

ART. I.—GLACIAL GEOLOGY OF NOVA SCOTIA.—BY REV. D.  
HONEYMAN, D. C. L., F. R. S. C., F. S. SC., &C.

*Read November 2nd, 1887.*

ALTHOUGH engaged in Geological investigation in Nova Scotia for many years, I may say since 1860, I had found the superficial Geology altogether unattractive until the year 1873. On Her Majesty's birthday of that year, while I was sauntering with a friend spending the holiday, on the shore of Cow Bay, on the Atlantic Coast, 9 miles east of Halifax (*Vide* Admiralty Charts of Harbor), I observed peculiar boulders of familiar rocks. These were different from the bulk of the boulders, which were, quartzites, argillites and granites, derived from Lower Cambrian and associate rocks of the region. The boulders in question were amygdaloids having amygdules of zeolites, e. g. stilbite and heulandite. The only rocks that could produce these in British America is a range of igneous rocks connected with the Triassic Formation that lie north and west of Halifax. These rocks are celebrated for their minerals, which are found in all the American Museums, and of course in the British Museum. The question was asked by my friend: How did these boulders come here? I had seen similar boulders on the Avon Estuary, at Windsor, Nova Scotia, which my friend, Professor How, told me came from Blomidon opposite. This headland is the eastern extremity of the range of rocks already referred to. I suggested that some vessel, which had taken in ballast at the Avon, had thrown them overboard in the Bay, and that they had been *washed ashore by the sea*. Another and better answer was furnished when we came to Osborne Head, on the east end of the Bay. Here amygdaloid boulders were seen falling from the drift of which the Head is formed. Abundance were found on the beach at its foot. In the drift I found a beautiful boulder of moss agate. My associate, Mr. Stirling, also found another specimen of this mineral on

the shore at the east side of the Head. Judge James had also found a fine specimen in the preceding year. These abound in veins, in the traps of Blomidon. Still the question was asked: How did the boulders, etc., come to the bluff? Massive boulders of quartzite lay at the foot of the bluff and partly embedded in it. These were striated and grooved in a singular manner. We were thus referred to Point Pleasant, Halifax, especially the well known and wonderfully striated and grooved *rocks moutonné* at Prince of Wales Tower. *Vide.* Picture in Sir C. Wyville Thomson's Challenger Expedition Volumes. Procuring the Admiralty "Chart of the Coast of North America from the Strait of Belle-Isle to Boston," I located on it our glaciated rock surface. On extending the lines or courses S. 20 E., N. 20 W. and S. 30 E. and N. 30 W. magnetic, northerly, they were seen to pass by Blomidon and over it. Several ruts on the same surface distinctly show that the agency that formed them had moved in a southerly direction. All this seemed very satisfactory. An important problem thus presented itself for solution. As the occurrence of the Triassic amygdaloid rocks was limited in an easterly direction to Five Islands on the north side of the Basin Minas, it was considered that a parallel (S. 20 E.) drawn from Five Islands to the Atlantic Coast would limit the occurrence of the boulders on the shore. There were still other boulders observed occurring in abundance associated with the amygdaloids on the shore and in the bluff. These are syenitic gneisses, syenites, hornblendic granites, diorites, &c. They were at once recognized as of Archæan rocks, whose nearest seat is the Cobequid Mountains. Through these our Blomidon striation line would also pass.

I found, after a course of investigation extending over many years, that Osborne Head is one of a series of heads and less elevated deposits which extend from Thrum Cap, in the mouth of Halifax Harbour, to Three Fathom Harbour, a distance of 16 miles, *Vide.* Chart. In this "Terminal Series" I have found represented by boulders, not merely the Triassic Igneous rocks of Blomidon and the Archæan Metamorphic of the Cobequid Mountains, but also Silurian fossiliferous rocks and Carboniferous,

having *fauna* and *flora* from the formations that occur in the region traversed, the transporting agency having levied on every formation that lay in its path, and discharged its freight on and in the Atlantic. *Vide.* List of specimens exhibited in the Nova Scotian department in the Centennial Exhibition, Philadelphia, 1876. Trans. 1877 and 1886. In further illustration of our subject I intend only to record investigations of the present year yet unpublished, while I may incidentally refer to previous records.

COW BAY *revisited*, 1887.

The experience of 14 years led me to expect the finding of new points of interest which had been overlooked at the first. The season being more advanced, the day was beautiful, the sea view charming; the lake, which is separated from the sea by two raised beaches and an intervening terrace, was adorned with fields of white water lilies (*Nymphaea odorata*), basking in the bright sunshine. Coming to the shore, attention was attracted by an amygdaloid boulder—a traveller from Blomidon. It lies before me in my new representative collection; its colour is dark brown; its amygdules are *heulandite* and *stilbite*. Another distinctive boulder was next observed and added to our collection. This is of Syenitic gneiss from Archæan rocks of the Cobequid Mountains. The distance from Cow Bay to Blomidon is 65 miles. The middle of the Cobequids is 15 miles further. At first I connected associate boulders with Osborne Head. This has its own beach and boulders. Our first discovered boulders and the present came from a low section of Mosher's farm, on which is the road to the shore. This farm is chiefly composed of glacial drift. It is also part of the "Terminal Moraine." I have incidentally noticed a terrace which separates the fresh water lake from the sea. This extends to a considerable distance. Its groves of scraggy spruce afford convenience and shelter for picnic parties. A cart road passes along the middle. It has a ridge of sea-worn boulders next the lake and a large bank of similar boulders next the sea. Shelving in this direction it is succeeded by beautiful sand flats, in which *Echinarachnius parma* abound. The boulders of the ridges and terrace are

generally of Lower Cambrian quartzites. Among these, however, we find abundance of beautiful boulders of Archæan syenites, syenitic gneiss, porphyrites, &c., and also Triassic amygdaloids. Out of these we made up our collection of 25 specimens.

#### DARTMOUTH RAILWAY.

Several years ago I fully investigated the Glacial Geology of this side of the Halifax Harbor, and recorded my observations in the Transactions of the Institute. As in other parts of the province, a line of railway has been constructed here, which enables me to improve previous work. The great drift accumulations which contribute to the picturesqueness and roughness of the eastern side of the harbour have been exposed more than formerly. Two fine new sections are particularly instructive. We have now three good sections. The first is an old section of the eminence on which Judge James' residence and grounds are situate. This was our chief key to the geology of the moraine previously. The section is near the line of railway, not on it. There was nothing new observed here. It is on the north end of the accumulations. Walking along the railway (S.) we reach Mott's factory. On a field to the south of it, we have the first new section. Here I found abundance of boulders of Archæan rocks, such as we have already named, and several boulders of basalt (dolerite) and an amygdaloid. I took specimens of these to form a new representative collection. The next section south of Troop's wharf is more varied and of looser material than the preceding. A prominent constituent is a coarse red brick clay. This is a section of a beautiful green field belonging to Dr. Parker and others. Here were abundance of the usual Archæan boulders and also Triassic. In the clay I observed, partly projecting, an amygdaloid of grey colour. It was found to be of large size, the remainder of it being deeply imbedded in the clay. Other amygdaloid boulders of various sizes and replete with beautiful amygdules of *heulandite* were also found imbedded in the same clay. Of these I took specimens, leaving the remains for other collectors. The collection from these sections contains 19 specimens. I would here make a remark which is applicable

to all the collections. I label the collections from each locality immediately, as it is the only way that I can distinguish them. They are all so much alike. I have also come to regard Triassic amygdaloids and basalts as characteristic (*fossils*) of Postpliocene accumulations of the "Cow Bay Type."

#### POINT PLEASANT.

There is an accumulation of the above character at this Point. This is the site of an old battery which protected the boom which formerly crossed the North West Arm. The shore section of this is renovated every spring by the agencies—frost, thaws and sea-storms. Lying to the south of the Tower glaciation, and being otherwise conveniently situated, it is very frequently visited and levied upon. Thus the representative amygdaloids become at times rather rare. Under my guidance members of the Institute often go there. Professor Richards, of the Massachusetts Institute of Technology with associates and students have twice examined it and collected specimens. Members of the British Association, after the Montreal meeting, also visited it. Last spring I also conducted thither the teachers of the Halifax Science School. This section shows also a massive quartzite boulder beautifully grooved and striated, being evidently a part of the machine that grooved and planed the Point Pleasant rocks. The other localities where the phenomenon has been particularly noticed are Osborne Head, Cow Bay (as above), and Thrum-Cap, Cornwallis or McNab's Island. *Vide* my Papers in Transactions of the Royal Society of Canada, Vol. III., and in the Royal Jubilee Number (1887) of the Journal of the Society of Science, Letters and Art, London. This seems to be a characteristic of the "Terminal Moraine," of which the Point Pleasant accumulations seems to be a part.

#### GLACIATION.

In my constitutional walks in the south side of the city I have been giving special attention to the phenomena of glaciation. I have found in the streets, especially those newly and partially made, and on the north side of Pleasant Park, a sort of a series

of glaciated surfaces extending from Tower Road to Pleasant Street. Two remarkably beautiful exposures extend completely across the street (Ivanhoe), and form a pavement for nearly half its length. My assistant and I have carefully taken the courses of lines, without number, on all the surfaces, and find a uniform direction—S. 30 E., N. 30 W. There is not the variation that we find at Prince of Wales Tower. *No body, but one moving in a uniform direction, could make such a track.*

#### EXHIBITION GROUNDS.

Walking in these grounds I observed one boulder, and afterwards several of the same kind, large and small. I recognized their *basaltic* character. I examined pieces of them according to my usual methods and found that they contained *magnetite* and also *olivine*. They were thus identified with the basalts of Blomidon and Partridge Island.

#### CAMP HILL.

This is a well known locality on Halifax Common, adjoining "Camp Hill Cemetery." According to the measurements of the Royal Engineers, it measures 700 feet north and south, and 500 feet east and west. Its height above the mean tide of Halifax Harbor is 175 feet, its distance from the Harbor is 1350 yards, and from the North West Arm one mile. I have just discovered that this is a grand accumulation of the "Cow Bay type." Its constitution has been disclosed by military and other excavations. These occur throughout its length and width. Here I have collected all the usual Archæan and Triassic boulders, some of the latter are very beautiful. The collection numbers 28 specimens. My assistant, Henry Piers, also made a collection. Shortly after one of the lady teachers of the "Science Class" brought to the Museum a collection from this locality. One of the trap boulders had a bright amethyst vein. I consider this as one of the most important localities.

#### BLOCK HOUSE HILL.

According to the Royal Engineers measurement this hill is two miles north of Camp Hill, and 225 feet above Bedford Basin.

It is so called as on it was erected a block house fort which commanded Bedford Basin and the road to Prince's Lodge (Duke of Kent's). It is now a cultivated field, but the site of the fort is still plain. From the heaps of stones on the field, Henry Piers brought to the Museum first a boulder of basalt and afterwards the usual Archæan and Triassic boulders. We may, therefore, regard this as another locality.

#### THE AVON.

Last summer on an excursion to Wolfville I proceeded from Halifax by the Windsor and Annapolis Railway. This line approximately runs in the track of our glacier, so that on our way to the Avon we may be considered as following the *receding* glacier. The North Street Station from which we start, stands opposite H. M. Dockyard, where lately rose, Observatory Hill, which was a vast accumulation of the "Cow Bay Type." Of this we have a splendid memorial collection in our Museum, made during its removal. The hill disappeared finally, on November 4th, 1885, at 3.50 P.M., railway time; I watched its disappearance. Starting and proceeding we pass on the right of Fort Needham, another accumulation of the same kind, at Three-Mile House we come into the vicinity of Blockhouse Hill. We are in the track, on Bedford Basin. Navy Island is near the opposite shore. In the beginning of my investigations I was on this island and found the characteristic boulders of Cow Bay. When the Royal Engineers were surveying around Bedford Basin, Colonel Akers, R. E., late major general, examined the island and made a collection of boulders corresponding with his Thrum Cap collection. He intended to present both to the Museum of the Royal Engineers at Chatham. This island is 10 miles north of Thrum Cap. A full account of the glacial phenomena of this Basin is to be found in my paper, *Transactions of the Institute, 1885-6*. At Bedford we cross the bridge that crosses the Sackville River. On the opposite side of this, we have a drift cutting. I examined this when it was fresh and found our familiar boulders. It is now obscured. If we were to change our route and travel the Windsor Road, which runs nearly parallel with the Sackville

River, we could find our boulders, over another 15 miles. At this distance I picked up an amygdaloid last summer. They *seemed* to stop here. Proceeding, we reach Windsor Junction. Here we find the usual red drift with our boulders. If we were to go by the Intercolonial, we would find drift sections with amygdaloids, &c. The last of these we found a few years ago at Enfield Pottery and Brick Works in the red clay. This is 26 miles from Three Fathom Harbour, part of our "Terminal Moraine," where we found the last of the amygdaloid boulders on the Atlantic Coast. From the Windsor Junction we proceed onwards by the Railway to Windsor. We shortly pass through drift cuttings. In these we found the characteristic boulders in abundance. The ballast from them showed many and beautiful amygdaloids. The sections are of the only cultivatable land of the locality. How largely! the glacier has contributed to the sustenance of the inhabitants of the region which we have traversed. The underlying rocks only produce barrens. We come to Beaver Bank Station. To the right is a quarry of slates and paving stones. The rocks are glaciated; the grooves running in Halifax courses. Proceeding, we observe drift sections, chiefly on the left hand side the road. This has the usual appearance, and doubtless contains the usual boulders. Coming to the vicinity of the disappearance of amygdaloids, &c., on the Windsor Road referred to, the drift seems to disappear, and does not reappear until we reach Newport. For many years this interruption seemed unaccountable. We conjectured that the transportation had been effected away to the left of the railway. I had occasion, in 1855, to examine the region of Lakelands. On the side, a lake near the Windsor Road, and also near the house and building, I found the boulders of which I had been in quest. I was certainly gratified with the discovery. Locating this position on my "Geological Map of the Province," I find the name of the lake is L. Pigot, and that my Halifax and Blomidon general glacial line *almost* touches it. It seems to pass almost through the site of the buildings. This coincidence is certainly striking. The track thus crosses about Oland's farm, and passes to the right of the railway. Coming to Newport we have passed



through our Lower Cambrian Formation, with its gold fields, near Windsor Junction and Mount Uniacke, and we have entered upon the Lower Carboniferous, with its sandstones, gypsums and limestones. All these are seen exposed in railway sections. The geological gap is enormous; all the formations between the Lower Cambrian and Lower Carboniferous are unrepresented. On the Lower Carboniferous is the post-pliocene drift. Here there is another gap. Our boulders, often large in size, are frequently seen. We come to the gypsum of Windsor, in quarries. These also outcrop on the banks of the Avon, with fossiliferous limestones, of which we have abundance of boulders at Lawrencetown Head on the "Terminal Moraine." It was here that I first became acquainted, about twenty years ago, with those amygdaloids with which we are now so familiar. It was not clear to me how the Archæan boulders of the Cobequid Mountain rocks became associated with the amygdaloids as we have found them until I visited this locality with the members of the British Association. Dr. Blanford then turned my attention to boulders here, mixed with amygdaloids. I at once saw that they had crossed the Minas Basin with the amygdaloids, and that consequently some of the latter might have come from Partridge Island. I had not previously revisited this locality since I had commenced my investigations, and hence the perplexity. We now cross the Avon Bridge and proceed onward. Only drift is observed in all directions until we come to about 3 miles from Hantsport. An outcrop of gypsum is observed. Its continuation was afterward seen in considerable quantity on the side of the Avon. We now reach Hantsport. Here on the following morning we are to be met by the professors, lecturers and students of the Summer Science School, now in session at Acadia College, Wolfville.

As this locality was new to me I made a *reconnaissance*, rising at day-break, 5 o'clock. The ground is hilly, without any outcrops of rocks. Observing from the railway station a section of one of the hills, I approached it and found it to be a section of drift. Our familiar boulders, Archæan and Triassic, appear in great force and of all sizes. We are now in sight of Blomidon

and only 15 miles distant. We make a collection corresponding with that of Cow Bay. Having arranged this on the platform, we await the arrival of our excursionists. On their arrival we define our standpoint, topographically and geologically. We are in sight of the county line of Hants and Kings. The underlying formation is Lower Carboniferous; the overlying, Post-pliocene. The collection corresponds precisely with one lately made at Cow Bay, on the Atlantic coast, the intervening distance being that traversed. We first examine the section and proceed to the shore. Taking advantage of the ebbing (Bay of Fundy) tide, we examine the fresh and clean section as we proceed onward. It is all of the same character as the Hantsport section. Now and then an amygdaloid boulder is met with, having amygdules of larger than usual size and minerals of less common occurrence. I would specify a piece of trap having a beautiful amethystine vein. The Archæan boulders are of the usual varieties and varying sizes. The sections continue a long distance. How long, we had no means of ascertaining. We at length reach a cove where on the opposite side we find strata exposed. These are the first of the series of Lower Carboniferous strata, which is known as "Horton Bluff." This extends to Avonport, which terminates our excursion. We are now 50 miles from Thrum Cap, 14 from Blomidon, 18 miles from Partridge Island, 29 from the middle of the Cobequids.

#### BLOMIDON AND PARTRIDGE ISLAND.

We had an excursion to these on the following day. Proceeding by steamer, we reached Blomidon and landed at Amethyst Cove. The chief objects of search were minerals, especially amethysts. Beautiful amethysts and agates were collected. Our attention was also directed to the rocks. We were now at the home of the Basalts and Amygdaloids. Large masses fallen from the cliffs are pointed out and compared with the travelled boulders. We afterwards proceeded to Partridge Island, landed on its basalts, examined them, the more particularly, as we regarded them as the near relations of the basaltic boulders at Halifax. After hard climbing, especially for the ladies of our

party, we reached the other side of the Island, where the rocks are amygdaloidal, and, so to speak, amorphous, having zeolitic and jaspideous veins. As our time was short and uncertain, and depended upon the flow of the (Bay of Fundy) tide, our look at the rocks and their contents was very hurried. As for myself, this was not of much consequence, as I had already given them some considerable attention on my previous visit with the members of the British Association. After noticing the connection of those igneous rocks with the sandstones of the Triassic Formation we re-assembled and embarked on board the steamer. I could only then take a look of the Cobequid Mountains rising at no great distance—the home of our Archæan boulders, with which we have become familiar, but not more so than we are with the parent rocks, which we have repeatedly and carefully examined. *Vide* papers on the Cobequid Mountains. Trans. I. N. S., Vol. III, 1873-4.

The height of these Archæan Mountains only in one instance exceeds 1000 feet. We have thus followed our glacier in its retreat up to its possible source. We stop there.

In our first paper which we communicated to our Institute on this subject, and which we also read before the American Philosophical Society, Philadelphia, during the Centennial Exhibition, I incidentally referred to the work of two previous observers and their theories of the phenomena observable in our field. *Vide* Transactions, Vol. IV., page 122. The observers were Dr. Dawson (Sir J. W.), and the late Thomas Belt, F. G. S., "the Naturalist of Nicaragua," who is well known in connection with gold mining in Nova Scotia, and as an original and active member of our Institute and a personal friend. Both of these are regarded as authorities in Glacial Geology. We will quote the *ipsissima verba*, and only append one or two notes. This seems to me to be all that is necessary. In Dawson's *Acadian Geology*, second edition (1868), page 71, we thus read: "Nor would I exclude altogether the action of glaciers in eastern America, though I must dissent from any view which would assign to them the principal agency in our glacial phenomena. \* \* \*

The striation itself shows that there must have been extensive

glaciers, as now, in the extreme Arctic regions. Yet I think that most of the alleged instances must be founded on error, and that old sea-beaches have been mistaken for moraines. I have failed to find in our higher mountains any distinct sign of glacier action, though the action of the ocean breakers is visible almost to their summits; and though I have observed in Canada and Nova Scotia many old sea-beaches, gravel-ridges, and lake-margins, I have seen nothing that could fairly be regarded as the work of glaciers. The so-called moraines, in so far as my observation extends, are more probably shingle beaches and bars, old coast lines loaded with boulders, trains of boulders or 'ozars.' Most of them convey to my mind the impression of ice action along a slowly subsiding coast, forming successive deposits of stones in the shallow water, and burying them in clay and smaller stones as the depth increased. These deposits were again modified during emergence, when the old ridges were sometimes bared by denudation, and new ones heaped up."

Mr. Belt observes, Transactions of Institute, N. S., Vol. I., Part IV., 1866: "*Local character of drift.*—Having thus sketched out the probable action of the ice, during its advance, culmination and retreat, and explained the general distribution of the drift, it only remains to apply the theory to a few of its more striking features. The local character of most of the drift stones in Nova Scotia is one of these. Here and there a few blocks of granite are found that have been brought two, four, or even eight miles, but the great majority of fragments belong to the rock formation over which they lie. Boulders of slate occur where bands of slate cross the country, and boulders of quartzite where the bed rock is quartzite. Fragments of quartz, sometimes containing gold, are easily traced to the lodes (invariably to the north of them) from which they have been detached, and thus many auriferous lodes have been discovered. The local character of the stones in the drift is opposed to the supposition that to the north the land was so elevated that the ice moved over the country like a great glacier, and is in favor of the theory that it was formed by the retreating margin of a great accumulation of ice. If there had been during the glacial period high mountains to the north of Nova

Scotia, far-travelled blocks would have been of frequent occurrence. But without high ranges northwards, and with its own hills only of moderate elevation, we find as we might expect that the blocks are easily traced to their parent rock. Some boulders of granite have been carried farther because here and there granite hills rise above the general elevation of the country." Here we have two theories antagonistic to each other and both antagonistic to our glacial theory. I think that our grand array of facts summarily disposes of both. In opposition to 8 mile transportation we have proved 80 miles. As our glacier is only one of a system, see "Our Glacial Problem," Trans. 1884-5, high mountains to the north of Nova Scotia may or may not be found necessary.

We give the "sea agency" due credit for making such accumulations as the "Terrace" at Cow Bay, for destroying largely our "Terminal Moraine," and for scattering its material in the sea and along the sea shore. We will give it and other post glacial agencies (Champlain and recent) credit for aiding the advancing and retreating glacier itself in obstructing and destroying the glacial highway, such as in the forming of the Minas Basin and in scooping out and scattering the material, solid and superficial, so as to render any similar movement now impossible and to bewilder and mislead observers. We have thus also new accumulations formed and boulders scattered to the north, east and west of their original positions. *Vide* Geology of Kings and Annapolis Counties. Trans., Vol. V., page 29, and Geology of Aylesford (Annapolis County). Trans. 1886-7.