TRANSACTIONS

OF THE

Nova Scotian Institute of Natural Science.

ART. I.—PRECARBONIFEROUS FORMATIONS OF ANNAPOLIS AND KING'S COUNTIES.—REV. DR HONEYMAN, D. C. L., F. R. H. S., &c., *Curator of the Provincial Museum, and Lecturer on Geology and Palæontology in the Technological Institute, &c.*

(Read November 12, 1877.*)*

NICTAUX.

THIS is one of the great Iron Districts of the Province. It is situate in the eastern part of the ancient, beautiful and fertile County of Annapolis. For the past forty years it has been known to Geology. Latterly, while the Devonian has gradually lost ground in Nova Scotia so as not to be *certainly* recognized as one of the Formations of the Province, this has generally been regarded as, at least, a sure resting place. Dawson's Acadian Geology, with map, *second Edition*, 1868. The strata containing its iron deposits have been considered to be of Devonian age,—and the associated Granites have also been considered to belong to the *latter part of the same age*. The Devonian age of the other granites associated with the great metamorphic—auriferous—Band of the Province, has been inferred from the same premises. I must confess that I have always entertained doubts of the validity of these conclusions, and I have taken the first opportunity that presented itself of examining the district in order to test their validity. As this was my first visit to Nictaux, and as I expected to find everything Geologically different from the other parts of the Province which I had examined, I proposed

to make myself a little familiar with the general aspect of things before investigating details.

I accordingly took a glance at the Rocks of the Falls of Nictaux River, and at the numerous outcrops of rocks appearing on the Old Road between the Falls and the Cleveland Mountain Iron Deposits. I inspected the excavations in the *magnetite beds* below the residence of Messrs. Stearns and Page. I followed the strike of the strata toward the Nictaux River, and found cuttings on the Nictaux and Atlantic Railway which might be useful in the prosecution of my investigations. I accepted of the generous offer of hospitality and assistance of Messrs. Stearns and Page, and thus secured an admirable centre of operations and valuable aid. A plain copy of Church's excellent map of the County was also placed at my disposal, as well as Mr. Page with his horse and carriage; so that my equipments for work were all that could be desired.

On the second day Mr. Page took me to the *Old Mines* on the east side of Nictaux River, and left me to make the best of my opportunity.

The aspect of matters here did not look very encouraging. The mines were filled with water, the banks of rubbish were obscured with age and vegetation. Only a few little patches of fossiliferous iron ore were seen lying here and there, having a few specimens of *Spirifer nictauensis*, Dawson. There was therefore nothing to excite special interest. Taking the course of the trench, I followed it easterly, seeking for other openings mentioned by Mr. Page. Not observing them, as I had not advanced far enough, I deviated from my course and proceeded to the high ground lying to the north. I then observed strata outcropping on the farm of Benjamin Wheelock, (Church's Map). Examining these I found them to be sandstones, altered more or less with abundance of fossils in casts. I at once recognized the Mayhill sandstone or Medina sandstone of my "Upper Arisaig Series." I was at home, and now proceeded to a systematic examination of

Locality 1, B. Wheelock's.

The fossils collected in this locality are :—

Athyris.
Spirifera.
Orthis, var. species.
Strophomena.
Strophodonta.

The genus *athyris* is eminently characteristic of the Mayhill or Medina sandstone of Nova Scotia, a member of the "Upper Arisaig Series." In this horizon it is very abundant. At Arisaig, Lochaber, Marshy Hope and Sutherland's River, it occurs generally in casts, sometimes however, it is found in the same rock specimens, in groups, whole and in casts, so that there is no room for mistaking its character. The peculiar shape of the cast of the ventral valves is easily recognized. It has not been recognized in any other division of the Arisaig series, except in the Ironstone bed of Arisaig Brook, and in the Ironstone bed of Blanchard, East River of Pictou. In the chief localities where this form prevails it has also an eminently characteristic associate, the coral *Petraia*, e. g. *Petraia Forresteri*, Salter. Although I have not yet found a similar association in this locality, we may confidently anticipate that this defect will be remedied.

The only other genus of the above list to which I would at present direct attention, is *Strophodonta*,—Hall.

This is readily distinguished from the *Orthis* and *Strophomena*, by the crenulated hinge line, from which the genus derives its name. The typical form being *Strophodonta prisca*,—Hall, of the Clinton, New York. The species of our locality is about twice the width of *Str. prisca*, and the width is to length as 7 to 5. We have casts of ventral and dorsal valves.

Hall's note on his species is interesting. "This shell occurs in shaly laminated sandstone highly charged with oxide of iron, associated in the iron ore beds in the town of Kirkland, Oneida county." The *Strophodonta*, under examination, occurs also in shaly sandstone in like association. I only give this as a coincidence. Our Stropohdonta seems to be older than the *Str. prisca*.

The sandstones here are included in siliceous argillaceous slates as at Arisaig.—*Transactions.* So that the strata are lithologically as well as palaeontologically, identical. Observing that the strata had a high southerly dip, I proceeded northerly in order to ascertain the cause of their alteration and elevation. I had not far to go to find the cause. I found the last outcrop of strata on Wheelock's Farm, passing under the line fence to Parker's Farm, which lies on the east side of Wheelock's. This was overlying *Diorite*, having an imposing outcrop. This was just what might have been expected, a precise coincidence with the order of things at Lochaber, Merigomish, Sutherland's River and McLellan's Mountain, in the Eastern Counties of Antigonish and Pictou.

Here the Mayhill sandstone strata, as generally in like connection, are vertical. The strike is N. 80 E., S. 80° W. To the north of this Diorite the ground makes a rapid descent, bringing us to the valley where all seems to be obscure. Re-crossing the Diorite, Slate and Fossiliferous Sandstones, and still advancing south the ground is obscure, no strata appearing. About 20 rods short of the road we come to a trench filled with water—this is a part of the Old Mines of which I was in quest. Mr. B. Wheelock, the owner of the Farm, who had come to my assistance somewhat opportunely, succeeded in getting for me two interesting specimens of the Iron ore. Adhering to the casts of some large and imperfect *Lamellibranchs* were found *Serpulini* and *Escharoid* forms *in groups*. Still farther south on the north side of the road, strata were seen. These were dark coloured slates—metamorphosed—having abundance of minute crystals—cubes of pyrite and occasional fossils.

Crinoid joints.
Spirifer crispus.

These seem to belong to the C. member of my "Upper Arisaig Series,"—Aymestry or Niagara Limestone.

The strike of these strata is N. 55° E., S. 55° W. and their dip. 70° S., 35° E. Beyond this no higher strata appear. According to the measurement on Church's map, the distance of these

strata from the Diorite is about half a mile. This accords with the distance given by Mr. Wheelock. This would make the vertical thickness of this series of strata about 2480 feet. This is about the thickness of the same members of the series at Arisaig, and the horizon of the Iron ore is approximately the same as that of Arisaig, and also of East River, Pictou, Clinton age. Returning to Cleveland Mountain we find Diorite outcropping at I. Allen's, and at a new house between Parker's and Allen's, occupying the same position relative to the bed of iron ore, as the Diorite already observed. Still farther we find the same Diorite outcropping on the W. side of Nictaux River, in the Railway section; and then we find it outcropping in Mr. Page's garden; then largely exposed in Banks' Field between Stearns' and Page's and the road, and then on the road. The three last occupy the same position relative to the beds of Magnetic Iron ore of Cleveland Mountain already referred to. Shewing the *Clinton Age* of these deposits.

Under Mr. Page's valuable guidance, I proceeded to examine other exposures of the Iron beds and their associated strata. Another trench at Parker's Farm, already referred to, was pointed out. This was on a line with B. Wheelock's locality 1. Like the other it was filled with water—specimens of the iron ore were collected from those scattered around. At a short distance to the north of this bed, or under it, another *Trench* was pointed out—the ore of this bed is *Red Hematite.* Still farther north we came upon a great exposure of slates and white quartzites. This is a continuation of the Medina sandstone strata of Loc. 1. Here they are more highly metamorphic and are apparently nonfossiliferous. Succeeding these is the great *Diorite* already referred to. Mr. Page shewed me specimens of *Fibrous Gypsum,* which he said were brought up when a well was being sunk near the roadside. This is somewhat singular, and apparently incomprehensible.

Thence we proceeded in a north-easterly direction, and passing out of the Mountains into the Valley. At a distance of 2¾ miles—air-line—we reached an outcrop of Red Hematite. On the east side of the road that runs at right angles to Valley Road,

that passes below the mountains, a short distance north of the Cross-roads, we found a potato field with the soil like red ochre, with abundance of ore of Red Hematite scattered over the surface. Underlying this outcrop I found grey slates *in situ*—Mayhill sandstone age—with specimens of the *desiderated Petraia* in casts. Proceeding to Meadowvale—to a distance of one mile from the Windsor & Annapolis Railway,—we took a road running easterly and at a distance of ¾ of a mile we turned off into a field road, and after going south about ¾ of a mile we approached Torbrook locality, and found large pieces of white quartzose rock—sandstone—identical with that of Locality 1, B. Wheelock's, having,

Athyris, sp.
Spirifera, sp.
Strophodonta, sp.

The sandstones and fossils in my collection cannot be distinguished from those of Loc. 1, except by the labels.

Coming to the excavations we found large heaps of ore,—red hematite. These excavations are on the north side of Torbrook, part of the red ferruginous strata in which the ore is imbedded is beautifully exposed in the bed of the brook. The strata are metamorphosed and tilted, seeming to indicate the presence and influence of *Diorite*, as at B. Wheelock's, Parker's, the Railway and Stearns and Page's. So that there can be no question that this is a continuation of the *Iron ore beds* mentioned in the other localities.

A day or two before, when I was on the New Canaan Road in the mountain south of this locality, Mr. Page pointed it out as the position of an iron ore bed. I could not suppose that it had any connection with the other beds. Lying in the valley, at a distance from the foot of the mountain, at the side of a brook, where every exposure visible seemed brick-red. I concluded that the formation there must be *New Red Sandstone*, and that the ore must be of a character altogether different.

Preceding observers have gone *wide astray* in defining the course of the Nictaux Iron beds, as the direction given in Geolo-

gical Maps, e. g. the *Maps of Acadian Geology.* The course there defined, would make them traverse the mountain strata on which we were standing when the works of Torbrook were pointed out to me in the dim distance.

The fossils of the Red Hematite and Red Slates collected are:

Ptylodictyum problematicum.
Stenopora fibrosa.
Cornulites flexuosus.
Trilobite, pleura.
Spirifera, sp.
Modiolopsis orthonota.
Tentaculites, sp.
Bellerophon expansus.

The course of the iron ore beds may be defined thus on Church's Map:

1st. Magnetite beds. Stearns and Page's, distant from the Annapolis Railway due south, $5\frac{1}{4}$ miles.

2nd. Beds at Wheelock's and Parker's, distance from the Railway, S. $3\frac{1}{3}$ miles.

3rd. Beds at Torbrook, S. $2\frac{5}{8}$ miles, or *2 miles S. of the Annapolis River, and nearly a mile from the County line.*

The same line is defined with the *utmost accuracy* in the Map of Acadian Geology, Ed. 1868. The course begins in the Devonian West of Nictaux River, traverses this formation, passes into and traverses the *Upper Silurian*, even to the *New Red Sandstone.*

This is certainly range enough for the Bed, Devonian and Upper Silurian; the position might be called a dilemma for the author, believing as he does in the Devonian age of the iron deposits. I was led to infer the probable existence of middle silurian fossils in connection with the ores of Cleveland Mountain. A search in the direction supposed, led to the discovery of fossils on the side of the public road. The fossils were not *in situ*, but they were evidently not far from their original position. This position was apparently on the *wrong* side of the *Diorite* already referred to.

LOCALITY 3, CLEVELAND MOUNTAIN.

The rock containing the fossils is *slaty, siliceous,* and *pyritous.* The fossils are :

Petraia, sp.
Crinoid joints.
Athyris, sp.
Spirifer, sp.
Strophomena, sp.
Corallines, sp.?

Mr. Page took me to another locality already alluded to, on the New Canaan Road, S. W. from the Mines of Torbrook.

Loc. 4. W. Wheelock's (*Church Map.*) In a hollow beginning at the road and passing along the house, and onward to the height, strata were observed which we thought might be fossiliferous. On examination we found strata outcropping at the top of the hollow, which seemed to correspond with those of No. 1, B. Wheelock's. They were white siliceous rocks (sandstones) with slates. In these we found abundance of fossils identical with those at No. 1, with additions.

Stenopora fibrosa.
Trilobite pleura.
Orthis, various.
Strophodonta, sp.
Spirifera, sp.
Ambonychia, sp.
Tentaculites.

The dip of the strata seemed to be nearly vertical with a tendency northerly.

I went over the ground some distance to the south of the fossiliferous strata looking for *Diorite* as at Loc. 1, but all was obscure. Returning by the Hollow we found dark coloured strata having a dip 76° N. 30 W.

In the digging of a well in the front of the house, fawn coloured slates have been cut. These seem to be the *Dictyonema Websteri* of Beech Hill, Kentville, Kings County. At the road

where the hollow meets there was a considerable outcrop of fawn coloured slates.

To the east of this locality and about ¾ of a mile from the county line we found the strata of the mountain side beautifully exposed in a branch of Torbrook. These strata resemble those of Kentville and Beech Hill. They are grey, reddish and varying coloured.

Near the foot of the mountain before the brook reaches the valley, the strata are solid and penetrated with quartz veins. A short distance above the road the brook takes its rise and the strata disappear. The strata are metamorphosed and apparently non-fossiliferous. Their strike is N. 60 E., S. 60 W. Their dip is 82, S. 30 E. At the road they are vertical. This seems to be an upper silurian series, *intervening* between the middle silurian of locality 4, and that of the iron ore series of locality 2, Torbrook.

Still farther beyond the county line, in King's Co., at Gordon's Farm—*Church Map.*

LOCALITY 5, GORDON'S.

In this farm, on the south side of the New Canaan Road, strata were observed outcropping in several places, associated with *Diorite.* In a stone heap I found a piece of sandstone with casts of fossils. The size of the specimen is about 10x6 inches, thickness 1¾. It is coarse, shaly, ferruginous. The fossils are:

Athyris.
Orthis.
Spirifer.
Strophodonto, grandis?

This *Strophodonta* differs from those found in localities 1, 2, 4. It is larger, its width is 2 inches, its length 1 8-20 inches, its width is to that of the other 10:7; its length 14:10. The smooth part of the hinge at the beak measures four twentieths of an inch, the crenulation on either side of the beak area measures seven twentieths, on either end of the crenulation the smooth part of the hinge line measures eleven twentieths. It is the cast of the dorsal valve.

The specimen doubtless, represents *sandstone* beds in the strata.

Parallel lines drawn on the Maps of Annapolis and King's (Church's), show that an extension of these strata westward would pass in the *rear* of locality 4, at a distance of about ¼ of a mile, so this locality seems to belong to a *repetition* of the series of strata represented in locality 4, *further south.*

A rocky eminence, about half a mile south-east of Gordon's, near the side of road branching off New Canaan Road, attracted attention, and had to be examined. On our way we passed from the Middle Silurian strata into others of a widely different lithological aspect, indicating *greater age.* The present strata are gneissoid—micaceous. The eminence when reached presented a very striking appearance. It was entirely formed of gneissoid strata, marvellously contorted, surfaces presenting the ornamental lines of oak or pine panelling, and other lines of beauty. The aid of the photographer was desiderated to picture the rocks. The pressure contortions of Point Pleasant rocks, Halifax, are plain in comparison.

I shall have occasion to notice these rocks in the sequel.

A farther examination of Cleveland Mountain, showed that the Magnetite containing strata outcropping on the road had the regular strike and dip until we reach Hatley's, i. e., about a quarter of a mile south of the Diorite, at Stearns and Page's. They are then seen assuming a synclinal arrangement, having a dip 70 S., 50 W., and 52 N., 45 E.

This syncline appears on the road below the house, and in the pasture. This gives direction to the drainage. In general, however, the strata here are broken and confused. A broad *Magnetite* bed in the valley thus formed seems to shew the effect of this disturbance. We proceed onwards, and, after a few paces, we come to the *cause* of the disturbance. A considerable band of gneissoid strata, succeeded by granite. These having been *thrust up,* have caused the disturbance. These gneissoid rocks are quite distinct from the Magnetite strata, and nothing but hasty observation could confound them. They are not seen here in contact. Passing over granite, about a mile in width, on

the road, we come to slates containing fossils, which, *apparently*, separates this granite from the broader granite, filling a gap between the two. The granite over which we have passed is seen exposed on the left, east, but it does not extend to any great distance in this direction. Here it bounds the valley. Standing on the granite on the road we have an uninterrupted view as far as Locality 1, B. Wheelock's, and along the New Canaan Road as far as W. Wheelock's, Locality 4. On the right the Granite rises into a mountain, passing on it rises behind Hatley's and advances to Banks' Mountain, where we shall meet it again.

The last westerly exposures are seen on a new road (?) which Mr. Page and I traversed when returning from the examination of a locality west of the Mountains. This shews its length to be 1½ miles. The band of Middle Silurian strata that fills the apparent gap between them extending to Dunn's and Hogan's on the road, seems to be less than half a mile in width. East of the road it becomes obscure at no great distance, so that I was unable to trace its course in this direction. Westerly it is found extending about a mile, making its last appearance on a road that leads to Lawrencetown. Here it appears near a mill seat; it then passes into the forest and is obscured.

This Band is peculiarly interesting:—

1st, on account of its *Fossils.*

2nd, " " *Magnetite.*

3rd, " " *Granite association.*

LOCALITY 6, FOSSILS.

The first outcrop on the road contains lenticular patches of impure limestone. This is whitish, pyritous and fossiliferous. The fossils collected are:—

Stenopora fibrosa,

Spirifer sp.

LOCALITY 7.

About half a mile farther west, I picked up one hand specimen containing:—

Ptilodictyum problematicum?

Spirifer sp.

Locality 8.

At the Lawrencetown Road, near the Sawmill, strata was observed. A piece which I broke off contained fossils. The rock is calcareous. The strike of the strata is N. 55 E., S. 55 W. The fossils are:—

Stenopora fibrosa,
Crinoid, joints,
Spirifer?
Avicula?
Incertae sedis.

The last are leaf-like forms, ribbed, bifurcating, first into coarse, and these in turn into finer ribs or striae. It is possibly *Bryozoan.*

Magnetite.

About half a mile west from the road, Mr. Page pointed out to me beds of Magnetite. The position of these is on the south side of the Band, not far from its junction with the granite. This is a matter of some interest, geologically as well as economically, as it tends to shew the intimate relation that exists between this and Stearn's and Page's Magnetite Band. Mr. Page conducted me to the locality for the purpose of shewing me the course and extent of these deposits. There can be no doubt that the *apparently* different series of iron-bearing rocks under examination all belonged to one series of strata and Iron beds. I refer to this, also, for another purpose, i. e. to establish the age and relation of another apparent series, where we may not have the aid of Palæontology for direct correlation.

Granite Connection.

At no great distance west of the road at a point before we reach the fossiliferous outcrop, I observed outcrops of slate and granite, apparently at close quarters. I found, however, that these were distant about 70 paces. As it had been affirmed that the lithological character of the supposed Devonian strata was materially affected by proximity or connection, I examined the exposed strata very carefully, and found that there was no such lithological change as a metamorphosis into Gneissoid rocks. They were of about the same character as the Silurian strata at

Stearn's and Page's, Wheelock's or elsewhere, where *Granite* could only be found in boulders. I do not mean, however, to affirm that the granite was not a secondary agent in affecting their *position* as elsewhere observed—e. g., Hatley's.

Farther west, nearer the magnetite beds referred to, I observed outcrops of slates and granites at the distance of *one pace*, without the alleged lithological change. Not far from this last, I found the slate and granite in contact, and no appearance of the alleged change. In contact the slate was so friable that I could not get two inches to hold together. I had to try about 6 inches distance before I could succeed in getting the specimen on my table, which is only 3 x 1½ inches in size. It is certainly not gneissoid rock with *garnets, mica or such like.* The specimen of granite associated with it now, as originally, is a reddish granite somewhat weathered. This shews, *beyond question,* except to any one who *will not* be convinced, that the granite had its present character, *minus,* the weathering, before the associate middle silurian was formed on it. It is therefore of *pre-middle silurian age.*

This granite and the associated middle silurian band of strata are not defined on the Map of Acadian Geology, Second Ed., so that the author may be disposed to question their existence. They are there, *notwithstanding* the scale of the map be set up as a defence.

At Dunn's and Hogans', the south side of this middle silurian band, the strata have a strike, N. 75 E., S. 75 W., and a dip of 90 degrees. Here the band is not seen in contact with the granite. The road passes over a boar's back, probably of drift, beyond this the granite reappears and continues without interruption beyond New Albany to a place not yet ascertained.

Supposing that this band of strata, in its course eastward, assumes the normal strike after parting with the granite in the same manner as it does to the west at the Lawrencetown Road, and passes onward, N. 55 E., and supposing also that the strata of localities 4 and 5, W. Wheelock's and Gordon's, in like manner, were to proceed westward to meet them. The road to Bloomington, on the east side of Nictaux River, might be considered a

place of meeting. Expecting to find outcrops of these strata, I traversed, so far, the road referred to. In passing along this road, southward, we found Allen's *Diorite*, and then passed over the ground *overlying the* course of the fossiliferous iron ore beds already noticed; we then descended into the valley viewed from the granite on the New Albany road, and then ascended. Within a few feet of the position indicated by hypothetical lines on Church's Map, a prominent outcrop of strata was observed. The first piece of rock which I collected from the strata contained two specimens of petraia. The collections of localities 4 and 5, on the south side were thus supplemented, in the same way as that of locality 1 was supplemented by locality 2, on the north side. This specimen of rock in common with the other specimens collected in the same locality 9, shows that the strata are siliceous, hardened and very pyritous, fossils are numerous and various on account of the hardness of the rock, they are principally available where the rock is weathered.

The strike of these strata is N. 55 E., S. 55 W. At no great distance to the south of the fossiliferous strata, at a barn, are lower strata with *Diorite*. The strata in contact with the diorite is very hard, having beautiful crystals of *tin white pyrites*, Arseno-pyrite; the strike of these strata is N. 75 E., S. 75 W., the dip is 85 N. 35 W. The existence of this *Diorite* seems to indicate its existence at locality 4, south of the New Canaan Road.

The strataon this side of the valley seem to be synclinal to these of the north side, having the Iron Mines. This geological arrangement seems to have formed the valley.

I would here observe, that the Diorites seem to have had an influence over the strata in altering and hardening them, which the granite did not possess, and that the prevalence of these is the cause of the general metamorphism which seems more or less to have affected all the Middle and Upper Silurian strata of this region and their contents. They also seem to have been the primary agents in elevating them, and giving direction to their strike and dip, the *granites* having been *made* to assist in the work of *elevation* and *disturbance*. I shall have occasion to refer to and illustrate these phenomena in the sequel.

The fossils of this locality (9):

Petraia, sp.
Stenopora fibrosa.
Crinoidea.
Cornulites flexuosus.
Spirorbis.
Beyrichia, sp.
Dalmanites, sp.
Trilobite, incert gen.
Orthis, sp.
Strophomena, sp.
Spirifer, sp.
Avicula, sp.
Incertae sedis.

Petraia here is not *P. Forresteri*, but it is a species of very common occurrence at Arisaig, and other localities having Mayhill sandstone strata. *Crinoidea*, are casts of column joints. One is more ornamental than any that I have yet seen, it resembles *Pentacrinus*, it may possibly belong to *Glyptocrinus*.

Beyrichia, not distinguishable from *Beyrichia Kloedeni*. There are two specimens of this fossil, being external and internal casts. This is the lowest position of *Beyrichia* in Nova Scotia. The *genus* culminates in D, "Upper Arisaig Series." It also occurs in the lower carboniferous limestones. *Dalmanites*, sp. This is a large trilobite. Its first appearance suggested *Dalmanites limulurus*. The cephalic shield has the same form, spines, eyes, front, glabella. The pleura are spinous. The pygidium is unknown. It differs, however, considerably on closer examination, the eye is much larger, and so is the whole head. The thorax is about the same as *Dalmanites limulurus*, Fig. Hall's Pal., N. Y., but its proportion to the head is different. It seems to be nearer to *Dalmanites Hausmanni*. It is possibly a *new species*.

Trilobite, *incerti generis*. Of this I have only casts of two *pygidia* (internal and external). At first I supposed that it was a species of Proetus. The tail has the smooth margin of this genus, but on closer examination, I found that the margin was

spinous. I then compared it with a small species of the genus, *Lichas,* in Hall's Pal., N. Y., but I found, that while the margin has some resemblance, our specimens are *much unlike.* It may, therefore, be a *spinous Proctus,* or it may belong to a different *genus.* In either case, this will make the fifth genus that I have discovered in the Middle Silurian formation of Nova Scotia, viz —*Calymene, Homalonotus, Phacops, Dalmanites* and *incertum genus.*

Incertæ sedis. There are several forms that come under this class, especially some leaf-like forms which may be fucoids, one is *veined* like a leaf.

Advancing still further on the road, southward, we find strata out-cropping, and when we have ascended to the cross roads where the road to Bloomington turns to the left, we see on the right side a fine out-crop of strata on which the school-house stands. This locality (10), has its fossils. The strata, judging from the specimens, are very siliceous and much hardened. The strike is N. 55 E., S. 55 W., and the dip northerly. This bears the same relation to the preceding locality as Gordon's to W. Wheelock's. The strata here are succeeded—underlaid by Diorite, showing a large outcrop. It crosses the road to the right and has a width of 93 paces extending to Jefferson's barn.

To this igneous rock the strata are evidently indebted largely for their metamorphism and also for their present position. The fossils collected here are :

Stenopora fibrosa
Cornulites flexuosus.
Spirifer, sp. ?
Orthis, sp. ?
Tentaculites.

Proceeding farther on the road on which we have now entered we find succeeding the Diorite gneissoid strata. These are seen outcropping in front of Viditoe's house. We have thus the same sequence as at locality 5, (Gordon's). We have evidently reached the strata of a different formation. The lithological character of the strata on either side of this Diorite is very dissimilar. Their

original characteristics, existing at the time of the intervention of the Diorite must also have been very different.

At a farther distance of about a quarter of a mile, we reach another and very interesting outcrop of the same series of strata. These are neither so solid nor dark and ferruginous as the strata at Viditoe's. The latter resemble the strata associated with the granite at Hatley's, being what is commonly called *Ironstone* at Halifax. The strata of the present position correspond with the contorted Gneissoid strata of the height beyond Gordon's, only they are not so much contorted. An interesting fact in the present case is that the strata are in *contact with granite*, and not merely in contact, but fragments of the strata are actually *imbedded* in it, showing that the strata were *consolidated* before their present *apparent* connection, and that the granite was in a sort of plastic condition when brought into this connection. It shews that the granite assumed its present relations and condition after the formation if not metamorphism of the (now) Gneissoid Strata. The Gneissoid character, their mineralogy, contortion, &c., may be accidents connected with the production of the *Granite phenomena.*

Some of the strata here abound in small *garnets*, dark-colored and red. The rock itself is composed of orthoclase and black mica. These phenomena and associations are quite common in Halifax Geology, where *andalusite* and *chiastolite* represent the garnets of the present case.

Passing over these *garnetiferous* strata and associated granites along the road to E. Viditoe's, *a straight distance* of *three-fourths of a mile*, I unexpectedly came upon an outcrop of clay slate. This is black, ferruginous and quite soft, so as to be easily cut with a knife. It is seen in occasional outcrops to a distance of ¼ of a mile. The strike of the strata is E. & W., the dip is 80 S. They are evidently isolated, nothing but granite is observed all around. I did not find any fossils in them, their precise age may therefore be regarded as uncertain. They seem to be an *outlier* crowning the granite. There are no Diorites connected with them; they are not hardened, and are far from being gneissoid. If the granites had been in a molten state like a seething cauldron

as *graphically depicted*, after their formation, why were they not metamorphosed or engulphed? *Mirabile dictu!* they have only been lifted up. In all probability they are of middle or upper silurian age.

The end of this series is six and a quarter miles from the forks of the Annapolis and Nictaux Rivers. By applying the compasses to the Map of Acadian Geology, it will be found that this series lies in the Devonian colouring, extending to its southern border. South of this the same Map indicates a width of 11 miles of upper silurian before coming to the granite. These strata must be *concealed* by the granite, I did not see them. In justice to the author of Acadian Geology, I would observe that the colouring of the map in the edition of 1855, is, in this case, preferable as well as in a multitude of cases, to the last and improved map, the former being more in accordance with *facts*; the latter with fanciful *theories*. I would now give prominence to the following *inferences*.

1st. The Fossiliferous formation is *principally* of middle silurian May-hill sandstone age, of England, and *Clinton* of the United States.

2nd. The age of the Iron deposits of Nictaux is approximately, *Clinton*, being the same age as the *fossiliferous* Iron bed of Arisaig, and the *fossiliferous* Iron bed of Blanchard at East River, Pictou.

3rd. The granites of this region are of pre-middle silurian age, and therefore of lower silurian age.

4th. The Gneissoid formation is *apparently pre-granitic*, and therefore pre-*lower silurian?* i. e., of the age of lower members of the Lower Silurian or probably Cambrian.

Resuming our examination we return to Cleveland Mountain, examining more closely the outcrop of *Diorite* on the road at Banks', i. e., the Diorite under-lying the *Magnetite* beds and strata of Stearn's and Page's, we find associated with it on the west side of the road, a considerable outcrop of Gneissoid strata with red felspathic and micaceous rock (granite?) These do not *re-appear* with the Diorite east of the road. Following the outcrops of rocks on the road, *northerly*, we come to fossiliferous

locality 3. Beyond this we have several considerable outcrops of strata, slates and quartzites. These extend beyond the *road to Banks' mountain* and school house, until we reach *Diorite* outcropping. This Diorite is of considerable width. Beyond this we have a broad band of black ferrugineous strata, and then a band of red siliceous (Cryptocrystalline) rock pervaded by quartz, veins. This is followed by a prominent *black volcanic rock*, with small cavities containing slender crystals of epidote? we have then slates and quartzites, and *Diorite* at the brow of the mountain. Descending, we reach a cross road. Here we have an outcrop of slates with *Diorite.* A prominent outcrop of rock is seen to the west of the road, a wide field intervening. Examining this, I found the rocks to be granite with gneissoid strata (micaceous schist).

No other strata appeared until we reached the beginning of the *Upper Silurian strata* of "Acadia Geology," the strata of the Falls of Nictaux river. There are gneissoid strata, where polished by the running water having a beautifully banded appearance, they are slightly crumpled and jointed, they are micaceous and highly metamorphic. I found in them a lenticular deposit of pyrite. The strike of the strata is N. 60 E., S. 60 W., and their dip 70 S., 30 E. They extend wholly across the river, the water runs nearly in the direction of their strike. To all appearance they are an easterly continuation of the gneissoid strata, last examined in association with the Granite. Immediately below the Falls we make a great lithological transition, passing into grey homogeneous and soft shales. These outcrop on the west of the river, and form walls on either side. This band terminates with a *Diorite* at the site of an old saw mill. In close connection with the *Diorite* the strata have a greater solidity and hardness. It is not like any Upper Silurian series that I have observed elsewhere in Nova Scotia. It has some resemblance to the Middle Silurian series, which occur on the south side of the East Branch, East River, and also at Sutherland's River. *Vide*—my papers on the Pre-carboniferous Formations of the Pictou Coal Field. *Transactions.*

The *Diorite* besides hardening the contiguous strata has given

them a dip 70 S.. 35 E., and a strike N. 55 E., S. 55 W. I did not find any fossils in the strata. Lithological considerations would lead me to regard them as of Middle Silurian age. Beyond these comes the valley.

Extension Eastward.

All the strata, noticed below the Falls, disappear at no great distance in the valley, so that those geological maps which make them border the mountains are *decidedly in error.* All the others of Cleveland Mountain, after appearing in the railway cuttings and outcropping on the east side of the Nictaux river, and underlying and giving contour to the ground beyond, disappear in the valley before coming abreast of Locality 1, B. Wheelock's and Parker's. B. Wheelock mentions some exposures of rocks in a small brook in the valley north of the *Diorites* on Parker's which may possibly represent some of these. Since I received this information in Halifax I have not had an opportunity of examining the said appearance.

Extension Westward.

Under Mr. Page's guidance I was enabled to make a very satisfactory examination of their westward extension.

Taking the road to Banks' Mountain, we passed over outcrops of the strata between Stearn's and Page's *Diorite*, and the *Diorite* north of the school house, or rather the part of them between the road the school house and the *Diorite.*

We also passed over part of the strata between the latter *Diorite* and that of the *Epidotic Rocks* and following Diorite. These strata appeared to keep the normal S. 55 W. course, until we approached the summit of Banks' Mountain. Here the strata were *thrown into confusion, neither strike nor dip being observable.*

Beyond this, in Parker's farm, strata were observed outcropping. We proceeded to examine these and found that the strata were gneissoid, having a strike east and west. Enquiring at Mr. Parker if the Granite was to be found solid at no great distance, he led us along a wood road, and after crossing a great band of compact black gneissoid strata, we came to the solid granite.

This is a continuation of the gneissoid strata and granite already observed on the road at Hatley's. The confusion of the strata on the summit of the mountain is evidently caused by the *thrusting up* of the granite and associated gneissoid rocks, as has already been observed at Hatley's. On the east side of the mountain Mr. Page and I observed the *Diorite of this series outcropping.*

Another object which we had in view was the examination of Banks' Iron mine. Mr. Page led me to the mine. This is situate on the north side of Banks' Mountain. The ore of this mine is *Magnetite,* the rocks are much hardened by metamorphism. I had not much time to examine this locality. I intended to re-examine it but did not get an opportunity. This is one of the *old mines.* It is evidently in the extension of the strata whose outcrop we have noticed at the Cross Roads, associated with the *Granite and Gneissoid Rocks* which are regarded as connected with the gneissoid strata of the Falls. I have not yet examined any extension westward of the strata below the Falls.

WEST OF BANKS' MOUNTAIN.

I examined the outcrops in this direction along with Mr. Page, when observing an Iron deposit. I shall reverse the order of examination in giving an account of it. Beginning at the summit of Banks' Mountain, we take a road on the north side leading to a new road in course of construction on the west side of the mountain—in this way we traverse in a manner the rocks occurring. We passed over granites, the last outcrops of the boss of granite which enters into the constitution of the mountain. Looking back we see the mountains rising in our rear, in grand proportions. Our road is admirable, geologically, but awful for a horse and waggon. The difficulties and obstructions impeding progress were regarded as of rather a desirable character by the geological observer.

We observed strata outcropping the probable extension of Banks' *Magnetite* strata. *Diorites* were also observed. So that the mountain thus beset, before and behind, east and west, must, at the *Diorite producing period,* have had a shaking, troublous

and also an elevating time. A broad outcrop of *Diorite* was also observed on the road, *to the north* of the fossiliferous and *Magnetite* strata of the *Gap*, at Locality 8, on the road to Lawrencetown—and also another outcrop of crystalline rocks of a very mixed character. At C. Beals', in the heights south of Lawrencetown, strata were observed outcropping—the probable extension of Banks' Magnetite strata. On the north side of these Diorite was exposed in outcrops. This band also seemed to underlie the swampy, meadow at Beals', in which were taken *in situ* beautiful specimens of *Bog Iron ore.* This is the *deposit* of which we were in *quest.*

While Mr. Page was extracting specimens of Bog Iron Ore, I went to examine the heights to the south, which seemed to be a range of outcrops of rocks. Expecting to find granite, I saw nothing but height after height of *Diorite rocks* extending south, east and west, as far as could be observed by the naked eye. We returned home by the new and old mountain roads which have been described.

Observations.

After having established the age, and course of the Iron-bearing strata from Meadowvale to Cleveland Mountain, I was for some time at a loss to determine the age and relations of the strata outcropping from Stearns and Page's to the old saw mill below the Nictaux Falls.

1st. The rocks dipping in one direction seemed a regularly ascending series, extending upwards of four miles.

2nd. This breadth, with the high dip. 70 degrees, gave an enormous thickness.

3rd. The lithological variety, crystalline, uncrystalline metamorphic and gneissoid rocks.

4th. All underlying a Middle Silurian series.

These phenomena seemed to indicate a Lower Silurian formation of great thickness.

At length I seemed to find a satisfactory solution of the problem, furnished by certain *Palæontological, Mineralogical* and *Lithological* data.

THE POSITION OF THE FOSSILS OF LOCALITY 3.

1st. This seemed to underlie the *Diorite* of Stearns and Page, instead of overlying it, being situate on the north side rather than the south, and therefore did not belong to the Magnetite series of strata.

2nd. It seemed too far above the Diorite north of the school-house, and consequently did not seem to occupy a proper position in this series of strata.

These considerations seemed to indicate some structural peculiarity.

3rd. The existence of Banks' *Magnetite* (old mine) evidently shews that the containing band of strata is a repetition of Stearns and Page's Magnetite strata or of the fossiliferous and Magnetite strata of the gap, in other words it shewed that all the three series of beds *were originally one series.*

4th. The peculiar character and position of the Granite gneissoid rocks of the Falls strata continuation, as well as the Gneissoid and Granitic ? rocks associated with Stearns and Page's *Diorite* seemed to indicate that these were insertions from underlying formations brought up by the respective Diorites.

The Mineralogical *datum* seemed to indicate *repetition*, the Lithological *addition*, and the Palaeontological *plication*. Thus, then the enormous thickness is apparently the result of the repetition and plication of strata of the same age, with the addition of rocks of an older period. This much for the strata, &c., on the north with the southerly dip.

The strata on the south with the northerly dip have also their structural peculiarity to be explained.

The apparent succession on this side is peculiar. There is a *Diorite* with an overlying series of strata having fossils indicating a certain age, dipping northerly, and then there is another Diorite with an overlying series of strata having fossils of the same age as the other series, in the same position, in the series, and also dipping northerly. This arrangement seems to include the strata of Localities 4 and 5, Wheelock and Gordon's. We have therefore, here also, *repetition* if not *plication*.

The Northern and Southern thus have a synclinal arrange-

ment, of which the Valley lying between, holds the axis. The series of Torbrook branch, near the county line of Annapolis and King's, comes in between the two to continue the mountain outline.

Diorites.

These have evidently been the chief agencies in the Metamorphosis of the Middle Silurian formation, and in the induction of the structural phenomena which have been observed.

As elsewhere in Nova Scotia, viz.: At East River, Irish Mountain, McLellan's Mountain, Sutherland's River, these phenomena have evidently been induced between the Upper Silurian and Lower Carboniferous periods, i. e., Devonian.

So that these may be regarded as the only *representation of the Devonian age at Nictaux*

Economics.

In my work at Nictaux my attention was chiefly directed to the solution of problems in our Geology.

Yet my attention in the course of my investigation was necessarily in some measure directed to the Economics of the district examined. Mr. Page's valuable assistance — without which I would have been unable to make the satisfactory examination that I did—insured a certain amount of attention to Economical Geology.

Iron Ores.

1st. Magnetite.

The principal areas of *non-fossilliferous Magnetite* that came under my observation are:

1st. Stearns and Page's.
2nd. Banks'.
3rd. Of the Granite Gap.

All these are situate in the mountainous region, west of Nictaux River, in the region of *maximum* metamorphism and disturbance. No. 3 did not seem to be of so much economic as geological importance. My examination of No. 2 was merely assuring of the existence of *Magnetite*, which was made known by ancient mining, and described fully by Gesner and others. *Vide Gesner's Nova Scotian Geology and Mineralogy*, 1836.

The first, Stearns and Page's, which seems to be by far the most extensive and important, being situate near my centre of operations, necessarily received more of my attention. The excavations on the Magnetite beds, below the house and toward the river, were the first objects to which I directed attention, as well as almost the last. Other excavations were pointed out to me by Mr. Page—which appeared sufficiently numerous and distinct—extending from the middle to the top of the band of strata as far as the line between Stearns and Page's property and Hatley's. Much time and labour had evidently been spent in exposing the iron deposits of the locality. The dipping compass has been well applied in ascertaining the positions of the deposits; but the work of the miner is required to reveal their true extent and the relative positions of the several beds. These beds were unknown until Messrs. Stearns and Page commenced their explorations. The ore besides being abundant, is reputed to be of superior quality.

Fossiliferous Ores.

Brown and Black.

These are the ores which have been chiefly worked at Nictaux. The old trenches to which I have had occasion to refer in the course of my investigations, were the old mines from which the greater part of the ore was extracted which was smelted at the old furnace at the Falls of the Nictaux River. Specimens of this fossiliferous ore, with *Spirifer nictavensis*, Dawson, are to be found in Museums.

Hematitic.

This ore seen and excavated at Parker's and also at *Torbrook*, *Meadowvale*, is a beautiful ore. It is often arenaceous and fossiliferous. It has the appearance of a good ore and *seems* to be abundant.

Granites.

These are sufficiently abundant and accessible. They are not much different from the Halifax granites, but the variety is greater, some of the reddish varieties are very beautiful, and adapted for ornamental purposes. At the back of Banks' Mountain, masses of very beautiful varieties, were examined.

Garnets were found in some of the Granite boulders as well as in the gneissoid strata.

GNEISSOID.

Rocks similar to the Gneissoid rock, *Ironstone*, of N. W. Arm, Halifax, may be applicable to building purposes.

The rocks of the Nictaux Falls are quarried for building stones.

ART. II.—A CONTRIBUTION TOWARDS THE STUDY OF NOVA SCOTIAN MOSSES.—By JOHN SOMMERS, M. D., *Prof. Physiology and Microscopy, &c., in the Halifax Medical College. Examiner in Physiology of University of Halifax, Lecturer on Zoology, &c., to the Institute of Technology, Halifax.*

(Read before the Institute, Dec. 1877.*)*

THIS paper is presented as one of a series, which, time and opportunity permitting, will be continued until a complete col lection of our Moss Flora will be described.

I stated on a previous occasion, as a result of a then superficial observation of the subject, that the study of this class of the Provincial Flora would repay well for any labour expended upon it, inasmuch as it afforded an unexplored field for research. I had at that time but little idea of its extent, or of the profit and pleasure which subsequent experience has proved to be derived from its cultivation.

The study and detection of the minute distinctions which enable us to separate the species and genera of mosses, demands from the observer very careful and laborious microscopic work, without which it is impossible to attain to success.

To one who can snatch but few leisure hours from his more engrossing labours, the task of collecting and arranging the material presented by this class of vegetable growth is an exacting one, many species being so fugaceous that constant alertness is