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## GLACIAL DISTRIBUTION IN CANADA.

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1. *Triassic Amygdaloids (A) and Carboniferous Boulders.*—The author's investigations of glacial distribution in Canada began in 1873. On the beach at Cow Bay, east of Halifax Harbour, Nova Scotia, abundance of amygdaloid boulders were seen. These were at once referred to Cape Blomidon, whose rocks are Triassic basalts, amygdaloids, &c. Blomidon, or some part of its rock extension to Five Islands, N. E., and Brier Island, is the only series of rocks in Eastern Canada which could produce these boulders. Red Head, on the east side of Cow Bay, was seen to be the secondary source of the boulders. From this bluff of drift large and small amygdaloid boulders had just fallen. Here an agate was found, and specimens of Blomidon zeolites. Great masses of Cambrian quartzites had recently fallen, and were still imbedded in drift. These were strikingly grooved and striated on varying sides. Rock surfaces had also been observed on our way showing glaciation. Action and reaction were thus suggested. A copy of the Admiralty Chart, on which Blomidon and Halifax both appear, was procured. A very fine and extensive glaciated expanse of Cambrian argillites at Pleasant Park, Halifax Harbour, was located on this map. The direction of the glaciation and grooves, S. 20 E., N. 20 W., was extended, and found to pass in front of Blomidon. Deep grooves were seen having a south-east termination, where the graver had evidently been fractured by coming in contact with hard edges of tilted and crumpled strata, the grooves terminating in small *striae*, running in different directions and disappearing. These show that the glaciating agency had evidently come from the N. W., the direction of Blomidon.

An interesting problem was thus presented for solution. I found similar boulders occurring in abundance on the Atlantic shore, from Point Pleasant, Halifax Harbour, west of Cow Bay, to Three Fathom Harbour, east of it. Associated with these were Lower Carboniferous Limestone boulders with fossils (*Brachiopoda*, &c.,) and boulders with Carboniferous plants, such as *Stigmaria*, *Lepidodendra*, and *Calamites*, from the beds intervening between Blomidon and the coast. This is very interesting, as showing that the transporting agency levied upon every formation over which it passed. An iceberg could not do this: a glacier could. The distance between Blomidon and Cow Bay is 62 miles. Drift accumulations and drift sections occurring on the lines of railway, especially the Windsor and Annapolis Railway, were all examined, and the amygdaloid boulders were found to increase in numbers as we approached their source.

2. *Triassic Amygdaloids (B)*.—From a distance of 45 miles west of Blomidon, amygdaloids have also been transported to the Atlantic coast. In the drift cuttings of the Nictaux and Atlantic Railway, on the side of the Nictaux River, I found amygdaloids of the same character as those of Blomidon. I also observed a fine outcrop of Lower Silurian argillities on the north of Cleveland Mountain, on the south side of the Annapolis Valley. North Mountain, a continuation of the Blomidon range, is on the north side of the valley. The position of the glaciated rock-surface is at a height corresponding with the general elevation of North Mountain, 600 feet. This is the most northerly glacier found in Nova Scotia. The Triassic sandstones, which are undoubtedly in the valley, although they cannot be seen, must have filled the interval between the two mountain ranges in Pre-glacial times to account for the glaciation indicated and the passage of the amygdaloids. In my collection I have a large amygdaloid boulder which was picked up at Lunenburg, the Atlantic terminus. The Nictaux and Lahave Rivers, which nearly meet at their sources, are approximately in the line of transport, as are also a long chain of lakes. The Nictaux River flows northerly into the Annapolis River in the valley: the Lahave River, southerly, into the Atlantic. The Nictaux and Atlantic Railway runs generally in the same course.

3. *Archæan Gneisses, &c. (A.)*—On the north of Blomidon, at a distance of 13 miles, is the south side of the Archæan rocks of the Cobequid Mountains. This range extends from Cape Chignecto, on the Bay of Fundy, through Nova Scotia, to a distance of ninety miles. Boulders have been transported from it in a direction, indicated by glaciation, S. 20 E. mag., the same as the Blomidon amygdaloids. These are spread broadcast in the eastern part of Colchester County and the County of Hants, which bound Halifax County on the north. (*Vide* papers in the “Transactions of the Nova Scotian Institute of Natural Science,” 1881–2 and 1882–3). In Halifax County they are largely intercepted by a great belt of granite, which is generally six miles wide, extending from Major’s Lake, near Waverley Gold Mines, on the west, to Ship Harbour on the east. Some of the Cobequid boulders reach the shore along the course of the Musquodoboit River, and other breaks in the granite belt, *i. e.*, a granitic transportation takes the place of the other, the boulders of the latter having to be closely searched for among the abounding granite boulders at Musquodoboit Harbour and Clam Bay. At the Waverley (W.) end of the granites, or rather at the end of another granite occurring farther north, which seems to come into a line of it, the Cobequid boulders have found a better passage. Their course became changed to S. W., as is seen by the glaciation of the Cambrian argillites at the Intercolonial Railway, near the Grand Lake. This brings them into Bedford Basin, Halifax Harbour, and the City. The Archæan transportation thus unites with the Triassic, so as to predominate over the latter. The combined transportation then deposits the accumulations at Laurence Town, Cow Bay, and at Eastern Passage, Halifax Harbour, at Thrum Cap, McNab’s Island, and George’s Island in the Harbour, at Point Pleasant, Fort Massey, Fort George, Observatory Hill, H. M. Dockyard, and Fort Needham, and at Navy Island, Bedford Basin (*‘Trans.’* 1881–2.)

In like manner the great and extensive granites (B) on the west side of Halifax Harbour, in their extension toward Blomidon, at Bedford, intercept a part of the amygdaloids, and in turn are transported towards the Atlantic. Some of these boulders

become huge *roches perchés* e.g., the great "Rocking Stone" of Spryfield.

3. *Archæan Gneisses, &c. (B).*—Eight miles from the north-east termination of Nova Scotia, near Cape St. George, Antigonish County, on the Northumberland Strait, is the "Typical Archæan Series," which I first recognized in 1866. Dana, in his 'Manual of Geology' (1874), gave it the name "Archæan," which I have since adopted. I found the boulders of the series, on the shore and in the drift, at Ogden's, Gypsum Bluff, St. George's Bay. The largest boulders on the shore are very striking in appearance. It is more than twenty years since I first noticed them. It was then supposed that they had been carried from the coast of Labrador. The identical rock was easily recognized among the series on the Northumberland Strait, associated with crystalline limestones and serpentines. There is no apparent glaciation, but a line drawn on the Admiralty chart from the rock *in situ* to the drift-section of St. George's Bay coincides exactly with the line of Blomidon transportation.

*Fiords.*—Looking at our chart, we observe that the Strait of Canso, which separates Nova Scotia and Cape Breton, and which enters St. George's Bay, runs parallel with our last Archæan transportation line. All the harbours of Nova Scotia, from the Strait of Canso to Ship Harbour, where the great granite belt ends, are approximately parallel. From Ship Harbour to Halifax Harbour, the harbours conform with the changed direction of transportation. Halifax Harbour, Bedford Basin, and the Estuary of the Avon are approximately in the line of the Blomidon amygdaloid transportation, and are only about eight miles apart.

*Remarks.*—The Archæan of Northumberland Strait lies (14') north of the Archæan of the Cobequids. The transportation could not originate there; we must, therefore, look beyond Nova Scotia. This consideration led me to refer to Logan's 'Geology of Canada,' (1863). Examining the Tables of Glaciation Grooves, I found that the S. E. courses to the N. E., N., and N. W. of Nova Scotia, prevailing over the S. W. in the proportion of two to one. The Nova Scotia transportation is, therefore, a contin-

uation of that of Quebec Province, and my investigations have given it an Atlantic terminus.

*Ottawa Gneisses (C.)*—On a visit to Ottawa, in May, 1882, I observed massive boulders of Archæan gneisses in a number of places. At the Rifle Ranges I examined them more particularly. Some of the gneisses were beautifully banded, others of them contained abundance of magnetite. In Sir W. Logan's table, the course of the glacial grooves at Rideau River, Stegman's Rapids, and also at Barrack Hill, is S. 45 E., true meridian. Defining this course on Vennor's Map, I found that a N. 45 W. extension passed between the Hull and Laycock Magnetite Iron Mines. According to the same table, at Hull the glacial grooves run S. 45 E. This is certainly a satisfactory coincidence.

*Kingston Gneisses (D) Archæan.*—When I was at the Dominion Exhibition at Kingston, in September, 1882, my attention was directed to the large quantity of boulders which lay about the exhibition grounds. The greater part of them corresponded with the Ottawa boulders, with the exception of the magnetic ones, and were consequently Archæan. One boulder was of Trenton Limestone, and was glaciated. Looking for glaciation *in situ*, I found it on the limestones at the edge of the water near the entrance to the Royal Military College. The course of the grooves was S. 54 W. magnetic. The direction observed by Sir W. E. Logan was S. 45 W., true meridian, while "other grooves run S. 85 E." Trenton Limestone is the formation on which Kingston is built, and of which it is built. Hence it is called "the Limestone City." In the approach to it, near the Rideau Canal, the Archæan (Laurentian) is seen with the Trenton Limestone lying directly upon it, in the same way as on the Railway from Montreal to Ottawa, near the latter. We have now reached long. 76° 25' to 29', and lat. 44° 14' to 19'. In long. 80° 54', lat. 44° 28', is the last of the south-easterly grooves (S. 5 E.), according to Logan. In long. 79° 33', lat. 46° 10', is Nipissing Lake. Here, and beyond all grooves are, therefore, S. W. Lake Temiscamang, long. 79° 26' to 30', lat. 47° 7' to 36', has glaciation generally S. E. This is the region of divergence as well as of watershed,

*Rimouski Gneisses (E) Archæan*—At the Railway Station on both sides of the railway, I found and examined Archæan boulders of large size. Some of these were granitic gneisses identical with those that I found at Ottawa and Kingston. The only place where the rocks of this kind are to be found *in situ* near Rimouski is on the opposite side of the River St. Laurence, which is here 20 miles wide. Glaciation was found by Sir W. E. Logan at Kempt Road, near Metapedia Lake, long.  $67^{\circ} 43'$ , lat.  $48^{\circ}$ . Its course was S. 80 E.

I would observe that the lines of glaciation of Pleasant Park, Halifax, extended in a northerly direction on our Admiralty chart, pass through Rimouski at a distance of 310 miles.

Our field of observation thus extends from Cape George, Nova Scotia, long.  $62^{\circ}$  to Kingston, Canada, long.  $76^{\circ} 25'$  to  $29'$ , *i.e.* through  $14^{\circ} 25'$  long., and from Halifax, lat.  $44^{\circ} 34'$ , to Rimouski, lat.  $46^{\circ} 26'$ , *i.e.* through  $3^{\circ} 52'$  lat.