituents. In general all the workable deposits of nickeliferous pyrrhotite or chalcopyrite, are situated at or near the borders of bands of this quartz-hypersthene-gabbro or norite.

Genesis of ore.

It is now confidently believed that these several sulphides which the rock contains were introduced simultaneously and as integral portions of the norite magma. At the same time pneumatolytic or secondary action was taking place on an extended scale and much of the sulphide material has undergone a subsequent rearrangement and consequent local enrichment. It must be understood, however, that the secondary action was proceeding during the slow cooling and differentiation of these immense bodies of norite magma, and that the ore-bodies were acquiring their present position and dimensions during this extremely slow diminution in temperature of the whole mass, so that the final consolidation saw these ore-bodies under very much the same conditions as at present obtain.

Brecciated ore.

The brecciated character of many of the ore deposits seems to give emphasis to the fact that autoclastic action has played an important part in the formation of many of these deposits, the sulphides being possibly more susceptible to rearrangement, while the accompanying rocky portions have undergone extensive fracturing and dislocation. Associated with the nickel-bearing norite and passing by insensible gradations into it, is a rock which has been called 'micropegmatite.' This rock, which is closely allied to the granites, must be considered as an integral and differentiated portion of the nickel-bearing eruptive. There is an undoubted and perfect transition from one

rock type to the other. This transition is now well understood. Microscopically, this change consists in the gradual assumption of a reddish colour replacing the green or greenish gray of the rock, this being accompanied by a corresponding increase in the amount of quartz and felspar. The hornblende of the norite is gradually replaced by biotite as the prevailing ferro-magnesian constituent, while orthoclase succeeds plagioclase as the prominent felspathic mineral. Concomitant with this, a decided foliation may be noticed to have been induced, corresponding with the general strike of the band, while micropegmatite or granophyre is very characteristic over large and often widely separated areas.

Nature of transition to norite.

Three belts of norite.

In the Sudbury mining district there are three main belts of these norite and associated micropegmatites. These may be called, respectively, the northern, southern and middle belts. At present they are mapped as distinct and separate, but genetically and mineralogically, they are essentially identical. They likewise belong to the same geological period and are very nearly, if not quite, synchronous. The most northern band starts from the old Ross mine (W.R. 5) near the line between lots 5 and 6 on the line between concession III and IV of the township of Foy, and extends in an east-south-east direction into the township of Bowell, where, on lot 6, concession II, it branches. One band runs south-west into the townships of Lumsden and Morgan, where its limits have not been ascertained. The other or main band runs on to the east, cutting across the township of Wisner, and crosses the Vermilion river immediately north of Bronson lake. Trending still more to the north it connects with the large area of basic rocks to the west of Lake Wahnapitae. The delineation of this belt is mainly owing to prospectors. The middle band of norite, according to the present state of our knowledge, starts on lot 12, concession III of Trill; extends north and north-east through this township into Cascaden, and crossing under Windy lake, goes on uninterruptedly through the north-west corner of Dowling, to lot 2, concession IV, Levack. There is probably then a considerable break between this and the Ross mine on the northern nickel range on the one hand and the basic band which runs through part of Morgan, but both bands are almost identical in mineralogical composition and are certainly genetic equivalents. It is along the northern contact of this band and the granitite-gneiss to the north that the famous Levack deposits are situated. This band of norite is about eighteen miles long and in places nearly half a mile in width.

Middle band of norite.

Main or southern band.

The most important and famous band of norite, however, is the southern belt, which, starting in more or less isolated patches and areas

in the township of Drury, coalesces into one large band in the eastern part of this township. It then extends in unbroken continuity in a north-easterly direction as far as lot 3, con. III of Garson, a distance of over thirty-two miles. The basic or norite portions of this band would average nearly two miles in width throughout its length. In the township of Denison the basic rocks extend over the greater part of the third, fourth, fifth and sixth concessions. About lot 2 the band attains its maximum width of nearly four miles, but a short distance east it is divided up into two belts by the intrusion of a mass of coarse "augen" granitite-gneiss. The northerly, which is the more important of these two belts, has a course of N.N.E. through the north-eastern part of the township of Denison and the south-eastern corner of the township of Fairbank. Thence it extends across the Vermilion river, covering part of the township of Graham and portions of the township of Creighton. From thence it runs across the central part of Snider, through the north-western corner of McKim and the south-eastern part of Blezard and, with the exception of lots 1 and 2, extends continuously across concession III of Garson. Through Creighton and Graham, this belt is over two miles in width, while near the old Dominion mine it is almost three miles from north to south across the norite. The southern branch of this great belt runs across the Vermilion river, covering parts of Graham, and thence on through Waters past Copper Cliff, where it rejoins the other branch. The lenticular mass of granitite-gneiss which divides this southern belt into two portions, thus occupies a strip of country one and a half to two miles wide through Graham and Snider, terminating at or near the Copper Cliff mines. It is newer than the norite, piercing and altering the basic rock.

Two branches.

It is now confidently believed that the nickel and copper deposits of Sudbury are the most important of their kind known in the world. The inauguration of the extensive and well equipped works of the Mond Nickel Company at the Victoria mines, and the extension of the works of the Canadian Copper Company, will rapidly place Sudbury in the foreground of the nickel-producing areas of the world.

Value of deposits.

Haliburton and Bancroft Areas, Ontario.

Professor Frank D. Adams.

The field-work in the Haliburton and Bancroft areas was very nearly completed during the summer of 1900. The time which could be devoted to the work during the past summer, namely two months and

Field-work by Dr. Adams.

a half, was accordingly spent in finishing the field operations and in beginning the preparation of the report.

Townships covered.

Six weeks were spent in July and August in the examination of the specimens collected during the several summers past and in the preparation of the geological maps of the area, and on August 21, I left Montreal for the field, where I remained until September 24. The field work during the past summer was carried on chiefly in the townships of Monmouth, Glamorgan, Harvey, Burleigh and Dysart. The geological relations in the two former townships are very complex, but were worked out successfully with the aid of the topographical surveys made in this area by Mr. L. N. Richard of the Geological Survey, who accompanied me during a portion of September. The distribution of the nepheline syenite, which occurs abundantly in these townships and which, in the eastern portion of the area embraced by the Haliburton sheet, holds the large deposits of corundum discovered by the Survey and now so extensively worked, was carefully traced out and several new areas of this rock, often containing indications of corundum, were discovered and mapped. The great gabbro area in the southern portions of these townships, which holds the iron ores occurring there, was also surveyed and carefully studied. Great bodies of excellent limestone were also found in the south-western portion of Glamorgan.

Work by L. N. Richard.

Distribution of rocks.

Dysart.

After the completion of this portion of the work, the eastern half of the township of Dysart was examined, in order to determine the limit of the limestones against the granite-gneiss and the character of their contact. This work having been completed, the southern portions of the township of Burleigh and Harvey and a portion of western Cavendish were surveyed. The mapping of the entire area was thus finished. With the completion of this work it may be appropriate to state very briefly what has been accomplished.

Burleigh and Harvey.

Area covered by geological survey.

A large area in eastern Ontario, comprising about 4,200 square miles, about the geology and mineral resources of which, at the time the work was commenced, practically nothing was known, has been surveyed topographically and geologically, and a great mass of information concerning its character and resources has been collected. Two maps have been prepared. The first of these, known as map-sheet number 118 of the Ontario series, (Haliburton sheet) is on a scale of four miles to an inch, and comprises an area of 3,456 square miles, its four corners being situated respectively in the townships of Finlayson, Hagarty, Grimsthorpe and Digby and having as its chief centres of population the villages of Haliburton, Bancroft, Coe Hill, Whitney and Barry's Bay. The Ottawa, Arnprior and Parry Sound railway runs across the northern portion of the sheet, while the Victoria

Haliburton map-sheet.

branch of the Grand Trunk railway, the Irondale, Bancroft and Ottawa railway and the Central Ontario railway have their termini in the southern portion of the area.

Bancroft sheet.

The second map is a special one and is to be known as the Bancroft sheet. It comprises an area of 2,040 square miles and has been drawn on a scale of two miles to an inch. It embraces the south-eastern portion of sheet 188, reproducing it on a larger scale and it also includes the country to the south, as far as Stoney lake, representing an additional area of 680 square miles. The necessity for this second sheet arose from the impossibility of showing the geological structure of so complicated an area on so small a scale as that of sheet 188. It was also found that a study of the district to the south of the Haliburton district was necessary in order to interpret the structure of the northern area. The Bancroft sheet will represent the first large Laurentian area in Ontario which has been mapped in such detail and will show excellently the character of a typical area of the rocks of the upper division of this system. Both maps will be coloured so as to represent the areas and distribution of the several petrographical units which comprise the districts which they represent, without any attempt to modify the mapping by introducing considerations of relative age.

Granite gneiss.

The survey has shown that the northern half of the area mapped consists almost exclusively of granite-gneisses of igneous origin which would in all probability have been classed by Logan as Fundamental gneiss. The southern half of the area on the other hand, consists chiefly of a series of very ancient sedimentary rocks, largely limestones, which rests upon the gneissic series, but which has been invaded and altered by it. Large areas of the sedimentary series have been so shattered and penetrated by the granite-gneiss that a sort of breccia on an enormous scale has resulted. Great bathylites of the granitic rock arch up and break through the sedimentary series elsewhere, the latter being wrapped around the bathylites in great sweeping curves.

Bathylitic structure.

The same bathylite structure is observable in the northern gneisses also, and can be traced by the curving strikes of the foliation of the gneiss, but here the limestones have been swept away by erosion.

In the south-eastern portion of the area the limestones are found in a comparatively unaltered condition and are associated with great volumes of amphibolite and other foliated rocks, as well as with occasional bands of conglomerates—some of which, at least, have been shown by Dr. Barlow to be of autoclastic origin. The amphibolites are in part altered volcanic tufas. A great volume of nepheline syenite has been

Autoclastic rocks.

shown by the survey to occur, associated with the limestones in the southern portion of the area. This remarkable rock has apparently some genetic connection with the limestones and also with the granites. Great intrusions of gabbro have also been found associated with the amphibolites in several parts of the district, and quite apart from these latter rocks marked evidences of volcanic action have been observed in several parts of the Bancroft sheet.

Economic minerals.

The area embraced by the survey is one which contains many mineral deposits of economic value—iron ores, mica, corundum, apatite, mineral paint, etc. These have, in all cases, been examined and their description will constitute an important chapter in the report now in course of preparation, which will form a compendium of all that is known of the mineral resources of the area in question.

Botany and Zoology.

Professor John Macoun.

Since my last report of progress was completed I have continued to conduct the correspondence and to perform the usual routine work of this Branch. When an opportunity offered last winter I worked on Part VII of the Catalogue of Canadian Plants and was able to finish it before spring. This part includes the Hepaticæ (Liverworts), Lichenes (Lichens) and an addendum to Part VI—the Musci. It is unnecessary to refer in detail to the enormous amount of work involved in the above and in the examination and labelling of a large number of specimens.

Catalogue of plants.

The following table will, however, give some idea of the latter:—

Liverworts	1,874
Lichens	3,892
Mosses	11,025
Total	16,791

These 16,791 specimens are now in the cases in the herbarium and are arranged in such a way that any one taking Parts VI and VII of the catalogue can see the various species and forms mentioned in the text. This work is now in the hands of the King's Printer, and the first part—the Liverworts—has been printed.

Flora of S. W. Ontario.

For many years I had desired to investigate the flora of south-western Ontario and it was understood before the death of Dr. G.

M. Dawson that I should take up that work during the summer of 1901. It seemed advisable, from a scientific standpoint, to examine the flora and fauna of the Grand river and see how they compared with those of the south shore of Lake Erie. Both the late Dr. Dawson and yourself considered it better to take a broader field and to look more at the economic side of the question and make some sort of report on the fruit-producing capabilities of the region traversed. With the above object in view, I left Ottawa on May 8 and returned on September 7, after spending four months in the field.

Owing to the work I have had to carry on in many distant fields and the multiplication of duties, a proper examination of the flora of the interlake peninsula of Ontario had never been made. Sir William Hooker, in a letter to the writer in 1861, urged him to make a personal examination of the shore of Lake Erie and stated that less was known of the flora bordering on the great lakes than of that within the Arctic circle.

As the natural flora of a country is an index of its capabilities and climatic conditions, so an examination and enumeration of the various species of plants growing in a given region, will, when properly understood, solve the problem of the success or failure of any branch of agriculture in that region. Owing to this knowledge, the writer was enabled in 1872 and in later years, in the face of continuous opposition, to publish to the world the suitability of Manitoba and the prairie region generally for the growing of cereals. It was only from a knowledge of its plants that he could do this, and as nature never errs, his prophecies have been entirely fulfilled.

Fruit-growing.

Of late years fruit-growing has been a paying branch of agriculture, and the Niagara peninsula and Essex county have been the advertised counties for its production. It was thought that an examination of the country would show that these areas could be greatly enlarged and that fruit culture could be made profitable over the entire district. Acting on this thought, the country between the Niagara river and Owen Sound was thoroughly examined during the past summer and over 1,400 species of plants collected. In no instance was anything found to indicate a lack of warmth and everything favoured the assertion that the whole region was suitable for the cultivation of fruit, ranging from small fruits to cherries, plums, apples, pears, peaches and grapes. There can be no question regarding this matter, as wherever the growing of fruit has been attempted it has been a success if properly undertaken. The purpose of this report is not to speak of fruit-growing in any special section of the region, but to refer particularly to the natural fruit and its bearing on the products of the soil generally.

Niagara.

On May 8 work was commenced at Niagara Falls and a note made of the plants found growing within a radius of eleven miles of that point. Special attention was given to the old forest growth, which largely consisted of hickory and oak, though no less than thirty species of trees were enumerated. Later it was found that the same forest trees, with variations on account of soil, extended to Windsor. These trees differ very much from those met with on Lake Huron and east of Toronto and it may be safely said that this difference in the forest growth must result from a milder climate in winter in the south-western part of the province. Peaches are the most tender fruit grown in Canada and at present heavy crops are raised between Hamilton and Queenston, and indeed wherever attempts have been made in the Niagara peninsula. A similar fruit centre is the district around Leamington and Kingsville in the county of Essex. This district has the same forest growth that is found at Niagara and the climate is practically the same. It is perhaps needless to say that fruit culture with profit can be carried on in every part of the country between these two points.

Leamington and vicinity.

Although the peach has been just selected as an example, it was not meant to exclude other fruits. Cherries, plums, pears, apples, grapes and small fruits succeed equally well. The capacity of the country under discussion for growing crops has hitherto been little understood, as tobacco culture is only now becoming a remunerative business. Only a few years ago it was scarcely thought of as a paying crop, yet in 1900 one firm paid out over $250,000 for that raised in the neighbourhood of Leamington. A very large tobacco warehouse was being erected at Leamington last summer by another firm and it was currently reported when I was there in August that 5,000 acres of tobacco were under cultivation for it.

Tobacco.

Collections of plants were made at many points, and in every locality visited the growth was noted, and the conviction forced itself upon me that the capacity of the whole region was only limited by the amount of intelligence brought to bear upon its natural capabilities.

Lake Huron.

Less time was spent on Lake Huron than Lake Erie, but the counties bordering on the former and on Lake St. Clair are known for their grain and general fertility and locally for their fruit. The time will come when the export of apples from this large area will be second to that of no other part of Ontario. The soil in most places is of the right kind, being largely mixed with lime, and the climate being cooler than that on Lake Erie, the fruit will be later in ripening and hence will keep better.

Apple-raising in the past in many districts has been a hap-hazard business. Each farmer put out an orchard, generally leaving the agent to select his stock, took more or less care of it, and waited for returns. Returns came in the shape of fall or late summer apples but scarcely any winter varieties, and hence no return in a monetary sense for the time and labour spent. This has been the case in parts of Essex county, where fine orchards have been cut down because they yielded only unsaleable fruit. Orchards planted with winter varieties in any of the counties north of the Thames must of necessity be expected to produce good fruit, and I look to this region for the future winter supply of Manitoba and the North-west until the prairie provinces produce their own fruit. Apple raising.

During two weeks in May large collections of botanical specimens were made in the vicinity of Niagara Falls, and on the 23rd of that month I took the train for Leamington, in Essex county. Though having my headquarters there, I made trips to Ridgetown, Kingsville, Arner, Amherstburg, Sandwich and Windsor. In all these places I secured large collections and added numerous species to our known southern flora. From a cursory inspection very little can be learned except in a general way, so I made a thorough examination of the district, and am satisfied that Lake Erie and the Detroit river and even Lake St. Clair, by no means form natural limits to the flora, either of Ontario or the States to the south. This deduction is based on the natural floras of the whole districts and from their identity. It is probable that the Canadian side is warmer in the autumn, owing to the heat from the water being blown in upon it at that season.

Three trees which range as far south as Texas come to perfection both at Niagara and Leamington, and very likely in the intervening country. These are the custard apple *(Asimna tritloba)*, the sassafras *(Sassafras officinale)* and the red mulberry *(Morus rubra)*. These trees, coming to perfection in the district, show that its climate is much milder in winter than would be expected from its latitude. The herbaceous plants are even more southern in their facies, and indicate a warm summer climate. This is more apparent in Essex county than it is in the vicinity of Niagara Falls. Southern trees.

Chatham and the valley of the Thames was visited and numerous rare and interesting plants were seen in perfection, and the astonishing growth of weeds and native plants gave proof of the richness of the soil. Here is seen an assemblage of plants that it was hardly expected could find a home so far north. These were cup plant *(Silphium perfoliatum)*, prairie dock (*Silphium terebinthinaceum*) and *Actinomeris squarrosa*, all of which grew in great luxuriance along the Thames. Valley of the Thames.

Many other rare and beautiful plants were seen, but none equalled the rose mallow *(Hibiscus moscheutos)* and the tall orange lily *(Lilium superbum)*, which were far from rare on the line of railway towards Windsor.

Windsor and vicinity.

A visit had been made to Amherstburg, Windsor and Sandwich in June and many things noted as worthy of record. On this account the last ten days in July were spent at Sandwich and a large collection of plants made, which had many points in common with prairie species. Indeed, many species found in the woods were more at home in grassy glades which seem to have been their natural habitat. Of these species were *Liatris spicata*, *L. scariosa*, *Ludwigia alternifolia*, *L. polycarpa*, *Vernonia Macounii*, a new species, *Lycopus lucidus*, and many others. The woods were full of species that had seemingly only crossed the border, though some of these were found at Leamington also. The flora of Essex county requires careful examination, and many species will yet be found that have not hitherto been recorded as Canadian. These are rare, of course, and are of more interest to the botanist than the general public.

Pelee point.

The flora of Pelee point and Pelee island is of this character, but in the little time at my disposal, exhaustive work could not be done. On Pelee point, however, fine specimens of the blue ash *(Fraxinus quadrangulata)* and the three-thorned acacia *(Gleditschia triacanthos)* were seen, and the nettle tree *(Celtis occidentalis)* occupied more than half the area on some parts of the point. Pelee island has many interesting species; the more notable trees not found on the north shore were the red bud *(Cercis Canadensis)*, Kentucky coffee tree *(Gymnocladus Canadensis)*, and *Tilia heterophylla*, a southern form of basswood.

Some time was spent at Wallaceburg, near Lake St. Clair, and although the flora was very rich, few species not seen elsewhere were noted. The wheat fields and meadows in this section were covered with heavy crops and large areas were planted with the sugar beet, which, I was told, is one of the staples of the district.

Sarnia and vicinity.

The careful study of the country near Sarnia being necessary, I remained there for ten days in June and about the same time in August. Like Sandwich and Windsor, this district has many peculiar plants, but the most interesting thing noticed was the influx of more northern species, showing that the colder water of Lake Huron had a tendency to lower the general temperature. It would be interesting to know what the difference of the winter and summer temperature is between Windsor and Sarnia. Here the hickories and oaks had largely disappeared and the sugar maple was the principal tree. The

sandy point around Point Edward at the outlet of Lake Huron and the marsh between it and Sarnia, has a flora in many respects peculiar to itself. Being either sand or marsh, its flora partakes of the nature of these, and is not, for that reason, indicative of climate. Visits were made to Camlachie and Wyoming, where the nature of the forest away from the sand, could be more easily seen.

Goderich. A visit to Goderich showed that the Lake Huron forest was almost identical with that of Hastings or Northumberland counties, except that elm, maple and black cherry were larger and better developed on Lake Huron than east of Toronto. Numerous herbaceous plants were seen, but very few were uncommon or of peculiar interest. In the river bed tuberous Indian plantain *(Cacalia tuberosa)* was found, and associated with it another rare species, Great St. John's wort *(Hypericum Ascyron)*. The valley of the river Maitland is deep and quite narrow near its mouth, and on this account has not the flora which is usually found in such places.

Between Goderich and Southampton the forest everywhere proved that the estimate I had formed of it on the lower part of Lake Huron held good. The same terms may be applied to the lower part of the Bruce peninsula and the country between Southampton and Owen Sound. Indeed the whole district, extending almost to Collingwood, may be included in the future apple-growing area of western Ontario.

Bruce peninsula. An examination of the Bruce peninsula showed that from the Fishing islands to Cape Hurd or Tobermory the shore facing Lake Huron was low and almost bare of soil, with shallow water for a long distance from the land. On shore, the land rose gradually and was very rocky and totally unfitted for cultivation. The coast facing the Georgian Bay was said to be quite elevated and the land, at least in part, suited for farming purposes.

From the plants found along the shore I surmise that the ice is piled there in spring and that vegetation is somewhat retarded thereby. Asters and other composites were in great profusion, and some forms were collected that may possibly be new to Ontario. Near Tobermory many new species were collected, among them *Solidago Gillmani*, new to Canada, and *Helenium Huronense*, new to science. Owing to the clearness of the water, there was no difficulty in seeing the bottom at twenty-five and even thirty feet. The lake for hours would often be perfectly smooth and while the lead was being cast we could examine the bottom by looking over the side of the boat.

During the last two months of field-work I was assisted by Mr. Percy Marshall and with his help was enabled to make much larger collections than would otherwise have been possible.

With the exception of a few reptiles and batrachians no natural history specimens besides plants were collected.

Collections received.

As usual there have been many collections of plants examined at the office besides those brought in by the members of the staff. Three collections from Prince Edward Island, sent by Mr. Lawrence Watson. A very fine collection from Labrador, sent by Dr. Alex. McKay. A large and valuable collection from Anticosti, sent by the Abbé Laflamme, of Laval University, Que. A collection of Ontario plants sent by Mr. W. Scott, head master of the Normal School, Toronto. Collections made at Banff, Rocky Mountains, were sent by Mr. N. B. Sanson, curator of the museum there. Collections were sent from British Columbia, by J. A. Pinco, B.A., head master of the High School, Victoria, by J. R. Anderson, Deputy Minister of Agriculture, Victoria, and by R. H. Jameson, who collected in many parts of the province. Mr. Gwillim, formerly a member of this staff, sent a very nice collection from Nelson, B.C., and another was received from Miss E. Girdwood, of Cottonwood, B.C. Besides these many minor collections were sent to the office and the naming of these, with the correspondence involved, took far more time than the above enumerations would convey to the reader. My own collections this year amounted to over 2,500 sheets of specimens, representing upwards of 1,600 species. The sorting and naming of these and getting them in order was no small undertaking, but this has been done since my return from the field.

I am now engaged in reading the proofs of Part VII of the Catalogue of Plants, and in preparing the MSS of Part II of the Catalogue of Canadian Birds, which I hope to have nearly completed by next spring.

Future work.

The writing of Part VIII of the Catalogue of Canadian Plants is in contemplation; this will conclude my work on Botany. When written it will include the characeæ, sea-weeds and at least 1,000 specimens of fungi. Before completing this work, however, it will be necessary to have a better knowledge of the sea-weeds of the St. Lawrence river and gulf. Large collections have already been made of the Pacific coast species, and consequently our knowledge of them is much more complete than of those nearer home.

Presentations.

Presentations.—Mr. C. Scrim presented to the museum a section of two trees, *Pinus strobus* and *Quercus rubra*, which had grown together in the form of an X; the specimen is about three feet high and the two trees were fastened together by the bark.

A very fine specimen of *Polyporus fomentarius* was presented by Mr. Leggatt, of the *Evening Journal*.

A specimen of wood showing an extraordinary example of the filling up and repair of tissue was sent to the museum by M. L. W. Shipman, of Almonte, Ontario.

Herbarium work.

My assistant, Mr. J. M. Macoun, did not return from the Paris Exhibition until January, and on that account the number of specimens mounted and distributed during the year was not as large as it would otherwise have been. Since my last summary report was written 4,195 sheets of specimens have been mounted and placed in the herbarium cases. Of these 2,150 were Canadian, 576 from the United States and 579 from Europe and other foreign countries; 910 sheets of Cryptogams were also mounted; 1,660 sheets of specimens were distributed from the herbarium, chiefly in exchange for specimens received. The principal institutions to which specimens were sent are:

New York Botanical Gardens	257
U. S. National Museum	263
Kew Gardens	220
Natal Botanical Gardens	150

We are still very deeply in debt for specimens received from individuals and public institutions, but hope during the coming winter to find time to label and distribute a sufficient number of specimens to more than balance all our accounts.

Several large contributions have been made to our herbarium from foreign countries during the past year. These include collections from Alaska, sent by the N.Y. Botanical Gardens, from the Western United States, sent by the U.S. National Museum, and about 1,100 specimens from the Missouri Botanic Gardens. These last are a part of Dr. Engelmann's private collection.

Work of assistants.

The employment of Miss Stewart as our clerical assistant will enable us to bring the general work of the branch more nearly up to date this winter than it has been before. Since her employment she has been chiefly engaged in filing arrears of letters, writing labels and in completing the numbering of the sheets of botanical specimens in our herbarium. Since January 1, Miss Stewart has for two hours each day assisted the librarian. Several years ago, we adopted the system of placing a running number on every sheet of specimens mounted, and Miss Stewart has just completed the numbering of the Canadian specimens mounted before this system was adopted. Of Canadian flowering plants alone we have now 32,431 mounted sheets.

Assistant botanist.

After his return from Paris, my assistant (Mr. J. M. Macoun) was chiefly occupied until spring with accumulated arrears of office work, which included the determinations of specimens left over from previous years. During May he spent some time in a further study of the violets of the region about Ottawa, several new species being added to those already known. Descriptions of these and other new species have been published from time to time in *The Ottawa Naturalist* and elsewhere, and I would respectfully draw your attention to the need of some publication in the form of an annual bulletin, in which we could record the progress made in Natural History work in Canada.

NATURAL HISTORY OF THE INTERNATIONAL BOUNDARY.

Mr. J. M. Macoun having been appointed naturalist to the Canadian International Boundary Commission, joined Mr. J. J. McArthur's party at Chilliwack, B.C., on June 11, and worked in the Chilliwack valley until September 3. He makes the following report:

Boundary Commission.

'As soon as I was notified of my appointment as naturalist to the Boundary Commission, I took steps to secure the services of Mr. William Spreadborough of Bracebridge, Ont., who has been attached to one or other of the Geological Survey parties as field naturalist during every season but one since 1888. Mr. Spreadborough went at once to Chilliwack and had been collecting birds, mammals and plants in that vicinity for about three weeks when I reached there on the afternoon of June 11. My instructions were to join Mr. McArthur as soon as possible. Mr. McArthur happening to visit Chilliwack that evening, I delayed my departure until the next day, when I accompanied him to his camp about twelve miles from the village.

Cutting trail.

'Having learned from Mr. McArthur that his progress up the Chilliwack river was very slow on account of the difficulty he was experiencing in cutting a trail through the dense forest, I decided that I would remain on the outskirts of the forest until he had reached Chilliwack lake. This arrangement permitted me to make a very thorough study of the flora and fauna of the valley in the immediate vicinity of the Chilliwack river, and of the low hills which bordered it in the vicinity of our camp. At this time, and during the whole season, Mr. Spreadborough was occupied in collecting and preserving the skins of birds and small mammals.

'After remaining two weeks at "Macguire's" where my first camp was established, I moved about ten miles up the river to "Thurston's" where there was a small clearing. After collecting there for a few

days I started for Chilliwack lake on July 5, Mr. McArthur furnishing me with the means of transport. From July 6 until July 31 I worked in the vicinity of Chilliwack lake, ascending most of the mountains which border it. In nearly all of these ascents I was accompanied by Mr. Spreadborough and when necessary we camped for one or more nights near the summit of the mountain we happened to be on. During the period I was on Chilliwack lake I made Mr. McArthur's camp my headquarters, and was furnished by him with supplies and transport whenever I required them. Chilliwack lake.

'Between July 31 and August 19 I worked slowly down the Chilliwack river, ascending mountains to the north and south of the river. Three days were spent on the Cheam range and, with the exception of this trip, my whole work, up to this date was done either on the International Boundary or within a few miles of it. Even when on the Cheam range the boundary was only about ten miles distant.

'On August 20, I went to Sumas lake in order to study the flora of the so-called Sumass "prairie". I remained there three days and made a complete collection of the plants in the vicinity of the lake, while Mr. Spreadborough collected birds, mammals and reptiles.

'Rejoining Mr. McArthur's camp at the mouth of Tami Hy creek, Mr. Spreadborough and I ascended the mountain of the same name on August 28, camping near the summit for three days. This finished my botanical work for the season and I started for Ottawa on September 3, leaving Mr. Spreadborough to collect birds and small mammals. He continued at work until November. The result of the season's work in specimens was 1,972 sheets of botanical specimens, 442 skins of birds and mammals, about 300 reptiles and batrachians, and a few shells and insects. Specimens collected.

'Since my return from the field my time has been in part occupied in studying the specimens collected during the summer. In nearly every large genus of plants new species were discovered and many species hitherto unknown in Canada were collected. It will require the whole winter to work the specimens up properly, and no detailed report on either the plants or animals of the Chilliwack valley can be written until this is done. The specimens collected in British Columbia in previous years are being studied with those collected in 1901, and my complete report, when published, will include the work done by others in earlier years. New species.

'The arrangement by which I was made dependent upon Mr. McArthur for supplies and transport worked satisfactorily in every respect and Mr. McArthur not only was at all times willing to assist

me in my work, but his long experience in mountain surveying and exploration enabled him to make many suggestions to me that greatly increased the results of my work.'

On Borings for Natural Gas, Petroleum and Water; also Notes on the Surface Geology of part of Ontario.

Dr. Robert Chalmers.

Wells and borings.

Your instructions to me in May last regarding field-work for the season were to undertake an investigation of the wells and borings for petroleum, natural gas, brines and potable waters in that part of the province of Ontario extending from the St. Lawrence river westward to Lake Erie and Lake Huron, and also to study the surface geology at all localities which might be visited. Considerable progress has been made in this work, but owing to the extent of the field and the varied character of the investigations, it could not be carried out in sufficient detail in the time allotted to enable me fully to report upon it. This is more particularly the case in regard to the inquiry concerning natural gas and oil, and the water supply of cities and towns. Although it was found difficult to get exact data on these subjects, still a large amount of valuable information has been secured. A great deal of exploratory work in search of gas and petroleum is now going on, the results of which are not yet available. Moreover, some of the smaller gas and oil fields recently exploited seem likely to be extended, and it would be premature at present to make any statements regarding their prospective value. All that can be done in this report, therefore, is to record as briefly as possible the facts which came under my notice, making special mention of matters of economic importance.*

Valuable information secured.

Economic importance.

Brockville.

I left Ottawa on the 21st of May and commenced work at Prescott. Dr. Ells of this Survey joined me at Brockville, and a few days were spent by us between that place and Kingston, endeavouring to ascertain the relation between the marine Pleistocene deposits in the upper part of the St. Lawrence valley and the clays and sands of the Lake Ontario basin. The western limit of the marine beds was found at Brockville and northward along the line of the Canadian Pacific railway to Smith's Falls, while Erie clay, supposed to be of fresh water formation, was noted at Lyn, Gananoque, Kingston and west-

Limit of marine beds.

*See Report on Natural Gas and Petroleum in Ontario prior to 1891. By H. P. H. Brumell, part Q, Annual Report, Geol. Surv. Can., vol. V, 1890-91.

ward. Proceeding from Kingston to the natural gas and petroleum fields of the Ontario peninsula, I was engaged almost uninterruptedly in that region till the close of field-work on the 12th of October.

THE OIL FIELDS OF LAMBTON COUNTY.

Lambton county.

The oil wells of Petrolea, Oil Springs and Sarnia naturally demanded the first attention from their importance. In this investigation I was greatly assisted by Mr. James Kerr, of Petrolea, who has made a special study of the oil wells of Ontario since they were first operated. A number of these wells have been yielding oil since 1860-61, and, as might be expected, there has been a greater or less falling off in the quantity produced, a certain proportion of the wells giving out from time to time. A large number of new wells have, however, been put down every year, so that the supply of oil has been kept up nearly to the average.

Yielding oil since 1860.

Thickness of strata.

The usual depth of the oil-bearing formation is from 450 to 475 feet. As the surface deposits are from 100 to 125 feet thick, the rock has to be penetrated only about 350 feet.* Well drilling is, therefore, not a very expensive business, and in some parts of the Petrolea field the ground is literally riddled with wells, which are often not more than 200 to 300 feet apart. At present there are few of these that yield more than a barrel of oil a day, while most of them furnish much less. One operator informed me that he had 120 wells in a certain part of the Petrolea field which gave him about 100 barrels of oil a week. This may perhaps be taken as the average yield. The total number of wells now producing oil in the county of Lambton is approximately estimated at from 10,000 to 11,000. They all terminate in the Corniferous formation. The greater part of the petroleum obtained from the wells of Lambton county is sold to the Imperial Oil Company, whose refinery is at Sarnia.

Average yield.

Test well.

A deep test well was drilled at Petrolea in 1900, terminating some 432 feet in the Trenton. The total depth of the well was 3,777 feet. The Onondaga salt group was struck at 1,275 feet and was found to be 895 feet thick. The water in the well was shut off by a $6\frac{1}{4}$ inch casing. No oil, gas or salt water was found.

Bothwell Oil Field.

Bothwell.

A new local oil field has been opened up near Bothwell in the township of Zone, Kent county, a short distance to the south-west of the former oil field of the Thames valley in the township of Mosa,

* "The Ontario Oil Field" was described by Dr. Robert Bell in a paper read before the Royal Society of Canada in May, 1887.

which was known as the Bothwell field and wrought for some years. This new oil pool lies between the Grand Trunk railway and the Thames river, about two miles and a half west of the village of Bothwell. Mr. J. F. Carman was the discoverer. He and Dr. Fairbanks, Messrs. Brewer and Puddicombe, together with Hiram Walker & Sons are the principal operators. Messrs. Clark and Elliot have oil wells to the east of Bothwell village. The oil is found in a limestone at about 400 feet beneath the surface, or rather from 395 to 410 feet. The beds passed through in drilling consist of (1) 210 to 212 feet of surface materials, (2) a few inches of dark shale, probably Hamilton, and (3) 175 to 200 feet of Corniferous limestone. Each of the operators mentioned has a separate oil area and power-house. The total number of producing wells at the time of my visit was from 200 to 240, but new ones are continually being sunk. The yield of oil is from ten to fifty barrels a month for each well, and a total of 5,000 to 6,000 barrels a month for the whole oil field.

Beds passed through.

Output.

The oil belt is five or six miles long, following the Thames river, and from a half to three-quarters of a mile wide; but a smaller oil pool has lately been opened up to the north of this, on what is supposed to be a separate anticlinal. In this oil field, there are said to be three or more north-east and south-west anticlinal axes—one main axis and several subordinate ones. Another series of anticlinals crosses these at a wide angle. The productive oil wells are found at the intersection of the two sets. The dip is lower on the southern sides of these anticlinals than on the northern, and consequently oil occurs further from the axes on the former side.

Anticlinals.

Dutton Oil Field.

Dutton.

Another oil pool has recently been opened up at Dutton, in the township of Dunwich, Elgin county, about three-quarters of a mile from the Lake Erie shore. The wells here, thirty-two in number, yield from 1,000 to 1,100 barrels a month. They are about 435 feet deep, 255 feet of this being surface beds. The rock consists of 165 feet of limestone, probably Corniferous, with sandstone beneath. The oil is said to be in the sandstone.

Tilsonburg Oil Wells.

Tilsonburg.

Wells from which oil was obtained were sunk in Dereham township near Tilsonburg in 1861. Recently several other wells were drilled in the vicinity of this town, but they failed to give oil in quantity. Last year, however, Mr. J. W. Cuthbertson, of Tilsonburg, sank two wells in the valley of Big Otter creek, below the town and has met with success.

The upper well (No. 1) is just above the Grand Trunk railway bridge (Wabash line) on lot 6, concession XII of Dereham in Oxford county. The boring is 268 feet deep and passes through (1) surface beds 81 feet, (2) rock 187 feet, the latter consisting of limestone (Corniferous) and sandstone beneath, as at Dutton. The flow of oil from this well is about 24 barrels a day.

Three new wells.

No. 2 well is about a mile and a half below No. 1, in the valley of Otter creek. In it the beds passed through consist of 74 feet of surface materials, with limestone and sandstone beneath, as in No. 1 well. The oil comes from the sandstone, which is probably of the Oriskany formation. This well (No. 2) yielded at first about seven barrels in the 24 hours, but the flow fell off to about a barrel and a half at the time of my visit.

A new well (No. 3) was being drilled when I was there (October 7), about midway between the two others. A depth of 165 feet had been reached and the limestone at that horizon had a perceptible odour of petroleum.

The facts in regard to these smaller oil pools show that the districts in which they occur were not thoroughly explored in former years, and that not only the Corniferous limestones but the underlying sandstone is oil-bearing.

NATURAL GAS.

Natural gas.

The principal gas fields of Ontario, as is well known, are situated in Essex and Welland counties. The Essex field, first opened up in 1891, has been the most productive. It is, however, of very limited extent, being only about five miles long, following the Lake Erie shore from Kingsville. Kingsville to Leamington, and about one mile wide. To show how this small field has been drawn upon, it may be stated that there was exported from it to Detroit alone between February, 1895, and July, 1901, 9,639,355,600 cubic feet of gas. These are probably minimum figures and besides there was a considerable export to Toledo, not to mention the quantities supplied to the Canadian towns and villages. This heavy drain on the gas storage of such a small area could naturally have but one result, namely, speedy exhaustion, and for the last year or two the supply has declined so rapidly that consumers fear they may very soon be left without any gas at all. In the hope of maintaining the supply, the United Gas Company undertook, during the past summer, to clean out and deepen the existing wells and to sink others to a considerable depth in the gas field in order to test the productiveness or otherwise of the Trenton formation. The salt water

Exhaustion.

Deep wells.

was pumped out of the wells and it was found that this operation was followed by an increase in the gas pressure, but it was only temporary, for soon after pumping ceased, the wells went back to their former condition. In the deep wells no gas was found, though the Trenton seems to have been reached at several points. Since my return from the field, however, I have heard that a new supply has been obtained from a well sunk at Wheatley, but particulars are wanting.

Gas from oil wells.

Several of the oil wells in Sarnia and Plympton townships, Lambton county, yield gas in small quantities, sufficient to heat and light the farm houses in the vicinity and furnish the power necessary to drive the pumps of the oil wells. The gas from these has been used for many years.

Gas in the Thames Valley.

Thames valley.

Natural gas is found in the surface deposits on the south side of the Thames in the townships of Orford and Aldborough, at a depth of 90 feet. A hard-pan occurs here, beneath which there is a bed of sand and gravel. It is in this that the gas is found. The farmers bore for it and pipe it to their houses, using it for heating and lighting purposes.

The Welland Gas Field.

Welland gas field.

This is the largest known gas area of the province, being eight or ten miles long and from two to four miles wide, and has been operated since 1890. The principal portion of the gas is piped to Fort Erie and Buffalo, N.Y. The wells are from 750 to 850 feet deep. In the shallower wells to the west of the Welland canal the

Source of the gas.

gas is said to come from the Clinton, and in the deeper wells to the east and south-east from the Medina, although these formations may not be its original source. Mr. D. A. Coste, manager of the Provincial Gas Co., informs me that very little falling off is noticed in the supply of gas in the Welland field. The company employs men who look carefully after the wells, keeping them clean and pumping out at once any water which may get into them.

Deep wells.

Deep wells have recently been sunk in the Welland field—one on lot 4, concession V, township of Willoughby, (No. 143) to the depth of 3,032 feet. Drilling stopped at what was supposed to be the Calciferous formation. Salt water was struck at 3,030 feet. There was little showing of gas, and this only in the bottom sandrock. The Clinton formation was reached at 473 feet from the surface and the Medina at 594 feet; the base of the Medina at 614 and the summit

of the Trenton at 2,313 feet. From the base of the Medina to the summit of the Trenton the rocks seemed to be all shales.

Another deep well was drilled on lot 9, concession II of Humberstone, seven miles south-west of the last. The granite was struck at 3,300 feet. Neither gas nor oil was found.

The Dunnville Gas Area.

Dunnville gas area.

In Haldimand county, four or five miles north-east of the town of Dunnville, gas has been found in paying quantity. The gas wells are situated in Moulton township, near Diltz station on the Michigan Central railway. One of these, when sunk a few years ago, yielded 1,000,000 cubic feet a day. Other wells producing gas in less quantities have been drilled in this area. The town of Dunnville is supplied with gas from wells in this vicinity. Drilling was going on at the time of my visit, and it is supposed the gas field extends further to the north-east towards the county line. The depth of the wells and the thickness of the formations yielding the gas are the same as in the Welland field west of the canal. The surface deposits are about 100 feet thick. About twenty-one wells have already been drilled. Salt water is reached at 300 to 400 feet.

Gas in Pelee Island.

Gas in Pelee island.

Gas and petroleum were found many years ago on Pelee island, in the geological horizon at which they occur in Essex county, but in quite limited quantities. Since that time, further development work has been attempted but without satisfactory results. The wells are situated in the central part of the island and were sunk to a depth of about 800 feet. Only two derricks were standing at the time of my visit, and the pump at one of these was idle. A small flow of gas was escaping with the oil from the other well. This is piped and utilized in heating a couple of farm houses in the vicinity. These wells were put down near an anticline in the highest part of the island.

The Hepworth Gas Wells.

Hepworth gas wells.

Borings for natural gas and oil were carried on at different places in the counties of Grey and Bruce for some years, but without success. Last year, however, a company called The Grey and Bruce Oil and Gas Company, Limited, was formed and commenced operations in the vicinity of the village of Hepworth. Two wells, starting in the Niagara formation, were sunk into the Trenton limestone. The first

Depth of wells.

(No. 1) was put down to a depth of 1,420 feet and is reported to have yielded 250,000 cubic feet of gas per day. This well gave salt water at 760 feet from the surface. No. 2 well was drilled to a depth of 1,409 feet, going into the Trenton formation 359 feet where gas was found in quantity. The pressure at first was 400 lbs. to the square inch and the flow 500,000 cubic feet a day. The company has recently installed a gas plant and is supplying the village of Hepworth with gas for illuminating and heating purposes. A third well was being sunk which the company hoped to finish this winter. These wells are on lot 1, concession X, township of Amabel, county of Bruce, and near Hepworth station, Grand Trunk railway.

SALT WELLS.

Salt wells.

No changes have of late years taken place in the salt industry of Ontario, further than the sinking of a number of wells at Windsor and the erection of a salt block there by the Windsor Salt Company. This company is now manufacturing 800 barrels of salt a day and practically controls the salt business of Ontario. Salt is manufactured at Sarnia, Clinton, Wingham and Kincardine, but on a smaller scale, as the market is limited.

Extent of salt beds.

The salt-bearing formation of Ontario seems to be of great extent and it contains a number of separate beds of this mineral one above another. Commencing at Kincardine on the Lake Huron shore, they are found to extend southward in a wide irregular belt of country to the St. Clair river, thence across the whole breadth of the south-western part of the Ontario peninsula to Lake Erie, and they apparently occupy a basin extending north-eastward up the Thames valley. The quantity of salt in the area referred to is practically unlimited, and forms an asset among the undeveloped resources of the province which must have a great future value.

WATER SUPPLY.

Water supply.

Although the rainfall in Ontario is amply sufficient to afford a good supply of water everywhere throughout the country, even in those places farthest from lakes and rivers, yet good water for domestic purposes is often difficult to obtain from wells in the solid rock. In districts underlaid by salt beds the water from such wells is usually saline or brackish, the brines permeating the shales and sandstone and sometimes even the limestones. Even where no beds of common salt exist, the waters from the deeper strata are frequently impure owing to the

presence of other ingredients in solution, which sometimes render them unfit for domestic use. Sulphurous waters from such sources are also common. On account of these impurities, some of the towns obtain their water supply from that stored in the thick beds of sand and gravel on the higher grounds and in the banks of rivers and brooks. Where these beds rest on compact Erie clay or upon the boulder-clays, as they sometimes do, the water stored in the former escapes along the line o contact of the loose deposits with the underlying clay. A series of springs may thus occur at or near the foot of a bank where the water may be collected into basins and constitute a considerable water supply. In ordinary seasons, a sufficient quantity may always be obtained in this way, but in seasons of drought or when a destructive fire takes place, a community depending upon such a supply may be awakened to the fact that it is inadequate or at least is not to be depended upon in an emergency, and they seek for means of supplementing that obtained from such sources. This has been accomplished by boring artesian wells in a few cases, but the problem of supplying water to some of the towns in southern Ontario has not yet been satisfactorily solved.

Saline and sulphurous waters.

Cause of springs.

A few towns obtain their water from rivers and filter it through gravel and sand or purify it by other means. But in the thickly settled parts of the country the stream waters have become more or less contaminated from the refuse of the towns and villages along their banks and thus become generally unfit for use. The system of purifying these waters, otherwise than by the filtration process mentioned, will require to be adopted to render them serviceable or potable. A number of towns pipe their water supply from the nearest lake. Petrolea, for example, has a main laid from Lake Huron.

Water supply from rivers and lakes.

PLEISTOCENE GEOLOGY.

The Pleistocene geology of the part of Ontario under discussion is of unusual interest. The beds are of great thickness and variety, compared with those of other parts of Canada which I have visited, and their origin and history appear to be very closely connected with those of the Great Lakes, over a large part of the region. The Erie and Saugeen clays, and the Artemisia gravels of this region were described by Dr. Bell in the chapter on superficial deposits in the Geology of Canada, 1863, and my observations tended to confirm the accuracy of the descriptions there given. The immense banks of these clays observed often elicited the inquiry in my mind as to where such quantities of materials came from and by what agencies they were brought into their present positions. In many places the beds are from 100 to 250

Pleistocene geology.

Recent formations.

Thickness of beds.

feet in thickness. The surface deposits when examined and studied in detail are found to consist of a series of clays, sands and gravel, which must have been laid down under a variety of conditions. We have here land deposits as well as shallow and deep water beds. A generalized section of the whole series as observed in the Ontario peninsula exhibits formations which may be classified in the following descending order :—

Descending sequence of formations.

1. Clay and sand with gravel near the summit. The whole more or less oxidized and of a yellowish colour. The clay burns to red bricks. This clay often contains calcareous concretions and is met with throughout the whole region from the marine plain at Cornwall and Brockville westward to the higher grounds of the Ontario peninsula. At Prescott and Brockville it contains marine shells, chiefly *Macoma Balthica*, but in the west no fossils have been found in it.

2. Boulder-clay, often thick, but much denuded, underlaid by sand and silt deposits. In consequence of the denudation it occurs mostly in detached areas.

3. Arenaceous and silty beds, in places apparently forming upper parts of the Saugeen clay (No. 4).

4. Gray, partially oxidized or brownish clay, thinly stratified, becoming sandy in the upper parts. Fresh water shells occur in the lower part or at the contact with the Erie clay (No. 5). This is the Saugeen clay described in the Geology of Canada, 1863.

5. Stratified bluish-gray clay, sometimes dark in the bottom. It becomes lighter in colour when dry and burns into white bricks. This is the Erie clay described in the Geology of Canada, 1863. In the upper part, it contains fresh water and land shells such as *Campeloma* (sp.,) *Succinea obliqua*, *Polygyra thyroides*, etc.

6. Boulder clay, usually in a thin sheet.

7. Decomposed rock *in situ*, often absent.

8. The surface of the fundamental rock.

Interglacial beds.

The interglacial beds of the foregoing section are often from 100 to 150 feet thick, and it is evident that during their deposition there must have been land-surfaces in some part of the lacustrine area. The land shells were found not only in the deposits along the Lake Erie shore, but in the clays of Pelee Island ; at the latter place, from five to fifteen feet above the level of the lake. The interglacial period appears to have been of long duration.

Glacial striæ were found at the Queenston quarries on the Niagara escarpment, with a direction of S. 48° W. On Pelee island their course is S. 80° W. These groovings were produced, it seems to me, during the second glacial period. Glacial striæ.

CHANGES IN THE LEVELS OF THE GREAT LAKES.

It is evident to any one who examines the terraces and plains bordering the Great Lakes, that Huron and Erie and probably Ontario also, stood at higher levels at the close of the Pleistocene period than they do at the present time. In the subsidence of the waters which followed, the various lakes seem, however, to have reached a level considerably lower than that which they have now. This low-level stage probably occurred in the Recent Period, that is, since the latest of the Pleistocene beds were laid down. I may here give a few of the principal facts showing that this shrinkage of Lakes Huron, Erie and Ontario actually took place as stated. Not having visited Lake Superior I cannot speak of it from personal knowledge.* Levels of the Great Lakes.

1. West of Port Rowan, along the Lake Erie shore, a number of stumps of large trees, probably a score, more or less, were observed, their roots in soil below the lake level while the upper parts (of the stumps) are broken off as if by the lake ice. They are now nearly covered with sand. Stumps below lake level.

2. At Goderich the prostrate trunks of trees are found in the mouth of the Maitland river, ten to fifteen feet below the level of Lake Huron, embedded in the bottom of a layer of clay and marl. It is evident these trunks were laid down when the lake was lower. They were pointed out to me by Mr. Peter McEwen, who was one of the first to call my attention to certain facts connected with the fluctuations of the levels of the Great Lakes. Trunks o trees.

3. The streams discharging into Lakes Huron, St. Clair, Erie and Ontario, as, for example, the Aux Sables, Sydenham, Thames and Grand rivers, and in the Lake Ontario basin, the Humber, Don and the smaller streams to the east, including the Cataraqui at Kingston, have the lower parts of their courses flooded from the lakes. In the case of the Thames and the Sydenham, this condition extends up-stream for many miles, the depth being from ten to twenty-five or thirty feet. With existing levels, it is evident these rivers could not have eroded their channels to these depths. The lakes must, therefore, have been Flooded estuaries.

*See paper on 'The Geological History of Lake Superior,' by Dr. Robert Bell, F.R.S. (Read before the Canadian Institute, Toronto, April 15, 1899.)

at least twenty-five or thirty feet lower at one time, to have allowed the rivers to erode such channels. As a filling-up process seems to have been going on since the period of low water, the river channels were probably considerably deeper then than they are at the present time.

SAND DUNES AND SPITS.

Sand dunes and spits.

The spits and dunes along the north shore of Lake Erie seem to have been formed by materials drifted from the west. The point east of the mouth of the Detroit river, the south-west point of Pelee Island, Pelee Point, Rondeau Point, Long Point, Long Island, etc., have all been formed in this way. The movement of the sand takes place along the littoral and to a depth of fifteen or twenty feet in the lake, and is no doubt due to currents caused by the prevailing winds. It affects the mouths of harbours and necessitates the construction of piers and breakwaters, and in some places dredging is required from time to time.

Sand drift.

In the Lake Ontario basin, the sand driftage has apparently been from east to west. Toronto island and Burlington Beach may have been formed by this movement. These beach formations exemplify the conditions which prevailed in the interglacial period in this region when land and fresh water shells were buried together in the clay and sand beds of that time.

WATER SUPPLY OF LONDON, ONTARIO.

Consulted as to water supply of London

On the 11th of November I received instructions to proceed to London, Ont., to confer with the Water Commissioners of that city respecting its water supply. Two or three days were spent in company with Mr. John M. Moore, C.E., the superintendent and engineer, in examining the sites of the different wells and springs in the vicinity and collecting all the information available concerning them. Although there is no immediate danger of a shortage of water in this city, yet in view of its growth, both in regard to population and business, it was considered advisable by the commissioners to obtain the best advice possible about providing for an increased supply in the future.

Source of present supply.

The water supply of London is obtained from a number of springs on the banks of the river Thames, two to three miles below the city, at a place called Springbank. The surface formations there are gravel and sand, 200 to 300 feet thick, underlaid by a clay hardpan. These gravels and sands serve as a storehouse for the rainfall, a large part of which, after seeping through them, escapes into the river valley in the form of springs along their contact with the underlying clay. This

spring water is collected into large basins or ponds which are connected with a pumphouse, and are thence forced into a reservoir 276 feet above the water works datum and from this the city main receives its pressure.

Wells in solid rock.

In our investigations, it was found that the wells sunk into the solid rock here do not yield potable waters. Wells of this kind have been drilled at the water works pumphouse, at the junction of the north and south branches of the Thames, at Carling's Brewery, and at the Insane Asylum. In the first three the waters were sulphurous ; in the asylum well (2,250 feet deep) the borehole had to be closed at the bottom of the surface deposits, and the supply of water obtained by that institution is now derived from these deposits, occasionally supplemented from a pond near by.

Doubtful use of artesian wells.

Although the Water Commissioners of London were anxious to have one or more deep artesian wells bored near the city, yet in view of the above mentioned facts, I did not feel warranted in advising them to sink any. Instead of this, the scheme of obtaining a supply of water from the river Thames was urged upon them, but though quite practicable, they contended that it involved the erection of an entirely new system of waterworks, besides the employment of filtering and purifying processes, all of which the city could not afford at present.

Thames water might be used.

The only other sources from which water was obtainable in quantities sufficient to supplement the present supply, were new springs and wells in the surface deposits. On the North Branch, about four miles above the city, there are springs which have been computed to yield 850,000 gallons a day.

Copious springs.

The water from these could be pumped into the street main now in use. A further addition might be obtained by sinking wells in the surface deposits near the junction of the North and South Branches, also in a flat in the valley of the latter, below the Port Stanley railway bridge. At both of these points I recommended test wells to be put down to ascertain the quantity and quality of the waters, both in the recent surface beds and the underlying solid rocks.

Acknowledgements.

I desire in closing to express my sincere thanks to Messrs. James Kerr, of Petrolea ; Peter McEwen, of Goderich ; John Corrie, of Stratford ; Jno. M. Moore, C.E., of London ; E. P. Rowe, of Hepworth ; J. S. McLister, of Bothwell ; J. W. Cuthbertson, of Tilsonburg ; D. A. Coste, of Buffalo, N.Y., and others for information and various acts of kindness.

The District around Kingston, Ontario.

Dr. R. W. Ells.

Work by Dr. R. W. Ells.

The winter of 1900-01 was spent in plotting the work of the preceding year and in revising the surveys made by the late Mr. N. J. Giroux during the years 1895 and 1896, the greater part of which was put into shape for the final compilation. The area included in these surveys by Mr. Giroux extends from the Ottawa river to the River St. Lawrence, east of a line from Ottawa to Prescott.

Two reports were also written, viz., that on the map of Ottawa city and vicinity, and a revision of the report on the area included in map-sheet No. 121 of the Ontario and Quebec series, comprising the area along the lower Ottawa and extending north from that river for about fifty miles.

Field work for 1901.

Field-work for 1901 began on May 24, when, in company with Mr. R. Chalmers, nearly two weeks were spent in examining the clays and other surface deposits between Prescott and Kingston in order to search for marine shells in that district. In this connection it may be stated that these shells were found as far west as Brockville, where they occur quite plentifully in two brickyards in rear of the town, and also at an old brickyard on the road to Tin Cap, about four miles north-west of the former place. West of this, though the clays present many features similar to those seen at Prescott and Brockville, no marine organisms have yet been observed.

Surveys made along Rideau lakes.

On June 6th, work was commenced with two assistants, Mr. R. Hugh Ells, B.A., and Mr. W. L. Lodge, M.A., in the area adjacent to the Rideau canal between Oliver's Ferry and Kingston. A careful examination was made of the numerous lakes along the entire route, and a number of mica and iron deposits were examined at several points in order to compare the conditions there existing in connection with these minerals, with those found in the area north of the Ottawa river.

Route from Jones Falls to Gananoque.

From Jones Falls a route was followed, by way of the village of Morton, the Beverly lakes and the Gananoque river, to the town of Gananoque, on the St. Lawrence, and a number of road surveys were made in the country adjacent in order to fix the boundaries of the sandstone outliers in this direction. Returning to the canal at Seeley's bay, the country to the west, including the townships of

Storrington, Loughborough and Bedford was carefully studied and the area north to the Devil's lake was examined, the canal being again reached at Mud lake, near Newboro'. This district is an important one, owing to the presence of numerous deposits of mica and iron at a number of points.

Kingston and vicinity.

Returning to the St. Lawrence again, surveys were made of the roads in the townships of Pittsburgh and Kingston, in the former of which a number of scattered outliers of the Palæozoic rocks are seen. An examination was also made of the shores and islands in the river between Kingston and Gananoque, at which place the examinations of last year ended. The contacts of the overlying Cambro-Silurian limestones and sandstones with the crystalline rocks are numerous and show some interesting features. The waters of Lake Ontario were found to be too rough for small canoes, and the work was carried on by land for the remainder of the season, using a buckboard, with odometer attachment for registering the distances. In this way, over 1,000 miles of roads were surveyed, principally in the counties of Frontenac and Addington. This work was in charge of my assistant, Mr. Hugh Ells, by whom the surveys in the area north of Lake Ontario were connected with the Canadian Pacific railway and with those made further north in 1896. My other assistant, Mr. Lodge, was transferred, early in July, to another Geological Survey party.

Prince Edward county.

An examination was made of Amherst island and of several other islands in the vicinity, as also of a large part of the peninsula of Prince Edward county and the country along the Bay of Quinte as far west as the town of Trenton, which is just west of map-sheet No. 112, to which the season's work was mostly confined. In part of this work I was accompanied by Dr. H. M. Ami, who made a study of the fossils of the Black River and Trenton formations and obtained large collections from a number of localities.

After Dr. Ami's return to Ottawa, several weeks were devoted to an examination of some of the principal mining locations, especially with reference to the mica deposits, some of the mines of this mineral being among the most important yet found in Canada.

I returned to Ottawa towards the end of August and was there detained for several weeks in correcting proofs of the two reports on the geology of the areas along the Ottawa river, but the work in the Kingston district was carried on by my assistants till September 20th, the surveys westward being connected with the Canadian Pacific railway at Tweed station. Subsequently several short excursions were made in the vicinity of Ottawa to complete details of structure in connection with the map of this area.

Work of Mr. Alexander Murray.

The previous work of the Geological Survey in the Kingston and Belleville district was done by Mr. Alexander Murray, in 1852. The results were published in the Annual Report for 1852-53, now out of print, and a large amount of interesting and valuable information, is there given relative to the distribution of the sedimentary formations which are for the most part of Black River and Trenton age, underlain in places by sandstones, which at that time were supposed to belong to the Potsdam formation. Certain shales and arkose layers, resting upon the crystalline rocks at different points, with overlying beds of cherty limestones, were supposed to pertain to the horizon of the Chazy. The characters of the several divisions of the crystalline rocks which underlie these formations are well described by Mr. Murray in the report referred to.

Limestones of the Kingston district.

Among the important points to be determined in connection with the geology of the Kingston district is the age of the limestones which have a wide development about Kingston city, and throughout the area to the north and west, and their proper stratigraphical relations to certain sandstone deposits which underlie these at a number of localities. In places the limestones, which become interstratified with greenish-gray marly shales in their lower portion, rest directly upon the underlying reddish granite or other crystalline rocks; but at many points there is an intervening deposit of greenish, sandy and calcareous shales and grit, generally quite thin and rarely more than a few feet in thickness. When these beds rest directly upon the crystalline rocks they often contain small pebbles of granite and quartz and are made up of the decomposed materials of the underlying rocks, with the aspect of a true arkose. They apparently form the lowest member of the limestone formation and sometimes hold fossils, chiefly small orthoceratites and a species of *Leperditia*.

Arkose beds at base.

The contact of the limestones with the granite is well seen near the summit of the ridge in Barriefield, opposite the city of Kingston, where the calcareous strata are sometimes tilted in every direction at angles varying from ten to twenty degrees, the inclination being apparently due to conditions of deposition on a rounded underlying surface. On the shore of Deadman's cove to the east of Barriefield hill, there is a thin underlying deposit of the green arkose filling the irregularities in the granite surface and passing directly upward into the limestone.

Road between Gananoque and Kingston.

The shore road from Gananoque to Kingston shows these limestones at several points. That they are of Black River age, is proven by the presence of characteristic fossils of that formation almost to the very base of the series. Along the Gananoque road the underlying shales

sometimes rest upon the beds of sandstone, which are sometimes reddish but generally gray in colour. They somewhat resemble the Potsdam sandstone in the area north of Brockville, but as a rule, are rather less siliceous. They are also well seen along both sides of the Rideau canal between Kingston Mills and Washburn, where they have a thickness of nearly fifty feet. Large outcrops of the sandstone are also seen around the shores of Dog lake in the township of Storrington, and at Battersea. The lower portion of the formation is frequently a conglomerate containing pebbles of quartz and sometimes of granite. As a rule the sandstones are in nearly horizontal layers, but sometimes, owing apparently to deposition on a sloping surface, the strata are inclined at an angle of ten to twenty degrees.

Age of the Kingston limestone.

In physical characters, the lower portion of the limestone formation north of Kingston resembles some of the limestones of the Chazy formation of the Ottawa district. They are highly dolomitic, hard and cherty, breaking with a sharp conchoidal fracture, and certain layers resemble a true lithographic stone. The lower part of the formation contains but few fossils, though organisms referable to the horizon of the Black River limestone are sometimes found. Among these, a species of *Leperditia* is somewhat abundant, and scattered forms of *Tetradium fibratum* also occur which serve to fix their position fairly well. The lower hundred feet contain interstratified beds of marly shales, sometimes several feet in thickness, while the upper part of the formation is a heavy bedded limestone filled with large fossils, such as *Columnaria Halli*, *Actinoceras Bigsbyi*, *Stromatocerium rugosum*, large masses of *Tetradium fibratum*, and other characteristic forms. The thickness of the entire series in rear of Kingston is somewhat over 200 feet above the basal beds of sandy and marly shale or arkose.

Thickness of Black River limestone.

At Kingston Mills on the Rideau canal, the contact of these rocks with the underlying granite and gneiss can be well seen about 200 yards west of the canal on the line of the Grand Trunk railway, where in a cutting there is a direct superposition of the green marly shales on the granite. These green basal beds near their contact with the granite are highly fossiliferous, the principal fossil as yet found being a small orthoceratite. To the east of the canal the limestones are seen along a road south of Rideau station, the rocks here having a low anticlinal structure, owing apparently to deposition upon a boss of red granite which is exposed near by. Black River fossils are here found down to the very base of the limestone. In this area no trace of the underlying sandstone is seen.

Contacts near Joyceville.

The outcrops of sandstone, already referred to as occurring along the canal above Kingston Mills, can be well studied at what is known

as Gildersleeve's quarry on the east bank, about four miles above the locks. This deposit can be traced to the north-west as far as Joyceville corner, where the sandstone rests directly upon granite and gneiss, and dips S. 20° E. < 4°. The breadth of the sandstone along the road south of the corner, is several hundred yards and on this road it is directly and conformably overlaid by the Black River limestone, with interstratified shaly bands holding the characteristic fossils of that formation. The limestone here forms a low escarpment north of the road near a church, the dip being precisely the same as seen in the sandstone. It extends south-east for a mile and three-fourths, and at that distance is again underlain by the granite and gneiss, the sandstone not appearing in this direction, so that the limestone apparently occupies a shallow basin at this locality. Along the road down the east side of the canal, traces of the underlying sandstone are seen beneath the limestone, at a distance of about four miles north-west of the corner east of Kingston Mills.

Gildersleeve's quarry.

At the quarry the rock shows much false bedding, but some of the layers are massive and well suited for building stone, for which purpose it has been quarried somewhat extensively. The colour is in places a dark red, but in the upper part of the escarpment grayish shades prevail. In portions scattered pebbles of quartz occur and the rock forms a conglomerate. This rock resembles the sandstones of Potsdam age near Ottawa, and along the shores of Rideau lake, where it is directly overlaid by the Calciferous formation. It is soft when quarried, becoming hard after removal from the parent bed; in this respect resembling freestones of Carboniferous age. In the quarry several curious cylindrical concretions occur which resemble the trunks of fossil trees, and at one time they were regarded as such. They stand upright in the face of the quarry, the two principal ones having diameters of three and four feet, with an outer zone of three inches or more in concentric layers, corresponding to what would have been the bark if the structure had been organic. At the top of the cliff the upper ends of these concretions are slightly hollowed out, readily distinguishing them from the surrounding rock. The material of the cylinders is similar to that of the quarry rock. Numerous rounded concretions, from half an inch to two inches in diameter are found in the vicinity of the supposed trees, which by some persons have been regarded as the fruit. Rounded concretions of this kind are found in similar sandstones at the southern end of Knowlton lake.

Cylindrical concretions in quarry.

Unfortunately there is no fossil evidence from the sandstones themselves to fix their age, except the occurrence of certain markings resembling *Scolithus*, and this is not sufficient of itself to accurately determine horizons.

Age of the sandstones.

If we reject the early view of Murray as to the Potsdam age of these sandstones and classify them, on stratigraphical grounds, as a sandy local development at the base of the Black River formation, then it may be stated that no trace of the true Potsdam, Calciferous or Chazy formations has yet been recognized in the district west of a line from Gananoque to the upper Rideau lakes. This was the view apparently held by Mr. Eugene Coste in regard to similar sediments in Madoc and Marmora, which form part of the Palaeozoic outliers occurring there. On the map of that area, made in 1886, these were coloured by him as belonging to the Bird's Eye and Black River formations. Why the lower formations should not have been deposited throughout this western area is not clear, there being no apparent cause for their absence, since the Calciferous is extensively developed throughout the district extending north from Brockville to the upper Rideau lake, and thence eastward to the Ottawa, where it is in turn overlaid by sediments of Chazy age.

Development near Westport.

These sandstones have now been traced by numerous outcrops from the West Rideau lake near Westport, where they undoubtedly represent the western extension of the great Potsdam-Calciferous area of the Ottawa basin, southward to the St. Lawrence near Kingston. At Westport the sandstone rests upon the granite or other crystalline rocks, and passes upward through the Calciferous and Chazy formations into the Black River limestone. Along the Rideau canal south of Newboro', and in the area both to the east and west, while the sandstones and conglomerates present the same general aspect as is seen in the Rideau lake district, the strata of the Calciferous and Chazy, proper, appear to be absent entirely, at least in so far as has yet been ascertained, and the Black River limestone and shales rest either upon the sandstone or directly upon the crystalline rocks, with merely the occurrence of a thin deposit of arkose beds at their base.

Conformity to the sandstone.

The apparent conformity of the limestones to the sandstones can not be regarded as conclusive evidence that they all belong to the same series; since everywhere throughout the Palæozoic basin of the Ottawa and St. Lawrence rivers these sediments are generally in a nearly horizontal attitude throughout. Under the circumstances therefore or until more conclusive proof is furnished from the study of these rocks, we hold that it will be better to regard these basal sandstones and conglomerates as more properly belonging to the Potsdam sandstone formation, as originally suggested by Murray, than to the Black River limestone division.

Black River formation west of Rideau canal.

The outline of the Black River formation west of the Rideau canal, in the direction of Tamworth and Tweed, is somewhat irregular. At several points deposits of the green arkose occur, but the limestone often rests directly upon the crystalline rocks. The sandstones are rarely seen west of the line of the Kingston and Pembroke railway. They are however well exposed at several points in the townships of Loughborough and Storrington, and on the railway at a point about two miles north of Hartington station, there is a good contact of the limestones and the green shales upon the underlying sandstone, the whole series being a conformable one all the way upward from the contact of the latter on the granite. Around the shores of Dog lake in the former township, the sandstones are well displayed and at one point on the north side contain several large but pockety deposits of red hæmatite which have been mined to some extent. At Battersea also the sandstones are well seen on the red granite in nearly horizontal ledges to the north and east of the village, but on the south side the granite on the road is covered by the green arkose which passes directly up into the cherty limestone.

Contact at Battersea.

To the south of the road however, the greenish beds rest upon the sandstones which fill up irregularities in the underlying gneiss and granite. The gneiss at this place is very quartzose and in places rusty, and it has been penetrated by the granite mass.

Howe island.

On the islands lying in the St. Lawrence between Kingston and Gananoque, notably on Wolfe and Howe islands which are the largest, several good contacts are seen. On the north-east end of the latter, which is several miles above Gananoque, ledges of sandstone occur, in places resting upon the granite and filled occasionally with pebbles of white quartz. These are overlain by the green, gray and black shales, which are found at the base of the cherty limestones, near a small cove known as Bush bay, about two miles from the lower end of the island. The beds are all horizontal. Some of the shaly layers are very like certain green Chazy shales of the Ottawa basin, but are not quite so hard or slaty. They pass directly up into the limestone which contains Black River fossils. and which thence occupy the whole of the island along the south side. On a road across the island from Bush bay, the Black River limestone rests upon white quartzite about midway to the north shore. The quartzite is penetrated by red granite, and the latter is seen along the north side of the island below the mouth of Big bay. The south-west part of the island is all Black River limestone.

Contact of Black River limestone with quartzite.

On Wolfe island the Black River limestone is the prevailing formation. It is seen in low ledges along the shore where this is not occupied by clay or sand. Wolfe island.

The northern part of the island is occupied by the cherty variety with shaly layers, but near the village of Marysville the upper portion of the formation is well seen and contains great numbers of fossils in which *Tetradium fibratum* is abundant. These rocks extend south of this to a point opposite the north end of Simcoe island, when they are overlaid by limestone of Trenton age. The rocks of the Trenton formation apparently occupy all the western end of the island and are well seen at Bear Point at the south-east extremity, from which a large collection of fossils has been obtained. The rocks of the island are all so nearly horizontal that dips cannot be measured.

Simcoe and Horse-shoe islands off the west end of Wolfe island are both occupied by fossilferous sediments, partly of Trenton age. Garden island, which lies off the city of Kingston, is composed of Black River limestone. Further west, Amherst island and the whole of the peninsula of Prince Edward county, are apparently entirely occupied by the Trenton formation, which abounds with fossils everywhere. Simcoe and Horse islands.

The Black River formation, seen at Kingston, continues westward along the shore of Lake Ontario as far as the village of Bath, where it is overlaid by the Trenton limestone. The latter thence extends across the peninsula of Adolphustown to Deseronto, where basal beds holding *Receptaculites* are seen in the bed of Sucker creek, about half a mile south of the Grand Trunk railway near Deseronto junction. The outline of the formation north of this is somewhat irregular and the Trenton limestone occupies basin-shaped areas upon the Black River to the north of Napanee, whence it extends north-west into Tyendenaga township. The Black River limestone shows in a bold escarpment on the west line of the township of Richmond, about six and a-half miles north of the Bay of Quinté and a short distance south of the crossing of Salmon river, whence the southern boundary of the formation continues south-easterly to the shore of the bay. The rocks are well exposed near Shannonville station on the Grand Trunk railway, where there is a boss of granite and quartzite upon which the newer limestone is deposited. The Black river limestone forms the north side of the Bay of Quinté at Ox Point, about three miles east of Belleville, and large and valuable quarries are here located in the massive beds near the summit of the formation. The opposite shore in Prince Edward county, at Massasauga Point, is of Trenton limestone. At Ox Point the strata are, in places, inclined at an angle of ten to fifteen degrees, probably indicating an underlying boss of the crystalline rocks. Kingston and Adolphustown. Shannonville Station G.T.R.

Belleville.

The Trenton comes into view west of this place in a cove and is again seen at Belleville on the Moira river and northward along this stream for several miles, the exact contact with the Black River formation not yet being traced in this direction. From the Moira river the Trenton continues along the north side of the Bay of Quinté and is well seen in low-lying ledges in rear of the town of Trenton, which is just beyond the western limit of map-sheet No. 112.

Arkose beds of Rideau lake.

The arkose in the Kingston district differs somewhat from that seen along the shores of Rideau lake where it is well exposed along the south side near what is known as the Narrows. Here the Potsdam sandstone and the overlying Calciferous are well developed, but the basal beds in the lake district sometimes consist of a coarse conglomerate made up of pebbles of gneiss, granite, quartzite and crystalline limestone, some of which are at least two feet in their greatest diameter. All these pebbles are water-worn and are cemented by a sandy and calcareous paste. No conglomerates of this character have been recognized anywhere west or north of Kingston except at one place on lots 3 and 4, ranges VII and VIII, of Loughborough township, where a four feet bed of coarse conglomerate was recorded by Murray in 1852 as resting on crystalline limestone. The colour of the Potsdam sandstone around Rideau lake, as also of the sandstones in Kingston district, varies from red to gray, the former colour being due to red hæmatite which sometimes forms masses of considerable extent, capable of being locally mined. This hæmatite character is also seen in the Kingston area at several places, the ores being generally pockety masses, sometimes of large size, near the contact with the crystalline rocks.

Red hæmatite.

Crystalline rocks.

North of the area occupied by the Black River limestones the crystalline rocks are well seen. They consist of gneiss, quartzite, limestone and schists, the whole resembling what is known in the province of Quebec as the Grenville series and in Ontario as the Hastings series. They lie in a number of undulations and are broken across at many places by masses of generally red granite which are newer than the schist and limestone. Masses of dioritic rock, pyroxene, and large dykes of pegmatite are common throughout the area occupied by the crystalline series.

Surface deposits.

Along the contact in the vicinity of Tamworth are heavy deposits of sand, gravel and boulders which may represent in this direction the extension of what has been called the 'Iroquois beach' which is so well developed north of Toronto. No fossils have been found in any of these deposits, nor in the clays west of the Rideau canal.

Valuable mineral deposits are found in the district, more especially in connection with the crystalline rocks. In the Black River limestone,

north of Kingston, there is a somewhat remarkable fissure extending across the country for several miles which has been filled with baryta, the thickness of the vein ranging from a few inches to over three feet in places. The mineral is grayish-white and has been opened up on lots 16 and 17, range IV, of Kingston township, and is seen also on lots 15 and 16, of range V. The vein crosses the lots in a north-east and south-west course. An interesting feature in this vein, which is vertical, is the presence of small quantities of anthraxolite in connection with the baryta. Baryta vein near Kingston.

Anthraxolite was also noticed from a vein, apparently cutting red granite, at a point about one mile west of Chaffee's lock, on the north side of Opinicon lake. The material is very pure, almost pitchy in character, and ignites readily with a match. It is found in the debris thrown out by some animal in excavating through the drift at the foot of the granite ledge, the vein itself not being seen. Anthraxolite.

The iron ores which occur in connection with the sandstone have already been referred to. The deposits of hæmatite are found principally at Dog lake, which connects with the Rideau canal a short distance north of Brewer's locks, and at several points along the north side of Opinicon lake. At the latter place borings have been made with a diamond drill to a depth of several hundred feet. The ores occur in the sandstone near the contact with crystalline limestone and the deposits appear to be pockety in character. Another deposit of red ore is seen near the road a short distance west of the lake on the north half of lot 13, range XIV, of Storrington. The outcrop here is uncovered for a space of about seven feet square and the extent of the deposit is unknown. The other deposit is on lot 2, range XIV, Bedford. Iron ores.

The principal mining industry in the district at present is the production of mica. This mineral is found in connection with the pyroxene rocks at a number of places in the townships of Loughborough, Storrington and Bedford especially, and in the Rideau lake district in North and South Burgess and South Crosby. Mica deposits.

Mining has been carried on for a number of years at various points in the district, and a study of some of the principal deposits was made for the sake of comparison with those which occur on the north side of the Ottawa. The conditions appear to be the same in both these mining districts. The principal deposits are found in two forms, viz., in fissures in the pyroxene itself, where the mica crystals occur often in large masses, apparently segregated from the containing rock, in which case, calcite so often found elsewhere in association with mica is almost entirely absent; and secondly, as contact deposits in the Mode of occurrence of mica.

pyroxene, near the junction with the gneiss rock, in which case the mineral is usually associated with more or less calcite. Good illustrations of the latter mode of occurrence are seen at the Stoness mine near the lower end of Buck lake, on lot 4, range XII, Bedford, where an inclined shaft, which is on a slope of 45 degrees, has reached a depth of about 450 feet and where the rock of the dump from the principal mine is almost entirely composed of calcite. At this mine several cross dykes of dark diabase cut the deposit.

General Electric Co's Mine, Sydenham.

Of the fissure type of veins, that of the General Electric Company near Sydenham, on lot 2, range VII, Loughborough, is a good example. Here calcite is almost entirely absent in the dump, and the pyroxene, which is of a light green colour, forms a large dyke cutting transversely across a grayish and sometimes rusty gneiss. On the south-west side of the main pit there is a heavy dyke of hard blackish diorite rock or a dark hornblende granite which in some parts gives place to a pinkish red. This forms the foot-wall of the principal vein, which here dips to the northeast at an angle of 60° to 70°. The vein consists of masses of crystals of amber mica, often of large size, some of them being as much as five feet across the face. It is generally of excellent quality and comparatively free from fractures. The thickness of this deposit is from ten to fifteen feet. Along the foot-wall are occasional small lenses or patches of calcite, pinkish or gray in colour. The mica deposit is therefore of very large size, and the vein appears to fold over the crest of the large diorite dyke. Small quantities of green apatite are found in the pyroxene.

The McLaren and Fulford mine, South Crosby.

At the McLaren and Fulford mine east of Davis lock, on lot 15, range VII, South Crosby, which was opened some twenty years ago as an apatite mine, and re-opened in 1900 for mica, the country rock is a reddish-gray gneiss, much intersected by granite. At the opening there is a heavy dyke of dark hard diorite which intersects the pyroxene, and in the excavation the mica vein sometimes widens to a thickness of eight to ten feet, many of the crystals being of large size. Bunches of iron pyrites are found in places near the edge of the vein, and when this occurs the good quality of the mica is seriously affected, it becoming much broken and discoloured. Apatite, both red and gray in colour, occurs in some abundance and there is a small quantity of red hæmatite in parts of the excavation. Small bunches of pink calcite also occur. The output of mica is large and its quality fairly good.

Tett's mica mine.

At Tett's mine, which is about three miles from the upper end of Devil's lake, on lot 2, range VIII., Bedford, the country rock is also a reddish and reddish-gray gneiss with bands of rusty gray gneiss, the

strike of which is about N. 50° E. and the dip to the north-west. This is cut by a heavy dyke of light-green pyroxene which is in turn cut by a very hard grayish granite. The mine is opened by a series of pits in the pyroxene, but as unfortunately these were filled with water at the time of our visit, the relations of the mica could not be clearly ascertained. The output is, however, stated to be very considerable, and the crystals of large size. There is but a small showing of calcite at this place, and the pyroxene cuts directly across the strike of the gneiss, the mica occurring apparently as a contact deposit near the junction of the gneiss and pyroxene. Bunches of iron pyrites occur in the hard pyroxene and the course of the dyke is about north-east. Large crystals of pyroxene are found at this place.

Smith and Lacey mines.

At the Smith and Lacey mines on the north side of Opinicon lake, the country rock is largely a rusty gneiss which is cut by several dykes of pyroxene, some of which are of large size. No pink calcite was observed at this place, but there is an abundance of light greenish-gray rock, apparently a felspar on the dumps. The mica is of large size and good colour and apparently very abundant at some of the openings, but as no work was being carried on at the time of our visit the chances for observing the relations were not very good. The mica appears to occur in fissures in the pyroxene.

The above descriptions of the leading mica deposits serve to show that the conditions at these mines are almost identical with those already described as occurring in the area north of the Ottawa. There are a number of other deposits in the district, some of which appear to be of excellent quality, but these were not examined owing to the lack of time.

Iron deposits of the Kingston district.

The iron deposits are of two kinds, and have been well described in the report by Mr. Ingall on the ores of the Kingston and Pembroke district. It is not necessary to refer to them in detail in the present summary. Of these the magnetites are associated with the crystalline rocks, generally in connection with masses of intrusive rocks, which cut the gneiss and limestone of the district. The hæmatites, on the other hand, are usually found associated with the sandstones, which have been already described. They are of a different origin, and some of them have already been referred to on a previous page.

Felspar deposit of 13 Island lake.

In connection with a number of the granite dykes which everywhere abound in the area of the crystalline rocks, notably in the pegmatites, large masses of pink felspar are found. Among these the most important yet noted are at a locality on lot 1, range II, of Bedford, near the shore of Thirteen Island lake. The felspar from this location is

beautifully clear and apparently largely free from iron. It is quarried and shipped from Bedford and Verona stations, on the Kingston and Pembroke railway. The quantity is said to be almost unlimited. The distance of the mine from Bedford, by winter road, is about four miles, and from Verona, by the regular road, about seven miles. Other large deposits of this mineral occur in the vicinity. The principal mine has been worked by Richardson and Smith.

Felspar of Kingston mills.

Another similar deposit of felspar occurs in the granites near Kingston Mills, and it has been worked to some extent. The quality at this place is also excellent.

Lead mines.

No new developments have been made in the lead deposits, of which several are found in the townships of Lansdowne, Bedford and Loughborough.

Talc.

A deposit of talc has recently been opened and mined to some extent near the road from Gananoque to Kingston and about three miles from the former place. Work on the deposit of this mineral on one of the islands, in Rideau lake, a short distance from Portland, has been discontinued.

Limestone quarries.

Large and valuable quarries have been opened in the limestones of the Black River formation at Kingston, Wolfe Island, Napanee and a number of other points throughout the district. At Deseronto, a large quarry is located in the Trenton limestone about a mile north of that town. The quarry at Ox Point, near Belleville, in the upper part of the Black River formation, has already been referred to.

Sandstone quarry.

The sandstone of Gildersleeve's quarry on the Rideau canal furnishes an excellent building stone. Some of the output has been shipped to Montreal, and a number of houses and public buildings in the neighbourhood of Kingston have been constructed either wholly or in part of this stone. The effects of the red stone in combination with the gray limestone is very good. At present the quarry is not worked.

Copper, gold, actinolite, zincblende.

Mines of copper and of gold have been opened in the neighbourhood of Flinton, in the northern portion of the area. No work was being done at these during the past season. A deposit of actinolite has been worked to some extent near the road between Flinton and Kaladar, and a number of tons of the mineral have been extracted. A deposit of zincblende occurs in Olden on the north side of Long lake, from which about 100 tons of ore have been taken.

Shell-marl.

Shell-marl is found in the bottom of many lakes throughout the area north of Kingston. A large part of Loughborough lake is underlaid by this substance, more especially in the western half. In Mr. Murray's

geological report for 1852–53, it is stated that the bottoms of all the lakes from this to White lake in Olden, are more or less of the same substance. It was also found in White lake in Sheffield, and on the brook which flows from it to Beaver lake; but the largest and most available deposits met with were on Mr. McDonnell's property, on the 15th and 16th lots of the second concession of Sheffield, and on the 12th lot in the third and fourth concessions of the same township. The deposit on Mr. McDonnell's place, extends over an area of 200 acres and perhaps more, with a thickness over the greater portion, of at least ten feet, which was proved by pushing a pole of that length through it in various places, without striking any other material. On the surface there is a thin soil, bearing a luxuriant growth of prairie grass. Mr. Murray says:— Deposit in Sheffield township.

'The marl on the 12th lot of the third and fourth concessions, extends over at least 300 and perhaps 400 acres or more, but its thickness I could not ascertain. The place where it occurs is mostly a marsh or swamp, and the deposit is covered over by an accumulation of peat, averaging about four feet in thickness.' Mr. A. Murray quoted.

A large deposit of marl of excellent quality which occurs near Marlbank in the township of Hungerford, has been used for some years in the manufacture of Portland cement. The marl occurs in the dry bed of a lake with an extent of about 150 acres and a depth in places of not far from thirty feet. The cement works are located in close proximity to the deposit at Marlbank, but a second manufacturing plant has recently been established at Strathcona, six miles east of Napanee on the line of the Bay of Quinté railway, the raw material being brought from Marlbank. This location is admirably adapted for the purposes of manufacture, being near the line of railway. Marl deposit at Marlbank.

Petrography of Shefford and Brome Mountains.

Principal J. A. Dresser.

In accordance with the plan of the Geological Survey to complete the petrographical examination of the series of remarkable volcanic hills which crosses the St. Lawrence valley from Shefford and Brome to Rigaud, investigations have been continued during the past season on Shefford and Brome mountains. The unusual character of these hills has been mentioned in several earlier reports of this Survey, especially those for 1863 and 1894, but it is only recently that detailed petrographical examinations have been begun. Petrographical investigations by Prof. J. A. Dresser.

Work facilitated by private investigations.

This work is likely to be greatly facilitated by private investigations. Mr. O. E. LeRoy, B.A., McGill University has already presented the results of a very complete examination of Rigaud mountain to the Geological Society of America at the winter meeting of 1900. Therein he shows that this mountain is more likely connected with the porphyry intrusion at Grenville than with the present series. A petrographical description of Mount Johnson of this series by Dr. F. D. Adams will soon appear, while similar work at the hands of Professors Harrington and Adams has been in progress at Mount Royal for some time. Mr. LeRoy has also the examination of Belœil mountain well under way. There remain therefore Yamaska, Rougemont and Montarville yet to be studied; also Calvaire, should preliminary investigations prove it also to belong to the series. In all cases, the results of these detailed researches have shown that these hills are of rare geologic interest.

Shefford mountain report.

The report on Shefford mountain has been completed and was placed in your hands in May last, while in the months of July and August, the field-work necessary for the completion of a similar report on Brome mountain was carried out. In previous summary reports it has been stated that Shefford mountain is an elevation covering some nine square miles in area in the county of Shefford. It has been caused by three successive volcanic eruptions, the lavas of which have formed rocks of rare types in each case. A careful microscopic study of over one hundred specimens of these rocks has been made, and also a complete chemical analysis (by Mr. M. F. Connor, B.A.Sc., Radnor Forges, Que.) of one

Igneous rocks.

of the main types. The first (in point of age) of these igneous rocks is found to be essexite. It forms two masses in the mountain, the later rocks having probably been thrust up through the original body, thus dividing it into two parts. One comprises the locality of Coupland's lake and thence extends northward to the edge of the mountains near Shefford Mountain post office. The other extends along the margin of the mountain from Beauregards corner to McCutcheons road and includes the important rock of Morriseau's quarry.

Dounan's quarry.

The second rock is a variety of syenite distinguished as Nordmarkite in its type occurrence, which is in southern Norway. It forms all the marginal part of Shefford mountain not occupied by essexite. A contact phase of this is the rock at Dounan's quarry, which proves to be of unusual value for monuments and other decorative work for which granite or syenite is commonly employed. The possibilities of this quarry were mentioned in a summary report for 1900. Since that report was written, however, the quarry has been acquired by Mr. C. J. Hill, of the Granite and Marble Cutting Works, of Richmond, who has in a couple of weeks' preliminary work already taken out a quantity of

material which, when polished will have a value of about $3,000. From the success thus met with Mr. Hill contemplates the dressing of the rock at the quarry and possibly the erection of polishing works there as well. Other portions of both these rocks seem to be well suited for economic purposes.

The third rock is pulaskite, also a rare syenitic type. It forms a smaller part of the mountain and extends from Coupland lake southeastward over the highest point above Knotts corner. It here terminates in a point at the south, being scarcely two hundred yards wide where crossed by the mountain road. A summary sketch of the rocks of Shefford mountain was published by your permission in the October number of the *American Geologist* of the current year.

Area of Brome mountain.

Brome mountain embraces an area of about thirty square miles in the townships of Brome, East Farnham and Shefford, which belong respectively to the counties of Brome, Missisquoi and Shefford. The central portion in the vicinity of Brome pond consists of a rather level basin about two and a-half by two miles in extent, which is generally overlain by heavy beds of clay, and is surrounded by a nearly continuous rim of hills rising from 600 to 1,000 feet above the level of the surrounding country. At West Shefford station this level is 440 feet above mean sea-level. The interior is well cleared, while the hills are all wooded; yet, as most of them are used for pasture lands, the highest points were generally found well enough exposed to afford fairly satisfactory conditions for geological study.

Drainage of area.

The drainage of almost the entire area is towards the south-west. Brome pond, a small sheet of water some three-quarters of a mile in length and half as wide, lies in the lowest part of the interior basin, and is drained into the Yamaska river through an opening in the hills known as Glen Farnham. No definite information was obtained as to the depth of the pond. Fed by a brook whose dimensions are not much less than those of the outlet, it must be largely a drainage lake. Yet, as it lies at the contact of two different igneous rocks, and as springs are common along these contacts, the pond probably derives some of its waters from underground sources. Two other ponds, known as Gales and Silver spring or Bull's pond are each about half as large as Brome pond. They have much smaller drainage basins, with much less sediment along their banks, and are presumably more largely fed by subsurface inflow.

Earlier reports.

In the earlier reports which have been referred to, it has been shown that Brome mountain is of igneous intrusive origin. The surrounding sediments have been shown by Dr. Ells, in the annual report of

this Survey for 1894, to belong to the Sillery division of the Cambrian system and to the Phillipsburg series (D 2 b) of the lower Trenton.

The mountain was first crossed in two directions, first, from West Shefford village to the 'centre road' between Sweetsburg and Knowlton, and next from Tibbetts hill to Gale mountain, thus giving two complete sections across the area. The contact with the enclosing sediments was next traced out as carefully as possible, and finally the different rock masses which comprise the igneous part of the mountain were separated from one another. Representative specimens were taken from all parts of the mountain, of which thin sections are in course of preparation. Three analyses of the main or representative types are now being made by Mr. M. F. Connor. I must acknowledge with warmest thanks, the valuable help received from Mr. H. A. Honeyman, M.A., Knowlton, in the latter part of the field-work.

Composition of mountain.

The mountain consists of two principal rock masses of different ages of intrusion, with a smaller area of distinct character and probably also of different age. The earliest is a dark-gray rock weathering dull brown. In texture it is coarsely holocrystalline and frequently has a porphyritic structure. Felspar, hornblende and biotite are the principal constituents that can be distinguished in the hand specimen. In general aspect it resembles the theralite of Mount Royal in places, and in others the essexite of Shefford mountain. Flow structure is sometimes found. This rock forms the south-western part of the mountain from the vicinity of the Iron Hill Cemetery to a distance of half a mile north of Gale pond. It skirts Brome pond on the south-west. A mass, which is apparently separate, runs from Colliers hill for a mile and a-half towards Shefford station. Probably a part of the same original occurrence, it is either cut apart by the irruption of later rock, or covered in the intrusion of the latter. The contacts are so far concealed as to make it difficult to determine which has been the case.

Second variety of igneous rock.

The second variety of igneous rock forms the northern part of Gale mountain, Oak Hill, the vicinity of Hayes' quarry, Spruce mountain, Pine mountain and Tibbetts hill. It is a fawn-coloured or light-gray rock, in texture very coarsely crystalline. Felspar, and a small amount of a green bisilicate are the chief constituents of the rock. In places, however, nepheline can be seen by the unaided eye. A single microscopic section from the farm of Nelson Keet and near the head of Brome pond shows the felspar to be microperthite and the bicilicate algerine-augite. Both are embedded in nepheline, which is here scarcely perceptible without the aid of the microscope. Pegmatitic structure is common in this rock, while certain parts are porphyritic. It has been

used in the construction of the Canadian Pacific railway bridge over the Yamaska river near Sheffington, and also of the Roman Catholic church at West Shefford. In those parts of the mountain which have easy railway access it should eventually prove a valuable material for ornamental and constructive purposes. Its close resemblance to the laurvikite of Norway, which is much used for interior decorations on the continent of Europe, is important. The favourable railway communication of this locality, together with the various kinds of rocks suitable for ornamental purposes in Shefford and Brome, should give rise to a 'granite' industry at West Shefford, comparable to that of Quincy, Massachusetts, or Barre, Vermont. Some of the pegmatitic phases might be found useful for the production of felspar for pottery manufacture. Where protected from glaciation, this rock has commonly disintegrated to a depth of several feet and the weathered material, being generally somewhat uniform in size and always angular in form, makes excellent road metal. Large quantities are thus available at many points, a fact of which the Good Roads Association of the township of Brome would do well to avail itself. The name 'Iron Hill' does not appear to find justification in the presence of any considerable quantity of that metal. The name has probably been derived from the limonite coatings common on the joint planes of the syenite of the vicinity.

Probable economic value of granite.

The third rock type occurs on the road between West Shefford village and Brome pond, and is in part on the farm of John Jones. It extends for a quarter of a mile east of the road and, by greater resistance to erosion, forms a low and rather flat-topped hill. It is a greenish-gray rock and porphyritic in structure, the phenocrysts being probably felspar. The rock has the general appearance of a tinguaite, but its identification is as yet by no means definite, as no detailed study of it has yet been made. Its relation to the other igneous rocks is not clear, as the contact is concealed in all cases as far as could be found, either by drift or, in larger measure, by sedimentary outliers, which have been protected from removal by the greater durability of the rock already mentioned. Completely surrounded by the syenitic rock just described, this tinguaitic rock differs from the latter in being of an effusive, or hyperbyssal, rather than of a plutonic character. While it may be a more rapidly cooled part of the larger mass, it seems more probable that it forms a separate intrusion.

Third rock type.

Although the character of its crystallization might be regarded as indicative of the extension from an active volcano, of which this point would have been the vent, the presence of sedimentary outliers in many parts of the mountain and even at higher levels, as on Pine mountain, seem to indicate unmistakably that Brome mountain, like Shefford, is an uncovered laccolith and has never been an active volcano.

Brome mountain never an active volcano.

Geological Exploration of Anticosti.

(The Very Revd. Professor Laflamme.)

(Translated from the French.)

Work by Rev. Prof. Laflamme.

The geological study accomplished at Anticosti during the past summer extends from English Head to the north as far as Pavilion river to the south-west, that is, it covers a distance of slightly over 100 miles. All the observations here recorded, therefore, only apply to that part of the shore. The remainder will be taken up later in another report, if circumstances permit. As to the geological study of the interior, that is to say, going up the rivers and making sections, I had to give it up this year owing to the clouds of mosquitoes which swarm in that part of the country even at the end of August, and which render any continuous work very difficult. This could better be undertaken in September and October, towards the end of the season.

Stratigraphy of the island.

General stratigraphy.—This is to be found described in a very detailed form in Mr. Richardson's report for 1856 and in the geology of Canada for 1863. The very full and detailed sections which are there given should not, however, be taken too literally. The composition of the different strata of any one group, their attitudes and thicknesses, vary to such an extent at different places, that unless work is done at the exact spots where they were determined by the geologist of 1856, notably dissimilar results and conclusions would be arrived at.

It is true that the main divisions are such as they were then determined to be, but we had to give up going into a superabundance of secondary details of too numerous subdivisions. To generalize in too absolute a fashion would be laying one's self open to errors.

All the beds of the island from one side to the other lie conformably to each other, almost horizontally except for a very slight dip, hardly noticeable, towards the south or south-west, but sufficient to account for the difference in appearance between the north shore and the south shore of the island.

Abrupt cliffs.

The rocks on the north side form quite abrupt cliffs, which rise in places to more than 500 feet; those on the south shore are low lying, rising but little above the level of the St. Lawrence, except in a few cases, owing to local faulting.

Nowhere have I noticed folds or bends of any importance, except the very low anticlines revealed by sections along the shore above the Jupiter and Lachute rivers.

Two important faults.

However, two rather important faults occur in that part of the shore which I examined. One is seen at Cap-à-l'aigle (Ellis bay) and extends parallel to the shore at a certain distance from it beyond Rivière-aux-Canards. On the north side, this line of fault is disclosed by an abrupt cliff, and on the south side by a string of small lakes found at its foot. At the latter point the shore has been formed by the action of the waves depositing the débris torn from the partly covered beds. The second fault is found at Jupiter river. It crosses the shore obliquely one mile above its mouth at the western extremity of Cape Jupiter. From that point it crosses Jupiter bay and disappears on the shore of the West Point. The southern wall is lower than at Cap-à-l'aigle; it sinks under water and the waves have hollowed out Jupiter bay from the northern wall, which rises into a cliff. At this place the northern cliff rises to a height of some 200 feet.

This faulting was not accompanied by any changes in the regular disposition of the beds. The strata remained horizontal on both sides of the break.

Hudson River limestones.

All the strata seen on the island are limestone, with the exception of some thin and irregular layers of sandstone at Pointe aux Graines, Riviere aux Canards, and Riviere Becsies. The Hudson River beds themselves, which form the whole northern shore from West point as far as Baie aux Renards are also limestones, but the latter are more argillaceous than those on the southern side. Imbedded in these are large corals impregnated with petroleum to such an extent that on breaking them the oil oozes out. The presence of these petroliferous fossils might lead one to hope that this valuable liquid may sometime be found in quantity on Anticosti island, but this is not very probable. The corals referred to are only met with in the Hudson River beds along the north shore. No physical disturbance has affected these strata, which are everywhere horizontal, and there are no reasons for the belief that crevices or cavities exist in them to act as reservoirs in which the petroleum, scattered throughout the mass, would in time have collected. Moreover, these corals are not abundant and the calcareous beds which contain them do not present the bituminous character found in other places, as for example in the vicinity of Quebec city or at Lake St. John.

Glacial phenomena.

The rocks of Anticosti are very often exposed on the tops of hills. In the lower parts they are concealed by a greater or less thickness

of gravel and calcareous detritus of modern origin. At different places are found varying thicknesses of stratified clay, with fossils similar to those found in post-glacial clays in other parts of the province. Their surface is covered by a layer of silicious sand, also stratified, but devoid of fossils. These argillaceous beds cover a part of the western side of the island, where they are put under cultivation. They also appear very distinctly as river terraces at Cap Ste. Marie, and also from Rivière du Cap as far as Rivière Pavilion. Unfortunately these argillaceous deposits are not likely to extend very far into the interior, except at Lake Plantain and vicinity. Moreover, at a short distance from the shore, they are covered by a thick layer of mould which would render their availability as farming land very problamatical. Nowhere are these quaternay deposits as thick as in the great central plain of the province of Quebec.

As a rule the rivers of Anticosti have completely removed these argillaceous deposits and have eroded them to the rock over which they flow, and this in spite of the restricted volume of water which they discharge, so that their erosive power is comparatively small.

Clays of post-glacial origin.

These clays are post-glacial. The fossils which I found contained in them, and of which I have sent you specimens, amply prove this. The numerous pebbles which they contain are all calcareous, with sharp angular edges and are almost all derived from the rocks of the island. Moreover, the eminently calcareous character of the clays themselves is a proof that they are the result of the decomposition of the strata found on the island, that they were formed almost entirely 'in situ' and that the older rocks on the north shore had very little or nothing to do with their origin. Therefore all the farming soil of Anticosti seems to me to be of local origin. The great scarcity of siliceous sands may thus be accounted for, the formation of the island containing very few beds of sandstone and no other siliceous rocks.

Glacial striæ scarce.

The glacial striæ are very scarce on the island, owing to the calcareous nature of the rocks, which weather easily. I found, however, a few very distinct ones at Rivière du Cap, which had been protected by a bench of sandy clay some twenty feet in thickness. Their direction is from north-east to south-west.

Moreover, evidences of glacial action are very apparent on studying the pebbles and boulders which are found in every part of the island, even on the highest points. These pebbles are everywhere numerous, some of good size and rather well rounded. They consist of fragments of gneisses, granites, pure labradorite, and other rocks, which evidently come from the north. These pebbles together with the evidence af-

forded by the glacial striæ already referred to, constitute an undeniable proof of the passage of the ancient land ice over the surface of the island.

That the waters of the subsequent period (Champlain) covered the island of Anticosti is amply proved by the presence of the fossiliferous terraces of arenaceous clay, as well as by numerous calcareous pebbles with marks of burrowing by *Saxicava*, etc., which are also found everywhere on the island, both in depressions and on eminences.

Uplifting distinctly marked.

The uplifting which characterized the close of this period throughout the province is distinctly marked on the island. Two phases of it may be recognized; they are clearly shown by two systems of terraces which are noticeable at two different levels between the St. Marie and Jupiter rivers. One of these is found at a height of about fifteen feet and the other at some thirty feet above the level of the St. Lawrence. This uplifting is still going on, and appears to be taking place with remarkable rapidity. This is proved by the deposits of gravel which form the subsoil of a great part of the island between Ste. Claire Bay and Strawberry cove, as well as the apparent filling up of Ellis bay.

The gravel is of contemporaneous origin, as benches of it are in course of formation on the rock beaches along the shore (on the 'reef,' as it is called on the island), wherever the combined action of the wind and currents favours it. I believe it is shown beyond doubt that the deposits of the Champlain period had not invaded a certain number of the bays, these being filled in later by the debris derived from the different beds and moved about by the action of the waves.

Ellis bay filling up.

Ellis bay is distinctly being filled up. Lake St. George, situated on the north-east, has just been connected with it by an artificial waterway. These two were formerly connected underground, the lake forming originally a sort of lateral extension of the bay, the uplifting of the surface which took place later separating them. At the bottom of the bay, near the dwelling place of the famous smuggler Gamache, there was, within the memory of man, a small harbour where large row-boats could take shelter. This no longer exists, the harbour being almost completely dried up.

Rock beaches extending.

The keeper of the western lighthouse (Mr. Malouin) states that the rock beaches, which are uncovered for more than a mile at low tide, appear to extend further out from the shore every year, as if, as he expresses it, the water of the St. Lawrence was slowly receding year after year.

I have seen almost everywhere, from Bay Ste. Clair to Otter river, shore deposits at levels much above those now reached by the highest

tides. At Grain point these deposits extend over an area of several acres. Their surfaces are covered by long wave marks which are all parallel to the shore line. Similar marks are found at several places on the island at short distances from the shore, and hunters who have lost their way in the bush refer to them to get their bearings, experience having shown that by walking at right angles to these marks they will eventually reach the shore. All these facts tend to show that at least the north-west part of the island is even now undergoing a movement of uplifting, and this at a comparatively rapid rate. This elevation goes on to such an extent that in my opinion it will have to be taken into account when it becomes necessary to determine the harbours and sheltering places on the coast.

Island covered with peat.

It may be stated that the whole of the island is covered with peat, which is always very coarse on the surface. This peat is composed of a mass of vegetable debris barely decomposed, in which the organic structure remains quite visible. At Ellis bay, however, a bed of black peat occurs much older than the surface deposits. It is found under a layer of clay and gravel over ten feet in thickness.

Trees of fair size.

The peat of Anticosti, when mixed with a small proportion of clay or of marl, constitutes a wonderfully fertile soil, in which vegetables and cereals can be grown to perfection. The trees also attain good dimensions but in places where the peat lies immediately over the gravel or on bed-rock, it constitutes too thin a soil and the trees do not, in such places, attain their full development, but remain dense and small. Still wherever a layer of peat, a couple of feet in thickness, rests directly on a marly or clayey subsoil, the trees are found of normal size.

Peat-bogs, proper, abound on the island. It may be said that they occupy the whole surface from East point as far as Salt lake. It has not been possible for me, owing to the short time available, to determine the exact extent or value. It can, however, be asserted that the aggregate of these areas is enormous and the deposits may be said to be inexhaustible.

Small lakes numerous.

Lakes are numerous on the island but none are of any great size. All, or nearly all, have the bottom covered by a thick layer of white calcareous marl, containing great quantities of fresh-water shells. But the chemical action of the aquatic plants is one of the principal agencies in its formation, and the material is evidently derived originally from the calcareous beds of which the island is composed. This is distinctly shown by the studies and experiments of Dr. Schmidt, physician at Bay Ste. Claire, the results of which were published in 'Le Naturaliste Canadien' of December, 1900.

This marl may be seen in places all along the shores. It is very easily recognized at a distance owing to its clear white colour, which contrasts strongly with the dark tints of the underlying beds of limestone and of the overlying peat. Wherever it is present wild plants and flowers grow exceedingly well and attain much larger dimensions. This feature is specially noticeable between Grain point and Duck river. Marl.

From what has just been said, it may be gathered that the soil of Anticosti is very variable from the farming standpoint. The peat or humus which almost everywhere constitutes the surface, forms a very fertile soil, the quality of which should not decrease or become exhausted when it overlies a clayey subsoil. But wherever it rests upon solid rock or gravel deposits, it may be expected that farming will become more and more difficult, unless great quantities of fertilizers are used. Soil variable.

Economic Minerals.—Besides the coarse limestone which can be used almost everywhere for the production of lime, large quantities of a pink crystalline limestone are found between the South-west point and Pavilion which probably would take a fine polish and could be used as an ornamental stone. This limestone abounds in crinoid stems which are completely mineralized of a reddish tint, darker than the background, and would present a very pleasing appearance when polished. Of course the economic value of these deposits cannot be definitely ascertained without some preliminary work, with the view of testing the lower beds to see whether the quality of the stone improves in depth. Economic minerals.

Other crystalline limestones are found to occur in the vicinity of South-west point; these are bluish-grey in colour and would make very good building stone. Moreover, I was told that beds of sandstone occurred on the south-east shore of the island, which could be used for the same purpose. Crystalline limestone.

On the Galiote, at about one mile from the river shore, my assistant found large deposits of pyrite. Pyrite is also found in thin sheets in the limestone beds which extend along the shore at the 'Jumpers,' about four miles below the South-west point lighthouse. Deposits of pyrite.

No trace of limonite or galena was found. The rocks of the island do not contain enough iron to warrant the hope of ever finding deposits of limonite.

Forests and Timber.—As a rule the trees on the island of Anticosti do not attain as large a size as they do in the more southerly and westerly parts of the province of Quebec. Along the shores, owing to the influence of the violent winds which blow towards the interior, the trees are almost everywhere stunted, with the branches bent and Timber.

entangled, and so thick that it is often very difficult to make any headway through them. In the interior of the island the trees are not so close together and are better developed. Certain areas may be considered as timber lands, though it is doubtful if large quantities of timber can be obtained. But wood which can be used for the manufacture of pulp is present in great quantities.

The following species have been recognized : *Abies balsamea, Betula papyracea, Larix Americana, Alnus rubra, Viburnum opulus, Abies alba, Abies nigra, Populus tremuloides, Sorbus Americana, Thuya occidentalis, Corylus rostrata* and several species of willows. Explorers who went into the interior of the island during the autumn season state that the trees found there are of much larger size. Besides the above kinds, they report the presence of *Pinus strobus* and *Fraxinus Americana.*

Second growth of trees.

In 1884 or 1885 a bush fire swept over a part of the north shore of the island. The trees which were then destroyed have been replaced by poplar and birch.

As to herbaceous plants, I hope to be able to send you a list of these later on. Dr. Schmidt, already mentioned, who devotes a great deal of attention to botany, has begun a herbarium composed exclusively of the plants of the island. His collection already numbers several hundred specimens, and he has very kindly promised me a list of the plants obtained, which list I shall forward to you.

Fur bearing animals.

There are very few species of land mammals on the island. The following are the only ones met with : black bear, red, black and silver fox, otter, marten and a very small rodent. Mr. Menier, the owner of the island, has gone to a great deal of expense in importing and placing on Anticosti, moose, cariboo, Virginia deer, beaver and even buffalo, in the hope of acclimatizing them and enriching the island with game. But the experiment is as yet of too recent date to be able to judge of the ultimate results.

I cannot conclude this brief report without acknowledging the kindness with which I was greeted by the proprietor of the island and his head employees. They were ever willing to give their help with the utmost readiness. Mr. Commettant, governor of the island for Mr. Menier, Abbé Tremblay and Dr. Schmidt in particular were a great help to me. Dr. Schmidt kindly added to my collection of fossils several species which I had been unable to obtain and which he had found in the course of his excursions. I am glad to have an opportunity to publicly offer them my most sincere thanks.

New Brunswick.

Professor L. W. Bailey.

I have the honour to submit the following Summary Report of geological explorations made by me during the past summer in the Province of New Brunswick. Work by Prof. L. W. Bailey.

In a similar report submitted the previous year, it was announced that in connection with the study of certain Silurian rocks, reported by Mr. W. J. Wilson, of the Survey Staff, in the Parish of Canterbury, York county, where previously only Cambro-Silurian strata were supposed to exist, fossiliferous strata containing graptolites of Upper Cambrian age had been found by the writer in the valley of Eel River, near Benton, Carleton county. One of the objects of insvetigation in the season just closed, was, by your direction, the separation of the Cambrian and Silurian rocks in the district referred to, and the determination of the limits of each.

For the purpose named, I made a very careful review of the section afforded by the St. John river between Woodstock and the great central granite range of York county, as well as of the country lying to the westward of this stream as far as the International boundary. In the prosecution of this work I was, for a few days, accompanied by Dr. G. F. Matthew, of St. John, and to his intimate knowledge of the Cambrian system, in all its various aspects, as well as its contained organisms, I am indebted for very valuable assistance, as I am also for the benefit of his great skill in the solving of different stratigraphical problems. Section reviewed.

The following letter, addressed to me by Dr. Matthew, well expresses the nature of the problems referred to, as well as some of the directions in which their solution was sought. Letter from Dr. Matthew.

St. John, N.B., October 8, 1901.

'Prof. L. W. Bailey.

Dear Sir,—Having visited with you some of the more important sections of the Cambrian and Silurian rocks in York county, I would offer the following suggestions bearing on the possible structure and age of the early Palæozoic sediments in that part of the province. These remarks are made chiefly in paralleling the strata of the district

above referred to with the known Silurian and Cambrian rocks of the southern counties of New Brunswick.

Synclinal structure in northern York County and Carleton County.

'*The Border of Carleton and York Counties.*—It appears to me that the structure of the strata in this district is related to two synclinal folds, the axes of which diverge at a considerable angle from Monument Settlement on the western border of the province. One of these runs about N.N.E., mostly west of the provincial boundary line in the State of Maine, but crosses into New Brunswick northwest of Woodstock. The other proceeds east from Monument Settlement crossing the St. John at or near the mouth of Eel River.

Cambrian slates of southern Carleton Co.

'*Cambrian.*—' North of the axis of the syncline last named the strata appear to be Cambrian. At Benton and extending east and west from that village, there is a belt of black and dark grey slates which would correspond to the Bretonian division of the St. John group in the nature of its sediments. In this belt, at Benton, you have discovered a *Dictyonema* which I cannot distinguish from *D. flabelliforme*, Eichwald, a well-known fossil of the Upper Cambrian. There are here also obscure remains of trilobites, of which one appeared to be the pygidium of an *Agnostus*, and another a pleura with a shape and groove like that of *Parabolina* and its allies.

'North of these dark shales and extending as far north as Woodstock, is a large body of gray slates and quartzites that, in texture and appearance of the beds, may be compared with the Johannian division of the St. John group. Like that division of the Cambrian of the southern counties also, it contains burrows of *Monocraterion*. Other pits observed on the surface of the layers were those of *Arenicolites*. Such burrows, however, might be found in strata of later date than the Cambrian.

Ordovician fossils of Beccaguimic river.

'That this belt of rock is Cambrian seems to be shown also by the occurrence of Lower Ordovician fossils in it on the Beccaguimic river, north-east of Woodstock. These fossils are in the highest beds just where they pass beneath the Upper Silurian slates. The fossils of this band, therefore, have a relation to the quartzites beneath, similar to that held by the Arenig fauna in the St. John basin, relative to the underlying Cambrian portion of the St. John group.

'In both areas the Ordivician fauna occupies only a narrow belt at the summit of the terrane, the great bulk of which is Cambrian. It would be impossible to show on a map of even moderate scale the Ordovician portion of the terrane in either of these areas; and, therefore, it seems to the writer desirable that the Ordovician coloration

should be removed from this portion of the geological map and Cambrian substituted.

'Two types of eruptives appear in this region; one consisting of agglomerates and ash-rocks along the syncline that runs east and west in the valley of Eel river, and which also show in Monument Settlement, near Dinnen's Mill. The other type is associated with granitoid grits and gray levigated ash-rocks. Rocks of this character were noted at a number of points between the quartzite slate series and the black slates, but inclnded in the former. These rocks are seen on the St. John river at Woodstock, and at Oak Mountain and Dinnen's Mill in Monument Settlement; as well as further south and east in Canterbury. Eruptive rocks of southern Carleton Co.

'These granitoid grits are found on both sides of a lenticular area in which Silurian fossils have been found between Benton and Canterbury, and they are succeeded to the south by quartzites which appear to be on the reverse side of a basin of which the Woodstock Cambrian quartzites form the north side. Next these to the south are the granites which traverse the central part of York county. Granitoid grits.

Silurian.—The discovery of Silurian fossils in the basin above referred to, by yourself and Mr. W. J. Wilson of the Survey staff, show that all the strata in this district cannot be Cambrian. Silurian fossils.

'Within the area enclosed or bordered by granitoid grits there are slate conglomerates which lie outside of the localities where the Silurian fossils are found. These may form the limiting beds of a basin of Silurian rocks bordered by the granitoid grits, slates and quartzites of the Cambrian. This view implies that the black slates (Bretonian) of the Cambrian have been removed by denudation on the south side of the Cambrian basin and are there covered by the Silurian.

'The fossils found in this basin are brachiopods of Silurian type and some obscure corals. The course of this basin of Silurian rocks is nearly parallel to that of the Cambrian, and its axis lies to the south of the axis of the Cambrian basin. Fossils.

'*Intrusive Syenite.*—A band of intrusive syenite which runs nearly parallel to the western syncline of the Cambrian rocks has affected their condition in Benton and its vicinity, throwing them into close folds parallel to the direction of the syenitic ridge, and causing a very marked squeezing together of the black slates, so that the hydrosomes of the Dictyonemas are shortened in one direction and lengthened in the other. The rods of the hydrosomes that lie transverse to the line of pressure are nearly twice as far apart as those that are parallel to Syenite.

it, and the colonies of these animals might be thought to consist of two species, if it were not observed that the width of the bars is always governed by the direction in which the colony lies on the slab of slate.

Upper silurian graptolites near Fredericton.

'*The East Central Part of York County.*—Another belt of slates and quartzites which crosses York county and which has heretofore been thought to be of Cambrian or Ordovician age has yielded you graphites which it appears to me must belong to the genus *Monograptus*. This discovery of Silurian graptolites within a few miles of Fredericton has received further support from the finding of two species of *Monograptus* in shales several miles further to the north-west. This, coupled with the discovery many years ago of Silurian fossils on the Nashwaak, might be supposed to indicate that the whole of this belt of slates may be referred to the Silurian, as the strata are very uniform over large areas.

Silurian rocks.

'*General Comparisons.*—One should bear in mind that there are two important divisions in the Silurian terrane of southern New Brunswick. The older of these is to be correlated with the Clinton and Medina groups of the New York system. In most places it consists of black and dark grey slates and grey quartzites and flags. These are the 'dark argillites' of the Survey Report of 1875-76. To this division belong the slates and quartzites with graptolites described above.

Silurian of Rocky Brook.

'The distribution of these slates in York county appears to indicate that the overlying division may rest unconformably upon it, else we should find the upper division infolded with it. This may be the case at Rocky brook, on the Nashwaak, where fossils of the summit of the Silurian have been found. With the exception of this area on Rocky brook, the upper division of the Silurian has not been recognized in this area in the centre of York county.

Pale argillites.

'The pale argillites of the Survey Report of 1875, &c., form the upper part of the Silurian system in this region. They are found north and west of Woodstock, in Carleton county, and on the other hand are to be seen in a belt along the south side of the central Carboniferous area of Central New Brunswick. This division would include strata of Niagara and Upper Helderberg age. It is more calcareous than the Lower Devonian, and fossils are found in it in a number of localities, and then of such a kind that the Silurian age of the rock has usually been easily recognized.

'Compared with the Silurian series of Passamaquoddy bay at the Mascarene shore (see Report of 1874-75), the pale argillites would correlate with divisions 3, 4 and 5. Of these, division 3, according to

Dr. Ami, contains a Niagara fauna. The dark argillites would compare with divisions 1 and 2, and to this portion of the system, as above remarked, the graptolite beds of York county should belong.

'In conclusion, let me say that any light I may have been able to throw on the age of these rocks is due to your excellent judgment in taking me to such localities as would yield important data for correlation.

'I am, yours sincerely,

'G. F. MATTHEW.'

Previous opinions confirmed.

The above conclusions of Dr. Matthew, so far as they relate to the rocks of northern York and of Carleton county are in the main similar to those already reached by myself, and in part stated in previous reports. While, however, the general structure, within the region examined, may be regarded as fairly well ascertained, the details of distribution, owing partly to the disturbed and altered condition of the rocks and partly to their concealment by forest and drift, present many difficulties. It is proposed that these shall be made the subject of a special report now in course of preparation.

Silurian graptolites near Fredericton.

The discovery of Silurian fossils *(Monograptus)* in the quartzite-slate band south of the granite was made by me during the past summer on Murray's brook, seven miles west of Fredericton. Subsequently, in my company, Dr. Matthew found similar forms on the right bank of the St. John river, in Central Kingsclear, five or six miles distant from the locality first named. From the uniformity of the beds between these points and over all the area to the westward as far as the international boundary, we believe that all are of one system, and that the tract, coloured on existing maps as Cambro-Silurian, must be assigned to the Silurian system. The same will be true of much of the region east of the St. John river in the southern portion of the parishes of Queensbury and Bright; but, inasmuch as along the valley of the Keswick river they pass beneath the rocks of the Coal formation, of which the border here bends far to the north, we are unable as yet to connect them directly with the rocks of the Nashwaak valley. With the exception of the fossiliferous strata found on Rocky brook and referred to above, the rocks of this valley, as seen at Stanley, as well as those of Tay creek, McLean's brook, Ryan's brook, the Taxes and the S. W. Miramichi, are more highly altered and may be of greater age.

Work with Mr. H. S. Poole.

Another work assigned to me for the past summer was the revision, in connection with Mr. H. S. Poole, of the Carboniferous rocks of New

Brunswick, a subject in which public interest has recently been awakened, partly as the result of private enterprise, but mainly on account of the efforts of the New Brunswick government to promote the development of the coal fields at Grand lake, Queen's county.

Considering the nearly horizontal attitude of the coal rocks in the great central Carboniferous basin, and the fact that the observations of many years had failed to reveal the existence of other than small seams near the surface, the all-important question appeared to be the determination of what part of the entire Carboniferous system these surface rocks represent; that is to say, whether they are the equivalents of the Mill-stone Grit formation, as contended by some geologists, or of this formation with a portion of the middle or productive measures, as thought by others, or finally, whether they appertain to the Newer or Permo-Carboniferous period. While the first view would seem to preclude the possibility or at least probability of any considerable seams being found, the second and last would favour, though by no means establish, such conclusion.

Comparison with Carboniferous rocks of Nova Scotia valuable.

In attempting to arrive at any definite opinion upon this subject, it is evident that a comparison of the Carboniferous rocks of New Brunswick with those of Nova Scotia, where this system is so well represented and has been so thoroughly exploited, should be of the greatest possible value. With this object in view, a joint survey of the field was undertaken by Mr. Poole and myself, at the request of the Director, my knowledge of localities in New Brunswick enabling me to point out, without loss of time, such places as would be likely to afford valuable information, while Mr. Poole's long and intimate acquaintance with the coal districts of the sister province, made it possible for him to institute the desired comparisons. All parts of the coal field were visited by us together, but, as constituting the connecting link between the Carboniferous areas of the province, special attention was paid to the districts about Moncton, Sackville, Dorchester and the Albert county coast.

Proposed reports on the area.

The general results of the comparisons referred to are embodied in the Summary Report of Mr. Poole, accompanying this; while a more elaborate and joint report, reviewing the whole subject of the Carboniferous system in New Brunswick, will be submitted as soon as it is prepared. In the latter, all the facts bearing on the occurrence of coal in the province, as derived from the topography of the district, evidences of erosion, surface exposures, stratigraphy, mining operations and boreholes, will be considered at length, and recommendations will be offered as to future practical work.

ECONOMIC MINERALS.

Coal.—The railroad connecting the coal mines at Grand Lake with Fredericton is in course of construction, and when completed next summer, is expected to lead to a much more vigorous working of the mines than has heretofore been attempted. The railway company is asked by the government of New Brunswick, in return for a subsidy, to supply a plant capable of producing 500 tons of coal a day, or 150,000 tons per year. It remains, however, to be seen, whether, under the conditions existing at Grand lake, such a production can actually be maintained. With a yield of 2,000 tons to the acre, 500 tons would involve the removal of coal from one-fourth of an acre per day, or from one acre every four days, which, with an average soil-capping of 12 feet, would mean a large amount of unprofitable work; while in the case of operations wholly beneath the surface, the necessity of the removal of sufficient rock to allow room to the workmen would again be a serious drawback. It cannot, however, be doubted that the output of these mines, especially with the present high price of coal, might be materially increased. Operations in the Grand Lake coal basin.

More or less work has been done in the Dunsinane coal field during the past summer, but only of an exploratory character. No important developments have been made. Work at Dunsinane coal mine.

At Coal Branch, in Kent county, a shaft has been sunk in the vicinity of the coal seams previously reported there, and where operations were believed to indicate the existence of a three-foot seam of coal at a depth of 44 feet. The drill used, however, being a churn-drill, could not give very accurate results, and those obtained by shafting have not yet been reported.

Petroleum.—Petroleum was discovered in Westmoreland county over thirty years ago, and its occurrence there may prove to be of importance. For the following statement of work done in searching for oil in this county I am indebted to Mr. Harold B. Goodrich, the geologist in charge for the owners, and it is given entirely on his authority. According to Mr. Goodrich: 'After a summer's field work in New Brunswick, well No. 1 was located at Upper Dover, Westmoreland county (on S. A. Steeve's farm) in September 1899. It was driven to a depth of 1,340 feet. The geologic column was:— Petroleum.

Boring No. 1. Upper Dover

	Feet.
Middle Carboniferous (sandstone, &c.)	110
Lower Carboniferous (conglomerate, marl, &c.)	200
Albert shale formation	720
Probably older rocks	310
	1,340

'The two upper formations were nearly flat, but, as usual, the underlying Albert shales were found to be intensely folded and possibly faulted, so that the measure of their actual thickness is by no means correctly given in the column. We struck much gas at various horizons and two sands that were well fitted to contain oil, but were dry. The hole was abandoned in May, 1900. This first boring was a test to determine the condition of the Albert shale-oil beds under a cover of the younger rocks.

Boring No. 2. St. Joseph's college Memramcook.

'In May, 1900, the rig was removed to St. Joseph's college and well No. 2 was put down to a depth of 1,040 feet. There was much gas, and at 365–370 feet an oil sand and flow of oil was struck. Several accidents made it impossible to take advantage of this oil and the well was sunk further. At 670 feet, salt water was found. The drilling was entirely in the Albert shale series, which for the last 200 feet was mainly close-grained sandstone with shale bands.

Boring No. 3.

'No. 3 was begun one mile north of the college on February 27, 1901. The drilling was through hard and soft layers of Albert shale. A poor record was kept, and it is possible that a slight flow of oil or gas may have escaped the drillers attention. No petroleum is shown by the record, although the shales were highly bituminous. At 555 feet the well was abandoned owing to quicksands. The last ten feet was in red sandy marl or conglomerate.

Boring No. 4, oil found.

'Well No. 4 was commenced in May, 1901, at a point 400 feet north of No. 2 at the college. The total depth was 408 feet. At 176 to 204 feet there were twenty-three feet of oil-bearing sandstone. This was not recognized at the time, so boring was continued. Later the hole was filled up to this depth; it was torpedoed and a pumping apparatus was placed. While it has not been pumped continuously to date, there has been a considerable product which shows no sign of decreasing. The oil is of excellent quality.

Boring No. 5.

'Well No. 5 was located, on August 5, 1901, 200 feet S.W. of No. 4. The geologic section is practically the same as the latter; bituminous calcareous shales, with small hard limestone beds. At 174–178 feet there was a sandstone with considerable gas. At 247–275 feet is an oil-bearing sand (the same thickness as that of No. 4). No attempt was made to pump this well, but instead it was plugged and now awaits further development in the field.

Boring No. 6.

'The last week in August, No. 6 was located 100 yards N. by. W. of No. 4. Up to date we have reached 226 feet and are still sinking. In that distance we have passed through three separate flows of gas.

Almost the entire section is bituminous black shale. The present indications for a producer are excellent.

'In well No. 7, which was located on September 11, about 200 yards north of No. 4, we are now down about 340 feet. The section was similar to that of No. 6. At about 190 feet we struck gas, which was later cased off. At 326 feet there was a flow of petroleum, probably from fissures in the shale. We decided to bore still further, hoping for an increase in the quantity of oil. However, as the well is in excellent condition we can at any time use the present supply.' Boring No. 7, oil found.

The above wells were visited by the writer on the 5th of July, at which time, with a 2½ inch pump, worked by steam, the yield was four barrels for a period of six hours, or at a rate of from eight to ten barrels per day. The oil was a heavy, dark-green lubricating oil, well adapted as a machinery oil, and estimated as having a value of about $7.50 per barrel. Its specific gravity at 60° Fahr. is 0·860, while that of the American crude oil varies from 0·79 to 0·88. No analysis has yet reached me, but it is thought by those in charge that it will probably yield at least 30 per cent of burning oil, 15 per cent of lubricating oil and 10 per cent of solid paraffine. Yield of oil.

Copper.—While in Westmoreland county, a visit was made to the works of the Intercolonial Copper Company near Dorchester. The conditions of the occurrence of ore at this point have been given in earlier reports. The ore is of low grade, not averaging over 3½ per cent of copper, but is widely disseminated through the mass of the rock, from which, it is thought, that by the employment of new and improved processes it can be profitably extracted. For this purpose a large and expensive plant has been introduced, but at the time of our visit it had not yet been brought into operation. It is proposed to crush the entire rock, consisting of grey conglomerate and sandstone, more or less mixed with coaly matter and containing the ore, mainly chalcocite, in veins and scattered nodules, and, after roasting and treatment with acids, to separate the copper by electrical action. As copper ores of a like character and with similar associations are known to occur elsewhere in the province, as on the Nepinquit river, near Bathurst, the results of the operations at Dorchester will be awaited with interest. Copper mines near Dorchester.

At Chester, in Albert county, an opening was being made in a very hard ash-like rock of Huronian age, through which was disseminated small strings of chalcocite, associated with more or less green malachite. It adds another to the many localities in this great pre-Cambrian belt in which copper ores have been observed, but is less promising Copper deposit at Chester,

than those of Alma and Point Wolfe, further west. No well defined lode was exposed.

Borings in the nickel deposits near St. Stephen.

Nickel.—The Government drill has been in operation in connection with the nickel deposits near St. Stephen, but without satisfactory results as yet. The extreme hardness of the rock, a crystalline diorite with disseminated pyrrhotite, makes progress extremely slow and expensive, while no important increase in the percentage of nickel has yet been found to warrant the outlay.

Molybdenite has been reported from the vicinity of the S. W. Miramichi, and good specimens have been shown to me, but I have been unable as yet to obtain any particulars as to quantity.

The Coal Problem in New Brunswick.

Professor H. S. Poole, Dalhousie College, Halifax.

Coal in New Brunswick.

Rocks of the Carboniferous system cover a very large area in New Brunswick, although but little workable coal has yet been found among them. It was hoped that in the extensive region in the north-eastern part of the province, in which these rocks had not been exhaustively explored, better coal seams than any yet known in that district, or near Grand lake, might be discovered at the surface, or that by carefully working out the geological structure, some place might be pointed out where borings for coal might be made with a good prospect of success. Professor H. S. Poole of Dalhousie College, Halifax, was requested to undertake this work. He had previously made a study of the coal measures of Nova Scotia, including Cape Breton, while Inspector of Mines for that province, and also while actively engaged in the practical working of some of its collieries.

Investigations by Prof. Henry S. Poole.

He reports as follows:—'I considered the problem of discovering coal from a commercial standpoint, as though I were engaged by a corporation, prepared to explore and follow up any indications that held out even the least prospect of success towards the establishing of permanent coal-mining operations. Two months were spent in making a general reconnaissance of the Carboniferous system in New Brunswick and studying the relation of its strata to the rocks underlying the same system in Nova Scotia and to their assumed equivalent in that province, visiting many of the known exposures of coal seams, regardless of size, and keeping in mind my experience elsewhere of seams variable in thickness and coal measures hidden under formations

of later deposition. In this inquiry I allowed myself to generalize more freely than would be justified if one were engaged in a detailed survey of the actual exposures, and as yet, in possession only of superficial information. The benefit of any doubt was given to the inquiry.

Area of Carboniferous rocks.

For convenience of description, the area occupied by the rocks of the Carboniferous may be divided into two districts by a line running through the older rocks of Indian mountain some six miles to the northward of Moncton, and paralleling the Intercolonial railway between St. John and Moncton. Such a line traverses Lower Carboniferous rocks, except between the mountain and the Straits of Northumberland, where newer measures overlap. North of the line the Carboniferous beds lie practically flat and unbroken. To the south, they are more inclined and disturbed, appearing on the confines of Nova Scotia as continuations of members of the Joggins section.

The people of New Brunswick are so keenly alive to the value of workable seams and the streams of the province have been so thoroughly traversed by lumbermen, that it may be accepted that no seam of workable thickness crops to the surface and has been overlooked. This being assumed, it follows that success from further search can be hoped for only where experience or theory may suggest examination being made under the superficial deposits or by boring into the more deeply seated strata.

Renewed interest in known coal seams.

Of the known coal seams, nothing specially new has to be reported. They have been described in late reports by Dr. Ells and Prof. Bailey. There has, however, been renewed interest in explorations at Dunsinane and Coal Branch, and a beginning has been made in the sinking of a slope at the former and a vertical shaft at the latter place.

Throughout the northern district, nothing was noted that indicated a possible presence of thick coal seams either near the surface or in depth—nothing to hold out hope that measures rich in bituminous deposits might be discovered by systematic search. The only discovery that seemed possible would be that of a thickening of the thin seams in those parts of the country that are as yet unexplored.

Coal pebbles.

At Indiantown, coal pebbles with water-worn fragments of fine shale appear in some sandstone beds and they have been apparently derived from an underlying seam not at present known. A somewhat similar occurrence of coal pebbles has been noted to the east of Dunsinane.

The southern part of the Carboniferous district, with its thick sections and its unconformities, possesses possibilities of finding workable coal on closer examination. It appears that certain beds on the New

Brunswick side of the Bay of Fundy are continuations of some of those in the Joggins section which have a definite relation to the coal-bearing series of Cumberland county, and they entered through Cape Maringuoin, Grindstone Island and Mary's Point to New Horton, where they curve rapidly and run down the coast at an increased angle of dip to Cape Enrage. With them would curve the overlying Joggins seams, outcropping under the waters of Shepody Bay.

To the north-eastward, the structure is not so clear. The Millstone grit series folds over, dips to the north-west and is unconformably covered by Permo-Carboniferous strata where the dip again reverses. So decided an unconformity suggests that the equivalents of the Joggins coal measures may possibly be repeated in that direction under newer formations extending to Northumberland Strait and up the coast.

Assistance.

During part of my time I had the benefit of Prof. Bailey's company, experience and local knowledge. I am also indebted for information and assistance to many persons interested in developing the resources of the province, chief among whom are Lieut.-Governor McLellan, Hon. A. T. Dunn, Mr. F. Black, Mr. P. S. Archibald, Mr. J. White, Mr. W. Ogden, Capt. Bacon and Mr. H. C. Read.

Prince Edward Island.

Mr. Lawrence W. Watson.

Work by Mr. Lawrence W. Watson.

Acting upon the instructions contained in your letter of the 17th June last, I have, since receiving the same, prosecuted the work therein outlined at every possible opportunity. The conditions under which the work was undertaken naturally differed in a considerable degree from those governing the members of your permanent staff or those persons employed for a time upon investigations for your Department to the exclusion of all other work. This consideration, and the fact that much data for an exhaustive report upon several parts of the inquiry committed to me could not be procured without an expenditure (needless because not demanded by any existing urgency) which might be avoided, without detriment to the ultimate result desired, by waiting for and taking advantage of favourable opportunities for visiting distant localities without much attendant expense, make it imperative that the present report be a preliminary one, to be supplemented later by one in fuller detail.

In no particular of the investigations undertaken is the necessity of these considerations more emphasized than in the endeavour to solve the problems of our geological formations, for the solution of which, much patient search has to be made for fossils, by no means abundant in our strata. I have visited many localities and spent much time in collecting the fossils which have been forwarded to you. Much work must still be done before the question of the exact positions of our rocks in the geological scale can be satisfactorily settled. The geology of St. Peter's Island has not been studied as much as it deserved to be, owing to its difficulty of access. I hope, however, to be able later, to report upon this locality which is comparatively rich in organic remains. Geological value of work.

Investigations so far made do not warrant any change in the opinion that coal areas may underlie the Post-Carboniferous rocks of certain districts at a depth not too great for mining. As the depth of the superincumbent strata may be less than anticipated, and as the coal measures with their wealth of coal may be nearer the surface than is generally supposed, and as the cost of boring is less than formerly, it seems desirable that in view of possible success, such operations should be undertaken in these districts. Underlying coal areas possible.

No minerals of any importance have been found. I collected some nodules of copper ore on Governor's island, but did not find indications of any considerable deposit. I have not been able to find any evidence that gold occurs in this province to any greater extent than the reported discovery of 'colours' in the sand of the sea-shore. No minerals found.

In the department of Surface Geology a few words may be said about recent deposits. Peat bogs, of small individual extent, but covering in the aggregate a considerable area, are found in many places, the quality of the deposits and their depth varying greatly. Some of them have been visited, but consideration of these will best be reserved until a comparative statement can be prepared showing their extent and the results of analysis of the peat. This subject suggests economic possibilities of too great importance to this province to be disposed of without fuller investigation than the time allowed for this inquiry and report permitted. Peat bogs.

Beds of 'mussel mud' are frequent in our bays and inlets. Formed of accumulations of shells of oysters and mussels, decayed animal matter and alluvium, they constitute a valuable fertilizer, much used by our farmers. It is pleasing to record a late regulation, which prohibits digging the mud where it is covered by beds of living oysters. I shall take advantage of the approaching season of digging to submit samples of this product to you.

Sand dunes.

In view of the fact that our coast-line is very generally being worn away at a comparatively alarming rate, the formation of sand dunes on our northern and eastern coasts is interesting and important. While these are of comparatively slow formation, the whole contour of one of these sand-hills may be changed in one storm, and entrance into harbours may be shifted or occluded. I observe that the sand dunes upon which vegetation grows, change least, and that the sand is arrested by any such object as a fallen tree, and thereby protected from displacement by powerful winds. Most beneficial results would, therefore, follow if fences of spruce and similar trees were placed in parallel lines along the sand tracts.

I have devoted much time to the study of the flora and have collected some hundreds of plants. As soon as time permits, I will, if desired, give a complete list of all the species of our flora hitherto authentically identified.

Collections made.

Collections of mollusca, algæ, reptilia, batrachia and the smaller mammals have been made and forwarded to your Department. I visited and made collections from Indian shell heaps, finding therein ornaments or implements of stone and fragments from the manufacture of the last mentioned, all of which have been already forwarded.

The foregoing is an outline of the work done. It may be supplemented later by a report in more detail containing lists of fossils and of our fauna and flora, together with further notes upon the various subjects you suggested for study and investigation.

Kings and Hants Counties, Nova Scotia.

Mr. Hugh Fletcher.

Work by Mr. H. Fletcher.

The winter of 1900-01 was spent by Mr. Fletcher in compiling plans and sections from surveys made in the field by himself and his assistants during the previous summer, as detailed in the Summary Report for 1900, pages 162 to 166.

Coal seams examined.

He left Ottawa on June 18, for Sydney, Cape Breton, to examine borings and explorations made among coal seams of the Millstone Grit, near Grand lake and Cochran lake. The Tracy seam near the Moseley pits south of Cochran lake, was proved to be six feet thick, but to have not more than three feet and a half of coal in one clean layer, three small partings breaking up the rest of the coal. The seam, where opened, some miles farther west, yielded three feet and a half of good coal.

Extension of the Mullins seam bored for.

On Grand Lake road at the bridge over South-west brook, a hole, bored in the hope of cutting a workable extension of the Mullins or Carroll seam, passed through 750 feet of gray sandstone with only a few thin layers of shale and coal. Subsequently a hole was bored to this seam at the outlet of Lynk lake, near the outcrops mentioned in the Summary Report for 1895, where it was found to be only three feet thick. In no case was more than one workable seam found.

Principal field of investigations.

The greater part of the season, however, was spent on the south side of Minas Basin, in the counties of Kings and Hants, in the district lying between the Avon river on the east and the Salmon-tail river, Gaspereau lake, and Coldbrook on the west, bounded on the north by the shore from Falmouth to Ira Woodworth bay, and extending south into the granite country at the head of the west branch of Avon river. Mr. M. H. McLeod was again Mr. Fletcher's assistant, and he had also with him Messrs. A. T. McKinnon and Wm. L. Lodge. He is greatly indebted to Professors A. E. Coldwell and Ernest Haycock, of Wolfville, to Professor Kennedy of Windsor and many others for assistance.

District historically interesting.

Though this district is more noted for its early history, the picturesque beauty of its shores, waterfalls, lakes and woods, the richness of its meadows, and productiveness of its farms and orchards than for its mines, yet rock-formations of great interest attract tourists and students to the country every year, to study its geology, and carry away specimens of the amethyst, agate, jasper, chalcedony, zeolites, magnetite, copper and other curious crystals and aggregations from its traps, the beautiful selenite and fibrous gypsum from its Triassic marls, and ripple-marks, rain-prints, fish-remains and other fossils from its more indurated sediments.

Relics of Indian inhabitants.

Remains of the villages of the Micmac Indians, their landing-places, trails, and burying-grounds, are still traceable at Starrs Point, Canard, Gaspereau and other places. Heaps of shells and bones of various animals attest the former abundance of game and fish. They are associated with implements and arrow-heads of a primitive civilization, chipped out of stone obtained from Blomidon or fashioned from pieces of native copper from Cape d'Or.

The Acadians.

The ancestors of the Acadians, who displaced the Micmacs, to be dispossessed in turn by the British, came from a country of marshes on the west coast of France, where the sea was kept out by artificial means. They found around the Bay of Fundy, in Nova Scotia and New Brunswick, similar marshes underlaid by finely pulverized, friable red mud, brought in by the tides, into which the roots push themselves for several feet; and turning to account their skill and experience, they

built many miles of dyke, at first enclosing small areas alongside the upland; next, by concerted, skilful effort, building across the rivers from point to point, with a sluice or *aboiteau* in the channels to let out the fresh water and keep the salt water from flooding the marshes and killing the vegetation. By this means they reclaimed and brought under cultivation thousands of acres of excellent meadow-land, which has retained its extraordinary fertility for one hundred and fifty years, and still produces grain, vegetables and fruit, yielding two to three tons of timothy to the acre when well drained, turned over and seeded down once in every five or ten years, and is sometimes so valuable as to be rated at $400 per acre.

Marsh lands reclaimed.

The home of Evangeline.

One of the largest of these marsh lands is Grand Pré, in Kings county, celebrated in verse as the home of Longfellow's Evangeline, and situated between the beautiful valleys of the Gaspereau and Cornwallis rivers, up which the phenomenal tides of the Bay of Fundy run for several miles to form, at high water, inlets navigable for small craft. Near it are the willows and apple-trees of the early French farmers, a well and the ruins of their church and houses.

Other dyke-protected meadows occur at the mouths of the Avon, Canard, Habitant and Pereau rivers, of historic interest in the struggle for supremacy in the New World between the English and French, during the seventeenth and eighteenth centuries. They are bordered by sloping fields and undulating uplands, while away to the northward Blomidon rises to a height of 500 feet, crowned with evergreens and hardwood, opposing to the turbulent tides a perpendicular wall of basaltic trap, jutting out past the fringe of bright red sandstone that forms the cliffs to Pereau and Kingsport. Cape Blomidon is the eastern buttress of the north mountain range, which, extending thence to Brier Island, shuts out the fog of the Bay of Fundy from the Annapolis valley. Another elevation of great scenic interest in this vicinity is the 'Look Off,' three miles from Canning, from which an extensive view is presented of the surrounding country, with fine orchards laden with apples, plums, pears, cherries and small fruits, gardens and grazing lands for cattle and sheep; and deep valleys, lakes and woods, dimly seen to the southward, full of trout and salmon, moose, bears, partridges and other game. Many such fine views and imposing and attractive pieces of scenery are easily accessible from the railway. Among these are the valleys of the Gaspereau and Coldbrook, the Deep Hollow, Whiterock, Black River falls, Moores falls, the beaches and sea cliffs, particularly between Kingsport and Blomidon.

Cape Blomidon.

Places attractive for scenic beauty.

The dyke lands have been described by many writers.*

Kings county affords a great variety of geological formations. Those of sedimentary origin belong to the following periods: Pleistocene, Triassic, Carboniferous, Devonian (Horton), Silurian (perhaps including Cambro-Silurian or Upper Cambrian), Lower Cambrian (upper gold-bearing series). Igneous or Plutonic rocks are also present in hill-masses and dykes. Following the Triassic came a great effusion of trap. All the rocks to the top of the Silurian are affected by an intrusion of the gray granite that forms so important a feature on the Atlantic coast; and are also cut by dykes of gray diorite. These intrusions appear, however, to differ in age and material from that which has formed the Cobequid hills and altered the strata of Riversdale and Harrington river. Geology of Kings county.

Notwithstanding all that has been written† in general descriptions of these formations, much still remains to be done to define on a map their precise boundaries and relations.

Drift material from the North mountain is found as far south as Etna (Greenfield) and other points on the South mountain. Pebbles and boulders from the Cobequid hills also abound in the boulder-clay of all the sea cliffs, valleys and beaches. Professor Coldwell has described south-easterly glacial striæ on rocks of the ridge immediately south of Wolfville; an old beach-formation parallel to the present water frontage at the same place; and trunks, stumps and roots of trees *in situ*, about thirty feet below high-water mark on the northern side of Long island, representing, he argues, a subsidence of the land of forty to fifty feet. An interesting deposit of shell-marl, used as a fertilizer, has been dug from a bog on the land of Mr. William Wallace at Canaan. Bog iron and manganese have been worked to a small extent south of Coldbrook station, at Canaan and other localities. Drift material. Bog iron and manganese.

The southern limit of the Triassic runs westward from Avonport and follows a short distance south of the Cornwallis river. The belt, which has an average width of six miles and a half, is bounded on the north by the North mountain, the uppermost beds being those cut by the trap. It contains, near Kingsport, friable sandstone, for the most Description of Triassic belt.

*Herbin's 'Marshlands' and 'Grand Pré'; Haliburton's 'Sam Slick' and 'History of Nova Scotia'; Longfellow's 'Evangeline'; Macleod's 'Notary of Grand Pré'; Theodore Rand's Poems; Gesner's 'Geology and Industrial Resources of Nova Scotia'; Dawson's 'Acadian Geology'; and others.

†Report by Jackson and Alger; Gesner's 'Geology of Nova Scotia' and 'Industrial Resources'; Dawson's 'Acadian Geology'; Papers by Professors Coldwell and Haycock and by Dr. Honeyman in the 'Transactions of the Nova Scotian Institute of Science'; and others.

part brick or Indian-red, with great irregular layers or patches of conglomerate; overlaid, towards Pereau, by finer marly beds, which extend to Blomidon and include layers of selenite, nine inches and downward, in the upper portion. A narrow outlier is found in the large brook above Kentville, separated from the main basin. Sections of these rocks have been measured wherever accessible. Their total thickness is not great. They are spread over this large tract in almost horizontal layers, and it has been suggested that underlying formations might be reached by boreholes.

Carboniferous limestone.

From a point half a mile above the West Branch, the Avon river flows through a basin of red and gray marls, flags and sandstones, gypsum and limestone of the Carboniferous limestone formation. In the neighbourhood of the plaster and limestone quarries of St. Croix, Windsor, Falmouth, Mount Dennison and Hantsport this basin is of great extent; but it enters Kings county only in a narrow zone along the shore from Hantsport to Blue Beach.

Horton series.

A somewhat irregular belt of more metamorphosed rocks is met with in the West Branch of Avon river, the Mill Branch, Halfway and Gaspereau rivers. These, as they occur at Horton Bluff, have been called the Horton series.* Sections have been made there and on the Curry and other brooks flowing into Gaspereau river, to define their thickness, which is probably not less than on the north side of Minas Basin. The base is well defined at Gaspereau, Halfway river and other places; from it the 'Wickwire sandstone' is largely quarried for foundations of buildings; and it yields also the quarry sandstone of Halfway river.

Controversy as to true position of Horton series.

A brief reference may here be made to a controversy that has arisen among palæophytologists concerning the true position of this series.† Some of them, while correlating the Horton with the rocks of Riversdale and Harrington river, in Colchester county, have classified it as above the Devonian of New Brunswick; others regarding the Riversdale and the Devonian of New Brunswick as identical, would place the Horton beneath them. In the region now under examination, the Horton rests upon no rocks younger than Silurian, and comes from beneath the Carboniferous limestone, 'the old Lower Carboniferous, or Keokuk-St. Louis,' according to Schuchert, and is clearly, therefore, neither Upper Carboniferous nor Millstone Grit. 'Surely,' an eminent palæobotanist remarks, 'the coefficient of error should not be so

* Acadian Geology, pages 252—257.

†'A Backward Step in Palæobotany,' by Dr. G. F. Matthew, in Trans. Roy. Soc. Can. for 1901; Can. Record of Sc., Jan. and July, 1901; Ottawa Naturalist, May and July, 1901.

great as to permit an entire geological period to intervene between its palæontologically theoretical position and its actual place.'

Marine fossils found in underlying series.

The rocks next underlying contain, between Canaan and Gaspereau lake, Silurian marine fossils.* West of New Minas, the fossil, *Dictyonema Websteri*, is obtained from a series apparently distinct, resembling the so-called Cambro-Silurian of Antigonish and Pictou counties, but referred by Dawson to the Silurian, by Honeyman to the Lower Silurian, and by Coldwell to the Cambrian. The stratigraphical relations have not yet been thoroughly worked out. From the former are quarried the impure limestones of Gaspereau lake and Canaan; from the latter, the flinty, quartzose flags of Highbury.

Graphitic slates of Lower Cambrian age.

Graphitic slates of the age of the Lower Cambrian or Upper Gold-bearing series, sometimes so black as to be worked for graphite, are largely developed in the Halfway, Black and Gaspereau rivers. They are cut by small veins of quartz, some of which have been exploited but do not seem to be persistent or to carry gold. Just below a bridge about three miles above the mouth of Black river, an east-and-west anticline brings to the surface beds of whin; but it is not known that gold-bearing veins have been discovered along its axis.

Rock series cut by diorite dykes.

This series, as well as the preceding, is everywhere intersected by dykes of light-gray dioritic rock and cut off to the southward by a great mass of granite, which stretches nearly to the Atlantic, a blackish granular diorite generally occupying a narrow zone at the contact. The diorites and the granite are all, however, older than the Horton rocks, the latter containing fragments of both. The granite is usually gray, but in Black and Little rivers it is in part red. Both varieties make durable ornamental and building stones. Where Triassic rocks are broken through by the trap of the North mountain the alteration of their soft sediments does not extend to many feet from the contact.

Characteristic minerals.

Vuggs, both in the latter and in the trap, are filled with crystalline aggregations varying in size from mere druses to several inches in diameter, and veins and plates contain many other minerals already described as characteristic of the traps of the Bay of Fundy at Cape Blomidon and many of the small coves from Scotts bay westward—the amethyst and black quartz, agate and jasper being especially prized by collectors. A list of the varieties to be obtained at different points is given in Dr. Hoffmann's 'Annotated List of Canadian Minerals.'†

* Acadian Geology, pages 562 to 573, 594.

†Cf. also 'Acadian Geology'; Gesner's 'Geol. of N. S.'; Jackson and Alger; Herbin's 'Grand Pré'.

Columnar, granular or crystalline, basaltic trap occupies a narrow chain along the contact with the Trias from near the 'Look Off' to Cape Blomidon, thence on the outer shore to Cape Split. The shores from Scott's bay westward to Baxter harbour and the greater part of the trap area inland are, on the contrary, occupied by sheets of amygdaloid, dipping north-westward at a very low angle.

Veins of magnetite are found at Blomidon, as at Gerrish mountain and other places, of less than workable size. Native copper and malachite are also present, but apparently in much less quantity than at Cape d'Or, in Cumberland county, where the Colonial Copper company is spending large sums of money in search of a paying deposit.

Borings near Leamington.

Fifty-six hand-drill borings, ranging in depth from 10 to 82 feet, have been made near Leamington, in Cumberland county, to trace the course of the coal seams overlying the large beds worked in the Springhill coal field, and the relation of these latter to small seams of the Upper Maccan river. These explorations were not undertaken, as has been already stated, for the discovery of workable coal seams at the surface, the outcrop of those of the Springhill mines having turned to the eastward and become concealed among faults at the bottom of the basin near Rodney; but to determine the lines along which the lower levels in the working of these seams must pass by the outcrops of small seams overlying them at stated distances. It is also desirable to ascertain whether the conglomerate upon the slope of the Cobequid hills south of Leamington and westward towards Apple river, instead of being Lower Carboniferous, may not rather represent higher measures, just as the 1,500 feet belt near the Chignecto and Styles mines is, according to Barlow and McOuat, a local replacement of the fine sediments that on the Joggins section immediately underlie or include some of the coal seams.

Assistance given.

For kind assistance in this work, Mr. Fletcher has again to thank Mr. J. R. Cowans, of the Cumberland Railway and Coal Company, the gentlemen mentioned on page 162 of last year's Summary Report and Mr. George C. Harrison, C.E., of Southampton.

Nova Scotia Gold Fields.

Mr. E. R. Faribault.

Office work by Mr. E. R. Faribault.

Mr. E. R. Faribault returned to Ottawa on August 26, 1900, from the Paris International Exhibition, where he had been sent to superintend the installation of the Canadian mineral exhibit; and after thre

weeks field-work in the gold districts of eastern Nova Scotia, he reached Ottawa again on September 28 to resume his office work, on which he reports as follows :—

'The last three months of 1900 were spent in the office preparing a report on the collection of Canadian minerals sent to the Paris Exhibition* and in attending to correspondence and other duties in connection with the exhibit. I also prepared a plan to be used for the installation of that mineral exhibit in the space allotted to it at the Glasgow International Exhibition of 1901.

'The winter months of 1901 were devoted to the compilation of the large scale plans of the gold-mining districts of Waverley and Tangier in the county of Halifax, both of which were handed in for publication before leaving for the field. Some progress was made also in the compilation of the surveys made several years ago for the Lawrencetown and Preston map-sheets, lying immediately east of Halifax Harbour, and in this work I was assisted from May 1 by Mr. Owen O'Sullivan.'

Field work.

On the field-work accomplished in Nova Scotia during the past season, Mr. Faribault reports as follows :—

In accordance with your instructions, I left Ottawa on June 15 for Nova Scotia, to resume the surveys interrupted last year, in connection with the mapping and study of the structural geology of the gold-bearing rocks of that province.

Mr. Owen O'Sullivan also left for Nova Scotia on June 15, and from that date until his return to Ottawa on October 4 he was engaged with the exception of three weeks, occupied in surveying with Mr. C. O. Senécal, in continuing, under my supervision, the much delayed compilation of the topographical surveys of the region lying immediately east of Halifax Harbour and the line of the Intercolonial railway.

Assistants.

I was again ably assisted in the field, during the whole season, by Messrs. Archibald Cameron and Jas. McG. Cruickshank, who have been my assistants for sixteen and fourteen summers, respectively. They joined me at Halifax on June 18, and, after a few days spent revising surveys to the east and west of Halifax, they were engaged surveying the region passed over in 1896 and covered by the St. Margaret's Bay sheet, No. 71 and the Aspotogan sheet, No. 70. This region covers 240 square miles of land, includes the numerous lakes and streams flowing southward into St. Margaret's bay, and the East river of Chester, flowing into Chester basin, and it extends inland to the

* Summary Report Geol. Surv. Can., 1900, pp. 16 to 37.

north and west as far as the old Annapolis road and the Windsor-Chester road. The shore roads were surveyed with the odometer, and several of the lumbering roads of the interior were chained to be used as tie-lines; while the streams, lakes and other traverses were measured by pacing and the prismatic compass.'

With the exception of a few small outliers of Carboniferous limestone along the coast, the whole of the district surveyed is underlaid by granite, is very rough, with rugged rocky hills or huge boulders of granite strewn over the surface, and is of but little economical importance. The country is mostly barren along the coast, but well wooded with good timber some distance in the interior. It is unfit for agriculture and uninhabited, except along the sea-shore, where a prosperous scattered population is engaged in fishing and lumbering.

Messrs. Cameron and Cruickshank were engaged in the field until the 28th of October, when they began the plotting of their surveys.

Acknowledgments.

In the performance of my field-work, I have received much information and assistance from miners and other persons, and I wish to thank especially the Hon. C. E. Church, ex-Commissioner of Mines; Hon. A. Drysdale, Commissioner of Mines; Dr. Edwin Gilpin, Inspector of Mines; Hon. S. H. Holmes, and Messrs. Roderick McColl, D. Weatherbe, F. H. Mason, N. W. Keddy, Geo. E. Francklyn, T. N. Baker, J. H. Austen, and Sidney Y. Bauld, of Halifax; A. F. Church and J. B. Morrell, Bedford; Geo. W. Stuart, Truro; A. A. Hayward, Waverley; G. J. Partington, Isaacs Harbour; John H. Anderson and Mark Anthony, Musquodoboit Harbour; John J. Withrow, South Uniacke; Capt. C. D. Lordly, Alex. M. Church and Principal Lawson, Chester; John A. Wheeler, Irving Croft, D. C. Butterfield, Amos A. Hiseler, H. B. Bigney, Charles Mills, D. M. Fraser, and John Croft, Jr., Chester Basin.

Nature of work.

My own work in the field was confined principally to a closer study of the geological structure of the gold-mining districts of Montague and Lake Catcha, in the county of Halifax, surveyed in 1898, and briefly reported on in the Summary Report for that year, and the gold-mining districts of South Uniacke, situated partly in Halifax and partly in Hants county, surveyed in 1899, and also reported on in the Summary Report for that year. The structure of the anticlinal folds, the location of the auriferous quartz veins and the numerous faults affecting them were carefully made out, and the results added to the plans of these districts previously plotted on the scale of 250 feet to one inch. These plans are ready for publication, and that of Montague is now in the hands of the engraver.

A special detailed survey was also made of the gold district of Gold river, in the county of Lunenburg, and a plan plotted on the scale of 250 feet to one inch has been completed.

A revision was also made of the geological structure of the region lying to the north of Chester basin, between the East river of Chester, Gold river, and Chester Grant, surveyed in 1895, for the general mapping of the country, on the scale of one mile to an inch.

Some preliminary notes on the structure of the Gold River gold district will no doubt be welcomed by those interested in it.

Gold River gold district.

Gold River Gold-mining District.—This district is situated on the Gold river, in the county of Lunenburg, one mile above the bridge spanning the stream on the shore-road, where it discharges into Chester basin. It is five miles north of the town of Chester, twelve miles east of Mahone bay, a station on the Central railway, and fifty miles west of Halifax, by the shore road.

First discovery of gold.

There is a tradition that gold was originally found on the river by early French settlers, and hence its name. Another authority asserts that the name was originally 'Gould river'. The first discovery of gold of which we have positive information was made by Messrs. Daniel Dimock and David Whitford, on June 20, 1861. Mr. Henry Poole visited Gold river in 1861, and in his report to the Government said: "One quartz vein was fifteen inches wide, and had thick beds of quartzite rock above it, and several feet of thin laminated slates below, and the vein bore N. 60° W. and dipped 38° north." This description agrees with a quartz vein opened on the north-east bank of the river and shown to me as the first vein opened in the district.

Area of the district.

The mining operations have all, to this date, been prosecuted on the north-eastern side of the river, but important surface developments have also been made on the south-western side. In the district, gold-bearing veins have been discovered over an area 7,000 feet long and 4,000 feet wide. A detailed survey has been made of this area, and a plan plotted on the scale of 250 feet to one inch.

Geological structure.

Great difficulty was experienced in working out the geological structure of the district. No mining operations were being carried out when the survey was made and most of the old workings were full of water and inaccessible. The surface is heavily covered with glacial drift or decomposed rock and natural rock-exposures are very scarce. Were it not for the good sections available along the deep valley of the Gold river, and the informations gathered from the miners who have worked from time to time in the several mines, it would have been impossible to make out the structure of the measures.

Interbedded veins.

All the auriferous quartz veins discovered in the district belong to the interbedded class of fissure veins. They follow the planes of sedimentation of belts of slates interstratified between heavy beds of quartzites and they occur along the truncated dome of a huge anti-

Horizon.

clinal fold. The horizon of the strata brought up by this upheaval is estimated to be 6,600 feet below the base of the group of slates which form the upper division of the Acadian gold-bearing rocks, giving a total erosion of some 17,000 feet of known sedimentary rocks.

Anticlinal fold.

The general course of the anticline is north-east and south-west. At the western limit of the district, a six-inch lead, opened in a slate belt by Mr. N. W. Keddy, on area 1076, block 1, curves westerly around the crown of the anticline and pitches 37° west. The anticline is well exposed on Gold river at the Hemlock fall, where it pitches 15° south-westerly. At the eastern extremity of the district, on area 314, block 3, a five-inch lead discovered by Mr. Charles Mills in a wide slate belt just north of the Gammon group of leads, has been found to curve in a south-easterly direction around the crest of the anticline and dip 30° east.

On the south side of the anticline the strata curve abruptly and dip southerly at high angles, increasing rapidly and reaching 85° at a distance of 2,000 feet to the south of the anticline. On the north limb the strata dip at much lower angles, and vary from 35° near the

Dome.

axis to 45° at a distance of 1,700 feet northward from it. The axis-plane of the fold dips thus to the north at an angle of 65°, and the upheaval has the form of a much elongated, elliptical dome whose centre is not far east of the bridge spanning the East Branch.

Veins on the south limb of anticline.

All the most important veins operated in the district are situated on the south limb of the anticline. The tilted-up strata of the south limb have necessarily been subjected to more shearing and fissuring in the process of the upheaval than the less disturbed ones of the north limb, and as a result they were more favourable to the formation of large auriferous quartz veins. So far, 32 leads have been discovered within a breadth of 2,300 feet of strata on the south side of the anticline, and of these 17 have been developed or worked to some extent. The present surface developments show that the veins are very persistent along their course from one end of the district to the other, and that they must also extend to very great depths.

Gammon group of saddle-reefs.

The district has not yet been prospected sufficiently to determine with any certainty the zones of special enrichment. The Gammon group of leads, opened immediately south of the anticline, at the east end of the district, is very promising as a low grade ore deposit.

Within a distance of 170 feet the group shows seven large quartz veins, dipping vertically, giving a total thickness of 70 feet of crushing material, and holding several bands of well mineralized ore. It is probable that this extensive development of quartz in the leads is confined to a relatively small portion of the crown immediately south of the anticline. The size of the veins will probably be found to diminish in depth, but, if the developments are carried in the direction of the axis-plane of the fold, which dips 65° north, a succession of large superposed veins will probably be discovered going to great depths. More development work should be done towards the west along this part of the anticline.

Minor fold.

An important crumple of the strata has been observed in a shaft sunk by Mr. T. N. Baker 500 feet south of the Gammon leads, on the intersection of the Baker fissure vein, running north-west and south-east, with the Vermilion lead, which follows the stratification. The foot-wall of the Vermilion lead is here crumpled into a small anticlinal, which runs N. 76° E., dips 31° E., and is followed 40 feet north by a small synclinal fold, beyond which the rocks assume their general course towards the north-east. The streak of rich ore found here is undoubtedly caused by this disturbance, and it is probable that similar enrichments will be found on the leads affected by this disturbance to the north and south of the Vermilion lead. Very rich drift has been found along a depression to the south-east, and it probably comes from the intersection of the Captain and the Picayune leads with either this crumpling or the Baker fissure vein.

Leads worked on the south dip.

The leads which have been worked on the south side of the anticline, are met with in the following order from north to south:—The Jumbo lead, worked to a depth of 80 feet; the Vermilion lead, 40 feet; the Captain lead, worked by several shafts at the Victor mine to depths of 200 feet, and at the Lincoln mine to depths of 119 and 250 feet; the Picayune, 200 and 211 feet; the Mill lead, 100 feet; the Fox lead, 70 feet; the Brisco lead, 40 feet; the Hiseler, 50 feet; the Croft Hill lead, 40 feet, and the Iron lead, 40 feet.

North Star lead.

As far as can be ascertained from the present developments, the leads which are most promising on the south dip are the Gammon, Jumbo, Vermilion, Captain, Picayune, Mill and Fox leads. The only lead worked to any extent on the north dip is the North Star lead, situated at a distance of 1,500 feet to the north of the anticline. A rich streak or roll, dipping west at a low angle, has been worked 600 feet in length and 100 feet in depth on this lead. The intervening section between the North Star lead and the anticline has not

yet been much prospected. It is probable, however, that the ground immediately north of the Gammon leads and the anticline contains some valuable leads.

North-west bulge.

On the north-west side of the anticlinal fold the strata curve gently in a south-westerly direction towards the main anticline and form a broad bulge favourable to the formation of quartz veins. The rock section exposed along the Gold river, from Innes and Big Cumberland pools to the head of Mosher's fall, presents some eighteen interbedded veins situated on this bulge. Some have been tested and found auriferous, but none have been prospected to any extent.

Touquoy gold drift.

It is said that the richest drift discovered in the district was found on the old Touquoy property, at the south-west end of the district. Much prospecting has been done for many years back by Mr. Damas Touquoy and others to find the lead, but the surface is covered with glacial drift to a depth of twenty to twenty-five feet and the float of gold quartz is only found at the top of the drift and has possibly come a long distance. It is very probable, however, that the lead will be found on the above described bulge and possibly at no great distance from the anticline. More prospecting should be done along the anticline, between the Keddy lead and the Croucher lead, and beyond it as far as the Hemlock fall on the river.

Faults.

The structure of the anticlinal fold has been subjected to much disturbance since the folding and the deposition of the interbedded quartz veins. Unfortunately, the rock exposures are too few and the developments accomplished are as yet too limited to determine with any certainty the many faults affecting the district. Several of them run transversely through the anticlinal fold. A left-hand fault has been observed to give a displacement of seventy-five feet on the North Star lead, and running a little east of south along the west side of a swamp, it crosses the river at Big Cumberland pool and passes west of the Hemlock fall, where the anticline appears to have been shoved 200 or 300 feet, to the north of the Croucher lead. An important left-hand fault appears to have displaced the rocks along the Eastern branch, but its direction could not be ascertained. A left-hand fault, giving a shove of some twenty feet on the Croft Hill leads, runs up the river, passes east of the Jumbo crusher and eighty feet east of the eighty-foot shaft on the Jumbo lead. A few small faults have also been encountered in the workings of the Captain lead at the east end of the district. There is also probably a left-hand fault of 100 feet or more west of Baker's workings on the North Star lead, and possibly also to the east of them.

Several falls, cascades and rapids are met with along the course of Gold river through the district, and a few of these have already been utilized, in a small way, as water-power for the mines. An excellent water-power could be established at Little or Big Cumberland pool, where 75 or 100 feet of a head could be had with little cost from the Mosher's falls. With such a power in the middle of the district, there is not the least doubt that many of the large belts of low-grade ore, overlooked to the present day, could be worked at a good profit, and make the district one of the best producers in the province. Excellent water-power.

Cambrian Rocks and Fossils of Cape Breton.

Dr. George F. Matthew.

During the past season I was engaged in June with Dr. Bailey in examining the slate and quartzite rocks of the western part of York county and the southern part of Carleton county, New Brunswick. Subsequently I visited, with Dr. Bailey, exposures of these rocks on the western border of the Carboniferous area in York county. The results of these examinations are given in Dr. Bailey's Summary report.

For the greater part of the month of July I was working on the Cambrian rocks in Cape Breton, examining some districts not previously visited and perfecting the work in other parts of the field. The general results of my work so far as they relate to the geological structure are embodied in the comparative table submitted herewith. From this table it will be seen that almost every Cambrian fauna of English rocks of this age occurs in the Maritime provinces of Canada. In other words the Cambrian history is complete, without breaks here as in Great Britain. The table also shows the position in the Cambrian formation of certain iron ores and slate deposits, and where mineral wealth of this kind may be looked for with the best prospect of success. The upper ferriferous horizon is in that part of the formation in which the hematite beds of Bell Island, Newfoundland, are contained. The lower iron-bearing band is in the middle of the red rocks of the basal part of the Cambrian. Work by Dr. Matthew in Cape Breton.

The most promising of the slate rocks of the Cape Breton Cambrian for economic purposes are found at the top of the basal part of the formation in the Mira river valley. They are of the same age as the argillites or clay slates that are quarried at Trinity Bay in Newfoundland. Their value will depend upon the ease of cleavage and accessibility to a market. Promising slate rock.

Lower Portion of the Palæozoic Rocks

English Equivalent.	Llandeilo.	Arrenig.	Tremadoc.	Dolgelly.	Ffestiniog and Maenterog.
Leading Genera of the Several Groups.	e. Harpes, *Trinucleus*, in N. W. New Brunswick.	d. Cyclognathus Parabolinella, *Tetragraptus*, Didymograptus, in S. New Brunswick.	c^3 *Asaphellus*, Parabollinella, Triarthrus, Bellerophon.	c. *Dictyonema*, Monobolina, Schizambon, Acrotreta. b. *Peltura*, Sphærophthalmus, Leptoplastus, Ctenopyge. a. *Parabolina*, Agnostus, Anomocare, Orthis, in S. New Brunswick.	c. Agnostus, Lingulella. (Place of Olenus.)
Maritime Provinces	3. Bretonian Division.				2. Johannian.
European Writers.	Ordovician.		Primordeal Cambrian.		
	Lower Silurian.			True or Eo-Cambrian.	
Groups, and kinds of Rocks in Cape Breton.	3. Dark gray, and black carbonaceous shales often changed to slates; a few thin seams and lenses of dark limestone and some thin flags.				2. Micaceous gray slates, flagstones and quartzites. Iron-bearing in Mira Valley, Cape Breton.

IN THE MARITIME PROVINCES OF CANADA.

1. Dark gray slates or shales with calcareous lenses. Gray sandstones. Interraned conglomerates at and near the base.	True or Eo-Cambrian.		1. Acadian.	*b.*	*Paradoxides*, Beyrichia, Lingulepis. Obolus, Lingulella.	Menevian.
				d e.	*Paradoxides*, Solenopleura, Ptychoparia, Microdiscus.	
				c.	*Paradoxides*, Conocoryphe, Liostracus, Agnostus.	Solva.
				a-b.	*Protolenus*, Ellipsocephalus, Beyrichona, Trematobolus, in S. New Brunswick.	
3. Fine greenish gray argillites, some reddish gray. Horizon of roofing slates in C. Breton and Newfoundland.	Sparagmite Formation, Norway.	Basal Cambrian. (Mihi.)	Etcheminian.	3. Upper.	Ptychoparia? Ostracoda, 4 genera. *Acrotreta*, Lingulella, Obolus. Acrothyra, Hyolithes.	Caerfai.
2. Red sandstone and red and gray argillite. Lower iron-bearing horizon of Cape Breton Cambrian.				2 and 1, Lower.	*Holasaphus*, Paradoxidoid trilobite, Ostracoda, Billingsella, Lingulella, Acrothyra, Obolus, Hyolithes.	
1. Gray shale or slate, with some quartzite and conglomerate, the latter especially at the base.					Lingulella, Leptobolus, Obolus. Acrothyra, Acrotreta, Hyolithes.	
Co. Dolerites, breccias and amygdaloidal ash rocks. Some gray shales about thé middle.			Cold-brookian.		Lingulella, 2 Ostracoda. Acrothyra, Acrotreta.	Pebidian ?

Having but a short time at my disposal in Cape Breton this year, I devoted it to extending the examination in the district already explored, and to study some doubtful points which I had not been able to settle satisfactorily when previously in the island.

In the valley of the Mira river, by the discovery of the Paradoxides fauna at several points, I was better assured of the distribution of the middle members of the Cambrian system, and by exploration on St. Andrews channel, I was able to satisfy myself that strata, formerly thought to be more recent than the Cambrian, were of that age. Details in reference to these matters will appear in my fullest report.

General result of the exploration.

I may now add some statements in regard to the general result of the exploration—first, in its bearing on a scientific knowledge of the Cambrian of the Atlantic provinces, and—second, in regard to a few facts bearing on economic points. The writer may premise that previous to his first visit to the island, two Cambrian faunas had been discovered there; the first, before the work of the Geological Survey of Canada was extended to the island. This was made known by the late Dr. D. Honeyman, and was the fauna of Peltura and Sphœrophthalmus fossils which were found on McNeil brook, of the Mira river, and sent to the great exhibition in London, where they were determined by the late J. W. Salter. The second discovery was made by Mr. Hugh Fletcher, during exploration for the Canadian Geological Survey, in the valley of McLeod brook, near Barasois. These fossils were examples of Dictyonema, and were determined as being of the species *D. socialis*, Salter (= *D. flabelliforme*, Eichwald), by Prof. Chas. Lapworth.

Recognized European faunas.

Other fossils were collected in various parts of the Cambrian field by Mr. Fletcher, but they did not result in determining any known Cambrian horizon. Thus, of the five European faunas of the Cambrian-Paradoxides, Olenus, Peltura, Dictyonema, and Asaphellus, only the third and fourth had been recognized. And of the faunas older than Paradoxides, the varied fauna of the Protolemus bed of New Brunswick was unrecognized, as were also the several sporadic faunas containing trilobites of the Olenellus family that had been found at a distance north, north-east and south-west of Cape Breton.

Cambrian system in Cape-Breton.

It remained then a question whether a large part of the Cambrian system was wanting in Cape Breton; or whether the older part was represented by barren measures. It is true that Mr. Fletcher, during his survey of the Cambrian district of the island, had collected small Brachiopods at several points, which had been determined by the late Mr. Billings as Obolella. But at the time of Mr. Fletcher's survey, a

number of small species of different horizons that are now placed in other genera were then included in Obolella. Hence these fossils gave no certain indication (under this name) of the part of the Cambrian system to which they belonged. The task before the present writer, was to discover if these missing faunas were present in the island, and by their means and through a knowledge of the physical aspect of such rocks as might enclose them, to work out the succession of members in the Cambrian rocks and trace their distribution in the areas where such rocks were found.

Important fossils found.

Of the faunas named above, we have not been able to recognize the Protolenus fauna, but that next above it was discovered on the Mira river, in Bengal settlement, and on Trout brook. The fossils appear to belong to *Paradoxides rugulosus*, or a closely allied species. A more important discovery was made by Mr. S. W. Loper, when collecting in this part of Cape Breton for the United States National Museum. He found a Paradoxides, which the writer ascertained to be a variety of *P. Forchhammeri*, thus indicating the presence of the upper Paradoxides fauna, not heretofore certainly recognized in America. It occurs in a part of the Cambrian, which, hitherto, neither in New Brunswick nor Cape Breton, has yielded trilobite remains.

Cambrian faunas continuous.

In explorations in the valley of McLean brook, where Mr. Fletcher had found Dictyonema, the overlying fauna of Asaphellus (Tremadoc fauna) was found. This extended the faunas in Cape Breton to the summit of the Cambrian system. There still remains a blank where the fauna with Olenus and Parabolina come in, but this is simply due to the barrenness of the measures, as the strata are continuous without any break from the Paradoxides to the Peltura fauna. Thus, so far as the typical Cambrian faunas and rocks are concerned, there is a continuous and unbroken succession in Cape Breton.

Difficulty of studying basal Cambrian rocks.

In studying the basal Cambrian rocks of this island, we are confronted with a difficulty which has been an obstacle to the investigation of this series in other fields, viz., the barrenness of large masses of these rocks and the irregularity in the distribution and the localization of the limited faunas which they contain—limited not only as regards the number of fossils usually met with, but also of the few groups of the animal kingdom represented in the various occurrences. When to this is added the imperfect preservation of the fossils, it will be seen that there are many obstacles to a full and satisfactory knowledge of these ancient faunas of the basal Cambrian.

Brachiopoda and Ostracoda on Indian brook.

After searching a number of sections of these rocks with indifferent success, we were so fortunate as to discover on some branches of Indian

brook, on East bay, sections that gave excellent results so far as the Brachiopoda and Ostracoda are concerned. Here the fossils were sufficiently numerous and well preserved to enable one to speak with some confidence as to the succession of forms in the Etcheminian, the conditions of their habitat, the currents prevailing during the entombment of the faunas, and the appearance and disappearance of certain types of animals during this long period.

Further, it was ascertained that there were two successive faunas in these rocks, marked by Brachiopoda and Ostracoda. If we had the trilobites we should probably have subordinate divisions of these two faunas. There is probably a third fauna in the mud-beds of the volcanic rocks beneath, which contain four or five forms different from those of the Etcheminian.

Division between Etcheminian faunas.

The line of division between the two Etcheminian faunas is at the top of the red sandstone and shales of the middle group of the Etchiminian beds. At this stage, quite a number of new species appear and displace the earlier ones. Here the genus *Acrothele* comes in. Besides being common in the Upper Etcheminian, this genus continues so in the Protolenus beds and those holding Paradoxides, and is sparingly represented in the higher Cambrian.

Value of minute fossils in determining horizons.

Among special zoological features belonging to the animals of this early time that are worthy of notice the value of minute fossils stands out with some prominence. Their importance is well shown by Tullberg's Monograph on the Agnosti. But in this case it is the minute Entomostracans and Brachiopods which yield valuable characters for determining horizons. Many of the Ostracoda of the Etcheminian beds, like those of the Protolenus fauna, had visual organs, having a prominent ocular tubercle in each valve situated close to the anterior end of the hinge line; the main adductor muscle was placed close behind it. In this they differ from the common forms of the Ordovician and Silurian rocks, in which the supposed muscle mark is toward the middle of the valve. In form, as well as in structure, their nearest relatives are those of the Protolenus beds, which follow them in natural succession. Of two new types in these faunas, one (Bradorona) is abundant in the Lower Etcheminian, and is peculiar in its shovel-shaped valves; the other with smaller but proportionately longer valves is common in the Upper Etcheminian. On the whole, the Etcheminian forms of Ostracoda are large.

A character emphasized by writers who have made the Ostracoda a subject of investigation is their social habits; they occur in swarms wherever found. Anyone would be impressed with this who has seen

a cluster of Cyprids floating shell to shell in the quiet waters of a sheltered pond, and on surfaces of the shale of the Ordovician and Silurian rocks this peculiarity of habit is strikingly shown by the closely packed layers of the shells of the Ostracoda which they sometimes contain.

Habits of Ostracods.

But it is a singular fact that the writer has seen no indication of such a habit in the Protolenian and Etcheminian Ostracods. On the contrary they are always solitary, and scattered sparingly among the shells of Brachiopoda, where these last often cover whole surfaces of layers. It is also pretty certain that they had habits of burrowing and hiding. In a bed of dead shells of Brachiopods (Protosiphon) of the Protelenian time, that had been drifted on a Cambrian shore in the Kennebecasis valley, and packed together with spaces between the valves, once-living Ostracods (Beyrichona) are found, where they had sheltered themselves with their valves tightly closed, as in life. And it is common to find them thus, or with the valves partly agape in beds where the valves of the Brachiopods are scattered. These peculiarities appear to indicate a difference of habit from the later types of Ostracoda

Brachiopods.

The Brachiopods, which are so abundant on some layers of the Etcheminian sediments of Indian Brook, have also yielded some facts new to science. Such small fossils as those of the genus Acrotreta are not much of a prize to the ordinary collector of fossils, for they are too small to be attractive objects in a cabinet. A few have been found and described from the Cambrian rocks. In Europe they have been referred mostly to von Seebach's species *A. socialis*; while those found in America have usually been thought to be of Billings' species *A. gemma*. (This, however, is not Cambrian but Ordovician).

Acrotretas.

Externally the Acrotretas are much alike, and the almost uniform ornamentation of a fine striation concentric to the umbo, leaves little room for the discrimination of species by outward characters. In form they do not vary greatly, and in size there is little change from the earliest Cambrian to the middle of the Ordovician system.

The Cape Breton beds of the Basal Cambrian, however, not only show great variation of form, but they contain a group of species so far removed from the typical Acrotretas, that it seemed necessary to institute a separate genus (Acrothyra) for them. These peculiar forms far outnumber the typical Acrotretas in the basal beds of the Cambrian, and have two well-marked species, one of which is found in the lower, and the other characterizes the upper Etcheminian fauna.

New species.

It is by their internal characters, revealed by the mould of the shell, that these minute species are most readily discriminated; so that including the two genera Acrothyra and Acrotreta, there are about

eight species of Acrotretoid Brachiopoda in place of the two or three that have been hitherto recognized.

Minute Brachiopods.

While speaking of the minute Brachiopods, one may refer to those of the genus Leptobolus—small thin shells with the lateral and central muscles far advanced toward the front, and with the vascular trunks near the margins. They thus had large visceral cavities and narrow mantle margins, both early larval characters, as may be seen by the development of *Obolus (Botsfordia) pulcher*. In both points above named they differ from typical Lingulella, which had a comparatively small visceral cavity and wide mantle borders. These little Leptoboli are found sparingly in the Lower Etcheminian, but they are quite abundant in the Upper Etcheminian beds. From this they extend up to the thin flags and shales that come beneath the Peltura fauna, being found sparingly and at intervals in the intervening measures; and they probably continue on to the typical forms in the Ordovician, described by the late James Hall. No doubt several species have been described under Lingulella.

Lingulella.

Of Lingulella proper, and of Obolus, there are two species which deserve attention, because of their considerable size among the diminutive species, which in general, characterize the Etcheminian beds; and because each is found in the mud-beds of the group, the one in the Upper and the other in the Lower Etcheminian. They have been found to appear when sandstones and grits cease to be deposited, and disappear on the recurrence of coarse sediments. In the Middle Cambrian we find species which resemble these in form and size, but they are most abundant in the sandstones and flags. The Etcheminian species referred to are *Lingulella Gregwa* and *Obolus Bretonensis*, the former of the Lower and the latter of the Upper Etcheminian fauna.

Fourteen zones.

The collections on which the above observations are based, have been made from fourteen zones or beds of the Etcheminian sediment, of which eight are in the Lower and six in the Upper Etcheminian. They therefore represent a fairly continuous succession of the Inarticulate Brachiopods, and the Ostracods, of that distant period.

Continuous history.

That the zoological history of the time was so continuous in the East bay district is to be attributed to the deposition of these Cambrian sediments in a narrow sheltered sound, and to the comparatively thin mass of sediments which the group exhibits here. Their mass did not sink sufficiently deep into the earth's crust to be changed by the internal heat of the globe, nor was it covered by heavy masses of sediment of subsequent ages. They were well protected from lateral thrust and so are not much distorted. In the thicker deposits of the

Mira valley of this age, fossils, judging by our experience, are of rare occurrence.

Trilobites. Of trilobites, good examples were found at only one locality, and these of a kind not found elsewhere in the Etcheminian. The many-jointed spined pygidea of one species are most like those of Megalaspis at the base of the Ordovician, but the head-shields do not agree with that genus. These belong to the Lower Etcheminian. A few trilobite remains, like shields of Agraulos and Ptychoparia, are found at the top of the Upper Etcheminian.

The Articulate Brachiopods are represented by a Billingsella in the Lower Etcheminian, and the Hyolithida, by the two genera, Hyolithes and Orthotheca, in poorly preserved examples, occurring at intervals in these Etcheminian beds.

Other groups. Other groups found elsewhere in the Basal Cambrian, such as Gasteropods and Lamellibranchs, remain unrecognized in the Cape Breton beds of this age. This is also the case with the Archæocyathinæ. Probably the water was too heavily charged with sediment and too much agitated to allow these to flourish.

Useful minerals. As the writer's work in Cape Breton was chiefly palæontological, its value in relation to the useful minerals was chiefly in fixing horizons where these occur and so affording the means of tracing them from one district to another. Some exploration and digging for iron ore have been made on the small streams that feed Indian brook from the north. The ore is a red hematite, and is in fahlbands, irregularly distributed in a ferriferous red sandstone. The openings exhibited much lean ore with some of better quality. This ore is in the middle division of the Etcheminian, and therefore much older than the hematite beds at Grand Mira.

Iron ore.

It was noticed that the Upper Etcheminian on the Mira river, in a number of places, consists of fine-grained, compact gray clay-slate. When Mr. Fletcher, in his reports, speaks of gray 'argillites,' he usually means the fine rocks of this group, though sometimes the term is applied to argillites occurring higher in the Cambrian. The term is specially appropriate to the Upper Etcheminian, not only because the nature of the rock fully meets the meaning of the term used, but because to this horizon or to that of Protolenus just above, belong the slate quarries of Trinity bay in Newfoundland. Some of the slates of this age in the Mira valley may be of economic value.

Mineral deposits. In the Bretonian or upper part of the Cambrian of Cape Breton, no mineral deposits of economic value are known to me. The soft con-

dition and ready disintegration of the rocks of this division have resulted in the production of fine soils, which add to the fertility of the Mira valley. Without this soil the farms in this valley would be stony and unproductive. The pale buff soils which they produce are in striking contrast with the red soils resulting from the degradation of the Lower Etcheminian rocks, or the stone-laden areas covered with fragments of the Coldbrook volcanic rocks, or the still older Pre-Cambrian syenites.

Chemistry and Mineralogy.

By Dr. G. C. Hoffmann.

Chemical work.

In reporting on the work done in these branches of the Survey's operations, Dr. Hoffmann says:—'The work carried out in the chemical laboratory during the past year has been conducted upon the same lines as those heretofore followed—that is to say, it has been almost exclusively confined to the examination and analysis of such minerals, etc., as were deemed likely to prove of more or less economic value and importance. Briefly summarized it embraced:—

Various analyses.

'1. Analyses of fuels, including, among others, peat from the province of Quebec; coal from Black brook, Cochrane lake, province of Nova Scotia, from Dunsinane, King's county, province of New Brunswick, and from section 24, township 6, range 23 west of the fourth principal meridian, District of Alberta, North-west Territory; and of lignite from Little Bow river, also in the district of Alberta.

'2. Analyses of iron ores from, among other places, the west side of Middle river, Victoria county, and Cleveland, Annapolis county, in the province of Nova Scotia; the township of Sarawak, in Grey county; a short distance north of the north-east arm of Lake Temagami; Iron lake, north of the north-east arm of Lake Temagami; Turtle lake, north of the north-eastern extremity of the north-east arm of Lake Temagami, and Michipicoten, in the district of Algoma; also the township of Strange; and a point near White Fish lake, district of Thunder Bay, in the province of Ontario.

'3. Analyses in regard to nickel contents of pyrrhotite from the townships of Graham and Dowling, in the district of Algoma, province of Ontario; and from Shuswap lake, Yale district, in the province of British Columbia.

Assays for gold.

'4. Assays for gold and silver, of numerous samples of material from quartz veins in the Yukon district, North-west Territory, most o

which proved to be more or less auriferous, two in particular, namely, one from a vein on the McQuesten, at a point about 120 miles above its entry into the Stewart, and another from a claim at the head of Victoria gulch, both of which contained at the rate of over two ounces of gold to the ton of 2,000 lbs. Also of samples of ore taken at different depths from a vein situate between the forks of Five-mile creek, a stream flowing into the west arm of Kootenay lake, and from other localities in the West Kootenay district of the province of British Columbia. As likewise of specimens from a quartz vein at Kiwagama lake, south-east of Abitibi post, Lake Abitibi, in the province of Quebec.

'5. Analyses of limestones and dolomites, including that of a limestone from the twenty-sixth lot of the seventh range of the township of Weedon, Wolfe county, in the province of Quebec; and of a dolomite from near Brookville station, St. John county, in the province of New Brunswick. A continuation of the series of analyses of such stones which have from time to time appeared in my annual reports, in connection with an inquiry into their individual merits for structural purposes, suitability for the manufacture of lime or for hydraulic cement, or employment for metallurgical and other uses. Limestones and dolomites.

'6. Analyses of natural waters, with a view of ascertaining their suitability for domestic or manufacturing purposes, or possible value as remedial agents, from a well in the town of Lunenburg, Lunenburg county, and from a spring on the farm of Angus Cameron, about a mile and a-half below Scotsville, on the west side of Margaree river, Inverness county, in the province of Nova Scotia; from a spring four miles from Andover, on what is called the Indian Reserve, Victoria county, in the province of New Brunswick; from a boring at Ramsay's Corners, on the eighteenth lot of the seventh concession of the township of Gloucester, Carleton county, in the province of Ontario; from a spring above West Pinchbeck, Riske creek, district of Cariboo, and from a spring at the north end of Atlin town, on the east side of Atlin lake, in the extreme north of Cassiar district, in the province of British Columbia. Natural waters.

'7. Analyses of some minerals not previously recognized as occurring in Canada, and the examination of many others, in most instances of economic importance, from localities where they were not previously known to occur, all of which will be referred to in detail in my next annual report. New minerals.

'8. Miscellaneous examinations, such as the examination, and, in many instances, partial analysis, of samples of bituminous shale, bog- Various examinations.

manganese, clays, copper-ore, graphite, iron-ochres, marls, river sands for gold and platinum; silts, and other material not included under the preceding headings.

Information as to specimens.

'In addition to the work already outlined, a very large number of mineral specimens, seven hundred and five, have been received, during the period in question, for identification or analysis, or the obtaining of information in regard to their economic value. Of these, very many were brought by visitors; the greater number, however, were received from residents in more or less distant parts of the Dominion. The information required in regard to those specimens which were brought by visitors, was not infrequently communicated to them at the time of their calling, or failing that, owing to a more than mere cursory examination being necessary, or when a partial or even complete analysis was considered desirable, it was subsequently conveyed to them by letter; whilst that sought for in regard to those sent from a distance, was also, necessarily communicated by mail.

Letters and reports.

'The number of letters personally written, in connection with the work just referred to, and which were mostly of the nature of reports embodying the results of the examination, analysis or assay, as the case might be, amounted to three hundred and twenty-four, whilst the number of those received amounted to one hundred and twenty-eight

'My annual report, giving a detailed account of the chemical and mineralogical work, briefly referred to in my summary report for last year, has been written, passed through the press and is now in the hands of the binder.

'Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have, as a result of the interest taken by them in their work, and their great assiduity, accomplished a large amount of work, and proved most efficient aids. Of these,—

Mr. Johnston's work.

'Mr. Johnston has carried out a series of gold and silver assays, made many important mineral analyses, and also conducted a great variety of miscellaneous examinations. Of the mineral analyses made by him, one, in particular, calls for special mention, namely that of a mineral containing a large percentage of chromium which has recently been found in considerable quantity in the district of Lillooet, province of British Columbia. He has also recognized among some mineral specimens received for identification, a compact massive form of datolite, a mineral which had hitherto been met with in but one locality in Canada; and he has likewise identified, in some small crystals, occurring in specimens of a vein-stone collected by Mr. Broadbent, and to which

my attention was drawn by the latter, the mineral faujasite, a species which had not previously been found in the Dominion.

Mr. Wait's work.

'Mr. Wait has made a number of water analyses, analyses of iron ores, manganese ores, limestones and dolomites, &c., and also conducted many miscellaneous examinations. Among the waters examined by him was one of particular interest, in whatever light regarded, namely, that from a spring at the north end of Atlin town, on the east side of Atlin lake, Cassiar district, in the province of British Columbia. This water which was very carefully and most obligingly collected and furnished by Mr. W. J. B. Pinder, of Atlin, has been shown by the exhaustive analysis of Mr. Wait to contain—disregarding for present purposes the constituents occurring in minor quantity—as much as 433·48 grains of bicarbonate of magnesia in an imperial gallon. There can be little doubt but that it is to this and similar springs that the extensive deposits of hydromagnesite occurring at the back of Atlin town site, owe their origin. The material of these deposits, as likewise the water itself, will, most probably, in the near future, receive the attention they deserve.

Mr. Broadbent's work.

'In the work connected with the mineralogical section of the museum, I have, as heretofore, been ably assisted by Mr. R. L. Broadbent, who has, apart from the general museum work—which includes the labelling and cataloguing of all newly received specimens, and the maintenance of the collection generally, in an orderly condition,—arranged and catalogued the collection of foreign minerals, which now comprises some five hundred specimens. He also spent some time in the field for the purpose of collecting cabinet specimens for the museum, and others for Mr. Willimott's use in making up collections for distribution to Canadian educational institutions. With this object in view, he visited several localities in the townships of Portland East, and Derry, in Ottawa county, province of Quebec; those of Madoc, Marmora lake, and Dungannon, in Hastings county, and that of Bagot, in Renfrew county, in the province of Ontario. He made it a special point to visit the locality of occurrence of the datolite—the mineral previously referred to, and succeeded in collecting a fine series of specimens of the same and its mineral associations. On handing these to me, he drew my attention to some small crystals which he had observed on some them. These crystals were subsequently examined and, as already stated, identified by Mr. Johnston as the somewhat rare mineral faujasite—a species new to Canada. Among other specimens collected by Mr. Broadbent, may, in addition to the foregoing, be more particularly mentioned, some interesting specimens of native antimony—a mineral not previously met with in Ontario, from the

Faujasite.

Minerals collected.

township of Madoc, and some good specimens of crystallized malachite, from the township of Dungannon. The minerals collected by him comprised :

	Specimens.	Weight.
Almandite	27	
Andradite	....	470 pounds.
Arsenopyrite	....	200 "
Celestite	....	175 "
Datolite	120	
Faujasite	6	
Fluorite	100	
Galena	135	
Graphite	12	
Hematite	....	200 "
Limestone	....	100 "
Lithographic stone	....	175 "
Malachite	6	
Native antimony	30	
Perthite	225	
Phlogopite	306	
Sandstone	....	100 "
Stilpnomelane	7	
Talc	....	100 "
Tourmaline	35	
Miscellaneous	12	

Additions to the museum.

'The additions to the mineralogical and lithological section of the museum, during the past year, embraced :—

(A.) Collected by members of the staff or others engaged in field-work in connection with the Survey :—

Bailey, Professr L. W. :—

a. Eighteen fragments of material referred to as copper ore, from a pit at Chester, Albert county, N.B.

b. Fourteen fragments of material from the Colonial copper mine, near Dorchester, Westmoreland county, N.B.

c. Two fragments of cordaite shale from two miles above Dalhousie, Restigouche county, N.B.

Barlow, Dr. A. E. :—

a. Danaite from the township of Graham, district of Algoma, O.

b. Corundum from the township of Raglan, Renfrew county, O.

Johnston, J. F. E. :—

Molybdenite and bismuthinite from Lake Kewagama, Q.

Additions to the museum.

McConnell, R. G. :—

a. A specimen of asbestiform actinolite from the Klondike river, Yukon district, N.W.T.

b. A specimen of rutile from Thistle creek, Yukon district, N W.T.

(B.) Received as presentations.

Barlow, Dr. A. E., Geological Survey :—

Corundum from Montana, U.S.

Bulpit, C. H., Malone, Hastings county, O. :—

Magnetite from lot 17, con. XI., Marmora, Hastings county, O.

Burke, D. F., Port Arthur, O.

Coal from near Blairmore, Crow's Nest Pass Railway, Alberta, N.W.T.

Canada Paint Company, Montreal, Q. :—

Iron ochre from Cap de la Madelaine, Champlain county, Q.

Chambers, R. E., Bridgeville, N.S. :—

a. Barite crystals from Bridgeville, Pictou county, N.S.

b. Limonite from Bridgeville, Pictou county, N.S.

Craig, B. A. C., Canada Corundum Company, Toronto, O. :—

Twenty samples of dressed corundum from the Craig mine, Raglan, Renfrew county, O.

Harrison, J. E., Madoc, O. :—

Talc from Huntingdon township, Hastings county,

Holmes, N. D., Ottawa :—

Mica from Dakota, U.S.

Hopkins, W. H., Hamilton, O. :—

Auriferous quartz from the Mikado mine, Lake of the Woods, district of Rainy River, O.

Kirkgaard, P., Canadian Gold Fields Company, Delora, O. :—

Auriferous quartz from the Florida mine, and auriferous quartz (Ribbon quartz) from the Last Chance mine, Mogollon Mountains, New Mexico, U.S.

Additions to the museum.

Low, A. P., Geological Survey, Ottawa, O. :—

a. Scheelite, rose quartz, and quartz crystals from Japan.

b. Petzite from Calgoorlie, West Australia.

c. Noumeaite and Garnicrite from New Caledonia.

Moberly, G., and C. Cameron, Collingwood, O. :—

Marl from lots 25 and 26, con. VII and VIII, Flos township. Simcoe county, O.

Moon, Albert, Madoc, O. :—

Specimen of native antimony from the Dufferin mine, Madoc, Hastings county, O.

Morrison, Murdoch, Renfrew, O. :—

Zircon, from the township of Westmeath, Renfrew county, O.

McEvoy, James, Fernie, B.C. :—

Erythrite from the Crow's Nest branch of the Canadian Pacific Railway, between Creston and Kootenay Landing, West Kootenay district, B.C.

McNaughton, G. W., General Electric Mining Company, Sydenham, O., per Dr. R. W. Ells :—

Mica (phlogopite) 33 by 24 inches, from lot 11, con. VII, Loughborough, Frontenac county, O.

Rust, Randolph, Port of Spain, Trinidad, West Indies :—

Asphalt and petroleum from Aripero, Trinidad, W. I.

Scott, W. D., Winnipeg, Man. :—

Petzite from the Boulder Perseverance claim, Calgoorlie, West Australia.

Shirley, F. S. Glenalmond, Q. —

Mica (phlogopite) from Portland East, Labelle county, Q.

Stewart, James, Grande Prairie, B.C. :—

Calcareous tufa, actinolite, andradite and tremolite

Wallbridge, C. M., Madoc, O. :—

Group of calcite crystals from the Wallbridge mine, Madoc, Hastings county, O.

Winning, Bush, Glenalmond, Labelle county, Q. :— Additions to the museum.

Mica (phlogopite) from the township of Derry, Labelle county, Q.

In addition to the foiegoing, there has also been added to this section of the museum :—

109 specimens of rocks, with microscopic sections, from the Yukon district, N.W.T., collected by R. G. McConnell.

56 specimens of rocks, with microscopic sections, from the Atlin district, B.C., collected by J. C. Gwillim.

226 specimens of rocks, with microscopic sections, from the East coast of Hudson Bay, Ungava district, collected by A. P. Low.

58 specimens of rocks, with microscopic sections, from Great Slave lake, Mackenzie district, collected by Dr. R. Bell and J. M. Bell.

15 specimens of rocks from Great Slave lake, collected by J. W. Tyrrell.

8 specimens of rocks from the West coast of Hudson Bay, Keewatin district, collected by D. T. Hanbury.

'Mr. C. W. Willimott was engaged during the early part of the year in going over, arranging, and taking stock of the collection of minerals under his charge and employed by him in the making up of collections for distribution, in order to ascertain what further material it would be necessary to procure in the course of the summer, to make good deficiencies. This accomplished, he visited, for the purpose specified, numerous localities in the townships of Hull, Templeton, Wakefield, Wright, and Egan, in Ottawa county, province of Quebec; subsequently, certain localities in the township of Grenville in Argenteuil county, Bolton in Brome county, Ascot in Sherbrooke county, Coleraine and Thetford in Megantic county, and Broughton in Beauce county, in the province of Quebec; and finally, localities on the East River of Pictou, in Pictou county, Parrsborough, Partridge Island and Two Islands, in Cumberland county, Kingsport in King's county, and Hantsport and Windsor in Hants county, in the province of Nova Scotia. Mr. Willimott's work. Educational collections supplied.

'In the prosecution of this work he succeeded in collecting a large and varied assortment of minerals. The same comprised :— Minerals collected.

	Specimens.	Weight.
Agate	....	250 pounds.
Analcite	80	
Amygdaloid	....	200 "
Apatite, crystals in matrix	140	
Chabazite	200	

	Specimens.	Weight.
Chromic iron		450 pounds.
Chrysotile (asbestus)		75 "
Chrysotile, in serpentine		300 "
Gypsum, fibrous		200 "
Heulandite	120	
Hornblende schist		300 "
Lepidolite		50 "
Limestone		200 "
Limonite		650 "
Phlogopite	60	
Picrolite		150 "
Quartz crystals	900	
Scapolite		175 "
Steatite		200 "
Stilbite	150	
Strontianite		350 "
Tourmaline	123	
Miscellaneous	30	

'In addition to the above minerals, Mr. Willimott has received, for making up collections:—

Presents

Coal, of the Carboniferous, presented by E. Hargreaves, Esq., Manager of the Springhill Coal Mines, Nova Scotia, 200 pounds.

Corundum crystals, in the matrix, presented by B. A. C. Craig, Esq., Canada Corundum Co., Toronto, Ontario, 2000 pounds.

Gypsum, presented by C. J. Osman, Esq., Manager of the Albert Manufacturing Co., Hillsborough, Albert county, New Brunswick, 300 pounds.

Educational collections.

'Prior to Mr. Willimott's leaving for the field, and since his return, he has, for the most part, been engaged in making up collections for distribution to various Canadian educational institutions. The following is a list of those to which such collections have been sent:—

High School, Paradise, N.S.	consisting of	100	specimens.
Public School, Rainham Centre, O	"	100	"
Waller Street School, Ottawa, O	"	100	"
Public School, Nelson, B.C.	"	38	"
High School, Gananoque, O	"	125	"
Broadway School, Woodstock, N.B.	"	125	"
High School, Carleton Place, O	"	125	"
Normal School, London, O	"	125	"
High School, Wood's Harbour, N.S.	"	125	"
Collegiate Institute, Whitby, O	"	125	"
High School, Newmarket, O	"	125	"
High School, Westville, N.S.	"	125	"
Grand Falls Superior School, Grand Falls, N.S.	"	125	"
High School, Pembroke, O	"	125	"
High School, Rodney, O	"	125	"

'In addition to which the undermentioned have been supplied with :—

McGibbon, R. D., Montreal, Q.	1	specimen.
Collegiate Institute, Napanee, O.	1	"
Guerra, René, Paris, France	30	"
Wright, W. G. Hawkesbury, O.	1	"
Fisher, Hon. S., Ottawa, O.	1	"

The Progress of Mining in Canada in 1901.

Mr. E. D. Ingall, Mining Engineer to the Department.

In reviewing the progress of mining in Canada, only the general features can be pointed out, as no detailed and reliable data are available until after the close of the year. Review of mining industry.

The gold-mining industry naturally calls for attention first, accounting as it does for nearly half the value of the mineral product of the country. No very startling developments were presented during the year as far as the eastern part of Canada is concerned. In Nova Scotia the mines operated upon the quartz leads are practically all long-established enterprises, and the industry with slight fluctuations, pursues year by year the even tenor of its way. The mining of the alluvial gold in Quebec province, remains still in abeyance. In Ontario there is not much to note. In this province are many belts of the rocks shown as Huronian on the maps of the Survey, which in the aggregate constitute a large area of this metalliferous series. As railway construction makes the outlying portions of the province easier of access, more vigorous and thorough search over these areas by the prospector will doubtless reveal many other gold-bearing veins, so that future years promise to show a steady extension of operations in this province. Whilst the output of gold from the Yukon placers hardly comes up to that of 1900, doubtless other rich districts will be found in future years in other parts of this extensive country. The reports of finds of rich gravel in some of the older districts of British Columbia, where the richer placers had been supposed to have been worked out years ago, show that unexpected discoveries of great importance may be made at any time in a young and undeveloped country such as this. Apart from the production of gold from the shallower placer deposits, the progress in hydraulicing, etc., as well as in vein-mining, is steady, with every chance of continued advance in future years. Gold.

The grand total of the production of gold in Canada owes much also to the operations in the mining and smelting of the pyritous ores

of Southern British Columbia, the rapid growth of which in late years will have an important effect.

Copper.

The larger proportion of the copper production of Canada results also from the operations on these deposits of mixed sulphide ores, not only in the districts of East and West Kootenay and Yale, but also in the coast sections of British Columbia, and the largely increased activity in this respect will result in a considerable augmentation of the copper output of the country, which result will be still further enhanced by the growth of the mining industry located in the Sudbury district. The interest which has of late been taken in the copper ore deposits of the Huronian district between Bruce Mines and Sault Ste. Marie, resulting in the reopening of the old mines at the former place and the exploitation of similar deposits in the surrounding district, is an interesting feature of the present copper situation. The long-established mines in the Eastern Townships of Quebec province can be reckoned on as constant contributors, and word comes to hand as to increased interest and activity in exploration in the Maritime provinces. Taken as a whole, the copper industry of the Dominion has exhibited many satisfactory features which should show when the figures of production become available later.

Nickel.

The nickel industry of Sudbury district has also many encouraging features to record. The inauguration of the works of the Mond Co., of the Nickel-Copper Co. of Hamilton, and of the Orford Copper Co. give evidence of the general prosperity, resulting in greater activity in smelting as well as in mining and prospecting.

Lead.

Unfortunately the lead industry, which, with the exception of small amounts produced in the east, is practically confined to British Columbia, has suffered a considerable set-back. The operators of the Slocan and other galena mines in the south-western part of the province have found themselves largely debarred from their chief market in the United States, owing, it is said, to difficulties regarding freight and smelter rates, so that production of this metal will have suffered a very considerable falling off. The authorization of the payment of a bounty by the Dominion Government for the next five years on all lead refined in Canada from materials produced in Canadian smelters from Canadian lead ores, may perhaps lead to the installation in the country of works for this purpose and so relieve the situation by rendering the home mines independent in this respect. The price of lead also has been somewhat lower than the average for 1900, tending to further depress the situation.

As such a large proportion of the silver production of the country is represented by that contained in the argentiferous galena mined in British Columbia, the depression in the lead industry will also affect the output of silver. Silver.

One of the most hopeful features of the progress of the mineral industry during 1901 is to be found in the advance which has been made in the important branches of coal and of iron mining and smelting. The new departure made at Sydney, Nova Scotia, in the inauguration of the two large iron and steel plants of the Dominion Iron and Steel Company and the Nova Scotia Steel and Coal Company respectively, will doubtless lead to most important results, not only in enlarged mining of coal and the making of coke for consumption in the iron works, but also doubtless in the establishment of other important accessory industries, such as ship-yards, bridge works, &c. All over the country, increased interest has been shown in the question of our resources in iron ores, and even in British Columbia, where iron has been quite an unimportant factor in the past, much greater attention is being paid to exploration for these ores. The opening up of the Crows Nest Pass coal fields and the considerable enlargements made and contemplated in the coking plants of the companies operating them, is a fact of the greatest importance, especially to the smelter interests already established or about to be inaugurated in the west, and we may look forward to the opening up of yet other areas of Cretaceous coal in this region as extensions of the railways bring them within the sphere of working conditions. Coal and iron. Development at Sydney N.S

An epoch-marking episode is to be noted in the shipments of Canadian pig iron from Cape Breton to Glasgow, Scotland, at prices, it is said, admitting of successful competition there, even with Scotch pig. The importance and promise of the iron and coal industries of our eastern seaboard, have begun to attract notice, and in a contribution to the *Colliery Guardian*, Sir Christopher Furness, the well-known English authority, draws the attention of his countrymen to many important features. He points out the unexcelled shipping and loading and unloading facilities both with regard to the ore supply at the Newfoundland mines and at the works and mines in Cape Breton. Also, that the excellent arrangements and the extensive use of machinery result in a much larger output per man and a much smaller cost of production than is possible under the present conditions of the British collieries, so that with the advantages possessed, 'with two splendid harbours and no high railway rates for carriage to the water, also with an unlimited supply of coal, they are in a position to produce and deliver f. o. b. at a figure quite out of the question for any of our Canadian pig iron for Scotland.

collieries to compete with.' He further expresses the opinion that the coal from this point will be bound to enter into competition 'with our north and south country coal in the Mediterranean markets,' also that 'This company can deliver coal f. o. b. at less than $1 per ton. The steel company will be able to make pigs at less than $6 per ton; steel blooms at less than $10 per ton, and steel rails at about $12.'

Iron smelting.

The possibilities of iron smelting in the central parts of Canada are being demonstrated in the continued operation of smelters at Deseronto, Hamilton and Midland, in Ontario, whilst the inauguration of the contemplated iron and steel plant at Sault Ste. Marie will be a most important feature in the industry. The works in this province still use a very large proportion of foreign ore, but the increased output from the Michipicoten district would seem likely to inaugurate a brighter era.

To the metal and coal-mining industries, already alluded to, must be credited about 85 per cent of the value of the total mineral production of the country. Regarding the non-metallic mineral output contributing the other 15 per cent, there is nothing very unusual to report, although there are some interesting points worthy of note.

Graphite.

After some years of depression, the graphite industry carried on in western Quebec, seems to be in a fair way to be placed on a permanent basis. Work was prosecuted at the deposit at Calumet and some selected mineral was shipped. The North American Graphite Company worked during most part of the year and shipped a number of car loads of the finished product of its mill. It is hoped that the investigations and experiments during past years, made by this company, have resulted in such improvements in the methods and machinery for the treatment of the rock that the difficulties encountered in the past will no longer debar the development of the extensive deposits of graphite-bearing rock of the vicinity. In Ontario, the Ontario Graphite Company has been taking steps to extend its operations by erecting a mill for the treatment of the ore.

Asbestus and mica.

Natural gas.

In asbestus, the mines have been operated as usual. The mica mines had to contend with dullness of the trade and accompanying low prices. In the inter-lake peninsula of Ontario, as in past years, a number of bore-holes were put down in connection with the operation of oil and gas fields and a few pools of oil were thus located. Difficulties begin to be met with in regard to the supply of natural gas, the pressure being said to have lessened rapidly during last year in the Essex field and trouble with water in the wells having been encountered. It is claimed, however, that so far there has been no serious

falling off of pressure in the Welland field. An effort is being made by the Provincial Government to prevent the export of this fuel to the United States, where most of it has so far been consumed, but without success so far, owing to legal difficulties encountered in trying to apply the law.* This failure is regrettable, as gas to the value of nearly three million dollars since the commencement of the industry, rating it at a very low price per thousand, has been produced, the greater part of which went to build up industries outside of Canada, which gained very little proportionately by the exploitation of this mineral asset of the country. Some little attention was paid to the further exploration of the North-west Territories for gas with results which have, so far, not transpired. Export of gas.

In the cement industry, considerable activity has been shewn in the formation of new companies and the erection of new works for the manufacture of Portland cement, chiefly in Ontario. As this industry naturally connects closely with the general prosperity of the country its rapid growth of late years is a most encouraging sign. Portland cement.

The central portions of the Dominion being unfortunately lacking in any supply of coal, the growing interest taken in the utilization of the large resources in peat is of great importance. At several points, works are in operation or being erected, including the large and important plant of the Trent Valley Peat Company, near Peterborough, Ontario. Peat.

It is gratifying to note also that the corundum deposits are still being developed. The existence of corundum in Ontario was pointed out some years ago by officers of the Geological Survey. The Canada Corundum Co. worked its mill the greater part of the year. The plant is capable of turning out three tons of pure corundum per day. These operations have resulted also in showing that the material can be properly graded. Operations were also carried on in the same vicinity by another company, regarding which no particulars are to hand. Corundum.

As usual, inquiries have been made at the Department regarding a number of mineral substances which are of economic value or are becoming so. A list of these has already been given in the first part of this report. Among the more important and interesting are platinum, felspar and molybdenite. There has been a small production of platinum in British Columbia for many years, but of late this has fallen off. It was obtained in connection with the placer washings on the Similkameen river. Now, however that the demand has so Platinum.

* The above was written in December last. Since that time exportation has been stopped.

increased and that the prices quoted give it a higher value than gold, it is hoped vigorous prospecting will result and that further deposits may be found. Important data regarding the geological conditions which may be taken as indicative of the most likely places to look for the metal, will be found in the remarks of Mr. R. Brock in this report, and in the forthcoming advance statement of this Section it is intended to give further information bearing on the subject.

Molybdenite.

The demand for molybdenite at good prices still keeps up, so that with the discovery of workable and accessible deposits, a new industry could be inaugurated. This mineral is of common occurrence in the Laurentian rocks of Eastern Canada and discoveries are also reported from British Columbia. At no point, however, has it, so far, been developed sufficiently to prove its existence in commercially workable quantity. It seems to occur mostly as disseminated crystals in quartz veins, and where the larger and thicker foliated crystals are plentiful, it would seem that profitable extraction by crushing and hand picking should be possible in view of the prices offered, viz. $200 to $250 per ton for the pure mineral. With regard however to the class of ore carrying the mineral evenly disseminated in small flakes, as is so often the case, difficulty would probably be experienced in making an efficient separation by the usual methods of ore-dressing, the flakes being apt to float away with the lighter gangue material. The results of experiments to test this, which were made at McGill University mining laboratory, are given in the Summary Report of the Director of the Geological Survey for 1900.

In the foregoing remarks no effort has been made to give other than a sketch of the main features of the mineral industry of the country, viewed as a whole, for the year 1901. Many details will be found in the accompanying reports of the different field officers of the Survey for the various districts, and in the full report of the Mines Section to be published later in the year, will be found the detailed statistics and technology of each mineral industry.

Mapping and Engraving.

C. O. Senécal, Geographer and Chief Draughtsman.

Report of Geographer and Chief Draughtsman.

have the honour to report as follows on the work carried out under my supervision during the period which has elapsed since January 1, last. The staff has been increased in number since June 1, and at present ten map-compilers and draughtsmen, including four field-

assistants, who also attend to mapping when not actually employed in field work, are engaged in compiling and putting in shape for publication, parts of the field work and maps hitherto left in arrear, and in attending to the current work of the office. Staff.

During the past summer, several of these men having been sent to the field as usual, the work they had in hand, was, of course, temporarily stopped. The Klondike topographical and geological map and several sheets of the Ontario and Nova Scotia series have thus been delayed, but these will be resumed at the earliest date possible and will likely be ready for publication during the course of the winter.

The routine work, including laying down geographical projections, correcting proofs of maps and reports, making tracings and drawings for office and field use, supplying information to the librarian, preparing various memoranda in reference to the reproduction of maps, engravers' accounts and other subjects, has been distributed among the staff and attended to. Routine work.

The assignment of work has been as follows :—

Mr. L. N. Richard has drawn for reproduction by engraving, the Manitou Lake sheet, No. 4, Western Ontario series ; has prepared for lithography the coloured copies of the Trafalgar and Stellarton sheets, Nos. 42 and 43, Nova Scotia series. A list of place-names covering the map of the Atlin mining district, B.C., for the Geographic Board was made by him, and he also reduced part of Dr. R. Bell's astronomical observations made in Baffinland. During my absence from the office on field duties, his time was spent in cataloguing maps, making reductions of railway and other plans for field use, supplying information to the librarian and in general draughting work. He has now in hand the revision of the map of the district around Bancroft, Ontario. For the purpose of completing the western portion of this sheet, he was sent on August 16, to meet Dr. F. D. Adams in the field, and under the latter's instructions to make micrometer surveys along several roads in the townships of Glamorgan, Monmouth, Cavendish and Anstruther. He returned to this office on September 9. Assignment of work.

Mr. W. J. Wilson, who last year had accompanied Dr. R. Bell, in the Michipicoten region, was occupied in laying down on the scale of publication, the material gathered for sheets 143 and 156, Ontario series, covering part of that district. He also attended to general draughting work required in the office. He left for the field accompanied by Mr. J. F. E. Johnston, under instructions from the director on June 10, and both returned on October 20. The above mentioned

compilation will be resumed by Mr. Wilson as soon as he has completed his report on this summer's work.

Mr. J. F. E. Johnston will continue the topographical mapping of the Klondike sheet, which will probably be completed and ready for publication before the end of the present calendar year.

Mr. E.O. Prud'homme has had charge, as in former years, of the maps held in stock for sale and distribution. Besides making several drawings for office and field use, he has drawn and lettered for the engraver the following maps and plans, viz., maps of the city of Ottawa and vicinity in Ontario and Quebec, and of the Atlin mining district, B.C., plans of Montague and Waverley gold districts in Nova Scotia, and partly the East Kootenay sheet, B.C. He has also spent some time in labelling rock specimens, etc. A series of diagrams showing the mineral productions of Canada, and five sketch-maps of new explorations are also being drawn by him for photo-lithographing.

Special map for Pan-American Exhibition.

Mr. J. Keele has compiled the greater part of sheets 119 and 122, Ontario and Quebec series, and constructed a special wall map of parts of the counties of Frontenac, Renfrew, Lanark and Leeds, for the Pan-American Exhibition. This map was prepared on the scale of two miles to 1 inch, in response to a request from the Kingston Board of Trade, but was not, however, intended for publication. Mr. Keele was away on leave of absence from February 26 to April 23, and left for the field as assistant to Mr. R. G. McConnell in the Klondike region in the beginning of June. He returned to this office on October 15 and will resume his work on the Ontario sheets as soon as he shall have completed the sketch-maps of the exploration of 1901 in the Yukon district, which he is at present compiling for the Summary Report.

Mr. H. Lefebvre continued the compilation of the Lake Nipigon sheets, attended to the cataloguing of maps, plotted sheets, note-books, &c., and was employed on general draughting work until he left the Geological Survey on April 1.

Mr. W. H. Boyd completed the compilation of the geological map of Atlin mining district (No. 742). He was detached to assist Mr. D. B. Dowling in the field from May till October, and since his return has been occupied in reducing astronomical observations, compiling a small sketch-map of the past summer's exploration in Keewatin for publication in the Summary Report and in plotting his survey.

Mr. J. A. Robert, who, a few years ago, had in this department acquired some experience in map-compiling was re-employed and since

May 7 has been occupied in mapping Mr. H. Fletcher's surveys, covering sheets Nos. 59 to 63 and 76 to 79, Cumberland county, Nova Scotia.

Mr. Owen O'Sullivan was employed on general work from April 13 to 29. He has since been occupied in reducing and compiling Mr. E. R. Faribault's surveys made in Halifax county, Nova Scotia, on sheets Nos. 53, 54, 67 and 68. During the summer he was instructed to accompany Mr. Faribault to Nova Scotia and there to continue this work, the nature of which required this officer's personal supervision. Mr. O'Sullivan also assisted me in the field from July 18 to August 7.

Mr. Paul Frèreault has been employed in this office since June 3. He has drawn on autographic paper for lithography a series of thirteen maps of mines, intended to illustrate the report of the Mining Engineer of this Department, on the iron-ore deposits of the district traversed by the Kingston and Pembroke railway, Ontario. He reduced and transferred from the Admiralty chart, the coast of Nova Scotia from Halifax to St. Margaret's bay for map-sheets Nos. 68 to 71, the compilation of which will be undertaken at an early date. He also made several tracings and reductions of railway and other plans for field and office use, and he is at present completing the southern portion of sheet No. 121, Ontario and Quebec, from Dr. R. W. Ells' surveys made in 1900.

Mr. Vincent Perrin has been employed in this office since October 15, and is now making a tracing for the engraver of the map of the Grass River region north of Lake Winnipeg, and attending to general draughting work.

Mapping by field-officers.

The following maps have also been compiled and drawn by field officers from their respective surveys:—

Grass river region, Keewatin, scale 8 miles to 1 inch, by Mr. D. B. Dowling.

East coast of Hudson Bay, Ungava, scale 8 miles to 1 inch, by Mr. A. P. Low.

West Kootenay sheet, B.C., scale 4 miles to 1 inch, by Mr. W. W. Leach.

East Kootenay district, B.C., (preliminary sheet) scale 4 miles to 1 inch, by Mr. J. McEvoy.

Crows Nest coal-fields, B.C., scale 2 miles to 1 inch, by Mr. J. McEvoy.

Mr. J. M. Bell mapped his exploration of Great Bear lake and route between this lake and Great Slave lake, on a scale of 8 miles to 1 inch.

A map of the northern portion of Labrador peninsula, compiled from recent explorations and sketches from natives, has been received from Mr. A. P. Low, and will appear in the Summary Report for the present year. Although not published as a geological map, it will add to our knowledge of the geography of this almost unexplored region.

The West Kootenay sheet, British Columbia, which has been sent in parts to the engraver since 1898, has been completely engraved. Proofs have been received and the geologically-coloured copy is being prepared. This sheet is of the same scale and covers the same area as the Kamloops and Shuswap sheets, namely 80 miles square.

Size of British Columbia sheets reduced.

While British Columbia is fast developing its mineral resources, the difficulty of accurately mapping the geology and topography of its southern portion necessitates surveys which, on account of the mountainous character of the country, cannot be made as quickly as surveys elsewhere in Canada, and the time spent in the compilation of such large geological sheets is very considerable. It seems desirable in order to bring them before the public within reasonable time, that smaller map-sheets should be drawn. It is therefore suggested that the size of the sheets of the British Columbia series be reduced to one-half their original area by drawing an east and-west line through the centre of each, as shown on the accompanying index-map. An obvious advantage is that the sheets of greatest economic importance could be executed first and published without delay.

Dominion map.

The engraving of the eastern half of the Dominion map on the scale of 50 miles to 1 inch, has been completed, and the eleven colour-stones for the western half were prepared and proved, but the publication of this sheet has been delayed on account of important geological information relating to the Klondike, Great Bear lake and Great Slave lake regions, received since, and involving material changes on several of the colour-stones.

Accompanying sketch-maps.

A number of sketch-maps are being prepared for publication in the present Summary Report to illustrate part of the progress made in the field during the past summer. These maps, although quickly compiled, are sufficiently accurate to meet immediate requirements and will supply valuable information, pending final adjustment and compilation of the surveys on our regular serial sheets.

Cataloguing.

The cataloguing of maps, survey records, etc., is attended to by the staff. More space and a few presses and cabinets are desirable, in which to store conveniently the accumulated manuscript maps and other records.

Numerous Geographic Board meetings were attended and lists of place-names covering parts of the Atlin, West Kootenay and Grass river sheets were submitted for approval. Geographic Board.

The publication of sheets 42 to 48 and 56 to 58, Pictou and Colchester counties, N.S.,—deferred on account of certain geological points requiring final settlement—was decided upon by the director and the edition of sheet No. 42, (Trafalgar sheet) has been received from the printer. Publication of Nova Scotia sheets.

From July 15, to August 7, my time was spent in the field. For the purpose of laying an accurate base-line on sheets Nos. 67, 72 and 73 of the Nova Scotia series, upon which to tie the detailed surveys of Mr. E. R. Faribault—which are now ready for the compiler—a transit and chain line was run along the Intercolonial and the Dominion Atlantic railways from Bedford Basin to Hantsport, connecting the opposite coasts of Nova Scotia. From the data of this survey, the following points were determined :— Field work by geographer.

Locality.	Latitude.			Longitude.			Magnetic Declination.
	°	′	″	°	′	″	
Bedford station (I.C.Ry)., ...	44	43	43	63	39	54	
Windsor junction.....	44	47	12	63	38	25	
Beaver Bank station (D.A.Ry.).....	44	47	46	63	41	28	
South Uniacke station....	44	52	10	63	47	20	
Mount Uniacke station...	44	53	29	63	49	50	
Stillwater station....	44	55	2	63	57	10	
Ellershouse station.....	44	56	45	64	0	26	20° 16′ W.
Newport station.....	44	57	41	64	3	26	20° 37′ W.
Windsor station	44	59	49	64	8	16	
Hantsport station	45	4	5	64	10	40	

The above latitudes and longitudes depend on the position of the Halifax navy yard flag staff as given on Admiralty charts Nos. 311 and 2320.

The magnetic declination was ascertained at every station, but those observations only which were free from possible local disturbance are here recorded.

Maps etc., published.

Twenty-eight maps, one sheet of sections, four profiles and seven diagrams, published during the period covered by this report, are enumerated below :—

Catalogue Number.	Maps, Sections, Profiles and Diagrams.	Area in Square Miles.
752	Yukon District—Salmon river gold fields—Scale, 2 miles to 1 inch.	138
753	" Sixty-mile river gold fields—Scale, 6 miles to 1 inch.	
711	British Columbia—Atlin gold fields (preliminary edition)—Scale, 6 miles to 1 inch.	4,920
759	" Sections of coal-measures, Crows Nest coal fields—Scale 300 feet to 1 inch.	
751	Keewatin—Exploration of Ekwan and Trout rivers and west coast of James bay—Scale, 50 miles to 1 inch.	
758	Ungava—Sketch map of northern interior of Labrador peninsula—Scale, 50 miles to 1 inch.	
	Ontario—13 maps illustrating the mode of occurrence of iron ore deposits in eastern Ontario, viz. :—	
726	Bedford and Glendower mine—Scale, 400 feet to 1 inch...	
727	Robertville and Mary mines—Scale, 200 feet to 1 inch.. ..	
728	Fournier mine—Scale, 200 feet to 1 inch	
729	Christie lake mine—Scale, 200 feet to 1 inch	
730	Wilbur mine—Scale, 200 feet to 1 inch.....	
731	Yuill mine—Scale, about 37 feet to 1 inch.....	
732	Bluff point mine—Scale, 400 feet to 1 inch.....	
733	Calabogie mines—Scale, 200 feet to 1 inch.....	
734	Culhane mine—Scale, 200 feet to 1 inch	
735	Black Bay or Williams mine—Scale, 120 feet to 1 inch.....	
736	Chaffey and Matthew mines—Scale, 600 feet to 1 inch	
737	Playfair or Dalhousie mines—Scale, 50 feet to 1 inch.....	
738	Dog lake mine—Scale, 50 feet to 1 inch.....	
714	Ontario and Quebec—City of Ottawa and vicinity—Scale, 1 mile to 1 inch.	450
760	" " Sketch map of Lake Abitibi region—Scale, 16 miles to 1 inch.	
593	Nova Scotia—Sheet No. 42 (Stellarton sheet)—Scale, 1 mile to 1 inch.	216
709	" Mt. Uniacke gold district—Scale, 250 feet to 1 inch.	
721	" Waverley gold district—Scale, 250 feet to 1 inch.	
764	" Geological sketch map of parts of Hants and Kings counties—Scale, 2 miles to 1 inch.	
	Four profiles to accompany report on altitudes, viz. :—	
746	Profile No. 1—Canadian Pacific Railway—Montreal to Winnipeg.	
747	Profile No. 2—Canadian Pacific Railway—Winnipeg to Vancouver.	
748	Profile No. 3—Canadian Pacific Railway—Old location via Yellowhead Pass.	
749	Profile No. 4—River St. Lawrence and Great Lakes.	
754-757	Four index maps—Part of British Columbia, Western Ontario, New Brunswick and part of Quebec, and Nova Scotia—Scale, 50 miles to 1 inch.	
	Also seven diagrams showing mineral production of Canada.	

There are at present nineteen maps and plans in the engraver's hands or in press and about forty others at different stages of progress, nine of which have been completely compiled and will soon be ready for the engraver. Maps in progress.

The accompanying index-maps, showing the progress of the mapping up to date, are intended to be distributed with the List of Publications. Index maps.

The examination and repairing of the field instruments has been as usual, attended to, and I beg to report that several micrometers, aneroid barometers, chains, cameras, prismatic compasses and nearly all the compass-tripods are practically worn out, and should soon be replaced. Field instruments.

Since January the following instruments were purchased:—

One cyclotomic mountain transit and tripod, No. 14, from A. Lietz & Co., San Francisco, Cal.

One Hadley sextant, No. 7, from Cary, London, Eng.

One Abney level, No. 15 " "

Three prismatic compasses, Nos. 64, 65, 66, from Cary, London.

One 300-ft. steel band, No. 22, from W. & L. E. Gurley, Troy, N.Y.

Two 66-ft. steel bands, Nos. 23 and 24 " " "

One surveyor's compass and tripod, No. 15, from Keuffel & Esser, New York.

One watch, No. 13, from Henry Birks & Son, Ottawa.

The number of official letters, memoranda, &c., relating to map-work, sent and received was 260 and 150 respectively. Correspondence.

Palæontology and Zoology.

Dr. J. F. Whiteaves.

Dr. Whiteaves reports that 'the manuscript of the "Catalogue of the Marine Invertebrata of Eastern Canada," commenced in the fall of 1899, was completed in May last. In order to give the latest information on the subject, a considerable portion of the manuscript was rewritten in the early part of 1901. The catalogue was published on 24th of August last, the greater part of two months having been occupied in seeing it through the press. In its printed form it consists of 272 pages, large octavo, with two illustrations in the text. With the exception of the jelly-fishes and a few small crustacea, nearly all the Catalogue of Marine Invertebrata.

Number of species.

species enumerated in it are from the sea bottom, at various depths, and most of them were obtained by dredging. The number of species of invertebrata from the seaboard of Eastern Canada south of the Baie des Chaleurs that have been determined or described up to August, 1901, would seem to be 1,064, as follows:—

Protozoa	64	species.
Sponges	36	"
Coelenterata	119	"
Echinodermata	71	"
Marine worms (Annulosa)	138	"
Brachiopoda	3	"
Polyzoa	115	"
Mollusca	282	"
Crustacea	198	"
Pycnogonida	11	"
Chordata	27	"
	1,064	species.

'As remarked by Dr. Bell in his letter of introduction to this catalogue, "it is hoped that the latter will act as a stimulus to renewed activity in the study of marine zoology, and that it will be of use not only to zoologists but also to students of the fossils of the post-tertiary deposits of the eastern portion of the Dominion."

"Mesozoic Fossils."

'The manuscript of the fifth and concluding part of the first volume of "Mesozoic Fossils" was commenced in September (1901), and about fifty pages of it have been written. The part will probably be completed and ready for the printer early in the spring. It is intended to consist of descriptions or identifications of numerous additional species or specimens of fossils from the Cretaceous rocks of Vancouver and adjacent islands, with a revision of the fauna of these rocks up to date. It will be based upon material that has been accumulated during the last five years, including 160 specimens of Vancouver Island fossils recently received from Mr. Walter Harvey, and about 100 from the Rev. G. W. Taylor, all of which have been examined and studied.

Mollusca from Ungava.

A paper entitled "Notes on some Land and Fresh-water Mollusca from Fort Chimo, Ungava Bay, Ungava," has been prepared and published in the *Ottawa Naturalist* for March, 1901. Another paper entitled "Note on a supposed new species of *Lytoceras* from the Cretaceous rocks at Denman Island, in the Strait of Georgia," has been written and published in the same journal for May, 1901.

Other work.

'At the request of Section IV of the Royal Society of Canada, a Bibliography of Canadian Zoology for the year 1900 has been compiled and presented to the Society, at its last meeting, for publication in its Transactions for 1901.

'A collection of exotic shells has been named for the Museum of Ottawa University and a set of duplicates of recent Canadian marine shells, mostly from the coast of British Columbia, has been selected, labelled and presented to the same museum.

'In all, some thirty-three small collections from various localities, have been examined and reported upon provisionally during the year, and answers, as usual, have been written to many inquiries for information on various palæontological and zoological topics.

'During Dr. Bell's absence in the field for the greater part of August and September, the duties of Acting Director have devolved upon me.'

'The following specimens have been collected by or received from officers of the staff, or employees, during the year 1901 :— Collections by the staff.

Professor Macoun :—

Small collection of snakes and batrachians from south-western Ontario.

Dr. R. W. Ells :—

One hundred and four specimens of fossils from the Trenton limestone at Bear Point, Wolfe island, Ontario.

Hugh Fletcher :—

Fourteen specimens of a graptolite (*Dictyonema Websteri*?) from Silurian slates at Kentville, N.S.

R. J. McConnell :—

Bones and portions of skulls of bison, Rocky Mountain sheep, &c., from the stream gravels on Thistle creek, Yukon territory.

A. P. Low :—

Two specimens of supposed fossils, from island off Long island, ten miles north of Cape Jones, east coast of Hudson Bay.

L. M. Lambe :—

A large collection of remains of dinosaurs, turtles, crocodiles, fishes, primitive mammals, and other vertebrata from the Belly River series of the Red Deer river, Alberta.

W. McInnes :—

Stone adze or scraper from the north side of Lac Seul, Keewatin.

Collections by the staff.

Dr. H. M. Ami :—

About 250 specimens of Trenton and Black River fossils, from the counties of Frontenac, Addington, Prince Edward, Lennox and Hastings, Ont.

Several hundred Pleistocene fossils from various localities in the valleys of the St. Lawrence and Ottawa rivers. Several fragments of pottery from the shore of Lake Ontario, in Prince Edward county.

Twenty specimens of Chazy fossils from Ironsides, P.Q.

R. W. Brock :—

Indian pestle from the north fork of Kettle river, B.C.

D. B. Dowling :—

One hundred and fifty specimens of Silurian fossils from the Equan river, Keewatin.

About twenty-five Pleistocene fossils and twelve fresh water shells from the plateau west of James bay.

Two specimens of mice from the valley of the Equan river.

J. M. Macoun :—

Four hundred and forty-two skins of birds and mammals, and about 300 specimens of fifteen species of reptiles, batrachians, &c., from the Chilliwack river valley, B.C.

W. J. Wilson :—

Twenty-five fossils from the Utica slate at Ottawa.

Fifty-nine arrow heads, adzes, pieces of pottery, &c., from the east end of the portage across the peninsula in Lake Abitibi, five miles east of the outlet of the lake; and a few fresh water shells from that lake.

W. W. Leach :—

Thirty-six fossils (plants, mollusca, corals, &c.) from various localities and formations in the Crows Nest Pass.

R. A. Daly :—

Sixty fossils from the Chilliwack river valley, Coast Range, B.C.

Fifteen specimens of fossil plants from Sumass mountain, B.C.

J. C. Gwillim :—

Twenty-five specimens of fossiliferous rocks from various localities in Atlin, B.C.

Collections by the staff.

H. S. Poole, Stellarton, N.S. :—

Fifteen specimens of fish teeth, scales, &c., from roof of coal seam at Mill Brook, Fair View, near Dorchester, N.B.

A. McKinnon :—

Two recent marine sponges (*Desmacidon palmatus*) from Cape Blomidon, N.S.

Collections from other sources.

'The additions to the palæontological, geological and ethnological collections during 1901, from other sources, are as follows :—

By presentation :—

(*A.—Palæontology.*)

Mrs. H. A. Nicholson, Aberdeen, Scotland :—

The types of ten species of fossil corals, from the Trenton, Hudson River, Corniferous and Hamilton formations of Ontario, described by the late Professor H. A. Nicholson, with thirteen microscopic sections illustrative of their structure.

Colonel C. C. Grant, Hamilton, Ont. :—

Twenty-five specimens of fossils from the Silurian rocks of Ontario; six from the Niagara chert at Hamilton, and nineteen from the Hudson River drift at Winona, Ont.

Mrs. Hetherington, Cannamore, Ont. :—

Specimen of a fossil coral (*Columnaria Halli*) from the Birdseye and Black river formation on lot 6, concession X, Finch.

W. S. Odell, Ottawa, Ont. :—

Remains of seal from marine Pleistocene clays near Ottawa.

A. R. Wilson, Fernie, B.C. :—

Fine specimen of a fossil plant from Hosmer, B.C.

Rev. G. W. Taylor, Wellington, B.C. :—

Sixty specimens of Cretaceous fossils, some of them new to science, from Brennan creek, near Wellington, V. I.

Dr. C. F. Newcombe, Victoria, B.C. :—

Specimen of *Turrilites Charlottensis*, shewing the septation which was previously unknown; and cast of the interior of the dorsal surface of the test of a heart urchin; both from the Cretaceous rocks of the Queen Charlotte Islands.

Collections from other sources.

T. J. Pollock, Aylmer, P.Q. :—

Small collection of native Pleistocene shells from Aylmer.

W. Milne, Ottawa, Ont. :—

Marine Pleistocene shells from a depth of twenty feet in the main drain, corner of O'Connor and Mutchmor streets, Ottawa.

M. P. Davis, Sillery, P.Q. :—

Root of hemlock (*Tsuga Canadensis*) from Pleistocene gravels at Victoria Cove, Sillery, P.Q.

Captain Constantine, N.W.M.P., Dawson, Y.T. (per G. M. Dawson) :—

Fossil plant from near Nulatto, Yukon river.

A. H. Taylor, Ottawa (per Dr. H. M. Ami) :—

Tooth of mammoth from the Pleistocene of the Yukon valley near Dawson, Y.T., collected by Dr. A. M. Taylor.

J. W. Baldwin, Ottawa, Ont. :—

Specimen of trilobite (*Triarthrus*) from the Utica formation at New Edinburgh.

T. C. Weston, Quebec City, P.Q. :—

Two specimens of an *Orthoceras* from the Black River limestone at Lorette falls.

E. W. Kendall, Ottawa, Ont. :—

Twenty specimens of marine Pleistocene fossils, from seven miles north of Morrisburg, Ont.

E. A. Hoare, Quebec City, P.Q. (per Dr. Ami) :—

Series of cores and other drillings from the bed of the St. Lawrence at Victoria Cove, Sillery, on the site of the foundation of the piers of the Quebec bridge.

Frank Burrows, Joggins Mines, N.S. :—

Two pieces of core of a calyx drill, with fossil plants, from Lynx lake, at head of Lingan Basin, just above the coal, in boring made by Mr. Burrows, July 13, 1901.

Small piece of shale, with *Cordaites*, &c., from Buchanan's seam, supposed to be the same rock as the above.

(B.—*Zoology.*)

Collections from other sources.

Zoological specimens.

Dr. R. Bell, Ottawa :—

One specimen each of the Canadian Porcupine, Laughing Goose, Least Rail, Ptarmigan, Bald Eagle (young), Gyrfalcon and Great Horned Owl, from the west coast of Hudson Bay.

Rev. G. W. Taylor, Wellington, V. I. :—

Twenty-nine marine calcareous sponges and one silicious sponge, from Boat Harbour, six miles south of Nanaimo.

Robert Fox, Maxwell's Lake, P.Q. ; per W. L. Marler :—

Two pairs of the Arctic Three-toed Woodpecker ; one pair each of the Pine Grosbeak, Northern Shrike, and white-bellied Nuthatch ; and one specimen of the Pileated Woodpecker.

S. E. Wilson, Cascades, P.Q. :—

Star-nose Mole (*Condylura cristata*), from the Cascades.

J. E. Keays, London, Ont. :—

Set of three eggs of the Red-shouldered Hawk (*Buteo lineatus*), from near London.

Rev. C. J. Young, Sharbot Lake, Ont. :—

Set of three eggs of the Red-shouldered Hawk, from Leeds Co., Ont.

H. H. Ross, Medicine Hat, Assa. :—

Horned Toad (*Phrynosoma Douglasii*), from Medicine Hat.

Edwin Beaupré, Kingston, Ont. :—

Set of four eggs of the Swamp Sparrow (*Melospiza Georgiana*) with one Cowbird's egg,—from the Cataraqui Marsh near Kingston.

E. J. Chamberlin, Ottawa :—

Fine specimen of head of Moose (mounted) with abnormal antlers.

V. V. Rogers, Ottawa :—

Young loon and fine male Canvas-back Duck (*Aythya vallisneria*), both shot at Stanley Island, St. Lawrence River.

Messrs. McDougall and Secord, Edmonton, N.W.T. ; per the Hon. Clifford Sifton :—

Two skins of the Arctic Fox.

Collections from other sources.

Lawrence W. Watson, Charlottetown, P.E.I. :—

Specimen each of the Black Hare and Grey Hare from Prince Edward Island.

W. M. Antiss, Ottawa :—

Specimen of Brunnich's Murre, shot near Ottawa.

(C.—*Archæology.*)

Archæological specimens.

F. Dunn, Barry's Bay, Ont. ; per Dr. A. E. Barlow :—

Four stone implements from Welshmans Island, Barry's Bay, Renfrew Co., Ont.

W. E. Calvert, Ottawa :—

Stone gouge found on Elgin st., near Pattersons Creek, August, 1884.

Mrs. M. Deane-Freeman, McLeod, Alberta :—

Two 'buffalo stones,' very scarce and held in great reverence by the aborigines from the Blood Reservation at Fort McLeod.

Artesian Wells, Palæontology, Archæology, Bibliographies, etc.

Work by Dr. H. M. Ami.

Dr. H. M. Ami reports as follows:—'During the earlier part of the year much of my time was spent in office work: determining various collections of fossils from different provinces obtained by officers of the staff and others, with a view to ascertaining the precise geological horizon or formation to which they should be assigned.

'Examinations were made of numerous samples of drillings and cores from wells sunk at various localities in Ontario and Quebec. Sections were prepared in some instances from these logs, giving the order of succession of the strata traversed and the geological formations represented. The wells were for the most part bored for petroleum, natural gas, salt or water.

Well at Ramsay's corners.

'From lot 18, con. VII, township of Gloucester, county of Carleton, numerous specimens of the core of a diamond drill in "Well No. 1," near Ramsays Corners, were sent to the department for examination. The Pleistocene formation in the district reached a thickness of 204

feet, while the Lorraine formation, consisting of fine-grained silicious mudstones and shales with here and there a thin calcareous band, was found to be much thicker than shown in any previous records in the department. Notes on the fossils detected in the cores of drillings at different depths were kept and afforded satisfactory evidence upon which to determine the age and position of the strata traversed. Well No. 1 reached a depth of 469 feet, whilst well No. 2, on lot 8, con. V, Rideau front, in the township of Gloucester, was drilled to a depth of 460 feet, and the Utica formation, consisting of black bituminous shales, was satisfactorily recognized. An estimate of the probable thickness of the Palæozoic sediments in this vicinity gave 1,540 feet.

Well four miles east of St. Gregoire.

'Notes on a series of drillings from a deep well on Concession Pointu, four miles east of St. Gregoire, township of Becancour, Que., were recorded, and a section giving the succession of strata at various depths prepared from the materials sent from the well in which it was reported that a bed of salt, fifty feet in thickness occurred. No evidence of the salt rock was found. The drillings consisted, for the most part, of fine-grained red silicious mud, representing the Medina formation, or lowest division of the Silurian system in that district.

Microscopic sections.

'Microscopic sections, numbered 2,211 to 2,215, were prepared from small chips of rock occurring in the drillings sent to the Geological Survey for examination from the depths of 1,632½ and 1,635 feet respectively in the well at Hepworth, Ontario. Dr. Barlow, to whom these micro-sections were submitted, describes the rock as "grit, chloritic and kaolin material, fine-grained limestone or dolomite, and arkose." This rock resembles in character the basal series of strata underlying the Black river formation throughout central Ontario or lying between that formation and the uneven rounded and worn surfaces of the Archæan below.

'During the drilling for water on the property of the Ottawa Produce Company in Nicholas street, in Ottawa city, where the surface rock, only a few feet below the level of the street, consists of the upper beds of the Trenton formation, water rising to the surface was struck in abundance. It was ascertained that the well was put down in a direction in line with the strike of the folded strata which may be seen at the south-western slope and base of Nepean point, Ottawa.'

Assist Dr. Ells.

At the end of July Dr. Ami was instructed to proceed to Kingston and vicinity in order to assist Dr. Ells in determining in the field the age of some of the rocks, from the palæontological evidence, and thirteen days were spent on this work.

Some obscure fossils obtained by Mr. Gwillim at three localities in the Atlin gold district in British Columbia, were examined by Dr. Ami and subsequently by Dr. T. W. Stanton, of the United States Geological Survey, who furnished a few notes on them for Mr. Gwillim's report.

'Amongst the collections obtained during the past season are two specimens of a core of a calyx-drill from Lynx lake at the head of the Lingan basin, just above the coal and 21 feet down in a boring made by Mr. Fraser Burrows. They exhibit three well-known species of fossil plants, characteristic of coal-bearing strata: *Sphenophyllum cuneatum*, *Alethopteris Serlii* and a *Cardiopteris*.

Collections recorded.

'Records of all the additions to the ethnological and archæological collections have been made and the specimens catalogued. Records of additions to the palæontological collections in the Museum were also kept, as well as a list of additions to the series of sections for the microscope. Amongst the latter is a series of foraminifera, &c., from boulder clays (glacial?) collected by Dr. Dawson and other officers of the Survey in different portions of Canada. These minute organisms are of value in ascertaining the origin of the boulder clays of the North-west Territories. They were mounted by Joseph Wright, Esq., of 4 Alfred St., Belfast, Ireland, to whom the department is under special obligations for their determination and identification.

'Micro-sections of Prof. D. P. Penhallow's new species of larch from the Churchbridge well, Manitoba, at the depth of 200 feet in the Pleistocene of that province, were received and recorded. The specimens from which this species was described were collected by Messrs. J. B. Tyrrell and G. H. Webster in 1892.

Loan of specimens.

'As mentioned in last year's Summary, through the kindness of the authorities of the American Museum of Natural History, New York city, this Department has been lent, in order to study and re-figure, if necessary, the original types of certain species of Silurian fossils from the Arisaig coast of Antigonish, Nova Scotia. The first consignment of these fossils has been studied and drawn preparatory to their return to the Central Park Museum. The examination of these types throws much light upon difficult questions in nomenclature and classification which have arisen in the study of Silurian faunas from Stonehouse, Moydart, McAdam and Arisaig. From the light yellow or buff weathering fossiliferous sandstones, &c., of the Arisaig rocks, as described on page 180 of the Summary Report for 1900, the 'interstratified bands of shale,' &c., mentioned, must be eliminated from the arenaceous series. These strata are highly disturbed and may consti-

tute a separate or distinct series whose relations and age require to be examined more critically before a definite conclusion may be reached.

'Further studies have been made on additional specimens of the genus *Dictyonema* from different localities in Nova Scotia and New Brunswick. Specimens of *Dictyonema Websteri* from the highly inclined and cleaved red and green shales of King's county, Nova Scotia, have also been studied and notes made upon them.

'Synopses of Canadian palæontological publications have been prepared for the 'Geologische Centralblatt,' at the request of Dr. K. Keilhack, Director of the Geological Survey of Germany, &c., and in accordance with instructions received from the late Dr. G. M. Dawson.

Survey's collections in Peter Redpath Museum.

'At the time of Sir J. W. Dawson's death, a number of collections of fossil plants were in his hands and these are now awaiting determination in the Peter Redpath Museum. These collections are as follows : Fossil leaves and other plant remains from the Red Deer and Blind Man rivers ; fossil plants from Port McNeil, British Columbia ; fossil plants from various localities in the Queen Charlotte Islands ; plant remains from Lytton, B.C., collected by the late Dr. G. M. Dawson ; specimens of fossil ferns from Skidegate Inlet, Queen Charlotte Islands, collected by the late Dr. G. M. Dawson and recently described in MS. by Prof. Penhallow as a species of *Osmundites*.

Fossils donated.

'During the past year, a small collection of fossils was selected and sent to the Museum of King's College, Windsor, Nova Scotia, from amongst the duplicate specimens in the Museum, and a collection of about 150 specimens of fossils from the geological formations of the Ottawa district was determined and sent to Prof. H. S. Poole, of Dalhousie University, Halifax, N.S.

In the same period the following papers were published :—

Papers published.

'Preliminary lists of the organic remains occurring in the various geological formations comprised in the map of the Ottawa district, including portions of provinces of Qnebec and Ontario, along the Ottawa river.' Published as an appendix to Dr. Ells' report on the Geology of the Ottawa City map.

'Preliminary lists of the organic remains occurrring within the area comprised in the Grenville map sheet.' Prepared as an appendix to Dr. Ells' Report.

'On the Geology of the Principal Cities in Eastern Canada.' containing descriptions of the various systems, formations, characteristics fossils, etc., arranged in tabular form for the cities of

St. John, Quebec, Montreal, Ottawa and Toronto. Trans. Royal Society of Canada, 2nd series, Vol. 6, Sec. IV, pp. 125–173.

'On a new or hitherto unrecognized geological formation in the Devonian system of Canada.' Published in the Canadian Record of Science, Vol. 8, No. 5, pp. 296–305, January, 1901.

'Knoydart Formation of Nova Scotia.' (Read before the Geological Society of America, Albany, N.Y.) Published in Bull. Geological Society America, Vol. 12, pp. 301–312, Pl. 26, August, 1901, Rochester, N.Y.

'Description of new tracks or trails made by some fish-like organism from the fine-grained silicious mudstones of Antigonish county, Nova Scotia.' Read before the Nova Scotia Institute of Science, May 13, 1901, and printed in Proc. and Trans. Nova Scotia Inst. Sc., Halifax. (Session 1900–1901.)

'Stratigraphical Note,' containing subdivisions of the Devonian and Silurian of the Arisaig region of Nova Scotia. Published in Science, new series, Vol. 13, No. 323, pp. 394–395, March, 1901.

'Notice of Prof. E. D. Cope's article on Cyphornis, an extinct genus of birds.' Published in Canadian Record of Science, Vol. 8, No. 5, pp. 331–332, January, 1901, Montreal.

'Brief Biographical Sketch of Elkanah Billings,' Palæontologist to the Geological Survey of Canada from 1856–1876. Published in the American Geologist, Vol. 27, No. 5, pp. 265–281, May, 1901, Minneapolis, Minn.

'A biographical sketch of George Mercer Dawson.' Published in the Ottawa Naturalist, Vol. 15, No. 2, pp. 43–52, May, 1901, followed by 'Bibliography of Dr. George M. Dawson,' Vol. 15, No. 9, pp. 201–213, December, 1901.

'Besides the above, part of the manuscript of a list of the fossils of the Grand Manitoulin and adjoining islands has been prepared. This report is the result of a study of the palæontological literature of these islands and includes determinations by the late E. Billings, J. J. Bigsby, G. Stokes, Baron de Castelnau, the writer and others. When completed it will form an appendix to Dr. R. Bell's report on the Geology of the Manitoulin Islands now in course of preparation.

Mining Institute.

'At the March meeting of the 'Canadian Mining Institute,' held in Montreal, the following paper was read: 'On the succession and thickness of the geological formations in the gas and oil-fields of Ontario.' The subject-matter in this paper is being embodied in a report for

the Department on the gas and oil wells of Ontario and Quebec. At the same meeting, at the request of the executive of the Mining Institute, I prepared and read a biographical notice of the late Dr. G. M. Dawson. A Bibliography of Canadian Geology and Palæontology during the year 1900, was prepared for the Transactions of the Royal Society of Canada. I have also supervised the preparation of the manuscript of the Index to Canadian Geology and Palæontology from my card catalogue of the Bibliography of Canadian Geology, &c. The bibliographies of the following writers have already been prepared :— Sir William E. Logan, Sir Richard Owen, Sir J. William Dawson, Dr. T. Sterry Hunt, Elkanah Billings, C. Fred Hartt, L. W. Bailey, S. H. Scudder, Dr. G. M. Dawson, H. M. Ami.

Pleistocene geology and artesian wells.

Dr. Ami having already paid some attention to the Pleistocene geology of the province of Quebec and the valley of the Ottawa river, and also to the collecting of logs of artesian wells, he was given the following instructions. Shortly after receiving them, however, he was sent, at the request of Dr. Ells (as mentioned on a previous page) to assist him palæontologically in his work in the district around Kingston. Thirteen days of his time were devoted to that work.

In order to do thoroughly the Pleistocene geology of the areas mentioned in Dr. Ami's instructions, the time of one man for more than a single season might be profitably spent and it was explained to him verbally that he would only be expected to do what he could to obtain as much new information as possible to add to what we already knew of this interesting subject in the region west of the city of Quebec, described in his instructions.

INSTRUCTIONS.

OTTAWA, July 13, 1901.

Instructions.

DEAR DR. AMI.—In the month of April, I mentionned to you that I wished you to make certain original investigations in the field in two departments of geology which I knew were congenial to your taste and inclination, viz: (1) in connection with the pleistocene geology of part of the province of Quebec and part of the Ottawa valley, and (2) to collect in the same regions the records of artesian wells bored into the solid rocks in search of water, etc.

The general nature and the main divisions of the superficial deposits of the province of Quebec are described in the Geology of Canada, 1863. Since that time geologists have been paying much attention to pleistocene geology and it has now become very desirable that we

should make a more systematic and complete investigation of these deposits than has hitherto been attempted.

Instructions to Dr. Ami.

For this purpose, I wish you to work in the field during the present season on this subject and that of the artesian wells referred to. The territory you are to examine extends from the city of Quebec up the River St. Lawrence to Lake St. Francis (where the boundary of Ontario comes to the water) and on either side of the river as far as the high lands which limit the area of the Saxicava sands to the north-east and the south-west. Try to map out in more detail than has heretofore been done, the geographical distribution of this formation and also of the underlying Leda clay. Also try to ascertain the thickness of each formation at as many localities as possible. Visit such localities as you may think likely to prove of particular interest, as to these or other superficial formations and make such investigations as will enable you to describe correctly the phenomena observed. Note the names of all the species wherever you may observe the occurrence of organic remains in any of the surface deposits.

Your work in the Ottawa valley will extend from the mouth of the river as far west as Mattawa and will be mainly on the south side, extending to the general line of the height of land of the St. Lawrence. Here the Leda clay and Saxicava sand will also claim your attention with the same objects as in the St. Lawrence valley. The work you have already done in this district, especially in connection with the organic remains at Green's Creek, etc., will be of much service to enable you to prepare as full a report as possible on the whole subject.

In both the St. Lawrence and Ottawa regions you will also investigate ancient glacial phenomena and all the evidence connected with moraines, boulders, drumlins, kames, osars, sand or gravel plains, old or new land slides, ancient potholes, etc.

Wherever you find distinct evidence of ancient shore lines, take their altitude above the sea or some well-established bench-mark, or water level. As to boulders, note the general size prevailing at any given place, whether angular, sub-angular or rounded, composition or character, how grouped or arranged or occurring.

Note what has been ascertained by experience as to the value or otherwise of clays in different places for the manufacture of brick, pottery, tiles, etc.

Ascertain as much as possible as to peat—the areas, position of boundaries all around the bog, depth, quantity, former attempts to manufacture or use, reasons of failure, suggestions for further trials, etc.

Particulars should be noted as to shell-marl, infusorial earth, ochre, bog iron, sand for moulding, glass-making and any other substance that may be of value.

Collect as much information as possible in regard to springs, wells and underground waters generally among the superficial deposits.

(2.) *Artesian wells.*

As to this second division of your work, try to ascertain where any artesian well has been or is being bored. In each case obtain the best possible 'log,' together with samples of the cores or drillings. Where no regular or systematic 'log' of the well has been preserved, try to ascertain any facts you can about it from the most reliable source, such as date of boring, by whom bored, total depth, general character or rocks penetrated, or any peculiarity connected with them, such as the quantity of water obtained, whether saline, bitter, hard, soft, etc. Inquire as to any indications of gas or petroleum.

The above will provide an ample field and amount of work for your energies for one season without going to Gaspé, about which you spoke. I expect to be able to obtain 'logs' of the wells which have been bored in this district from another source and you will therefore not proceed to that part of the province.

Yours faithfully,

ROBERT BELL,
Acting Director.

H. M. Ami, Esq., F.R.S.C., &c.,
Geological Survey,
Ottawa.

Entomology.

Dr. James Fletcher.

Report of the Entomologist.

Dr. James Fletcher, Entomologist and Botanist to the Dominion Experimental Farms, as Honorary Curator of the entomological collection in the museum of this Department, furnishes the following report:—

I have the honour to report that the entomological collections are all in good condition. A few additions have been made, mainly from

my own collection. The most important of these is a specimen of the very rare *Erebia Vidleri*, Elwes. Three specimens of this butterfly were discovered over thirty years ago somewhere in the mountains of British Columbia by a Capt. Vidler, but nothing was known as to the locality and date. In 1898, on August 15, I was fortunate enough to rediscover the species on Mount Ché-am, near to Agassiz, in the valley of the Fraser. Three specimens were taken, one of which I have had pleasure in depositing in the National Museum. Very few additions have come from the collections made by the field staff of the Geological Survey.

Collections received.

1. I have received one small collection made by Mr. William McInnes around the Lake of the Woods in the autumn of 1899. These were chiefly lepidoptera which had been already recorded from that district.

2. A small but exceedingly interesting collection was handed to me by Prof. John Macoun for naming, made on Telon river in June and July, 1900. These specimens bore on the labels 'J. L.' but Prof. Macoun tells me that they were collected by Mr. Jas. Tyrrell In this collection I found one specimen of the rare Arctic butterfly *Erebia Rossi*, Kirby, of which previously we had no specimen in the collection. There were other species in this collection which will be of use for the cabinets, but which were in rather poor condition.

3. A collection of lepidoptera, coleoptera and neuroptera, was made by Mr. James Macoun in June, July and August, 1901, along the Chilliwack river and at Sumass lake, in British Columbia. In this collection was one much damaged specimen of the rare *Erebia Vidleri*, above referred to, taken at 6,000 feet elevation in the Ché-am mountains. These are the only localities so far known for this insect. Among the beetles, the best addition to the museum was *Pachyta armata*, Lec., a rare and handsome carambycid.

Utility of collecting.

May I again ask you to urge upon the members of the staff the value to the museum of collections of insects, however small these may be, when exact dates and localities are given. As I have pointed out previously, if each party would bring back only half a dozen specimens, there would doubtless be included in these every year valuable additions to the national collection. Every specimen placed in the cabinets bears the collector's name and the locality and date of capture. Full credit is also given every year in the report, and complete lists are kept with the idea at some future time of publishing a systematic catalogue of the insects of Canada, similar to Prof. Macoun's invaluable catalogues of plants and birds.

I am quite aware that the officers of the Geological Survey have a great deal to do when in the field and that they have not many facilities for collecting and caring for such delicate specimens as insects, but their opportunities are so exceptional and such good work has already been done by a few, such as yourself, Dr. Geo. Dawson, Messrs. John and J. M. Macoun, W. McInnes, A. P. Low and J. McEvoy, that in the hope of inducing others to do work of a similar nature I beg to request you to ask all members of the Geological Survey staff working in the field in new localities to make an effort to bring home with them at least a few specimens every year. No matter what these may be, there is sure to be something among them that is desirable, and which will add, not only to the museum collection, but to the known facts with regard to many species of economic and scientific importance. I would specially request that attention be paid to the insects which injure forest trees, and, in conclusion, I would point out that great care should be taken in labelling every specimen with the locality and the date of capture. Lepidoptera, neuroptera and hymenoptera may be placed in envelopes, one specimen in each; specimens of orthoptera should each be rolled in paper, and coleoptera may be placed in bottles among sawdust slightly dampened with alcohol. The label for these should be written in pencil on paper and placed inside the bottle with the specimens.

Exceptional opportunities.

Insects injurious to trees.

The Library.

Dr. John Thorburn.

During the ten months from January 2, to October 31, 1901, there have been distributed 8,305 publications of the Geological Survey, comprising reports, parts of reports, special reports and maps. Of these 4,364 were distributed in Canada; the remainder, 3,941, were sent to foreign countries as exchanges to universities, scientific and literary institutions and to a number of individuals engaged in scientific pursuits. Due care has been exercised in the distribution of our publications, inasmuch as if all the applications were granted, the supply which is limited would soon be exhausted. A large number of the earlier reports and maps are now out of print, and can no longer be supplied.

Distribution of publications.

The sales of publications during the above period, including reports and maps numbered 3,117; the amount received for these being $530.45.

There were received, as donations or exchanges 2,427 publications, including reports, transactions, proceedings, memoirs, periodicals,

Donations received.

pamphlets and maps; besides which twenty-seven publications were purchased and thirty-seven scientific periodicals were subscribed for.

The number of volumes bound was 120.

Letters.

The letters received in connection with the library numbered 967, besides 744 acknowledgments for publications sent out.

The number of letters sent out from the library was 969, besides 521 acknowledgments for exchanges and to persons from whom publications were received.

Volumes in library.

There are now in the library by actual count 12,706 volumes, besides a large and valuable collection of pamphlets.

As has been frequently stated in former reports, the space available for library purposes is altogether insufficient. The cases are filled and a large number of books are piled up on the floor of the library and in other parts of the building, and consequently, it is often difficult to find books which are required for consultation by members of the staff.

It may be stated that books in the library are available for consultation by persons wishing to obtain information in regard to any scientific subject.

Visitors to the Museum.

Visitors to the Museum.

The number of visitors to the museum who signed their names, was 37,895 during the calendar year 1901, being an increase of 1,804 over the previous year, but a large percentage of the visitors do not take the trouble to register.

Staff, Appropriation, Expenditure and Correspondence.

Staff, etc.

The strength of the staff at present employed is fifty-four.

During the year changes in the staff have taken place by the death of Dr. G. M. Dawson, Deputy Head and Director, and by the resignation of Messrs. J. C. Gwillim, A. P. Low and James McEvoy.

Messrs. W. W. Leach and Jos. Keele, science graduates, were appointed to the positions rendered vacant by Messrs. McEvoy and Gwillim.

The funds available for the work and the expenditure of the department during the fiscal year ending June 30, 1901, were:—

Details.	Grant.	Expend'ure.
	$ cts.	$ cts.
Civil-list appropriation	53,900 00	
Geological Survey appropriation	62,000 00	
Civil-list salaries		51,436 14
Exploration and survey		21,724 86
Wages of temporary employees		16,952 32
Printing and lithography		13,276 84
Purchase of books and instruments		1,307 58
" chemical apparatus		133 38
" specimens		91 60
Stationery, mapping materials and King's Printer		1,459 19
Incidental and other expenses		2,299 26
Advances to explorers on account of 1901-02		14,234 27
		122,915 44
Deduct, paid in 1899-1900 on account of 1900-01		9,537 80
		113,377 64
Unexpended balance civil-list appropriation		2,463 86
" " survey "		58 50
	115,900 00	115,900 00

The correspondence of the department shows a total of 6,822 letters sent, and 7,110 received.

I have the honour to be, Sir,
Your obedient servant,

ROBERT BELL,
Acting Deputy Head and Director.