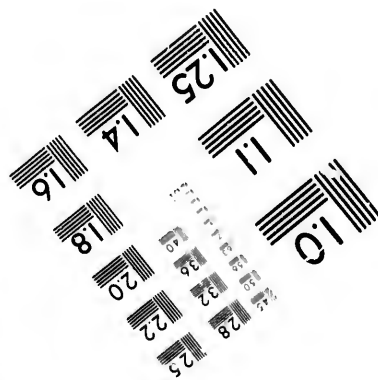
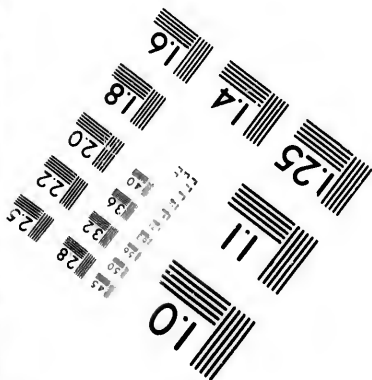
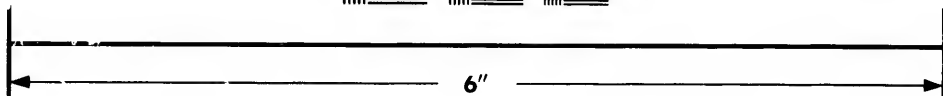
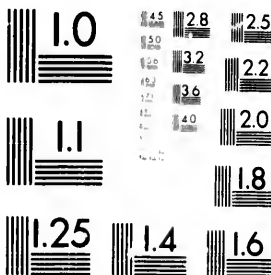


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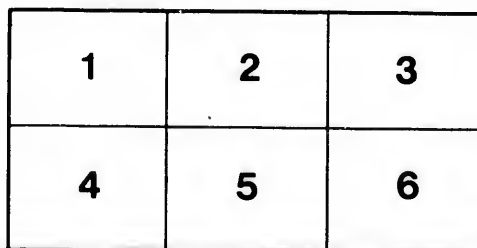
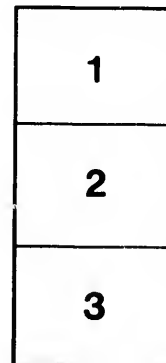
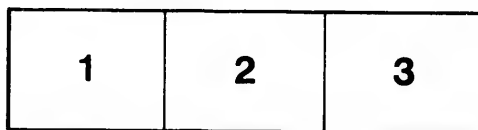
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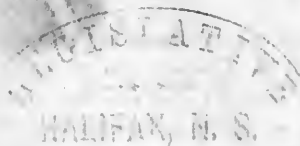
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REMARKS ON RECENT PAPERS ON THE GEOLOGY
OF NOVA SCOTIA.

(From a Paper communicated to the Nova Scotian Institute of
Natural Science, by J. W. DAWSON, LL.D., F.R.S., &c.)

The following remarks have reference to two papers by the Rev. D. Honeyman, D.C.L., Curator of the Provincial Museum, Halifax, published in the Transactions of the Nova Scotian Institute of Natural Science, Vol. iv., Part iv., 1878. These papers are respectively entitled — "Pre carboniferous Formations of Annapolis and King's Counties," and "Nova Scotian Geology, Pre-carboniferous, Lower Carboniferous, &c." Special reference will be made to the following points: (1.) The age assigned by Dr. H. to the fossiliferous rocks of Nictaux and New Canaan and their relation to the intrusive granites of the region. (2.) The Geology of the Pre-carboniferous Rocks of the Eastern part of Nova Scotia and Cape Breton.

1. NICTAUX AND NEW CANAAN.

In the first of the papers above referred to, Dr. H. very freely criticises my conclusions respecting the age of the rocks of these localities, but does not take the trouble to state what these conclusions are, so that a reader unacquainted with the facts might take it for granted that all these rocks had been referred to the Devonian system, or that no definite idea of their age had previously been given. For this reason I shall take the liberty to quote from a paper on the Silurian and Devonian Rocks of Nova Scotia (April, 1860), my actual results, which are given in nearly the same form in *Acadian Geology*, 2nd edition, 1868. I may premise that these results were worked out at a time when

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there were no railways or county maps to assist the explorer, and when the aids in determination of fossils were much less accessible than at present; and also that I have added some explanatory notes, which are included in brackets.

"The oldest fossiliferous beds seen (at New Canaan) are the fine fawn-coloured and gray clay slates of Beech Hill, in which Dr. Webster, many years since, found a beautiful *Dictyonema*, the only fossil they have hitherto afforded. It is a new species, closely allied to *D. retiformis* and *D. gracilis* of Hall, and will be described by that palæontologist under the name of *D. Websteri*, in honour of its discoverer. In the mean time I may merely state that it is most readily characterised by the cellules, which are very distinctly marked in the manner of *Graptolithus*."

"The *Dictyonema* slates of Beech Hill are of great thickness, but have in their upper part some hard and coarse beds. They are succeeded to the south by a great series of dark coloured coarse slates, often micaceous, and in some places constituting a slate conglomerate, containing small fragments of older slates, and occasionally pebbles of a gray vesicular rock, apparently a trachyte. In some parts of this series there are bands of a coarse laminated magnesian and ferruginous limestone, containing fossils which, though much distorted, are in parts still distinguishable. They consist of joints of crinoids, casts of brachiopodous shells, trilobites and corals. Among the latter are two species of *Astrocerium*, not distinguishable from *A. pyriforme* and *venustum* of the Niagara group, and a *Heliolites* allied to *H. elegans*, if not a variety of this species.* On the evidence of these fossils and the more obscure remains associated with them, Prof. Hall regards these beds as equivalents of the Niagara formation of the New York geologists, the Wenlock of Murchison. Their general strike is N. E. and S. W.; and to the southward, or in the probable direction of the dip, they are succeeded, about six miles from Beech Hill, by granite. They have in general a slaty structure coinciding with the strike but not with the dip of the beds, and this condition is very prevalent throughout this inland metamorphic district, where also the principal mineral veins usually run with the strike. The beds just described run with S. W. strike for a considerable distance, and are succeeded in ascending order by those next to be described."

* [These corals fortunately show their structure very distinctly when cut and polished, though from the hardness of the rock their external forms are obscure.]

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" At Nictaux, 20 miles westward of New Canaan, the first old rocks that are seen to emerge from beneath the New Red Sandstone of the low country, are fine-grained slates, which I believe to be a continuation of the Dictyonema slates of Beech Hill. Their strike is N. 30 to 60 E., and their dip to the S. E. at an angle of 72°. Interstratified with these are hard and coarse beds, some of them having a trappean aspect. In following these rocks to the S. E., or in ascending order, they assume the aspect of the New Canaan beds; but I could find no fossils except in loose pieces of coarse limestone, and these have the aspect rather of the Arisaig series than of that of New Canaan. In these, and in some specimens recently obtained by Mr. Hartt, I observe *Orthoceras elegantulum*, *Bucania trilobita*, *Cornulites flexuosus*, *Spirifer rugecosta* ? and apparently *Chonetes Nova-scotica*, with a large *Orthoceras*, and several other shells not as yet seen elsewhere. These fossils appear to indicate that there is in this region a continuance of some of the Upper Arisaig species nearly to the base of the Devonian rocks next to be noticed." [Some Lamellibranchiate and Gastropod shells in the limestone above referred to, led me to infer that some member of the Upper Silurian series not seen at Arisaig may occur here, and may represent the Salina formation of the American geologists, just as distinct Niagara fossils, not seen at Arisaig, occur in New Canaan.]

" After a space of nearly a mile, which may represent a great thickness of unseen beds, we reach a band of highly fossiliferous peroxide of iron, with dark coloured coarse slates, dipping S. 30° E. at a very high angle. The iron ore is from 3 to 4½ feet in thickness, and resembles that of the East River of Pietou, except in containing less silicious matter. The fossils of this ironstone and the accompanying beds, so far as they can be identified, are *Spirifer arenosus*,* *Strophodonta magnifica*, *Atrypa unguiformis*

* There is in the iron ore and associated beds, another and smaller *Spirifer*, as yet not identified with any described species, but eminently characteristic of the Nictaux deposits. It is usually seen only in the state of crusts, and often strangely distorted by the slaty structure of the beds. The specimens least distorted may be described as follows: General form, semi-circular tending to semi-oval, convexity moderate; hinge line about equal to width of shell; a rounded mesial sinus and elevation with about ten [to twelve] sub-angular plications on each side; a few sharp growth ridges at the margin of the larger valves. Average diameter about one inch; mesial sinus equal in width to about three plications. I shall call this species, in the meantime, *S. Nictavensis*." [It is nearly allied to the well-known *Spirifer mucronatus* of the Hamilton group.]

[now known as *Orthis hipparionyx*], *Strophomena depressa* [now usually known as *S. rhomboidalis*], and species of *Avicula*, *Bellerophon*, *Favosites*, *Zaphrentis*, &c. These Prof. Hall compares with the fauna of the Oriskany sandstone; and they seem to give indubitable testimony that the Nietaux iron ore is of Lower Devonian age.

"To the southward of the ore, the country exhibits a succession of ridges of slate holding similar fossils, and probably representing a thick series of Devonian beds, though it is quite possible that some of them may be repeated by faults or folds. Farther to the south these slates are associated with bands of crystalline greenstone and quartz rock, and are then interrupted by a great mass of white granite, which extends far into the interior and separates these beds from the similar, but non-fossiliferous rocks on the inner side of the metamorphic band of the Atlantic coast. The Devonian beds appear to dip into the granite, which is intrusive and alters the slates near the junction into gneissoid rock holding garnets. The granite sends veins into the slates, and near the junction contains numerous angular fragments of altered slate.

"Westward of the Nietaux River, the granite abruptly crosses the line of strike of the slates, and extends quite to their northern border, cutting them off in the manner of a huge dyke, from their continuation about ten miles further westward. The beds of slate in running against this great dyke of granite, change in strike from south-west to west, near the junction, and become slightly contorted and altered into gneiss, and filled with granite veins; but in some places they retain traces of their fossils to within 200 yards of the granite. The intrusion of this great mass of granite without material disturbance of the strike of the slates, conveys the impression that it has melted quietly through the stratified deposits, or that these have been locally crystallised into granite *in situ*.

"At Moose River, the iron ore and its associated beds recur on the western side of the granite before mentioned, but in a state of greater metamorphism than at Nietaux. The iron is here in the state of magnetic ore, but still holds fossil shells of the same species with those of Nietaux.

"On Bear River, near the bridge by which the main road crosses it, beds equivalent to those of Nietaux occur with a profusion of fossils. The iron ore is not seen, but there are highly

fossiliferous slates and coarse arenaceous limestone, and a bed of gray sandstone with numerous indistinct impressions apparently of plants. In addition to several of the fossils found at Nietaux, these beds afford *Tentaculites*, an *Atrypa*, apparently identical with an undescribed species very characteristic of the Devonian sandstones of Gaspe [this is now known as *Leptocoelia flabellites*], and a coral which Mr. Billings identifies with the *Pleurodictyum problematicum*, Goldfuss, a form which occurs in the Lower Devonian in England, and on the continent of Europe."

It will thus be seen that I recognized, on the evidence of stratigraphy and fossils, in the district extending from New Canaan to Bear River, the following groups of rocks:—

1. The Niagara series, the Wenlock of English geologists, represented by the *Dietyonema* shales and the coral-bearing rocks of New Canaan. This group may be called either Middle or Upper Silurian, according to different classifications in use.

2. The Upper Arisaig series (of my arrangement, not of that subsequently advocated by Dr. H.) This is the equivalent of the Lower Helderberg series of America, the Ludlow of England, and is the upper member of the Upper Silurian as held at that time.

3. The Oriskany series, represented by iron ores, sandstones or slates. At that time the Oriskany was regarded by all as Lower Devonian. More recently some American geologists have proposed to place it in the upper part of the Upper Silurian, above the Lower Helderberg, with which its fossils have some affinity.

If I understand Dr. H., he admits the ages which I have assigned to Nos. 1 and 2 above mentioned, though, after his usual manner, without giving the slightest credit for the original discovery of the facts, but he assigns No. 3 to the horizon of the Medina sandstone, a formation older than the Niagara, and regarded as an equivalent of the Mayhill sandstone (Llandovery) of Great Britain. The first reason assigned for this opinion is one based on mineral character, "I at once recognized the Mayhill sandstone," &c. On this I may merely remark that any geologist who would profess to distinguish at sight the Oriskany sandstone from the Medina sandstone would be more characterised by boldness than prudence. The stratigraphy of the district is confessedly somewhat obscure, and I fail to find in Dr. H.'s paper any new light tending to the inversion of the section as it

was understood by me many years ago. The fossils must in this matter furnish the most reliable information, and in this department unfortunately Dr. H. merely gives lists of genera, most of which have a very wide range, and which prove nothing, unless the species can be determined with accuracy. In this, however, there is some difficulty. The specimens are usually merely casts, they are much distorted, and from the hardness of the rocks they can usually be procured only in fragments. When in the region, I collected very diligently, and have since carefully studied my collections, and compared them with fossils of various portions of the Upper Silurian and Devonian; but though I have arrived at much more definite determinations than those given by Dr. H., I have hesitated to publish detailed lists. It is now necessary, however, to go into details, and I trust I can show to the satisfaction not only of palæontologists but to that of any student who possesses a geological text-book, that Dr. H.'s conclusions on this subject are wholly illusory.

The following list refers to my collections from the Nictaux ore and the neighbouring beds, and from Moose River and Bear River, on approximately the same horizon:—

1. *Zaphrentis*, a large species with deep calyx; but a cast merely, and therefore not determinable specifically.—Nictaux.

2. *Favosites*. General form and size of cells similar to those of *F. cervicornis*, Ed. and Haime; tabulæ continuous and very close.—Nictaux and Bear River.

3. *Pleurodictyum problematicum*, Goldfuss. Cast of a large specimen.—Bear River.

4. *Stenopora*. A branching species with very fine cells.

[Of the above corals No. 3 is characteristically Devonian. The others are found in association both in the Upper Silurian and Devonian.]

5. *Strophodonta magnifica*, Hall. A large *Strophodonta*, resembling, as far as the specimens admit comparison, the above species, characteristic of the Oriskany.—Nictaux and Bear River. Dr. H. somewhat disingenuously writes of *Strophodonta* as if it were a characteristically Clinton genus. In point of fact, of 56 species of this genus catalogued by Miller in his American Palæozoic fossils, 43 are found in the Oriskany and overlying formations, and only three as low as the Clinton and Niagara, while no species whatever is known in the Medina.

6. *Strophomena rhomboidalis*. Fragments from Nictaux.

7. *Spirifer arenosus*, Hall. This characteristically Oriskany species is so abundant at Nictaux, that though the specimens are imperfect, I think its recognition certain. It is found also at Bear River.

8. *Spirifer arrectus*, Hall, or allied, also an Oriskany species.—Nictaux.

9. *Spirifer Nictavensis*. This is the most abundant species in the Nictaux ore, some specimens of which are crowded with it, and it is also found at Bear River. It is very nearly allied to the well known *Spirifer mucronatus* of the Devonian. It is perhaps still nearer to *S. Gaspensis* of Billings from the Gaspé sandstone; and no Spirifers of this type are known to extend so low as the Medina.—Nictaux and Bear River.

10. *Orthis hippariouyx*, Hall. A characteristic Oriskany shell, apparently represented by casts of the interior.—Nictaux.

11. *Leptocelia flabellites*, Hall. This little shell is abundant at the base of the Devonian in Gaspe, and the same or a very similar species is found at Nictaux and Bear River.

12. *Rensseleria ovoïdes*, Eaton. A very characteristic Lower Devonian species at Gaspe and elsewhere.—Nictaux.

13. *Megambonia*, very near to the Oriskany species *M. lamellosa*, Hall.—Nictaux.

14. *Avicula*, a large species of the type of the Oriskany species *A. textilis*, but too imperfect for determination.—Nictaux.

15. *Tentaculites*, not distinguishable from *T. elongatus*, Hall, of the Lower Helderberg.—Bear River.

16. I group together a *Platyceras* very near to an Oriskany species, a *Bellerophon* and an *Orthoceras*, found at Nictaux.

Fragments in my collection indicate several other species; but the above I hold to be amply sufficient to prove that the beds in which they occur are approximately of the age of the Oriskany sandstone, and cannot possibly be so old as the Clinton formation. I may notice in farther evidence of the facts stated above, that slates very near to the ore-bed hold Upper Arisaig (Helderberg) species, so that there appears to be a passage from the Lower Helderberg to the Oriskany, which would be quite natural; whereas the juxtaposition of Lower Helderberg and Medina fossils could take place only by extensive faulting or the absence of all the intermediate formations. It is also to be observed

that independently of the determination of species, the whole aspect of the fauna of the Nietaux iron bed, in its abundance of large ribbed spirifers, of large strophomenoid shells, and of great lamellibranchiate species, is different from that of the Medina, and on the contrary reminds an observer forcibly of the Oriskany sandstone of Gaspé and of western Canada. I shall show in the sequel that it is also distinct from that of the Upper Silurian red hematite of Pictou.

It should, however, be distinctly understood, that, in so far as I have held Devonian rocks to exist at Nietaux and Bear River, the upward extension of such rocks is limited to the Oriskany sandstone, and should any one hold that this formation may be included in the Upper Silurian, I have no objection; though I think that on physical grounds and by virtue of its close relationship with the overlying formations, it has quite as good claims to be correlated with the Lower Devonian.

The question which has been raised respecting the age of the granite, can only be discussed profitably on the ground. My notes of many years ago assure me, however, that I have traced the Lower Devonian beds into contact with the granite in such circumstances as prove the later date of the latter, and there are now in my collections specimens showing the gradations from the fossiliferous to the altered strata, including some which hold Oriskany fossils, but have assumed an incipient gneissic structure, and were penetrated by granite veins. It is further to be observed that the age assigned by me to these granites accords with the fact that in Nova Scotia the formations older than the Carboniferous are more or less in an altered and disturbed condition, and that granite debris does not occur as a prominent ingredient in our formations till the Lower Carboniferous age. In the district in question, the thick beds of granitic sandstone in the Lower Carboniferous near Wolfville and Lower Horton, afford a good illustration. I hope that this interesting district may soon be surveyed and mapped by the officers of the Geological Survey, when we may expect to have more light thrown on this subject. In the meantime I would caution geologists against accepting the somewhat crude deductions of the paper referred to, more especially as this question affects our conclusions as to the age of the auriferous veins of the Atlantic coast, and as to the correlation of the intrusive granites of Nova Scotia with those of other parts of Eastern America.

2. PRE-CARBONIFEROUS ROCKS OF EASTERN NOVA SCOTIA.

The second paper, above referred to, is of a character so autobiographical, contains so little that is new in a scientific point of view, and deals so unceremoniously with the reputations of nearly all who have worked in the geology of Nova Scotia, that it is difficult to criticise it without being personal. I shall endeavour, however, to avoid this, and to confine myself to the geological questions involved.

The first attempt, after Dr. Gesner's Geology of 1836, to deal with the complexities of the older rocks in Eastern Nova Scotia, was made nearly thirty years ago, in a paper on the Metamorphic and Metalliferous Rocks of Nova Scotia, published in the Journal of the Geological Society in 1850; a very imperfect attempt, no doubt, but still a step of progress, and one involving much hard labour under very difficult circumstances. Before preparing the paper, I had examined lines of section from Pietou to the Atlantic coast, and had collected fossils at Arisaig and on the East River of Pietou. In this paper, the "shales, slates and thin-bedded limestones of Arisaig" were referred to the Silurian system, on the evidence of their fossils, as were also the similar rocks occurring on the east side of the East River of Pietou. I was obliged, however, to add that specimens taken to England by Sir C. Lyell, with whom I had visited the East River in 1842, had been referred by palæontologists there to the Lower or Middle Devonian age, and that Prof. Hall, the best American authority on these fossils, appeared to lean to a similar conclusion.

The cause of this doubtful position of the matter is easily explained, without attaching any blame to the eminent geologists above named. At that time the line of separation of the Devonian and Upper Silurian was not very clearly defined; and indeed it may be said yet to be in some uncertainty, since it is only within a few years that it has been proposed to transfer the Oriskany sandstone to the Upper Silurian, and in the latest classification of the Gaspé series by the Geological Survey of the Dominion,* no less than 880 feet of shales and limestones are designated as "passage beds" between the two. In addition to this, the fossils from the Nova Scotia beds were to a large extent different from those both of the New York series and of England,

* Billing's Palæozoic Fossils, 1874.

so that their general facies only could be compared, many of them were in an imperfect state of preservation, and our whole collections were not large.

Matters remained in this state until the preparation of my *Acadian Geology*, published in 1855, when it became very desirable to obtain some clearer light on the subject, and accordingly considerable collections of the fossils were made and sent to Prof. Hall, and to palæontologic friends in England, in the hope that these difficulties might be cleared up. But up to the time of the publication of the book, and for some time thereafter, no aid came from either quarter. In these circumstances, being convinced that some of the lower fossiliferous beds must be Silurian, and supposing that some of the upper beds were Devonian, but having no means of separating them, I included both under one chapter, and placed over the few fossils I ventured to figure, the title "Devonian and Upper Silurian."

On my removal to Canada in 1855, I at once availed myself of access to the collections of the Geological Survey, and of the advice of Mr. Billings in the arrangement of my collections, and sent further specimens, along with a number of species communicated to me by Dr. Honeyman, the late Dr. Webster of Kentville, the late Dr. Harding of Windsor, and Mr. Hartt of Wolfville,* to Prof. Hall; and in 1859 I received from him the series of descriptions of the Nova Scotia Upper Silurian fossils published in 1860 in the *Canadian Naturalist*, and which really constituted the "first step" in the palæontology of these difficult rocks. The only credit that the gentlemen above named or the writer can claim is the collection of materials; and Nova Scotia owes a debt of gratitude to the New York Palæontologist for his gratuitous labours in our behalf, at a time when he was pressed with many and engrossing occupations. It was at this time, and while I was in correspondence on the subject with all the friends in Nova Scotia above named, and with Prof. Hall, that, in advance of the latter gentleman's full report, I sent to the Nova Scotia Literary and Scientific Association a communication, in which I referred to the labours of all these gentlemen, and stated the results arrived at as follows:—"At Arisaig and other places in the East, where

* Afterwards Prof. Hartt of Cornell, and the head of the Survey of Brazil; a very able geologist, too early removed by death, and who worked most successfully in the geology of New Brunswick and Nova Scotia.

the older rocks come out from beneath the Carboniferous system, we have a series of shaly and calcareous beds, consisting of two members. The Upper, and more calcareous and fossiliferous of the two, is of the same age with the Lower Helderberg of the New York geologists and the Ludlow of the English geologists. The Lower, more shaly and containing Graptolites, may be as old as the Clinton, the Upper Llandovery of England." In the following sentences the occurrence of similar fossils on the East River and at Earlton is indicated, and the several ages of the New Canaan and Nictaux series already stated are referred to. This paper was written in the summer of 1859, and was published in a Halifax newspaper, I suppose, in the winter of the same year. It appears that Dr. Honeyman had previously, in a paper which he calls his "debut" in writing on Nova Scotia geology, and dates April, 1859, asserted the Upper Silurian age of the Arisaig series, and on this ground has based very large claims with reference to Nova Scotia geology. I have not a copy of this paper, and do not remember its contents, if indeed I ever saw it; but on his testimony I have, both in my paper of 1860 and in the 2nd edition of *Acadian Geology* (page 566), acknowledged his prior publication, feeling, however, that the credit of establishing the age of these rocks on a firm basis belonged to Hall, and that Dr. H.'s reiterated assertion of his claims, coupled with sneers at my "supposed Devonian age" of these rocks, was, to say the least, in very bad taste. In truth, what we required at that time was not a mere opinion from any local geologist as to the age of these rocks, but a careful comparison by a palæontologist of the wide experience of Hall.

Here intervenes an unfortunate circumstance, on which Dr. H. dilates with evident pleasure, though he perfectly well knows the true explanation of it. In the masterly description of the Pictou coal-field by Logan and Hartley (*Reports of Geological Survey*, 1869), one of the most thorough geological investigations ever made in Nova Scotia; by some unexplained oversight, these authors referred to the older rocks, east of the East River, as Devonian, and gave my authority for this; although in my paper of 1860 and again in 1868 in *Acadian Geology*, I had described these rocks as Upper Silurian. Immediately on noticing this error, I mentioned it to Sir William, but this was not till after the publication of the Report. The rocks in question were not within the direct scope of Sir William's work at the time, and

were merely incidentally noticed, but I know that he regretted the error very much, though of course as I had, eight or nine years before, abandoned all idea of these rocks being Devonian, I could not be blamed for it.

Another point raised in the paper now in question, is the use of the terms *Upper Arisaig* and *Lower Arisaig*, a point perhaps of no great geological importance, but of some consequence since the abuse of those names has tended to cause confusion. Dr. H. calls this a "new division introduced in the second edition of the *Acadian Geology*, 1868," but it was really introduced in my paper of 1859 above quoted, and this Dr. H. has himself admitted in the *Journal of the Geological Society*, vol. xx, p. 233, though it seems now to have escaped his memory. The reasons for this division were as follows. The term "Arisaig series" is a useful local name for the peculiar development of the Upper Silurian in Eastern Nova Scotia. The results of Prof. Hall showed that the fossils were referable to the Canton and Lower Helderberg, without the intervention of any distinct representative of the Niagara limestone, and as the lower and upper members were somewhat distinct in mineral character, it seemed the most natural course to divide the series into Lower and Upper. Dr. H., who had an opportunity of showing his fossils to the late eminent palæontologist Mr. Salter, gives on his authority a more minute subdivision into five members. This will be found discussed in *Acadian Geology*, I trust in a fair spirit, and the relations of the two arrangements pointed out. But more recently Dr. H. has thought proper to change the name of the whole Arisaig series as before understood, to "Upper Arisaig," and to include as "Lower Arisaig" rocks which he regards as Laurentian. This is objectionable, not only as interfering with established and useful names, but as extending local terms to a degree which no other geologist can possibly accept. It amounts in fact to calling the whole Eozoic and Lower Palæozoic by the local name "Arisaig series." For these reasons I shall continue, as heretofore, to use the terms Upper and Lower Arisaig for the subdivisions of the Upper Silurian as represented at that place.

Another question raised in this paper relates to certain rocks at Lochaber, in which Dr. H. affirms that he found fossils of the genus *Petraia*, which I had informed him belonged to the genus *Zaphrentis*, and thereby misled him as to their age. The specimens referred to were sent to Montreal in 1860, along with

a paper by Dr. H., which was read before the Natural History Society, and I was requested by him to give some opinion as to their age and nature, which I did, after consulting the late Mr. Billings, and added a note on the subject to Dr. H.'s paper when it was published. Some time afterwards I was surprised to find Mr. Salter's authority cited in direct opposition to mine, with the usual flourish of trumpets as to a great mistake discovered and exposed. On re-examining the fossils, which still remain in my collection, I could not change my opinion of their nature; and never having had an opportunity to compare notes with my poor friend Salter, one of the soundest palæontologists of our time, and who has on more than one occasion done us good service in determining difficult fossils, as the pages of Acadian Geology show, I have not yet had any solution of the mystery, and have not complained of this, though I felt that I had received a poor return for an intended service. The fossils themselves are however of some interest. They consist of two turbinate corals from Lochaber, one from Marshy Hope, one from Doctor's Brook, and one from French River, with a few other species from Lochaber. These corals are in the form of mere impressions, in which state it is not always easy even to distinguish genera. Still, in the deep fossette, the character of the septa, and the traces of the horizontal tabulæ, they all have the characters of *Zaphrentis* rather than *Petraia*; except one from Lochaber, which which can scarcely be anything other than a *Heliophyllum*. The other fossils from Lochaber are a *Stenopora* similar to one found at Arisaig and East River, *Strophomena rhomboidalis*, an *Orthis* resembling *O. elegantula*, and shells resembling *Pentamerus* and *Atrypa*, but not well preserved. The *Zaphrentis* from Doctor's Brook resembles *Z. Stokesii*, a species of Niagara age. That from Marshy Hope seems different, and in its form and deep cup resembles the *Z. rugulata* of Billings from the Gaspé limestones. These might fairly belong to the Lower Arisaig series, and possibly to the lower part of it. The French River specimen is merely a cast of the exterior and quite undeterminable. But the Lochaber species seems different, having a shallow cup, with deep fossette, and from its association with *Heliophyllum* and the other fossils, I still think it probable that it belongs at least to a higher horizon than that of the Lower Arisaig. Of course as I have not seen the specimens submitted to Salter, I cannot express any opinion as to them; but if similar to mine, I am at a loss to account for his opinion, and as the specimens in my possession

seem to contradict the greater age assigned to the rocks, I have not ventured to adopt that opinion—though, up to this time, without taking any notice of Dr. H.'s references to my supposed mistake.*

Another point in which I find I am at issue with Dr. H. is the age of the great iron ore bed of "Webster's" or "Blanchard's" on the East River of Pietou, and which also has been traced to the eastward in Merigomish. This I have assigned to the Lower Helderberg on the evidence of stratigraphy and fossils. Of the latter large collections have been made by Mr. D. Fraser and myself in connection with the recent explorations of these ores. They appear to be of unequivocal Upper Arisaig facies, but include many new and interesting forms which I had hoped to have described ere this time, but this has proved absolutely impossible from want of leisure. They may represent a special horizon in the Upper Arisaig, or even between the upper and lower members, or their peculiarities may be the result of local conditions of deposit. Dr. H. seems to affirm that this iron ore is of the same age with that of Nictaux, and that both are of the age of the Clinton or Medina sandstone. Neither of these positions can be correct, for the fossils of the East River hematite seem closely related to those of the typical Upper Arisaig series, while those of the Nictaux ores are, as already shewn, newer than the Upper Arisaig. These two great deposits of iron ore are therefore not of the same age, and neither of them can be as old as the Clinton. Dr. H. correlates them with the Clinton ore-beds of the United States, but he omits to notice that there are also ore-beds in the Helderberg series of that country. I should not, indeed, be surprised were some of the newly opened beds at Nictaux, which I have not seen, to prove of Helderberg age, or were beds of Oriskany age to be found at Pietou. It is probable, however, that these ore-beds are less constant than some of the strata associated with them.

The remarks made by Dr. H. on the alleged Lower Silurian of Wentworth, scarcely merit criticism. It is to be regretted,

* It is to be observed here that the relations of the genera *Petraia* and *Zaphrentis* are not so clearly defined as they should be. Some palæontologists of eminence reject *Petraia* altogether, and unite these corals with *Cyathophyllum*, and the limits of the genus *Zaphrentis* are differently understood by different authorities. Still there are certain forms, by whatever name known, which are, in our American geology, characteristic of certain formations, and it is by this indication that I have been guided in this case.

for his own sake, that he has ventured to attack Mr. Billings's determination of the age of the fossils, as he has done (p. 480), and also that he has republished his section of the Wentworth cutting, in which the well-known intrusive dykes of dark diabase, so abundant in the Cobequids, figure as bedded diorites, and swell the thickness of a section which is in many respects truly "remarkable." I have not had an opportunity to examine Dr. Honeyman's collections from Wentworth; but those I have myself made, and those I have seen in the Museum of the Geological Survey, by no means warrant his determination of a Bala or Hudson River age. This subject will be found noticed in the Supplement to Acadian Geology, p. 75.

This review has extended to too great a length; but one is tempted to notice the Laurentian discoveries of the author. Dr. Honeyman, when employed by Sir W. E. Logan in 1868 in exploring at Arisaig, examined the coast east of Malignant cove, and found there the extension to the sea cliff of rocks apparently identical with that old metamorphic series which I have named the Cobequid series. These he has described as Laurentian, and quarrels with Sir W. E. Logan, Dr. Hunt and myself for failing to admit this age. My own justification is,—first, that, as Dr. H. admits, there is no good evidence from stratigraphy or fossils to prove this great age; and secondly, that after somewhat extensive studies of Laurentian rocks, I have been unable to see any resemblance between the typical rocks of this age and the so-called Laurentian of Arisaig, the Cobequids and southern Cape Breton. All these rocks I hold, for reasons stated in the Supplement to Acadian Geology, to be probably either Lower Silurian, Cambrian or Huronian. Dr. H. repeatedly taunts me with affirming these rocks, and even those of St. Anne's in Northern Cape Breton, to be Devonian; and goes so far as to relate an anecdote (p. 453) which would seem to show that so late as 1867 he had retailed this fiction to Sir Wyville Thomson, in connection with specimens of *Eozoon* stated to have been obtained in these rocks. Lest the same practical joke should be played on others, it may be well to say that I have never seen anything resembling *Eozoon* from St. Anne's, and that I am not aware of ever having supposed the crystalline rocks of that promontory to be Devonian. In reality, after much study of specimens, and after revisiting in 1877 some of the most instructive sections in Nova Scotia, I fail to perceive any good lithological evidence for the Laurentian age of any of the older rocks of the Province, except some of those in

Northern Cape Breton, and notably those of St. Anne's mountain, which have, apparently on good grounds, been referred to this age by the late Mr. Hartley and Mr. Fletcher.

One word as to the geological map in 'Acadian Geology,' which notwithstanding its imperfections, needs no apology, when its nature as a mere preliminary and imperfect sketch, the result of private effort and not of a regular survey, is fairly considered. The materials do not exist for a detailed map of the older formations of Nova Scotia. They are being slowly accumulated by the labours of the Geological Survey of the Dominion; but I do not expect to live to see them complete. Dr. H.'s criticisms, which are so microscopic as scarcely to allow for the accidents of printing, would be unfair, if applied to a map on this scale, even had I been employed to make a regular survey of the country, and had many years been spent in the work. They are specially objectionable when applied to a work executed without public aid; and when proceeding from a man who has enjoyed opportunities of official employment not accorded to me. The time was when I had hoped to have spent my life in working up the geology of my native province, and more than twenty-five years ago I suggested a method in which at little public expense this end might have been secured. Had I been engaged for those years in an official survey, and had the result been as incomplete as it stands at present, there might have been reason for complaint. My excuse for attempting a map at all, is the necessity of it in order to render descriptions of local geology intelligible; and if any apology is needed for my continuing to work in the geology of Nova Scotia, I must plead my affection for my native country, and my interest in its structure, which have induced me, perhaps unwisely, to prefer such work to pursuits of other kinds, in some respects more tempting or more remunerative. Nor shall I regret this, even though, in my advancing years, I may receive from my countrymen no other reward than that scant courtesy which they extend to me through the Curator of their Provincial Museum.

NOTE.—Since writing the above, I have received Volume "F" of the Report of the Second Survey of Pennsylvania, relating to the "Fossil Iron Ore Beds" of Middle Pennsylvania. In this report, bedded iron ore deposits are described as occurring in the Clinton, Lower Helderberg, Oriskany, Corniferous and Marcellus, so that they range, as I believe they do in Nova Scotia, from the Middle of the Upper Silurian to the Lower Devonian inclusive. The principal deposits in Pennsylvania are in the Clinton, Oriskany and Marcellus. In Nova Scotia only small layers are known to me, at Arisaig and East River, so low as the Clinton, and the principal deposits seem to be Lower Helderberg and Oriskany. The analogy is thus sufficiently close, beds of the age of the Marcellus not having been recognised in Nova Scotia.

I have used the term "Devonian" in the above paper; but, owing to the doubts and controversies respecting the Devonian rocks of England, I greatly prefer the term "Erian," derived from the great development of the typical rocks of this age on the shores of Lake Erie.

February, 1879.



