

In England and Canada the genus *Asaphus* rises into the *Middle Silurian*.

It is not known to appear higher, not even in the Upper Silurian, *much less in the Devonian*.

The *pygidium* of a small *asaphus* occurs in the Wentworth, I. C. R., strata. *Museum Collection*.

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ART. V.—NOVA SCOTIAN GEOLOGY—KING'S COUNTY.—BY THE  
REV. D. HONEYMAN, D. C. L., *Curator of the Provincial Museum, &c.*

(Read January 3, 1879.)

INTRODUCTION.

One morning in June, 1877, I left Halifax with the determination of making an intimate acquaintance with the rocks of King's County. Arriving by the train at the Wolfville station, I took the direct road, past Acadia College, to the high land, with the expectation of meeting with rock exposures. I took a passing look at the amygdaloid boulders in the drain, regarding them as the possible fellow travellers of our Halifax drift acquaintances. Reaching the height above Wolfville, I was gratified to find a good exposure of solid strata. Standing on these rocks, I deferred operations until I had admired the interesting scenery in view. Below lies old Acadia College, the beautiful Town of Wolfville, and *Grand Pre*, of Evangeline fame, with its brilliant garb of summer green. Beyond stretches Cornwallis, with its serpentine streams, its fertile fields, and numerous villages. Towering on the north is North mountain, with Blomidon looming and advancing into the Minas Basin, hiding the Minas Channel, Cape D'Or, and Cape Chignecto. This fine sheet of water, bounding *Grand Pre* and Cornwallis, extends to the distant north as Minas Basin and Cobequid Bay. The Cobequid range of Cumberland and Colchester rising to the dim distance beyond.

Having thus indicated the sphere of our operations, and our first starting point, I shall arrange my remarks on these operations under three comprehensive divisions:—

1. Pre-carboniferous,
2. Carboniferous,
3. Post-carboniferous.

1. The examinations, as far as made, divided the pre-carboniferous formations into two areas, viz.: the Wolfville and Kentville, the two respective starting points of the examinations made.

The 1st area is about 20 square miles in extent. Its N. E. corner lies in Wolfville; its N. W. at the entrance of the Deep Hollow road. The distance between these two points is  $3\frac{1}{2}$  miles. The S. E. corner is at Vaughan's Mill, Greenfield, on the Halfway River, *Church's map*. The S. W. corner is at Bezanson's Mills, on the Black River. The distance between these two points is about 3 miles. Greenfield is about 5 miles distant from Wolfville. The greatest width of the area is about  $2\frac{1}{2}$  miles from Wolfville, south, and 5 miles west of the falls of Black River, where the pre-carboniferous and carboniferous appear in close connection, on the Halfway River road and side of the mountain. The rocks in this area are largely obscured, still, there are many and interesting exposures around Wolfville and in the Deep Hollow road. In certain elevated positions, and in the Gaspereaux River, Black River, and Halfway River, the great desideratum is the evidence of fossils. None were observed in this area although strictly searched for. Lithological evidence of age and diversity of formation was all that was observed. This seemed to divide the rocks into two series. At Vaughan's Mill and Bezanson's Mill, and on the road intervening, the exposures seemed to indicate Upper Cambrian age. The exposures around Wolfville, the Deep Hollow section, and sides of the Gaspereaux River, the Falls of Black River, and outcrops farther up the river, seem to indicate another, probably Lower Silurian.

The whole aspect of the rocks at Wolfville is so different from anything that I had observed elsewhere, that I was altogether perplexed. The rocks are Argillites, grey and red, in a state of metamorphism more decided than any Middle or Upper Silurian in Antigonish, Pictou, or Colchester. They approximate so

nearly to the Argillites of Halifax in all but colour, that I felt disposed to refer them provisionally to the same age. The tilting and obscure stratification, the occurrence of large crystals of pyrite and quartz veins, here and elsewhere, as in the Deep Hollow, seemed to favor this view. The only seeming doubtful feature was the occurrence of Diorites in the Deep Hollow. The great quartzites at the meeting of the Deep Hollow and Gaspereaux roads, near the great saw mills; the quarries in these great beds; the various blocks of quartzite dislodged; the beautiful dendritic and moss-like figuring in the cleavage joints, even more striking than in the Halifax quartzite;—all tended to deepen the first impression.

The magnificent exposure of rocks of the Falls of Black River presented another aspect, which tended to confuse and unsettle in reference to the age of the preceding. My usual good fortune failed me in the examination of this area. How welcome would have been the sight of a familiar fossil. I came to regard a search as hopeless as in the slates of Halifax itself. I am under great obligations for guidance to the Deep Hollow and Falls of Black River, as well as to other localities, to Mr. Robert Starr, of Starr's Point, Cornwallis.

On consulting Church's Map, I observed certain saw-mills considerably back in the County. Mr. Thomas DeWolf, of Wolfville, kindly undertook to guide me to these localities. Traversing the old mountain road to Half-way River and Windsor, we entered the area about the middle where the Pre-carboniferous and Carboniferous areas meet (already referred to). Here we found a great exposure of Black Argillites of very ambiguous character. Before reaching Half-way River we found ourselves in the Carboniferous areas—a considerable outcrop of sandstones appearing on the road with Carboniferous *flora*.

We evidently continued in this area as far as Half-way River and the County line. Taking the road leading up the river, we came to *Bezanson's Mill*, where nothing particular was observed except large masses of granite. On reaching *Willet's Saw-mill*, we observed a section of Carboniferous strata on the right side of the road. After this we observed nothing but drift, we

seemed, however, to have re-entered the Pre-carboniferous area. Reaching *Vaughan's Mill, Greenfield*, we found a magnificent exposure of pre-carboniferous rocks, having lithological characters widely different from the other rocks of the area. The resemblance of these to the black argillites of Halifax and Dartmouth, is sufficiently obvious. I felt no hesitation in regarding them as the north side of the great Cambrian series of our gold fields. Looking to the heights beyond we observed massive granites which *seemed* to indicate solid granite *underneath*. Traversing these in passing on from *Vaughan's Mill* to *Bezanson's Mill*, on Black River below the lake, we found outcrops of black argillites, the enormous and frequent occurring blocks of granite being only transported rocks, derived from granite outside of area, and not yet examined. At *Bezanson's Mill* the black argillites were seen outcropping. Gneissoid and granite specimens were collected from rocks not in situ—precisely like the Halifax—granite and gneissoid rocks.

We then followed nearly the course of the Black River, observing the fine exposure of argillites at *Payzant's Mill*, and occasional outcrops between this and the Falls. Before reaching the Falls we ascended the mountains on the right observing occurring outcrops of metamorphic rocks, and thus crossed the area to its border at *Gaspereaux River Bridge*. We then proceeded along the road that leads up the river, on the *Wolfville* side, towards the *Deep Hollow*, observing the extent of the quartzites already referred to. We passed through the *Deep Hollow* and emerged from the area described at its N. W. Corner. This examination led to the conclusion that there are two series of pre-carboniferous rocks in the area, viz.: Cambrian and Lower Silurian, which may be locally characterized as *Greenfield, Wolfville*.

The second area examined is about  $\frac{1}{4}$  of the size of the preceding one and much more irregular. It begins at *Kentville*, the first strata being exposed at the mills, a little above the bridge, on the side and in the bed of the brook. At the great dam a little farther up, they are considerably exposed on either side; a little above this they disappear in the brook giving place to outcrops of another formation. They are again seen in a limited section

on the Beech Hill road. This shews that the high ground on the right is formed by these pre-carboniferous rocks. Above the bridge the continuation of these rocks is manifest by the exposure in the bed and sides of the brook, and in outcrops on the high lands on the right. Below the bridge are several branches of the brook, the most important has two falls, the lower and upper, the one at Mr. Webster's farm, the other near the summit of the height of New Canaan.

The rocks of the area are slates and shales with occasional arenaceous beds. Their colouring is sufficiently varied, sometimes it is beautiful and ornamental. The colours are red, yellow, fawn coloured, black and grey. They are not so highly metamorphic as the rocks of the preceding area, and their stratification is more obvious. There are also fossils in one member of the series. In the brook at Kentville some of the strata are yellow with beautiful red, wavy lines, having the appearance of woody structure (pine). At the dam the slates are black and deep red (ochrey) with occasional green, being coloured by films of carbonate of copper. At Webster Falls there is a set of fawn coloured slates of considerable thickness, having sandy strata with a vesicular structure. I was fortunate enough to come upon a part of the fawn slates having *Dictyonema Websteri* (Hall), named after the discoverer, the late Dr. Webster. The strata of the Upper Falls are black slates, almost like roofing slate. The height and arrangement of the strata must form a beautiful waterfall when the brook is well filled with water.

The *Dictyonema* and other strata of the area have been referred to the Niagara Limestones (Upper Silurian Period), on the slender palæontological grounds of *Dictyonema* occurrence. Others are disposed to regard this as an evidence of Lower Silurian age, so that the age of the rocks of this area may also be regarded as doubtful. I have not observed any unquestionable Upper Silurian rocks of similar aspect. In Cape Breton *Dictyonema* is a Lower Silurian form, the same is the case at Quebec. It occurs in the Upper Lingula Flags of Wales. The revelations of Nictaux and the occurrence of *Asaphus ditmarsiae* at Clement's tend to shake faith in received opinions. The

Diorites noticed are regarded like the Nictaux Division, as of Devonian age.

2. *Carboniferous*.—The carboniferous area of this county is about 25 square miles in extent. Its first appearance on the west is at Wolfville, where it is found overlying rocks of the pre-carboniferous area. Its next appearance is at the back of Wolfville where it is well seen on the road to Gaspereaux and in an adjoining hollow. The strata here are very coarse grits, overlying the pre-carboniferous argillites. It next appears in the Gaspereaux River at the bridge adjoining pre-carboniferous rocks. I have already noticed its next appearance on the mountain road, where the rocks are coarse grits overlying pre-carboniferous argillites. Its next appearance is at *Willet's Mill*, where the pre-carboniferous strata are observed. It is thus only seen in contact with the Wolfville series. On the old mountain road sandstones have already been observed. Geologically higher than the strata in contact. These show the formation to be carboniferous by the *debris* of fossil flora. Higher in the area outcrops of grits and sandstones are of frequent occurrence and sandstones extensive, but uninteresting. When we reach within a mile of the shore of the estuary of the Avon, outcrops of black shales appear, and on the shore about five miles distant from the junction of the pre-carboniferous and carboniferous, there is a magnificent section—Horton Bluff and Blue Beech. This section is lofty and extensive, in common with sections on the Minas Basin shores, it is sharp and comparatively free of debris. Here I found sandstones with *matted kelp* surface. Clay-ironstone and abundance of beautifully shaped *Septaria*, Fossil Flora, *Lepidodendra* and *Stigmaria* and *Sporangites*, Fauna, Reptilian footprints, scales and teeth of *Palæoniscus*, and a half of the lower jaw of *Palæoniscus* with teeth in place. No carboniferous strata were observed west of the point indicated at Wolfville. Still it is possible that concealed or overlapped strata may exist in the valley. During the Carboniferous period there was no North Mountain or Blomidon narrowing the Bay of Fundy. It then extended as far as the Wolfville, Kentville and Nictaux pre-carboniferous, or nearly so. Conditions similar to those now existing in the Bay of

Fundy seem then to have prevailed. Conditions rather favourable to the denudation of shores, than for the accumulation of *littoral deposits*. The first littoral check given to the sweep of the waters seems to have been the pre-carboniferous rocks of Wolfville, which seem to have been a cape of the Carboniferous period. This seems to have been favourable to a coarse sandy accumulation (Grit), while at the same time the Cobequids had a shingle forming shore (Conglomerate).

3. *Post Carboniferous*.—Triassic Sandstones, &c., occupy the area north of the pre-carboniferous from Wolfville westward. They are first observed at the united corner of the Carboniferous area. Here they are seen overlying the carboniferous strata, at no great distance they are then seen at Jessup's; directly overlying pre-carboniferous argillites without the intervention of the carboniferous. These overlying strata are loose and incoherent, wanting the compactness of the carboniferous strata, and not much different in appearance from banks of drift. At *Elderkin Brook*, near Kentville, a fine section is seen on the site of a saw-mill. On the west side of the Dam up Kentville Brook a fine exposure is seen of the same formation, overlying the ochreous and copper coloured slates described in this locality. They reappear up the Brook at the Shooting Range, and make an occasional appearance as far up as the mouth of the Webster Falls tributary. At *Elderkin Brook* they appear in their characteristic manner; soft, sandy strata of decided red colour. The east side of the area is beautifully exposed in sharp and clean sections from Starr's Point onward to the extremity of Blomidon. The north side is seen rising to the brow of North Mountain and terminating with Blomidon on the east (apparently). In this area conglomerates similar to the lower beds of the Cobequid Triassic do not appear, and the compactness of bedding which make the sandstones of the latter available for building purposes, is notably wanting. At Starr's point the beds contain veins of calcareous spar, some of these are of considerable thickness. Crystals are of sufficient size and transparency to shew the phenomena of double refraction. At Blomidon foot were observed considerable masses of selenite and fibrous gypsum dislodged from the Triassic

sandstones. Irregular beds of impure manganese were seen in a road section near Starr's Point. The red colour of these sandstones are an obvious feature. Theories have been indulged in to account for its existence. At the close of the Carboniferous period conditions of deposition appear to have changed, so as to favour the formation of the Triassic sandstones at Kentville and elsewhere, but not so as to form conglomerate as in the Triassic of the Cobequids. The pre-carboniferous area of Kentville seems to have formed a breakwater in the Triassic Period.

4. *Trappean Area.*—My acquaintance with this area is derived from the Blomidon cape and shore, a traverse from Lower Pereaue to Scott's Bay, an examination of the rocks on the shore of Scott's Bay, and a return with a diversion leading to the junction of the Ross Creek Road (Church's Map). The rocks observed are Basalt, Trap, Amygdaloid and Ash. Among the fragments of Basaltic rocks on the Blomidon shores the prismatic structure is of frequent occurrence. The Amygdaloids correspond with the boulders abounding in our superficial drift. Ashy beds are represented by boulders occurring in the same drift. Minerals from the Amygdaloid traps of Blomidon collected are, Jaspers in great variety, Agates, Mesolite and Natrolite. These are of usual occurrence. A specimen found here is the *new mineral*, *Louisite*. At Scott's Bay, in the Trap, were collected Agates, Jaspers, Amethysts and Natrolite. Fine specimens were rare in this locality; Mr. Steele, the local collector, being on the constant look out for choice minerals. In his collections were seen, besides beautiful agates from this locality, an exquisite collection of varieties of Natrolite, many of them of rare beauty, and the striking mushroom like Mordenite var. Steelite (How) with bristling Stilbite). They were collected at Cape Split. They subsequently came into the possession of Professor How, who has given a good account of them.

Some of these have found their way to the Provincial Museum. The Webster collection in the Museum fully represent the minerals of Blomidon. We often designate these igneous rocks as of Triassic age. As they are intrusive they might be called *Post Triassic* rocks, as it seems a rather difficult matter to prove their age.



5. *Post Pliocene*.—The boulders of Amygdaloid in the drift cutting east of Acadia College, Wolfville, have already been referred to. In the hollow over against the Gaspereaux Valley, at the junction of the Pre-carboniferous and Carboniferous strata, already noticed, the occurrence of similar boulders was so striking, that it appeared as if the rocks must be *in situ*. In the Gaspereaux Valley they were seen in sufficient abundance. I also discovered them at Greenfield on the Halfway River. There is no doubt but that they are to be found in intermediate drift, if looked for. Mr. Ellershousen informed me that they occurred in the drift at Ardoise. They are to be found all along in the drift cuttings of the Windsor Railway. In previous paper, "On the Superficial Geology of Halifax Co,"—*Transactions*, 1876-7—I pointed them out in great abundance in the drift cuttings between the Beaver Bank Station and the Windsor Junction. At the Windsor Junction they are found in abundance at the drift. They occur in the drift at Bedford, in the Navy Island, in Bedford Basin, in the drift cuttings at Richmond, in the Citadel Hill, in the Dartmouth drift beds, in George's Island, McNab's Island, Point Pleasant; apparently at Ketch Harbor, Sambro, Devil's Island, and along the Eastern shore as far as Three Fathom Harbor. Thus notably has the Blomidon area of rocks suffered from the exactions of post trappean and post pliocene agencies. Its height must therefore have been considerably greater than we now find it. The sandstone of the valley must have risen to a greater elevation than at present, forming a highway for the transit of the mountain *debris*, the valley having been subsequently formed, and the pathway destroyed. The remains of these sandstones on the sides of the Trappean area, and the sections on the shore, running almost on a level with the Trap elevation, as well as the elevation of the drift on the south side of the valley, tend to prove the former existence of this highway. If Minas Basin then existed, its boundaries must have differed greatly from those now apparent. The creeks and sections of new red Sandstone now extending between Blomidon and *Grand Pre* were unformed, and the Estuary of the Avon unknown. These were doubtless exten-

sions of the great highway. Even the new red Sandstone of the Minas Basin itself, between the Cobequids and Hants, was not exempted from similar service, as the extensive Syenite transported to the Atlantic coast in like manner indicates. "That all parts of the valley were considerably elevated is evident from the appearance of Cleveland Mountain, Nictaux, and the Nictaux and Atlantic Railway sections. In these drift sections we have Amygdaloids from the North Mountain, and on the northern edge of the Cleveland Mountain, at the junction of the new and old road I observed a beautifully polished and striated surface of strata at an elevation equal to the greatest height of North Mountain, indicating the elevation of the former sandstone highway over which the amygdaloids of the railway drift must have passed.

Last of all, I would notice another transportation which may have happened in this period, at its close.

I have already referred to the enormous and abundant masses of Granite observed at Halfway River and on the heights at Greenfield. These have apparently been transported in N. E. direction, while the amygdaloid transportation has been to the S. E. A similar occurrence of granites was observed at Nictaux. Restoring all the material referred to as transported in pre-post-pliocene, post-trappean and post-pliocene time, as well as more recently, I would connect, widen and heighten the trappean regions of North Mountain, Digby Neck, Long Island, and Briar Island. I would also connect these with Isle Haute, Cape D'Or, Partridge Island, Parrsboro, Two Islands, Five Islands, thereby closing up the Minas Channel between Cape Split and Cape D'Or, and bridging the space between the North Mountains and the Cobequids. I would fill up Annapolis Valley and the Minas Basin and Cobequid Bay. I would increase the bulk and possibly heighten the Cobequids. I would contract the Bay of Fundy by connecting the red sandstones of Quaco with those of Nova Scotia. Pre and post-pliocene agencies, especially the latter, are then set to work transporting and effecting changes. At the close of the pre-pliocene period, the Annapolis Valley, the Basin of Minas and Cobequid Bay are formed, and

the existing agencies generally commence their work. At the close of the post-pliocene period, and the scooping of the Annapolis Valley, the granite transportation may have been effected.

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ART. VI.—THE LIMONITE AND LIMESTONES OF PICTOU COUNTY,  
N. S.—BY EDWIN GILPIN, A. M., F. G. S.

(*Read Feb. 10, 1879.*)

I PURPOSE this evening laying before you a few notes on the Limonite or Brown Iron ores of Pictou County, their source and relation to the associated Limestones; and, from the information at my disposal, to show that there is a possibility of these ores and their derivatives being much more widely spread than is generally considered to be the case; and in connection with the supposed sources of these ores, I will briefly draw your attention to the great dynamic changes in the district, which have generally been overlooked, and which have played an important part in the formation of the Limonite.

The most superficial student of Geology can hardly avoid a correct conjecture at the comparative ages of the strata he passes over in this county. Were the turf and wood removed from the ground, a bird's eye view would present each formation, colored by the hand of the Great Architect, and showing in its covering of soil the materials it is composed of.

The light sandy soil of the Upper, or (as it has been called), the Permo Carboniferous, the clays of the Coal measures, the reddish loam of the Lower Carboniferous, and the meagre boulder laden clays of the Silurian, all mark, with an interval of a few yards, the passage from one set of measures to another.

In an equal degree, the valley of the East River, above Springville, spreads before the traveller the distinctive landscape, marking the contact of two dissimilar rock systems. On the one hand the Silurian hills rise abruptly three or four hundred feet above the River, projecting here and there in bare, weather-worn knolls, or covered with a dense growth of gnarled birch and maple, and showing in places farms which have ill repaid the husbandman's labour. On the other hand, the Lower