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Yours Truly
Alexr. Murray

THE

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ALEXANDER MURRAY, F.G.S., F.R.S.C., C.M.G.

BY ROBERT BELL, B.A.Sc., M.D., LL.D.

The subject of this biographical sketch was assistant provincial geologist of Canada (as it was before Confederation) from the commencement of the Geological Survey of the united province in 1843 till 1864, and afterwards director of the corresponding Survey of the island of Newfoundland from 1864 to 1883. Owing to his having divided the period of his active life almost equally between the two countries, it could not be expected that many persons would know much of his career in both. Indeed, there are but few at this day who are familiar with his personal and at the same time his scientific history in either of them. Having had a long personal acquaintance with Mr. Murray, and being conversant with his labors in both spheres, I have been asked to write a short account of his life.

His services to the topography and geology of Canada and Newfoundland were very important, and deserve to be gratefully remembered. Although he was a well-known figure in old Canada during the period of his active employment, so rapid are the changes in a country like ours, and so quickly do the new comers occupy the places of the pioneers, that the labors of Murray are already being forgotten; and, at most, only a vague impression remains of what he actually accomplished even among those who have most to do with similar work in these provinces at the present time.

A brief sketch of the career of Alexander Murray, and a succinct enumeration of his work which would help to preserve to him the credit of his labors ere it is too late, would, therefore, be not only a just tribute to his memory, but a useful record for reference hereafter in regard to the geography and geology of Canada and Newfoundland. For these reasons I have been induced to respond to the above mentioned request; and in undertaking this duty I propose in the personal part of the narrative to paint a true picture, giving the shadows as well as the lights, so that the reader may form a correct estimate of his character.

It was my good fortune to be tolerably well acquainted with Mr. Murray's history both in Canada and Newfoundland—otherwise I would not have attempted the present task. Not only was I associated with him for seven years at the headquarters of the Geological Survey in Montreal, but I accompanied him one year, as assistant, to his favorite haunts among the Huronian rocks of Lakes Superior and Huron, which, it is well known, he was the first to investigate; and, as regards Newfoundland, I have had opportunities of going over his work in different parts of the island and afterwards of discussing its geology with him during several weeks' residence at St. John's in the winter of 1868–69. Where my own knowledge was lacking at any point, I have obtained the requisite information through the kindness of friends of his in both countries. Among those in Canada I would mention Major Joseph Wilson of Sault Ste. Marie, Mr. John Johnson and Mr. Scott Barlow of Ottawa, former assistants; and as to Newfoundland, his widow, now resident in Edinburgh, Mr. Thomas C. Weston of Ottawa, Rev. Moses Harvey of St. John's, and more particularly Mr. James P. Howley, his assistant on the Island, to whom further reference will be made.

Mr. Murray was a friend of my late father, the Rev. Andrew Bell, who had given much attention to the geology of Upper Canada and had mapped the distribution of the rocks in the lake peninsula, according to the divisions which had been made by the geologists of the State of New York, before the commencement of the government Geological Survey of Canada. It was when on a visit to my father, in 1850, who was then living in Dundas, that I first saw Mr. Murray. Although only a boy at that time, I had a distinct recollection of him as a bright, genial and pleasant looking man. On this occasion my older brothers assisted him to measure the strata in the cliffs around the head of Lake Ontario, among which was the "Sydenham Road Section," published in his report for that year and which has been so often used for reference in regard to the rocks of the surrounding country. During this visit, my father, who was familiar with the country northward to Georgian Bay, furnished Mr. Murray with information which enabled him to lay out his time, in examining it, to the best advantage—all of which he acknowledged in his report to the government. I renewed Mr. Murray's acquaintance in 1857, when I joined the staff of the Geological Survey, and have followed his labors to the close of his life.

When in St. John's in the winter of 1868–69, I was requested by the government to give evidence as to the value of Mr. Murray's survey of the island. This evidence was published by the government, and was said to have influenced the legislature in continuing the survey.

It was during 1868 that Mr. Murray was fortunate enough to secure the services of Mr. James P. Howley, who continued to assist him with so much ability in the prosecution of the survey until his retirement in 1883, since which time, with one interruption, Mr. Howley has carried on the work alone up to the present year.

Before attempting to trace Murray's career as a geologist, we shall notice briefly his family history up to the time of his leaving for Newfoundland, and further on give a similar notice of his domestic relations in that colony. Murray was remarkable for having, as it were, duplicated his life-history, or to have enjoyed two separate spans of life of about the same duration, in each of which his career was very similar in nearly all respects. He repeated in Newfoundland the same kind of preliminary geological and topographical work he had done in Canada, and having married and brought up a family in the latter province, he became a widower, and, on going to Newfoundland, married again and reared a second family of children. So completely separate were his two spheres that one is apt to think of him as he would of two distinct individuals, and his biography must necessarily branch into two separate parts.

Murray was born at Dollerie House, Crieff, in Perthshire, Scotland, on the 2nd of June, 1810, and died in the same town on the 16th of December, 1884, in his 75th year. He was the second son of Anthony Murray, Esq., of Dollerie House, Anthony being the eldest, and William, who was killed in the Indian mutiny in 1857, being the third son. They belonged to the family of the Murrays of Ochtertyre, referred to by the poet Burns in his song "Blithe was She," and were cousins of Sir Patrick Murray, the present proprietor of the estate of his forefathers.

His first wife was Fanny Judkins, of Liverpool, a sister of the late Captain Judkins, well known for many years as the commodore of the Cunard line of steamships. By her he had a son and two daughters. The son, Anthony Hepburn, born in Scotland 30th October, 1840, adopted the military profession, and has been an officer in India since about 1857. He is still in that country, and is now a colonel in the Horse Artillery. His eldest daughter, Mary Helen, born at Woodstock, Upper Canada, 2nd October, 1838, married, about 1856, Mr. Frank Elwes, then of Woodstock, and soon afterwards removed with her husband to England. She has been a widow for some years, and is still residing in England. The second daughter, Helen, born at Woodstock 19th March, 1843, married, in 1861, Bernard Fabricotti, proprietor of the Carrara marble quarries in Italy, but she and her husband lived most of the time in London, where she died in 1882.

Murray was educated at the Royal Naval College, Portsmouth, entered the navy in 1824 as midshipman, passed for lieutenant in 1833, and retired in 1834. Although he did not remain long in the service, the atmosphere of a man-of-war of those days clung to him throughout life. He was fond of nautical terms and illustrations and the strong language of naval officers of the olden time. On account of these peculiarities, when he removed to the seafaring colony of Newfoundland he was christened Captain Murray by the people, and among them was always known by this honorary title.

During his career as a naval officer he had an opportunity of seeing some active service, and was present in the "Philomel" at Navarino on the 20th of October, 1827, where he was wounded, and received a medal for the part he took in that engagement. At the time of the rebellion of 1837–38 in Upper Canada he volunteered his services to the government and was on duty for a short period.

The salary attached to the position of assistant provincial geologist does not appear to have been sufficient to secure his services for the entire year, and Murray was allowed to devote part of his time to agriculture. He purchased land in the township of Blandford, not far from Woodstock, one of the best districts in the upper province, and continued to hold his farm all the time he was connected with the Geological Survey of Canada. For the first few years he kept the management of it in his own hands, his wife looking after matters while he was absent on geological field-work a part of each summer or at the office of the Survey in Montreal a portion of each winter. He found, however, that in his case "gentleman farming" would not pay, and so he rented this property and took a house in Woodstock. Here his wife died in the winter of 1862–3 while her husband was temporarily residing at the headquarters of the Survey in Montreal. . . .

Murray was a man of medium height, rather fair complexioned, with blue eyes and flaxen beard. He was well built and had powerful muscles until he was overtaken by a paralytic stroke previous to 1856, after which he refrained from performing the feats of strength in which he had formerly delighted. The portrait accompanying the present sketch is from a photograph taken at Crieff in 1867.

He was noted as an ardent sportsman and lover of dogs, guns and fishing-rods. But he confined himself to the lines he could follow in a wild country, and neglected most of the sports of civilized regions, such as horse-racing, cricket, etc. But when Murray was a young man, before public sentiment became so refined as it is at the present day, he did not deny having a weakness for the "manly art" and some other sports which are now tabooed in "society."

The animals he killed during his surveys and explorations in the backwoods always formed a welcome addition to the diet of salt pork, and often it constituted the only food in camp. He was an excellent shot with both rifle and gun, and many a bear and deer fell under his aim, to say nothing of the multitudes of ducks, grouse, snipe, woodcock and other wild fowl. He had a great fondness for fly-fishing, which he considered "the grandest sport in the world," and he would go into raptures over the capture of an extra big trout.

To show how confident he felt of his skill as a marksman the following anecdote may be related:—On one occasion when at the Sault Ste. Marie several land surveyors arrived on their way into the back country where they were going to run base lines and lay out townships. Murray had explained to them the use of the Rochon micrometer telescope, with which he measured most of his distances, when one or two of the surveyors expressed a wish to see a practical demonstration of the working of the instrument. For this purpose they sent one of their voyageurs, a Frenchman, to take Mr. Murray's disc-staff to the small island opposite Capt. Wilson's house, where he was to hold it erect at any spot Mr. Murray might indicate after he had landed. Murray told him that he was to move the staff to whichever side he might wave his hat. "C'est bien, Monsieur," said the voyageur, as he pushed off in his canoe. The first position he selected not suiting Mr. Murray, the latter took off his hat and waved him the pre-arranged signal. The man had evidently misunderstood, for while continuing to hold the disc-staff in a provokingly negligé style, he took off his own hat and waved it most gracefully to the same side. This made Murray furious, and he signalled wildly with his hat to the other side. The man changed hands on the staff and waved more elegantly than even on the corresponding side. Words failed Murray for the occasion, and, gasping for breath, he handed the micrometer to some one near him and ran for his rifle. The voyageur wore his Sunday coat, a light alpaca. It was hanging open from his shoulders and blown a little way out from his body. With a steady hand Murray sent a bullet through the fluttering coat-tails, which evidently gave the man a jerk at the instant he heard the crack of the rifle, for he dropped the staff, exclaiming, "Mon Dieu, je suis tué."

A cold bath every morning was regarded by Murray as more essential than his prayers, and no matter how inclement the weather might be, or how inconveniently his tent might happen to be pitched for getting at the water, he would never allow the cold, rain or wind, or such obstacles as a marsh, a jam of driftwood or the tangled brush, to prevent him reaching deep water and enjoying his "dip." Late in the autumn, after the snow had whitened the ground and the ice was forming around the shores, he still continued the practice with unabated rigor. Cleanliness was a sort of hobby with him, and he had a very poor opinion of anyone who did not "tub" with reasonable regularity. When on an exploratory "traverse" in the woods, if a river or a narrow lake lay across his course, he would not hesitate to plunge in and swim to the other side rather than lose time in making a raft, as most explorers do under such circumstances.

His duties as an explorer in the forest regions soon rendered him an expert bush-ranger and canoeman, while his experience at sea had taught him to handle sail-boats well. The freedom of the woods and waters of the west had a great fascination for Murray, and I have often heard him say how much he preferred life in the bush to that in Canadian civilization.

He took little interest in the public affairs of Canada, but in British politics he was a most pronounced Tory. Without being a tuft-hunter, he had a great admiration for the Scotch and English aristocracy, and attributed to their influence, more than to anything else, the prestige which the nation has won, not only in arms but in all the arts and sciences which flourish in Great Britain.

In matters of belief Mr. Murray was a Protestant, and although not much known in "religious circles," he led a straightforward life and had a cordial detestation of every kind of cant and hypocrisy. Although very outspoken and sometimes not over choice in the language he used in the society of men, among women he was gentle, affable and delightfully polished in manner and conversation. He was fond of children, kind to the poor, and in cases of sickness or misfortune was considerate, generous and sympathetic.

Socially, Mr. Murray was always in great demand during his sojourn both in Canada and Newfoundland, although he was not very fond of "going out" in society. When he and Sir William Logan were present in any social assembly they always formed the centre of attraction and charmed the company with their entertaining stories, jokes, or general conversation, and occasionally by a song. These were cheerful days in the Survey offices in Montreal. Every now and then the pleasant voice of Logan or Murray might be heard echoing through the rooms, and the dull, quiet work over maps, rocks and fossils, was relieved by many a hearty laugh. A visit to the museum was a treat to strangers if they should be fortunate enough to be escorted through it by either of these men.

Murray's voice was seldom heard in public, yet he was a good speaker when occasion required. His speech at the Toronto banquet to Logan after his return, newly knighted, from the Paris Exhibition of 1855, was the best of the evening, and was regarded as a very fine effort On 15th February, 1869, I had the pleasure of listening to his popular lecture on "The Economic Value of a Geological Survey," delivered in the Athenæum Hall in St. John's before a large and intelligent audience, which included the governor of the colony and most of the members of both branches of the legislature. The subject matter of itself, his method of treating it and the delivery, were all excellent and called forth a very hearty vote of thanks.

Usually good natured and genial, Murray was, nevertheless, quick-tempered, and in the heat of provocation sometimes said or did what he immediately after repented. Many stories might be told in illustration of this trait in his character, but two or three must suffice.

On one occasion, when sitting beside Sir William Logan at a public dinner at the St. Lawrence Hall in Montreal, one of the waiters gave him some impudence. In a moment Murray was on his feet and knocked the man's head against the wall behind him. In the morning Murray, hearing that the waiter was about to take out a warrant against him for assault, made haste to have him arrested for using insulting language. Whereupon the man was glad to compromise matters, and the affair dropped.

In 1860, on our return from a coasting voyage along the south shore of Lake Superior, Mr. Murray and I were camped at the head of the portage on the Canadian side of the Sault Ste. Marie. One of our men, Pierre Pilon by name, a well known character in these parts, became somewhat the worse of liquor, and was seized with a desire to have a letter written to his wife at Shi-ba-o-na-ning, of whom he seldom thought when sober. Mr. Murray was lying on his back in his little tent reading a book and enjoying a much needed rest. Every little while Pilon would put his head into the tent door and again request him to write the letter, always forgetting he had already done so more than once. Mr. Murray put him off, good-naturedly at first, but with increasing wrath each time the man nagged him, and also reminded him in more and more forcible language that he was drunk. The last time he thrust his head into the tent Murray's face "spoke volumes" without his uttering a word. In an unguarded moment the half-intoxicated Pilon changed the subject and remarked, "Monsieur Murra, you look lak 'e dev, sair." Murray threw down his book, sprang to his feet and seized the rifle which always lay beside him. Pilon had only a moment to run behind the large canoe-house near by. Before Murray's temper could cool to a reflective stage he had made the circuit of the building several times in pursuit of the fugitive. Then, doubling back on him, there was a lively game of hide-and-seek round the corners of the building. Meantime the Indians and I, convulsed with laughter, threw ourselves down behind the largest boulders we could find lest the expected bullet might come our way. In a few minutes, however, Mr. Murray walked quietly back to his tent and the next morning discharged the offending Pilon.

Mr. Murray having been the first to survey and map the river now known as the Petewawé, gave it this name after an old Indian friend of his whose principal camping place was at the mouth of the river, and who was well known to all frequenters of old Fort William, which stood on the opposite side of the Ottawa.

Mount Logan, in the Shick Shock range in Gaspé, was so called at the suggestion of Mr. Murray, and he also gave the names they now bear to many of the geographical features in the country north of Lake Huron, which he was the first to lay down correctly on the map. He was an excellent surveyor and astronomical observer, as well as a neat and skillful draughtsman, as witnessed by the numerous large and well executed maps of his in the office of the Survey. Most of his surveys were plotted with his own hands, in the field. The numerous latitudes which he took have been found of great service in fixing positions in many parts of old Canada and Newfoundland. His surveys of Lake Nipissing and the various channels of French River, made in several different years, were found sufficiently accurate for the purpose of the Ottawa Ship Canal Survey, and were adopted by the engineers of that project—Shanly, Clark, Perry, Norman and Galway—who gave him credit for the use they had made of them.

In 1842 the Geological Survey of Canada was instituted by the government, on a petition of the Natural History Society of Montreal, made at the suggestion of the late Rev. Dr. Mathieson. Mr. (afterwards) Sir W. E. Logan was appointed provincial geologist, but owing to unfulfilled business engagements in England he asked for leave of absence and spent the winter of 1842–43 in the old country. Here he appears to have first met with the subject of our sketch in the beginning of 1843, and to have engaged him as his assistant. Little is known of Murray's early studies as a geologist, but even when a midshipman he appears to have had a taste for the science, and had some practical training under Sir Henry T. De la Beche, with whom he served on the Geological Survey of Great Britain during 1841; while his nautical education had already fitted him to undertake topographical surveying. He arrived in Canada in May, 1843, and immediately commenced operations in the western province, while Logan returned from England, by Halifax, the same spring. On his arrival the latter proceeded to the north-western part of Nova Scotia and measured the celebrated section of the Carboniferous rocks at the Joggins, near the head of the Bay of Fundy, which is published in detail in the Report of Progress for 1843. He then went to the eastern part of Gaspé and examined the coast in detail from Cape Rosier to Paspebiac. This was the commencement of the Geological Survey, which has since been extended to nearly all parts of the northern half of the continent.

Murray wrote little for publication besides his official reports to the governments of Canada and Newfoundland.

When the Royal Society of Canada was founded by the Marquis of Lorne, it was made to include Newfoundland, and Murray was appointed one of the original Fellows. In 1882 he contributed to its Transactions an interesting paper on "The Glaciation of Newfoundland." He was elected a Fellow of the Geological Society of London in 1870, and in 1878 was created a C.M.G. through the recommendation of Sir John Glover, then Governor of Newfoundland.

When Logan and Murray commenced the Geological Survey of old Canada the greater part of the areas of both provinces were uninhabited, unsurveyed and unknown. The problem before them was to ascertain the general geological structure and the geographical distribution of the rock-formations, in spite of these difficulties. The region was so vast that it required some courage for two men to undertake this task. It was impossible for them to map out the rocks without making their own topographical surveys simultaneously with the geological ones. They could only do this by following the rivers and lakes through the forests and mapping them out as they went along. These surveys have subsequently proved to be wonderfully accurate, considering the difficulties under which our pioneers had to labor, and ever since they were made they have been found to be of the greatest service, even up to the present time; and, as topographical surveys alone, they have repaid many times over their small original cost.

But in addition to much of this kind of work, Murray made regional geological surveys of a considerable area on the north side of the North Channel of Lake Huron, of the area south and west of a line from Kingston to Penetanguishene, including the lake peninsula of Upper Canada, and of the country between the St. Lawrence and Ottawa rivers, as far west as a line from Kingston to Bytown. Besides assisting Logan in exploring parts of the north shore of Lake Superior, Murray's own work on that lake consisted of surveys of the Kaministiquia River, Dog Lake and River, Michipicoten River and Batchawana Bay, and also an examination of the south shore as far west as

L'Anse and Limestone Mountain, with a view to correlate the rocks of the two sides.

His topographical and geological surveys in the country directly north of Lake Huron embraced a greater or less portion of the course of each of the following rivers: Echo, Garden, Thessalon, Mississagi, Serpent, Blind, Spanish, Whitefish, Wahnapitæ, Sturgeon and Maskinongé; also Lake Wahnapitæ and numerous lakes connected with the Thessalon, Mississagi, Blind and Maskinongé Rivers. Between Georgian Bay and the Ottawa, he surveyed most of the numerous channels of the French River, the Sturgeon, Meganatawan, Muskoka, Petewawé, Bonnechere, southwest branch of the Madawaska, and the head waters of the Ottonabee Rivers and many lakes connected with them, including Lake Nipissing and Muskoka Lake. In Lower Canada he surveyed the Bonaventure, St. John or Douglastown, Matane and Ste. Anne des Monts, and assisted Logan (in 1844) to measure a traverse from the St. Lawrence to Baie de Chaleur by way of the Chatte and Cascapedia Rivers. During the season of 1849 he was again with Logan in making a geological survey of the region between the Chaudière River and the Temiscouata Road.

The early finding of nickel ore on the north shore of Lake Huron is worth referring to in connection with Mr. Murray's work and the subsequent discoveries of this metal in such abundance in the Sudbury District. In 1848 Murray examined the Wallace Mine, near the mouth of Whitefish River, where the initial discovery was made and which had been opened the previous year. The ore which he brought to the laboratory of the Survey at that time was found to contain 8·26 per cent. of nickel, "but as two-fifths of the specimen consisted of earthy materials which might readily be separated by dressing, the quantity of nickel in the pure ore which this would represent, would equal nearly 14 per cent." The country rocks of the Wallace Mine belong to the same part of the Huronian system as those in the vicinity of Sudbury Junction, which lies on their general strike to the north-eastward.

A preliminary geological reconnaisance of parts of Newfoundland was made by Prof. J. B. Jukes in 1839–40, and his results were contained in his Physical Geography and Geology of Newfoundland, published in London in 1841. In 1862 Mr. James Richardson made a geological examination of the northern peninsula of the island from Canada Bay on the east side to Bonne Bay on the west, in connection with the Canadian Survey. I am indebted to Mr. James P. Howley the present government geologist of Newfoundland for the following notes on the origin of the regular Geological Survey which is still in operation. In 1862 or '63, Hon. James Rogerson, a member of the government, when on a visit to New York, had a conversation with the Hon. Mr. Archibald, the British consul general there, as to the mineral resources of the colony, when the latter recommended the institution of a geological survey and gave Mr. Rogerson a letter of introduction to Sir William Logan. He afterwards met Sir William, who entered warmly into the proposal and offered to send Mr. Murray to undertake the work. Mr. Rogerson communicated with Hon. Mr. (afterwards Sir) Hugh W. Hoyles, attorney general and premier of the island, who completed arrangements and obtained a grant of money from the legislature for beginning operations. The survey was under the honorary general direction of Sir W. E. Logan. Mr. E. Billings, palæontologist and Dr. T. Sterry Hunt, chemist and mineralogist of the Canadian Geological Survey gave Mr. Murray valuable assistance gratuitously from time to time.

Mr. Murray left Montreal on the 18th of May, 1864, with Mr. H. H. Beckett, as assistant, in order to enter upon his new duties. On his arrival at St. John's, he received more detailed instructions from Attorney General Hoyles and soon after commenced his field work, going first to the north-eastern side of the island. The next two seasons were devoted to the coast and interior of the western side. In 1867 Murray went to Paris to place a collection of the economic minerals of Newfoundland in the Universal Exposition which was being held there. An account of the mineral resources of Newfoundland, addressed to Mr. W. C. Sargeaunt of London, then Crown Agent for the colonies, was published in the journal of the Society of Arts for 11th October, 1867. Returning to Newfoundland in August, he spent the remainder of the season examining Tilt Cove Mine and the surrounding country. While jumping from block to block in crossing a talus under one of the cliffs near Cape St. George early in the summer of 1866, he broke the tendon-Achilles of one of his legs, but in spite of this serious accident he continued his field-work for the remainder of the season, thereby preventing a satisfactory healing afterwards and he became lame for the rest of his life.

In 1868, Mr. James P. Howley was appointed assistant geologist. During this and the next two years, the attention of both Murray and Howley was directed to the eastern part of the island. In April 1869, Murray came to Montreal to visit Sir William Logan and on his return to Newfoundland he examined the copper deposits of Bonavista Bay, surveyed Terra Nova River and made a preliminary examination of Bay East River.

Surveys of the Exploits, the largest river in Newfoundland and of Red Indian Lake were made by Murray in 1871, while Mr. Howley was examining the shores of Exploits and Gander Bays. Sir Wm. Logan visited Murray in May of this year on his way from England to Montreal and spent about three weeks with him at his home in St. John's. Murray devoted most of the year 1872 to equipping a small geological museum in St. John's and arranging his specimens in it and also to preparing a general geological map of the island which was reduced by the late Mr. Robert Barlow to a scale of 25 miles to the inch. This map was engraved by E. Stanford of London and issued in 1873. His field work this year was confined to the peninsula of Avalon and a portion of the shores of Trinity Bay.

The summer of 1873, was devoted to ascertaining the extent and possible productiveness of the coal-field of Bay St. George. In connection with this work, Murray traced out the distribution of the Carboniferous rocks in that region and also of the Silurian strata in the northern part of the same district. In 1874, he surveyed Gander River and Lake, while Mr. Howley surveyed Port-a-Port Bay and part of Bay St. George. His report accompanies that óf Mr. Murray, who speaks of it in the highest terms. Before starting to the field this year, Mr. Murray paid a visit to Sir William Logan in Montreal. In a characteristic letter to Mrs. Murray, dated 8th May, he says: "Here I am at my old quarters and am charmed beyond expression to have to tell you that my dear old friend is very much improved in health and will, I fondly hope, be spared to us for a long time to come. That he has considerably failed there can be no manner of doubt, but the old stuff is strong in him yet and what between a noble constitution and indomitable pluck, I hope he may even last as long as old Bennett! The prospect of having me with him, I am told cheered him very much; and since my arrival he has apparently so much recovered as to be very much like what he ever was. ......Yesterday we walked in together and were busy all day going over the museum, new offices and one thing and another till time to return to dinner......I find myself so much made of here that I don't know how I shall get through all I have to do......I am getting, however, every kind of assistance in the meantime and I am made to feel while here at least, that I am one of themselves."

From this time till 1880, Mr. Murray continued to do more or less field-work each season, except in 1875, when he says his services were "required by the government for special purposes not immediately connected with geological investigations." Mr. Howley appears to have been in the field every season till 1883. In this year, owing to ill health, Mr. Murray was retired upon full pay and Mr. Howley was employed till 1887, in making land surveys for the government. Geological work was resumed in the latter year and is still continued under Mr. Howley, who is assisted by Mr. Bayly and Mr. Thorburn.

Mr. Murray's annual reports, which were never very voluminous, were published year by year in St. John's, and some of them were reprinted in Montreal. When Mr. Howley made reports on the work assigned to him these were also published along with Mr. Murray's. On Murray's retirement from the direction of the Newfoundland Survey, he went to live at his native town of Crieff in Scotland. He had previously revised his annual reports and in 1881, he republished them at his own expense in one volume, through Ed. Stanford of Charing Cross, London, along with a large orographical map of Newfoundland(65 x 58 inches).

The space at our disposal will scarcely permit of even a brief summary of the scientific results of the Geological Survey of Newfoundland, which are clearly set forth in the official reports. They include the blocking out of the distribution of the rock-formations over the whole island and the tracing of them in more detail in certain areas where they were of most interest either scientifically or economically, such as on the west coast from Cape Ray to Bonne Bay, on the south side of Notre-Dame Bay and around some of the bays in the eastern part of the island. The greater part of the interior has been shown to consist of Laurentian and Huronian rocks. Cambrian strata fringe all the great bays in the east and occupy a large area between Trinity and Bonavista Bays. Cambrian and Silurian formations are developed all along the west coast and also at the head of White Bay on the north side, and small patches of Devonian sandstones, etc., were identified between Canada and Hare Bays north of White Bay. The Carboniferous rocks with thin seams of coal around Bay St. George and the north end of Grand Pond were carefully mapped out.

The general strike of all the formations throughout the island is north-easterly and south-westerly. The Upper Laurentian with crystalline limestones and titaniferous iron ones forms the western flank of the Long Range (of mountains) lying eastward of Bay St. George. Elongated areas of granites and greenstones occur among the crystalline rocks in various parts, all having the same general run as the stratified masses. Serpentines were found to be largely developed in different regions, among which may be mentioned the west coast from Port-a-Port Bay northward more than half the distance to the Strait of Belle Isle, around Hare Bay near the northern extremity, Notre-Dame Bay and the head waters of the main Gander River.

The Cambrian and Lower Silurian formations are so well displayed and so rich in fossils that Mr. Howley thinks among them will be found the solution of certain problems in the geology of eastern north America. He is of opinion that the serpentines form two distinct groups, one belonging to the Cambrian or Silurian and the other to the crystalline series.

Before any Cambrian fossils had been discovered in Newfoundland, Mr. Murray, was led to believe, from other considerations, that certain rocks in the eastern part of the island belonged to that system and after much search he found a few at Bell Island and around Trinity Bay, which were described by Mr. Billings in his Palæozoic Fossils, Vol., II. Part I, and in the Canadian Naturalist, new series Vol. VI, July, 1872. In the summer of 1874, Sir Wm. Logan sent Mr. T. C. Weston, a lynx-eyed collector on the Canadian survey, to find more fossils among these rocks. He discovered them in abundance in the banks and on a small island in Manuel's River and also at Bell Island and Topsail Head, all in Conception Bay. These localities have since been visited by Prof. C. D. Walcott and described in his "Correlation Papers-Cambrian," which constitutes Bulletin 81 of the U. S. Geological Survey.

The original work that Mr. Murray performed in Newfoundland during the twenty years which he devoted to it were of more service in making the island favourably known to the outside world than anything which had previously occurred. The economic results of the Geological Survey have been very important. Before it was commenced the interior of the island was unknown, even geographically, and the great value of its mineral, timber and agricultural resources was unsuspected. The fisheries were supposed to be the only source of wealth and the interests of the mercantile class were opposed to the development of any others. At first Mr. Murray's reports, pointing out the other riches of the island, were received with incredulity, but after a time there was a reaction in the opposite direction and a mania for mining and prospecting set in. Copper was successfully mined in large quantities in several places, but many speculative enterprises failed, and blame was unreasonably cast upon the Survey. The information contained in Mr. Murray's reports in regard to the timber led to the carrying on of lumbering operations in several quarters. These reports also showed the existence of considerable areas of cultivatable land around Bay St. George, and in the valleys of the Humber, Exploits and Gander rivers and more serious attention has since been paid to the agricultural capabilities of the colony. All this has given the people new ideas and has led to great changes in the positions of classes. The affairs of the colony are no longer controlled entirely by the merchants, nor do the working men depend so exclusively as formerly upon the fisheries. Other industries are springing up and a railway is being built across the island.

Before closing this brief sketch of the late Alexander Murray, we must say a few words about his domestic life in Newfoundland. After having been a widower for six years, he married Miss Elizabeth Cummins on 28th January, 1868. Five children were born of this marriage, namely, Mary Isabella Logan, 24th March, '69; Frances Augusta, 30th December, '70; William Edmond Logan, 11th September, '72; Alice Oliphant, 17th August, '74, and Alexander Greene, 3rd January, '76. Sir Wm. Logan left £1,000 stg. for the benefit of the eldest son who had been named after him. Murray was greatly pained when he heard the news of the death of his old chief and life-long friend to whom he was much attached, and he wept like a child.

As before remarked, he was created a C.M.G. in 1874. He acted as aide-de-camp to Sir John Glover, Sir Henry Maxse and Sir Frederick Carter, respectively, while these gentle-men were Governors of Newfoundland. He was highly respected by all members of the different governments under which he served, and was most kindly supported by his brother officials who reciprocated his obliging disposition and good will.

Having, while in Canada, been thrown so much into contact with the Aborigines, and knowing their character, he became the great friend of the Indians of Newfoundland, some of whom served him for as many as fourteen years. They are said to speak of him yet as the best hearted man that ever lived. His house was their home in St. John's, and the photographs of Murray and his family are to be seen in all their wigwams, where they are highly prized.

While living in St. John's his manner was very unobtrusive and he appeared to care little for any society but that of his wife and family. Latterly he became a member of the Church of England and appears to have manifested a simple Christian piety. He enjoyed his full pay from the Newfoundland Government to the close of his life, but no pension was granted to his family, who were left ill-provided for, and would have fared badly but for the great and continued generosity of Sir Patrick Keith Murray and the present Laird of Dollarie, Mr. Anthony Murray, mentioned in a previous part of this article.

NOTES AND DESCRIPTIONS OF SOME NEW OR HITHERTO UNRECORDED SPECIES OF FOSSILS FROM THE CAMBRO-SILURIAN (ORDOVICIAN) ROCKS OF THE PROVINCE OF QUEBEC.[1]

By HENRY M. AMI, M. A., F. G. S.

BRYOZOA.

SOLENOPORA COMPACTA, Billings, var. MINUTA, N. var.

Zoarium, consisting of small globular or irregularly shaped masses which are apparently amorphous and com-

[1] N.B.—Throughout the text, the terms, *cell, intertsitial cell, zœcium, spiniform tubuli*, etc., have been used by the writer in order to be uniform with the terminology employed by Mr. Foord, in his "Contributions to the Micro-Palæontology

pact to the naked eye, but exhibit under a microscope the typical and characteristic structure of the genus Solenopora (Dybowski). One of the specimens measures 5-40ths. of an inch in height and 15-40ths. of an inch in diameter, in the direction of the section which is cut partly at right angles to the tubes and partly in direction of the tubes *i. e*, parallel to them.

The species evidently belongs to the genus of which *Solenopora compacta*, Billings, is the type, and is almost identical with it. The tubes or zoœcia, however, are more closely arranged and more numerous, being proportionally smaller in the Quebec specimens than in the typical examples from the lower beds of the Trenton formation of other portions of Canada. The tubes in the examples from Quebec also appear to be more tortuous, and at times resemble the structure observed in such forms as *Girvanella* or *Strephochetus.* Of the genus *Solenopora*, there appear to be two, and perhaps three distinct forms from the Cambro-Silurian or Ordovician strata of Canada.

1. One of these, the typical *Solenopora compacta*, Billings, sp. (=Stromatopora compacta, Billings; =Stenopora compacta, Dawson; =Tetradium Peachii, Nich. and Etheridge; =Solenopora spongioides, Dybowski; =Tetradium Peachii, var. Canadense, Foord; (Cymatopora compacta, Dwight, M.S.S.) occurs in abundance through a considerable thickness of the lower beds of the Trenton of Ontario and Quebec, and has zoœcia varying from 1-320 th. to 1-400 th. of an inch in diameter, whilst the Scotch representative described by Dr. Nicholson and Mr. Etheridge, jr., has zoœcia which measure 1-420 th. of an inch—" one-thirty-fifth of a line "—in diameter.

2. A second species of this genus *Solenopora*, occurs in the limestones of the Bird's Eye and Black River formation at Paquette's Rapids, on the Ottawa River. This locality is referred to by Billings as one of the places where this

of the Cambro-Silurian rocks of Canada," 1883. I very much prefer the terms "*autopores*," "*mesopores*," "*acanthopores*," etc., now employed by Messrs. Foord, Ulrich and other authors.

Stromatopora (now Solenopora) *compacta* could be found, and gives no figure nor microscopic characters whereby the species may be recognized. Now that *Solenopora compacta,* Billings sp., is a well established species which finds place in the nomenclature of present writers, it appears from an examination of microscopic sections of the Paquette Rapids form, that it is distinct from the ordinary form and is readily distinguished therefrom by the large size of its zoœcia—they vary from 160 to 200 in the space of one inch, *i. e.*, each zoœcium varies from 1-160th. to 1-200th. of an inch in diameter. The specific name *Solenopora Paquettiana,* is here proposed to receive such forms as this which present the generic characters of the genus Solenopora, but have zoœcia or tubes much larger than in *S. compacta,* and also less wavy. The zoarium is also considerably larger than ordinary specimens of *S. compacta.* No diaphragms have been detected in the longitudinal section of this form. There must obviously have been diaphragms at more or less regular intervals in the tubes, but, as in most specimens of *S. compacta,* they are not evident. Very skilfully prepared sections of especially well preserved examples from the Trenton rocks of Poughkeepsie, N. Y., kindly presented to the writer by Prof. W. B. Dwight, of Vassar College, have revealed the tabulæ of *S. compacta.*

3. The third form occurs in the hard compact cherty limestone rocks of Quebec city at Côte d'Abraham, and closely resembles the type species *S. compacta,* but is clearly distinct from *S. Paquettiana,* both from the size and regularity of its tubes. From *S. compacta,* the Quebec variety '*minuta,*' differs in having smaller zoœcia, less regularly arranged and often very tortuous. There are from 480 to nearly 600 tubes in the space of one inch, and these are all in close contact. No septal teeth or spiniform projections from the wall inwardly have been detected in any of the zoœcia, which are irregularly rounded polygonal and triangular at times.

Under the microscope this form, *S. compacta,* var. *minuta,* may be readily distinguished from the other two species, and on this account has had the varietal designation affixed.

Locality.— Côte d'Abraham, Quebec City, Quebec.

Collectors.—H. M. A. and N. J. Giroux, 1888.

Micro Sections.—2,110 and 2,115. Prepared by Mr. T. C. Weston.

DICRANOPORA PARVA, N. SP.

Length of the only specimen (fragment) examined: ·175 inch; breadth, ·05 of an inch. There are from six to eight rows of cells across the polypary which are obliquely disposed in lines, so as to give to the zoærium a quincunxial arrangement which is characteristic and evident. Between the cell apertures, whose margins are somewhat thickened, are seen low depressed and indistinct lines which give a slightly longitudinal aspect to the rows of cells, besides the oblique or quincunxial disposition. This form appears to be distinct from those described by Mr. Ulrich from the Cincinnati group of Ohio, and the name *D. parva* is here suggested for this form.

Locality.—Gagnon's Beach, near the boundary between Matanne and McNider Townships, Quebec.

Collector.—T. C. Weston, 1887.

PRASOPORA LYCOPERDON, Vanuxem var. SELWYNI, N. VAR.

Zoarium sub-hemispherical, massive, about half an inch in diameter and the same dimension in height; tubes erect, prismatic.

Tangential or cross-section. This section exhibits the characters and general features of the genus *Prasopora*, Nich. and Ether, jr. The zoœcia are polygonal however, and in close contact with one another, there being only an occasional interstitial cell developed between the zoœcia. This almost total absence of interstitial cells, so prominent and characteristic in typical examples of *Prasopora lycoperdon*, Vanuxem, (=P. Selwyni, Nicholson), from the Trenton formation of Canada and the United States, differentiate the Quebec species or variety from the typical species.

Longitudinal section. This section shows the characters of *P. lycoperdon*, save the smaller or interstitial cells with closely arranged tabulæ which appear to be wanting. The curious oblique funnel-shaped or invaginating diaphragms with tabulæ developed in them at different heights, are exceedingly striking and characteristic; some of the zoœcia present horizontal and straight diaphragms from wall to wall. There are about 72 zoœcia in the space of one inch, or each zoæcium is ·0138 inch in diameter. In this character this variety comes closer to the smallest representatives of the type (*P. lycoperdon* Vanuxem or *P. Selwyni* of Nicholson), which are 1-70th of an inch in diameter.

Locality.—In the hard cherty limestone bands of Côte d'Abraham, Quebec City, Quebec.

Collectors.—H. M. A. and N. J. Giroux, 1888.

Micro sections.—Nos. 2,107, 2,108, 2,109, 2,116. Prepared by Mr. T. C. Weston.

Diplotrypa Quebecensis, N. Sp.

Zoarium sub-hemispherical, base concave, height about two lines, diameter about half an inch.

Tangential or cross section. Zoœcia about 1-60 th. inch in diameter, varying from 1-50 th. to 1-75 th. of an inch. In shape, the zoœcia are polygonal, but often circular, mostly in contact, but at times one zoœcium is almost completely isolated by the presence of interstitial cells, which are developed throughout the zoarium but in greater number in certain portions of it. The interstitial cells vary considerably in shape, size and distribution, being often triangular, hour-glass shaped, and four, five, and even six sided at other times. No spiniform tubuli are seen in this section.

Vertical or longitudinal section. The tubes are perpendicular to the base of the zoarium and regularly disposed. The walls are comparatively thick, and especially in the upper portion of the zoarium. The zoœcia have a few distinct horizontal or slightly curved tubulæ or diaphragms, whilst the interstitial cells have more numerous and horizontal diaphragms developed.

NOTE. The paucity of tubuli in the specimen examined may be due to its state of preservation or fossilization, as the few that are seen in the zoœcia are only faintly visible in the coarsely crystalline calcite which fills the tube. No spiniform tubuli are seen in this section.

This species is most nearly related to *Diplotrypa Milleri*, Ulrich, but differs therefrom in possessing much fewer diaphragms, both in the zoœcia and in the interstitial cells.

It differs also from *D. Whiteavesii*, Nicholson, *D. Petropolitana*, Pander, *D. regularis*, Foord, and *D. infida*, Ulrich, in possessing no spiniform tubuli.

Locality.—In the hard calcareous beds of Côte d'Abraham, Quebec City

Collectors.—H. M. A. and N. J. Giroux, 1888.

Micro sections.—2,113. Also prepared by Mr. T. C. Weston.

MONOTRYPA INCERTA, N. SP.

Zoarium, small, sub-cylindrical or irregularly elongate sub-spherical, height, ·25 inch ; longer diameter, ·375 inch ; shorter diameter, ·25 inch.

Tangential section. In tangential sections, the zoœcia are seen to be regularly polygonal of uniform size, and apparently of one kind only. The walls around each are clearly visible and are only moderately thickened. Occasionally a smaller zoœcium is developed between the larger ones, but appears to be only an immature zoœcium and differs in no respect from the larger or proper zoœcia. There are no interstitial cells at all. The other generic characters are also evident.

Longitudinal section. This section exhibits the uniform prismatic character and regular size of the tubes. Diaphragms are tolerably numerous and straight, whilst at times they have a decided curvature. These are distant from each other one tube diameter or thereabouts.

The zoœcia are ·0156 inch in diameter, or number 64 in the space of one inch, as measured both in the tangential and longitudinal sections.

Locality.—In the hard compact cherty beds of limestone of Côte d'Abraham, City of Quebec, Quebec.

Collectors.—H. M. A. and N. J. Giroux, 1888.

Micro sections.—2,111, 2,112 and 2,114. Prepared by Mr. T. C. Weston.

Doubtful Species.

Besides the foregoing species of Monticuliporidæ and Bryozoa which were obtained from the hard calcareous band of Côte d'Abraham, Quebec, there occur in addition, two forms whose generic and specific affinities are still doubtful, since the material from which Mr. Weston prepared the microscopic slides which contains both is somewhat imperfect and poorly preserved, most of the structure of one polypary having been obliterated in the one, and in the other case the matrix is very granular, which fact gives a granular and obscure aspect to the organism. The specimen from which the slide was prepared, was obtained also from Côte d'Abraham, Quebec, and the number of the slide or section is 2,117. For reference sake the two forms are designated A. and B. respectively.

FORM A.

Genus ? — Species — ?

This form consists of a small, narrowly cylindrical or slightly flattened polypary, with one row of rather deeply and obliquely situate cells on each side of the median axis or line which separates the zoarium into two parts. The zoarium measures seven-sixtieths (·116) of an inch in diameter, whilst the width of the zoœcia or tubes at their aperture measures less than 1-100th. of an inch in diameter. The polypary is obtusely rounded at one extremity—the distal extremity of the zoarium—and the cells are inclined at an angle of about 45° to the median axis. No evidence of tubulæ or diaphragms of any sort have been observed in the section. The microscopic section shows the skeletal parts of the polypary to be fibrous in structure. In a general way, this form appears to belong to the family of *Ptilodictyonidæ*, but its generic and specific affinities are still unknown.

FORM B.

GENUS ? — SPECIES ? —

This form consists of small sphæroidal or irregularly shaped masses which present an exceedingly minute, yet recognisable radiating tube-like structure with faint indications of concentric lines. The zoarium (?) appears to have certain affinities to the genus *Solenopora*, Dybowski, but differs therefrom in the size and distribution of the corallites (?) and in several other points. It has also been compared with *Girvanella* and allied forms, but although poorly preserved, shows salient characters of difference.

In examining and re classifying the genera and species of Monticuliporoids in our collections, a similar form was observed in *Micro-section* 804, prepared by Mr. Weston from a specimen of Trenton limestone collected at Hull, Quebec, by Mr. W. R. Billings in 1882, alongside a species of *Heterotrypa*, probably *H. solitaria*, Ulrich, which designation Mr. A. H. Foord has attached to the slide holding the large polypary. Though more irregularly shaped in outline than the Quebec City specimen, the Hull one is evidently and easily seen to be congeneric and co-specific with it. Along the outer portion of the zoarium, the radiating tubes (?) or zoœcia (?) are more clearly visible, whilst the central portion is occupied by more or less regular (somewhat granular) network which resembles a reticulate structure. The diameter of the Quebec City specimen is ·0146 of an inch. The matrix in which both the Hull and the Quebec specimens are preserved, is such as to obliterate such a minute structure as the zoarium (?) evidently possessed. When found imbedded in a finer grained rock, the exact relations and true affinities of this interesting form will, it is hoped, be more definitely ascertained.

PALÆONTOLOGICAL NOTES.

BY HENRY M. AMI, M.A., F.G.S.

I.

ON A COLLECTION OF FOSSILS FROM THE ORDOVICIAN OF JOLIETTE, IN THE PROVINCE OF QUEBEC.

In the "Geology of Canada" for 1863, Sir William Logan has given several interesting notes on the structural relations of the rocks about Joliette (or "Industry" as it is sometimes called,) and has also shown that the Chazy, the Bird's Eye and Black River as well as the Trenton terranes all occur there along the shores of L'Assomption River, whose rapid flowing stream affords magnificent water power for saw and carding mills, a foundry and an important paper factory.

These *three* Ordovician terranes are beautifully exposed along the cliffs and banks of L'Assomption River, from under and close to the mill above the 'upper bridge' to the 'old mill' or 'Vieux Moulin,' some two miles below the town. Some excellent building stone has been extracted and is still being quarried out, well adapted for railway bridges, piers and dwellings, whilst the more crystalline beds in the Desmarais quarries afford a superior quality of lime when burnt.

THE CHAZY.

The Chazy terrane is characterized by Sir William Logan as gradually thinning out in this section of Canada—being visible and estimated at a thickness of some *thirty* feet only—and holding a fossil which Mr. Billings recognised as the *Pleurotomaria staminea*, of Hall—now better known as a *Raphistoma, R. staminea*, Hall, sp.

This species is eminently characteristic of the Chazy in many parts of Canada and the United States—so that its presence leaves no doubt as to the occurrence of the Chazy at Joliette. It is hoped that future investigations will afford more ample material wherewith to describe this most interesting series which gradually dies out a little farther east and reappears some 500 miles down the St. Lawrence—at the Mingan Islands, north of Anticosti.

THE BIRD'S EYE AND BLACK RIVER.

The Bird's Eye and Black River terrane of Joliette consists of *fifty* feet of limestone holding the well known and typical fossil corals, viz: *Columnaria Halli*, Nicholson, and *Tetradium fibratum*, Safford. These fifty feet of strata form the base of Sir William Logan's Trenton in this district whose total thickness he estimated at 480 feet.

THE TRENTON.

During the summer of 1881 the writer had an opportunity afforded him of examining the beautiful exposures of this highly fossiliferous terrane along the banks of L'Assomption River for a distance of some three miles, and obtained quite an interesting suite of specimens which it is proposed to place on record in this paper.

No Trenton fossils are described or referred to by Sir Wm. Logan in the volume cited above.

The Trenton, however, is therein described and subdivided into three sections in descending order as follows:—

	Feet.
(*a.*)—Evenly bedded and dark coloured limestone	200
(*b.*)—Nodular limestone	140
(*c.*)—Gray coloured limestone	90
Total	430

From a collection made at "Industry Village," in 1852, by Sir William Logan, the following forms have been determined by the writer:

1. *Strophomena alternata*, Conrad.
2. *Leptæna sericea*, Sowerby.
3. *Orthis testudinaria*, Dalman.
4. *Asaphus Canadensis*, Chapman.

It would thus appear from the above list that we have here strong evidence for the presence of the upper beds of the Trenton with the probable existence of the Utica terrane. The occurrence of *Asaphus Canadensis*, Chapman, indicates close proximity to the Utica, if not indeed the actual presence of that terrane. These facts, therefore, point to a higher horizon than had hitherto been indicated in the "Geology of Canada" above cited.

The following list of Trenton fossils is based upon the collection made by the writer in 1881—at the quarries near the "Pont des Dalles"—and at the old mill, some two miles down the river below this bridge. As can be readily seen they are eminently characteristic species. I have no doubt that this list could be swollen to larger proportions as the rocks are highly fossiliferous and the specimens in a very good state of preservation.

The occurrence of orthoceratites several feet in length and in abundance, and of beautifully preserved and large specimens of *Conularia Trentonensis* is especially worthy of note.

LIST OF TRENTON FOSSILS FROM JOLIETTE, QUE.

1. *Diplograptus cf. D. putillus*, Hall.
2. *Solenopora compacta*, Billings, sp.
3. *Stictopora acuta*, Hall.
4. " *sp. indt.*
5. *Ptilodictya maculata*, Ulrich.
6. *Monotrypella Trentonensis*, Nicholson.
7. *Prasopora lycoperdon*, Vanuxem.
8. *Amplexopora Canadensis*, Foord.
9. *Serpulites dissolutus*, Billings.
10. *Glyptocrinus ramulosus*, Billings.
11. *Orthis plicatella*, Conrad.
12. " *testudinaria*, Dalman.
13. *Strophomena alternata*, Conrad.
14. *Leptæna sericea*, Sowerby.
15. *Conularia Trentonensis*, Hall.
16. *Cyclonema bilix*, Hall.
17. *Trochonema umbilicatum*, Hall.
18. *Pleurotomaria Progne*, Billings.
19. *Endoceras proteiforme*, Hall.
20. " *multitubulatum*, Hall.
21. *Calymene seneria*, Conrad.

22. *Asaphus platycephalus*, Stokes.
23. *Illænus cf. I. Milleri*, Billings.
24. *Ceraurus pleurexanthemus*, Green.

NOTE.—The strata in the neighbourhood of the rapids and falls below the town point to the existence of local faulting or dislocations, as they are considerably disturbed and are seen to dip to as high an angle as 60° to the S.W. L'Assomption River is one of those post-tertiary streams which is fast cutting its way through the Leda clay and Saxicava sand terranes, as also through the uppermost members of the Cambro-Silurian or Ordovician system in the higher levels.

II.

ON THE OCCURRENCE OF FOSSIL REMAINS ON THE MANITOU ISLANDS, LAKE NIPISSING, ONTARIO.

The Manitou Islands—which form a group of six beautiful Islands—are pleasantly situated in the basin of Lake Nipissing, Ontario, and are easily reached by way of North Bay, an important railway centre along the line of the Canadian Pacific Railway. Whilst the shores of Lake Nipissing are completely made up of Archæan rocks, these islands are seen to consist at several points of sedimentary strata which when examined are found to be rich in fossil remains and indicate with tolerable precision the horizon or period when these strata were laid down.

The occurrence of *Tetradium fibratum*, Safford; *Columnaria Halli*, Nicholson; *Ormoceras Bigsbyi*, Stokes, and an obscure specimen of *Goniceras anceps*, Hall, suggest the natural inference that the limestone beds of these islands belong to the Black River formation.

The early, and, perhaps, only record of fossiliferous limestones on these islands "holding Orthoceras with a few obscure fossils" may be found in Alex. Murray's report to Sir Wm. Logan for the year 1854[1] "*Ormoceras tenuifilum* of Hall" is therein noted with considerable certainty and

[1] Report of Progress, Geol. Surv. Can. 1853-54 55-56, p. 124.

the strata consequently referred to the Black River formation.

The collection upon which the following list of species of fossils is based, was made in the summer of 1884 by Dr. A. R. C. Selwyn who was assisted by Mr. H. P. Brumell. They comprise seventeen species of Ordovician fossils characteristic of the Black River formation as follows:—

LIST OF SPECIES.

1. *Columnaria Halli*, Nicholson.
2. *Tetradium fibratum*, Safford.
3. ? *Coscinium proavium*, Eichwald.
4. *Stictopora acuta*, Hall.
5. *Ptilodictya recta*, Hall.
6. *Amplexopora Canadensis*, Foord.
7. 8. Several species of *Monticuliporidæ*.
9. *Streptorhynchus filitextum*, Hall.
10. *Rhynchonella increbescens*, Hall.
11. *Ecculiomphalus Trentonensis*, (?) Conrad
12. *Pleurotomaria subconica*, Hall.
13. *Ormoceras Bigsbyi*, Stokes.
14. " (?) *fusiforme*, Hall.
15. *Endoceras multitubulatum* (?) Hall.
 (= *Vaginoceras multitubulatum*, *H. sp.*)
16. *Endoceras proteiforme*, Hall.
17. (?) *Gonioceras anceps*, Hall.

Note.—The Rev. J. M. Goodwillie, M.A., who resided in North Bay some years has just informed me that he has made an extensive collection of fossil remains from these islands, so that additional forms will doubtless be found when the collection is examined.

OTTAWA, Feb. 1892.

THE PHYSICAL FEATURES OF THE ENVIRONS OF KINGSTON, ONT., AND THEIR HISTORY.

BY A. T. DRUMMOND.

Two years ago, when revisiting for three months the scenes of my earlier years at Kingston, the opportunity occurred again of examining, hammer in hand, the Laurentian ridges, the limestone escarpments, and the picturesque islands which contribute so much to the variety of the landscape in the neighbourhood of the city, as well as make its environs so geologically interesting. When a student at Queen's, I had gone over the ground, occasionally with Dr. Geo. Lawson, now of Dalhousie College, Halifax, but then of Queen's, sometimes with the late Dr. John Bell, of Montreal, who was an enthusiastic botanist, and often, alone, and as the familiar spots, one after another, came, after long years of absence, once more to view, many a pleasant memory of extended rambles and of interesting discoveries was recalled. The geological notes then made when a student have not been published, but some of them are still of interest and will be referred to here and be supplemented by the more recent notes.

Lying almost at the point of contact of the old Archæan rocks with those of the overlying Cambrian and Trenton, and in a section of country where the evidences of glacial action in quaternary times are very marked, besides being at the foot of Lake Ontario where the waters of the Great Lakes join the St. Lawrence amid the diversified features and scenery of the Thousand Islands, Kingston has much to interest the geologist. The city itself is, in reality, situated on what appears to have been an ancient island, whose length was about six miles with an extreme breadth of three miles, and whose boundaries, apart from the harbour front, are now well defined by the limestone escarpment, which, leaving the lake shore west of the Lunatic Asylum, skirts the broad valley of Little Cataraqui Creek some miles in a northerly and then north-easterly direction, until, veering around to the south-east as it approaches Kingston Mills, it meets Great Cataraqui Creek and then parallels it in its entry to the harbour at Kingston.

The harbour fronting Kingston is, in its main expanse, underlaid, probably throughout, by the Black River limestones, judging by the comparative uniformity of the soundings in the channel. The usual depth there is from

9

ten to twelve fathoms. Off Cedar Island the bottom may have suffered by the disturbances which affected the whole Laurentian area, as I have found there the greatest depth of the harbour—seventeen fathoms.

The precise area occupied by the palæozoic rocks in the environs of the city, and their age, have not hitherto been as accurately defined as is desirable, and a brief reference to these and the Laurentian rocks is necessary.

LAURENTIAN ROCKS.

The Laurentian rocks are met with in great masses at Kingston Mills, and thence eastward and north-westward, forming here and among the Thousand Islands the gneissic ridge, as it were, which connects the Laurentian areas of New York State with those of Canada. Nearer Kingston, these rocks appear on the summit of the Fort hill, on the banks of Haldimand Cove, and on Cedar and Milton Islands, in each case forming ridges which—as elsewhere among the Thousand Islands—lie in a general north-east and south-west direction. The Laurentian strata have been here elevated into these great ridges at a period subsequent to Black River times, as, on the Fort hill, the limestone strata are tilted up at a high angle on both sides of the steep ascent, and overlie the Laurentian from the base to almost the summit, which is crested with gneiss.[1] On the north side of Cedar Island the limestone strata are also seen near the water's edge in a similar but less tilted position. Again, there are not wanting some indications, near the granite quarries on the banks of Haldimand Cove, that the granitic rocks here are not earlier in age than the

[1] My friend, Mr. Frank D. Adams, informs me that at Lake St. John limestone rocks of lower Silurian age, with similar dips at their immediate contact with the sloping gneiss floor on which they were deposited, have been found by the Geological Survey officers in reality in their natural beds as deposited, the material having apparently rolled off, as it were, from the apex and lower down, and adjusted itself in sloping beds on the sides. In this instance at Kingston, however, the evidence of upheaval is distinct, and I am glad, since this paper has been put into type, to have the corroboration of so careful an observer as Prof. James Fowler, of Queen's University, Kingston, who writes that "the breaks in the strata and the dip towards the bridge on the one side and the river on the other, look as if the elevation took place after the Black River was laid down."

Black River, and are probably contemporaneous with the upheaval of the Laurentian strata.

POTSDAM SANDSTONE.

On the banks of the Rideau Canal the Potsdam sandstone is first met with about five or six miles to the eastward of Kingston Mills, and is here of suitable quality and in ample quantity for building stone. On the south side of Pittsburg, opposite Howe Island in the St. Lawrence between Kingston and Gananoque, and again at the lower end of that island, it is once more seen, whilst at Gananoque it forms the eastern bank of the ravine near the village and both banks of the river Gananoque immediately in the village. Judging from the soundings made by me, it, likewise, forms the bed of this stream and extends outwards some distance under the St. Lawrence. The stone is used with very good effect in Gananoque for building purposes. Hay Island, Tidds Island, part of Round Island, and the upper end of Wellesly Island at the Thousand Island Park, also belong to this formation. There are thus exposures of the Potsdam sandstone at intervals to within six miles of Alexandria Bay, and as the same rock reappears near there and continues again at intervals to Brockville, there is a probability that in earlier times it has had a very much more extensive development in the valley of the St. Lawrence here, possibly, originally, bridging over the present Laurentian break.

BLACK RIVER ROCKS.

The city of Kingston itself is underlaid by the Black River limestones, these in turn resting directly on the Laurentian strata, as is well illustrated on the Fort hill, Cedar Island, the banks of Haldimand Cove and elsewhere. These Black River strata, underlying and around the city, are somewhat deficient in fossils, and at the time of publication of Sir William Logan's General Report on the Geology of Canada in 1863, considerable doubt was entertained as to whether these rocks, in, at least, their lower portion, might not belong to an earlier epoch. My own subsequent finding, however, of *Orthoceras rapax*, Bill, and some fragments of crinoidal columns in a deposit of somewhat disintegrated rock containing numerous silicified fragments of fossils and directly reposing on the Laurentian in a cutting of the Grand Trunk Railway at Kingston Mills, finally determined the late Mr. E. Billings, the palæontologist of the Geological Survey, to refer the strata to the Black River age. Those strata which rest directly on the Laurentian are generally, however, quite devoid of fossils, and not infrequently the lower layers have the appearance of a conglomerate, the imbedded material being small worn boulders of gneiss and quartzite from three inches to one foot in diameter, and numerous sharply angular pieces of quartz, chiefly of smaller size. On the north side of the Grand Trunk Railway track the limestones terminate west of Kingston Mills, but on the south side they extend in a partly covered escarpment about five miles farther eastward, and cover the intervening space thence to the St. Lawrence. Garden Island, and the greater portion of Howe, Wolfe, and, possibly, Simcoe Islands, are of Black River age.

TRENTON ROCKS.

At Cape Vincent, in New York State, opposite Wolfe Island, the limestones contain, amongst other life, *Calymene Blumenbachii*, Bron, and *Leptæna sericea*, Sow, which sufficiently indicate their Trenton origin. At Horse Shoe Island, at the head of Wolfe Island, about eight miles southwest of Kingston, and again at Collinsby, on the Grand Trunk Railway, the rocks apparently belong to the same epoch. Thus, if any actual distinction is to be retained in Canada between the Black River and Trenton epochs, a line drawn across the St. Lawrence through these localities would appear to about indicate where the Black River rocks are succeeded by the true Trenton.

QUATERNARY DEPOSITS.

From the period of the Trenton to that of the Quaternary, the environs of Kingston appear to have had a long rest from the inroads of the water and from other disturbing influences, beyond the special elevation of the Laurentian ridges before referred to, and the general elevation of the whole country here and to the north-eastward, to admit of the necessary fall for the great glaciers of the glacial period. The traces left by quaternary forces are seen in the limestone escarpments at many points in the environs of the city; the broad river valleys now occupied by Little Cataraqui and Great Cataraqui Creeks; the ice grooves, visible in every direction, but developed on a magnificent scale, near the upper steamboat landing on Wolfe Island; the great deposits of sand at Cataraqui and elsewhere; and the Laurentian and other boulders scattered everywhere, even on the top of the Fort Hill, where the huge block of unworn Potsdam sandstone, half buried in the soil, is a conspicuous object.

Whilst the history of the site of the city and its environs during the vast ages which elapsed between the Trenton period and the close of the Tertiary, is almost a blank, yet, from the latter time, its history begins once more. Suggestions of great forces having been at work come, as we have seen, from all sides—from the lake bottom, the river valleys, the grooved rocks, the great stretches of escarpments, the scattered boulders. At the close of the Pliocene the Laurentian area in the townships to the northward and eastward was higher than it presently is, and circumstances seem to show that this elevation extended so far over the limestone area in the vicinity of Kingston that the lake shore at that time was probably outside of a line drawn from Stony Point, off Sacket's Harbour, to South Bay Point, in Prince Edward County. A rise of 100 feet would bring to the surface nearly the entire area presently under water between this limiting line and the city—excepting what would then form two inlets or river channels—the relicts, it may be, of two glaciers—the one on the west side of Duck Island and extending inwards towards Kingston to within three miles of the present Nine-mile Point Lighthouse, and the other on the east side of the same island and extending in the direction of the present American channel in the St. Lawrence, and to within four miles of the south-west point of Wolfe's Island.

LAURENTIAN RIDGES.

At this time, also, the Laurentian ridges, which are so numerous in the rear townships, and are illustrated around Kingston in the elevations comprising Cedar Island, the Fort Hill, and the south side of Haldimand Cove, had already appeared. These ridges which in reality indicate, in their prevailing general north-east and south-west course, the direction taken by the vast internal forces which gave rise to their upheaval, have had much to do with giving the direction taken by the great glaciers of quaternary times, and have also shaped the original outline of many of the numerous lakes in the Laurentian country in the immediate rear of Kingston, however much the glaciers may have subsequently smoothed the roughness of this outline. The general course of the numerous elongated lakes lying here in the laps of these ridges, and near the border-land where the Laurentian and the higher formations meet, is a most pronounced north east and south-west, and I cannot think that their outline is to be attributed solely to softer strata having been worn away. It was rather that the ridges and intervening valleys gave the course to the glaciers, and, in that course, these valleys had their outlines smoothed and their depths somewhat deepened, and were thus prepared for their new position as the beds of lakes in the less elevated country of the present day. The lie of the lakes, in sections of the Laurentian country farther west, takes different directions—sometimes to the south-eastward and across the general line of glacial action—and it will, I suspect, be found, in such cases, that this lie of these lakes conforms to that of the ridges in the surrounding country.

ORIGIN OF THE ISLAND.

Following the elevation of the land and the incoming of the glacial period, came probably the first outlining of the ancient island on which Kingston is situated. The present broad beds of Little Cataraqui and Great Cataraqui Creeks were gradually chiselled out, first by glaciers and then by the waters of what would then be two deep inlets from the lake and a river divided by the island, and thus the limestone escarpment which in large part forms the island's front was created. The sand deposits in the direction of Glenburnie, again at Cataraqui, and again in the estuary west of the Lunatic Asylum, would seem to indicate that the Little Cataraqui Creek valley was the channel down which the great body of the water from the Laurentian heights immediately beyond here came. The different beds of sand in the estuary also appear to mark three successive stages and conditions of deposit—the lowest, a coarse sand laid down in deeper water, the middle a strongly wave-marked bed, indicative of rapidly flowing waters, and the highest a deposit of fine silt-like sand, which has settled during comparatively still waters.

THE OUTLET OF LAKE ONTARIO.

Perhaps the most interesting questions are connected with the outlet of the waters of Lake Ontario into the St. Lawrence here. Have these waters since Ontario expanded from a river into a lake always flowed downwards to the ocean over the Laurentian ridge at the Thousand Islands? Presently there is a depression here between the Adirondacks of New York State and our Canadian Laurentian ridges sufficient to admit of this downward flow, but, between Kingston and Cape Vincent, it is a comparatively shallow depression. The lake is undoubtedly pre-glacial, but the somewhat higher elevation of the Laurentian area at the close of the Pliocene to admit of the descent of the glaciers, would make it probable that at this time, as well as during the melting and recession northward of the ice area, the outflow was by way of Lake Oneida and the Mohawk Valley. Even at the Park towards the centre of the Thousand Islands, the grooves in the sandstones lie S. 40° W., showing that there must have been some elevation in the heart of the Laurentian ridge there to admit of the necessary ice flow, not merely there but onwards to the south-westward over the ice-grooved limestones at Kingston and Wolfe Island. During the glacial epoch, and its inter-glacial periods, if any, here, the outlet was, the American geologists insist, so completely blocked with ice that the flow was necessarily by way of the Mohawk Valley to the ocean, but it does not seem requisite to assume that there was this ice blockade, as the already existing elevation probably formed a more than ample barrier to the lake waters.

If this view of Laurentian depression be correct, then the St. Lawrence, immediately before the commencement of the ice age, was a modest stream, taking its rise here in the Adirondacks or Canadian Laurentians and flowing towards the sea in very much the same course as now, for this course was not much altered by the subsequent ice flow north-eastward from the Laurentians. The river from Brockville, immediately above which the Laurentian ridges under the river disappear, downwards to the first rapid near Edwardsburg, has, on the whole, a considerable uniformity of depth in the channel, and flows through a low, comparatively level valley, unobstructed by islands. The river Ottawa, on the other hand, was, probably, at this time a much larger stream, as the great limestone escarpments and the terraces along its course seem to indicate. The oscillations of the earth's surface in eastern Ontario and in Quebec had led to its being at one time an arm of the sea, and at another, perhaps later time, a great river, which Mr. J. K. Gilbert even thinks found its rise in the Georgian Bay and drained the upper Great Lakes. During the ice age, and the subsequent Champlain times, the path of the icebergs and glaciers was, in a general sense, down the valley of the Ottawa, and this, no doubt, occasioned much of the wear of the strata in the river's course.

The oscillations in level over great stretches of country or local warpings of the strata, will explain many of the physical features of a district. Thus, around the outlet of

Lake Ontario there were changes of this character. A depression at the Thousand Islands, and a rise in level at the south-eastern end of Lake Ontario, led to a gradual change in the lake's outflow from the valley of the Mohawk to the valley of the St. Lawrence. This change took place in the Champlain era, and was probably contemporaneous with that condition of depression in Eastern Ontario and Quebec and that condition of flood and depression in the peninsula of Ontario west of the Thousand Islands, which has given us the sands and clays of the one section and the great areas of the clays in the other. Since then there have been further warpings of the surface, involving a rise from the Trent Valley westward and on the south and east sides of Lake Ontario. These disturbances have, in general terms, brought us to the order of things at the present day.

The Water Supply of the City of Kingston, Ontario.

By Prof. W. L. Goodwin, Queen's University, Kingston.

In the course of an inquiry into the water supply of Kingston, several facts of considerable interest have been made out. The objects of the investigation were principally :—

1. To ascertain the character of the well-waters used in the city,

2. To determine the degree of purity of the water supplied by the waterworks, and,

3. To make comparative tests between the waterworks supply and the water of Lake Ontario at various points near Kingston.

In the course of this investigation it was found advisable to discover approximately the direction of the harbour and lake currents, and to obtain data regarding temperatures at various depths.

Wells.

Kingston is unfavourably situated for obtaining good water by means of wells. The average thickness of the soil is small, and the underlying limestone has no filtering power. The water, when it reaches the rock, must either flow over its surface, lie in the hollows, or form streams running in the wide cracks. In most places the wells must necessarily be very shallow, mere pits for surface water, or they must be excavated in the rock. In either case it is evident that more or less surface water must find its way in. The filtration being very imperfect, the well is seriously contaminated if there is any source of contamination near. Some deep-well owners have built cemented stone walls from the rock to the surface, so as to exclude, if possible, the surface water. But, that even this fails to prevent pollution is proved by the following chlorine estimations made at my request by Mr. F. J. Pope, M.A. The well is very carefully made, partly in the rock, partly in the overlying clay and soil. The walls from the rock upward are good masonry laid in cement. The samples were taken about every second day. The weather was broken, being characterized by heavy rains with intervals of fine weather. The experiments were made during October, 1890 :

Parts of chlorine per million.	Weather.
52	Rain
53	Rain
53.5	Rain
53.5	Fine
54	Heavy rain
54	Fine
54.3	Heavy rain
54.2	Fine
53.5	Fine
53	Rain beginning
54	Heavy rain
54½	Heavy rain
54½	Raining
55	Heavy rain

It is to be noted that the weather before these determinations were made was, on the whole, fine, so that they form a record of the effect of rain on the well. An inspection of the numbers and the weather notes shows clearly that the amount of chlorine is increased by the rain, but only slowly. There is a cesspool about 30 feet from the well, and it is very likely that the overflow from this, increased by the rainfall, finds its way along the surface of the rock and through the cracks into the well. In the most favourably situated wells on the outskirts of the city I have found from 10 to 20 parts of chlorine to the million. This well was then probably pretty badly polluted even before the rainy season began. I doubt if the most careful cementing above the rock insures a clean well. The limestone itself offers many channels for the passage of the polluted water into the well.

For the sake of comparison I insert here Mr. Pope's report on an underground rivulet in Portsmouth, about two miles from Kingston. The samples were taken during the same period as those from the well :—

"The water issues from a fault which it follows for a considerable distance before emerging.[1] The spring is situated on a hill and is distant from outhouses, refuse pools, &c."

Sample.	Parts of chlorine per million.	Weather.
1	14.6	Fine. Two days after heavy rain
2	14.6	Showery
3	14.6	Showery
4	14.6	Fine
5	15.7	Heavy rain night before sample was taken
6	15.0	Fine
7	14.9	Heavy rain night before
8	14.4	Fine
9	14.0	Fine
10	14.0	Fine
11	14.1	Fine
12	14.6	Fine
13	14.7	Raining
14	13.7	Heavy rain
15	13.9	Fine
16	14.3	Fine
17	13.9	Showery. Heavy rain night before

[1] A small surface rill disappears into a large crack in the rock about ¼ mile above this.—W. L. G.

Mr. Pope concludes that the chlorine is affected very slightly by rains, but is somewhat decreased by heavy rains owing to dilution with pure water. I think we may take this spring as representing the unpolluted water of this district, as found in deep wells.

In the spring and summer of 1891 I determined the chlorine in 45 wells, selected by Dr. Fee, our Health officer, as suspicious or obviously bad. A few of these wells were not in use for drinking, but for various reasons had not been closed. The majority of them have since been condemned and filled up. Some of them were filthy beyond description, and were yet considered by those who used them to be excellent wells. In depth they varied from 10 ft. to 50 feet. They were scattered all over the city. I have here arranged them in order of purity (as determined by the chlorine test):—

No.	Chlorine.	No.	Chlorine.
1	15	24	127
2	17.8	25	128
3	20	26	131
4	21	27	138
5	26	28	142
6	43	29	150
7	44	30	161
8	45	31	167
9	49	32	168
*10	50	33	174
11	55	34	180
*12	59.6	*35	194
13	64	36	204
14	73	37	210
15	74	38	210
16	77	39	216
17	77	40	216
18	83	41	223
19	84	42	230
20	94	43	230
21	94	44	328
22	97	45	1760
23	106		

Number 45, I thought, must be a salt spring, until I heard that it was from a shallow well dug in the soil of an old cow byre. The chlorine in the majority of these waters is so high that further and confirmatory analysis was needed in order to fix upon the danger line. The chlorides might be derived from mineral instead of from animal sources. Nos. 10, 12 and 35 were submitted to further analysis. The results, which I give here, show that a water containing 50 parts of chlorine to the million is very bad.

PARTS PER MILLION.

No.	Free Ammonia.	Alb. Ammonia.	Chlorine.	Oxygen consumed.	Solids.
10........	.26	.16	194	2.50	2040
12........	1.60	.60	50	10.25	500
35........	2.66	.14	59.6	2.02	735

Nitrates were abundant in each, particularly in No. 10. Number 12 was swarming with bacteria.

The method for determining the oxygen consumed was the alkaline permanganate method of Schulze and Trommsdorf as modified by J. Klein.[1] I have found this method perfectly accurate, as judged by concordance in results, and very rapid and convenient. The whole operation occupies only about twenty minutes.

Some years ago I made a careful analysis of a Kingston well-water containing 15 parts of chlorine to the million and found it pure. The conclusion to be drawn from the foregoing results is that Kingston well-waters containing more than 15 parts of chlorine to the million are suspicious, and are almost certainly bad if the amount reaches 50 parts.

THE WATER WORKS SUPPLY.

Up to the present the supply has been drawn from two points near the waterworks wharf (see map A.) As large drains discharge at points not far above and below this, it was thought (not unnaturally) that the source might be undesirably impure. Analyses of the harbour water have been made several times by the late Dr. Bayne, of the Royal

[1] Journal of the Chemical Society, 1887, p. 1000; Arch. Pharm. [3], 25, 522.

Military College, by Capt. Cochrane (R.M.C.), and by myself. There has been substantial agreement in all these analyses, as follows:

Free ammonia	Little or none
Albuminoid ammonia	.09
Chlorine	5

The Dominion analyst analysed a sample drawn from a tap in the city, and reported:

Free ammonia	.050
Albuminoid	.100
Chlorine	2.5

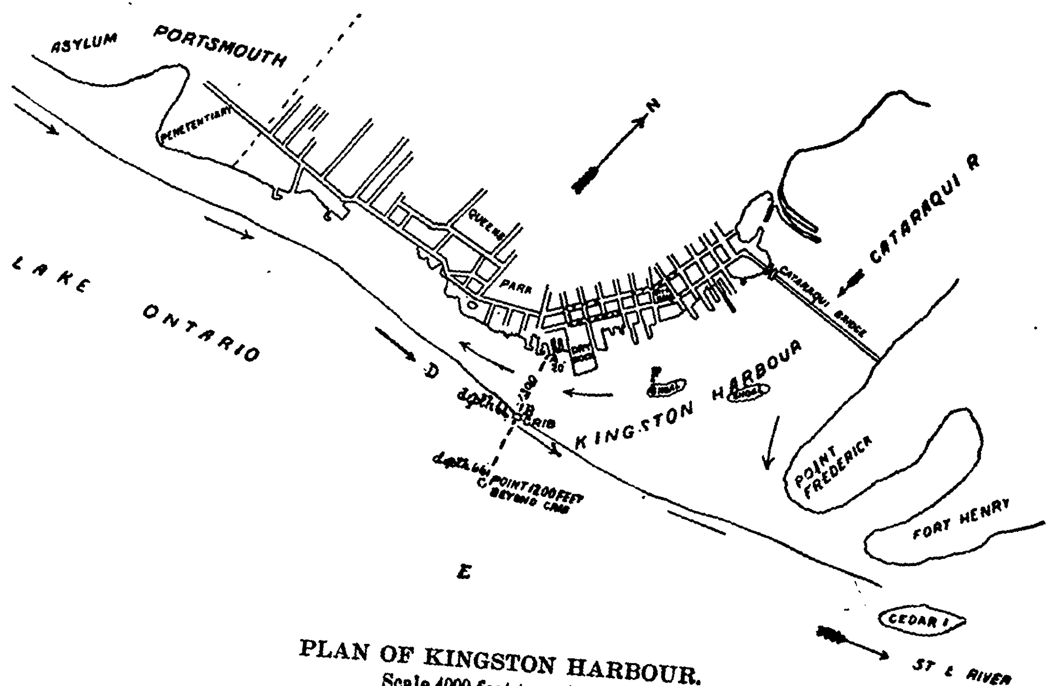
These results indicate a water of fair purity only, and considering the increased flow of sewage owing to growth of the city and extension of the drainage system, it was decided to extend the suction pipe to a point B (see map) 1300 feet out from the present intake. The Board of Health considered it advisable to have the two sources tested to see what improvement in purity would be made by the change. Samples were taken April 15th, 1891, from A at 18 feet from the surface and B at 30 feet from the surface. In this, as on all other occasions during this investigation, the samples were brought to me in numbered bottles, and I was ignorant of the sources from which they were drawn. This freedom from prepossession is perhaps desirable where the results of the analysis depend so much on delicate distinctions of shades, as in Nesslerising. The results showed the present source to be a little better than the proposed:

Sample.	Free Ammonia.	Alb. Ammonia.	Chlorine.	Oxygen consumed.	Solids.
No. 1 (new intake)	.013	.10	5.2	1.38	126
No. 2 (old intake)	.000	.09	5.0	0.82	128

This unexpected result led to a repetition of the analysis. Samples were taken on April 20th:

Sample.	Free Ammonia.	Alb. Ammonia.	Chlorine.	Oxygen consumed.	Solids.
No. 8 (new)	.007	.10	4.5	1.26	106
No. 9 (old)	.007	.09	5.2	1.44	103

This left no doubt that the proposed intake was at any rate no better than the present.



PLAN OF KINGSTON HARBOUR.
Scale 4000 feet to an inch.

Analyses were then made with the object of finding the point nearest the waterworks, at which a better supply could be obtained. Samples were taken on April 30th, 1891, from the following points:

No. 1—1300 feet from shore opposite Murney Tower, in line of Barrie street (map, D).
No. 2—At the proposed intake (B).
No. 3—1200 feet beyond the proposed intake (C).
No. 4—2500 feet beyond the proposed intake (E).
No. 5—Near Carruthers' shoal (F).

With the exception of No. 5 these samples were taken 30 ft. from the surface. No. 5 was taken 22 feet from the surface. The results of the analyses were as follows:

No.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Oxygen consumed.	Solids.	Remarks.
1..	none	.085	4.4	1.72	113	Some sediment.
2..	none	.086	3.9	1.64	118	" "
3..	none	.062	4.4	0.88	126	Clearer than 1 & 2.
4..	none	.060	4.5	1.12	102	" "
5..	none	.060	4.0	1 56	140	Slightly unpleasant odour when warm.

Above D, the point at which No. 1 was taken, the principal discharge of sewage is from the Asylum for the Insane, and from the Penitentiary. The analysis shows that the point D is not superior to the proposed intake (B). It also shows that purer water can be obtained by running the suction pipe 1,200 feet farther out than was at first proposed. I was much surprised to find that No. 5, with *albuminoid ammonia* so low, had been taken from a point so far up in the harbour. In my report it was mentioned as inferior to Nos. 3 and 4, as shown by the *oxygen consumed*, the *solids*, and the unpleasant odour (somewhat *marshy*, I noted it at the time) when distilling. The exceptional character may be accounted for on the ground that the harbour water is there (at F) mixed with the water of the Cataraqui River, a sluggish stream flanked by extensive marshes just before it reaches the city. However, the point awaits further investigation.

It now became quite clear that a supply of pure water could be obtained by running out the suction pipe 2500 feet from the shore.

Currents.

In order to complete their information the Waterworks Committee ordered experiments with floats so as to determine the direction of the currents in and near the harbour. These experiments were made by the City Engineer, Mr. T. O. Bolger, the manager of the waterworks, Mr. W. Hewitt, and myself. Professor Carr Harris, of the Royal Military College, made many valuable suggestions. The floats were made by weighting small 12 ft. scantling with bricks tied on at one end. In some cases floats of 24 ft. length were used in the deeper water. Without going into detail, I shall here give the conclusions arrived at after several weeks of careful observation.

1. From the Asylum to near the point D, there is a steady current *down* the lake outside of a line averaging 700 or 800 feet from the shore.

2. Inside this line there is a variable eddy current *up* the lake.

3. The dividing line between the currents moves towards the shore with westerly, and away from it, with easterly winds.

4. From a point near D the dividing line runs in a general direction towards Cedar Island. It must often pass very near the crib (B), but its position is very much influenced by the direction and velocity of the wind.

5. Between the dividing line and the shore, the water of the harbour is comparatively still. The feeble currents are largely controlled by the wind. In quite calm weather there is, however, near the waterworks, a slow current up the lake. On the whole, the harbour water may be considered to be, in comparison with the lake water, still-water.

These results explained the unexpected character of the water over the crib (B). This point is on the dividing line between the dead water of the harbour and the water moving down the lake. The water at this point is not so clear as that nearer shore, and has nothing to recommend it above the present city supply.

The problem of an abundant supply of pure water is thus easy to solve. Fortunately, Kingston is so situated that the pumping station, near the centre of the water front, is only some 2,500 or 3,000 feet from the inexhaustible supply afforded by the unpolluted waters of Lake Ontario. The only doubtful point is the effect of the great numbers of dead fish which are seen floating in the lake and river at a certain season of the year. This point could be easily settled by analysis.

TEMPERATURE.

On July 15th, 1891, some observations of temperatures were made by Mr. Hewitt and myself. A half-gallon corked bottle was lowered to the required depth and allowed to remain for a few minutes. The cork was pulled out by means of a cord attached to it, and about five minutes after bubbles had ceased to come up the bottle was quickly drawn to the surface and the temperature of the water taken. The thermometer used was one made by Negretti & Zambra, graduated in tenths of a degree. The temperatures were taken at the points C, B and A, and an intermediate point.

No.	Distance from Shore.	Depth.	Temperature.
1	2500 ft. (C).	30 ft.	60° F.
2	"	15 "	62.6
3	"	6 in.	64.6
4	1300 ft. (B).	30 ft.	60.3
5	"	15 "	62.2
6	"	6 in,	65.1
7	650 ft.	30 ft.	60.4
8	"	15 "	62.0
9	"	6 in.	65,1
10	20 ft. (A).	18 ft.	62.0
11	"	6 in.	67.1

These readings were taken about mid-day. The day was fine, with a light breeze blowing.

These eleven samples were then compared as to their clearness, &c. No. 1 was found to be the most free from suspended matter. Nos. 6, 9 and 11, were rather dirty. No. 4 also had considerable suspended matter. These results confirmed the evidence given by chemical analysis and by the experiments with floats.

It may be of interest here to mention that my colleague, Prof. Marshall, has found that the temperature of the lake water is just now (Feb. 27) uniformly 32° F. from the ice to the bottom at a depth of 53 feet. This cooling of the deeper waters below the point of maximum density can hardly have been brought about by conduction alone. No doubt there has been considerable mixing of the top layers with the lower by means of the current.

Some Laurentian Rocks of the Thousand Islands.

By Dr. A. P. Coleman, School of Practical Science, Toronto.

The Admiralty group of the Thousand Islands includes one hundred and fifty rocks, islets and islands extending two or three miles southwest of Gananoque. Two quarries and the bare glaciated flanks of the islands and the neighboring shore give excellent exposures of lower Laurentian rocks, here consisting of granite, gneiss and quartzite. Some dykes of fine grained diabase which intersect these rocks, though later than Laurentian are probably of precambrian age, since they do not pierce the Potsdam sandstone which overlies the eastern end of the group.

Granite covers the largest surface and has invaded the gneiss and quartzite, sweeping off portions of them, generally only a few inches or feet in diameter, but sometimes twenty feet or much more across. They are for the greater part quite sharp angled and uncorroded by the granite, and the quartzite fragments often stand out from the surface an inch or so, giving a measure of the depth to which the granite has weathered since the whole region was planed smooth in the Ice Age.

At a distance from these well defined fragments one finds here and there in the granite darker, finer grained spots with no distinct boundary, probably bits of gneiss more strongly acted upon. Here the gneissoid structure can scarcely be recognized, and it may be that some examples showing much of a bluish green augite under the microscope were torn from some deep seated augitic rock not found at the surface.

The granite is in general monotonously red and coarse grained, though finer grained portions occur, and the color sometimes bleaches to a bluish or purplish grey. It has been quarried for various purposes, and specimens prepared in Mr. Forsyth's stone cutting establishment in Montreal display a rich color and fine polish.

Rare veins in the granite or gneiss contain black tourmaline regularly intergrown with quartz, or crystals of greyish perthite with cleavage surfaces a foot across, graphic granite (an intergrowth of quartz and perthite), and massive quartz.

Under the microscope the usual constituents of granites in Ontario present themselves, quartz, potash felspars and and biotite frequently accompanied by hornblende. The rock is then a biotite hornblende granite.

The quartz is of the usual kind, crowded with fluid cavities, often "negative crystals" in form, containing carbonic acid or water with a cube of salt. Innumerable minute needles which are highly refractive and in isotropic quartz sections show parallel extinction, are probably rutile.

The felspars include a little orthoclase, microcline in much larger amounts generally with microperthitic inclusions, and a small quantity of ordinary plagioclase with a low angle of extinction from the twin plane. Micropegmatite in which quartz forms wormlike inclusions in felspar is very common.

The biotite is brown, though more or less weathered into greenish choloritic products, and the green hornblende is still more often decayed. With these minerals are generally found brown titanite in large amounts, as well as the pale variety, leucoxene, surrounding opaque masses of iron oxide. Thick crystals of apatite often join the preceding minerals. Minute zircons may be seen especially in quartz and the felspars. Magnetite, titanite and apatite with zircon are the only minerals usually idiomorphic. The large amount of titanium is worthy of mention, for titanite often equals the biotite in quantity.

That the granite has undergone strains since solidifying is proved by the frequent occurrence of undulatory extinction in quartz and felspar, as well as cataclase structure on the edge of the larger constituents.

The gneiss shows in most parts the usual wavy, sweeping curves of foliation including lenses of felspar and larger enclosures of quartzite, and is much more varied in character than the granite. It commonly contains a larger proportion of biotite than the granite, and hence is darker in color, though one variety from the mainland is nearly white and formed of thin layers of quartz and felspar almost free from mica. In grain the rock varies from coarse pegmatitic bands with felspars three inches across to very fine grained portions, almost hälleflintas.

A curious structure, probably resulting from a shearing motion, may be seen crossing both granite and gneiss, veinlike bands an inch or two wide, in which the basic minerals have almost disappeared, and quartz and felspar have been rolled into fine parallel plates, from which curves sweep off into the unaltered rock around, the curve on one side reversing the direction of that on the other.

Under the microscope the gneisses prove to contain all the minerals found in the neighboring granite except microcline, which is almost entirely replaced by orthoclase, generally with microperthitic inclusions. In most cases biotite is plentiful, hornblende absent, quartz sparingly present. This is, however, not the case in varieties resembling hälleflinta where quartz is the mineral found in largest amounts. Apatite occurs as needles and not as thick prisms, the form usual in the granite.

A microscopic examination of sections from lines of shear gives proof of immense crushing both of quartz and feldspar, though fragments of microperthite have sometimes resisted the crushing force and are enfolded by the thin layers. Large individuals of quartz are frequently drawn out lengthwise, broken into many pieces with slightly different orientation. It should be mentioned that the gneiss as a whole presents less evidence of violent strains than the granite.

The quartzite, which is generally subordinate to the gneiss, is white or tinged with red by the weathering of some ore of iron, probably pyrite. A little pale greenish muscovite, decayed felspar, specks of tourmaline and titanite complete the minerals visible without the microscope. In thin sections one is struck by the great numbers of rutile needles flashing brilliantly between crossed nicols. Thicker rods, perhaps of the same nature, are strongly dichroic, brown parallel to the chief section of the nicol, almost colorless at right angles to it. Hexagonal brown plates are perhaps biotite, but seem not dichroic. A few crystals of zircon finish the solid inclusions. Cavities, often crystalline in outline, contain the same fluids as were found in quartz from the granite and gneiss; though these cavities, as well as the rutile prisms are much larger than in the other rocks. The only crystal of apatite observed was thick like that from the granite. Cataclase structure is less strongly marked than in either of the other rocks.

In reviewing the three rocks described one is struck by the points of relationship between them rather than by their differences. They must have been formed under certain common conditions; for salt water, carbonic acid under great pressure and oxide of titanium are found in the quartz of all three. Every constituent mineral of the two schistose rocks, except a few scales of muscovite in the quartzite, is found in the granite, which may be looked on in a sense as forming a mean between them. If the various kinds of gneiss and quartzite were blended together, a rock very like the granite would result. It was intended to make a series of analyses to test this chemically, but time to carry out this purpose has failed.

It is impossible to conceive that the widely varying gneisses and their interposed layers of quartzite could have resulted from the consolidation of any viscous or semi-solid magma, though it is quite possible to imagine these schistose rocks as having been contorted when softened by heat in the presence of salt water and carbonic acid, and even melted in part into a viscid granitic magma.

The shearing displacements described above must have taken place after the granite had at least partially solidified. These movements must have occurred long before the dykes of diabase broke through, for they have sharp unaltered walls of gneiss and granite, which at that time were so far cooled as to be brittle.

Recent Auroral Displays.

By Prof. C. H. McLeod, of McGill College.

The auroral display of the night of February 13th was observed throughout the northern portion of North America, in Britain, and probably throughout northern Europe. It was without doubt the most brilliant of the auroras observed here since 1870. In Montreal, it became visible shortly after sunset, and increasing in splendor attained its greatest brilliancy at between 7 and 7.30 p.m. Thereafter, gradually fading, it appeared as a uniform haze at 8.30, and the sky became completely overcast shortly after 9 o'clock. The most marked feature of this aurora was the bright red cone of light having its base between N. and N. 60° W., and extending to the zenith. The cone maintained an approximately constant position, and was of a uniform bright red colour, changing in tint only as it increased to a maximum and faded away. In front of this bright red screen there were slowly moving streamers of brilliant reds and greenish tints, and these also extended at times throughout the whole northern quarter of the sky. Low down in the north there was an arch of white light, and at one or two points in the N. E. there were columnar patches of coloured aurora which also maintained a fairly constant position. The movements were of the slow and stately order rather than those of the "merry dancers."

Since this aurora there have been several minor ones, and on March 6th there was a display, which, though only faintly coloured, was quite as beautiful as that of the 13th. It was marked by a beautifully folded curtain-like aurora standing above a very dark cloud. The changes in the curtain were very rapid, and at times showed light tints of pink and green. The streamers were numerous, but were not coloured, so far as observed.

It is perhaps worthy of remark in connection with these two auroras that the days on which they occur are included in a list of six days on which bright auroras are supposed to return periodically. The days are Feb. 3, Feb. 4, Feb. 13, March 6, Sept. 9, and Sept. 29. The aurora of March 12th, though not equal to those described, is also worthy of record. Like that of Feb. 13th it faded into a uniformly hazy sky.

The aurora of Feb. 13th marked one of the most violent magnetic storms on record. At the Kew observatory the "magnetometers were not able to record the complete "extent of the vibrations to which free needles were sub- "jected, nor could the entire change of force be secured in "the field of the instrument. The limits, however, clearly "recorded, were 2° of declination, from .1760 to .1830 of "horizontal force, and from .4350 to .4420 units of vertical "force expressed in C. G. S. measure in absolute force."† At Toronto, "during the early morning hours the declina- "tion magnet was considerably west of its mean position, "and east of it during the afternoon. The vibrations were "exceedingly rapid, notably so in the morning when the "range of declination was over 2° 37′. . . . . The "horizontal component was very much affected. Some "of the vibrations were so rapid that they were barely "recorded. The disturbance started with a sharp increase "of the force. In the morning the force was considerably

† Letter to *Nature* by Mr. G. M. Whipple, Feb. 18th, 1892.

"below its mean value, and during the afternoon a rapid "recovery commenced between 0h. 38′ p.m. and 4 p.m. "(Eastern time), an increase of .0096 C. G. S. took place; "the total change of horizontal force during the disturb-"ance was over .0148 C. G. S. Between 6 and 9 p.m. the "vibrations were very swift. The changes in the vertical "component were also considerable."*

This magnetic storm was preceded by a most unusual outbreak of sun spots. The group of spots which became visible by rotation on Feb. 5th was, on the morning of the 8th, and for some days thereafter, easily visible to the naked eye. The area of the group, as measured here on the 8th, amounted in area to about $\frac{1}{120}$th of the sun's visible hemisphere, the length of the disturbed area being about 140,000 and the breadth about 100,000 miles. On Feb. 13th there was also another very large group of spots, then about making good its position on the eastern limit, which added very materially to the total spotted area on this day. This latter is probably the same group of spots which, after making one rotation, is now (March 14th) nearly central on the sun.

The Nickel Deposits of Scandinavia.

By Prof. J. H. L. Vogt, of the University of Christiania.

Prof. J. H. L. Vogt, of the University of Christinia, who is engaged in preparing a work on the nickel deposits of Scandinavia, has in a letter to Dr. A. R. C. Selwyn, Director of the Geological Survey of Canada, dated January 4, 1892, given some interesting facts concerning these deposits.

As these Scandinavian deposits are of especial interest to Canadians, since they resemble in many ways the great deposits occurring in the vicinity of Sudbury,† Dr. Selwyn has placed the letter in the hands of the Editing Committee of the Record of Science, and from it the following facts have been gathered. F.D.A.

* From a statement kindly furnished by Mr. C. Carpmael.

† See paper "On the Nickel and Copper Deposits of Sudbury, Ont," by Alfred E. Barlow, Can. Rec. of Sci. Vol. 5, Number 1, p. 68.

All the Scandinavian Nickel Deposits—perhaps 50 to 80 have been worked to a greater or less extent—are intimately related to masses of gabbro, a rock composed of plagioclase feldspar and augite, or of norite, a closely allied rock composed of plagioclase feldspar and hypersthene. The ore is Magnetic Pyrites, containing 3 to 5 per cent. of nickel and cobalt, which ore is a constituent of the gabbro but is principally concentrated along the contact of the gabbro with the surrounding gneissic rocks. The accompanying cuts illustrate the mode of its occurrence in three localities.

The scale is in meters.

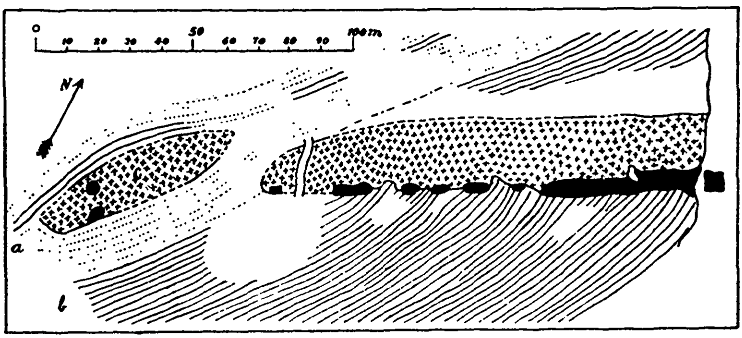


FIG. 1.—THE NYSTEN AND BAMLE MINES.

a.—Red Gneiss.
b.—Black Gneiss and Mica Schist.
c.—Gabbro.

The black portions are openings on pyrrhotite holding 4 p. c. of Nickel.

Associated with the Magnetic Pyrites ($Fe_8 \cdot S_9$) are ordinary Iron Pyrite ($Fe\ S_2$) Copper Pyrite ($Cu\ Fe\ S_2$) and in some places Titanic Iron Ore.

The Magnetic Pyrites when pure usually contains as before mentioned 3 to 5 per cent. of nickel and cobalt, but as much as 7 per cent. is sometimes present. These metals are usually present in the proportion of one part of cobalt to from seven to twelve parts of nickel. The Iron Pyrites on the other hand usually contains more cobalt than nickel. Copper Pyrite is never present in large amount.

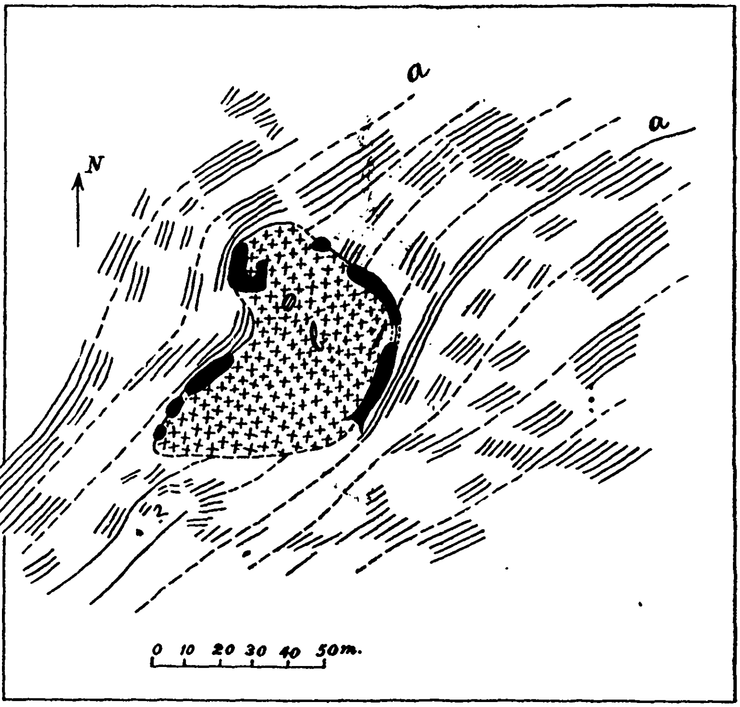


FIG. 2.—THE MEINKJAER MINES.

a.—Gneiss and Hornblende Schist.
b.—Norite.
The black portions are openings on pyrrhotite with 4 p. c. of Nickel.

Nickel, cobalt and copper are present on an average in the ore in the proportion of about 100 parts of nickel to 25 to 60 of copper and 8 to 10 of cobalt. These proportions hold good not only in the case of the numerous Scandinavian deposits, but also in those of other parts of Europe, as in Italy and Germany. This fact is of "high geological and genetic interest," as there seems to be some general law determining these proportions and it will be very interesting to ascertain whether they hold good in the case of the Sudbury deposits.

In the nickel ore in a few places the mineral Pentlandite (Eisennickelkies) has been discovered and in a single case

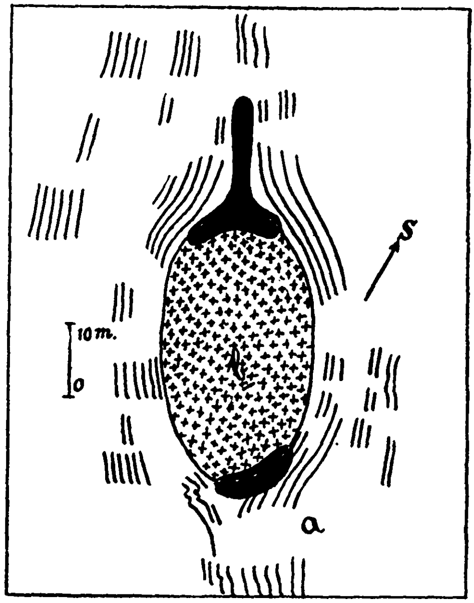


Fig. 3.—The Skaug Mine.

a.—Gneiss, etc.
b.—Gabbro.
The black portion shows the position of the Nickel deposits.

the mineral Cobaltite. The following figures give the number of tons of nickel annually produced in Norway in the several periods mentioned :—

1865–71	1872–73	1874–75	1876–80	1880–87	1888–91
50 to 80	150 to 200	250 to 320	80 to 120	60 to 120	90 to 130

The mattes hold about 50 p. c. of nickel. At present there are three or four smelting works in operation in Norway.

In Sweden in 1870-75 about 80 to 150 tons of nickel were produced annually, in 1880-85 about 40 to 80, while of recent years the annual output has fallen to from 10 to 30 tons.

Note on Magnesite from near Black Lake, Que.

By J. T. Donald, M.A.

(Read before the Natural History Society, Jan. 25th, 1892.)

In the "Annotated list of the minerals occurring in Canada," read before the Royal Society of Canada in May, 1889, Mr. G. Christian Hoffmann states that Magnesite "has so far only been met with in rock masses forming in association with serpentine, dolomite and steatite, beds in the townships of Sutton and Bolton, Brome County, Province of Quebec."

The object of this note is to place on record the occurrence of this mineral in characteristic crystals as incrustations on masses of serpentine on one or more of the lots known as numbers 24, 25, 26, Range A, Coleraine, Megantic County, Que. Since finding it in this locality, in the autumn of the year 1890, the writer has been on the look out for it at numerous other points in the Asbestos area, but as yet has not found it except in the locality above mentioned. Calcite, however, is quite common as an incrustation on the Serpentine throughout the area in which the asbestos is mined.

The Waters of two Artesian Wells in the Eastern Part of the City of Montreal.

By J. T. Donald, M.A.

(Read before the Natural History Society, Jan. 25th, 1892.)

One of the wells in question is on the property of Messrs. R. White & Co. on the corner of Craig and Beaudry Streets, the other is on the property of Messrs. M. Laing & Sons on the corner of St. Catherine and Parthenais Streets. Strictly speaking the latter is not entitled to be called an artesian well, as it yields water only by pumping. Mr. P. Laing informs me the water is "delivered by a pump having 36 inch stroke, and this without forcing throws twenty-five gallons per minute, and this pump has been at work for weeks without the slightest falling off in supply."

Messrs. R. White & Co. find that their well flows at the rate of thirty gallons per minute. It is however the intention of this firm to put in a pump, as a much greater quantity will be required to supply their own and their tenants' requirements.

The White well has a total depth of 266 feet, 60 feet through clay and gravel and 206 feet through rock. Water was obtained at a depth of 258 feet, but drilling was pushed to a further depth of 8 feet.

The Laing well has a total depth of 325 feet; 56 feet through clay and earthy material and 269 feet through rock. Unfortunately none of the rock matter removed in boring these wells has been preserved, except a single fragment from the White well to which reference will be made again.

A partial analysis of the water from each of these wells has been made and the results in grains per imperial gallon are as follows:

	Laing.	White.
Total Solids........................	43.70	36.42
Suspended Matter....................	2.04	.....
Calcium Carbonate...................	*14.32	heavy trace.
Calcium Sulphate....................	12.65	.....
Sodium Chloride.....................	9.38	2.32
Sodium Sulphate.....................	.....	6.85
Alkaline Carbonates & Bicarbonates with a little Silica..............	5.31	27.25

When the sample of Laing water was sent for analysis, the Messrs. Laing wrote saying that although it was turbid it was as clear as any they could obtain, nothwithstanding that they had been pumping for weeks. A few days after the analysis of the sample had been made the turbidity disappeared, and Mr. Laing informs me that "the pump is now delivering water that shows no cloudy matter whatever," and has sent me a sample which confirms his statement.

It is worthy of note that these two waters, which represent wells a short distance a part should show such a difference in their contained solids. The salts in the Laing water are such as one with a knowledge

* With a little Magnesium Carbonate.

of the locality of the well would expect to find. In the case of the White water it is rather surprising to find an almost entire absence of lime and magnesia, and the presence of a large quantity of alkaline salts, especially the carbonates and bicarbonates. In endeavoring to learn something of the source of these alkaline salts the writer communicated with the party who bored the well for Messrs. R. White & Co. He was of opinion that the only rock encountered in boring was limestone. Mr. R. White interrogated his employees who had assisted in the work of boring, and learned that one of them had preserved a small fragment of tho rock that was taken from the depth at which water was reached. On examination this proved to be not limestone, but apparently a shaly substance intersected, however, by minute veins of calcite. This shaly rock may be the source of the alkaline salts. The fragment of rock has been handed over to Mr. Frank D. Adams of McGill College, who proposes to submit it to microscopical examination, and who will be very glad to receive any samples from or information concerning any other borings made in this vicinity, as he is collecting materials for a detailed geological map of the whole district about Montreal.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY.

The third monthly meeting was held on the evening of January 25th, the Hon. Edward Murphy, President, in the chair.

The minutes of November 30th 1891, were read and approved.

Minutes of Council Meeting of January 17th, were approved.

A letter was read from the Museum d'Histoire Naturelle de Bordeaux asking for the publications of the Society. It was on motion by Mr. Beaudry resolved to place this Society on our exchange list.

Mr. J. T. Donald read a paper on crystallized magnesite from Black Lake, Que., and some notes on native platinum from British Columbia.

He also read a paper on the composition of the waters of two artesian wells in the eastern part of the city of Montreal.

After the paper had been discussed, it was moved by Mr. Adams, seconded by Mr. Beaudry that the thanks of the Society be tendered to Prof. Donald for his interesting communications, and that he be requested to publish them in the *Record of Science.*—Carried.

The meeting then adjourned.

The fourth monthly meeting was held on February 29th, Rev. Dean Carmichael, President, in the chair.

The minutes of meeting of January 25th, were read and approved.

Minutes of Council meeting of February 22nd were read.

Donations to Library, Dr. T. Sterry Hunt's last work. "Systematic Mineralogy," and to Museum, a swallow's nest from W. A. Oswald, Belle Riviere. On motion by J. S. Shearer, seconded by J. S. Brown the thanks of the Society were tendered to the donors.

Mr. W. H. Lynch, proposed by J. S. Shearer, seconded by the Very Rev. Dean Carmichael, and Mr. J. G. Shaw proposed by James Gardner, seconded by John S. Shearer were elected ordinary members, the rules requiring a delay of a month having on motion been suspended.

It was moved by J. Stevenson Brown, seconded by C. T. Chambers, that the Society deeply regrets the death of Dr. T. Sterry Hunt and desires to place on record its great indebtedness to him for his labors in its behalf while President of the Society and also during his many years of active membership, also for his valuable contributions to Canadian science.

Mr. W. H. Lynch then gave his interesting lecture on the "mineral resources of British Columbia." On motion of J. Stevenson Brown seconded by W. L. Lockerby the thanks of the Society be accorded to Mr. Lynch for his valuable lecture.

PROCEEDINGS OF THE MONTREAL MICROSCOPICAL SOCIETY.

The regular monthly meeting of this Society was held on January 11th when it was expected that Prof. Cox would give a paper on polarized light, but owing to his indisposition the lecture had to be postponed. The members, however, were requested to bring slides or other objects of interest, which several of them did, and a very successful meeting resulted.

Feb. 8th, Jos. Bemrose, F.C.S., read a paper on "Crystalline forms modified by Impurity." The formation of crystals was carefully explained and the effect of impurities on the forms of crystal described. Poisons forming crystals, it was stated, could be detected, separated from food, examined microscopically, and the kind of poison identified by its crystals. The lecturer had specially prepared a large number of slides to illustrate his subject, which demonstrated that there was great beauty of form and colour, as well as delightful and valuable results to be obtained by careful study of crystals. Polarized light was largely used in demonstrating the structure of the crystals exhibited.

Feb. 26th. A special meeting was held to hear Prof. Cox's paper "Polarized light, its usefulness in indicating structure." Ordinary light waves were first referred to, and then the special character of polarized light was treated of. The effect of Iceland spar in dividing the rays of light was demonstrated by introducing a crystal of that substance into the lantern, when the most wonderful changes in colour were observed on the screen. The actual formation of crystals was also shown in the same way by placing Benzoic Acid between two thin plates of glass, when after heating, the crystals could be observed forming. This was a most successful experiment and clearly demonstrated the value of "polarized light in indicating structure." Throughout, the lecture was illustrated at every point with mechanical and electrical apparatus, and at its close a vote of thanks was proposed by Hon. Senator Murphy, seconded by Dr. J.

B. McConnell, to Prof. Cox for his instructive and interesting paper.

The next meeting will be held March 14th, when the Rev. W. J. Smyth will give a paper on "The House Spider."

NOTICES OF BOOKS AND PAPERS.

TIN DEPOSITS IN QUEENSLAND.

The reports issued by the Geological Survey of Queensland, under the charge of Mr. Robert L. Jack, must prove of very great value to Australians, particularly to mining men, as, certainly, they are very instructive to their antipodal readers who are interested in geological work or the history and nature of the different mineral horizons. The reports, as read by us, are all written in a peculiar style, but it is extremely simple and succinct, and the many items of fact or detail are given in a manner very direct and concise, as all reports should be, each sentence being shorn of every unnecessary word.

The wonderful richness of the Australian mines, and the great area of mineral lands, are well known; it would seem as if men's wildest dreams had been surpassed in their realization by the vast wealth of precious metals and priceless gems that has poured forth so bountifully from the natural treasuries of this wonderful land. Realizing the importance of as complete knowledge as possible of the different mining fields, of the geology of each district, with the exact conditions and relationships of the ore deposits with reference to the enclosing or neighboring rocks, the reports of this survey would indicate that its chief endeavors had been spent in examining and reporting upon the different mining districts, explaining the geological formations, and giving the results of the mining operations up to date. Such reports, with their accompanying maps, must be a very useful and reliable source of information to all mining men, who, we believe, must look upon the work of Mr. Jack and his associates as being well done and of great practical benefit.

Reading over the reports from the different fields, issued last year, we were much interested by that one on the tin deposits and their mining, in the Coolgarra District. The rocks consist mostly of altered vertical greywackes, quartzites and shales, flanked on the east by lofty granite ranges, there being no sharply defined boundary line between the granite and the sedimentary rocks, except that the latter have become more flinty and felsitic. Throughout the locality, are dykes of some altered basic rock, with no prevailing direction, that are found more frequently in the sedimentary strata than in the granite, sometimes as intrusive sheets along the bedding planes, elsewhere following joint planes, even at times penetrating quartz veins. These dykes are the source of the tin, which is found only as the binoxide, cassiterite, or "tin-stone," running irregularly through the gangue in fine "stringers" or "leaders," that often swell out into large bunches, or else the ore is finely disseminated throughout the whole mass. As would be expected, more or less "stream tin," from the disintegration of the dykes, has been obtained by washing the alluvial bottoms of the gullies.

In mining, some of the claims have done considerable exploration work, and the ore has generally been found associated with galena, iron pyrites and more or less arsenical pyrites. The ore is concentrated to a form of rich matte, or "black tin," preparatory to shipment to the smelters, by roasting it in large calciners, and from 1884 to 1888, from 4,851.5 tons of ore crushed, the yield of black tin was 352.6 tons.

This Coolgarra tin deposit is interesting and peculiar from the fact that the mineral is found in these dykes of basic rock, while in other parts of the world tin is found for the most part in granite, in "stockworks," or masses traversed by many minute veins which necessitate the working of the whole mass to gain the ore. In Saxony large areas of porphyry have been mined for tin, but we can find no record of tin being found under such conditions as those described above.

It is strange that as yet throughout the world the areas in which tin is found are so few and limited in size, and that on this continent, which has been so prodigal in its production of all other metals, tin in sufficient quantities to be mined profitably is almost unknown. It holds such a strong place in commerce, where it is of such great economic use in tinning iron plates, and for the manufacture of bronze, bell metal, pewter, Britannia metal, etc., that there is a firm and growing demand for it, and any new area reported as productive of this metal immediately receives great attention, though many false alarms have resulted from men mistaking zinc blende, or "Black Jack," for tin stone, or by men manufacturing alluvial tin deposits, or placers, by importing several barrels of ore from Cornwall, and sagaciously scattering it about at some suitable spot, deluding some unsuspecting speculators into buying what they thought was better than a gold mine.

W. A. Carlyle, M.E.

ABSTRACT FOR THE MONTH OF JANUARY, 1892.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY.	THERMOMETER.				* BAROMETER.				† Mean pressure of vapour	‡ Mean relative humidity.	Dew point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. of Possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§ Max.	§ Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	14.67	21 5	10.6	10.9	30.2362	30.575	29.930	0.645	.0638	73.0	7.3	N.E.	10.6	6.7	10	0	00	Inap.	Inap.	Inap.	1
2	31.33	43 7	21.2	22.5	29.5407	29.762	29.313	0.449	1727	95.0	30.0	E.	13.3	10.0	10	10	00	0.44	....	0.44	2
SUNDAY......3	.....	36.2	17.9	18.3	......	......	....	.....	.....	....	....	W.	17.8	..	..	..	00	0.15	3.0	0.42	3 ....SUNDAY
4	10.70	18.5	5.0	13.5	29.6562	29.740	29.590	0 150	.0588	82.0	6.3	S.W.	20.7	7.5	10	1	35	...	0.1	0 01	4
5	6.02	10.0	2.3	7.7	29.7120	29.839	29.614	0.225	.0445	78.2	0.7	S.W.	20.7	3.3	10	0	75	....	0.2	0.02	5
6	10 82	18.2	3 5	14.7	29.6302	29.862	29.250	0.612	.0637	86.8	7.7	N.E.	26.1	10.0	10	10	00	....	4.1	0.41	6
7	17.30	20.2	13.8	6.4	29.4603	29.793	29.170	0.623	.0788	82.8	13.3	S.W.	21.9	5.3	10	1	00	....	0.7	0.07	7
8	16 28	21.8	12.1	9.7	29 9717	30.057	29.879	0 178	.0723	80.2	11.2	S.	7.2	6.8	10	1	47	....	....	....	8
9	19.13	22.6	11 2	11.4	30.2223	30.381	30.083	.298	.0800	76.7	13.3	S.W.	12.3	4.8	9	0	84	....	0.7	0.07	9
SUNDAY...10	.....	18.0	9.0	9.0	....	......	......	.....	.. .	....	....	S.W.	10 2	....	..	.	93	....	....	....	10 ....SUNDAY
11	15.10	22.2	6.5	15.7	30.6098	30.707	30.462	0.245	.0698	79.8	10.0	N.E.	15.3	6.3	10	0	09	....	....	....	11
12	32.98	37.4	20.7	16.7	30.2587	30.392	30.182	0.210	.1702	90.0	30 5	S.	13.4	9.5	10	7	00	0.03	0.4	0.07	12
13	26 27	34.0	20 3	13.7	30.1515	30.273	30.075	0 198	.1313	92.0	24.2	N.	21.4	10.0	10	10	00	....	1.7	0.17	13
14	23.63	27.4	19.0	8.4	29 9778	30.191	29.839	0 352	.1180	92.3	21.8	N.	24.2	8.8	10	3	00	0.11	5.0	0.61	14
15	14.25	20 4	8.5	11.9	30.3373	30.397	30.259	0.138	.0655	78.3	9.0	S.W.	17.3	7.0	10	0	03	....	....	....	15
16	3.65	9.1	-0.7	9.8	30.5450	30.606	30.461	0.145	.0388	76.2	-2.5	W.	0 9	0.0	0	0	78	....	....	....	16
SUNDAY...17	.....	23.6	-1.0	24.6	......	......	......	... .	.....	....		S.	8.9	....	..	..	00	....	....	....	17 ....SUNDAY
18	24.43	29.4	15.2	14.2	30.2015	30.321	30 044	0.277	.1213	91.2	22.3	S.	9.3	10.0	10	10	00	....	4.3	0.43	18
19	6 42	15.4	-2.4	17.8	30.0575	30.210	29.980	0.230	.0482	81.8	1.8	N.W.	12.8	7.2	10	0	00	....	5.0	0.50	19
20	-7 70	-2.4	-12.4	10.0	30.3287	30.383	30.252	0.131	.0257	86.2	-10.8	N.	5.1	5.8	10	0	38	....	.	....	20
21	8.62	15.0	-4.9	19.9	30.0668	30.205	29.912	0.293	.0517	79.2	3.7	W.	17.7	5.3	10	0	00	....	1.6	0.11	21
22	18.93	29 5	5.3	24.2	29.9895	30.287	29.738	0.549	.0927	84.2	15.0	S.	13.4	8.0	10	0	00	....	1.4	0.14	22
23	18.02	31.8	1.1	30.7	29.7770	29.924	29.655	0.269	.0917	79.2	12.8	N.	19.8	6.7	10	0	00	.. .	1.0	0.09	23
SUNDAY......24	.....	7.2	-1.5	8.7	....	......	......	.....	... .	....	....	S.E.	7.7	....	..		00	....	0.9	0.09	24 ....SUNDAY
25	9 22	13.5	3.1	10.4	29.3617	29.476	29.313	0.163	.0563	88.3	6.5	N.E.	12 0	10.0	10	10	00	....	4.5	0.43	25
26	2.78	10.4	-1.7	12.1	29.6483	29.916	29.392	0.524	.0377	76.2	-3.3	W.	25.2	8.0	10	4	00	....	2.1	0.21	26
27	-1.82	6.5	-9.7	16.2	30.0782	30.154	29.966	0.188	.0280	68.7	-10.0	S.W.	27.8	6.3	10	0	42	....	0.1	0.01	27
28	19.85	23.4	6.1	17 3	29.8067	29.154	29.753	0.160	0912	84.7	16.2	S.W.	18.6	10.0	10	10	00	....	0.8	0.08	28
29	20.33	23.4	14.8	8 6	29.7823	29.913	29 727	0.137	.1015	92.5	18.5	N.E.	10.8	10.0	10	10	00	....	1.8	0.18	29
30	16.43	18.7	14.5	4.2	30.0562	29.864	29.937	0.196	.0812	88.3	13.7	E.	12.1	8.7	10	2	00	....	0.3	0.03	30
SUNDAY........31	.....	19.9	14.0	5.9	....	30.133	......	. .	.....	...	....	N.E.	7.7	....	..	..	36	....	....	....	31.........SUNDAY
....Means	14.52	21.18	7.14	14.04	29.9794	.....	......	0.292	.0791	83.2	10.4	W. 32° S.	14.9	7.4	...	....	19.0	0.73	39.7	4.59	Sums ....
18 Years means for and including this month.......	12.14	20.60	4.04	16.6	30.0592	.....	......	0.338	.0733	80.9	....	......	....	6.5	....	....	¶31.8	0.86	30.3	3.71	18 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction....	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
Miles............	1332	2087	488	496	1039	4090	1338	227	
Duration in hrs..	84	110	53	56	102	228	74	21	16
Mean velocity....	15.9	19.0	9.2	8.9	10.2	18.0	18.1	10.8	

Resultant mileage, 2456.
Resultant direction, W. 32° S.
Total mileage, 11,097.

* Barometer readings reduced to sea-level and temperature of 32° Fahrenheit.

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 11 years only.

The greatest heat was 43°.7 on the 2nd; the greatest cold was 12°.4 below zero on the 20th, giving a range of temperature of 56.1 degrees. Warmest day was the 12th. Coldest day was the 20th. Highest barometer reading was 30.707 on the 11th; lowest barometer was 29.170 on the 7th, giving a range of 0.537 inches. Maximum relative humidity was 100 on the 20th. Minimum relative humidity was 56 on the 1st and 27th.

Rain fell on 5 days.

Snow fell on 22 days.

Rain or Snow fell on 23 days.

Auroras were observed on 1 night.

Fog on 1 day.

ABSTRACT FOR THE MONTH OF FEBRUARY, 1892.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY.	THERMOMETER.				* BAROMETER.				† Mean pressure of vapour	‡ Mean relative humidity.	Dew point.	WIND.		SKY CLOUDED IN TENTHS.			Per cent. of Possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
	Mean.	Max.	Min.	Range.	Mean.	§ Max.	§ Min.	Range.				General direction.	Mean velocity in miles per hour	Mean.	Max.	Min.					
1	27.18	34.5	18.7	15.8	29.9847	30.046	29.911	.135	.1258	85.3	23.0	W.	12.1	7.7	10	1	12	....	....	....	1
2	21.13	28.5	16.6	11.9	30.0225	30.161	29.835	.226	0942	82.7	16.8	N.E.	13.6	9.8	10	9	06	....	1.5	0.15	2
3	24.85	27.6	21.4	6.2	29.8777	29.951	29.805	.146	.1192	89.8	22.2	N.	15.9	10.0	10	10	00	....	2.4	0.24	3
4	20.17	26.6	15.3	11.3	30.0230	30.069	29.969	.100	.0893	81.2	15.2	N.	6.1	6.2	10	0	18	....	2.0	0.12	4
5	7.57	16.8	3.5	13.3	30.1288	30.224	30.083	.141	.0470	77.0	1.8	N.E.	13 2	5.3	10	0	55	....	0.6	0.06	5
6	3.02	12.8	-4.7	17.5	30.3510	30.394	30.293	.101	.0383	77.7	-3.0	S.W.	9.1	1.7	10	0	94	...	....	....	6
SUNDAY.......7	....	[illegible]	7.5	11.5	......	......	....	.....	.....	....	....	N.E.	10.1	....	..	..	00	....	1.4	0.14	7 ....SUNDAY
8	20 80	24.8	17.6	7.2	29.6062	29.696	29.540	.156	.1055	94.2	19.3	N.E.	13.5	10.0	10	10	00	....	5.8	0.47	8
9	23 92	31.0	18.7	12.3	29.7837	29.862	29.725	.137	.1113	86.2	20.3	S.W.	12.1	8.5	10	1	00	....	1.5	0.14	9
10	16.52	24.4	11.8	12.6	29.9578	30.047	29.794	.253	.0663	72.0	9.3	S.E.	10.4	5.8	10	0	44	....	....	....	10
11	20.93	27.1	9.7	17.4	29.4215	29.678	29.215	.463	.1018	88.5	18.2	E.	17.0	10.0	10	10	00	....	3.7	0.31	11
12	12.03	25.2	1.7	23.5	29.2698	29.505	29.152	.353	.0723	87.7	9.2	S.W.	32.0	9.5	10	7	00	....	6.1	0.50	12
13	-4.48	2.5	-9.0	11.5	29.7713	29.861	29.669	.192	.0232	64.8	-13.3	S.W.	36.2	0.0	0	0	98	....	....	....	13
SUNDAY 14	.....	14.5	-5.0	19.5	....	......	......	.....	.....	....	....	N.E.	13.3	....	..	..	00	....	3.7	0.37	14 ....SUNDAY
15	18.40	32.9	10.5	22.4	29.9727	30.323	29.522	.801	.0782	76.3	12.3	S.W.	29 4	6.2	10	1	68	....	3.1	0.31	15
16	6.68	11.2	1.8	9.4	30.5313	30.584	30.452	.132	.0387	65.5	-2.7	W.	14.0	1.7	10	0	87	....	....	....	16
17	7.10	12.0	3.4	8.6	30.5832	30.656	30.488	.168	.0387	64.5	-2.5	W.	10.0	0.0	0	0	97	....	....	....	17
18	9.45	18.8	-2.5	21.3	30.3137	30.414	30.235	.179	.0525	75.8	3.5	S.W.	14.5	2.5	10	0	84	....	...	....	18
19	16.13	24.4	4.4	20.0	30.3358	30.398	30.291	.107	.0760	81.0	11.3	N.E.	10.5	6.8	10	0	75	....	Inap.	Inap.	19
20	26.63	30.0	20.1	9.9	30.3635	30.413	30.319	.093	.1408	96.3	25.8	N.E.	11.4	10.0	10	10	00	.. .	4.3	0.43	20
SUNDAY.......21	.....	33.7	28.8	4.9	......	......	......	.....	.....	....		E.	12.0	....	..	..	00	....	Inap.	Inap.	21 .... SUNDAY
22	33.38	36.2	30.4	5.8	30.5545	30.574	30.533	.041	.1685	88.3	30.3	N.E.	9.5	10.0	10	10	00	....	....	....	22
23	33.45	37.5	30.4	7.1	30.5455	30.580	30.502	.078	.1708	89.0	30.5	N.E.	6.7	8.0	10	0	48	....	....	....	23
24	31.27	37.9	24.2	13.7	30.3822	30.504	30.248	.256	.1457	83.7	26.7	S.E.	6.9	5.7	10	0	68	....	....	....	24
25	30.82	36.8	26.4	10.4	30.1785	30.258	30.111	.147	.1400	81.5	25.8	S.	7.4	4.2	10	0	67	....	....	....	25
26	24.13	38.8	3.5	35.3	30.3982	30.757	30.157	.600	.1128	77.7	18.2	N.	20.6	8.2	10	0	00	....	Inap.	Inap.	26
27	-1.62	11.0	-8.6	19.6	30.9010	30.962	30.848	.114	.0308	77.7	-7.2	N.E.	28.9	0.7	4	0	00	....	....	....	27
SUNDAY 28	.....	16.5	-5.8	22.3	....	......	......	.....	.....	....	....	N.E.	14.7	....	..	..	98	....	....	....	28 ....SUNDAY
29	18.15	27.2	6.0	21.2	30.2570	30.311	30.190	.121	.0895	85.7	14.5	N.	5.4	8.3	10	0	00	....	0.3	0.03	29
............Means	17.91	24.83	10.23	14.6	30.1406	.....	......	.210	0910	81.2	13.0	N.38°W.	14.6	6.3	....	....	35.1	0.00	36.4	3.27	Sums ....
18 Years means for and including this month.......	15.72	24.17	7.04	17.1	30.0446	.....	......	.320	.0830	78.7	....	......	....	5.9	....	....	¶40.9	0.89	23.2	3.08	18 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
Miles............	1168	3160	672	226	432	3497	841	137	
Duration in hrs..	88	216	55	24	59	161	71	14	8
Mean velocity....	13.3	14.6	12.2	9.4	7.3	21.7	11.8	9.8	

Greatest mileage in one hour was 52 on the 15th.

Greatest velocity in gusts 60 miles per hour on the 15th.

Resultant mileage, 555.

Resultant direction, N. 38° W.

Total mileage, 10,133.

* Barometer readings reduced to sea-level and temperature of 32° Fahrenheit.

§ Observed.

† Pressure of vapour in inches of mercury.

‡ Humidity relative, saturation being 100.

¶ 11 years only.

The greatest heat was 38°.8 on the 26th; the greatest cold was 9°.0 below zero on the 13th, giving a range of temperature of 47.8 degrees. Warmest day was the 23rd. Coldest day was the 13th. Highest barometer reading was 30.962 on the 27th; lowest barometer was 29.152 on the 12th, giving a range of 1.810 inches. Maximum relative humidity was 100 on the 20th. Minimum relative humidity was 48 on the 13th.

Snow fell on 16 days.

Auroras were observed on 5 nights.

Lunar halos on 2 nights.