ART. V.—THE GEOLOGY OF CAPE BRETON—THE LOWER SILURIAN.— BY EDWIN GILPIN, JR., LL. D., F. R. S. C., ETC., *Inspector of Mines.*

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IN my last paper I gave a brief sketch of the Devonian Measures of Cape Breton and now come to the Lower Silurian rocks. I have already drawn attention to the remarkably limited developments of geological horizons in this island. Between the basal conglomerate of the Carboniferous and the Pre-Cambrian there intervene only a few limited areas referred to the Devonian and the Lower Silurian. The Laurentian hills of the island may have borne on their crests much fuller representations of the geological sequence than are now presented, but evidence is not wanting to show that for long periods they must have stood as now, bare and patriarchal.

The Lower Silurian of Cape Breton rests frequently upon the Laurentian, and its conglomerates include pebbles of its felsites, gneisses, etc. It is in turn overlaid at many points by Lower Carboniferous strata, and has yielded its fragments to form the basal conglomerates of the latter formation. The fact that hitherto the Lower Carboniferous conglomerates have failed to yield pebbles differing from the Lower Silurian and Laurentian rocks, forms an argument in favor of the view that the Lower Silurian and Devonian alone in Cape Breton mark the gap already alluded to. This argument is the stronger because the Carboniferous conglomerates are composed of material derived from strata close to the point of formation. They do not, as in several cases in Nova Scotia, contain boulders and pebbles that have been carried many miles.

The extent of these Silurian strata is observed at many points by the overlying Carboniferous conglomerates, and at other localities they appear to have been preserved by the protection against denudation afforded by the Laurentian ridges. These strata are not found in the counties of Richmond or Inverness,

and are represented in Victoria County only by a small outcrop near Cape Dauphin, referred with doubt, in the absence of fossil evidence, to this age.

A long narrow band runs from Moore's Brook, in St. Andrew's Channel (Little Bras d'Or) along the shore to the mouth of McLeod's Brook, which it ascends to its source, and then follows Indian Brook down until within a mile of its mouth, at the Chapel on the Escasonic Indian Reserve on East Bay. Except at Owl's Brook, this band is no where over a mile in width. Long Island is entirely composed of the slates and limestones of this group. At the Long Island, Barasois and McSween's Brook there is an unconformable capping of conglomerate. At Dugald's Point the conglomerate completely obscures it, and rests upon the Boisdale felsites. No exposure of the Silurian strata is visible for several miles, until Maclean's Beach is reached, where it reappears as a narrow strip between the Laurentian and Conglomerate. This outcrop terminates at Shenacadie, but a small outlier is visible about a mile to the westward. Similar outliers occur on East Bay, near the mouths of Mackintosh and Bown's Brooks.

At the head of East Bay, these strata outcrop again resting on the syenitic masses of the Coxheath Hills, and are in turn obscured by the Carboniferous conglomerate. The northern edge of this exposure runs from the foot of Gillis Lake, and passes a little South of McAdams Lake and continues to a point on the East Bay road about one mile west of the bridge over Spruce Brook. This strip is about a mile wide in the centre and gradually narrows at each end.

The greatest development of this horizon, however, is met in the Mira River district, and here it has been carefully traced and minutely described by Mr. Fletcher of the Canadian Geological Survey.

The Mira River forms its northern boundary until a point on the northern bank is reached, about two miles east of Marion Bridge, where the formation is met on the north side of the river, covering a tract of land nearly square and about three miles broad. The next exposure on the north side of the river is met

at the mouth of Salmon River, where these measures are interposed between Lower Carboniferous limestone and Laurentian felsites. The felsite rocks cut out this patch and almost completely surround it. Still passing toward the head of the lake, after an interval of about a mile, the Silurian strata are met again, and occupy the shore of the lake to its head, and the banks of the Giant Lake River to the foot of Giant Lake. This exposure, about seven miles long and four wide, projects into the felsites of the Mira Hills, and is in several places pierced by masses of felsite.

The shore of the lower half of Giant Lake is occupied by syenites and felsites, succeeded in the upper half by the Silurian strata, which form a band about seven miles long and three wide terminating on the northern shore of the Upper Marie Joseph Lake. There are several small outliers in this district, at Five Islands Lake, and on the shores of Framboise Cove ponds.

A line drawn from the head of Mira River to the shore at the northern side of Catalogne Lake forms the extreme southern boundary of these measures. This line passes within about a mile and a half of the head of Gabarus Bay. While the Silurian measures are unbroken in the northern part of this district along the shore of the Mira River, they are broken into by isolated ridges and projections of the Laurentian felsites, etc., of the Gabarus district. Thus we find within and to the north of the line running from the head of Mira to Catalogne, the felsites, etc., of the White Granite Hills, the String Lakes, Blue Mountains, Bengal Lakes, and Catalogne Road.

The stratigraphical arrangement of these measures cannot now be made out with any degree of certainty. The plications imposed on the strata during succeeding ages, and the severe denudation which has ploughed the island so deeply, have left the sections imperfect. Generally speaking these measures are now presented as imperfect folds, having a general north-east and south-west course with cross foldings, having their origin in local irregularities of the surface of the Laurentian rocks, upon which they were deposited. It may also be inferred from the volume of conglomerates, grits and coarse sandstones presented at several

points in the districts under consideration, that the original thickness varied with the conditions of deposition, which would be paralleled by the facts observable among the overlying Basal Carboniferous rocks.

The exact position of these measures in the Geological Scale is not yet determinable with absolute certainty. When comparisons are made between geological horizons in Nova Scotia and those further west, or on the western side of the Continent of Europe, it is found that the general conditions characterizing such horizons on one side or the other do not necessarily prevail in Nova Scotia. Local peculiarities of surrounding land, and duration and conditions of deposition, have produced such changes that the geologist can but say, so far as can be judged, such and such a series corresponds best with such and such a group.

Dana, in his Geology, gives an excellent account of the Potsdam period, then regarded as the base of the Lower Silurian, and the geological sequent to the Azoic period, the period preceding the appearance of animal life. Since then there has been introduced horizon after horizon, until, between the base of his Lower Silurian and the true Azoic, there stretches now a long list of measures. Thus Sir J. William Dawson, writing about a year ago, places in descending order, below the Silurian, the Ordovician, embracing the Cobequid Series, &c., and the Caradoc and Bala felsites, Llandeilo and Arenig Series, &c; then the Cambrian, embracing the Mira and St. Andrews' Channel series, under consideration at present, and considered by Dr. Dawson as representing the Lingula flags of England. Then the Acadian series of St. John and the Atlantic gold-bearing rocks of Nova Scotia, followed by Basal Cambrian rocks observed in New Brunswick, but not yet recognized in Nova Scotia.

Then come the Huronian, considered as represented in Nova Scotia by certain rocks in Yarmouth County, and parts of the districts in Cape Breton mapped by the officers of the Geological Survey as Pre-Cambrian and Laurentian.

Fossils occur at numerous localities in these measures, and no doubt as they are more fully examined a very complete and characteristic horizon will be extablished.

At Young's Brook, in St. Andrew's Channel, are found in thin greenish and bluish slates impressions of an Obolella, and parts of a trilobite, considered by Mr. Billings of Quebec group age. Above McCormack's Road, in McLeod's Brook, are beds of comparatively unaltered slates, resembling Carboniferous grey and bluish shales. These beds have yielded many specimens of Dictyonema, Obolella, and an obscure Orthisina. Near Marion Bridge, on the Mira River, light colored and gray and reddish sandstones yield Obolella but of species differing from those met on St. Andrew's Channel. Mr. Fletcher writes:—Considered in regard to the occurrence of animal life the contorted felspathic shale, sandstone and limestones found at the mouth of Mackintosh Brook, and on the shore below Allan and Donald McAdam's, are of the highest interest. Many of the shales are blackened with the impressions of brachiopod shells, while some of the limestone is largely composed of them. Among the shells there are numerous phosphatic nodules, up to three-eighths of an inch in length. On examination they are found to consist of a fine bituminous paste, with minute irregular grains of silicious matter aud fragments of lingula, which is supposed to have formed the food of the animals which produced the coprolities, and which, it has been suggested, may have been some of the larger Trilobites.—These coprolites are not uncommon in rocks of various ages. It is supposed that the apatite deposits of Laurentian age, now worked to some extent for the manufacture of fertilizers, were aggregated and crystallised from wide spread phosphatic nodules similar to these but of much earlier date. Similar coprolites have been observed at Arisaig in rocks of Upper Silurian age, and I have seen them near Sutherland's River, in Pictou County, in strata probably the continuation of the Arisaig rocks. They are not, so far as yet observed, of economic value in Nova Scotia.

McNeil's Brook, south side of Mira, is a good hunting ground for fossils. Characterizing this horizon, Mr. Fletcher says: "Above McNeil's Mill the Brook exposes argillite and fine sandstone, including a bed of nodular bluish gray and black, bituminous, often granular, limestone, full of fossils, among which were recognised Orthis, Obolella and the head of a trilobite. Above

the bridge on Trout Brook Road gray, black and bluish argillites form cliffs abounding in impressions of trilobites, including Agnostus and an Olenus (or Sphœrophthalmus) allied to O. Alatus of Boeck." The amateur who is willing to work up this district will probably figure as the discoverer of many new and important varieties of the life characterizing this interesting series of strata.

On the shore at Long Island there is a good section of these measures exposed, but the beds are so disturbed by folding, faults, &c., that no estimate of thickness can be given. The following from Mr. Fletcher's measurements at this point will serve to show the general character of the rocks met here.

Sea green, and blue purple, whitish and gray, laminated, calcareous, hematitic felsites, micaceous slates and argillites, one color passing into another, with thin beds of compact felsite and quartzite. Red, coarse, calcareous sandstone, alternating with greenish, laminated, micaceous, pitted marl, in contorted rolls, from which the layers may be removed like the coats of an onion. Greenish and blue papery slates, often contorted. White waving, close grained quartzite and quartzose sandstone, sometimes felspathic. Mottled fine grained, ferruginous sandstone, arenaceous shale, and argillite, intersected by quartz and calcspar veins. A very common rock is a compact and slatey grey or bluish grey felsite, sometimes calcareous. In places the Pre-Cambrian Syenite has lying directly on it a fine grained felsite greenish, with glittering specks, and films of hematite. Many of the argillites of this district are comparatively unaltered, and are frequently mistaken for Carboniferous shales, so that explorations have been carried on in them in the expectation of striking coal. Limestone is not abundant, but the beds are at many points decidedly calcareous. At McLean's Point there are many reticulating veins of calc spar in the rocks, which sometimes form compact beds of limestone, having in places a cone in cone structure.

At many points there are conglomerates frequently resting on the Laurentian rocks. They are of various degrees of coarseness, and consist of felsites, syenites, porphyries, gneisses, etc..

from the rocks they rest on. It is possible that further investigations may result in the separation of the lower members of of this series into a sub-horizon. The present facies of the rocks of this formation and their fossils show their accumulation in comparatively shallow border waters, having a comparatively mild temperature. Presumably the outline of Cape Breton was then as now indicated most strikingly by the comparatively elevated lands of the precambrian, which, together with the older rocks of Newfoundland, protected the Gulf of St. Lawrence and gave sheltered waters for the accumulation of the Silurian slates and marls, some of which we now find comparatively unaffected by metamorphic action.

This set of rocks in Cape Breton has not yet been found to carry any important mineral deposits. Mr. Fletcher speaks of the abundant presence of iron oxide in the rocks between the Barasois and McSween's Brook on St. Andrew's Channel. In one or two places it impregnates the rocks so strongly as to form beds of iron ore which, however, on being traced, proved to become of inferior quality. At one place near McLean's point an opening has been made into a bed of red hematite of excellent quality, and a few tons extracted. Although irregular at the surface the bed appeared to become more defined in depth. On analysis it proved to contain—

Metallic iron,	per cent.	62.50
Silica,	"	7.82
Phosphorus,	"	0.9
Sulphur,	"	trace.
Magnesia,	"	.88
Lime,	"	.67
Water,	"	1.10

I am not aware of any other deposits of iron ore in rocks of this age which promise to be of value. No mineral is more deceptive than iron ore. Its oxide spread in a thin film over boulders in a conglomerate and forming the cement of the mass has often led to the waste of large sums of money. A bed may be met giving the characteristic streak, color, &c., of an excellent

hematite, but a further examination shows that, perhaps, a few inches of the rock has been partially replaced by iron oxide, and that often yards away it has only enough iron in it to give a red color.

Traces of copper pyrites have been found at a few points in these rocks, but there does not seem to have been any igneous action paralleling that of the well-known copper fields of Lake Superior, and bringing up the metal from lower depths. It may, however, be found on further search that faults along lines of junction with the older rocks have permitted the accumulation of workable bodies of copper ore in these measures. Iron pyrites is not uncommon in layers of nodules, which at numerous places have made small beds of bog iron ore, a mineral not of much value until local furnaces are built. The soil overlying the Silurian strata is generally thin and cold, and in many places stony. Hitherto it has not attracted any appreciable amount of farming except at some points in the Mira River Valley, where presumably the present of limestone, &c., has given the soil some little superiority.