and consequently have large quantities of ores lying in their stores in England. This check cannot be considered otherwise than as a partial hindrance, which it is to be hoped will soon be removed. The surveyors also have returned without accomplishing their intended route, owing to the want of water and failure of stores. I believe they returned upon their route when half way across. It is true that we have had an exceedingly dry summer.

Art. IV.—Record of Observations on the Geology of Nova Scotia, since 1855.

By Rev. D. Honeyman, D. C. L., F. G. S., &c., *Director of the Provincial Museum.*

(Read December 12, 1870.*)*

I proceeded from Arisaig to examine the district about Antigonish, I took the road that passes along Arisaig Brook and Doctor's Brook, through the mountains. South of these mountains before descending into the lower ground I found a considerable outcrop of Lower Carboniferous Limestone, shewing the existence of the Carboniferous formation in this direction. Having reached Antigonish, I commenced the examination of the subtriangular area of rocks, of which the Sugar Loaf forms a part.

In this band there are two anticlinals and an intermediate synclinal. The south side of the one anticlinal is overlaid unconformably by carboniferous strata, and so is the north side of the other. The axis of the southern anticlinal is in the line of the summit rock of the Antigonish Sugar Loaf. This rock is greenstone. The line of the northern anticlinal is about two miles north of the Sugar Loaf. The greenstone of this axis is exposed in an outcrop on McDonald's farm near the Gulf Road, and also in McDonald's Brook to the east. This axis extends eastward and outcrops on the side of St. George's Bay. It also extends westward and outcrops in a bluff east of Saml. Cameron's. This area of metamorphic Arisaig strata is bounded S. W. and N. by carboniferous strata. In a small brook at the side of the Gulf

Road the limestone of the Doctor's quarry and their underlying conglomerates, are seen to lie unconformably on slates having their cleavage joints glistening with scales of micaceous peroxide of iron. The slates are the extreme outcrop of the south side of the southern anticlinal; they dip at an angle of 55°, while the unconformable conglomerates and limestones dip at an angle of 30°.

These facts are obvious, and the conclusion simple and prosaic; somewhat different it will be deemed from the poetic and lofty imaginings of some theorists, who, without observing facts, have seen the Sugar Loaf with its elevation of 710 feet (Bayfield) and its congeners with a glorious saddle of thousands of feet of carboniferous strata which have disappeared as if by magic, by the glorious agents of denudation. These have succeeded wondrously in establishing a connection between the various carboniferous areas of Nova Scotia and Cape Breton, and of these conjointly with other carboniferous areas of the American Continent in defiance of all interposed obstructions and the sterling principles of Inductive Philosophy.

The summit of the Sugar Loaf is about 1½ miles from Antigonish—the second axis at McDonald's Brook is four miles from the same town and the mountains at Walsh's, the northern exposure of the Silurian area. This appears to have been a small subtriangular island in the sea of the lower carboniferous period. There is a great band of conglomerates and grits with limestone and gypsum on its southern side, which separates the Sugar Loaf Silurian area from the great area of which the mountains of Arisaig form a part. This lower carboniferous band connects the carboniferous area which lies to the north of the Sugar Loaf area and stretches to St. George's Bay with the great carboniferous area which lies to the south of the same area, and stretches to the Strait of Canso. This band of conglomerates is an anticlinal—the axis of this is concealed. It seems to be a continuation of the northern axis of the Sugar Loaf area—the same axis seeming to pass into the other Silurian area. Whether this is the fact or not, remains to be proved by future investigation.

The gypsum deposits which lie to the south of the Sugar Loaf area, and skirts it throughout its length extending along the

carboniferous conglomerate to the west, and skirting the other Silurian area on the south, onward to James's River, the longitudinal extent being about fifteen miles, and extends to the settlement of lower South River, breadthwise across the harbor. These have manifested the existence of reservoirs of brine and saliferous clays, having a thickness of at least six hundred and ten feet. This accounts for the existence of the salt pond to which I referred, and on the origin of which I speculated in my paper on the Geology of Antigonish County, *vide* Transactions of the Institute, Vol. 2, Part 4.

In this area, situate on the south side of Antigonishe Harbour, there is a very interesting exposure of syenites and overlying limestones, which want more than a passing notice. A plan of these, which I made for the Geological Survey, coloured, presented a very curious appearance. The two rocks conjointly form a noticeable hill of the elevation of three hundred feet above the sea level, according to Bayfield. On the summit the limestone is parted by the syenite: the one and the other contending for the supremacy. The limestone forms the summit rock; the limestone is highly fossiliferous throughout—the prevailing fossils are *cyrtoceras*, *connularia*, *dentatium*, and *leperditia*. *Leperditia Okeni* is very abundant. The limestone here has this fossil in common with the Windsor limestones. I believe I found this organism in the Windsor limestones prior to its discovery by Mr. Hart, and I identified it as the Leperditia Okeni in the Hunterian Museum of the University of Glasgow in 1865. When I was Commissioner at the Dublin Exhibition, I found its representative in the fine collection of Leperditia and other entomostraca belonging to Dr. Hunter, Curator of the Museum. Another fact connected with the limestone in question is, that it does not appear to be affected by contact with the syenite, in the way that the Oneida conglomerate of Arisaig has been affected by contact with the greenstone. In contact with the syenite, I found the limestone and its fossils without the slightest appearance of alteration. I collected specimens of connularia from the summit limestone in as good condition as any connularia that I had met with. This shews unquestionably that the syenite is different in its origin from greenstone, and also that the process of meta-

morphism, by which it acquired its present constitution, was complete before it attained its present position; and that the limestones were formed directly upon the syenite in the bottom of the sea of the carboniferous era. The conglomerates around Antigonishe and Cape St. George have had a good deal of attention given to them. I was long puzzled to know whence they derived the most of their pebbles. One large mass on the shore of St. George's Bay, north of Ogden's, contained a boulder of coarse red granite, such as is to be met with at Sherbrooke and Country Harbour, but not nearer, as far as was known or suspected. The grits of Yankee Grant which are used in the construction of the Antigonishe cathedral, are micaceous in a wonderful degree. The question arose whence came the mica? The grit in Malignant Brook, to the North of St. Mary's chapel, are equally micaceous, whence comes the mica? The sandstones with carboniferous flora at Graham's Brook, near Cape George, were also very micaceous. In short, the farther the lower carboniferous strata became removed from known granitic rocks, the mica appeared to increase in proportion. All was made clear, or nearly so, by the discovery of an interesting series of rocks on the shore of Northumberland Strait, where I had long assumed the existence of a continuation and connection of the conglomerates of Malignant Cove and Cape St. George. This band, which is of considerable breadth, consists of diorites, hornblende rock, ophite, ophiocalcite, black quartzite, with quartz veins, having abundance of crystals of silvery mica. Succeeding these are bands of white and red syenite, having veins of green felspar. These syenites are sparingly hornblendic. Without much hesitation I concluded that I had discovered a band of Laurentian rocks, the ophiocalcites particularly leading me to this conclusion. I had never seen the Laurentian rocks of Canada, but I had seen and studied the fine collection of specimens of Laurentian rocks in the Canadian and Newfoundland departments, in the Paris Exhibition of 1867. This collection was exhibited by the Geological Commission of Canada. The part of the collection in the Canadian department was distant from the front of our court only the breadth of the passage, and the Newfoundland part not six feet from the door of my office; so that the collection and I became somewhat familiar in the course of six

months. I thought I had met my Canadian acquaintance at Arisaig. The discovery of Eozoon, by Drs. Dawson and Hunt, in specimens of the Arisaig ophiocalcite has confirmed this opinion. In all probability this band of metamorphic rocks is overlaid unconformably by lower carboniferous strata. Passing from Malignant Cove along the road to Antigonishe we meet with a good outcrop of sandstones These lie to the east of the terminal range of the Arisaig mountains, *e.g.* Sugar Loaf and McNeil's mountains already referred to. A continuation of these sandstones eastward will pass south of the Laurentian rocks, without giving much room for intervening rocks. This region is forest. In this Laurentian series, it will be observed, there exists mica sufficient to account for the micaceous character of the grits and sandstones already referred to. Many of the pebbles of the conglomerates also noticed may have come from this quarter. The only desideratum is a rock which could furnish the red granite boulder of the mass of conglomerate found on the shore of St. George's Bay. Although the rock has not been found, there is every probability that it may be found there. Of this we are certain at least, that all the constituent minerals are there, although I have not found them united in the same rock, so as to form the rock required. I go a step farther, and regard the syenite of McNeil's mountain with the middle and upper silurian metamorphic overlying it, and also the syenite with the overlying Leperditia limestone as outcrops of the Laurentian series; and then I would adopt Professor Hind's view of the character and age of the granite, and regard the Sherbrook and Country Harbour rocks as outcrops of the same series, and consider that one process of metamorphism affected the whole of this class of rocks in Nova Scotia.

I find the following observation in Acadian Geology, Ed. 1855, chap. 14, Devonian and Upper Silurian Systems, page 311, "Granite composed of distinct crystals of quartz, felspar and mica. Granite is a rare rock in this district, though found in great masses in the other metamorphoric districts.

In my paper on the Geology of Londonderry Iron Mines, read before this Institute in winter 1866–7, I noticed the existence of granite among the rocks underlying the slates containing the iron ores. These observations converge to the same point.

I have already observed that I found granite in a mountain at Big Baddeck, and was thereby led to infer and maintain that the auriferous slates of Wagamatcook, or Middle River Cape Breton, lying at no great distance from the mountain, were Lower Silurian metamorphic, like the slates of Nova Scotia Gold Fields. I would now observe, that among the specimens of polished marble sent to the Paris Exhibition from Nova Scotia there was a specimen of green marble (serpentine) exhibited by W. A. Hendry, Esq., Deputy Commissioner of Crown Lands. This specimen attracted some attention. It was particularly noticed by Dr. Sterry Hunt, of the Canadian Geological Commission, and Professor Lesley. Professor Wyville Thomson, of Belfast, also noticed it, and detected in it what he called Eozoonal structure. He asked me where it came from, and from what geological formation. I réplied, from Cape Breton; that I had not examined the locality; that Dr. Dawson in his Acadian Geology had supposed that Devonian rocks prevailed in the region. Considering that the specimen would be of sérvice in proving that the Eozoon Canadense was not organic, he asked for the specimen and received it. The specimen excited some commotion in London, among the Eozoonal controversialists. Dr. Hunt cognizant of all this, ventured to make the following forecast. "A line drawn from Malignant Cove (Arisaig) Laurentian to Newfoundland, will pass through Cape Breton, we may now expect to find limestones with Eozoon there." (Professor Hind's letter, addressed to Hon. R. Robertson, Chief Commissioner of Mines, Nova Scotia—*Chronicle Newspaper*.) Whether this specimen has Eozoon structure or not, there is one thing certain, that the specimen resembled the Laurentian of Arisaig, and there is every probability that the Cape Breton Laurentian and the Arisaig are of the same geological age—Laurentian. With a view to a farther elucidation of the subject, I requested Mr. Murray, student of the Presbyterian Theological Hall, when going to Cape North, C. B., last spring, to bring for the Museum specimens of the prominent rocks. Among the specimens which he brought there are very coarse granites;—two from Whitehead, Aspy Bay, one from a granite rock situate about fifteen miles from Cape Ray, or seventeen and a half miles S. S. W. from Whitehead. The felspar of the speci-

mens is flesh coloured; the quartz glassy white and red; the mica black and white. Some of the plates of black mica are 1 x ¼ inch; others 1¼ x 1 inch. The inland specimen of granite is the exact counterpart of the specimen from the mass of conglomerate in St. George's Bay: this is a coincidence. Comparing a specimen of the red syenite of the Laurentian at Arisaig, with a specimen of the red syenite of the syenite and limestone mountain S. of Antigonishe harbour, I find that the latter is much more hornblendic than the former. I find in the specimen of the Antigonishe harbour syenite a plate of green mica, the same as the mica of the specimen of granite from the Big Baddeck mountain. Mr. Hendry has kindly located Wagamatcook Gold Field and the St Ann's serpentine on a map of Cape Breton, belonging to the Crown Land office. This map is on a scale of 2½ miles to the inch. Upon the same map, Mr. Murray and Mr. Austen, of the Crown Land department, have located for me the rocks in the district of Aspy Bay, which produced the specimen of granite. On drawing a straight line on this map from Baddeck mountain so as to bisect the line connecting Whitehead with the locality having the granite, seventeen and a half miles S. of W. from it—of course this is only to be considered an arbitrary line—I find that Wagamatcook auriferous slates is five miles from the line on the one side, and St. Ann Laurentian three miles from the same line on the other side. These facts are somewhat striking, and may indicate Cape Breton as the meeting place of undoubted Laurentian and auriferous silurian, and as connecting Arisaig Laurentian with the granites of the Nova Scotian Gold Field.

In this way we come to the conclusion at which Professor Hind had arrived, by a shorter process, in reference to the Geological age of the gneissoid rocks of Nova Scotia and Cape Breton.

It will be observed that there are certain great geological formations that lie between the Laurentian and Middle Silurian which have no representative at Arisaig or the other localities which it represents, viz., the Huronian or Cambrian, and the Lower Silurian. Dr. Dawson in his Acadian Geology, 1st Ed. pointed out the band of rocks on the Atlantic coast which are the gold bearing rocks as Lower Silurian. I imitated his example in maintaining

this view in the Geological Society in 1862. Dr. Dawson still maintains his position in his Ed. of 1867. Prof. Hind has lately advanced a step farther, and shews the granite to be gneissoid and Laurentian, and the overlying formations which constitute the band in question to be Cambrian, Huronian and Lower Silurian.

I have heretofore chiefly appealed to the evidence of fossils, directly or indirectly, in proving geological age or succession.

In investigating the Nova Scotian auriferous band of rocks, this kind of evidence appears to fail us. I have searched long and diligently among the grits and slates of this series of rocks, for fossils, but hitherto without success. I have found from time to time, above the rocks, or in them, what I considered to be fossils, or possibly fossils, the former turned out to be of carboniferous age, the latter, mineral structure. I am afraid that the experience of other observers has been somewhat like my own. It is then, as heretofore, on other grounds that I regard the rocks in question, as differing from the non-crystalline rocks of Arisaig, and as at least contributing to fill up the gap mentioned. During my term of service in the Geological Survey of Canada, I made what I believe to be a complete collection of the Middle and Upper Silurian rocks of the counties of Antigonishe and Pictou, These are to be found in the Provincial Museum, along with representative specimens of the rocks of the auriferous band collected at Waverly, Wine Harbor, Halifax and Dartmouth, &c. There is no possibility of confounding the two sets of rocks.

There is no rock in Antigonishe or Pictou that can be mistaken for the pyritiferous and andalusite slates of the N. W. Arm and Point Pleasant—the same may be said of the pyritiferous grit called *whin*. The argillites have altogether a different aspect from any of the argillites of Antigonishe or Pictou. The Oneida conglomerate and the Medina sandstone, unaltered or altered, have no resemblance whatever to the grit or *whin*. The Clinton altered slates with their iron deposits, and abundance of quartz veins, occasionally slightly resemble some of the auriferous argillites, and have thereby attracted the attention of gold seekers, and given occasion for newspaper announcements of gold discoveries. But the slates cannot for a moment be mistaken for those of the Gold

Fields, by the practised eye, and the search for gold in these veins of quartz has been a vain one, and the reported discoveries have no foundation in fact. Arisaig, East River, Irish Mountain, Sutherland's River, and Antigonishe, have all had a short-lived reputation of this kind. Cape Porcupine belongs to the same category except that its reputation has assumed a permanent form, having been perpetuated in the pages of the progress volume of the Geological Survey of Canada, 1869. We read thus, page 745, "In Nova Scotia although the gold occurs throughout the coast series, it is also said to be found at Cape Porcupine in rocks of the same age as these upper slates (Silurian or Devonian.) This probable identification of a part of the gold formation of Nova Scotia, with the altered Upper Silurian and Devonian strata of Eastern Canada, gives an additional economic interest to these rocks whose metalliferous character has already been commented upon on pages 711 and 734."

One of the best sections of the Clinton argillites of the regions referred to, is on the line of railway from Pictou to Truro, commencing near the Gairloch station and proceeding onward towards Truro. A passing observer can easily distinguish the difference between the argillites there exposed and the argillites of the Gold Fields seen in sections on the Railway from the Grand Lake toward the Junction and Still-water between Mount Uniacke and Windsor. I would yet advance another reason, which I regard as shewing the priority in time of the rocks of the Gold Fields. These rocks *e. g.*, between Freshwater and Point Pleasant, exhibit a higher degree of metamorphism than those of the Arisaig Middle and Upper Silurian series, (metamorphic,) with flexures and contortions which the others do not exhibit, such as are to be seen in the Lower Silurian of the Highlands of Scotland and in Wales.

This appears to me to be at least presumptive evidence of unconformability existing between the Arisaig series and the Gold Fields. It would have been more satisfactory if we had had the one set of rocks directly superimposed on the other. This, I have been altogether unable to find. It may be considered that I have been here labouring to prove what is universally taken for granted. I have already stated that the opinion has been main-

tained by eminent authority, and that the priority of the auriferous formation to the Middle and Upper Silurian has not been universally conceded, or is altogether so evident as most people appear to imagine. There appears to be some reason for supposing that the rocks in question may be Devonian, as the only rocks found directly superimposed upon these are the unquestionable lower carboniferous. If this were taken as indubitable or even presumptive evidence of the position, it would carry too far and lead to the conclusion that every argillite immediately overlaid by lower carboniferous was Devonian, and we would thus be carried back to a very remote period in the History of Nova Scotian Geology, if any such period ever existed. It will be observed that all that I attempt to prove is that the auriferous slates and grits of Nova Scotia are older than the Middle and Upper Silurian, and newer than the Laurentian, and may be Cambrian or Huronian, or Lower Silurian or both. If they are Huronian and Lower Silurian, as Prof. Hind seems to have established, then Nova Scotia has a complete series of formations from the Azoic or Eozooic to the last of the Paleozoic series, viz: Laurentian, Huronian, Lower Silurian, Middle Silurian, Upper Silurian, Devonian, Carboniferous, New Red Sandstone.

Art. V. Remarks on the Geology and Physical Geography of the North-east Coast of Kent (England.) August, 1870. By Alfred S. Foord, Esq., London.

(*Read January* 9, 1871.)

My attention was first directed to that part of the coast of Kent between Ramsgate and *Broadstairs, covering a distance of about five miles, and consisting of the Upper Chalk Formation, the cliffs being well exposed along the whole distance in a bold escarpment, attaining an altitude in some places of from sixty to eighty feet.

The most striking point observable in viewing these rocks from

*Formerly Bradstowe.