GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., Sc.D., LL.D., F.R.S.

REPORT

ON AN

EXPLORATION

OF THE

EAST COAST OF HUDSON BAY

FROM

CAPE WOLSTENHOLME TO THE SOUTH END OF JAMES BAY

BY

A. P. LOW, B.Sc.

OTTAWA
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Richmond Gulf.

ROBERT BELL, L.L.D., D. Sc., M.D., F.R.S.
Acting Director Geological Survey Department.

SIR,—I herewith beg to submit my report on an exploration of the east coast of Hudson Bay. In so doing, I beg to acknowledge the kindness and assistance received from Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, and from the following gentlemen in that company's service: Messrs. W. K. Broughton, D. McTavish, D. Gillies, Miles Spencer, A. Nicholson, J. A. Wilson and Capt. Alex. Gray, all of whom materially aided in the success of the exploration.

I have the honour to be, sir,
Your humble servant,

A. P. LOW.

REPORT

ON AN

EXPLORATION OF THE EAST COAST OF HUDSON BAY

FROM

CAPE WOLSTENHOLM TO THE SOUTH END OF JAMES BAY

Area explored.

This report is based upon the information obtained by an exploration of the east coast of Hudson bay, extending from Cape Wolstenholme at the entrance of Hudson strait, southward to the Rupert river in the southern part of James bay. The work of exploration extended over the summers of 1898 and 1899; and during the intervening winter two exploration trips were made inland, the first into the barren interior, in N. lat. 57°; and the other on the northern branches of the Great Whale river. The information so obtained was supplemented by that collected from the northern Eskimos, who annually visit the trading post at Great Whale river, to exchange the products of the hunt for powder, shot and other necessaries. A number of sketch-maps and much information concerning the character of the north-western portion of the Labrador peninsula were obtained from these people, so that what was blank on previous maps may now be at least roughly filled in.

Surveys by Mr. G. A. Young.

A log-survey of the entire coast was made by my assistant, Mr. G. A. Young, B. Sc., who also carried out a micrometer survey of the coast between Richmond gulf and the mouth of Big river. These surveys have been plotted and appear in the maps accompanying this report. Mr. Young also kept a continuous set of meteorological observations and made a large collection of the plants found in this region, which although containing comparatively few new species, is valuable in extending the range of many already known.

Earlier investigations.

Rough surveys and observations must have been made long ago from the ships trading to Hudson bay, for the earliest charts of the bay give indications of all the principal features of the east coast. W. Coates, who was captain of one of the ships of the Hudson's

Bay Company between 1727 and 1751, left sailing notes in which he describes Richmond gulf and other places along the east coast. About 1860, Mr. Anderson, who was in charge of Great Whale river post, made a canoe trip northward from that place to Mosquito bay, to examine the porpoise fisheries in the northern rivers. He made an excellent track-survey of this portion of the coast, and a manuscript copy of his map is now in the possession of the Hudson's Bay Company at Great Whale river.

Exploration by Dr. Bell.

During the summer of 1877, Dr. Bell made an exploration of the east coast of Hudson bay, as far north as Portland promontory, and the results obtained were published in the annual report of the Geological Survey for 1877-78,* together with a map of the coast from Great Whale river to Portland promontory on a scale of four miles to one inch.†

During the summers of 1887 and 1888, the writer was engaged examining the islands of James bay and some of the rivers flowing into the east side of Hudson bay.‡

Division of area.

The east coast of Hudson bay may, for descriptive purposes, be divided into three portions, namely, the northern part extending from Cape Wolstenholme to Portland promontory, the middle section lying between Portland promontory and Cape Jones, and the southern portion from Cape Jones to the south end of James bay.

The northern and southern sections are very similar in character, the shores being formed of low rounded hills of gneiss or granite, rising very little above the wide drift-covered valleys; and inland, presenting a slightly rising plain broken by long, rocky ridges, hardly worthy of the designation of hills. The shores are rocky at points, while the bays are fringed by sand or boulder beaches. The water for a considerable distance from land is shallow, and the bottom very uneven, with rocky ledges and sharp ridges of boulders, which, when they rise above the surface, form the wide fringe of small islands characteristic of these portions of the coast. From the above description, it will be seen that the greater parts of both the northern and southern sections of the coast are dangerous to approach with ships drawing any considerable depth of water, especially in the present unsurveyed state of the waters. The central portion, however differs from the coast to the north and south of it, being bold, with hills often rising directly from the water to altitudes of a thousand feet and upwards.

Portions of coast dangerous for navigation.

* Report of Progress, Geol. Surv. Can., 1877-78, part c.

† In 1875 Dr. Bell made an examination of parts of the southern and eastern shores of James Bay. See Report of Progress for 1875, pp. 322-5 and pp. 341-2.

‡ Annual Report Geol. Surv. Can., Vol. III (N.S.), Part II.

Chains of islands, lying from half a mile to five miles from the coast with deep water between, extend along more than half this section, and afford excellent shelter for the largest ships, as well as a safely protected channel for small craft.

Cape Wolstenholme.

About Cape Wolstenholme the land rises abruptly with steep cliffs facing the sea to elevations of a thousand feet and upwards, being a continuation of the high land forming the south shore of Hudson strait. From Cape Wolstenholme the general trend of the coast is about south-west for thirty miles to Nuvuk. Along this stretch of coast the shores are generally rocky and indented by many small bays with numerous rocky islands lying between the mainland and the large, high Digges island. On leaving the cape the general elevation of the land sinks rapidly, so that at Nuvuk the highest hills have an elevation of not more than 500 feet, and the general level along the coast is much less. From Nuvuk to Kovik the coast runs nearly due south, and the distance is sixty miles. This portion is characterized by flat shores, rising slowly into barren plains of drift, from which protrude low, rounded ridges of granite. The shore in many places is fringed by long, low islands of drift, with very shallow water between. This is a favourite summer feeding ground for the barren ground cariboo, which roam over it in small bands. From Kovik the general trend of the coast is south for twenty-five miles, and then south-west for thirty-five miles to Cape Smith. The coast and country along the first of these courses is very similar to that last described, but along the second course a high range of snow-capped hills, which form the highlands of Cape Smith and the neighbouring islands, approaches the coast at an acute angle with a gradually narrowing, low drift plain between the sea and the hills. This range of hills comes out at Cape Smith, and from there runs far inland in a direction about east north-east, forming the north shore of Mosquito bay. The hills are formed of dark green diabase thrown up into a number of sharp, narrow, parallel ridges with a small river connecting chains of small lakes in each valley. The hills vary from 500 feet to upwards of 1,000 feet in altitude, and the higher summits are partly covered with snow. Rising as they do from the nearly flat country on both sides they form a prominent feature of the country.

Feeding ground of cariboo.

Mosquito bay.

Mosquito bay, as is usual with all unsurveyed inlets, has been shown altogether too large on previous maps. The distance from the point of the mainland at Smith island to its head is only twenty-eight miles, and being divided by a long, narrow point into two bays, varying from one to three miles wide, its total breadth is much less than

is given on the charts. Some of the older charts show a water connection between this bay and Hopes Advance bay on the west coast of Ungava bay, but it is now known that several hundred miles of land lie between them. Southward from Mosquito bay the coast-line is greatly broken by large, irregular bays, with generally rocky shores, never very high, and backed by a rocky country, formed of long, rounded hills seldom exceeding an elevation of three hundred feet. A wide fringe of islands extends along the coast; these are usually rocky, but many are formed of boulders and finer drift material. The water for a considerable distance from the mainland is shallow, and the murky nature of the bottom renders an approach dangerous for any craft. This character of coast extends from Mosquito bay to Portland promontory, or from latitude 58° 45′ to lat. 60° 45′.

Portland promontory to Cape Jones.

Between Portland promontory and Cape Jones the coast forms a long flat segment of a circle with the convexity to the eastward. This portion is characterized by bold granite hills rising quickly from the coast, and in part flanked by trap-covered sedimentary rocks, which also form chains of islands running parallel to the coast. The first of these chains is the Hopewell group, which lie close to the mainland and extend south-east for fifty miles from Portland promontory. They are formed from tilted sedimentary rocks capped with a considerable thickness of trap. The rocks dip gently seaward and present abrupt cliffs along their inner sides. The channel between them and the mainland varies in breadth from a few yards to upwards of a mile. At Hopewell Narrows, about the middle of the chain, the channel is less than twenty yards wide,* and is only covered with about three feet of water at high tide, thus rendering a passage for large craft impossible; everywhere else there is a sufficient depth of water.

From the Hopewell islands to the mouth of Langland river, the distance is fifty-eight miles and the general direction S.S.E. This portion of the coast is very bold, with high granite hills rising directly from the shore. A few small islands of granite and trap occur close to shore, and these, in conjunction with small bays, afford excellent shelter for small boats.

Sound formed by Nastapoka islands.

The mouth of Langland river practically marks the northern end of the sound which is formed by the Nastapoka chain of islands extending southward nearly one hundred miles to Little Whale river. These islands are similar to those of the Hopewell chain, but are without the capping of trap. The mainland is occupied by high granite hills, which to the southward of Nastapoka river, are flanked by tilted

* Report of Progress, Geol. Sur. Can., 1877, p. 33, part c.

sedimentary rocks capped with trap. The sound varies from a quarter of a mile to three miles in breadth, with deep water in the channel everywhere.

Manitounuk sound.

From Little Whale river to the northern opening of Manitounuk sound, the coast runs south-west for twenty-eight miles. The trap rocks rise directly from the water, forming a ridge from 600 to 1,000 feet high, and there are no harbours for even small sailing boats. Manitounuk sound from its northern opening to Great Whale river is about thirty miles long and it varies in breadth from half a mile to three miles. The northern or boat opening is very narrow and only available for small sailing boats. The second opening is eight miles farther south and has a good channel with deep water. The Manitounuk islands resemble those of the Hopewell chain, being formed of stratified sandstones and limestones capped with trap, with steep cliffs facing the sound and gentle slopes to seaward. The mainland is less rugged than to the northward, rising a mile or so from the coast into rounded hills of granite that vary from 500 to 1,000 feet in elevation. The margin between the hills and the water is occupied by sandy plains from which rise at intervals ridges of tilted limestone. These limestone ridges also form chains of small islands along the mainland. Another portion of the ridge forms a peninsula about ten miles north of Great Whale river, with an excellent harbour on its north side.

Great whale river to Cape Jones.

The distance from the mouth of Great Whale river to Cape Jones is eighty-five miles and the general direction about south-west. The coast along this section is remarkably straight without any bays or prominent points. The granite hills only come out to the shore in a few places, usually being from half a mile to three miles inland with sandy, terraced drift occupying the interval between them and the shore. A broken ridge of tilted up limestone rests upon the shore for about ten miles, commencing about 15 miles south-west of Great Whale river. Behind this ridge are a number of excellent boat harbours. This portion of the coast is very free from islands until Long island is reached, and in consequence is easily approached by vessels of all sizes. Long island is twenty-four miles in length and varies from half a mile to three miles in breadth. Its north-east end is thirty-five miles from Cape Jones, and it lies parallel to and about four miles from the mainland. On its inner side it frequently presents low cliffs of limestone and sandstone, while a second low ridge running down the middle of the island is formed of carbonate of iron capped by trap. Between the south-west part of the island and Cape Jones, the sound is occupied by a large number of low islands formed of lime-

Islands of limestone.

stone. From Cape Jones all the the way southward to the mouth of the East Main river, a distance of upwards of 175 miles, the character of the coast is very similar to that already described between Mosquito bay and Portland promontory. The mainland is formed of low rounded hills and ridges of gneiss and granite rising slightly above swampy valleys of clay and sand. With few exceptions the hills never exceed 200 feet in elevation, and the general level of the country is under fifty feet. The coast line is very uneven being broken into many large bays, while the entire shore is fringed with islands of rock or drift extending several miles out from the mainland. The water between the islands is generally shallow and the bottom uneven, so that it is dangerous to approach this uncharted coast with deep draught vessels.

Wastikun island.

Wastikun, a cone shaped island, lies about five miles north of the mouth of Big river; and as it has an elevation of two hundred and fifty feet, it is a prominent land-mark and is used as such for vessels approaching that river. The Paint Hills islands are also higher than any land in their neighbourhood and having deep water about them are safe to approach from seaward. Cape Hope island, which lies about fifteen miles north of the East Main river, is also high and is seen a long distance off.

Sherricks mount.

The coast to the southward of the East Main river is even lower than that to the northward, and the rocks only come out on shore in a few places. Islands are less numerous, and towards the mouth of Rupert bay are largely formed of drift. Sherricks mount, which marks the eastern entrance to Rupert bay, is a peninsula with a cone-shaped hill about 700 feet high, and it forms the most striking land-mark of James bay. To the southward of the East Main river the whole bottom of James' bay has been silted up with sand and mud brought down by the large rivers flowing into its southern part, and in consequence, wide flats extend far out from shore, increasing in width as Rupert bay is approached, so that in that bay the only navigable parts are in the channels cut out by the currents of the rivers flowing into it, and even these rarely have a depth exceeding ten feet.

Notes on the Northern Interior.

The interior country south of a line drawn from Richmond gulf to the mouth of the Koksoak river has been described in former reports*

* Annual Report, Geol. Surv. Can., 1887-88, Vol. III (N.S.,) part II. J.
ibid " 1895, Vol. VIII. (N.S.,) L.
ibid " 1896, Vol. IX. (N.S.,) L.

on the Labrador peninsula, and the present notes will be confined to the region situated north of this line. My personal knowledge of this region is confined to a trip of about one hundred miles made in winter from the coast of Hudson bay inland along the 57th parallel of latitude to Kasiagaluk, or Lake Minto; also to short excursions up the lower stretches of the Sorehead, Povungnetuk and Kogaluk rivers. This knowledge is supplemented by information derived from many of the Eskimos, who roam over this interior region; and who having been greatly underrated by Mr. Gillies and the Rev. Mr. Walton in supplying the information asked for, took infinite pains in making sketch maps of the areas personally known to them. By means of these sketches much of the map previously a blank is now filled with great lakes and their connecting watercourses. The north-western interior of the Labrador peninsula lying between Hudson and Ungava bays is not, as was formerly supposed, a high mountainous region. The northern part fronting on Hudson strait is the most rugged, the land there generally presenting abrupt cliffs to the sea, and rising quickly inland to elevations varying from 1,000 to 2,000 feet. This high plateau extends southward to a line drawn roughly east north-east from Cape Smith and coming out on the east coast in the neighbourhood of Cape Hopes Advance at the western entrance to Ungava bay. Along the Hudson bay coast, the land does not rise as abruptly as that fronting on Hudson strait, and one travels several miles inland before elevations of 1,000 feet or more are reached. The whole of the region is formed of long glaciated ridges of granite or gneissic hills, flanked to the southward with the high steep ridges of trap which are a continuation of the Cape Smith area of those rocks. The valleys between the ridges are dotted with lakes, none of which are very large, and these are connected by a network of small streams which seldom attain the size of rivers, as the watershed of this region is not far inland. The largest stream flowing into Hudson bay is the Kovik (brook), the mouth of which is situated near latitude 61° 30′. At a small rapid above its mouth, it has an average breadth of one hundred yards and an average depth of nine inches. The Illukotat, Kingwa and Korak are smaller streams emptying into the bay in the vicinity of Cape Smith. The whole of this northern hilly region is devoid of trees and in most places only bare rocks are seen strewn over with blocks and boulders of granite. The finer drift material is confined to the valleys. Although in a sense very barren and desolate, this region is not wholly so, as wherever any soil is found it supports a growth of arctic plants and the rocky surfaces are often hidden by lichens. Snow lies perpetually in patches in the higher valleys and the contrast between

Excursions inland made in winter.

North-western interior not mountainous.

Area devoid of trees.

it and the beautiful flowers that spring up in the immediate neighbourhood is very pleasing. The vegetation is chiefly saxifrages and other flowering plants growing close to the ground, together with the various white or gray lichens (reindeer mosses), sedges and grasses, all of which provide food for the large bands of barren ground caribou that frequent these regions during the summer months.

The area lying south of that just described and along the Hudson bay coast extending southward to Portland promontory and on the Ungava bay coast to Hopes Advance bay is described by the Eskimos as a moderately high plain largely drift covered, with low rocky ridges rising above the general level of the drift. The general altitude of this region is probably below 500 feet and long stretches inland from both coasts are considerably lower. This is a region of large rivers and great lakes. The Povungnituk and Kogaluk are the largest streams emptying into Hudson bay, which also receives the waters of the Sorehead, Koktak and Nauberakvik. The mouth of the Povungnituk river is near latitude 60° and it empties into a strait five miles in length which carries six fathoms of water up to the first rapid at its head. Above this it is separated into three channels by large islands; its volume must be nearly equal to that of the Ottawa river. This stream drains a large area of country to the east and north-east of its mouth, its headwaters extending to within one hundred miles of the coast of Hudson strait near Stupart bay. It is to the headwaters of this river that the Eskimo go annually to kill the barren ground caribou as they migrate southward in September; this they do by spearing them in the water while crossing the narrows of long lakes, or feeding places in the rivers. The Kogaluk is even larger than the last mentioned river and drains a number of large lakes to the eastward of its mouth, which is near latitude 59° 30′. Its headwaters interlock with those of Payne river flowing into Ungava bay and the summit is so low that very little difficulty is encountered in crossing this portion of the peninsula by following the waterways. Payne river is the most important stream emptying into Ungava bay and takes its rise in Tasukrak or Payne lake, one of the largest lakes of the peninsula, being about a hundred miles long.

Povungnituk and Kogaluk rivers.

The southern portion of the area under consideration extends along the Hudson bay coast from Portland promontory to Little Whale river, and along the east coast from Hopes Advance bay to the mouth of the Koksoak river. This area, although not high, is much more rugged than the central district and slopes up gradually to the southward where the watershed attains an elevation of about 800 feet. The entire

Extent and description of southern area.

region may be described as a rocky plateau greatly broken by rounded granite hills and ridges. The land rises abruptly along the western coast and for upwards of thirty miles inland is almost wholly driftless, nothing being seen but the naked rock, partly covered with arctic vegetation. The central area is less rugged and has more drift in its valleys, while the eastern part is less rugged than the western area. The valleys between the ridges are filled by lakes, often of great size, the largest of which is Kasiagaluk or Lake Minto, which is upwards of 100 miles long and empties into the Leaf river which flows eastward into Ungava bay.

Forest Areas.

Timber.

The southern portion of this region is partly wooded, the northern tree limit, leaving the coast of Hudson bay near the north end of Richmond gulf,* curves northward and crosses the route to Lake Minto about 20 miles inland, thence bending eastward and southward recrosses the Leaf river about 100 miles inland and comes out on Ungava bay near the mouth of the Koksoak river. The trees near the northern limit are all short and straggling; they grow only in the protected valleys and their struggle for existence is manifest by the number of dead tops and branches found everywhere. Black spruce and larch, or tamarac, are the last survivors of the forests to the south and the latter tree grows to about twice the size of the spruce. The white spruce reaches nearly as far north as the black spruce, and the balsam poplar comes next in order, followed quickly by the balsam fir, all of which trees are found on the islands of Richmond gulf. The banksian pine grows as far north as the Great Whale river, which is also the limit of the white birch and aspen.

Northern tree limit on Hudson bay coast.

As before stated, the northern tree limit on the coast of Hudson bay is towards the north end of Richmond gulf. Thence southward trees grow in protected gullies on the mainland to Mantounuck sound where the country is fairly well wooded with small black and white spruce and birch; small trees of the same species also growing on the inner sides of the Manitounuck islands. Southward of Great Whale river the coast is wooded to beyond the northern end of Long island, where the limit passes inland leaving the islands and Cape Jones barren. The trees again come out to the coast about twenty five miles south of Cape Jones and continue from there southward. The islands off the coast between Cape Jones and Big river, with the exception of a few southern ones close inshore, are all barren. To the

* See Report of Progress, Geol. Surv. Can., 1877, p. 25c.

southward of Big river the trees gradually extend outwards on the islands so that at Cape Hope all of them are wooded. Merchantable timber is found in the valleys of all the rivers northward to the East Main river and pulpwood to the Big river, beyond which, although much of the country is well wooded the trees are small and the branches continue to the ground, causing the stems to be full of knots and consequently of little value.

Climate.

Climate.

With a difference of 800 miles of latitude, it follows that the climate of the northern and southern portions of the east coast will show marked differences. The southern portion may be classed as cold temperate, while the northern part is truly arctic. The temperate climate may be taken to extend to Cape Jones or to be limited to the shores of James bay. While to the northward it is subarctic or arctic and unfit for agricultural purposes of any kind, at Rupert House in the southern part of James bay excellent root crops are grown annually. Oats have also been successfully grown there and no doubt the hardier varieties of wheat would also ripen.* Rupert House is situated practically upon the sea-shore and consequently directly influenced by the cold ice-laden waters of James bay which must considerably lower the temperature in early summer. Such being the case there can be little doubt that better crops could be raised a short distance farther inland, away from the direct influence of the sea.

Large area inland suitable for farming.

There is no doubt that the large area of country situated to the south and south-east of James bay and underlain by good clay soil capped with sandy loam would with proper drainage make excellent farming land capable of raising any crop grown in the North-west territories. At the mouth of East Main river, roots are grown to perfection and abundant crops of wild hay are gathered yearly to feed the large herd of cattle kept there. At Fort George, at the mouth of Big river, good crops of potatoes and other roots are grown annually, and cattle are also kept. This is the present northern limit of agriculture as nothing is grown at Great Whale river where sandy soil aids the climate to prevent the successful cultivation of any crop. In an appendix is given the meteorological observations kept during the time of the exploration.

Fisheries.

Fisheries.

The fisheries of Hudson bay will probably prove to be its greatest natural resource, as along the east coast the sea is found well stocked

* In 1896 and 1897 wheat ripened at Waswanipi, in lat. 1° 45′, or 122 miles south of Rupert's House, from seed sent by Dr. Robert Bell to the officer in charge of that post.

everywhere with food fishes. In James bay a net set at random along shore or about the islands always caught fish. These are usually sea-run brook trout and whitefish identical with the Lake Superior whitefish* and being sea-run are, like the trout, much improved in flavour. These trout and whitefish vary in weight from one to six pounds and are the best of food fish. Similar fish are found abundantly along the entire coast to Cape Wolstenholme. The Arctic trout or Hearne salmon* is found along the northern coast as far south as Seal river, which is situated a few miles south of Cape Jones. This is a beautiful fish with well flavoured, dark pink flesh and it varies in weight from one to fifteen pounds, the average being about five pounds. These fish are salted at Fort Chimo on Ungava bay and fetch nearly the same price in London as salted salmon from the same locality. They are very plentiful about the mouths of the northern rivers and along the coast, while the Eskimos report them abundant at the Belcher and other islands lying off the east coast. There is no doubt that this fish equals or surpasses in colour and flavour the salmon of British Columbia. Cod are known to exist in Hudson bay,* being taken at Cape Smith and at Comb Hills in James bay by members of the expedition. The Eskimos also catch them in Nastapoka sound and at the Belcher islands; at a number of places in James bay they are also taken by the Indians.

Hearne salmon plentiful.

The specimens of cod taken by us were not very large but the men who caught them were Nova Scotia fishermen and said that they were true cod and identical with those taken on the Grand Banks. Food for these fish is abundant in Hudson bay and there is no reason why extensive fisheries in this Canadian inland sea should not exist. The undoubted presence of cod in Hudson bay deserves investigation, as a very valuable and exclusively Canadian fishery may be found there. The presence of cod points to that of halibut in the deeper waters of the bay.

Existence of cod fish in Hudson bay confirmed.

The only other salt-water food fishes in Hudson bay are a couple of species of sculpin which are eaten extensively by the Eskimo. Sturgeon are caught in the lower parts of the southern rivers to the East Main river and lake trout occur in the mouths and lower reaches of the northern rivers. The Atlantic salmon does not appear to enter Hudson bay, as no record could be obtained of its doing so from the Eskimos. Its range in the arctic waters of Hudson strait seems to limit it to the rivers on the west side of Ungava bay. A curious coincidence in connection with this range of the salmon is that the ouananiche or land-locked salmon has never been found in the waters

* See Report of Progress, Geol. Surv. Can., 1877, p. 28 c.

of rivers flowing westward into Hudson bay although common in the rivers of the northern, southern and eastern watersheds of Labrador.

Detailed Description of Explorations.

Details of exploration.

Early in May, 1898, I received instructions to prepare for an exploration of the east coast of Hudson bay southward from Cape Wolstonholme. For this work the small yacht built in 1897 and used on an exploration of Ungava bay was available, it having been stored at Nachvak, the most northern post of the Hudson's Bay Co., on the Atlantic coast of Labrador. After finishing the summer's work I was instructed to pass the winter with my party at the Hudson's Bay Co.'s post at the mouth of Great Whale river, and in the spring months to explore the inland part of the northern portion of the Labrador peninsula of which little or nothing definite was known. During the summer of 1899 the exploration of the islands was to be continued and if time allowed the latter part of the season was to be devoted to the examination of the Huronian rocks which occur in the vicinity of Paint hills and Cape Hope on the east coast of James Bay. The yacht at the end of the season was to be stored for future use at Moose Factory and the party to return home in canoes up the Moose river to the Canadian Pacific Railway at Missinaibi. In pursuance of the above instructions arrangements were made with the Hudson's Bay Co. for the transport of the party and necessary supplies in their schooner from Quebec to Rigolet where the SS. *Erik* would be met and the voyage to Cape Wolstenholme continued in her, picking up the yacht at Nachvak. At the same time transport by canoes from Missinaibi to Moose Factory was arranged for a portion of the winter's supplies which could not be purchased at Moose Factory, from which place they were to be shipped with provisions purchased there to Great Whale river in the Company's schooner. Mr. C. C. Chipman, the Chief Commissioner of the Hudson's Bay Co., kindly sent me a circular letter to the officers in charge of the various posts at which we were likely to call, containing instructions to afford us all possible aid and information and providing for our wintering in the Company's buildings at Great Whale river.

Arrangements for transport of party from Quebec to Rigolet.

Mr. G. A. Young appointed assistant.

Mr. G. A. Young, B. Sc., who had been with me during the preceding two years, and who was well qualified to undertake the duties that would devolve upon him, was again appointed as assistant. The remainder of the party was made up of James Lantz, sailor and carpenter ; James Schupe, sailor and cook, and Henry Ford, sailor and

Eskimo interpreter. Lantz had the year previous been with Dr. Bell in a similar yacht on the north side of Hudson strait, and Ford was employed as interpreter on the *Diana*. I may here state that they all discharged their various duties in a satisfactory manner.

Having learned that the schooner would sail from Quebec on or about the 25th of June, I left Ottawa on the 20th for Quebec, where I was joined by Messrs. Young, Lantz and Schupe. Here the final supplies and outfit were purchased, and we were all ready to go on board at the time appointed, but owing to delays caused by the non-arrival of part of the cargo belonging to the Hudson's Bay Co., we did not leave Quebec until the 30th. The schooner was loaded above the bulwarks, and as the cooking and cabin accommodation were scant the trip of over two weeks to Rigolet was not pleasant, and was rendered more disagreeable by bad weather and fog which also caused considerable delay. Rigolet was reached on the 15th of July, and we there found the *Erik* awaiting us. The *Erik* left on the 19th, and, after calling at Davis inlet, reached Nachvak on the 23rd, where we found the yacht in good order, having been carefully looked after during the winter by Mr. Guy, the gentleman in charge of that post.

Embark on SS. *Erik* at Rigolet.

On the 26th of July we steamed out of Nachvak bay and were off Cape Chidley that night, having passed but little field ice and few icebergs. To the southward of Nachvak only a very few detached fields of ice were encountered, and along the whole Atlantic coast there was a remarkably small quantity of ice. This was probably due to the prevalence during the early summer of strong west and south-west winds which drove the northern pack away from the coast, as extensive fields of heavy ice were passed through by the *Erik* about one hundred miles off the coast when on her way to Rigolet from England.

Entering Hudson strait, some loose ice was met with off the Button islands. The next day we passed through stringers of loose ice, the heaviest being about ten miles south of Resolution island, with the appearance of wider streams to the southward. On the morning of the 28th, we were abreast of Frobisher glacier on Baffinland, and steamed along about ten miles from the coast, gradually approaching the land towards Icy cove, where we again sheered off for the Upper Savage islands and Big island. Little field ice and few bergs were encountered until about ten miles beyond Icy cove, where a few scattered pans were seen; after which open water continued to nearly abreast of the Upper Savage islands, when a thick pack was met with extending to the southward with open water five miles out from the

Enter Hudson strait.

islands. The open strip gradually narrowed as Ash inlet on Big island was approached, and the ship lay to for the night in the ice about five miles to the east of that place. The next morning we soon cleared from the pack, but more fields were seen to the southward about fifteen miles to the westward of Douglas harbour. These gradually widened and blocked the strait to within twenty-five miles of Charles island, when open water was again reached. During the night and next day more or less open water was passed, the ice in no place being tight or heavy enough to block the passage of an ocean steamer, and in the evening we were close to Cape Wolstenholme, where it had been decided to land our party. During the passage from Nachvak we were all busily employed partly sheathing the yacht with strips of maple to protect her from the ice, and in making necessary alterations inside and overhauling the gear.

Leave the *Erik* near Cape Wolstenholme.

Early on the 31st we steamed into Erik cove, situated just east of Cape Wolstenholme. The *Erik* anchored near the head of the cove, and we were busy all day unpacking our outfit and stowing it aboard the yacht, and in getting the sails bent. Everything being aboard, the *Erik* left us at 7 p.m. for Churchill, and we sailed to the head of the cove, anchoring near the mouth of a little river which flows in from a deep valley extending to the southward. On the 1st of August, while the men were engaged on the yacht, Young and I ascended the hills to the westward of the anchorage and killed two barren ground caribou ; later we examined the rocks along the west side of the cove and ascertained the barometric heights of the terraces facing the open strait. Besides the two caribou shot, several small bands of these animals were seen wandering over the hills. Deer Creek cove, in which we anchored, lies immediately east of Cape Wolstenholme. It is about three miles long, two miles broad at its mouth and only slightly over half a mile wide at its head, where a small river enters on the west side. This stream for three miles wanders in a narrow channel from wall to wall of the extension of the valley, having cut down some thirty feet below the level of the sandy plain which fills the bottom of the valley. Beyond, the grade increases as the valley narrows, and the stream changes to a rapid mountain torrent. The cove and valley are walled in by steep cliffs that rise abruptly from 600 to 1,000 feet, and then more gradually into rounded hills, with altitudes ranging from 1,000 to 1,500 feet above the sea. The cliffs are largely composed of schists and gneisses, greatly rotted and standing on edge, and are thus very uneven. Great patches of snow filled all the gulleys and spread over the valleys between the upper hills. Many of these patches were formed of old snow, showing that they never

Patches of perpetual snow.

entirely melt during the few hot days of the short summer in this region. No trees grow anywhere, and the Arctic willows never exceed two or three inches in height, but notwithstanding this absence of forest, the Arctic shrubs and flowering plants covered with brilliant bloom, which carpet every spot where the least soil is found, give a pleasing sense of life which contrasts forcibly with the barren and frozen aspect of the rocky cliffs and the snow fields. In the main and smaller side valleys, the sand that flanks the cliffs is cut into many terraces which rise as a series of narrow steps to a height of over 800 feet, and as many as twenty-eight were noted in one series. These mark the successive shore lines of the land produced during its rise since the close of the glacial period. The rotten state of the cliffs would at first lead to the belief that they had been unglaciated, but an examination of the undecayed surfaces near the water and on the hills above show that such was not the case, the stream of the glacier having striated the summits of the highest points.

Absence of forest.

Starting next morning we only reached Cape Wolstenholme at noon, and anchored in the evening in a small cove four miles to the westward of it. The cape is a bold headland with jagged cliffs rising abruptly over 1,000 feet from the water, and formed of perpendicular bands of gneiss and schist. The irregular weathering of these rocks has given the coast a serrated appearance, and great cliffs extend from the water to the summits. These broken cliffs are the nesting place of tens of thousands of Brunneck's guillemot or murre. The noise caused by the birds leaving their nests when frightened by the discharge of a gun is terrific, and sounds as if the face of the cliff were falling. Wherever there was a shelf sufficiently wide for an egg to rest, there would be a row of birds packed tightly together and each straddling a single egg. The birds were exceedingly tame, and almost allowed themselves to be taken by hand before they would leave their egg. The eggs were very nearly hatched, and a few young birds were seen on some of the ledges. A large number of gulls, ravens and gyrfalcons were seen flying about the cliffs, and at the base we found the body of an Arctic fox, a victim of poaching.

Brunneck's guillemot.

Cape Wolstenholme terminates in a sharp narrow point about 200 feet high which stretches out about 200 yards from the main cliff. Past it, the tide sets with a very strong current. The east point of the eastern or smaller Digges island lies about two miles north of the cape. This island is a little over two miles long, and is formed of high deep cliffs like the mainland. It is also a favourite nesting place of the guillemots. It may be here stated that these birds do not breed to the west-

Observation station at Port Laperrière.

ward of Digges, and are only rarely seen along the east coast of Hudson bay. The larger island is about twelve miles long and is also rocky but not so precipitous; near its western end is Port Laperrière, where the station for observation of the climate was placed by the government in 1885–86. A quantity of loose ice was encountered in the channel between the islands and the mainland. In the evening we were visited by two Eskimos in kyaks, who informed us that they were encamped on the mainland several miles to the westward. One of them was engaged as pilot to a river, about a week's travel to the southward. Our anchorage was in a small cove sheltered by a bold rocky island, and the next day being calm, the morning was spent washing for gold in the stream which empties into the cove, but without any promising results. In the afternoon, accompanied by several Eskimos, we climbed the cliff and tramped a distance inland over rounded hills of bare rock rising gradually inland to a general level of about 150 feet and partly covered with blocks and boulders. The Eskimos killed two reindeer and report these animals abundant everywhere in the neighbourhood and along the coast for a good distance to the southward, after which they are found abundantly only after a day's walk or more from the coast.

Eskimos encampment.

The calm continued on the 4th, and we attempted to tow the yacht with the small boat, assisted by the Eskimos in their kyaks as far as their encampment, but only made six miles, when we were obliged to stop just inside the entrance of a small bay owing to our being unable to stem the tide. There was considerable loose ice and a large quantity entered the bay during the evening. The land rapidly decreased in elevation as we proceeded westward, the cliff becoming less abrupt and under 500 feet in height, while the land in the rear appeared to be under 1,000 feet in elevation, but continued very rocky with soil only in the lower valleys. Next morning we started early with a strong south-west wind, and soon found the Eskimos encampment on the inside of a group of islands close to the coast, about three miles west of our anchorage and about south-west of the western end of Digges island which lies about ten miles from the coast. We landed and found the band to consist of seven families or thirty-two persons in all. I took photographs of them while awaiting our guide and found that there were no other families for many miles on either side of them. These people are the most distant of those trading at the Hudson Bay post on Great Whale river, which is situated nearly 600 miles from Digges islands; their next neighbours to the east send their hunts to Fort Chimo in Ungava bay. They start on their journey to the post in January, and do not reach home again until June, as they travel with their entire families and hunt their living along the way. The men in summer kill walrus,

seals and caribou for food, clothing and fuel, and only a few could boast of fragments of European clothing, such as shirts, skirts and hats. Their fur hunt consists chiefly of white foxes, together with fewer skins of red, cross and black foxes, wolves and white bears, which with walrus tusks constitute their articles of trade for powder, shot and tobacco. Fur-bearing animals.

In the afternoon on the falling tide which runs south, we sailed four miles further, until we were compelled to take shelter in a small bay, owing to the wind forcing the ice tightly upon the shore. In making for the harbour the kyak belonging to our guide upset while towing behind, and in trying to take it aboard the small boat, the latter also capsized throwing Lantz and the Eskimo into the water, but luckily we managed to save both. The coast passed during the day continued to become lower and the cliffs disappeared giving place to low rounded rocky irregular bottoms. Shoals extend for a couple of miles off the the land and were marked by the heavy ice grounded upon them. The land rises slowly into large rounded hills 300 or 400 feet high, situated some three or four miles inland, and the country although still quite rocky has many ridges of boulders and finer drift on the mainland. We remained ice-bound until noon on the 8th, when a south wind loosened the pack along shore and allowed us to beat our way to the south-west. As we proceeded, the ice gradually opened and by evening there was a lane of open water over two miles in length with stringers of ice outside. The guide said that the prevailing west and south-west winds had driven large quantities of ice in from the strait and that this was the last of it. The coast is everywhere very flat and low and nowhere rises 100 feet above the sea. A few reefs of granitic rock form low points at long intervals along shore, the remainder consisting of sand and boulders which also form the low irregular ridges, and have numerous traces of ancient sea beaches in their lines of well-rounded boulders. The water is shoal for a long distance off shore and the bottom is broken by steep lumps and ridges of boulders, probably formed by the shoving of heavy grounded ice upon them. The shoals were everywhere indicated by masses of heavy ice piled upon them and consequently we were in no danger of running aground. The land was covered with mosses, lichens, grasses and arctic shrubs, and is a favourite feeding-ground for the barren ground caribou, numbers of which were seen either singly or in twos and threes moving about close to the shore all day. Ice-bound for a few days.

Owing to light winds we only made eight and a half miles south-west on the 9th, and in the afternoon went a few miles inland after deer as they are very numerous about here, and our guide informed us Caribou plentiful.

that farther on we would not get any without going far inland. We killed a young buck and saw many more quite close. The country inland is very sandy, sloping slowly up from the water and broken only by low boulder beaches and an occasional outcrop of gneiss rising a few feet above the level of the sandy plain. The many small ponds and swamps that occur between the boulder ridges are favourite breeding places for grey geese. Very little ice was passed, and we anchored about a mile off shore in three fathoms, there being no harbours any where along the coast and no islands. On the 10th, we made ten miles with a very light west wind, and in the afternoon twice grounded the yacht upon small hummocks of boulders on our way to the entrance of a small river; the second time we remained aground for two hours until floated by the rising tide, after removing a boat load of provisions and rigging a lifting gear with our spare spar. We anchored about a mile from the mouth of the river in the midst of a number of boulder shoals. Our course during the day was nearly south. The country was similar to that already described, being under 100 feet in elevation broken by long boulder ridges, and with a few low hummocks of rock rising above the drift. The water is shallow for several miles off the coast and the shore is masked by chains of low islands, formed chiefly of boulders that extend from one to three miles out. The channels between the islands were too shallow and the bottom too uneven to allow the yacht to pass and so we were forced to run our survey outside. We were visited by two old men in kyaks, who stated that all their people (nine families) able to travel, had gone inland to hunt deer, and that they would remain there until the snow came.

eese breed.

Description of coast.

Kovik river. The next morning we beat into the Kovik river and anchored at the foot of a small rapid two miles above its mouth, opposite three tents of Eskimos, containing a few infirm old men and women and some orphan children, who were all living on trout caught with a net. We went up the river in the small boat five miles to where it turns south-eastward, and could not get farther owing to the heavy sea and strong wind. We then climbed a rocky hill and saw the course of the stream for about four miles to the eastward, where it narrows as it passes into a gorge between low rocky hills, beyond which the Eskimos say it is very rapid and unnavigable. The river at the lowest rapid is about fifty yards wide and averages about a foot in depth. The rapids continue for a mile after which the river expands into a lake from a quarter to half a mile wide which continues eastward four miles and then changes to south for three miles, and again east three miles to where it passes into the gorge. The country surrounding the river is low and broken

by rounded glaciated rocky hills that never exceed 100 feet in altitude. These hills are covered with loose blocks and boulders, while the valleys between contain terraced sand overlying stratified clay which contains large quantities of fossil shells. The river is abundantly stocked with fish; the Arctic trout is most abundant and varies from three to ten pounds in weight; ordinary sea-run brook trout and white fish are also common. The natives were unacquainted with the Atlantic salmon as were those spoken to in the neighbourhood of Cape Wolstenholme.

River abounds with fish.

There were only light breezes during the morning of August 12th, with which we reached the mouth of the river where our guide left us. Young and I landed on the south point to examine the rocks and take compass bearings. The day being overcast without wind, was favourable to the mosquitoes and they took full advantage of it. We were on shore less than half an hour and returned to the yacht hardly able to see. This was the worst place for flies in my experience, but luckily the wind came in from the northward at one o'clock and we were soon rid of the pests. We sailed west eight miles across the mouths of two long bays full of low islands and boulder shoals, and then south-west twelve miles along a straight shore, broken only by long points of boulders extending as reefs for upwards of a mile from shore, and anchored close to Kettlestone Knob a conspicuous hill of serpentine lying about half a mile from the mainland and connected with it by a narrow neck of boulders. The coast passed was all low with an occasional low ridge of dark rock rising a few feet above the drift. The shore was boulder-strewn on the points and sandy in the bottoms of the small wide bays, with an occasional outcrop of rock most common during the early part of the run. The bouldery islands off shore were fewer and smaller than to the northward of the river, and the shallow water did not extend so far out from shore along this straight coast, which afforded no harbours. Kettlestone Knob rises about fifty feet above the water and appears to be the resort of a number of families of Eskimos during the seal hunting in the spring. The sites of several camps were seen which had been lately vacated, also a number of sealskins full of oil inclosed in heaps of boulders to protect them from wolves and foxes. The rock had evidently been worked in places, and it is the source from which the triangular stone lamps are obtained.

Kettlestone Knob.

Serpentine.

Eskimos camps.

The next morning opened with a light south-west wind accompanied by fog and drizzling rain. After 9 a.m., we dredged for a couple of hours in from seven to thirteen fathoms of water, and were not very successful. Warned by a rapidly falling barometer we sailed into

shallow water at the head of Kettlestone bay about three miles from the peninsula, and after sounding the channel with the small boat, ran the yacht into the mouth of a small river where good shelter was found behind a point of dark schistose trap rock. In the afternoon we took a walk inland over the low ridges of trap and up the course of the southern large brook which forms about half the river joining the northern brook about half a mile above the outlet. The country is broken by ridges of trap from 50 to 200 feet in height, with wide valleys between, filled with stratified clay and sand and with shingle beaches along the hill-sides. The valleys are dotted with ponds and small lakes. The ridges increase slightly in altitude inland, until they meet a high ridge of dark hills about twenty miles from the coast. These hills appear to vary in height from 500 to 1,000 feet and have many patches of snow on their sides. Their trend is north-east and consequently they run diagonally to the shore and come out on the coast in the neighbourhood of Cape Smith. A gale from the north-west accompanied by rain and fog caused us to remain at anchor all day in the mouth of the little river. The wind changed to east the next morning and moderated so that we got under weigh at noon, making twelve miles to windward in the afternoon, and anchored in a small circular harbour behind a ridge of boulders. The coast and country were similar to those already described, except that there are more rocky points breaking through the boulder ridges along shore and the water is somewhat deeper off shore. The ridge of high hills gradually approaches the coast and opposite the anchorage is about six miles inland

Ridges of trap rock.

We started at 6 a.m., on the 16th, and made seventeen miles, beating against a light head wind accompanied with showers and fog and anchored at dark under a small island about two miles to the westward of the inner end of Smith island. There is a very strong tide-rip where we anchored but owing to the thick fog we could not get any better place. The coast passed during the day had the same bouldery shores, broken by occasional points of granite with a few small islands of boulders close in shore. The country inland rises more abruptly than formerly and was terraced with numerous old beaches of boulders, but the general elevation is under 200 feet to the foot of the trap hills which reach the coast opposite the anchorage and which form the highlands of Smith island and the north shore of Mosquito bay. On the 17th, Young and I climbed the trap hills on the mainland while the men were fishing for cod. They caught two which measured twenty and twenty-two inches in length and said that they were true cod, similar to those that they had been catching all their

Cod fish caught.

lives on the Grand Banks of Newfcundland. They attributed their failure to catch more to the unsatisfactory nature of the bottom where they were fishing.* Large schools of harp seals were seen accompanied by flocks of gulls apparently chasing the cod in the vicinity of Smith island. I have since learned that cod is plentiful along the shore from Portland promontory to Cape Jones, and is found as far south as Paint hills in James bay. The Eskimos living on the Belcher and other groups of islands lying off that part of the coast catch numbers of these fish, some of large size. Large cod.

The hills on the mainland vary in altitude from 300 to 500 feet, being considerably lower than those a few miles inland. They are arranged in parallel ranges, in consequence of which the coast, where they reach it, is cut into a number of long narrow bays with a low valley at the head of each, down which flows a small stream connecting chains of lakes. The rocks are a dark-green brownish-weathering trap that has been intensely glaciated into smooth rounded bosses. The drift on the slopes is terraced to the summits, where beaches of boulders rest on the otherwise bare rocks. In the afternoon we shifted our anchorage intending to go to the head of one of the narrow bays, but found it too shallow and so made a harbour on the inside of Smith island. The current in the channel is strong and we had great difficulty in stemming the tide with a good breeze behind us. East wind continued on the 18th, with fog and rain, so we remained at anchor. The men again tried for cod but caught none, owing to the sandy bottom everywhere in the neighbourhood of the anchorage. Young and I made an excursion into the interior of Smith island which was found to be formed of hills similar to the mainland, but higher (600 feet) with valleys between, filled with stratified clay and sand, and up the hill-sides are terraces of boulders to over 500 feet above the present level of the sea. Smith island must form a prominent land mark from seaward, rising as it does abruptly above the level of the low coast on either side. It is about ten miles long by about four miles broad in the widest part. Its outline is very irregular, being broken into numerous small bays by the trap ridges. The channel between it and the mainland is a mile wide with only sufficient water for small craft to pass through it, and rendered dangerous by shoals and small rocky islets. Excursion into the interior of Smith island.

We started early on the 19th, with a north-west wind and sailed eastward ten miles through a number of low islands formed largely of trap, to the entrance of a long bay which we followed for ten miles

*Report of Progress, Geol. Surv. Can., 1877, part c. page 28.

further to its head. The mouth of the bay for three miles is blocked by numerous small islands which are the tops of low submerged ridges of trap. The water between the ridges is uniformly about five fathoms deep, but when crossing the ridges it is very shallow. Above the islands the bay varies in width from half a mile to a mile and a half and gradually becomes shallow towards its head where a small river enters that flows in the continuations of the valley from the northeast. On the north side of the bay the trap hills form a steep wall from 200 to 400 feet in height with higher hills inland, while a lower ridge of trap on the south side separates this from a similar long narrow bay.

Mosquito bay.

These two bays form Mosquito bay which is much smaller than represented on the charts. We found two families of Eskimo encamped at the head of the bay and procured from them some trout and venison. One of the men was engaged to guide us to the Sorehead river about a day's journey to the southward.

Next morning we left early with our guide, who later informed us that he was a stranger in these parts and did not know anything about the shoals outside. We crossed the mouth of the second bay of which we could see the head. It is about four miles wide at its mouth and is not as long as the northern bay, its surface being largely covered with low islands and boulder reefs, the difference from the northern bay being due to the trap rock being displaced by granite. From the south point of this bay the coast runs nearly south for seven miles and is only slightly indented by small coves between points of boulders and rock. A great number of low islands of rock and shingle lie for several miles off shore and in trying to pass between them and the mainland we narrowly escaped disaster on the numerous hummocks of boulders found everywhere. There was a fresh fair breeze blowing and a heavy sea swell running at the time so that it was very dangerous.

Ascend Sorehead river.

Fortunately we got clear of the islands and turning eastward entered the mouth of Sorehead river and ascended it for four miles when the yacht grounded. The country and coast passed during the day were low and similar to those to the northward of Cape Smith and characteristic of the granitic regions of this coast. Accompanied by Young and Lantz, on the 22nd I ascended the river about ten miles, when it became too small and rapid for further progress with the small boat, so we camped at the foot of a continuous rapid. The river is about one hundred yards wide at its mouth and continues so for about two miles and a half to the mouth of a large brook which enters from the northward, where it drains a number of small lakes between rocky hills on that side. Above this brook the main stream is only about 100 feet wide with steep clay banks from ten to forty feet high,

the river being cut into a clay plain from two to three miles wide that fills the valley between the low rocky hills on both sides. The stream gradually becomes smaller and where we stopped it was less than fifty feet wide and one foot deep. The valley gradually narrows from three miles at the mouth of the river, where the banks are almost level with the water, to less than half a mile at ten miles up, after which it soon passes into a narrow rocky gorge that rises rapidly to the general level of the hills, from 200 to 300 feet above the sea. The next morning we climbed the hills to the southward of the camp and took photographs showing the character of the country. We then returned down stream to the yacht. The highest hills are about 400 feet above sea level and are formed of well glaciated granite with very little drift scattered over them, the finer material having been removed to the valleys and the boulders arranged in beach ridges on the flanks of the hills, the sea having covered the highest summits. The hills are of various forms with wide valleys between them and these are usually filled with irregularly shaped shallow lakes and ponds. We saw several coveys of rock ptarmigan, large numbers of Canada geese and one barren ground caribou. In the next two days we made thirty-five miles, passing numerous rocky islands and boulder reefs with shallow water between them with a low mainland broken into irregular bays by numerous rocky points. Shortly after starting on the 26th, we unfortunately ran on to a small hammock of boulders and as the wind was increasing the position was dangerous. We took four loads in the small boat to an island near by and as the tide rose in the afternoon, by hauling at the anchors placed astern and lifting on the spare spar in the bow we managed to get afloat at 5 p.m., with little damage to the yacht, but did not get the ballast and outfit in place again until 9 o'clock.

Clay plain.

Game seen.

On the 27th we sailed six miles south-east to the mouth of a large river called the Povungnituk, which we ascended three miles. It had an average depth of five fathoms to within five miles of where it is broken by rapids, below which sandy shoals extend nearly to the anchorage. We put our net in here and caught twenty-six large trout and whitefish which we split and salted for winter use. The following day it blew a gale from the westward, so that we could not leave the yacht. On the 29th we ascended the river to the rapids. Here the stream is divided into three channels by two large islands. I estimate the total volume to be the discharge of a channel 600 yards wide, three feet deep with a current of three miles an hour. The eastern channel has about twice the volume of the western. This was the first large stream met with, and from what is known from the Eskimos no

Povungnituk river.

other considerable stream flows into Ungava bay, Hudson strait or Hudson bay between it and Payne river, which empties into Ungava bay on the 60th parallel or directly opposite the mouth of this river. Several families of Eskimos had encamped below the rapid and had gone up the north branch of the river shortly before our arrival. In the afternoon we sailed eight miles to the southward, passing a low rolling coast with many shoals and islands outside. On the 30th, in the morning, we made six miles across a wide bay with rocky shores, and in the afternoon crossed another wide bay and rounded a long, low point, making fifteen miles more before anchoring behind some boulder reefs. The afternoon's sailing was the most difficult yet experienced owing to the extremely shallow water and numerous reefs and sharp lumps of boulders extending for miles off the land.

Minerals found in schists near contact with granite.

The next day we continued down the same flat coast for ten miles, to the mouth of a large bay extending several miles to the northward, but so shallow and obstructed with shoals of boulders that we could not go up it. I have since learned that the Kogaluk river flows into its head. As there was a contact between the granite and dark basic schists at the mouth of the bay, the afternoon was spent examining the rocks and several large bands of pyrite, pyrrhotite and chalcopyrite were found in the schists. We were unable to move for the next two days owing too a heavy gale. On the 3rd September, although still blowing hard, we made fifteen miles along the same low coast cut into long irregular bays by low rocky points and fringed with islands and boulder reefs. We anchored at the head of one of these bays. A gale of wind lasting until the 6th kept us at anchor in this bay when we again started southward, but owing to the heavy sea running, we were obliged to keep well out from the land. The land continues low for fifteen miles, being largely composed of ridges of boulders never more than fifty feet high. In the next twelve miles it gradually becomes higher and more rocky, and where we anchored behind the peninsula of Portland promontory, the hills are from 100 to 300 feet high. Portland promontory is not at all like the sketch on the chart, and there is no channel inside it. It is joined to the mainland by a narrow neck, and is surrounded by large rocky islands which continue for several miles outside. The coast is exceedingly cut up by irregular bays dotted with rocky islands. A heavy gale of east wind accompanied by rain again delayed us for two days, when taking advantage of a strong north wind on the afternoon of the 9th, we rounded the point and made thirty-nine miles to Hopewell narrows. The distance shown on the chart from Portland promontory to Hopewell narrows is too short, so that instead of entering the sound well to

Portland promontory inacurately mapped.

the southward of the narrows we passed in just above, and as there was not enough water to float our boat through the passage, we had to beat out again losing half a day in doing so. The coast from Portland promontory is high and rocky with sharp granite hills rising from 300 to 500 feet above the sea. The sound is formed by a chain of long islands separated from one another by narrow openings. The chain runs roughly parallel to, and from a half to two miles from the coast. The islands are from 100 to 350 feet high, and are formed of stratified rock capped with heavy beds of dark-green trap, all of which dip gently towards the sea, and in consequence the islands have gentle slopes seaward, while they present steep cliffs toward the land. *

Islands of stratified rock.

The 10th, and 11th, were spent at anchor in a small cove just north of the narrows as the wind was again too strong for sailing. On the 12th, we managed to beat around the island and entered the sound again immediately south of the narrows. There was a very heavy sea outside and heavy breakers in the channels between the islands. In the afternoon we sailed southward twenty miles and anchored behind a large island close to the mainland opposite the most southern opening to the sound. Next morning we passed through the opening and started down the coast before a gale from the north-west, but had to seek shelter after making five miles, as the seas were coming in over the stern, and we were obliged to let down all sail during the frequent squalls of snow. We found temporary shelter behind a point and later a good harbour behind a small island four miles further south, which we reached after a good deal of danger and trouble. The coast here is very rugged without any harbours for large craft. The shore is rocky and rises quickly into ragged hills from 400 to 600 feet high. Next morning the hills were white with snow and the small ponds covered with ice. The wind changed to south-west and we were obliged to beat against it all day with a heavy cross sea. We made thirty miles to the southward and anchored in a small cove three miles north of the second island of the Nastapoka chain. The coast passed during the day continued high and rocky with hills inland from 500 to 900 feet high, the shore being rocky and nearly straight with very few harbours. The first Nastapoka island is similar to those of the Hopewell group, except that there is no capping of trap.

Coast rugged with few harbours.

We beat all next day against a light south wind which died out in the afternoon obliging us to tow for two hours in order to reach the first harbour in a small cove about a mile north of the mouth of Langland river. This harbour is quite open to the westward and is not good. Our day's journey was sixteen miles down a coast similar

* See illustration Report of Progress Geol. Surv. Can., 1877, p. 19 c.

to that last described, and the anchorage is opposite the third island of the Nastapoka chain which is continuous to the southward for about one hundred miles or to within a short distance of Little Whale river. The chain is composed of forty-four islands, great and small, there being ten islands upwards of five miles in length. Like the Hopewell chain they are formed from beds of stratified unaltered rocks, all dipping gently seaward and presenting steep cliffs, from 100 to 400 feet high towards the land. The rocks are largely silicious and nearly every bed is more or less ferruginous, while some of them often of considerable thickness are almost pure iron ore. The ore is largely magnetite or a mixture of magnetite and hæmatite when associated with the sandstones, grits and jaspilyte, but with the limestones and dolomites, beds of siderite and ankerite are found, and as these, from analysis of specimens obtained by Dr. Bell, in 1877, contain a large percentage of manganese they form excellent ores for Bessemer steel. The various ores occur in great abundance in the rocks of all the islands and it is impossible to estimate the quantity of iron in this chain,* which must compare favourably as to quantity and quality with the immense deposits worked to the southward of Lake Superior, where some occur in a series of rocks very similar to those found on the islands of the Nastapoka chain. During the night it rained heavily and in the morning of the 16th, there was thick fog which continued all day with frequent showers. In the afternoon we sailed to the mouth of Langland river feeling our way, as we could not see fifty yards ahead, and anchored just inside the sand bar at its mouth. The entrance to the river is a narrow channel about ten yards wide at the bar which broadens outside and becomes shallow, so that there is less than a fathom of water in the shallower parts. Above the bar the river widens into a basin about 200 yards across, but filled with shoals. This basin extends inland about half a mile to where the river descends from a rocky ridge in a beautiful fall 60 feet high. The fall is narrow and is divided into two channels by a small island on its brink. It descends into a semi-circular basin about 100 yards in diameter and having sharply sloping walls of sand 100 feet high cut into the sandy plain which lies between the ridge and the coast.

Character of iron ore on Nastapoka islands.

Comparison of quantity and quality of iron ore.

On the morning of the 17th, we crossed the sound and measured a section of the rocks exposed on the third large island of the Nastapoka chain, and also took a number of photographs of the rocks and scenery from the top of the island. There was a light wind from the eastward but it died out at 3 p.m., being followed by a light southwest wind which obliged us to turn back from Whale point and take anchorage in a wide bay on the inside of Davieau island, there being no harbours on

Section measured on island of Nastapoka chain.

* See Report of Progress Geol. Surv. Can., 1877, pp. 16 and 21 c.

the mainland. The mainland about Whale point is lower and less broken than to the northward, but is still quite bold. We passed a couple of small rivers between the Langland and the point. On the 18th, a strong south wind accompanied with rain, fog and a very low barometer kept us at anchor in our harbour and I measured a section of the rocks on the island in the neighborhood. In the evening the wind shifted to northwest and this blew into our harbour, raising a heavy sea and making things unpleasant for the night. The next morning the wind moderated a little and being fair we started and soon arrived at the mouth of the Nastapoka river where we stopped to trade provisions with some Eskimos encamped there. The wind was now blowing a gale and the sea caused by the strong wind acting against the current setting north up the sound was short, heavy and breaking constantly. As there was no harbour on the mainland we were obliged to cross to the islands and did so with difficulty and with great danger of losing our small boat which was towing far astern, in fact, it was simply marvellous how it escaped being swamped as several times it was snatched away from under the comb of a great breaker. After a good deal of cautious manœuvring we managed to cross to the islands about ten miles to the southward of the Nastapoka river, and then ran on looking for a harbour which was finally found and where we anchored behind a long point with a reef outside. Here we remained during the next day, the wind blowing so hard that we could only make a landing against it with difficulty in the small boat. While here I took photographs of the thick beds (80 feet) of almost pure magnetite and others of the surf breaking on the outer side of the island. This gale was accompanied with heavy squalls of snow which gave a very wintry aspect to the scenery.

Photographs taken of iron ore beds.

On the 21st, the wind moderated towards morning and getting under way we made thirty-one miles to Richmond gulf before noon. We entered the gulf and anchored just inside, in a small bay on the south side. In the afternoon I examined the rocks in the neighbourhood. They belong to the same series as those found on the islands, the stratified rocks being first seen on the mainland some five miles south of the Nastapoka river, from there they continue as a facing of the granite hills to within a few miles of Great Whale river. On the 22nd, after a hurried examination of the north shore of the gulf we passed out again on the end of the falling tide and with a light southeast wind made Little Whale river at 9 a.m. After passing the river the wind died out and we drifted until noon, when the wind came from the north and freshened all the time, so that when we arrived at four o'clock at the northern entrance to Manitounuk sound it was

Richmond gulf.

blowing half a gale. We ran into the sound and anchored in a snug harbour behind a long point of sand extending from the island near the entrance. The Manitounuk chain of islands is about twenty-five miles long and extends to within six miles of the mouth of Great Whale river. The islands have a close resemblance to those of the Hopewell chain, being composed of similar stratified beds capped with great thicknesses of dark-green trap, often roughly basaltic in structure. The sound formed by these islands is a charming place after the barren, inhospitable coast to the northward. The colours of the trap and underlying stratified rocks in the high cliff of the islands contrast beautifully with the dark-green of the spruce and the lighter shades of the willows and mosses. The prevailing colours of the stratified sandstones are various shades of pink ; the limestones vary from buff through cream to light-blue, while the trap weathers a warm brown and purple and where the cliffs have recently fallen the colour is dark-green, so that there is no lack of colour in the picture.

Manitounuk islands.

On the 23rd, we sailed slowly down the sound, stopping in several places to examine the rocks and hunt for minerals in the trap. The wind continued strong from the northward and blew in fierce squalls off the high cliffs of the islands, so as to frequently throw the yacht down, although we were sailing with a three-reefed mainsail. Knowing that we would be unable to cross the bar at Great Whale river we anchored in a cove in one of the islands about five miles from the south end of the sound. The wind died out during the night and blew lightly from the eastward the following morning, enabling us to reach the mouth of the river at noon, but not being able to sail up to the Hudson's Bay post against the light wind and strong current, we remained at anchor until evening, when we towed up along shore and anchored opposite the post, thus finishing the work with the yacht for the season. We found that Mr. Gillies, who is in charge of the post, had not yet returned from Moose factory, whither he had gone in August, but he had left a letter placing his house at our disposal and we took full advantage of his kind offer.

Reach Hudson's Bay post at Great Whale river.

The next week was spent in dismantling the yacht and settling into winter quarters at the Hudson's Bay post with Mr. Gillies who arrived three days after us. The yacht was hauled out on a low sandy point in a small cove about half a mile above the post and was thoroughly covered up and secured for the winter. Mr. Young and myself were given rooms in Mr. Gillies' house with whom we messed. The men had a room in the servants' house and ate in the kitchen. Our cook was installed in the kitchen as chef and had two female assistants (one

High Rock, Manitounuk Islands, Hudson Bay.

Indian, one Eskimo) and we were all comfortable and happy. When the yacht was secured the men were set to work making large dog sleds for winter travel, and when they were finished the remainder of October was employed in chopping our share of firewood. Having finished that, I sent Lantz and Ford away on November 1, a few miles to the eastward where they hunted their food and lived in a tent. Young was engaged plotting the surveys made during the past summer and myself putting my notes in shape and devoting considerable time to the study of the Eskimo language.

Micrometer survey by Mr. Young.

Lantz and Ford remained away from the post until January 28, when they returned to make preparations for our spring work. On February 13 I sent Mr. Young, accompanied by Schupe and two Eskimos, to carry a micrometer survey along the coast from Great Whale river southward to Fort George at the mouth of the Big river. On the 16th the mail packet arrived from Moose Factory bringing us the first news we had had from civilization since we left there the previous June.

Explore region north of Nastapoka river.

On February 23, I started northward with two Eskimos and their dog teams to explore the region situated to the northward of the Nastapoka river. We were greatly delayed by rough ice along the coast and continuous rough stormy weather, so that it was the 2nd of March before we reached Whale point situated on Nastapoka sound near the 57th parallel of north latitude. From there we proceeded almost due east for forty-two miles through a sucession of small lakes and ponds lying between bare rounded hills of granite.

Starting from a small bay directly north of Whale point the route rises gradually for three miles over indistinct terraces and gravel beaches the highest of which, about 600 feet above sea level, forms a sharp ridge with a downward slope inland of 50 feet to a small lake, that lies in a narrow valley with nearly perpendicular granite walls rising from 100 to 500 feet above the lake. From the east end of this lake the route passes over a number of short portages between small lakes and ponds the level of each being somewhat higher than the last, so that at a distance of ten miles inland the water level is nearly that of the surrounding country, and the rolling granite ridges are seldom more than 300 and are usually less than 100 feet above the water surface. This country for 20 miles inland is quite devoid of trees, while farther on spruce and larch occur in clumps in protected places, at first as quite small shrubs but farther inland at Lake Minto, they grow about fifteen feet high and at their bases often exceed nine inches in

Lake Minto.

diameter. Continuing through a chain of small lakes for forty miles we came to the height of land and about five miles beyond it and at a slightly lower elevation, the western end of Kasiagaluk or Lake Minto was reached. The course of this lake was followed due eastward for nearly forty miles when further travel had to be abandoned owing to our failing to meet with the bands of barren ground carribou which usually frequent the lake at this season, and the consequent starving condition of our dogs.

Description of Lake Minto.

Kasiagaluk or Lake Minto is one of the largest lakes of the Labrador peninsula, being according to the Eskimos, upwards of one hundred miles long. The portion explored consisted of two bays, each about forty miles in length, with numerous minor bays running off from both, and the main bodies being covered with large islands. The northern bay is the larger, and varies from two to ten miles in width, while the southern bay is from one to five miles wide. The main body of the lake, at the junction of these western bays, is fully fifteen miles wide, and from there to its eastern end gradually narrows so that it imperceptiby passes into the Leaf river, by which it is discharged into Ungava bay about half way between Hopes Advance bay and the mouth of the Koksoak river. According to the Eskimos, the Leaf river is easily navigable, being without any direct falls or heavy rapids, so that the natives are able to ascend it to Lake Minto in their large skin boats.

Mr. Young met near Richmond gulf.

The return journey to Great Whale river was made without any incident of note on the way there. Mr. Young was met near Richmond gulf, he having during our absence carried the micrometer survey to Fort George, and on his return from that place continued the survey northward to Richmond gulf. The two parties returned together to the Hudson's Bay post at Great Whale river, where they arrived on the 13th March. Lantz and Ford, during our absence, had been sent inland up the Great Whale river with a load of provisions for the use of the party during the spring exploration in that region. They did not arrive back until the 19th, reporting great hardship owing to the deep soft snow and the open water at the rapids, where they had to make roads through the woods. On account of bad weather and sickness among the men, a start was not made up the Great Whale river until the 30th April, when the party, consisting of Young, our three men and myself left the post. Owing to the unfavourable reports of the men who had returned from inland, it was decided to go without dogs, and each individual started, hauling a small sled loaded with about 200 lbs. of provisions and outfit. The month of

April proved very unsuitable for this kind of work. The earlier part of the month was very cold and without the customary rains, so that the snow remained in a pulverulent condition, into which the sleds sank deeply, and required great efforts to drag them along. From the middle to the end of April, the weather was very boisterous with almost constant successions of heavy rains and snow storms, followed by unseasonably mild weather which caused the ice to leave the rivers and small streams, and obliged us to abandon our work on them and to travel as hurriedly as possible overland to the coast, in order to avoid being caught inland by open water, with no means of transport. The Indians of the region were caught in the same predicament as ourselves, and most of them suffered great hardships before reaching the places where their canoes were stored for the winter.

Weather unfavourable for trip up Great Whale river.

The course of the Great Whale river valley from its mouth is nearly due east for eight miles, to the first heavy rapid and fall. The river along this course varies from 200 to 500 yards in width and is obstructed by a number of small islands of rock or boulders. Its banks are usually high and formed of stratified clay overlain by sand except where the rocky walls of the valley come directly to the shore. The valley itself averages about a mile in width and its sides are formed of rounded granite hills that rise from 200 to 400 feet above the water. At the first fall the total descent is about thirty feet, consisting of a direct cascade of ten feet followed by a very heavy rapid. At the fall the valley contracts to about fifty feet and there is a small island in the middle which divides the stream into two channels of ten and twenty feet in width. This obstruction is passed by a portage of half a mile which ascends a gulley on the south side of a low rocky hill at the falls and reaches the river by an abrupt drop immediately above the fall. The valley above bears south-east for nearly ten miles to the second fall and along this course the river has an average breath of 400 yards with a swift current. The valley is about half-a-mile wide walled in by granite hills 300 feet high which are usually faced with terraced deposits of sand up to 150 feet above the river. The valley is well wooded with small spruce and larch rarely more than eighteen inches in diameter or above thirty feet in height.

Course of river described.

At the second fall the valley contracts to less than 100 yards in width and in a mile and a half the river has a descent of 200 feet. This is made up of direct falls of twenty, sixty and forty feet, respectively, the remainder being low falls and heavy rapids. The portage is on the south side and rises abruptly 300 feet when it passes along the

side of a rock hill and descends into a small bay a short distance above the falls.

River divides into two branches.

The river above widens out and for two miles flows from nearly south. Here the river is divided into two almost equal branches, that from the south-east having been explored in 1888, and a description of it given in my report of that year's explorations.* We followed the northern branch, which for eight miles above the forks flows from N. 80° E. through a wide flat valley with low banks and swampy land on either side, the river averaging about 300 yards in width with a sluggish current. Beyond this, the course of the valley is about north-east and the river becomes crooked and irregular in width while the granite hills close in so that after five miles it is again flowing in a narrow valley between rocky hills that rise from 300 to 500 feet above the water. The next six miles is almost continuous rapids culminating at the upper end in two falls of 50 feet and 100 feet, the upper being the higher. This stretch of river is passed by two portages, the lower being nearly four miles long, the upper about half a mile long with about a mile between them where a small lake expansion of the river occurs into which falls a large tributary from the eastward. The total descent here is upwards of 250 feet, so that above it is nearly on the level of the surrounding country, and flows from the north-east again between low willow-fringed banks, the channel varying from 400 to 800 yards for the next four miles. Small spruce and larch grow thickly except where they have been destroyed by fire, there being very large areas where the trees have been totally destroyed.

Other branches of northern branch.

Beyond this the course of the valley changes to north-west for two and a half miles and then north-north-east for two and a half miles to the junction of the Abchigamich and Coast branches of the river. The character of the river valley and surrounding country along these two courses is similar to that just described, a sluggish stream flowing between low terraced banks nearly on a level with the surrounding country, which is broken by rounded granite hills and ridges, the greater part of the forest having been destroyed by fire.

A cache was constructed at the junction of the rivers, in which we stored everything not required for a ten days' trip up the Abchigamich river. This stream, according to the Indians, takes its rise in a large lake of the same name situated about 100 miles farther inland.

Abchigamich lake the source of three rivers.

A striking peculiarity of this lake is that it has several outlets and being situated directly on the height of land, it drains eastward by a tributary of the Koksoak river which empties into Ungava bay, while

*Annual Report Geol. Sur. Can., Vol. III, Pt. II, pp. 50-55 J.

its westward flowing outlets form the head waters of the Abchigamich river and also of the Little Whale river. Such lakes with double outlets are not uncommon in Labrador, but it rarely happens that three rivers take their rise in the same lake.

Above the forks, the Abchigamich river, for three miles, flows from the east and for this distance it is very irregular in width and greatly obstructed by small islands. It cuts through wide, sandy terraces, the highest of which rise about 150 feet above the stream. At the end of this course the stream narrows and the valley is enclosed between steep granite walls that rise from 250 to 400 feet above the water. The general course of the valley, as far as explored, is from the south-east, but there are numerous minor deflections from this general course, especially where the stream is broken by rapids. These rocky hills are sparsely wooded with small spruce and larch, while much of the country has been burnt over. We only succeeded in ascending this river about twenty-five miles owing to the soft weather, which by melting the crust of the snow, rendered travel impossible after ten o'clock in the morning, and on several days when there was no frost we were unable to move at all. The river throughout this distance varied from 25 to 200 yards in width, having usually a strong current, with five rapids, each of which would entail a long portage in the summer time with canoes. Returning to the junction with the Coast river, we started up that stream with the intention of following it to its head in a large lake about twenty miles in rear of the mouth of Little Whale river and then descending that stream which also flows out of this lake.

Mild weather prevented completion of work.

We were unable to complete this work owing to the unusually early break up of the ice, which forced us to leave the river and pass overland by the valley of a small stream which reaches the coast opposite Boat-opening in the Manitounuk sound. The Coast river is slightly smaller than the Abchigamich river, and the first course of its valley above the junction of the latter stream is nearly north-west for eight miles. The valley for this distance is filled with sand, terraced up to 200 feet above the stream and backed by low, rounded granite hills. The river varies from 50 to 200 yards in width, and is without rapids. The valley next bends sharply to the east for eight miles, and the river is broken by a number of short, heavy rapids, terminating at the end of the course in a rapid of a quarter of a mile with three beautiful falls, and a total rise in the level of the stream along this course of about 140 feet, so that the highest terrace at the end is only about 60 feet above the river. This terrace is very persistent, and undoubtedly marks a sea

limit during the period of subsidence of the country, and shows the height to which the land has since risen, the upper terrace being now approximately 700 feet above sea level. The country surrounding this stretch is similar to that last described, but the granite hills become more rugged, and are covered with a thin growth of spruce and larch trees rarely twelve inches in diameter. The river next flows from the north for six miles, and about three miles up this course is joined by a large eastern tributary, nearly as large as the main stream. Along this stretch the character of the stream changes, as it now flows through small lake expansions connected by short rapids without any definite valley. The terrace along the upper part of the course is not continuous, and when seen is only about thirty feet high. The country is less rugged, and the rocky hills are marked by large deposits of boulder drift which lie in long drumlin ridges. The direction from which the river flows is again east for three miles, then north for four miles, and again east for eight miles, being exceedingly rough along the last course with eight heavy rapids or chutes ; and having ascended above the terraces flows in an undefined depression through a slightly rolling country. As before stated we abandoned work at the end of this course and returned down stream to the first bend, where we ascended the valley of a small southern tributary, and after four miles crossed the summit and continued south down another small tributary, making numerous detours over rugged hills, where the river was open at rapids, until we came to the edge of the plateau about four miles from the coast, over which the river is precipitated in a continuous rapids, falling upwards of 600 feet before reaching the sea. We arrived back at the Hudson's Bay post at Great Whale river and immediately began preparations for our summer's work. On the 12th of May, holes appeared in the river ice, and by the 21st the river was quite free of floating ice, but the open water only extended about a mile off the mouth of the river, while the ice on the sea appeared quite solid. The latter part of May was cold and stormy and delayed the painting of the yacht, so that it was not launched until the 29th. On the 1st of June we went aboard ready to start north for Richmond Gulf, as soon as the ice moved off the coast.

Preparations for summer work.

Attempts to get away were made on the 4th and 5th, but it was not until the next day that we succeeded in making our way through the floating ice, and getting into Manitounuk sound where we anchored in open water at the Paint islands about half-way up the sound. The following day we reached the Boat-opening and from the summit of one of the islands, saw a narrow streak of comparatively open water along the coast to the northward, with heavy ice outside. The follow-

ing morning we started at day-light and had no difficulty in reaching the mouth of Little Whale river at 9 a.m., as a light east wind had driven the ice off shore. At Little Whale river we found several families of Eskimos in a starving condition, and after relieving them we continued on to the mouth of Richmond gulf, where we found the tide rushing out strongly and carrying with it much floating ice. While awaiting the change of tide, the wind shifted to seaward and the ice closing in forced us to attempt to stem the tide. We started in with as much sail as we could carry and had got about half way up the narrows, when we were struck by a sudden squall, which almost drove the boat under. To save the yacht we were forced to luff up, and drop the mainsail and could only run the boat head on to the rocky wall of the channel. Luckily a small cake of ice resting on the rocks was struck first, and we escaped, with only the loss of our bob stay and some slight dints in the bow, from what might have been a disaster, as it would have been impossible to save the yacht if it had sprung a serious leak along side the perpendicular cliff where it struck. We finally made a small harbour just inside the narrows and getting out two anchors rode safely through the heavy gale of that night, which was accompanied by snow and squalls off the heads 1,000 feet above us, that caused the boat to tremble and sunk her several inches in the water as they burst down upon her. We remained in Richmond Gulf lake, which was found free of ice, until the 22nd June, the time being employed in a survey of the lake and a close study of the relations of the unaltered bedded rocks found on the shores and islands of the lake. The entrance to Richmond or Hazard gulf is situated eleven miles north of the mouth of Little Whale river, and opposite the north end of Belanger island, the second southern island of the Nastapoka chain. The entrance is formed by a deep rent in the rocks of the coast, and is about two miles long and varies in width from 100 to 400 yards. The water is very deep and the walls of the channel rise in perpendicular cliffs from 100 to 1500 feet, the height increasing inwards from the coast owing to the bedding of the rocks dipping seaward. This narrow channel connects a large salt water lake with Hudson bay and in consequence the water rushes in and out through it with great velocity, with the rise and fall of the tide allowing only short periods of quiet when the tide is high or low.

Eskimos starving at Little Whale river.

Survey made of Richmond Gulf lake.

Richmond Gulf lake is a large body of salt water, occupying a depression immediately behind the coastal range of trap-capped hills. Its greatest length from north to south is thirty miles while its greatest breadth along its southern shore is twenty miles. In form it is roughly triangular with the apex of the triangle at the north end. The western

Description of lake.

side is occupied by sharp cliffs, formed of bedded rocks capped by a thick overflow of trap. These cliffs are very jagged, and indented by deep bays, and as the rocks rise as they extend inland, the cliffs of the headlands are fully 1,500 feet above the water, while those at the head of deep bays are not above 1,000 feet to their summits. The cliffs are rarely perpendicular, but rather resemble gigantic steps from the irregular weathering of the rocks forming them. Along the south and eastern shores the bedded rocks have been faulted and in places replaced by granites, so that the coast is more irregular and less bold than along the western shore, the hills rising from 500 to 1,000 feet.

Rivers entering.

The southern part of the lake is covered by large high islands formed from tilted beds of the stratified rocks and traps. These rocks having been much faulted, the cliffs of the islands do not face in the same direction but vary from east to south. A number of large streams enter the lake on its east side; among these the Clearwater is the largest, while a couple of miles south of its mouth is the Wiachewan which has a beautiful fall of 315 feet where it descends to the lake.

Farther northward is the Deer river which like the Clearwater flows out of Clearwater lake. At the north end another fairly large stream called the North river flows in from the eastward, through a wide valley. The coast outside Richmond gulf is almost treeless, only small spruces growing in protected gorges. The change when the lake is entered is very striking as all the slopes of the hills and islands are well wooded with spruce and larch and only the summits of the hills are barren. Balsam poplar is found as straggling trees on some of the islands showing that the northern limit of this species almost coincides with

Fish plentiful.

that of the supposed much hardier spruce and larch. The waters of the lake are plentifully stocked with fish including arctic trout, brook trout and whitefish. Dredgings were made in from fifteen to twenty-five fathoms of water in a long narrow bay in the southwest angle of the lake, where the bottom was found to be soft mud.

The following list of species was determined by Dr Whiteaves from the dredgings so procured :—

Pecten (Camptonectes) Grœnlandicus, (Towerby.)
Modiolaria discors (L).
Portlandia glacialis (Wood).
Nucula expansa (Reeve).
Astarte Banksii, var. *striata* (Leach).
Astarte crenata ? Gray, var.
Macoma calcarea (Gmelin).

Thracia myopsis (Beck) Moller.
Saxicava arctica (L).
Tonicella marmorea (O. Fabricius).
Litorina rudis (Maton).

And the following sponges, determined by Mr. L. Lambe.

Suberites montalbidus.
Craniella cranium.

The above species are common in the Pleistocene sands and clays of the Gulf of St. Lawrence and show that the present conditions of the waters of Hudson bay closely resemble those of the St. Lawrence region during the close of the glacial period. During our stay in Richmond gulf, the ice in Hudson bay had been closely pressed in upon the coast filling up the Nastapoka sound and completely blocking navigation. We sailed out of the Gulf on June 22nd and managed with considerable difficulty to pick our way through narrow leads to the mouth of Little Whale river. Here we remained hemmed in by ice, until the 2nd July when a strong breeze off shore opened a channel and permitted us to sail south to Great Whale river. The time of our enforced delay at Little Whale river was spent in examination of the rocks of that neighbourhood, and in tracing out the lead-bearing limestones found near there.

Delayed by ice at Little Whale river.

At Great Whale river we were again delayed by ice until the 7th July when we were advised by all the Eskimos to abandon our proposed trips to the Belcher islands which lie about seventy miles off the coast, and about which owing to the prevalance of westerly winds during the early summer, the ice would be very thick. This advice proved correct as the Hudson's Bay Company's ship "Lady Head" was beset with heavy ice as far south as Bear island in James bay, where the ice was left on the 20th August.

Instead of going to the outer islands we directed our course southward along the east coast in order to complete the survey of that entire shore from Cape Wolstenholme to the head of Rupert bay. Sailing southward from Great Whale river, much ice was encountered for upwards of 60 miles until we passed into the Sound between Long island and the mainland, where the last of the ice was encountered on the 11th when we reached Cape Jones, which marks the entrance to James bay. The distance from the mouth of Great Whale river to Cape Jones is eighty-five miles in a straight line, and the coast, with a few minor undulations, runs about south-west. The land along this portion is generally low and sandy, rising in broad low terraces to the

Trip to Belcher islands abandoned.

rounded granite hills, usually situated a mile or more inland and only coming directly to the shore at points along the northern two-thirds of this distance. As far as Humbug harbour, twenty-two miles from Great Whale river, narrow ledges of Cambrian limestone have been tilted up upon the granite along shore and in several places good boat harbours are found behind these broken ridges. From the White Bear hills to Cape Jones, a distance of twenty-five miles, the shore is wholly composed of sand and shingle the granite only appearing in low hills in the immediate vicinity of the Cape. The ridges of limestone and other Cambrian rocks were seen thrown up along shore farther southward from Long island and the other islands off this part of the coast. These islands are particularly numerous between the south end of Long island and Cape Jones where they practically block the Sound. Long island is twenty-four miles in length and varies from one to three miles in breadth. It lies about five miles off the mainland, with its longer axis parallel to the coast, and its south end twelve miles from Cape Jones. It is made up chiefly of Cambrian limestone overlain with ferruginous cherty beds capped in places with trap. Its inshore side is generally formed of low cliffs of limestone with long intervals of low drift shores between. The highest part is not over two hundred feet above the sea. The coast southward from Great Whale river is not dangerous for large vessels to approach, and excellent shelter is afforded them inside the northern end of Long island, but to the southward and in the neighbourhood of Cape Jones the approach to the land is dangerous owing to the shallowness of the water and the uneven bottom with frequent reefs and boulder shoals.

Long island.

Trend of coast changes at Cape Jones.

From Cape Jones the general trend of the coast changes sharply to S. 40° E. and continues so to the mouth of the Big river, sixty miles away from the cape. To the southward of Cape Jones, the character of the coast changes greatly and becomes similar to the shores to the northward of Portland promontory. The shores are low and indented by numerous bays separated by low rocky points. The entire coast is fringed by innumerable islands extending in shallow water several miles out from shore. The general heights are so low that hills rising from 100 to 200 feet above the sea form conspicuous landmarks. The islands and outer points along this portion of the coast are barren, the trees being confined to the shores of the bays and the interior, where they form thick growths of spruce and larch. The boat channel from Cape Jones to Big river passes between the islands and is usually from one to two miles from the mainland. It is exceedingly crooked, passing by sharp turns through narrow passages between islands and shoals,

and is quite impossible to follow without the aid of an experienced native pilot. For ten miles southward of Cape Jones, the islands and shores are formed almost wholly of drift and boulders, and appear to consist largely of glacial débris in the shape of low hummocks or drumlins. Beyond this, low exposures of granite and gneiss occur on some of the islands, increasing in number towards the southward, so that at Pipestone gutway, forty miles from the cape, the islands and shores are very rocky. Along this distance there is not an elevation of fifty feet on either the mainland or islands. Just north of Pipestone gutway is the mouth of a large bay which extends many miles inland, but is so shallow that it is unnavigable even with small craft. This is called Paul bay and is a favourite stopping place for geese and wavies on their migrations in spring and autumn, as the wide grass-covered flats about the bay are excellent feeding grounds.

Islands formed of glacial débris.

Southward of the gutway to the Big river the islands are fewer and all rocky. One of these islands called Wastikun, situated about five miles north of the mouth of the river is a prominent landmark rising as it does into a rounded cone 200 feet high. Fort George is a post of the Hudson's Bay Co., situated on an island at the mouth of the Big river, and is the headquarters of the Whale river district. Here is found the most northerly cultivated land on the east coast of Hudson bay. Excellent potatoes and other root crops are grown here and a good herd of cattle adds to the comforts of this northern outpost of civilization. The Big river is one of the largest streams of the Labrador peninsula, taking its rise in the central area of the peninsula, close to the headwaters of the Kaniapiskan branch of the Koksoak river which flows northward into Ungava bay, and of the Manicouagan river of the southern watershed.

Fort George.

Fort George was left on the 17th July and the survey and geological examination of the coast and islands continued southward. The distance between the mouth of the bay and East Main river in a straight line is 115 miles and the general course is S. 10° E. This portion of the coast is somewhat higher and more rocky than that to the northward and the islands lying off it are as a rule larger, while only the outer ones are barren. The Big river discharges by two main channels separated by a wide flat sandy shoal. The northern channel is that used by larger vessels, as it leads past a small safe anchorage called Stromness harbour situated among some rocky islands about three miles northwest of the river. This channel has two sharp bends in it, and is difficult to navigate, whereas the south channel runs straight seaward. From the mouth of the river, the boat channel runs

Big river.

due south sixteen miles to Earthquake island, so called from the legendary trembling of the island during a battle between the Crees and Iroquois. Twenty miles farther south are the Comb hills where a ridge of granite forms a long point and several large rocky islands. The name is derived from the straggling trees along the summits of the hills somewhat resembling a gigantic comb.

Paint hills.

The next place of importance is the Paint hills, situated twenty-five miles south of Comb hills. They consist of two chains of large rocky islands stretching about ten miles out from the coast and formed of dark green squeezed trap intruded by granite. These trap rocks carry considerable pyrite, which on the surface is often rusty and to this the name of the locality is due. The Solomon's Temple islands which lie about ten miles to the southwest of the outer island of Paint hills are a continuation of the trap area and have the same character as the inside islands. Cape Hope islands are situated thirty-five miles south of the Paint hills and consist of one large and several smaller islands of trap. The highest point of the large island is 250 feet above the water, and is consequently a very conspicuous feature of the coast which everywhere else rarely exceeds 100 feet in elevation. The distance from Cape Hope to the mouth of the East Main river is sixteen miles. Along this portion of the coast the rocky islands give place to a few low shingle shoals and the shore is only broken by occasional low rocky points. A number of these shoals and two rocky islands obstruct the mouth of the river, rendering it difficult to approach even with small craft.

Cattle and sheep kept at post on East Main river.

A small trading post is situated near the mouth of the river on the south banks, but the place is used more for a farm or ranch than for trade. A large herd of cattle is kept here as well as a number of sheep, and the surplus stock is distributed annually to Rupert House and Moose Factory. The East Main river is not as large as the Big river, and drains the country between the latter and the Rupert. It was explored in 1892-93, and a full account of it is given in the report on the Labrador peninsula.* From the mouth of the East Main, the general trend of the coast is south-southwest for forty miles to Sherrick mount. The coast along this portion is exceedingly low, and rocky hills only come out to the shore in a couple of places; elsewhere wide bays with sandy shores and boulder strewn points are found rising slowly inland and faced with wide mud flats bare at low water. The islands off the coast are few in number, and owing to the shallow water surrounding them, hard to approach. In fact, although the

* Annual Report Geol. Surv. Can., Vol. VIII, (N.S.) pp. 77-102 L.

coast is free of islands, it is exceedingly dangerous to approach, owing to the shallow water extending far out over a very uneven bottom covered with boulder ridges. Sherrick mount is a bold peninsula of granite connected by a low sandy neck to the mainland. Its highest point has an elevation of 700 feet above the sea, and in consequence this cone-shaped hill can be seen rising above the horizon long before the surrounding lower country is visible. This peninsula marks the entrance to Rupert bay, into which flow the Rupert, Nottaway and Broadback rivers, all of which have brought down large quantities of sand and mud. In the course of time this has silted up the bay, so that at present it is only navigable in the channels kept open by the currents of these rivers, which if properly buoyed would allow ships of ten feet draught to enter the Nottaway river which flows in at its southern end. Two of these rivers have been explored, the Nottaway by Dr. R. Bell and the Rupert by the writer. The latter takes its rise in Lake Mistassini 300 miles to the eastward, while the Nottaway and the Broadback drain a great area of country to the south and south-east. Sherrick mount.

We ended our survey work at the mouth of the Rupert river on the 19th August. From there we crossed the southern end of James bay to Moose factory, where the yacht was unloaded, hauled out and stored for future use. The collection of rocks and natural history specimens was sent by ship to London, and thence back to Canada, while the party, assisted by four Indians, ascended the Moose river in a large canoe to the Canadian Pacific Railway, and so returned to Ottawa. Survey work ended.

GEOLOGY.

General remarks and description.

The rocks of the entire east coast of Hudson Bay are very ancient, and with the exception of those which form the chains of islands along shore between Portland promontory and Cape Jones, and also a narrow margin on part of the coast in the same region, they have all been cut by granite which has not only intimately penetrated them, but by its heat and pressure has so changed them to crystalline schists and gneisses that only in a few places can any trace of an original sedimentary origin be found. The unaltered sedimentary rocks with their associated sheets of trap and diabase bear not only a remarkably close resemblance to the so-called Cambrian rocks of other parts of the Labrador peninsula, but also to the iron-bearing rocks of the southern Geology.

shores of Lake Superior and the Animikie and Nipigon rocks to the north of Lake Superior. So close is this resemblance that hand specimens of nearly all the various rocks of these different areas can be duplicated from the Hudson Bay region, and this close resemblance is also found in the thin sections of these rocks when microscopically examined. A collection of hand specimens brought home by Mr. J. M. Bell in 1900, from the region of Great Bear lake, when placed beside the specimens from Hudson bay were found to bear so close a resemblance as to be undistinguishable without reference to the labels. The close resemblance of this series of rocks occurring over an area extending from southward of Lake Superior to north of the Arctic Circle, and from the eastern part of Labrador to the neighbourhood of the McKenzie river shows that the conditions under which they were deposited must have been nearly identical throughout this wide area. The finding of new areas of these rocks as the northern country is more fully explored points to an almost continuous deposition of this formation over the whole Archæan area of Canada. No fossils have as yet been discovered in any of the beds of this formation, but the presence of certain concretionary forms in its limestones and the amount of carbon in many of the shales lead to the belief that at least low forms of life existed at the time these rocks were deposited. The lack of fossil evidence as to their age, which is taken to be very great, makes their classification in the Cambrian probably erroneous, as in all likelihood they are of pre-Cambrian age and in the opinion of the writer are the oldest known sedimentary rocks of Canada. Notwithstanding this opinion they will continue to be classed as Cambrian in order to correspond with the areas of similar rocks of Labrador which have already been so classed.

Similarity of sedimentary rocks over wide area.

This series consists of several thousand feet of sedimentary rocks, commencing at the bottom with a considerable thickness of coarse arkose, formed largely of more or less rounded grains and pebbles of quartz and feldspar, cemented by infiltrations of quartz, and evidently representing a great mass of decomposed granite, from which the finer mica and decomposed feldspar had been washed out in a shallow sea. This, towards its summit shades into a great thickness of banded arkose, sandstone and argillite greywacke all of which are feldspathic and the argillites and greywackes also contain quantities of finely divided bisilicates and probably represent the finer material of similar decomposed granite. The basement granite from which these rocks were derived has not been recognized in the region under discussion. The upper beds appear to pass into argillites, greywackes and cherts, all more or less impregnated with oxide of iron which often is found in

Thickness and composition of series.

them as large masses of pure magnetite or a mixture of magnetite and hematite associated with red jasper. These beds are overlaid with cherty carbonates of lime, magnesia and iron, and are in turn capped by limestones, dolomites, carbonaceous shales and sandstones which form the upper beds of the series. These deposits, to the upper portion of the iron-bearing beds, appear to have been laid down in shallow water as ripple-marks are found on many of the beds. The upper beds of limestone and dolomite were deposited in deeper water. At the close of the period of deposition the beds emerged from the sea, and then took place an enormous eruption of dark-green trap and diabase, which was injected as sheets or laccolites between the bedding of different measures of these rocks from the summit of the arkose upwards. Not only was the diabase injected but it also flowed out over the surface, and there, cooling less slowly and without pressure, formed a fine-grained trap in many places full of small cavities formed by the expansion of contained gases, and subsequently filled by infiltration with chlorite, epidote calcite or agate. These surface flows are well seen in the trap capping of the Hopewell and Manitounuk islands and the coast about Little Whale river. At these places several different flows can be seen resting upon one another. The diabase also formed large vertical dykes cutting the sedimentary rocks, and these were the probable outlets of the diabase from the interior. The outburst of these dark-green igneous rocks, which did not greatly affect the rocks that they penetrated, was followed by a far greater outburst of granite and other allied acidic rocks which had a very marked effect upon the sedimentary rocks through which they burst. The granite irruption was co-extensive with the area now known as the Archæan region which embraces the greater portion of eastern Canada and extends southward into the United States, thus occupying fully a third of the northern half of North America. The irruption of the granite was almost universal over this waste region, and it is now found in large areas where no remnants of the former sedimentary crust remains. More often it is associated with bands and masses of silicious biotite gneisses, dark schists and crystalline limestone, which have been so altered by the heat and pressure of the granite intrusion that only in in a few places are traces of their original sedimentary character preserved. Not only did the intrusion change these rocks into crystalline schists but the accompanying hot solutions of silica have penetrated between their thinnest laminæ and there deposited extra quartz, thus further disguising their original structure and composition. The investigations of Adams and Barlow on the relations of the Hastings group of Eastern Ontario, show that the undoubted sedimentary rocks

Magnetite and hematite of upper beds.

Diabase dykes.

Granite intrusion changes sedimentary rocks.

of that region can be traced into crystalline gneisses and schists, and the silicious unaltered dolomites pass into a crystalline tremolite limestone. In the Labrador peninsula, similar changes of the limestones have been noted and the accompanying iron ores pass into magnetites associated with quartz often in the form of a magnetite gneiss. Along the east shore of Hudson bay in the rocks intruded by the granites, the limestones and iron-bearing beds are absent and the altered beds appear to be confined to the arenaceous beds of the series and the accompanying diabase sheets.

In the southern part of the area fronting on James bay, many of the very quartzose gneisses and schists, under the microscope display rounded grains of quartz, apparently arranged in bedded planes and sometimes showing obscure lines of growth outside the originally rounded grains. All of these rocks show signs of subjection to enormous pressure which has destroyed their original structure and it is only in very favourable cases that a clue to their original clastic condition is found. The diabasic traps afford the best example of the metamorphism induced by the granite. These dark-green rocks were very extensively developed along the east coast of Hudson bay and large areas of them are met with from near the Kovik river in lat. 61° 30′ southward to beyond the East Main river in lat. 52°. These basic rocks have different associations with the granites in the different localities where they are found. In some places they are surrounded by large masses of granite and then are usually much altered by the pressure induced by the intrusion, the extreme phase of the alteration being to dark and light-coloured hornblendic and chloritic schists. From this extreme the diabase is found passing up through lesser stages of alteration until it appears as masses only slightly altered near the contact with the granite upon which it rests.

Example of metamorphism.

The granite outbursts were not universal throughout this vast region, and the areas of so-called Cambrian sedimentary rocks represent areas where the earlier crust remained unbroken by any such intrusion ; and it is along the edges of these areas that the evidence of the later age of the granites is found, as there the granites are seen in a few places to penetrate the sedimentry strata and their associated diabases.

The granite outburst appears to have been followed by a period of quiet, during which the great masses cooled and solidified, and in doing so, probably contracted in size. This contraction probably disturbed the equilibrium in the crust by lessening the pressure on the side of the granite mass, and so causing the pressure outside the area to act upon the unaltered areas of the older sedimentary rocks as a

Granite irruption followed by period of rest.

thrust from seaward or towards the large areas of cooled granite. The result of this force acting upon the rocks close to the surface was to cause a buckling of their strata and a forcing of large blocks of the series over one another, and also over the now solid granite, so as to form them into long ridges which slope more or less gently away from the granite masses and present steep broken cliffs towards it. This throwing of the strata into ridges also causes repetitions of more or less similar sections of the formation in each ridge, and the development of cross faults in the ridges greatly complicates the work of identification of the various beds of the formation as seen in the cliffs. This phenomenon of ridges with sharp cliffs facing inland or towards large masses of granite is a universal characteristic of all the areas of these old sedimentary rocks throughout Labrador, and seems to be equally characteristic of the Lake Superior regions and of those westward of Hudson bay.

Solution of stratigraphical problems.

This explanation of buckling and a nearly horizontal movement of the bedded rocks afford a solution of many of the difficulties met with in a study of the stratigraphical relations of these rocks in themselves and in regard to the granites below them, and accounts for the unconformable contacts of totally different members of the series with the granites, in localities, but short distances apart, which cannot be done on the theory that often the lower beds are wanting in certain places owing to their not being deposited on uplifted portions of the sea bottom as no signs of such an equality exists, and all the lower deposits point to the existence of a nearly flat sea bottom extending over the continent and covered with a shallow sea at the time when they were deposited. There are also frequent discrepencies in the sections of the bedded rocks themselves, which are sometimes proved to be caused by such nearly horizontal over-riding of one part of the series by another portion, and cannot be accounted for in any other manner at present.

Result of pressure on shore ice.

The idea of this buckling and over-riding of immense blocks of these rocks was brought to the writer's attention by a study of the ice along the shore of Hudson bay when pressure is exerted upon it by storms from seaward during midwinter when the ice is very hard. The ice under these conditions is forced up into the ridges over the rocks on shore, and also for some distance out from shore into ridges upon itself owing to a buckling and fracturing along lines parallel to the resistance of the shore. These ridges are greatly modified by the breaking of the ice forming them into blocks by cross cracks, so that the ridges instead of resting uniformly upon the underlying ice or rock and having a uniform height, are thrown up into all shapes with a more or less regular dip seaward, and sharp faces toward the land,

while the height of the ridges varies with the tilting of the separate blocks, and also with the degree to which the ice has been fractured into such blocks. These results of the action of pressure on shore ice appear to be identical on a small scale with what happened to the so-called Cambrian formation subsequent to the cooling and probable contraction of the granites.

Following this movement of the bedded rocks in geological time came a much later outburst of diabase, which occurs in the form of dykes cutting all the older rocks. These dykes vary in breadth from a few inches to upwards of one hundred yards. They generally run more or less parallel to the coast, and perhaps fill deep cracks in the surface or were developed along lines of weakness. No large centres of gabbro or diabase have been found from which these dykes flow, nor are there any flat-lying flows of trap in connection with them.

No recent geological change.

No record of any other geological change has been noted along the east coast of Hudson bay from the injection of these newer diabase dykes until the advent of the glaciers in Post-Pliocene time. And during this great interval of time, the rocks forming this coast appear to have been continuously above the level of the sea, thus preventing the deposition of any fossiliferous beds. During the Silurian and Devonian times, there may have been a slight depression along the coast allowing the deposition of narrow rims of limestones of these ages, but if so they have been totally eroded by the glacial and other action, so that the only evidence of such deposits are a few fragments of lime stone scattered along shore, and these may have been transported by floating ice from the northern or western parts of Hudson bay.

During the glacial period the entire coast was covered with ice, and the records left by the glacial striæ show that the centre of glaciation at first was in the southern interior of Labrador, close to the present watershed of the south-flowing rivers. The second set of striæ show that the centre of dispersion moved north to about the middle of the peninsula, while the latest set of striæ are from the north-east and prove the last centre of glaciation to have been in the northern half of the peninsula of Labrador. Since the close of the glacial period, the land has risen to a height of upwards of 700 feet above its level during the ice age. There are no indications* that this rise is still going on, and if it is doing so it is too slow to observe.

* It may be mentioned that this opinion is not shared by Dr. Bell who has examined the east coast of Hudson bay from Moose Factory to Cape Dufferin, on Portland promontory, as well as the western side of the bay, and has published many reasons for an opposite conclusion. See "Rising of the Land around Hudson Bay." Bull. Geol. Soc'y. Am. 1895; "Evidences of Northeasterly Differential Rising of the Land along Bell river."Bull. Geol. Soc'y. Am. 1897. See also Smithsonian Report for 1897, pp. 259-367.

From an economic standpoint, the investigation of the rocks along the east coast of Hudson bay has shown† that extensive deposits of iron ore occur in the unaltered sedimentary rocks of the Cambrian. These ores occur as beds interstratified with certain silicious rocks of the middle portion of the series, and appear to have been deposited from solution in a shallow sea. The upper beds of ore occur as ankerite, or a carbonate of lime, magnesia and iron, and as such are usually associated with a large percentage of manganese, which renders these ores valuable in the manufacture of Bessemer steel. Beneath the carbonates are silicious beds in which the ores are present as oxides, either magnetite or hæmatite, or a mixture of both, associated with red jasper. These beds may be due in part to infiltration of iron leached from the carbonates above, but much of the iron appears to have been originally deposited in the present beds. Economic results.

The carbonate ores are found on all the islands of the Hopewell chain, on a number of the Nastapoka islands, and on Long island. The greatest thickness of ore noted was about twenty feet and it was broken by partings of black chert. The oxides are largely developed in the Nastapoka islands where their thickness is often more than fifty feet, but all of these measures are silicious and only part of them sufficiently rich for profitable mining. The oxide ores also occur on the islands and southern shores of Richmond gulf but of all the exposures seen there, none were sufficiently rich to be worked.

Granite intrusion causes segregation sulphides.

The intrusion of granite into the large areas of basic rocks met with along the coast at intervals from Kovik river to the southward of East Main river and the foliation of these latter by pressure has caused a segregation of the sulphides, always found scattered through the diabases, into long lenticular masses parallel to the foliation. And large veins of quartzose granite and pegmatite from the granites penetrating these basic rocks have also taken up some of their sulphides which may prove valuable ores. The area northward from Portland promontory to the vicinity of Mosquito bay appears to be the most promising for the discovery of sulphide ores in the form of pyrite, pyrrhotite and chalcopyrite as the diabases of that region have been greatly crushed and foliated and are also penetrated by a great many veins of quartz.

Little time could be given to the examination of that area and the chance specimens obtained from the mineral deposits there show that they contain a small quantity of nickel and copper without gold, but results obtained from hurriedly collected samples need not be taken as

† Report of Progress, Geol. Surv. Can. for 1877, Part c, pp. 16 and 21.

an indication of the absence of these metals in paying quantities in these rocks. The Paint Hills area of squeezed trap contains in places large segregation masses of pyrite which carry a small quantity of silver but no gold. Pyrites is also plentiful in the limestones of Long island and the islands north of Cape Jones. There is a bed of silicious dolomitic limestone full of cavities a short distance below the thick capping of diabase which extends along the coast from beyond the north end of Richmond gulf southward to the head of Manitounuk sound. In many places the cavities of this bed are filled with galena accompanied by pyrite and blende, all of which appear to have been leached out of the overlying diabase and to have been deposited in the cavities of the limestone. These deposits have not as yet proved to be sufficiently concentrated to allow of profitable mining.

Anthraxolite.

A vein of anthraxolite resembling anthracite coal is said to have been discovered on Long island.* This vein is reported to be about nine inches wide and cuts dark shales and limestone on the island. Similar veins of this mineral have been discovered in the interior of the Labrador peninsula, but it is only interesting as a mineral and is not economically valuable as the veins are too small to work with profit even if the mineral were equal to anthracite, which it is not, as it always contains a large percentage of quartz which renders it practically useless as a fuel.

Rocks suitable for building and decorative purposes.

In the upper portion of the Cambrian formation, as seen along the coast south of Great Whale river, on the Manitounuk islands, and along the coast, below the traps, are beds of fine-grained limestone, some of which might apparently be suitable for lithographic purposes. In many places the granites would afford excellent and beautiful building stones ; most noticeable among these is the area of augite-syenite found on Walrus island, of the Paint Hills group. This rock is a beautiful porphyry holding pearly crystals of feldspar varying in colour from pink to violet or flesh-red, set in a dark-green ground-mass. Large slabs of this rock could easily be obtained which would be admirably adapted for interior and exterior decorations.

DETAILED DESCRIPTIONS OF ROCK EXPOSURES EXAMINED ALONG THE COAST.

Crystalline Series.

On the west side of Erik cove, rusty weathering biotite-gneiss (1 and 10)† is associated with thin bands containing much light-blue

* Reports of Progress, Geol. Surv. Can. for 1875, p. 325 and 1877 p. 24 c.

†The numbers accompanying the rocks refer to those of the microscopic slides described by Mr. G. A. Young in a MS on fyle in the office of the Geol. Survey.

cherty quartz. The gneisses, where not decomposed, are dark-gray in colour with small flakes of dark mica and contain at times considerable graphite and pyrite disseminated in small plates and grains. The fine-grained feldspar is often splotched with buff. These rocks are usually greatly dotted and are generally rust-coloured from the decomposition of their contained pyrites. In a number of places a short distance above tide-level patches of white effloresence were observed, having a saline, ferruginous taste. These rocks are all well banded and stand nearly vertical. They are cut by large dykes of red pegmatite, derived apparently from a red mica-granite-gneiss which also cuts the rusty gneisses and in places contorts the beds.

High cliffs of granite.

Similar rocks were seen upon the hills to the southwest of the head of the cove and also forming the steep cliffs of Cape Wolstenholme, where, for a distance of eight miles, these vertically bedded gray and light-pink gneisses, cut and contorted by dark-red granite-gneiss and pegmatite, form cliffs that rise sheer from the water to altitudes varying from 400 to 700 feet. In going southward, as the cape is left, the proportion of granite-gneiss increases and it would appear as if the rocks inland to the southward were more largely intrusive, and as if the dark, rusty gneisses and schists were older bedded rocks caught up and altered by the intrusion of great masses and sheets of granite which were foliated by pressure subsequent to its intrusion, so as to now appear to be interfoliated with the more ancient bedded series, which on close inspection is seen to be cut across the bedding by the intruded granite-gneisses.

At Nauyok brook, west of Cape Wolstenholme and abreast the opening between Digges islands, the strike is N. 80° W.

Between Nauyok brook and the Eskimos encampment at Nuvuk, some ten miles farther to the southwest, the rocks are largely red granite-gneiss (3.4.6) varying from fine to coarse-grained and frequently having an augen-gneiss structure and being mostly micaceous, but often containing dark hornblende, and in places magnetite in small grains. These gneisses contain broken bands and patches of finer-grained dark-grey and greenish biotite-hornblende gneisses, (2) varying in size from large masses to small thin bands, the latter being often much contorted and fractured. Some of these inclosed bands are very basic and are composed chiefly of dark hornblende and augite with much plagioclase (5) while others are micaceous and quartzose, and some of the bands contain much dark-red garnet. All these rocks are cut by dykes of fine-grained, light-red granite, which in turn are penetrated

by dykes of red pegmatite. Strike at Nauyok, S. 70° W.; at Nuvuk, S. 60° W.

Coast low for thirty miles.

No landing was made on the low coast for nearly thirty miles beyond Nuvuk, when the rocks were found to be low ridges rising in places above the drift plain and consisting of coarse-grained hornblende-biotite gneiss (7) and diorite-aplite or malchite (8) cut by many large pegmatite dykes running in all directions and holding much dark hornblende. Dip of gneisses N. < 30°.

Two miles further on, coarse light-grey mica-augen gneiss was seen often containing hornblende. This gneiss evidently contains much plagioclase and is richer in this mineral in some parts than others, as the rock contains patches varying in size from a few square feet to upwards of 100 square feet, in which it is of a dark-green colour owing to the decomposition to saussurite of the component plagioclase. These patches contain more silicates than the lighter unaltered patches. At Koitasut the rock is mainly a very coarse augen-gneiss, some of the rounded orthoclase crystals being two inches by three inches. This gneiss encloses fragments of broken bands of dark mica and mica-hornblende schistose gneiss. Strike N. 45° E.

Kovik river.

Beyond Koitasut the coast is low and drift-covered and is flanked oy numerous islands of drift with shallow water extending several miles out from the shore, so that no examination of the rocks could be made until a small rocky island about five miles north the mouth of Kovik river was reached. There the rocks were well-banded dark and light-grey mica and hornblende schistose gneisses, some of the hornblendic bands being very coarsely crystalline. All the bands were garnet-bearing; the lighter and more quartzose micaceous bands containing the greatest proportion of this mineral. Strike N. 10° E. These rocks were cut by a dyke of fine-grained dark diorite-aplite (9-11-12) sixty feet wide and running N. 40° W. This dyke was injected subsequent to the foliation of the gneisses, as offshoots from the main dyke have been injected into partings of the foliation of the gneisses. There are also small quartz veins holding small patches of yellow-weathering dolomite.

For five miles up the Kovik river the rocks are almost wholly light pink mica-gneiss with broken bands of darker, more basic schistose gneiss. Strike W. to N. 60° W.

At the south point of the mouth of the river these granitic rocks enclose a wide band of black schist mostly mica-hornblendic with thin

bands in which hornblende predomiates. All the bands are garnet-bearing and they appear to be an ancient basic irruption squeezed and altered by the inclosing granite. Strike N. 50° W.

The next exposure examined was at the south point of the next bay four miles farther on, where the rocks are a mixture of light-gray and pink epidotic hornblende augen-gneiss (15) with wide bands of dark basic schists. Strike N. 70° W.

Kettlestone Knob.

Beyond this we were again unable to land owing to shallow water for fifteen miles when we reached Kettlestone Knob, a high rocky knoll joined to the shore by a long narrow shingle bar, but from the yacht the low ridge along the shore between these places appeared to be wholly composed of dark basic rocks.

Kettlestone Knob was found to be largely composed of a light pearly-green altered diorite (14), the alteration product of a mass of gabbro still showing in places on withered surfaces plagioclase crystals as white grains, while in other places a foliation had been induced altering the rock to a steatite-schist. The whole had been greatly shattered and is now cut by a net-work of quartz veins. Inclosed in this ancient gabbro are a number of broken bands of light-green greywacke (13), holding cubes of pyrites and greatly contorted, having evidently been caught up by the gabrro when it was irrupted. A few small veins of calcite run off from these slate inclusions. This locality is resorted to by the Eskimos who manufacture their lamps and kettles from steatite. Ridges of dark-coloured schists occupy the land on both sides of Kettlestone bay and extend inland from its head. At the mouth of the small river flowing into the bay these rocks were found to be dark-green hornblendic schists interbanded with light-green chloritic schists with thin bands of calcite, which with the other bands are found not to be persistent when followed along the strike, all giving out after a few yards. These rocks are identical with the squeezed traps of Cape Smith and other localities to the southward which are described farther on. About two miles up the river a curious crushed diorite or amphibolite rock (17), was found consisting almost exclusively of dark-greenish hornblende and having an augen-gneiss structure, that is large rounded lumps of radiating crystals of hornblende were enclosed in a schistose matrix of the same mineral.

Curious amphibolite rock.

The dark schists occupy the shore for nearly two miles south of Kettlestone bay, when they again give place to coarse pink and red granites which inclose broken bands of the dark schists and also bands of fine dark-gray, crushed diorite aplite (18). Strike N. 30° W. to N.

10° W. The granites occupy the coast and a gradually narrowing area inland, to the foot of the high trap range which approaches the coast from the north-east and reaches it about five miles northward of Smith island. This area of trap is about fifteen miles wide, and forms a range composed of several ridges of sharp hills, running more or less parallel to one another in a north-east direction inland. They form the large high island known as Smith island and determine the north side of Mosquito bay.

The trap, where undisturbed and fresh, is usually very fine-grained and dark-green in colour, apparently having been rapidly cooled, but no amygdules were seen, so that it may not have been a surface outflow although it appears to have been such.

In some places small patches have a diabase structure, while in others fairly large crystals of light-green plagioclase have been porphyritically developed. The rock weathers a rusty brown and appears to be in most places largely decomposed to chlorite. Nearly everywhere the trap has been fractured, most often in irregular prisms, probably from contraction on cooling. These series of prisms are inclined irregularly at various angles to the horizontal; usually they are nearly vertical. In many places the cracks have been in part filled with quartz and calcite, epidote, prehnite, chlorite and axinite being also found in them. In a great many places the irregular prisms have been decomposed for a thickness varying from one to three inches from the surface into a dark-green fibrous hornblende, while the interiors are more or less changed to a lighter green chlorite. Subsequent to these decomposition changes, foliation and squeezing of the trap were probably induced by the irruption of the granite, as these phenomena are more marked along the southern edge of the trap mass near its contact with the granite. As a result of these dynamic alterations, various stages of schistosity are seen in the trap, varying from a slight elongation and rounding of the irregular prisms to an extreme phase where their shape and character are almost obliterated, and the trap is altered to a typical Huronian schist, consisting of alternate dark and light-green bands of hornblendic and chloritic schists holding thin bands of calcite and quartz formed from the squeezing and lengthening of the masses of these minerals, which originally filled fissures between the trap prisms. When examined in small areas across the strike these banded schists resemble a bedded series of clastic and pyroclastic rocks tilted up at high angles, but when followed along the strike each band was seen to end sooner or later, and the whole mass was found to consist of a series of very long thin lozenges so drawn out as at first sight to be

Trap rock altered to Huronian schists.

taken for a continuous alternation of finely banded light and dark schists. Areas in which the trap had not been broken into prisms, or where the decomposition to hornblende had not set up around the rims of the prisms, presented when greatly squeezed the appearance of a continuous chloritic schist, but even in the most homogeneous of these a careful tracing of individual bands always showed that they were not continuous, but terminated like those of the banded schists. Areas of similar trap occur at intervals along the east coast of Hudson bay all the way to the southern part of James bay and where they have been disturbed and squeezed by granite intrusions they show all the phases of schistosity described above.

Granite of Mosquito bay.

The south shore of Mosquito bay is formed of low rounded hills of granite. At the south point of the bay much of the rock is fine, to coarse-grained red and grey granite, with very indistinct foliation in places. It is made up largely of feldspar, quartz, mica and epidote, (19, 20, 21); when coarse-grained the feldspar is porphyritic. The mass has been considerably shattered and the small veins are filled with salmon-coloured calcite, with epidote and quartz. The granite is cut by a dyke of dark-grey micaceous rock having the schistose structure parallel to the walls. This dyke is from two to three feet wide and runs N. 40° W. There are also a few segregations or broken bands of mica-hornblende-schist enclosed in the granite. The whole is cut by small dykes of fine-grained pink granite.

Metamorphic clastic rocks.

On the islands off shore and about four miles south of the above point the granite is not plentiful, the rocks being largely light and dark-grey fine-grained epidotic biotite–mica schist (22,23). The light-coloured bands are very quartzose. Some of the darker bands are reddish and look like altered ferruginous cherts. A number of thin quartz stringers holding pyrite are seen along the foliation or bedding planes. They have the appearance of metamorphic clastic rocks. Strike N. 40° W. On the north shore of the Sorehead river, near its mouth, similar bands of dark schistose gneiss occur, but they are more highly altered than the last and the beds are much broken by a red biotite gneiss (24). Strike N. W. Only coarse augen-gneiss (25) was met with on a trip of eight miles up the Sorehead river. The colour of the gneiss varied from gray to light pink and it was mostly micaceous, while some areas were epidotic. General strike north. At the south point near the mouth of the river a large mass of coarse to medium-textured dark greenish-gray diorite (26) appears to cut augen-gneiss, but is itself cut by dykes of pegmatite. On the islands about two miles farther out the rocks are well-banded gray and red gneisses,

the gray predominating and apparently having been intruded along the foliation planes by sheets of the red gneiss. Strike N. 60° W. At Magnet point there are large exposures of dark schistose diorite-gneiss (27) largely formed of mica and hornblende and containing much dark red garnet; also chloritic bands. These rocks must contain much iron as the local attraction of the compass is very great.

At Magnet islands there is a great deal of light-gray basic granite composed chiefly of feldspar and mica. It incloses much mica and mica-hornblende-schist, which are usually garnet-bearing and often pyritiferous. Strike N. All these rocks are cut by a large dyke of dark fine-grained diabase. On a small island just south of Thompson harbour there is a dark-greenish fine-grained augite-diorite (28) containing considerable magnetite and green hornblende, often in crystalline splotches. The gneiss is penetrated by a few dykes of white pegmatite and has gash veins of bluish opalescent quartz. There is also a coarser band containing more hornblende. Strike N. 30° W.

Diabase dyke.

Two miles to the southward of the exposure last examined, a small island was found to be largely composed of light-coloured granite and pegmatite inclosing fragments of mica and mica-hornblende-gneiss. The next exposure seen was on a small island about three miles north of Cape Anderson where the rock was a coarse-grained dark-green augite-diorite (29). It weathered dark-green with curious reticulating, reddish spots and veins and is highly magnetic. It is cut by veins and masses of granite.

The granites appear to again predominate about Cape Anderson and an exposure visited two miles south of it was wholly light-coloured granite-gneiss. Strike N. 30° W. The granites continue most abundant to the Povungnituk river. On a small high island near the head of deep water in that stream there is a fine exposure of crushed augite-diorite (30). It is cut by small dykes of red granite and pegmatite and is in contact along the strike of the foliation with a mass of coarse-grained light-pink granite-gneiss, which is evidently newer than the darker gneiss, as it incloses fragments of the latter, and is more basic near the contact than elsewhere. Strike N. 35° W. The rocks at the first rapid of the Povungnituk river and everywhere in the neighbourhood are all coarse red augen-gneiss containing broken bands of finer-grained mica-gneiss. Strike N. 25° W.

Augite-diorite.

Near the rapid is a dyke of dark fine-grained diabase (31) over 100 feet wide and running N. 75° W. On top of the hill the augen-gneiss incloses broken bands of dark altered gabbro in which some schistose structure has been developed.

For eight miles to the southward of the Povungnituk river, the light-coloured augen-gneisses predominate, and they cut and inclose much dark basic schistose gneiss, both hornblendic (33) (32) and micaceous, the former evidently an ancient irruptive rock, while the latter may represent a highly altered form of ancient clastic rocks.

No landing could be made in crossing Reef bay, nor for about fifteen miles beyond Reef point, owing to the low coast and the shallow water filled with reefs which extended well out from shore. The rocks seen on the low islands and points were largely dark schists and gneisses cut by wide dykes and masses of light-coloured granite and pegmatite. A large diabase dyke was seen cutting the rocks of the islands and shore at Reef point, and several others were seen to the southward of the point.

At Shoal harbour the rocks were coarse mica-granite, with many contorted and broken bands of finer mica-schist and gneiss cut by small pegmatite dykes. On the small low islands near shore and about a mile from Checkered islands, there are large exposures of typical dark and light-coloured Huronian schists. Strike, N. 20 W. These are largely chloritic and micaceous with hornblendic bands, and also some stringers or bands of quartz and calcite. They are an extreme phase of foliated trap, and the bands when carefully traced were found to pinch out like those of the Cape Smith area. These rocks contain much iron in the form of magnetite, pyrite and pyrrhotite, and some of the bands are sufficiently rich to be considered ores. One band about four feet wide was largely composed of pyrrhotite, with splotches of blue opalescent quartz. An analysis of this ore by Dr. Hoffmann gave the following results: copper, 0·06 per cent; nickel and cobalt, 0·08 per cent. Iron ores.

At Checkered islands, a great mass of old irruptive diorite (34) is cut by huge dykes and masses of pegmatite granite, which has affected the basic rock for upwards of 100 feet from the contact. The diorite having taken up light-coloured feldspar from the pegmatite, so that near the contact it looks like a light-gray syenite.

On the mainland adjoining the islands, large masses of pegmatite penetrate the altered schistose traps mentioned above and with basic eruptives (35,36) near their contact, change them into a fine-grained crushed diorite gneiss from the accession of feldspar. The schists are here associated with other very quartzose micaceous and hornblendic schistose rocks (37) usually holding dark-red garnets and quite distinct from the squeezed traps. They probably represent beds of altered

clastic rocks associated with the traps. Many of the hornblende schists contain a large proportion of magnetite in grains. Strike N. 10° W. This locality is directly on the contact of the granites with the basic rocks, as for several miles up the west side of Kogaluk bay only coarse granite was met with.

Contact of granite with basic rocks.

A landing was made on a small island off the south point of Kogaluk bay where medium-grained light-pink biotite and biotite-muscovite-gneisses (39-40-41) were found holding broken bands of mica and mica-hornblende schists. Strike N. 10 W.

About Mistake bay similar rocks (42) were met with on the mainland, some of the broken bands of hornblendic schists being rusty-weathering.

The next exposure examined was on a small island about three miles off the mouth of the Nauberakvik river where there are dark hornblende mica-schistose gneiss cut by dykes of dark-greenish hornblende-granite (44) containing much bluish opalescent quartz with magnetite and some mica. Both rocks are cut by dykes of pegmatite (43) containing considerable bluish quartz while the feldspar is beautifully mottled yellow and flesh-red. The schistose gneiss is in contact with a mica granite which near the contact is fine-grained but elsewhere very coarse in texture. Strike of schists N.S.W.

On the islands west of Alle Harbour is a coarse mica-granite-gneiss inclosing large masses of fine diabase (46) and bedded schists. Some of the schistose diorite (45) is pyritiferous and all of the dark rocks are penetrated by many dykes of pegmatite. On the mainland opposite, the rocks are largely granitic (47) and are cut by a newer diabase dyke forty feet wide, and running nearly parallel to the foliation. The gneiss near the contact with the dyke contains considerable chlorite. No further close examination of the rocks was made before Hopewell narrows was reached, but from the yacht the islands north of Portland promontory and the mainland to the south of that place were seen to be similar dark gneisses and schists, inclosed and cut by light-coloured granites and gneisses, which preponderate over the dark rocks on the mainland. On the mainland at Hopewell narrows the rocks are chiefly coarse-grained mica-hornblende-granite-gneiss foliated with fine-grained light-bluish very silicious mica-gneiss which may be an altered impure quartzite such as occurs on the Hopewell islands, in the unaltered rocks found there. This fine-grained gneiss is in broken bands inclosed in the coarser gneisses. Similar gneisses were seen to occupy the mainland to about four miles south

Rocks at Hopewell narrows.

of Hopewell point, where they were again examined and found to be largely coarse red mica-gneiss inclosing broken bands of dark mica or mica-hornblende schists usually very silicious.

The coarse-grained granitic rocks predominate along the mainland southward to beyond the mouth of the Nastapoka river, and as well as the darker schitose gneisses, they inclose at intervals along the coast, large patches of trap often but little foliated and closely resembling that overlying the unaltered sedimentary rocks of the Hopewell islands and the coast further southward.

On the trip made inland from Whale point to Lake Minto, the rocks everywhere met with for sixty miles were all granitic, usually coarse-grained and often having an augen-gneiss structure. The prevailing colour was pink, with areas of darker red and some grayish. Very few inclusions of the schistose gneisses were noted until within a few miles of the end of the exploration on Lake Minto where large masses of basic schists and diorites were found inclosed in the granites.

Large area of granite rocks.

The extensive area of country lying between Great and Little Whale rivers and extending inland some fifty miles is also almost wholly occupied by granitic rocks, only a few broken banded schistose gneisses at rare intervals were seen during the exploration of the northern branches of the Great Whale river.

Area of unaltered clastic rocks.

The coast from a few miles south of the mouth of the Nastapoka river southward to Boat harbour, eight miles north of the mouth of Great Whale river is occupied by a series of unaltered clastic rocks associated with bedded traps. Further south these rocks only occur as patches on the mainland and the small islands as far south as Cape Jones, the remainder of the coast being composed of the crystalline series, granite as usual predominating.

At Cape Jones the point is formed of medium-grained light-gray and greenish biotite-gneisses (130) composed largely of quartz and feldspar; when in large masses they are not well foliated. They cut and inclose masses of greatly contorted dark-greenish biotite-hornblende-gneiss and also a dark-green rusty-weathering gneiss rich in garnet and pyrite. General strike S. 80° W.

In places, cracks in the gneisses have been filled with brownish-weathering dolomite thus forming a dolomitic gneiss breccia. At the Indian encampment at Cape Jones, the granite is very coarse in texture with a rough augen-gneiss structure. It is intimately interfoliated with dark mica-schist and appears to have been injected as small dykes along the foliation planes of the latter.

On an island about one mile north of the mouth of the Pishop Roggan river medium-grained pink and red biotite gneiss was found cutting and inclosing large masses of very dark, medium-grained biotite-diorite (131). Strike W. About the same distance south of the river similar rocks were seen.

At Attikuan, light-pink and gray, medium-grained biotite-gneiss, not well foliated (133), contains a few angular fragments and broken bands of dark basic schist. In places the light-coloured gneiss is very coarse-grained and its feldspar is often decomposed to sausserite, the rock being in such places exceedingly fractured. Strike S. 60° W. The same coarse-grained light-pink gneiss, holding small fragments of dark schist was noted on the islands four miles south of Attikuan and again five miles further south.

Medium to coarse-grained gray and pink biotite gneiss (134) sometimes containing much epidote occurs at Kakachischuan on the north point of Paul bay.

At Pipestone gutway the rock is a red coarse augen-gneiss holding many bands of dark pyroxene gneiss (137). Strike N. 80° W. This mass is cut by a dyke of diabase 170 feet wide and running S. 50° E. But being thrown by a heavy fault it appears on an island to the westward. The dyke close to the contact on both sides is very fine-grained and compact, but towards the centre it is more coarsely crystalline (125-136-138). Where coarsely crystalline it is about half decomposed and this decomposition product is used by the natives in the manufacture of pipes. Alongside the main dyke on its east side is a smaller dyke about one foot wide; it is very fine-grained and almost glassy.

Diabase used in manufacture of pipes.

At Wastikun island and on the islands of Stromness harbour, the rocks are largely red, coarse biotite-gneiss with broken bands of dark basic schist and gneiss.

On Governor island, off the mouth of Big river, a large mass of dark-green diorite-gneiss is cut by coarse red augen-gneiss (141); strike N. 19° W. The diorite-gneiss is evidently a squeezed and decomposed diabase, as in many places a porphyritic structure with small rounded crystals of pale-green plagioclase is still seen; in other places it has been fractured, partly decomposed and drawn out into overlapping bands. Where the basic schist occurs in small masses in the gneiss, it is of a lighter colour and is more feldspathic with much mica.

Two miles south of the last exposure, coarse, pink biotite-hornblende-augen-gneiss was again met with on a small island. This gneiss under the microscope shows signs of great pressure (143). It is only hornblendic in patches, and in some places is garnet-bearing. It incloses large masses of fine to medium-grained, very quartzose, biotite-gneiss, pink and gray in colour (142.) These rocks have a distinctly clastic appearance, and are probably altered impure quartzites or arkose. The microscopic examination bears out this view (144–145), as the quartz in places is seen to be in elongated grains. Again at a small island about two miles beyond the last, these rocks (146) are met with in identical conditions, and are here cut by a huge dyke of diabase 210 feet wide running N. 20° W. It is fine-grained near its contact with the gneisses, moderately coarse in texture towards the middle and everywhere slightly porphyritic (147).

In Aquatuk bay the augen-gneiss predominates, but there are many considerable bands of the quartzose fine-grained gneisses which have the appearance of altered clastics (142). The islands off the north point of Aquatuk bay are largely coarse, pink and red biotite-gneiss, often with an augen-gneiss structure. They cut medium to fine-grained dark schists and gneisses, some of which are squeezed diorites (148) while others are very quartzose and are probably squeezed clastics (149–150.) These bands appear to have been injected with numerous thin bands of granite along the foliation planes; strike S. 70° W. The rocks on the small islands off the middle of the bay are red unfoliated biotite granite cut by small dykes of diabase (151). Squeezed clastics.

On Earthquake island the predominating rock is fine to medium-grained pink and red biotite-hornblende granite, largely unfoliated and apparently inclosing large angular masses of a coarse, lighter coloured hornblende-granite. In places this latter granite has a porphyritic structure due to large crystals of white feldspar. All are highly shattered and the cracks often filled with red oxide of iron. At the south end of the island the granite is lighter-coloured and is mixed with broken bands of very quartzose schistose mica-gneiss (152, 153). All are cut by many small veins of pegmatite at times holding numerous small crystals of biotite. Strike N. 80° W.

At the point of the mainland opposite Earthquake island the same coarse red pink granite (154) occurs holding broken bands of darker gneisses. The granite is most abundant on the shores of Dead Duck bay. At the south point of this bay the rock is wholly coarse augen-gneiss, in places unfoliated and cut by many large dykes of red pegmatite. Where old cracks occur in the granite and pegmatite the feldspar is much decomposed and dark red in colour. Strike N. 75° W.

At Gray Goose islands there are medium to fine-grained, pink and gray very quartzose biotite-gneisses (156-157) separated from overlying finer-grained biotite gneiss by ten feet of a coarse hornblende dioritic granite (155) much broken and cemented by pegmatite. Several large dykes of red pegmatite cut the gneisses which appear to have been inter-foliated with thin sheets of granite sometimes carrying hornblende. All are cut by small dykes of very fine-grained diabase (159). The schistose gneisses appear on the main shore about a mile north of Long point and continue for about a mile south of the point when they are cut out by the coarse augen-gneiss. On the mainland opposite Burnt island, coarse biotite and biotite-hornblende-augen-gneiss, light pink and gray in colour, were found inter-sheeted with more or less regular bands of highly quartzose biotite-gneiss (160) usually dark pink in colour and sometimes holding small garnets. There are also dark schists, usually micaceous but at times hornblendic.

Contacts difficult to determine.

All are cut by small dykes of fine-grained pink granite which is banded parallel to the length of the dykes and so does not conform to the general foliation. The augen-gneiss being irrupted along the foliation of the quartzose gneiss, there is often difficulty in determining their contacts.

On Burnt island, the coarse augen-gneiss predominates and in places contains large patches of quartzose-gneiss, the foliation of which does not conform with the general foliation and which appear to have been originally large fragments of clastic rock floated in the granite magma. Strike S. 80° W.

Near the mouth of the Beaver river these rocks (161) are cut by a large diabase dyke which has broken into and incloses fragments of the granite along its walls.

At Comb hills the rocks are chiefly medium to coarse-grained dark-pink biotite-hornblende-gneiss often containing large crystals of feldspar. These are associated with light-gray and pink, very quartzose biotite-gneisses and dark biotite and hornblende-schists. They are all cut by large dykes of very quartzose white pegmatite. Several large dykes of diabase cut these rocks on the outer islands of Comb hills.

On Pigeon island coarse and fine-grained light to dark-gray schistose hornblende-biotite-gneisses (162, 163) are cut by a fine-grained pink granite-gneiss which also incloses a dyke, five feet wide, of diorite gneiss. Strike S. 85° W. The next exposure examined was on a small island, five miles north of Loon point, where the rocks were

mostly very quartzose gray biotite-gneisses (158, 164, 165) sometimes holding small dark-red garnets and at times hornblende. They are associated with fewer bands of pink gneiss and are all cut by large dykes of nearly pure red orthoclase. Strike N. 85° W.

At Loon point there are about 500 yards of dark-green chloritic schists separated by several bands, from one to three feet thick, of a light-coloured friable biotite gneiss (166, 167). A few of the dark bands weather rusty from the decomposition of disseminated pyrite. They are abruptly cut by pegmatite and hornblende granite-gneiss (168). The above are apparently sheets of altered diabase which had been injected between the sandstone beds and both subsequently altered by pressure and heat during the period of the granite intrusion.

The Paint Hills islands are arranged in two chains extending out from a deep bay in a southwest direction upwards of ten miles and, after an interval of six miles, form the Solomon Temple islands. All these islands are formed from a sheet of diabase of which the breadth varies from three to five miles and which continues inland in a northeast direction from the head of the bay, thus having a known length of upwards of twenty miles. On these islands all varieties of diabase are found, together with all forms of its decomposition products and alterations due to pressure. The eastern end of Walrus island is occupied by a large mass of curious porphyritic augite-syenite (169, 170, 171, 172, 174) composed almost wholly of porphyritic crystals of pearly feldspar (perthite) which vary in colour from light pink to flesh-red and violet tints and occur in long, thin crystals up to two inches in length; along with the feldspar is dark green augite, often completely changed to epidote, especially in the vicinity of a large dyke of the newer diabase, where the granite is deep flesh-red and its pegmatite contains large masses of beautifully crystallized epidote together with tourmaline and a brownish mineral (danalite?) The syenite is penetrated by many small veins of quartz carrying small quantities of pyrite. Islands formed of diabase.

The diabase dyke which alters the granite is 120 feet wide and is very coarsely crystalline towards its middle. This area of granite is newer than the diabasic schists which it has displaced and it incloses fragments of the schists along the contacts.

The remainder of Walrus island is occupied by altered diabase (177-178) and the phenomena already described in connection with the areas of Cape Smith are here seen very perfectly illustrated. In places the unfoliated massive diabase is seen, in other places it has been fractured with a roughly basaltic structure and the prisms show a Altered diabase.

decomposition rim of green hornblende, while the spaces between the prisms are filled in part by calcite and quartz. Again pressure has elongated the prisms and induced foliation which in the extreme phase causes the rock to pass into a well foliated banded schist alternating dark and light with thin bands of calcite and quartz formed from the masses filling the original cracks in the basalt. This alteration, due to pressure is further complicated by various alteration products formed from the decomposition of the original diabase which itself varied from a fine-grained basaltic form through various textures to a very coarsely porpyhritic variety inclosing crystals of light-coloured plagioclase several inches in diameter and thence into anorthosite (182). These rocks therefore now afford all varieties of chloritic hornblendic, epidotic and other basic schists (175,176, 181,197) as well as non-foliated masses of similar rocks (190,173, 180,207.) The other islands of the Paint hills and Solomon Temple groups are formed of similar foliated and altered diabase, sometimes associated with thin bands of friable sandstone and fine graphitic schists (201-202). In a number of places the squeezed diabase is rich in pyrite which on analysis was found to contain a small quantity of silver but no gold. The pyrites appears to occur in segregation masses along certain bands and some of these masses contain many tons of ore and have been staked as mineral claims.

Mineral claims.

On the northern island the schists are cut by many dykes of granite and pegmatite. There appears to have been at least three series of these dykes the oldest being a red hornblendic, syenite or granite, (183, 184,185,186,187,188), the second a lighter coloured biotite-granite while the last was a pegmatite usually very quartzose and carrying pyrite and in places molybdenite. Some of these pegmatite dykes, especially on the outer northern islands contain much green feldspar or amazon stone. All these dykes in turn are cut by the newer diabase dykes, (195.) The general strike of the foliation of the schists is S.65°W. In places the hornblende dykes or augite syenite (189,190-191,192,193) have been badly fractured and the fragments rounded and inclosed in the green schists, thus forming excellent examples of cataclastic conglomerates. In a loose block found near the contact between the epidote and the large diabase dyke on Walrus island the rare minerals spodumene and danalite were detected by Dr. Hoffmann (229). The contact between the schists and gneisses (196-200) on the northern side of the mass is very complicated bands of both being mixed together and with hornblende syenite (205,204,203,199,198). To the southward of Paint hills the granites and light-coloured gneiss again occupy the shores and inlands ; and at Watt island the prevailing rock is medium-

Spodumene and danalite.

grained light-gray, very quartzose biotite-gneiss with many fractured bands of dark mica and mica-hornblende schists. All are cut by many dykes of red pegmatite. Strike S. 80°W. About Moar bay the same quartzose gneisses and dark-schists are seen, cut by red granite and pegmatites, the irrupted rocks increasing towards the south side of the bay, where more than half the rocks are granites. Strike N.75°W. At the south point of Moar bay the light coloured gneisses (208) are again most abundant and are accompanying with thick bands of darker schists (209); accompanying the darker schists are bands of pinkish quartzite, which have the appearance of baked sandstone. Strike N.85°W to N.55°W.

From Moar bay southward to the islands of Cape Hope the rocks are largely a coarsely crystalline biotite-hornblende-gneiss (210, 212, 213), very poor in quartz and often containing epidote and, although now foliated, they were originally irrupted granite cutting and inclosing broken bands and fragments of quartzose gneisses (211) and dark schists, many of these bands being garnet-bearing. Strike W.

The prominent islands of Cape Hope are formed from another area of squeezed diabase (217) similar in character to that of the Paint hills but containing less pyrite. The mass is cut by a similar system of acidic dykes, the oldest being a fine-grained hornblende-granite (216), the next in age a lighter coloured granite (215) while the newest are pegmatite (214). The schists and dykes cutting them are all traversed by dykes of newer diabase. Acidic dykes.

In the northwestern part of the large island there are veins or bands of calcite included in the schists which hold many fine crystals of dark-red garnet up to an inch in diameter. From Cape Hope to the East Main river the rocks seen were all granitic (218) and inclosed only a few bands of dark schists. Strike S. 75° W. At the mouth of the East Main river there is a light-pink epidote-syenite (219). Very fine exposures occur along the coast between the mouth of the East Main river and Sherrick mount, the rocks coming out only at long intervals in low points and islands. Six miles south of the East Main river is a small island of squeezed diabase (220). The next exposures are at a low rocky point just south of the Kaniapiskau river, where the rock is a dark-gray schistose mica-gneiss (221) full of dark red garnets much decomposed to mica. Strike N. 75° W. At Loon point similar schistose gneisses (223) occur; they are often very quartzose, and are cut by large irregular dykes of white pegmatite which in places contain crystals of biotite up to three by five inches in size. Strike N. 80° W. All are cut by a dyke of rusty diabase forty feet wide (222). Large biot crystals in white pegmatite.

At Sherrick mount* and on the islands around it, the very quartzose mica-gneisses (224) prevail and are associated with dark basic schistose gneisses some of which contain pyroxene. All these schists and gneisses usually contain much garnet (225-226-227-228). These rocks are cut by coarse grained, often porphyritic biotite-granite-gneiss which is at times hornblendic; and all are traversed by large dykes of white pegmatite. Strike N. 85° W. to N. 60° W.

The last rock exposure in the southern part of James bay is seen at Stag rock* where the rocks are dark biotite-quartzite containing many garnets interbanded with light-gray quartzite holding little garnet or mica. They are cut by large dykes of light-gray pegmatite containing much bluish quartz. A fine grained pink or gray granite also cuts the schistose bands. Strike N. 85° W.

CAMBRIAN.

General Observations.

Unaltered sedimentary rocks.

The islands lying along the coast from Portland promontory to Cape Jones are formed of a practically unaltered series of sedimentary rocks, often associated with outflows of trap. These rocks are also found resting continuously upon the granites, and associated crystalline rocks of the mainland from a short distance south of the mouth of the Nastapoka river to Boat harbour in Manitounuk sound, and beyond there in broken patches as far as Humbug (Hamburg?) harbour, some thirty miles south of Great Whale river. These rocks of the islands and the mainland all dip westward or seaward at angles varying from 5° to 45°, and the breadth of the strip resting upon the mainland varies from a few yards to upwards of twenty miles at Richmond gulf, where they attain their maximum development. This series of rocks bears a close resemblance to those found along the Koksoak and Hamilton rivers, in the interior of Labrador, which were called Cambrian in former reports, and are classed under that name in the present report, although there is no fossil evidence for such a classification. They are probably older than much of the granite of the Labrador peninsula, which has been called Laurentian, and they are probably the unaltered equivalents of many of the schists and gneisses inclosed in and cut by these granites.† Except in a very few places, the contacts between these sedimentary rocks and the underlying granites appear to be unconformable and due to faults, but in the few places where the rocks were seen to rest undisturbed upon the granite,

*Report of Progress, Geol. Surv. Can., 1875, page 323, Do. 1877, p. 17 c.

†These speculations involve questions to which the answers are only individual opinions.—R.B.

the latter was found to cut and alter the bedded series, thus undoubtedly showing the granite to be the newer rock.

This series of sedimentary rocks is largely composed of arkose, feldspatitic sandstones and quartzite, feldspathic argillite, greywacke, dolomites and limestones, all more or less ferruginous; and associated with them sills and dykes of trap and diabase, which also occur as surface flows. Composition of series.

The constituent matter of all the rocks (with the exception of the limestone and dolomite) is such as would allow them readily to pass into micaceous and hornblendic schists and gneisses by the intrusion of newer granites.* In some of the rocks of the lower portion of the series, consisting as it does of beds of ferruginous feldspathic arkose sandstones and argillites, this change would readily take place from the accession of heat and pressure due to such a granite intrusion; and to the northward of Great Whale river patches of such rocks were found in a partly altered state inclosed in granite; while to the northward of Richmond gulf portions of the trap overflow are found inclosed and altered by similar granite. As before stated the contacts of the bedded rocks and granite are usually unconformable and appear to be due to a nearly horizontal movement of the bedded series subsequent to the intrusion of the granite, due to pressure acting from outside the great areas of granite. This series of sedimentary rocks being close to the surface, and consequently above the line of folding, broke, as ice does upon the shore when pressed from seaward, and piled cake on cake not only upon unyielding granite but upon themselves. Their present positions show that such a horizontal pressure was exerted upon them, as they lie in ridges, roughly parallel, with their dips seaward. The action of a similar thrust force is observed wherever these rocks have been seen throughout the Labrador peninsula, the beds lying in a series of ridges all dipping in one direction with broken cliff faces on the opposite side. Along the east coast of Hudson bay there are three such ridges of the first magnitude; namely, that of the coast line, that of the islands, and another which forms the outer islands from fifty to seventy miles off the coast. Result of horizontal pressure.

On the Koksoak river sixteen such ridges were noted in only the eastern half of the area. The main ridges are themselves broken into minor ones, and in Richmond gulf and on the Nastapoka islands, faults transverse to the direction of the main lines of fracture have fractured the rocks up into immense blocks and interfered with the symmetry of the dips, thus emphasizing the analogy which these rocks

* See last foot-note.

bear to shore ice acted upon by pressure from seaward, which not only piles the ice up in ridges upon itself and the shore, but also causes it to break into cakes.

DETAILED DESCRIPTION OF CAMBRIAN EXPOSURES.

Cambrian rocks.

The unaltered Cambrian rocks were first met with on the south side of Portland promotory where they form the Hopewell chain of islands stretching south eastward along the coast for fifty miles. At Portland promotory are large masses of diabase and dark schists cut by dykes and masses of granite, and these schists are probably the equivalents of the trap outflows which cap the bedded rocks of this region.

The following is a section in descending order made on the island at Hopewell narrows, at about the middle of the chain, and is fairly representative of the rocks exposed by the inner cliff of all these islands, the rocks dipping seaward at low angles :—

	Feet.
1. Dark-green, brownish-weathering, diabasic trap (51) composed chiefly of augite with a small amount of much altered plagioclase. This rock flowed out at, or near the surface, and two partings show that the flow occurred in three outbursts	100
2. Light greenish-gray quartzite (49)	50
3. Dark carbonaceous shale and shaley limestone	40
4. Dark-red and green chert, stained by oxide of iron, and containing rhombs of siderite in groups and bands (50)	10
5. Light and dark-blue, fine-grained, cherty quartzite	75
6. Dark-gray sandstone with calcareous partings, so that the rock is split into flags. Contains many rounded grains of transparent quartz	10
7. Bluish-white quartzite	50
To sea-level.	
	335

For thirty miles from the south end of Hopewell sound the coast is free from islands and the rocks of the mainland are granite, with occasional small patches of dark green trap, resting upon them at intervals along shore. The islands of the Nastapoka chain extending from lat. 57° 50′ to lat. 56° 05′ a distance of over 100 miles, and lying from one to three miles off the mainland, form an excellent protected channel for vessels of all sizes.

Section on Broughton island.

The following section was taken on Broughton island, the third large island from the northern end of the sound, and nearly opposite the mouth of Langland river. Section in descending order :—

	Feet.
1. Dark greenish, ferruginous chert, always containing more or less magnetite, broken into thin bands by partings of magnetic ore, which are usually too thin to work without much separation from the lean ores. These rocks at times contain splotches of red jaspar and of ankerite which weathers brownish (54-57-58)..	150
2. Dark argillaceous shale, greenish on fresh fracture, breaks into rusty weathering blocks....	42
3. Light bluish-gray chert.....	1
4. Red jaspilyte, generally lean in iron (56).....	8
5. Dark greenish-gray, silicious shale with thin beds of green sandstone. Contains much chlorite.....	6
6. Fine-grained, light-greenish feldspathic sandstone	9
Concealed.....	10
7. Fine grained, light-green, feldspathic sandstone spotted with minute brown marks. In heavy massive beds from three feet to five feet thick (55).....	30
8. Fine-grained, greenish-gray, greywacke splitting into flags from two to six inches thick (53).....	20
To sea-level.	276

The above is a typical section of the northern islands of the Nastapoka chain, except that in some places the above strata are capped by from twenty to fifty feet of irregularly weathering rusty beds.

The next section measured was on the south end of Davieau island and is as follows in descending order :—

	Feet.
1. Rusty weathering, brownish-gray carbonate of iron, mixed with broken thin bands of dark-greenish chert..	20
2. Dark-gray chert with many partings of dark-brown argillite (60) containing considerable oxide of iron.....	120
3. Red and green lean jaspery ore with ferruginous dolomitic partings.	8
4. Red and green silicious argillite.....	50
Sea-level.	198

About the middle of Davieau island the following section was obtained :— Sections on Davieau island.

	Feet.
1. Shaley, silicious carbonate of iron with bands of massive dark chert from one to two inches thick	25
2. Red fine-grained arkose containing much magnetite and hematite (62).....	8
3. Rich jaspillyte with thin pure bands of magnetite (65).....	20
4. Dark-gray chert containing much disseminated magnetite (61-63).	9
Sea-level.	62

At the narrow part of Gillies island near its middle, there is an exposure of 100 feet consisting of 30 feet of rich jaspilyte over-and underlain by gray ferruginous cherts. The foregoing sections appear

to represent the middle beds of the series of the Cambrian, the top and bottom beds being wanting.

About Richmond gulf the Cambrian rocks are well represented on the shores and islands. In several places contacts with the granites are seen but except at the north end of the gulf and in Wiachewan bay the contacts appear to have been due to faults subsequent to the intrusion of the granite. At the north end of the gulf the granite was found cutting and altering sandstones and trap while at Wiachewan bay where the sandstones abutt against a large mass of coarse granite, they are baked to a white quartzite for about 50 feet away from the granite and are penetrated by numerous small quartz veins.

Sections disclose unconformity.

The high cliff ridge, which separates the gulf on its western side, from the waters of Hudson bay, exibits everywhere fine sections of rock. These sections disclose an unconformity between the upper and lower beds of the formation caused by a thrust of the upper beds over the lower. The line of fault forms an acute angle to the bedding plane and in consequence the beds of the portion above the fault are thicker as they are traced southward.

The following descending sections were taken at intervals along the coast ridge from the north end of Richmond gulf to Little Whale river ands how the thickening of the upper beds at the north end of Richmond gulf:—

	Feet.
1. Dark-green porphyritic diabase	50
2. Light-coloured sandstone with a few thin bands of buff weathering dolomite (107)	45
3. Yellowish-weathering fine-grained silicious limestone, with massive, buff weathering beds near top	75
Unconformity.	
4. Below this the rocks are medium to fine-grained arkose and quartzite with occasional bands of finer red felspathic sandstone (108)	790
Section of coast rocks on south side Little Whale river two miles inland:—	
1. Dark-green trap or diabase	150
2. Dark-grey flags of impure sandstone with yellow spots, and some thin sandy bands	33
3. Light-pink and gray sandstone	10
4. Dark-gray carbonaceous sandstone, with shaley limestone, and black shale, the sandstone giving out toward the top, so that the upper 6 feet is mostly shale, with a few thin limestone bands	30
5. Light-gray sandstone, parted by thin beds of arenaceous limestone	45
6. Light-buff weather, light-blue silicious limestone with many partings of light-blue chert, so that the upper 20 feet is flaggy	94

7.	Light-coloured cherty limestone, weathering buff, and full of cavities lined with quartz and containing weathered pyrites and sometimes galena and blende	30
8.	More compact light-blue cherty limestone	160
	Concealed	50
9.	Light-grey sandstone, holding many blocks of chert, and forming an angular chert	140
	Conglomerate	10
10.	Light-blue cherty dolomite weathering buff, with patches of dark-blue chert	210
	Unconformity—	
11.	Coarse, dark-red, arkose composed chiefly of red feldspar, decomposed hornblende and quartz in pebbles	175
	To drift plain.	2,097

From the above two sections it will be seen that the sedimentary beds between the trap capping and the unconformable arkose below increase in thickness from 120 feet at the north end of Richmond gulf to 672 feet at Little Whale river, while an intermediate section taken on the south side of the outlet of Richmond gulf gives a thickness of 315 feet for the same part of the series, while to the northward of the first section they thin out altogether leaving the trap resting upon the arkose of the lower portion. This thickening of the beds cannot be due to irregularities of deposition but to a fault and thrust which has caused them and the overlying traps to override the underlying arkose rocks. The action of this fault is observable on the north side of the narrows of the outlet of Richmond gulf, where a small knob of granite rises into the bedded series and was overridden by the upper series which in so doing followed its contour on the western side but did not descend the eastern slope leaving a space there which was subsequently filled by the breaking and dropping down of the bedded rocks due to pressure of their weight.

Thickening of beds due to a fault and thrust.

The following sections of the rocks were made from the cliffs on the shores and islands of Richmond gulf, and are useful as giving an idea of the difficulties encountered in forming an ideal section of the series. On the west shore just inside the outlet there is a long peninsula connected with the mainland by a narrow neck.* This peninsula is formed wholly of bedded rocks which vary in colour from nearly white to dark-red, and in texture from a medium-grained sandstone, to a very coarse grit, containing rounded pebbles of quartz and feldspar up to two inches in diameter. These rocks are very quartzose and always carry much broken and rounded feldspar, and have evidently been formed from the disintegration of granitic rocks almost in place, the bedding being arranged like deposits in a shallow sea as the finer beds exhibit signs of ripple marking. The rocks are such that with the

*A description and view of Castle peninsula are given at page 14 c., Report of Progress, Geol. Surv. Can., for 1877.

accession of heat and pressure they would readily return to a gneissic condition.* These beds everywhere underlie the other clastic rocks of the series and are probably the lowest rocks of the series, but nowhere was the gradation into the unaltered lower granites seen, from which they are supposed to have been derived. The total thickness of these beds as exposed on the peninsula is upwards of 500 feet and probably nearer 1,000 feet. The following section in descending order was taken along the cliff on the south side of the narrows of Richmond gulf.

Thickness of beds.

	Feet.
1. Dark-brown very fine-grained diabase much cracked and cemented with impure red and green chert (89)	240
2. Very fine-grained dark greenish-gray diabase, much shattered, the fragments often rounded fissures; filled with an impure red chert, so that in places the rock has the appearance of a conglomerate (90)	350
3. Lighter greenish-gray diabase slightly coarser than (90) much less fractured (91)	225
4. Brecciated dark green diabase, cut by a few small quartz veins and containing small cavities filled with quartz, and flesh-coloured calcite and small quantities of pyrite	850
Unconformity.	
Concealed	300
5. Dark-green fine-grained fragmented diabase	500
Concealed	50
6. Dark red arkose, fine-grained and very silicious (92)	100
7. Coarse-grained gray arkose containing pebbles of quartz and felspar up to one-half inch diameter	10
8. Mixed beds of dark red greywacke and arkose with more silicious and coarser partings (69, 71, 81)	6
9. Medium-grained pink arkose sandrock (64)	4
10. Dark yellowish-red arkose sandrock	4
11. Light-pink arkose sandstone (79)	10
12. Dark purplish-red fine-grained arkose	1½
13. Greenish medium-grained arkose (70)	2
14. Light-greenish compact quartzite	1½
15. Light-pink arkose sandstone	7
16. Red banded arkose sandstone	3
17. Light-pink arkose sandstone	6
18. Mixed dark and light-red sandstone (80)	10
19. Light-pink and light-red sandstone	4
20. Red banded and light-red sandstones	1
21. Light-pink and light-red sandstones	2
22. Banded red and light-red sandstones	1
23. Light-pink and red sandstones	6
24. Banded red and pink sandstones	55
25. Dark-gray greywacke, containing small quantities of magnetite (76)	2
26. Banded pink to red arkose sandstone (78)	300
27. Red arkose with more angular fragments	50
Unconformity.	
	3,101

* The "Origin of Gneiss". Proc. Am. Assn. for the Adv. of Sci. 1889, pp. 227-31.

The arkose beds of the peninsula appear to rest immediately below the above section, and there is probably but a little break between them.

Resting unconformably upon the above is the following descending section representing the upper members of the series, separated from the lower by the costal thrust-fault before mentioned.

	Feet.
1. Dark-green, fine-grained diabase	100
2. Pink sandstone with numerous partings of dark ferruginous shale	15
3. Light-gray and pink sandstone, with very thin ferruginous partings	75
4. White, very fine-grained sandstone	40
Concealed	25
5. Buff weathering, light-blue cherty dolomite, with concretions of chert, and coarser grained darker coloured limestone	40
6. Yellow weathering, very fine-grained light-blue very cherty dolomite, with thin partings of light-blue chert	60
Concealed	50
7. Buff weathering, dark-gray, silicious limestone, with frequent partings of dark chert. The limestone is full of cavities lined with quartz and calcite, pyrite and blende, and at times galena, but all too scattered to be of economic value	8
To fault.	413

Section at entrance to Richmond gulf.

The next section was made down a small brook falling into the south-west corner of the bay formed by the peninsula, just inside the entrance to Richmond gulf.

This section is from the fault dividing the upper beds downward, as follows:—

1. Dark greenish-gray, rusty brown-weathering greywacke (75)	35
2. Dark-green greywacke (73, 74)	5
3. Dark-green greywacke, with brown splotches of jaspery ore	15
4. Light-gray sandrock, mottled with spots of oxide of iron	10
5. Dark-red fine-grained slate greywacke, containing considerable iron ore and small angular fragments of jasper (87)	40
6. Dark-red argillite, with small patches of green (88)	5
7. Dark-green splotched greywacke	10
8. Dark-red ferruginous greywacke, with partings of red argillite	50
9. Dark cherty greywacke	5
10. Pink fine-grained arkose sandstone	4
11. Dark-red ferruginous silicious greywacke	10
12. Mostly dark-green ferruginous splotched greywacke with thin bands of red greywacke and red argillite	50
13. Dark green, compact, ferruginous greywacke with a few dark-red slatey bands	150
14. Shaley, red ferruginous chert (impure magnetite-hematite)	50
15. Green, cherty rock splotched and veined with red jasper	150
To shore.	589

The next section is situated four miles to the eastward on a hill facing northward. It is as follows in descending order:

1.	Coarsely porphyritic fine-grained diabase	100
2.	Light buff-weathering dolomitic full of light-blue chert and carrying small quantities of blende	20
3.	Cherty, light-bluff limestone containing much pyrite and blue chert	100
4.	Dark silicious limestone with partings of dark carbonaceous shale	80
5.	Fine-grained, dark and light-gray flaggy sandstone with partings of dark-greenish arenaceous shale capped with a thin bed of light buff weathering cherty limestone	15
6.	Light-blue, yellow-weathering dolomitic chert	3
	Concealed	15
7.	Dark-grayish chert	6
8.	Light-gray and white fine-grained sandstone	115
9.	Coarse light-gray sandstone splotched with rounded fragments of white feldspar	10
10.	Light-gray sandstone, medium to fine-grained and thickly marked with minute brown spots together with light grayish green cherty beds separated by beds of dark brownish calcareous ferruginous sandrock containing small fragments of green jasper. Beds from ¼ to 2' thick (114)	105
	Probable unconformity.	
11.	Light-pink arkose sandstone	75
12.	Light and dark-red arkose sandstone with many partings of red argillite	55
	Concealed	185
13.	Dark-red arkose sandrock carrying some carbonate of iron; most plentiful in the upper beds there forming a lean cherty ore	45
14.	Dark-red arkose sandrock containing considerable chlorite interbedded with pink more silicious arkose	140
15.	Dark-red ferruginous arkose with many partings of dark-red argillite	75
16.	Chiefly pinkish sandrock with a few bands of dark red greywacke sometimes greenish in colour	60
17.	Very dark-red fine-grained greywacke	50
	Dark-red ferruginous arkose splitting into flags (113)	75
	Concealed	80
18.	Dark-reddish and grayish arkose with partings of dark-red argillite and a few bands of coarser pink arkose (all ripple-marked)	33
19.	Light-pink fine-grained arkose	10
	To sea level.	
		1,452

The rocks of Cairn island and other islands in the southern part of Richmond gulf are largely pink and red arkose with (84) red and green micaceous argillite, and green greywacke. Nearly all the beds show ripple marks. The arkose in the upper beds shades into sandstone (93) from the elimination of feldspar. The following section made on the mainland immediately south of the narrows at Cairn island is interesting as showing the manner in which sheets of diabase have been injected between the bedding of the sedimentary rocks at this place.

Ripple marks.

1. Fine-grained purplish-green diabase with numerous amygdules of chlorite and at times calcite. Penetrated by veins and large splotches of reddish diabase (95)	400
2. Light-colored medium-grained green and pink arkose	85
3. Fine-grained decomposed diabase	28
4. Light-gray and pink flaggy arkose	30
5. Dark-green diabase	10
6. Light-greenish fine-grained arkose	40
Concealed	100
7. Dark-green diabase	60
8. Light-greenish fine-grained arkose	330
To contact with coarse biotite granite (96).	
	1,083

Contact of arkose with granite.

The contact of the arkose with the granite is a vertical fault from two to five feet wide and there is no appearance of alteration in either rocks near the contact.

To the southward an upward continuation of the above section is as follows :—

1. Dark-green diabase	200
2. Dark-red argillite	2
3. Dark grayish-pink sandrock	25
Concealed	10
4. Lean red jaspilyte	55
Concealed	15
5. Impure red jaspilyte	10
Concealed	15
6. Slatey impure jaspilyte	35
7. Diabase full of jasper veins	15
8. Slatey iron jaspilyte	10
9. Cherty dark-gray limestone	10
Impure jaspilyte	50
Diabase	400
	852

This diabase is the top member of the preceding section.

To the eastward of Cairn island the arkose rocks occupy a strip from 50 to 500 yards wide along the south shore of Richmond gulf, except for about a mile where the granite comes out to the shore. The islands in the south-eastern part are composed of interbedded diabase and arkose.

The granite comes out to the eastern shore at the foot of Whale bay, at the south point of Wiachewan bay, about three miles north of the mouth of Clearwater river; again to the northward of the mouth of Deer river and at the northern end of the gulf. Everywhere else along this shore and on the islands lying off it, the rocks are bedded arkose, greywacke and argillite, associated with flows of dark green diabase. The only other section of the rocks on Richmond gulf

which may be given is one measured in descending order at the cliff on the west side forming the point to the southward of Fishing-lake bay. Here the arkose of the bottom is not so thick as usual and the upper beds are more largely developed than elsewhere along this shore.

	Feet.
1. Fine-grained dark-green diabase (112) in places having porphyritic crystals of light-green feldspar; in other parts containing small amygdules of agate and chlorite or empty so that the rock is often honeycombed	55
2. Light-gray fine-grained sandstone (111)	8
3. Light-gray, coarse-grained sandstone (110)	40
4. Light-coloured dolomite with partings of chert and towards the middle of the measures large boulders of light-coloured grit	65
5. White compact limestone	10
6. Light-blue fine-grained silicious limestone with frequent partings of white and light-blue chert	80
7. Light-coloured yellowish to white, fine-grained sandstone with small specks and veins of yellow carbonate of iron	25
8. Light-gray medium to coarse-grained friable sandstone with calcareous matrix holding a few large dark-red garnets	15
9. Light-bluish limestone	5
10. Light-gray fine-grained dolomite with numerous partings of black graphitic shale from one to fifteen inches thick	60
11. Dark-blue compact dolomitic limestone weathering buff in beds from 3 to 24″ with shaley partings	70
12. Dark shaley limestone splitting into large flags from ½ to 4″ thick. Unconformity.	100
13. Arkose and sandstone. To sea-level.	720
	1,253

Other sections made.

Several other sections were made of the rocks forming the cliffs about Richmond gulf, but as those above given are quite sufficient to show the nature and succession of the rocks in this region the former are not included here. The diabase-capped sedimentary rocks occupy the coast from Little Whale river southward as far as the head of Manitounuk sound, where the ridge of trap-capped rocks passes into the Manitounuk islands. The following descending section was measured at Big Rock on the northern island of this chain where the greatest thickness of the measures occur.

	Feet.
1. Dark-green, fine-grained diabase, slightly basaltic in structure	225
2. Very dark, fine-grained greywacke slate, and fine greywacke, baked light-green for 15″ from contact with overlying diabase	36
3. Rusty weathering arenaceous limestone full of partings of sandstone and containing some carbonate of iron	52
4. Light-blue and pink, fine-grained sandstone	93
5. Light-pink sandstone	40
Concealed	25
6. Light-blue and pink sandstones	18

7. Dark shaley limestone	3
8. Light-blue and pink sandstone	15
9. Dark-gray silicious limestone containing grains of transparent quartz ; weathers rusty	33
10. Light-pink sandstone	31
11. Light-pink sandstone, very fine-grained with numerous partings of shaley limestone	23
12. Very fine-grained dark sandstone (84)	6
13. Grey sandstone with numerous thin partings of shaley limestone. Concealed.	18 30
14. Light-gray and bluish quartzite, with patches and pebbles of limestone, ripple marked	443
To sea-level	20
	1,111

A second ridge varying from 100 to 2,000 yards occupies the shore and the small adjacent islands from the northern end of Manitounuk sound to within five miles of the mouth of Great Whale river. The rocks forming this ridge are all fine-grained, light blue or pink dolomitic limestones, often silicious and containing concretions and partings of blue chert (122). The concretions are sometimes upwards of two feet in diameter, and are formed of thin alternate layers of limestone and chert, giving them the appearance of the fossil remains of some low form of animal organism. This ridge of limestones is continued to the south of the mouth of Great Whale river as patches resting upon the granite, as far south as Sucker creek. Dolomitic limestones.

Long island and the other islands between Great Whale river and Cape Jones are also formed of Cambrian rocks.

On Bear island the following descending section was measured :

1. Dark-gray micaceous sandstone becoming lighter coloured on top	20
2. Fine-grained black quartzite in beds from 3 to 24 in. thick. Contains considerable pyrites (120) (121).	30
3. Dark-blue shaley limestone	4
4. Dark-gray micaceous sandstone	20
	74

The following section was made about four miles from the north end of Long island. The cliff face on the eastern side gave as follows :

1. Light-blue dolomitic limestone containing many quartz grains (125)	30
2. Fine-grained, compact, light-blue, dolomitic limestone, very massive; weathers buff	60
3. Light-coloured, massive limestone, with partings of darker shaley limestone	25
4. Massive light-coloured limestone	50
5. Dark-blue fine-grained shaley limestone (124)	18
6. Fine-grained massive limestone with partings and concretions of black chert (123)	20
	203

There is an interval of a half mile to a second ridge inland on the island which gives the following descending section :—

1. Fine-grained dark green diabase (127)	50
2. Dark brown, yellow-weathering carbonate of iron with some calcite and interbanded with black chert (126)	20
	70

The underlying rocks are concealed by the drift.

On the islands to the south and east of Long island, pink and gray sandstones (129) overlie thick beds of massive concretionary limestone often carrying much pyrite.

Tickness of rocks difficult to define.

The above detailed descriptions of several of the sections measured in the Cambrian area, show how difficult it is to arrive at any definite conclusion as to the thickness or succession of these rocks. In the first place the capping of diabase which was probably a flow at or near the surface does not rest always upon the same beds, there being a difference of several hundred feet between the beds immediately underlying the diabase of the Manitounuk islands and those in the same position at Richmond gulf. The rocks, resting unconformably upon the lower arkose beds along the west side of Richmond gulf, also vary in thickness and in the number of the measures which rest directly upon the arkose. This difference is due to cross faults parallel to the direction of the thrust which allowed varying thickness of the upper rocks to be shoved over the lower in each huge cake lying between any two such faults.

The sequence of the formation in descending order is assumed to be as follows :

The upper portion is taken to be represented by the diabase-capped, light-coloured sandstones and limestones of the Manitounuk islands. These appear to rest upon a maximum thickness of 300 feet of cherty limestone, followed below by sandstones and argillites passing downwards through several hundred feet of dark red argillite sandstone and greywacke into the arkose at the base of the formation. The iron-bearing series of the Nastapoka islands are the equivalents of the red sandstones and argillites above the arkose. The total thickness of the formation is reckoned as follows in descending order :

	Feet.
1. Diabase capping	400
2. Manitounuk series	450
3. Limestones	300
4. Light coloured sandstones, &c	150
5. Dark red sandstone, argillite and greywacke	700
6. Arkose sandrock and greywacke	600
7. Arkose	1000
Total thickness of sedimentary rocks	3600

Glacial Geology.

The entire western side of the peninsula of Labrador during the glacial period was overspread by an ice-cap of a thickness sufficient to cover the highest summits, and to flow uniformly over mountain and valley from the interior of the peninsula outwards towards the coast. From the evidence of the glacial striæ now found marking the rocks, there would appear to have been movements in the position of the centre of dispersion of the ice, and perhaps periods of only slight glaciation corresponding to the interglacial periods of the United States. Along the east coast of Hudson bay, three marked sets of striæ are found, and from these it is seen that the earliest ice flow started from a central gathering ground between the 50th and 51st parallels of N. latitude, near the centre of the peninsula. The second set of striæ show that the centre of glaciation had moved in a north-west direction to beyond the 54th parallel, while the latest set shows a continuation of the north-west movement leaving the centre of dispersion between the 55th and 56th parallels, and about one hundred miles inland from the east coast of Hudson bay. In many places only one set of striæ is visible, and these, the latest, show along the northern half of the coast that the flow of the ice was radially towards the coast, as the striæ on the rocks facing Hudson bay show that the ice flowed westward, while those facing Hudson strait show a northward flow..

Three sets of glacial striæ.

On the Moose river which falls into the southwest corner of Hudson bay a very interesting fact in regard to the glaciers was noted in the direction of the striae found on its banks in the interior. The oldest striae there were from northwest to southeast and prove that the Keewatin glacier overran the region north of Lake Superior before it was covered by the Labrador glacier which has left newer striae from the north-northeast. Subsequent to or accompanying the period of ice accumulation there was a marked subsidence of the land which was followed by an uplift. This uplift is marked by terraces of sand and clay, often carrying marine shells and accompanied by old sea beaches, the highest of which are upwards of 700 feet above sea-level. The data to hand is not sufficient to determine if the elevation was constant and equal along the east coast of Hudson bay owing to the fact that the land for long stretches along that coast nowhere rises sufficiently high to mark the level of the highest terraces, which are seen at greater elevations elsewhere.

Subsidence of land followed by uplift.

LIST OF GLACIAL STRIÆ.

NOTE.—The courses of the striæ given in the following list are true or astronomical bearings, and record the directions from which the ice-sheet moved in each case.

Head of Erik cove	
Down the valley	S. 40° W.
Near the summit of hills	S. 10° W.
On summit	S. 20° W.
Nauyok island	S. 30° E.
Mainland in rear of Nauyok island	S. 60° E.
Camp bay (4th Aug.)	S. 10° W.
Nuvuk	S. 10° W.
Small island 10 miles west of Nuvuk	S. 20° E.
Icy cove	S. 10° W. S. 20° S. S. 35° E.
Two miles in rear of Icy cove	S. 10° W. S. 25° E
Thirty miles S.W. of Icy cove	S. 80° E.
Koitasut	N. 75° E.
Two miles north of Kovik	N. 75° E.
Kovik	N. 65° E.
South point of Kovik river	N. 65° E.
Kettlestone knob	S. 75° E.
Kettlestone river	S. 70° E.
Six miles north of Cape Smith	S. 75° E.
Cape Smith	S. 50° E.
North side Mosquito bay 5 miles from Cape Smith	S. 75° E.
" " 10 " "	E.
" " 2 " head of bay	S. 85° E.
South point, Mosquito bay	S. 65 °E.
Island 4 miles south of Mosquito bay	E.
Mouth of Sorehead river	E.
Eight miles up Sorehead river (on hill)	S. 80° E.
South point, mouth of Sorehead river	E.
Magnet islands	E.
Thompson harbour	N. 75° E.
Two miles south of Thompson harbour	N. 70° E.
Two miles north of Cape Anderson	S. 65° E.
" south " "	S. 80° E.
Two miles up Povungnituk river	N. 80° E.
First rapid " "	S. 80° E.
Shoal harbour	E.
Checkered islands	E.
North side Kogaluk bay	S. 80° E.
Island off south point Kogaluk bay	S. 85° E.
Island off Nauberakvik river	S. 85° E. N. 75° E. N. 55° E. N. 30° E.
Alle harbour	N. 70° E. S. 35° E. N. 30° E.

Mainland at Alle harbour.....N. 75° E.
Summit of island, Hopewell narrows.....N. 50° E.
Summit of Broughton island..... N. 70° E., (newer) S. 65° E.
Richmond gulf on summit of N. end.....S. 60° E.
" " summit south of Fishing lake.....S. 58° E.
" " island No. 1.....N. 80° E.
" " east point Cairn island..... S. 80° E, S. 70° E.
" " summit opposite narrows, Cairn island.....S. 85° E.
Great Whale river, one mile above H. B. post.....N. 85° E.
" " " one mile above 1st fall.....E.
" " " five miles above 1st fall.....E.
" " " at first fork.....S. 75° E.
" " " canon of 3rd fall .....E.
" " " five miles up Abchigamich branch.....S. 80° E.
" " " fifteen miles up Coast branch.....N. 85° E.
" " " end of survey " " .....S. 75° E.
Two miles south of Great Whale river.....E.
Ten " " " " " .....S. 85° E.
Black Whale harbour.....E.
Otaska harbour.....N. 80° E.
Humbug harbour.....N. 85° E.
Split rock.....N. 40° E., N. 60° E.
White Bear hills.....N. 50° E.
Long island.....N. 50° E., (older) N. 68° E.
Cape Jones.....N. E., (older) N. 60° E.
One mile north of Pishop Roggan river.....N. E.
Attikuan .....S. E.
Kakachischuan.....N. 55° E., (older) S. 35° E.
Pipestone gutway.....N. 63° E., (older) S. 55° E.
Governor island, Big river .....N. 60° E.
Two miles south of Governor island.....N. 65° E., (older) N. 85° E.
Five miles " " " .....N. 57° E., (older) N. 80° E.
North point of Aquatuk bay.....N. 52° E.
Middle islands, " " .....N. 52° E.
Earthquake island.....N. 55° E.
Mainland opposite Earthquake island.....N. 50° E.
Dead Duck bay..... N. 55° E.
" " " south point.....N. E.
Gray Goose island.....N. 35° E.
Mainland opposite Burnt island.....N. 38° E.
Burnt island.....N. E., (older) N. 62° E.
Comb Hills harbour..... N. 42° E.
Pigeon island ..... N. 37° E.
Five miles north of Loon point.....N. 30° E.
Paint hills, Walrus island.....N. 26° E.
Paint hills, Walrus island..... N. 37° E.
Paint hills, Walrus island.....(older) N. 77° E.
" " .....(newest) N. 30° E.
Paint hills, island No. 10 ..... N. 67° E.
" " ..... (oldest) S. 52° E.
" " .....(newest) N. 28° E.
Paint hills, island No. 14 .....N. 68° E.
" " .....(oldest) S. 52° E.
" " .....(newest) N. 23° E.

Paint hills, island No. 19 ..... N. 63° E.
" " ..... (oldest) S. 52° E.
Paint hills, island No. 21 ..... N. 21° E.
" " ..... (newest) N. 21° E.
Paint hills, island No. 23 ..... N. 68° E.
" " ..... (oldest) S. 52° E.
Watt island ..... N. 31° E.
" ..... (older) N. 63° E.
Moar bay ..... N. 26° E.
" ..... (older) N. 68° E.
Long point ..... N. 26° E.
North point Old Factory river ..... N. 28° E.
South " " " ..... N. 26° E.
Cape Hope island ..... N. 26° E.
" " ..... (older) N. 60° E.
High Rock island ..... N. 23° E.
" " ..... (older) N. 42° E.
Five miles south of East Main river ..... N. 35° E.
" " " ..... (older) N. 55° E.
Kaniapiskau river ..... N. 33° E.
Loon point ..... N. 35° E.
" ..... (older) N. 55° E.
Sherrick mount ..... N. 30° E.
" ..... (older) N. 55° E.
Stag rock ..... N. 33° E.
Missinaibi river Conjuring House portage ..... N. 10° E.
" Black Feather rapid ..... N. 20° E.
" Tom King rapid ..... N. 18° E.
" Sandy Bay portage ..... N. 20° E.
" " " ..... (older) N. 50° W.
" Albany rapid ..... N. 28° E.
" " ..... (older) N. W.
" Devil rapid ..... N. 25° E.
" Island portage ..... N. 25° E.