TRANSACTIONS

OF THE

# Nova Scotian Institute of Natural Science.

## ART. I.—NOVA SCOTIAN GEOLOGY—SUPERFICIAL.

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(*Read before the Institute, Dec.* 13, 1875; *and March*, 1876.)

### PART I.

TO ILLUSTRATE a course of investigations in the Superficial Geology of Nova Scotia, I shall make a kind of *General Section* of the Geological Formations as they occur along the Meridian of Halifax, 63°. 36′. 40″ W., from the Atlantic to the Gulf of St. Lawrence, with offsets.

From Sambro Head to the North West Arm, we have 11 miles of *granite*, overlaid on the east at York Redoubt, Falkland Village, and Purcell's Cove, by quartzite and gneiss, (Menevian or Lower). From this point, along the line for 35 miles the same formation continues. The line passes through the gold fields of Waverley and Renfrew. These formations conjointly extend the entire length of Nova Scotia. The rocks are granites, gneisses, schists, quartzites, argillites and siliceous limestones. Continuing the line of Section to the Cobequid Bay we have carboniferous 16 miles. This band extends to the west of the line about 40 miles. To the east it extends in varying width to the Strait of Canseau.

The rocks of this band are conglomerates and grits, sandstones and shales, having carboniferous *flora*, limestones and gypsums. Limestones of Windsor and Kennetcook are often largely fossiliferous.

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NOTE.—Read also before the American Philosophical Society, Philadelphia, May 16, 1876.

The line then crosses the Cobequid Bay a distance of 4 miles. It is presumed that the formation underlying the Bay is new red sandstone, of Permian (?) and triassic age.

On the north side of the Bay the line passes through this formation to the length of 3½ miles. The formation extends to the east of the line about 20 miles, and to the west about 130. The rocks are coarse red conglomerates and red sandstones. Associated with these is a great dyke and outliers of homogeneous and amygdaloidal dolerite (Trap.) This is the great depository of Nova Scotian Trap minerals, e. g. Zeolites, chalcedony, agates, jaspers, amethysts.

About 10 miles W. of the line Bass River, these traps have their beginning.

Bass River.—*This is a point of interest* in connection with my investigations, as I will show in a subsequent part of this paper. West of this are Five Islands, Two Islands and Partridge Island, celebrated for their *trap minerals.* Cape D'Or, known on account of its *native copper.* Blomidon, North Mountain, Digby Neck, &c. All celebrated on account of their trap minerals.

From Bass River to Briar Island, the two extremities, the distance is about 160 miles. This is the only trap having zeolites to be found in Nova Scotia. *This is another interesting fact to be particularly attended to.* The line then traverses the carboniferous band on the south side of the Cobequid Mountains, a distance of 2¾ miles. This may be regarded as a part of the Section of the I. C. Railway, through the Cobequid Mountains, as this section now approximately coincides with our line of section. This carboniferous band extends to the west of our line about 63 miles (to Cape D'Or), to the east about 45 miles (to the coal fields of Pictou) on the side of the Cobequid Mountains. The part of the band west of our line of section, which interests us more particularly at present, corresponds with the character of the formation generally. It has sandstones, shales and clays with *flora*, small coal-seams, limestones, and conglomerates. The conglomerates are largely composed of boulders of the underlying crystalline rocks, which may be readily appropriated by the formations of suc-

ceeding periods. On the line of railway a continuation of the line section, we have — feet of middle silurian. In another paper I have regarded this as the lower part of a middle and upper silurian band, having the upper part denuded and obscured by the preceding lower carboniferous conglomerates. This band extends east and west of the line of section, possibly as far west as Cape Chiegnecto, and to the east as far as the Pictou County line.

This band is chiefly remarkable for the iron deposits of Londonderry.

The line then passes through a band of Cambrian (?) Laurentian (?) strata, a distance of — miles.

This band also extends west of the line beyond (?) as far as Five Islands; and east?

The rocks of this band are gneisses, diorites, quartzites and crystalline limestones, e. g., marble of Five Islands.

Along the line is a width of — miles granitoid rocks. The band extends to the west of the line as far as Cape Chiegnecto, and to the east.

The rocks of this band are syenites, granites, diorites and porphyries. The line then passes through a Huronian and lower and middle silurian series, whose extent east and west of the line is obscured by denudation, and the over-lapping of lower carboniferous conglomerate, &c. On the line of railway the rocks are 1. Diorites, porphyries, jaspers, conglomerates. 2. Diorites, shales (fossiliferous). 3. (Middle silurian) slates (fossiliferous), diorites, porphyries. The width of these on the line is ——

The line then traverses the carboniferous formation a distance of 22 miles to the Strait of Northumberland, which bounds Nova Scotia on the north. This carboniferous band extends west of the line into New Brunswick, and east as far as Arisaig, 20 miles from Cape St. George, the eastern extremity of Nova Scotia. This includes the coal fields of Nova Scotia—Pictou, Springhill, and Joggins.

The line then crosses Northumberland Strait, a distance of 26 miles, and reaches the S. side of Prince Edward Island. The formation traversed through the Strait is in all probability the

carboniferons. It passes through the Permian (?) and triassic formations of Prince Edward Island, a distance of 26 miles, and reaches the Gulf of St. Lawrence, at New London, the position of the bed of the dendrerpeton triassic reptile, bathygnathus borealis (Leidy), Permian, theriodont (Owen.)

We have thus traversed the meridian of Halifax, a distance of 150 miles, indicating the different geological formations occurring in our course, their relations and characters.

I regard this as necessary for the right understanding of the observations which I am going to make on the Superficial Geology of a part of the County of Halifax. I consider that my field of observation is admirably situated. In consequence of this the material and deposits to be examined are well exposed by coast, harbour, road and railway sections, and as the geological formations indicated by the line of sections have a distinct and regular sequence, and are not interrupted to a great extent by complications which prevail in the east and west of Nova Scotia. We have thus a fair and open field in western Halifax and Hants, Colchester and Cumberland counties, to the north of it. I shall now examine the coast and shores, commencing at our meridian line of section at Point Pleasant, Halifax harbour.

At the Point at the entrance to the N. W. Arm, we find on examining the beach that the great proportion of boulders and pebbles, are quartzites, argillites, gneisses and granites, from the first band of the line of section, or that which underlies and surrounds the beach which I am examining. Mixed with these we find boulders and pebbles of amygdaloids, with amygdals of zeolites, chiefly *heulandite*. The source of these cannot be mistaken. They are without hesitation referred to Blomidon. On examining the adjoining bank section we find them falling out of the drift. Here then is the secondary source of these triassic boulders, the primary being at least 58 miles N. W. Equally abundant with the amygdaloids are boulders of syenites, diorites and porphyries. These crystalline rocks, also derived from the drift bank, have their nearest primary source in the central band of the Cobequid Mountains, the shortest distance being 80 miles. This is another

striking fact. Passing eastward we cross the harbour to McNab's Island. On its western side are abundance of triassic amygdaloids with Leolites, *heulandite* and *stilbite*. These have all come from the drift bank, and originally from the Bay of Fundy or Minas Basin. We have here also abundance of syenites, diorites and porphyries. These have come from the Cobequid Mountains. In addition to these are conglomerates and sandstones of carboniferous origin. These have been derived from the carboniferous of our line of section. The nearest primary source of these is 33 miles N. W.

Crossing the Eastern passage, we find on the shore boulders of triassic amygdaloid, having besides zeolites, amygdals of chalcedony, and also limestone boulders, which have the appearance of lower carboniferous limestones, although they do not show fossils. Limestone boulders were also observed at our starting point at the N. W. Arm, but as the bank is the site of a Battery, I did not attach special importance to their occurrence.

Still farther to the East is Cow Bay. On the extensive and beautiful beach beautifully rounded boulders of quartzite are very abundant. Some of these contain groups of large cubical crystals of *iron pyrites*. Interspersed with these are boulders of triassic amygdaloid. These first attracted my attention on June 24, 1873, the Queen's Birth Day.

When wandering on the beach on a holiday excursion, Mr. Stirling and I observed the amygdaloid boulders. I at once expressed the opinion that some vessel from the Minas Basin had discharged them in the offing. As we proceeded eastward the abounding amygdaloids, with the addition of syenites, diorites, gneisses, limestones with fossils, sandstones with fossils, at once rendered the opinion advanced improbable. Reaching the east part (Red Head) the immediate source of the supply of strange boulders was at once apparent. This lofty clay bank (50 feet in height) was replete with amygdaloids, and all the variety of boulders observed on the beach. Enormous masses of quartzite were also discharged. Many of these were strikingly furrowed and striated on varying sides. The aid of the photographer was desiderated to

picture the phenomena. An interesting geological problem thus presented itself for solution, and no time was lost in beginning the process.

In the clay bluff many interesting specimens were collected of representative boulders, e. g. syenites, gneisses, diorites and amygdaloids. A fine specimen of agate jasper was found embedded in the clay, whose triassic-trappean origin was readily recognized. Specimens in the Provincial Museum, collected at Blomidon by the late Dr. Webster, are strikingly similar. On the beach east of the bluff boulders abound—gneisses, granites, diorites, amygdaloids, porcellaneous jaspers, the collection on trying to make a selection is sufficiently puzzled and perplexed.

On this beach Mr. Stirling found an agate jasper of considerable size; on the same beach Mr. A. James, barrister-at-law, found a large and very beautiful specimen of one of these jaspers, the previous summer. I would here particularly notice the fact, that the granites and gneisses referred to as occurring among the boulders to the east of the harbour are peculiar. They are different from the known granites and gneisses of the band No. 1 of our section. The granites are the same as I found at Maccan Mountain in the Cobequid Mountains, associated with the syenites. The gneisses are of the Laurentian (?) of the Cobequids—*Vide Five Islands and Acadia Mines sections*, in my paper of last Session, Transactions 1873—4.

There are also many porphyries and jaspers, which I cannot refer to their original rocks. It is possible, however, that even these may have their home in the Cobequid Mountains.

On the same beach and at the same time, I found a boulder of yellowish grit, perforated in a singularly regular manner. After a little puzzling I recognized it as the bed of *stigmaria*, the perforations having been the beds of the rootlets. Here was a carboniferous boulder which had travelled from the carboniferous band to the north, a distance of at least 35 miles.

Not far from this was found another perforated boulder. This was of olive green quartzite, the perforations were casts of *crinoidal* columns. This doubtless belonged to the silurian forma-

tions of the Cobequid Mountains. I should only have been too glad to have been able to refer it to the silurian of band No. 1, as this would have been a notable discovery. The lithology of the boulder attested to its distant extraction.

This had travelled at least 60 miles. I would observe here that it is either in *Red Heads*, *vide* Admiralty Charts, or red banks, or the adjoining beaches, that the greatest number and variety of boulders are to be found. These Heads and Banks are sections of *boulder clay or drift.*

Passing eastward to the next head, Lawrencetown, we have fine beaches, with great abundance and variety of boulders.

Here we found as before—syenites, diorites, porphyries. A new feature here was the occurrence of granites of band No. 1. These come from granite, which occurs to the north of Lawrencetown. Inland large boulders of these granites occur as *roches perches*, on polished and striated surfaces. These beaches are remarkable for their *abundance* of lower carboniferous limestone boulders. These are large and small and in sufficient numbers to be of some service to the farmer.

Some of these are bituminous, emitting a strong odour when rubbed; others of them are highly fossiliferous, producing fine specimens of *fenestella.*

Another remarkable boulder which I found here contained a fine though somewhat rubbed cast of a lepidodendron. This, with the boulders of limestone, had travelled 35 miles at least.

Still another remarkable boulder which I found was an agate, size, $2\frac{1}{2}$x2x$1\frac{1}{4}$. It is largely composed of cacholong, and has numerous small cavities with quartz crystals, some of these are amethystine—the sides show that the matrix was trap.

Farther east in the extensive and lofty banks of boulder clay of *Half Island* and their beaches, we found abundance of massive and small boulders of granites, syenites, diorites and amygdaloids, and at Three Fathom Harbour we noticed particularly that triassic amygdaloids were still of frequent occurrence.

The nearest point whence these amygdaloids and agates could come to Lawrencetown and Three Fathom Harbour—are Bass River,

Five Islands, Two Islands and Blomidon, respectively 68, 70, and 69 miles distant.

Three Fathom Harbour is 15 miles east of our starting point, Point Pleasant. This was the farthest point of our investigation in this direction in 1873. My associates up to this point were Messrs. ~~Jones,~~ Stirling and H. Waddell.

From Point Pleasant, on our line of section, I now turn inland, on the same side of Halifax Harbour. Mr. Waddell found specimens of syenites and triassic amygdaloids, in an excavation at Fort Massey. I found syenites, diorites, porphyries and amygdaloids, with zeolites, in cuttings of the drift of the Citadel Hill.

From George's Island, in the middle of the harbour, I received in the museum a large and beautiful boulder of amygdaloid, with amygdals of *heulandite*. On the eastern side of the harbour at the Eastern Passage, Mr. Stirling found specimens of syenite and amygdaloid, with chalcedonic amygdals, having beautiful *moss-like* figures (moss agates.)

In the clay banks and beach between Mount Hope asylum and Dartmouth, I found numerous boulders of syenite, diorite, and amygdaloid.

In one of the same banks Mr. Stirling found a large boulder of *Maccan* Mountain granite, about 30 lb. weight. In an excavation on the hill he also found a boulder with a beautiful calamite, from the carboniferous formation in the north.

We see on the road sides in Dartmouth several immense syenite boulders, whose home is the Cobequid Mountains.

Mr. James has found a large boulder of amygdaloid, pophyritic diorite, similar to that of Wentworth conglomerate (No. 1) I.C.R. —*Vide* paper on the I. C. R., in the Cobequids, 1875.

In an excavation on the side of the Lawrencetown road, near its junction with the Preston road, I found large and fine boulders of amygdaloid. This point is about 5 miles N. of Point Pleasant.

In the road cuttings at the Richmond Station of the Railway, I found several boulders of syenite.

On Navy Island, Bedford Basin, near Dartmouth side, syenites, diorites, porphyries and amygdaloids are abundant. 1875.

At Hammond's Plains a large and beautiful specimen of limonite was found in the drift by a man when digging a well. It is supposed that this was transported from the Cobequid Mountains, (Londonderry Mines.)

Passing on to the Station of the Railway at Bedford, about 9 miles N. W. of Point Pleasant, I was joined by Mr. Frank West. We examined the road cuttings around Bedford, and found abundance of boulders of syenite and amygdaloid. We did not find any granite boulders.

I then made an examination of several drift cuttings on the lines of railway, commencing at the Windsor Junction. In this examination I was accompanied by Mr. Andrew Jack.

In the extensive cuttings of drift at the Junction we found abundance of syenites, diorites, porphyries, and amygdaloids. The amygdals were of considerable variety of zeolites. I found a piece of brown agate jasper, with cacholong. This is like specimens in the museum from Parrsboro. I also found a boulder of a *strange* granite—it is red and the mica beautifully green. Farther east on the line near Fletcher's, are deep drift cuttings. In these were found massive boulders of amygdaloid. Still farther to the east, in the clay of Enfield Pottery yard, we also found syenites and amygdaloids. This was our *ultima thule* in this direction in 1873.

The point reached on the line of railway is on the line of section 22 miles N. of Point Pleasant; 25 miles N. W. of Three Fathom Harbour; and 43 miles from Five Islands. This consequently is the nearest point from which the amygdaloids of the brick clay could come. From Windsor Junction I examined the drift cuttings as far as Beaver Bank Station. In these the amygdaloids were remarkably abundant. In one of these the amygdals were of beautifully radiated *mesotype*.

This was the farthest point that I reached on the line of railway in 1873, a distance of about 15 miles N. W. from Point Pleasant, and 45 miles from Blomidon.

Blomidon is consequently the nearest point from which the amygdaloids of Beaver Bank could come.

We have thus overwhelming evidence of extensive transportation

from north to south, from the Cobequid Mountains to the Atlantic coast, a distance of at least 78 miles.

The accumulations of drift on the Atlantic coast have been largely derived from every formation intervening.

We have found that there is no difficulty in referring the greater proportion of the boulders in the drift to an approximate source.

We have also found that the transported material has been deposited over the intervening surface as well as on the extreme coast.

The enquiry now comes by what means was the drift material transported and distributed as we have found it.

### INFERENCES.

1.—The collector of rock specimens who may not consider it necessary that these be collected from the original rocks *in situ*, can readily and easily be supplied from the boulders on the beaches, or from the sections of drift described.

2.—A better collection can be made in this way than by exploring the Cobequid Mountains, as the rocks are there so much obscured by forests.

3.—The drift has added to our knowledge of the lithology of the Cobequid Mountains by furnishing interesting specimens of metamorphic rocks allied to the known rocks, but not yet found in the mountains.

4.—Ores of metals and economic minerals may be found in the drift, far removed from their original position. This inference is of importance in a practical point of view, e. g. the iron ores of the Cobequid Mountains and the trap rocks.

## PART II.

### TRANSPORTATION. — COURSE.

At the Cow Bay Red Head, are seen massive quartzite boulders fallen from the drift and projecting from it; similar boulders are found at other Red Heads. These often have their sides strikingly grooved and striated. There is no hesitation in associating the

*grooves* and *striae* with those of the solid strata which are seen on the removal of the overlying drift. These phenomena are the results of action and reaction, the boulders having formed an acting part of the great machine which grooved, striated, ground and polished the surfaces of the hard rocks over which it passed. The striation of the rocks is there readily associated with the transportation of the quartzite and other boulders contained in the overlying drift.

Returning to the meridian of Halifax, we find at Point Pleasant, (*Vide preceding Paper,*) great quartzite boulders, grooved and striated, associated with amygdaloids, syenites, diorites, porphyries, &c. This point is also remarkable for its *roches moutonées*. One of these, which is the site of the Prince of Wales Tower, is remarkably striking and instructive. Its ruts distinctly indicate that the grooving and transferring agency advanced from north to south.

This rutted *roche moutonée* is the exposed edges of hard metamorphosed slaty strata. These have been much crumpled and faulted. The polished rock shows these crumples and faults very beautifully. The crumpled lines run east and west like the general strike of the strata. The ruts commencing near the north end of the exposure, continue in all their width and depth until they are intercepted by a set of these crumpled lines, which offer unusual resistance. Here the graving point is pictured beyond the crumples, and two or three small diverging lines have been made which continue a few inches and disappear. Other ruts proceeding in the same direction have had a like termination. These ruts sometimes are ragged, like a furrow made by a sharp point drawn across a pine board. The largest of these runs about 50 feet, a part of it has been diverted from the regular course. A large proportion of the ruts and striae run S. 20 E. magnetic; numerous *striae* run S. 30 E.—many intermediate.—*See Table.*

Exposed striated surfaces are very numerous in the Halifax peninsula. There are but few of these and unimportant, which I have not examined. With exceptional variations, the principal directions of the striae may be regarded as above. This is also their direction on the Dartmouth side, at the windmill and on the common.

I would now take the chart. On it I extend the Point Pleasant lines of striation northward.

We find that S. 20 E. and N. 20 W. lines pass through and cross the Minas Basin, impinging the point of Blomidon, and passing a little to the W. of Cape Sharp, cut the Cobequids

Again we find that the S. 30 E., N. 30 W., passes through Cornwallis, crosses the N. Mountain, west of Blomidon, crosses the Minas Basin, and passes near Cape Spencer, and cuts the Cobequid Mountains to the east of Cape Chiegnecto.

The Dartmouth lines of striation extend in the same direction.

Dr. Dawson, in his Table of Striation, Acadian Geology, Ed. 1855, gives lines farther east at Petite Riviere, Rawdon, and the Gore Mountain. The first of these extended northward, passes through the Minas Basin, and then passes through a break in the Cobequid Mountains.

The line of the Gore Mountain extended in the same direction, passes through Minas Basin and then cuts the Cobequid Mountains.

While we extend the lines observed by Dr. Dawson, northward, without any apparent difficulty, as we did the Halifax and Dartmouth lines, I find that I cannot in like manner run them parallel to the latter as far as the Atlantic, without obstruction.

Last autumn when prosecuting my observations, I found extensively exposed striated rock surfaces in the vicinity of the Wellington Station of the Halifax and Truro Railway, opposite the lower part of Grand Lake. I was astonished to find that the general striation here ran S. 25 W. and N. 25 E. About the same time in the preceding year, I had observed near Fletcher's, on the Truro side of the incline a striated surface, whose striae was in the same direction, S. 25 W., N. 25 E., and also at Beaver Bank station, on the Windsor side of the Junction, a striated surface was examined about the same time, having striae running S. 25 E. and S. 25 W. *i. e. converging.*

The lines at Wellington Station, if extended northward, cross the Minas Basin, and pass through the Cobequid Mountains along the hollow through which the Folly River flows and the I. C. R.

runs, through Folly Lake and through the valley of Wentworth and Wallace Rivers.

The lines of Fletcher's and the S. 25 W. and N. 25 E. lines of Beaver Bank if produced parallel to those of Wellington strata would cut the S. 20 E. and N. 20 W. lines observed by Dr. Dawson. The striation of the two extremes, Point Pleasant and Wellington Station, when extended (S. 30 W. and N. 25 E.) have an *arc* of 55° and include the Cobequid Mountains, from near Cape Chiegnecto to Folly Lake, a distance of $\frac{65}{}$ miles.

I would also direct attention to the *striation* east of Halifax.

Near the English Church, at the Eastern Passage, a striated surface showed a direction of S. 5 E., corresponding with part of the striation of Beaver Bank Station. On the Cole Harbour Road *striae* were observed having the same course. At Cole Harbour *striae* were observed having the same direction. A striated surface at Lawrencetown, with a granite *roche perché* also gave striation, having a direction S. 6 E. Dr. Dawson observed striation with nearly the same direction at Musquodoboit Harbour, 20 miles east from Halifax.

From these observations it would appear that at the point of convergence of the easterly and westerly striation, the one defined or *resultant* course became the regular southerly course of the striating and transporting agency, as all the shore lines of strata east of the Halifax Harbour, run approximately in this direction.

The distribution of amygdaloids and limestones (?) seems to indicate the S. 30 E. to S. 20 E. as the oldest *track*, as the *resultant* S. 5 E. could not convey the amygdaloids even of Bass River, the extreme east of the triassic trap, to such points as Lawrencetown Head, on the shore where they are remarkably prevalent, much less to Three Fathom Harbour or beyond.

The rareness of the occurrence of amygdaloids beyond Fletcher's on the line of railway, also seems to indicate that at the line of the distribution of the drift, at and beyond Fletcher's, the force moving in a south-west direction was an influential force. The striation all running in one direction, S. 25 W., indicates the same influence.

2ND AGENCY.

We are familiar with water and ice as transporting agencies. the former exercised in various ways, the latter as ice sheets in the Bay of Fundy and the Gulf of St. Lawrence. In Alpine regions ice in the form of glaciers is well known as a transporting agent.

The deposits which we have been examining as a class, are known by the names diluvium, drift. Parts of these are also distinguished by the qualifying adjective, *glacial* (deposit). The striation is also called glacial or glaciation, while others retain the term drift, e. g. gravelly deposit.

The term Diluvium refers us to early geology, when the deluge of Scripture was regarded as the great cause that produced these accumulations. This view is now, however, regarded as untenable.

The term Drift refers to another early view, which is still maintained by some in reference to the gravelly deposit,—that the northern hemisphere had been scoured by broad waters and currents which had extensively transported material from north to south, and left the banks of drift as monuments of the dreadful catastrophe.

The banks and their derivations, with the striation which we have been examining, are distinguished as glacial, and bring us to existing views and distributances, the agency being respectively, ice sheets, ice bergs, and glaciers. Heretofore in the field of our observation we have been dealing with incontrovertible facts, now we meet with in our field, controvertible opinions,—we meet with the advocates of ice sheets, and icebergs.

(*To be continued.*)

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ART. II. — ON A CORRESPONDENCE BETWEEN THE FLORA OF NOVA SCOTIA, AND THAT OF COLORADO, AND THE ADJACENT TERRITORIES. BY. JOHN SOMMERS, M.D., *Prof. of Physiology in the Halifax Medical College.*

(*Read before the Institute of Natural Science, Feb.* 14, 1876.)

WHILE engaged recently in looking through a Synopsis of the Flora of Colorado and the adjacent Territories, appended to the