

ART. IX.—NOVA SCOTIAN SUPERFICIAL GEOLOGY, WITH MAP,
SYSTEMATIZED AND ILLUSTRATED.—BY THE REV.
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Read May 14, 1888.

When mapping the geology of the Province I was led to make a separate map, to indicate its superficial geology. In doing this I had to classify the phenomena under the divisions (1) glacial, (2) champlain, (3) recent, and (4) pre-glacial, probable. It was found impossible, however, to define these in the same manner as the underlying geological formations, as there is an obvious blending of the several periods, so as to render it impossible to ascertain where the one concluded and the other commenced. Sometimes even the existence of one or other is only a legitimate inference arising from the "nature of things."

1.—*Glacial.*

This I have sub-divided into topographic—central, eastern, western. As the first has its chief development in the city of Halifax and its harbor it may, with the greatest propriety, be designated the Halifax division. *Vide* map. Its glacial character is here chiefly illustrated by striking and extensive glaciation.

It is now requisite to take into account certain great features of the *older geology*. We accordingly define on our map—1st, the archæan formation of the Cobequid Mountains; 2nd, the triassic igneous rocks of the Minas Basin, Blomidon, North Mountain, and onward to Briar Island, &c. We also define the granites of east and west divisions of Halifax County, and also of the South Mountain of Kings and Annapolis Counties. These will be found to give character to the glacial geology, and also to, still further, sub-divide the formation. They will also tend to divide the glacial from the succeeding champlain, if not the recent.

In our illustrative process I would use the initial capitals. A for the Cobequid archæan, T for the Blomidon, &c., igneous rocks, and G for the granites of Halifax, Kings and Annapolis Counties. Also, the small letters a, t, g, respectively, for boulders derived from these rocks.

The notable peculiarity of the central division is the prevalence of "Amygdaloid Boulders" with amygdules of zeolite minerals. It was the discovery of these in 1874, their identification with the triassic rocks of Blomidon and the establishing of a connection between these and their parental source, by means of the Halifax glaciation course, that led to the investigations in superficial geology, of which we now give the leading results. Associated with these amygdaloids and still more prevalent are found gneisses and cognate boulders from the archæan rocks of the Cobequid Mountain. We are thus led to indicate this formation in our map by a colour (red) corresponding with the characteristic colour of the deposit and the letters, t, a, (triassic, archæan). A line having a course S. 20 E., N. 20 W., magnetic or hypothetic extension of one of the prevailing glaciation lines, pervades the colour, connecting the deposits of the formation.

We would now define the Central Division on the map.

Regarding the Cobequid Mountains on the North and the Atlantic Coast on the South as two lines, we draw another (meridian line) through Blomidon connecting the other two. From Three Fathom Harbor, the S. E. extremity of the central formation, we draw another meridian extending to the Cobequids. We have thus an area of which the glacial course is a sort of diagonal, comprehending the Central Division.

On the East of this, we draw a meridian line from Clam Bay, on the Atlantic, long. 63° to the Cobequids. This area comprehends the Eastern Division.

On the west of the Central Division we also draw a meridian line from the Atlantic, near long. 63° 65° to North Mountain. This area comprehends the Western Division.

The Central Division is farther sub-divided. One grand granitic area occupies the south west side, and another intrudes into the eastern side. While we regard these rocks as Archæan, we

characterize them by the capital letter G. These two have been subjected to glacial transportation, and hence we have to use the small letter (g) in our Central Division Transportation.

The *t. a.*, accumulations form a grand striking and important part of our superficial geology. On the Halifax coast they extend along the Terminal moraine, from Osborne Head to Thrum Cap. In the Harbour they constitute a large if not the greater part of Cornwallis or McNab's Island and George's Island. On the Dartmouth side of the Harbour, they enter largely into the constitution of the elevated grounds on which are the Mount Hope Asylum. The great deposits of the city, whose names are strategic, Fort Massey, Citadel Hill, Camp Hill, Fort Needham, &c., and aspect picturesque, have all been proved to be *t. a.* in character. These include the Cemeteries, Fort Massey and Camp Hill. Thence onward to the vicinity of Blomidon similar deposits are found overlying the hard rocks and soft, as at the Cow Bay farm, at the Terminal moraine.

From Cow Bay to "Three Fathom Harbour," we have granites of frequent occurrence, characterizing the part of the Terminal moraine (*t. a. g.*)

On the Western side of the Harbour the transported granites, (*g.*) are often *roches perches*, perched rocks. The most remarkable of these is the great "Rocking Stone" of Spryfield. The "Eastern Division" is sub-divided into two parts by the granitic band which we have found intruding into the Central and contributing its quota (*g.*) to the "Terminal moraine." This extends eastward to the eastern side of the Division and beyond. Its width is about 6 miles. North of this and onward to the Cobequids we find boulders from the latter (*a.*) scattered broadcast. The vermilion wash of this area is consequently dotted with (*a.*). Amygdaloid boulders are also to be met with, associated with the archæan. These are different from the Triassic amygdaloids being from older igneous rocks that are found in the Cobequids associated with the metamorphic Archæan, and are not therefore regarded as characteristic. Of these the amygdules are calcite or quartz, and are thus easily distinguished from those of Blomidon.

This Archæan (a) transportation seems to have been intercepted by the granitic band and superseded. The granites (g) are now transported toward the Atlantic. The (a) boulders have, however, evidently passed along the course of the Musquodoboit River and reached the shore, where I found them mixed with the granite (g) boulders. Glaciation was also observed at no great distance on an exposed surface of Lower Cambrian Argillites.

In like manner at Clam Bay and Ship Harbour Lake where there is also extensive glaciation, (a) are associated with (g). On the Bay we have a part of the Terminal moraine (a g) exposed to the storms of the Atlantic, where as at Cow Bay a "Recent Formation" is in progress. We shall again meet with these in the sequel.

The "Western Division" is in like manner sub-divided by a great range of granites (g.) extending from N. W. side of the "Central Division" along the South Mountain of Kings and Annapolis Counties. The Northern part of this Division consists of the south side of the valley that runs between the North and South Mountains, and the north side of South Mountain. The characteristic transportation is (t) from the triassic (T) rocks of Blomidon and North Mountain. I would here observe that the (a) of the Central (t a) and the Eastern Division does not put in an appearance in the West Division; although it crossed the Minas Basin it did not cross the Bay of Fundy from the Cobequid Mountains.

We have examined this part at Wolfville, Kentville, Aylesford, and Nictaux.

At the two last localities, *glaciation* was observed on the north side of South Mountain, over which the (t) of North Mountain must have passed in its southerly course. I have not yet examined the southern sub-division. Mr. Murphy, the Government Engineer, has traced the Nictaux glacial course along the Nictaux and Atlantic Railway. *Vide* paper in Trans., Vol. VI., page 130.

In our Museum Boulder Collections, we have a boulder of gray Amygdaloid, which the late Peter Jack picked up at the Lunenburg ovens. I have no doubt that the great granite masses which I observed in the fields on the road between Chester and Lunen-

burg are to be regarded as (g) of the granites (G) of the South Mountain, and that amygdaloids (t) will also be found in the southern sub-division south of Aylesford and Kentville.*

GOLD.

Mr. Belt refers to the transportation of boulders of auriferous quartz in the glacial period, and his success in discovering the original lodes or leads by following the glacial striation course. Mr. Campbell of Dartmouth, maintains that he has washed gold out of the glacial drift.

METEOROLOGICAL.

Causes seemed to have changed "pre-glacial" temperate into extraordinary "glacial" frigid, and afterward the latter into extraordinary "champlain" torrid, which was succeeded by the existing conditions of temperature.

In this terrestrial magnetism seems to have acted a very important part, the character of which is still problematical. *Vide* "Our Glacial Problem," APPENDIX of Trans. of Institute, 1886.

2.—*Champlain* (Ch.)

While we regard our transportation and glaciation as the work of glacial agency, we consider the deposition of the glacial freight and its inland distribution as the work of champlain agency.

The extreme (?) torrid heat of the *latter* period succeeding the arctic cold of the *former*, the glaciers were forced to retreat and so to discharge their accumulated freight.

Their dissolution and consequent liberation of the captive floods must have been fearfully catastrophic, sweeping away barriers, transgressing boundaries and effecting endless confusion.

Of this we have ample evidence in the phenomena from time to time observed, and the perplexity and contradictions of even experienced and competent observers when interpreting phenomena from different standpoints.

We regard certain valley, excavation, striking northern transportation, sometimes, too, crossing southern transportation and

* These have been found by Mr. J. McLeod, on Meisner's Island, Chester.

other numerous irregularities as effects of the champlain period.

The formation of the valley of Kings and Annapolis which lies within the bounds of our western glacial division is a notable example. During the process a glacial highway was swept away. Granite masses from the South Mountain were displaced, carried northward, landed in the middle of the valley, and boulders were even carried into the North Mountain, and aqueous accumulations were formed in the valley, having North Mountain amygdaloids and South Mountain granites, and other rocks imbedded in sand hills, having bedding which is absent from the glacial accumulations of the central division.

Co-temporaneous with the excavation of this valley and the destruction of the glacial highway was a like operation in the central division, between Parrsboro', Blomidon and the south side of the Avon Estuary, where the waters of the Minas Basin now flow.

The celebrated "Boar's Back" of River Hebert, in Cumberland County, the filling of the break in the Cobequid, between Springhill and Parrsboro', through which the railway passes and the archæan (A) transported boulders at Springhill, &c, to the north of the Cobequids, are all referred to the champlain period and indicated by the (yellow) colouring of our map and the small letters (ch.)

In like manner we refer and indicate certain phenomena in Pictou County.

In following up the Archæan (A) transportation (a) of the eastern division I found boulders lying on the sides of the Pictou Railway, east of Mount Thom and the eastern extremity of the Cobequids and still continuing in a North East direction as far as the Albion Mines. Among the syenitic boulders, one which was very beautiful reminded me of a large boulder which I found at Merigomish in 1869, when I was in the service of the Geological survey. Of this I had a specimen in my rock collection. Sir W. E. Logan admired it very much and was disappointed when I told him that it was part of a boulder.

In Antigonish County, we have associated with an important glacial transportation, a champlain series of elevations which

commence near the shore, Malignant Cove, and extend in a southerly direction to a distance of 4 miles. On the top of the last hill is a R. C. Chapel, which is visible from a great distance. In the rising ground, in the town and around it are stratified clays one of the beds produced a number of specimens of a fossil plant. Some of these had a beautiful blue pigment, which Prof. How describes in his Mineralogy of Nova Scotia. *Vide* "Revision of the Geology of Antigonish County." Trans., 1885-6.

We have defined the formation on our map. From the eastern extremity of the province we pass to the western counties, Digby and Yarmouth. At Weymouth, the Railway shows a section of a formation which we regard as Champlain. *Vide* map. At the station was a large boulder (t) of triassic Basalt from the triassic (I) igneous range. *Vide* Polariscopic Notes Trans. Vol. VI., p. 121.

3.—Recent (r).

We go to Clam Bay, on the Atlantic coast and the eastern side of the eastern division. Here we find on the shore a section of (a g) formation very much covered by sands thrown up by the waves and winds. If we are to regard (a g) as a part of the "terminal moraine," then we have a glacial period formation overlaid by Recent with Champlain overlapped. We cannot for a moment suppose that the latter is missing, as the Atlantic must have been unintermittingly active since the glacial period.

There is however another alternative.

The Atlantic may have encroached so far on the Terminal moraine as to have reached the accumulations formed during the Champlain period. We may thus have the Recent in course of formation on the Champlain, and the succession may, in a manner, be considered as regular. The same reasoning may apply to Cow Bay and other parts of the coast.

Antigonish is built largely on "intervale" and hence the town itself was wont to be called by the old inhabitants "the Intervale."

This is formed at the confluence of a number of rivers and brooks and succeeds the Champlain referred to above. The Indian Gardens which lie at the head of the Harbour is a continuation of this intervale. All this is remarkable for its fertility.

With its picturesque environs, Antigonish is decidedly beautiful.

In Cumberland, Colchester, Hants and Kings Counties there are extensive formations which have their beginning in the champlain, extend through the early Recent and are now in progress. Of these are the Grand Pre, the marshes and dyke land of Amherst, the intervals of the Shubenacadie and the Stewiacke Rivers, and all the creeks of the various counties where the muddy tides of the Bay of Fundy force admission.

The deposits in the rivers and creeks, is the well known "marsh mud," which is fully appreciated by the agriculturists. The mode of deposition, the stratification, well shewn in cuttings, the rain prints, sun cracks, worm trails, foot prints, embedded leaves and shells are beautifully illustrative of phenomena observed in older formations, e. g., our Carboniferons.

Lacustrine.

In the bottom of Grand Lake, Halifax County, we discovered a formation which must have been a long time in progress. It largely consists of singular concretions, having an artificial appearance, so as to have been mistaken for "ancient pottery." I found, however, from an examination of the deposit and from chemical analysis that it was natural, and consisting of "ferruginous concretions." The whole is regarded as a formation of iron-sesquioxide with water. *Vide* Transactions of the Royal Society of Canada, Vol. I.

In some lakes are diatomaceous deposits, pure or clayey, e. g., in Fauleigh Lake, Colchester, and Long Lake, Halifax.

Bogs, &c.

Bogs and other surface formations have bog iron and bog manganese. Clays with limnæidæ, &c., localities are numerous in Nova Scotia and Cape Breton.

Clays and Sands.

Clays, sands and shingle, separate or intermingled, are the regular constituents of our sea beaches, and have been in past ages and are easily accounted for. Clays and sands which largely cover the interior are the results of the operations of agencies which cannot be readily specified.

Of course they are largely derived from the constituents of the geological formations with which they are associated.

The carboniferous regions—lower, middle and upper—and the triassic are chiefly to be distinguished, the latter for its red sands, and the former for its clays and sands.

Our map indicates that a champlain period left its mark on these regions, so as to cap largely and obscure the underlying formations, but not so as to obliterate the traces of their existence even where they are most obscure.

Recent agencies re-arrange and re-distribute so as to modify the material provided, and adapt it for economic purposes.

I would remark that after a rainy and stormy period the peculiar features of this surface geology are clearly displayed.

These were the conditions under which I collected in Nova Scotia and Cape Breton the beautifully illustrative collection which was exhibited in London, 1862. This consisted of clays of great variety, useful and beautiful. Ochre and ores (?) Bog iron and Manganese, &c.

GOLD.

In Lunenburg County we have the Ovens Gold washings. These are recent, and are still in the course of formation by the action of the Atlantic streams.

This has been regarded as illustrative of the mode of formation of the auriferous conglomerates of Lower Carboniferous age at Gay's River, Colchester County. *Vide* Transactions 1886-7.

Stone Age.—Implements.

Our Glacial Deposits, after the search of years, have failed to furnish any stone forms that can be regarded as the work of man.

In my examination of the superficial geology on the Bay Chaleur, New Brunswick, *Vide* "A Month Among the Geological Formations of New Brunswick," Trans., 1875, I was crossing a field to get at the section of the Intercolonial Railway from which was taken the skeleton of the Beluga which is in our Provincial Museum, I saw a stone axe in my way. Of course I picked it up. It is in our Museum, duly labelled with the date, 1874. I found the bed of the Beluga a section of Champlain

clays, having the characteristic shells of the formation. *Vide* Museum Collection. The axe could not have come out of this underlying marine bed. This by the way.

Our collections contain many axes now associated with it. These are Nova Scotian. One of them I found in the town of Dartmouth. Another with a groove was picked up by a boy and presented to the Museum. Our Glacial accumulations are not far from where the first was found. The last was found in a pile of stones above one of these accumulations—not in it.

A magnificent and beautifully-formed spear head has on it an inscription which informs us that it was found in an Indian grave more than twenty years ago. Sheriff Hill, of Antigonish, and I collected stone arrow-heads both well and indifferently shaped, at Ogden's Pond, on George's Bay, near our Eastern Glacial terminus.

In Lunenburg County, at Bachman's Beach on the Atlantic, and six miles North of the "Ovens" Gold Diggings, an arrow-head maker's factory was discovered about 1874. Of the first collection the late Mr. Lewis Anderson, merchant, Lunenburg, presented to our Museum 202 specimens Jasper arrow-heads of elegant form and beautiful chips of agates. There are also arrow-heads of quartz and porphyrite. Many of them were broken in the making. Of these the pieces have been fitted together. Associated are needles and other rude implements with nuggets of native copper, such as is found in the Triassic (T) igneous rocks of Cape d'Or, or Margaretville. Since the discovery many have gone to the locality and collected specimens, and the supply seems yet to be unexhausted.

We have another collection of Jasper arrow-heads and chips from another locality, in Cornwallis, King's County. The workmanship is much inferior to that of the preceding.

All the implements are of the same character. They correspond with those of Abbeville. Ours, however, cannot be older than early recent.

4.—*Pre-glacial?*

This division seems to be represented in the Cobequid Mountains, as I observed in my examination of the sections of the In-

tercolonial Railway in 1873. Transactions Vol. III., page 349. We read, "the gravel banks which obscure or partially cover the rocks of this band seem to merit more than a passing notice. The sections on both sides of the railway indicate the thickness and the extent of the accumulations of gravel. An examination of the material (e g) boulders, gravel and sand, shows that it is chiefly, if not wholly derived from the surrounding rocks."

The extent of the accumulations, their breadth and depth show that the waste of rocks must have been very great. The roundness of the material shows the amount of rolling to which it had been subjected, while its stratification indicates that water was the agency engaged in arranging the banks.

The formation of the material may largely belong to a period, or periods anterior to the post pliocene, while its diminution and partial transportation southwards was the work of the agencies of the latter period, &c.

We regard the gravel beds as the representatives in formation and time of those formations that occur between the triassic and post pliocene, as well as the post pliocene itself. We thus give work and attributable results to those mountain agencies which we find now in operation, and which we have no right to regard as quiescent from the triassic to the post pliocene periods.

This is represented by a gap in the deep colouring of the Cobequids and light *vermilion*.

The small proportion of colouring in our map, serves to show the extent of the investigations to be made, before the colouring can be completed.