

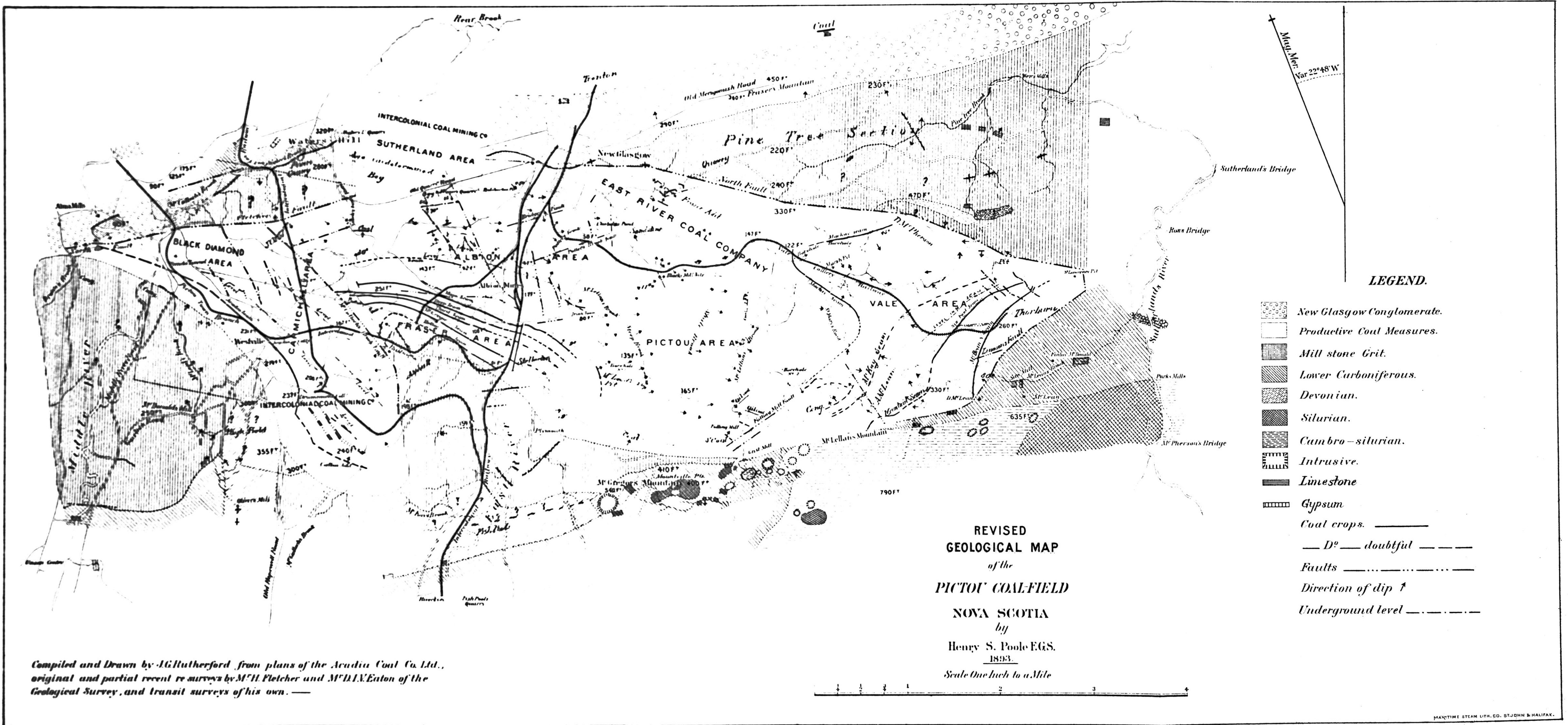
THE PICTOU COAL FIELD,—A GEOLOGICAL REVISION.—BY
HENRY S. POOLE, M. A.; F. G. S.; *Assoc. Roy. Sch. of
Mines, &c.*

(*Read February 13th, 1893.*)

It is now more than twenty years since the officers of the Geological Survey examined and reported on the Pictou coal field, giving in detail much of the important information thereon that had been collected by them and previous observers. Their report has been accepted ever since as a fairly correct delineation of the structure and salient features of the field. It contains two papers by independent observers, Sir William E. Logan and his assistant Mr. Hartley. Sir William took the least known portion of the field on the eastern side of the East river, leaving with Mr. Hartley that lying on the western side and both banks of the river.

Sir William, in his report, refers to the broken character of the field, the depth of the superficial deposits, to the numerous dislocations and the absence of rock exposures in many parts preventing a perfect series of the measures being built up; and he goes on to say, "what is now offered is to be considered as only a distant approximation to the truth, to be improved hereafter as occasion may serve and further developments may occur."

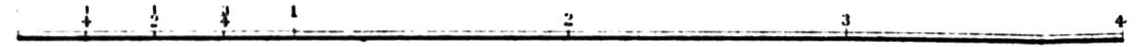
Additional facts which further working in the mines and later explorations in the field have brought to light now suggest certain modifications of the conclusions then reached; at the same time, it may be remarked they have confirmed many of Sir William Logan's own deductions. In this review of our present knowledge of the subject, what is here written is submitted as supplementary to the Report of Progress, for 1866-9 and in part as a commentary on it. To treat the whole subject anew in detail would necessitate the preparation of an article more elaborate than is now proposed, and at the same time require the repetition of much of the original report without the possibility of distinguishing what has been proved and confirmed from what is still conjectural. It is, there-



- LEGEND.**
- New Glasgow Conglomerate.
 - Productive Coal Measures.
 - Mill stone Grit.
 - Lower Carboniferous.
 - Devonian.
 - Silurian.
 - Cambro-silurian.
 - Intrusive.
 - Limestone
 - Gypsum
 - Coal crops. ————
 - D? — doubtful ————
 - Faults ————
 - Direction of dip ↗
 - Underground level ————

REVISED
 GEOLOGICAL MAP
 of the
PICTOU COALFIELD
 NOVA SCOTIA
 by
 Henry S. Poole F.G.S.
 1893.
 Scale One Inch to a Mile

Compiled and Drawn by J.G. Sutherland from plans of the Acadia Coal Co. Ltd., original and partial recent re-surveys by M.H. Fletcher and M.D.N. Eaton of the Geological Survey, and transit surveys of his own. —



fore, thought better to leave the report as it is and review it from page to page in such parts as the light of later operations by miners and observers seem now to warrant alteration or criticism. With the report in question was given the first comprehensive geological map of the coal basin and to date no revision has been published.* That which accompanies these notes and comments is necessarily based on it, but altered in such parts where it is believed data more correct warrant. The topographical work is, however, all new, from replottings and from mining plans reduced by Mr. Hugh Fletcher, of the Geological Survey and Mr. J. G. Rutherford. The map owes much to the accurate surveying and neat and careful draughting of Mr. Rutherford.

On comparing this revised map with that of 1869 it readily will be seen in what respects structural modifications have been suggested especially in that portion of the field which Sir W. Logan was careful to refer to as "wholly committed to Mr. Hartley." For many years the Survey map had been accepted as correct and no one thought of seriously questioning its accuracy. It was not until in the ordinary course of working one of the Albion seams of coal that it became a matter of moment to the writer to verify the assumed position of one of the known faults, and then on a comparison of several mining plans and reports being made it became apparent not only that the Survey map was incomplete but that it had inaccuracies which a full acquaintance with the records available at the time of its preparation might have avoided. This awakening of doubt led to further study and independent investigation stimulated by Mr Fletcher who working in the neighbourhood took a deep interest in the questions at issue, and to whom an indebtedness is due that only those who know him well can fully estimate. As investigation proceeded it became evident that some local knowledge of the structure surrounding the coal field was desirable for the better understanding of the conditions which effected its partial destruction, or if

*The map referred to is on a scale of 20 chains to an inch, but it is not yet completed. A reduction from it to a scale of one mile to the inch is here given for comparison with the Survey map of 1869, on the same scale.

preferably put, its partial retention. But it was not realized until the field of observation was thus widened how much of geological interest there is to be seen within an hour's drive of Stellarton.

Within that limit rocks of several ages can be studied. To the south rise peaks of great antiquity, yet composed of slates and sandstone with coarse grits, veined and contorted, derived from the destruction of still older formations of which no remains are now to be seen. These rocks are barren of fossils and for lack of more accurate knowledge of their age, they are classed as Cambrosilurian. On the flanks of these higher hills rest slates of exceeding fineness, which owe their origin to deposits in deep Silurian seas and they have retained remains of the life of that epoch, of crinoids, mollusks, corals and trilobites. In their turn as time rolled on these slates became exposed, suffered disintegration, and supplied material for the growth of succeeding systems. The ephemera of to-day can stand on the very bed they gave to ocean on the cradling of the oldest members of the Carboniferous. On other sides of the field lie the equivalents of those deposits of later date, made of household interest by the writings of Hugh Miller, that are brought by great convulsions in contact with the coal measures.

While these cycles were proceeding but prior to the later changes the region had been the seat of frequent volcanic activity, the strata were rent, lava had flowed and heat had altered the character of the deposits. And again when time had built up thousands of feet of Carboniferous strata, thick beds of coal, of sandstone, of shales and fireclays, and consolidated them under the weight of their own accumulations, had broken and uptilted them when no longer able to bear the strain of seismic movements and then exposed them to the denuding influences of air and sea, they in their turn made a floor, now once more visible, on which a new epoch piled up a new series of deposits widespread along the coast. These brought to the surface remained exposed, while elsewhere secondary formations were adding to their records, and they so remained

contributing their quota of disintegrated material until the glacial epoch came and spread its coating over all.

These several systems are outlined on the accompanying map but it is quite possible that as here distinguished the lines of demarkation may not agree with those on the map of Pictou County to be published by the Survey with Mr. Fletcher's concurrent report,* for exposures being infrequent lines of contact must necessarily be conjectural in many places and therefore the boundaries here given are to be taken as mere expressions of individual opinion and subject to criticism.

CONFIGURATION OF THE SURFACE :—No contour map of the field has been made other than by the Intercolonial Coal Company about their Drummond mine, but a general idea of the relative elevation may be formed by assuming the boundary lines of the formations that surround the coal measures as the bases of hills and by noting the river courses and the heights recorded on the map. The elevations shewn on the railways are from levellings, while most of the others are from aneroid readings. The map also defines by dotted lines levels at various depths of the pit workings.

RECENT DEPOSITS :—Subsequent to the deposition of the strata that have the red New Glasgow conglomerate as their base there are no remains of any other system until the Glacial epoch, and it would seem that since the disturbances that in mesozoic times defined the general outline of the country erosion has been continuous. Small deposits of peat, silt and river gravels are additions in modern days; the former only has been partially mapped, while no attempt has been made to shew the glacial drift which covers so much of the coal field and the surrounding formations at low elevations and on the northern slopes of the hills, the lea side of the drift in this part of the Province.

This deposit greatly interferes with the study of the subjacent strata and leaves much conjectural in the disturbed portions. It is so often foreign to the composition of the underlying rocks that it is very misleading to the prospector. A notable case

*Issued May 1893, without a map.

occurred in 1890 when several large blocks of coal were found in the loose ground within the supposed limits of the coal field just north of the Vale area. A trial pit on the spot exposed, instead of the expected coal measures, only red rocks, and the discovery although so disappointing was of value as it confirmed the general belief that the flow of the glacial drift into this district came from the high lands to the south west.

A paper in the Transactions of this Institute* on the surface geology of this field gave the thickness of the till or boulder clay in places as deep as 86 feet and referred to its character in some parts as drumlin. It may be added, in further proof of the till having been originally deposited in parallel ridges and not as a uniform coat over inequalities of the older surface, that since then in a pipe line cutting at Stellarton the thinness of the deposit in a shallow depression between two of these ridges exposed the crop of a small coal seam while the depth of the clay on either side was over 20 feet. The gentle slope of the ridges and the swampy nature of the depression debarred the idea that erosion occasioned the local thinning of the deposit. This exposure thus tended to confirm the remark made in that paper that in this field the sinker of trial pits more speedily reaches the metals in the hollows than on the ridges of the land.

To further show how foreign to the country rock is the composition of the till, in the same cutting a pebble of soft red triassic sandstone was turned out; now no similar rock is known in situ nearer than Valley Station, 40 miles to the south-west.

That the set of the drift was from the south-west is assumed from the direction of the surface ridges and from the course of the principal series of striæ on the rocky surfaces. There is a good exposure on Weaver's mountain, N. 45° E., another on the southern base of the highest peak of McLellan's Mountain overlooking the Marsh, N. 42° E. Also at Pictou, N. 53° E., and again near the Fox Brook school-house. The form too of the peak on the range of McLellan's Mountain close to the brook of the same name suggests a similar conclusion. Viewed

*Vol. VII, Part 4.

from the south-west it appears conical with steep slopes, while on its north-east side it is backed up with talus of considerable magnitude.

The tops of the hills in Pictou County are not so rounded as to suggest an erosion at all comparable to that which gave form to the crests of the Atlantic ranges of slate quartzite and granite, nor as was pointed out in the paper referred to does the general contour of this field indicate that it owes its present form principally to the erosion of this period. Rather that its hills and valleys are the result of long continued preglacial denudation directed by the texture of the measures and the faults which traverse it, the subsequent glacial erosion playing but secondary part. The preglacial water courses seem to have had the same direction as those of to-day, and to have been filled in with till which in many parts still remains as for example in the valley of McCulloch's brook, at lower levels than the beds in which these streams now flow.

In parts the composition of the till is irregular, notably in the neighbourhood of the present streams. Heavy deposits of sand occur in it near the East river and near the mouth of McLellan's brook high above the bed of the stream. In the sand are layers and balls of clay, boulders of foreign stone and occasionally a pocket of fragments of black shale torn from the adjoining banks. In other parts clay predominates and the sand is in streaks and layers.

This irregularity has suggested that these deposits may in part owe their origin during the ice age to summer floods having had their strongest flow approximately along the course of the drainage of to-day. With the material of local origin are striated fragments of the neighbouring Lower Carboniferous and older rocks and occasionally great boulders brought from the Cobequids and even more distant localities. To the south on higher ground, the major part of the deposits is of shattered fragments of local rocks, with sharp edges like the refuse of a quarry.

RED ROCKS :—When after 1858 the mineral rights other than those reserved to the General Mining Association were thrown

open to the public and explorations became general the coal prospector who in his search met with rocks of a red colour stopped working in that direction convinced that he had reached an horizon beyond the coals of workable thickness. In practice he was right; no good seams are immediately overlaid by red rocks in this field. This experience of the miner perhaps led the geologist who followed to infer that all the red rocks, so called, of the district are necessarily older than the coal measures; at any rate they were so classed, except by Sir William in McBean's areas.

The red rocks immediately south of Stellarton railway station and those about French's tunnel on the Middle river are so given by the Survey, but they are now believed to be of the same horizon as beds in undoubted coal measures, and the faults necessarily assumed to separate the two divisions have been proved, it may be said, to be non-existent.

In 1852 Mr. H. Poole mentioned the radical change that takes place in some of the strata when traced but a short distance; a change the more noticeable when the beds are followed from the centre to the margin of the field. Shales become more and more arenaceous until ultimately they pass into beds of sandstone even with intercalated conglomerates; black fireclays become brown and ultimately cold grey; and coals become coarse, then black fireclays and finally thin out. Boreholes at Westville put down from the upper to prove the quality of expected lower seams passed through into red rocks without finding the equivalents of seams underlying in order to the eastward at equal depths.

The coal of McLeod's pit on the east side of the East river, which is on the attenuated extension of the main seam, it is said directly overlies red rocks. This change of colour and character accompanies an approach to the margin of the basin; and if the present margin approximates at all to the margin of deposition, which is the present conclusion, a very decided difference in the appearance and quality would naturally be expected in those portions of any beds which bore this relation to one another.

Red rocks occur in strata both above and below the coal measures, and slight exceptions have been seen in these measures.

where they are barren of workable seams. There is a group of beds some 40 feet thick under the Marsh pit series and overlying the widow Chisholm seam on McLellan's brook that were cut by No. 2 borehole of the Acadia Coal Company in 1878, which are mottled with red somewhat similarly to the sandstones at the New Glasgow athletic grounds and other spots along the northern margin of the field, believed to be of other age. There is also a small local band overlying the Deep seam on the high ground approaching the McCulloch brook fault where that seam begins to become inferior in quality, and some of the sandstone bands thrown out on sinking the Forster pit became red on exposure to the weather.*

The red rocks are found of many shades varying from the bright brick colour of the metamorphic beds at Fish-pools, River-ton, and the purple grits of McLellan's mountain to the dull and chocolate reds of the Lower Carboniferous and the Millstone Grit, and the fresher tints of the Permian with their local and characteristic metallic sheen. As it were a forecast of the latter, there seems a general resemblance to them in certain beds that lie on the northern limits of the field. These beds are classed as Millstone Grit, but it must be confessed there is an inability to trace a similarity either in structural character, cleavage or appearance with rocks taken as typical of that system in this field, for instance, with those of McLeod's brook and those on the East river above the brick-yard unmistakably of the same age. The relative age of the red rocks in the several sections of this field has been so differently regarded by independent observers that in offering a new arrangement there is here no singularity. What the proper horizons are is of course still open to question, but in the recognition of distinct groups in series hitherto classed as identical an opening is made for future closer comparison and proper classification. The two divisions of the Fish-pool beds put as Millstone Grit in section 1, p. 60, of the Report of Progress will no longer be classed with those of McLeod's brook, or of Smoky-town, or of McLean's brook, or of Pine-tree. There can be no doubt that had Sir W. Logan himself compared the

* Logan's report p. 34.

rocks below the Coal Measures of Mr. Hartley's division with those of his own much of the rearrangement which now seems called for would have been avoided.

In the study of the relative position of these barren measures, a scale of hardness in the red argillites perhaps offers a rough and ready test of the age of rocks that otherwise may look identical. On exposure to the atmosphere the harder rocks, for instance, of Oliver's mill dam, present a slaty fracture, those of later origin associated with Carboniferous Limestone of McLellan's brook crumble into rhomboidal form; while in the Millstone Grit the particles have rounded edges and in the Upper Coal Measures the slickensided fracture of the marls facilitates their conversion into plastic clay.

FAULTS.

The Survey map of 1869 has about the Coal Measures of this district a continuous girdle of faults, presumably of great displacement, a displacement which subsequent writers have expressed in feet.* It will be seen later on that grave doubt is expressed whether the field has this structure and modifications are proposed that in parts materially change the outlines.

A study of the grouping of the faults of the field associated with the zones of varying quality in the coal seams and speculations as to their relative age and influence on the present limits of the basin are not without interest and possible value.

In the first place it may be noticed that where the circumscribing rocks are cut down by the passage of water courses there also disturbances pass into or out of the valley. The East river on entering the basin flows in on the strike of measures parallel to the western face of Weaver's mountain, its course northward is over ground known by subterranean workings to be much troubled by dislocations, but whether the faults of the coal measures which are heavy up to the northern margin also

NOTE :—"The colouring of Red Sandstones" J. W. Dawson, May, 1848, Quart. Jour. Geo. Soc.

* Rutherford, Trans. North of England Instit., M. E., 1871. The Coal Fields of Nova Scotia Map shews faults of 4000 feet. Gilpin, Trans. Roy. Soc. Can., Sec. IV., 1887. The Faults and Foldings of the Pictou Coal Field. Puts the displacement between 5000 and 6000 feet and speaks of the field "as now presented between bounding faults, like layers in a chest."

affected the overlying conglomerates and determined for the river its point of exit is not known. McCulloch's brook enters over broken ground, follows close to the great break that bears its name, and leaves the field on the line of contact between the Coal Measures and the older rocks. The chief depressions in the hills at the east corner of the field are attendant on faults which take their rise within; and the entrance of McLellan's brook marks the termination of the synclinal fold that holds the McBean and other seams at the Vale. It enters over Lower Carboniferous rocks lying between metamorphic hills.

On comparing the present map with that of the Survey it will be seen it differs greatly with respect to the positions assigned to the leading faults of the district.

The Potter's brook fault⁽¹⁾ which was made persistent, prominent and straight, is turned on the point of its solitary exposure, and its supposed influence far east and west of the river has vanished.

The subordinate McLeod fault⁽²⁾ of parallel course, placed west of the river has disappeared.

The problematical Mill-road fault⁽³⁾ remains unproved although the theoretical considerations for assuming its existence still remain.

The Lawson fault⁽⁴⁾ is no longer of any importance and is very limited in extent.

The West fault⁽⁵⁾ ceases to part the Coal Measures from the Millstone Grit, but in its position are shewn members of two series of faults, downthrows to the east at its assumed southern end, and downthrows to the west at its northern extension, both series diminishing in intensity as they approach the middle ground in the village of Westville.

The prominent McCulloch's brook fault⁽⁶⁾ has its position somewhat altered, it is swerved in its course and is increased greatly in magnitude.

New dislocations both proved and theoretical are now given and some minor faults in the centre of the Albion section are

Geo. Report, 1869 : (1) pp. 49, 85 ; (2) pp. 50, 75 ; (3) pp. 22, 43, 49 ; (4) pp. 33, 36 ; (5) pp. 73, 79, 81, 102 ; (6) pp. 77, 83, 85 ; (7) pp. 26, 36, 50, 73.

more correctly placed. To all of these faults reference will again be made.

As to the South fault ⁽⁷⁾ the question is raised whether the known western exposures of strata on the assumed line of dislocation do not partake more of the character of unconformable deposition with minor displacements than of an enormous dislocation; and the suggestion is now made that the chief fracture that gave elevation to the southern range of hills is to be found on the south side of the axis and not, as located on the north side, the conditions being somewhat similar to those attending the formation of the northern rim of the valley, where the general conditions seem to be, a disturbance on the south side of an elevated range of conglomerate resting unconformably on a surface of denudation, dipping northward and conformably overlaid by newer rocks inclined in the same direction.

Should the supposed character of the southern margin be borne out by closer investigation, the natural sequence would be to consider the conditions along the eastern rim somewhat analogous, and to regard the strata shewn to rest on Lower Carboniferous as the reduced representatives of the great thickness of measures found in the centre of the field, greatly modified it is true in colour and constituents, but not more so than has been found to accompany the approach of beds to the assumed limits of deposition in the Albion section.

Of the minor dislocations proved on working the coal seams, a definite parallelism is noticeable, and it is in some sections associated with a hading uniformly in the one direction. In the Albion mines section at Stellarton it is found that all the north and south faults lying to the west of the English slope are downthrows to the west without exception—unless it be the secondary slips often accompanying the breaks and perhaps some small faults taking this subordinate position to the great McCulloch brook fault. In the opposite direction, to the eastward of the English Church, the downthrows are found to be the reverse and to the eastward. The same condition occurs eastward of the

Foord pit where the levels cut a series of faults having this effect on the strata; and these faults were found to gain in magnitude as they went northward.

Then in the same district of workings it appeared that the series of troubles that have a course more nearly east and west, are invariably downthrows to the northward.

A similar experience attended the operations of the miners in other parts of the coal field. The eastern end of the workings in the McBean seam cut faults which became heavier as greater depth was attained and nearer approach was made to the opposite high ground. These faults are upthrows to the eastward and are associated with an increasing dip as the beds trend in that direction.

At Westville, the dislocations north of the village are as has been mentioned, all upthrows to the east. They are in sympathy with the McCulloch brook fault, also parallel to it and appear to be lateral spurs of the North fault. They may be called the Black Diamond series, for it was in the pit of that name that they were first exposed; since then an extension of the series towards the McCulloch brook fault has been shown in deeper workings of the adjoining Acadia area. The faults found south of the village in the Drummond mine dip in the reverse direction and belong to another series which may be called the Drummond series of faults. Those known in the pits are secondary to the line of contact between the Coal Measures and the older rocks of Highfield farm, the hill range behind the Drummond mine

Parallel with the general trend of the coast are the so called North and South faults which range east and west. Great faults having this course, Mr. Fletcher points out, are frequent in the Permian rocks, and it would seem that the parallelism of these lines of relief also preceded the period of the Coal Measures, at any rate so far as exposures permit of generalization. The beds underlying the comparatively little faulted New Glasgow conglomerate were also more disturbed, broken and brecciated along this line than elsewhere and so with the Lower Carboniferous along the line of the South fault.

It may be asked what is the relative age of the chief faults in

comparison with the several formations in the district, and are the faults of the Coal Measures confined to that period or are they still younger and subsequent to the Permian ?

So far as is known the rocks now classed as Permian do not anywhere overlie the Coal Measures.* Where they approximate most closely, as near New Glasgow, the Permian is seen to rest directly on unconformable brecciated beds of sandstone of disputed age, possibly Lower Carboniferous. Contact is again seen at Alma but here the Permian—New Glasgow conglomerate—rests on metamorphic rocks and dips towards the Coal Measures. It would seem then that the North fault which separates the two formations is later than both.

On page 324 of *Acadian Geology* a quotation is given from a communication from Mr. H. Poole, touching the finding of faults in a seam of coal that are not to be seen in the main seam overlying it at 157 feet, as perhaps “a proof of the contemporaneous disturbances and changes of level connected with the original formation of this conglomerate.” This was in 1853. The area of workings then open to observation was very small and in two seams only; it has since been extended by operations in four superimposed seams. The accompanying sketch shews the irregularity referred to, the vertical position of the main fault as it is found in each seam being shewn by distinguishing lines. The plan is necessarily incomplete, being limited by the present extent of the workings and by the fault passing beyond the crop of the highest seams. It further shews that while the fault dips to the north, it does not do so uniformly, but must in places jump back and consequently find relief along planes of bedding. The irregularity in the position of the secondary north and south cross faults also laid down on the sketch is still greater, and taken together these observations hardly bear out the above quoted supposition.

*Mr. Haliburton states in his paper in the *Transactions* of 1867 that the Richardson seam had its underlying strata resting on the conglomerate. “The conglomerate itself near New Glasgow dipped to the southward.” This evidently was the current belief of the day which immediately preceded the publication by Dr. Dawson of the second edition of *Acadian Geology* wherein page 322 mention is made of a southerly dip having largely induced him to put the New Glasgow conglomerate at the base of the coal measures. Now there is no knowledge that the conglomerate “crops out from beneath them (the productive coal measures) on an anticlinal line.”

Mill road fault :*—At Black's mill site, long abandoned, the rocks on the high north bank of McLellan's brook are seen to be disturbed. The throw of the fault Logan assumed to be 388 feet, but subsequent trial pits in 1878 at this point seemed to prove it not over 15 feet or of little moment, and this finding appeared confirmed in 1889 by numerous exposures of the strata along the immediate highway which shewed a regular but rapid turning over of the dip to the northeast. It is at this point that the series of black shales, some 1740 feet in thickness, overlying the Albion Main seam are succeeded by transition beds and then by the sandstones alternating with shales that are noted in the record of McLellan's brook—Section 3, page 19, and it seems probable that the observed dislocations at Black's mill site were produced by the flexure passing from soft shales to rocks of a harder texture.

The change in the measures from black shales to heavy bedded sandstones if it marked the location of a fault as assumed in the report, would give it a course more to the westward of south from Black's mill site than that shewn on the plan of 1869, but this seems to have been overlooked at that time. A similar assumption in 1850 led to the abandonment of the Colin pits which were started to forewin the main seam to the westward of the Dalhousie pits, for in that sinking instead of black shales only as in the shafts near the East river sandstones were pierced and they had an inclination somewhat different from that of the coal seam in the approaching workings; hence a fault was assumed to intervene.

The possible extension of the fault northward is mentioned on page 43, but the road exposures referred to above seem to disprove it. In 1878, the Acadia Coal Co. put down a number of boreholes along Shale brook, but they disclosed nothing that would tend to confirm the presence of this theoretical fault.

Rolls :—If Logan considered a fault probable in this part of the field to give relief to the strata turning from the middle to the southern syncline, there is on McLellan's brook close above

*Report 1869, p. 21, 40, 43 and 49.

the mouth of Marsh brook a monoclinic fold sharply uplifting the beds, it is followed a little higher up stream by two quick lateral deflections which must effect this purpose. Where exposed no break can be seen, but it may readily be conjectured that in their southerly extension towards the older rocks of McLellan's mountain a break in the continuity of the beds does occur; the more so as the section of strata pierced by No. 2 borehole of the Acadia Coal Co. in 1878 seems to require the passage of a fault to make the records and exposures coincide.

No mention is made in the Report of these rolls, but they evidently do give relief to the beds turning from a general south-east to a south-west course. The exposure on the west bank of the brook some 250 yards above the mouth of Marsh brook is very prominent, the dip is 80° with a quick bend at the bottom of the bank to an inclination of only 10° . Tracing the strike up stream, the dip flattens to 4° and then the beds sharply turn to the westward, but without breaking, and dip at 28° to the southward. From the drift on the west bank at this point containing fragments of coal it is probable that the widow Chisholm seam, one foot in thickness, is close by. The sandstone beds at this first flexure are succeeded by black shales, probably the same beds that are seen along the east bank of the brook just below the mouth of Marsh brook, and with them is a well-marked compact black bituminous bed, dipping on the east bank to the south-west and on the west bank to the south-east, marking the second flexure that brings the strike back into the original line without disclosing any actual fault. At one time the brook followed the curve of the strata but now its course is straight across the dips, and perhaps the exposures are much clearer now than they were twenty years ago.

Should these rolls be proved to develop southward into a fault the course indicated would take it to a break in the hill range, parallel to the course of the fault shewn at Patrick's oil coal pits, and across the western end of the southern synclinal of Logan where some heavy faulting is generally believed to exist. If further extended in the same course to the southward, it would cut a contact of Lower Carboniferous sandstones with a pro-

trusion of diorite and coincide with a valley that runs up into the Cambro-silurian hills.

Potter's Brook fault:—The course of this fault was ruled on the map of 1869 by an unswerving hand across the field, and marked where the bottom of the basin was supposed to be. Careful and repeated examinations of the locality, which gave its name to this fault, shew black shales dipping nearly vertical but with a course 15° more to the north of east than that previously given to the fault. Either course continued to the west would before very long take it into proved ground where it is not found, and eastward its extension less than a mile would take it into doubtful ground. Sir W. Logan, subsequent to his report, in a letter to Mr. J. B. Moore, remarked that he did not think this fault would be of importance in the Vale area. It thus appears to be only local, marking on the east side of the river the separation of the Albion series of measures from those of Potter's brook section on the north side of the basin.

McCulloch's brook fault:—This fault has left its impress on the face of the country to-day, the depression to the west corresponds with the downthrows while on the eastern side of the Westville section the thrust of the adjoining anticline is crowned by a hill. In a short paper on the Surface Geology of this field, previously referred to the opinion is expressed that when the brook, that gives its names to this fault, had its flow renewed after the deposition of the boulder clay, it was raised by that deposit out of its ancient bed and forced by the inclination of the strata and the superimposed deposit to cross to the eastern side of the fault, where it now runs, the ancient channel remaining filled with glacial drift. On descending the brook, the first exposure on the eastern bank is at the crossing of the Pictou Town Branch Railway; the eastern abutment of the bridge rests on the rocks while the western it on clay. The brook here appears to be on the edge of the fault and to continue on down the eastern side until it leaves the Coal Measures near Waters' hill and courses onward over older rocks to the Middle river.

The Survey map shews this fault to cross east of the west corner of the Albion area, but explorations in 1860 traced the Albion measures 5 chains west of the corner and in a trial pit, that got coal at this point, a fault was met with, and in another pit to the rise of it a borehole was continued after coal was got at 32 feet; at 40 feet the rods dropped 5 feet, and water drained away from the pit for a time. These trial pits would appear to be close to the fault. In them the measures dipped N. 10° E. 18°,* while a trial pit sunk in 1884, 12 chains further to the west, found the inclination below 65 feet of clay, N. 69° E. 26°, in strata of the Westville section, on the west side of the fault.

Other trial pits and boreholes were put down in 1860, south of the corner, but dropping into 40 and 50 feet of clay they were abandoned, and tracing the measures to the westward was stopped. Again in 1889 explorations made in this neighbourhood and to the northward found on the western side of the now assumed position of the fault, the till to be compact and uniform to the depths attained by the trial pits. This was not the case to the eastward of that line, where the rock was met within ten or fifteen feet of the surface.

Mr. Hartley estimated this fault at 1600 feet, but the proved inclination of the Acadia main seam, and later explorations along the western margin of the brook make it probable that a dislocation of 2600 feet is more nearly correct.

On approaching this fault from the eastward it is not found to produce a deflection of the measures within the Albion Lease; but it is otherwise immediately south of that area, and a folding back of the strata rapidly increases as the brook is followed up to the railway culvert. This deflection makes an anticline which is exposed by the railway at its highest point, McAdam's cut; and its influence is noticed in the workings of the several seams of coal at depths below where the surface shows no indications. It is accompanied by a thinning of the strata intervening between the seams, a feature that will be again referred to in treating of the Albion section. Continuing along the fault to

*All the courses given in this paper are magnetic.

the southward for about a mile, the line of contact then brings the Millstone Grit, dipping westward, against the Coal Measures, which dip at a light angle to the north-east.

The termination of the McCulloch brook fault to the south has not been made out, possibly it is cut off by the Drummond series of disturbances, which seem to increase rapidly in strength as they pass to the south-east, and limit the southern margin of the Westville section. To the north this fault was given a direction towards Smokytown, but now it is assumed to be deflected more to the north, with a course parallel to the Black Diamond series, and to the faults exposed in the deep workings of the Acadia pit, and to terminate against the heavy Fletcher fault.

Fletcher fault:—This fault, though a large one, and presenting facilities for examination seldom met with, does not seem to have been noticed by Mr. Hartley. It crosses McCulloch's brook, 16 chains below the Drummond railway bridge, and divides red and grey rocks, dipping at a light angle to the northward from the Coal Measures, dipping south, S. 40° , E. 13° , and shewing at the bridge a small seam of coal which Mr. Hartley assumed to be the Three and a Half Feet Seam of the Albion section. It fades to the north with a width of 130 feet, and inverts the lowest of the strata it disturbs. The age of these red and grey rocks is in dispute, in turn they have been relegated to several zones; they are barren, carry thin beds of grey conglomerate, coarse grits, and sandstones blotched with red and pink stains, besides beds of soft, red argillites. The present disposition is to consider them as Upper Coal Measures.

McAdam's cut fault:—This fault occupies the crest of the anticline in the Albion section, parallel to McCulloch's brook fault, which it in part relieves. It begins near the south line of the Albion area, and increases in strength as it passes to the south. Where it is exposed on the railway, the map of 1869 shewed the imaginary extension of the McLeod fault to pass, on an east and west course.

Dalhousie pit fault:—This is seen in the workings of the Main, Deep, Third, and McGregor seams. It begins near the line

of the anticline above referred to ; has a throw of 5 feet where it is pierced by the Third seam slopes, 13 feet at the bottom of the Dalhousie A. pit increasing to 19 feet where it crosses the barrier between the Crushed and the Burnt mines, and thinning out is lost east of the Crushed Mines Bye pit. Its hade is to the north, and the irregularity with which it breaks the strata is depicted on the accompanying plan and section. (*See Page 240.*)

The following sketch of the Crushed mines series of faults and types illustrates the occurrence of the minor troubles met with in parts of the workings which when they occur greatly interfere with getting the coal. (*See illustrated section.*)

The Lawson fault :—Turns out to be only a “ want ” of limited extent in the McBean seam, so that the conclusions based on its assumed extent must necessarily be now abandoned.* It is, however, probable that the Vale section is cut by one or two dislocations approximately parallel to its course, but more to the eastward as indicated on the map by the break in the line of the outcrop of the Six Feet seam.

The McGregor fault remains as shewn on the map of 1869. It has not been again exposed. It probably belongs to a series of dislocations that accompany the synclinal folding of the strata that lie on the northern flanks of the hill range.

The Bridge fault :—This fault crosses the East river at the New Glasgow railway bridge. Apparently it has a course parallel to Potter's brook fault, and repeats to the north the series of black shales and the lowest numbers of the overlying sandstones exposed on that brook above the Vale railway culvert, at the same time thrusting them to the west, repeating in fact the operation which the Potter's brook fault began. This fault is cut off to the westward by some one of the north and south faults that cross the coal basin to the eastward of where Muir's dip slants in the Foord pit, prove the trough shape of the field in that locality.

The Fulling Mill fault is one of a pair of parallel faults. It is well exposed below the dam where the road crosses

*Logan p. 33.

McLellan's brook, shortly after that stream enters the coal field. It is some 8 feet wide and has a course N. 80° W. The easterly dipping measures of McLellan's brook section are sharply deflected from N. 43° E. 20° to N. 20° E. 21° as they approach it. On its southern side the measures dip N. 8° E. 40°, and where seen higher up the brook on the bend leading to the grist mill, they are in an anticline and include a band characteristic of McLellan's brook section of compact black shale, containing fragments of plants. The fault is supposed to leave the bed of the brook and pass to the eastward immediately above the Three Feet seam of coal on the west bank where the measures are concealed. Following up the brook from this point the dips gradually change their direction from N. 40° E. to due E, thence to S. 60° E., due S. and S. 30° W. with an average inclination of 25°, all within a distance of 75 yards. When next exposed some 80 yards higher up, the second fault has been crossed and the measures are heavy bedded sandstones dipping N. 20° W. 50°. With the sandstones are beds of grey conglomerate, probably the lowest in the series of the productive coal measures, here resting conformably on what are believed to be Millstone Grit beds reduced at this point to a feather edge and with the same dip and strike overlying Lower Carboniferous.

The North fault :*—Frequent reference will be made to this fault which was given on the map of 1869 a curved course along the northern skirts of the coal measures, and its position is somewhat changed at one or two points. It definitely separates the coal measures from the Devonian and Permian where the Middle river crosses it, thence eastwardly its direction either carries it along the contact of these systems and up Waters' brook, or as the Fletcher fault across McCulloch's brook, in either case otherwise than as shown on the map of 1869. Thence eastwardly its course is in doubt for a mile or so. When next determined on approaching the East river its general direction has entirely changed and dividing the New Glasgow conglomerate and its substrata from the coal measures follows the course laid

* Journals of the House of Assembly, 1845, App. 49.

down by Sir W. E. Logan in his report. Its course is clear at the northwest corner of the Vale area, and is marked by the colour of the soil where the pent road from the Vale to Pine Tree passes. Exposures near the house of D. McPherson, where the older rocks dipping at a high angle to the S. S. E. have become denuded on the hill side, place it somewhat more to the south than before, and it would thus appear that the evidence produced to Logan of coal measures existing near the house of W. Love was insufficient.

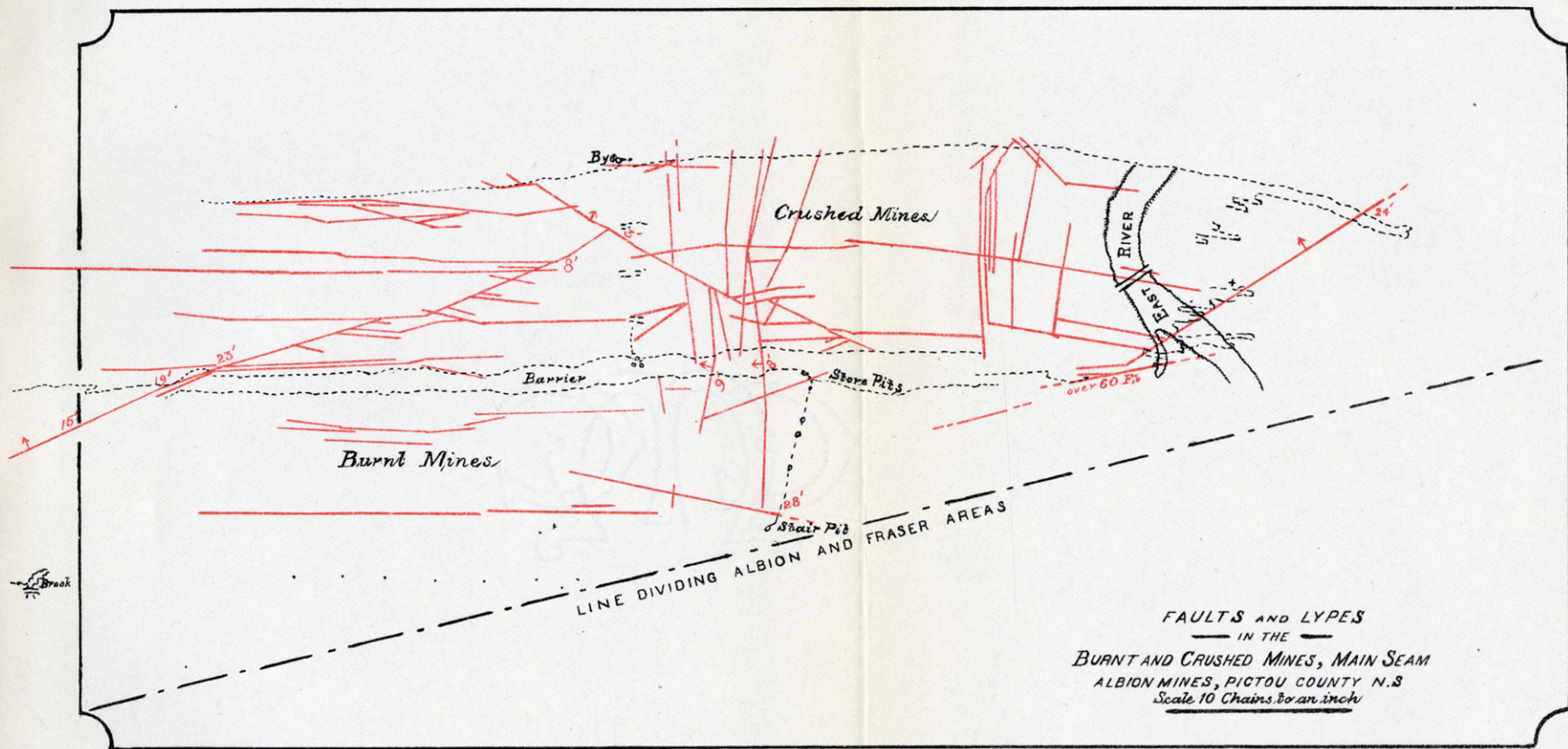
It is not to be understood that the faults here enumerated are all that are known to disturb the field, or that they are relatively the most important. Mention is made of some of them merely because they are referred to in the report of 1869 and the direction and influence then given them it is here proposed should be modified. It is evident there are other displacements of great magnitude especially along the northern margin of the basin, besides others of little or no stratigraphical moment. The endeavour here has been not to describe all the faults but only to make mention of those that are known to mark the flexures and boundaries of the coal field.

THE AGES

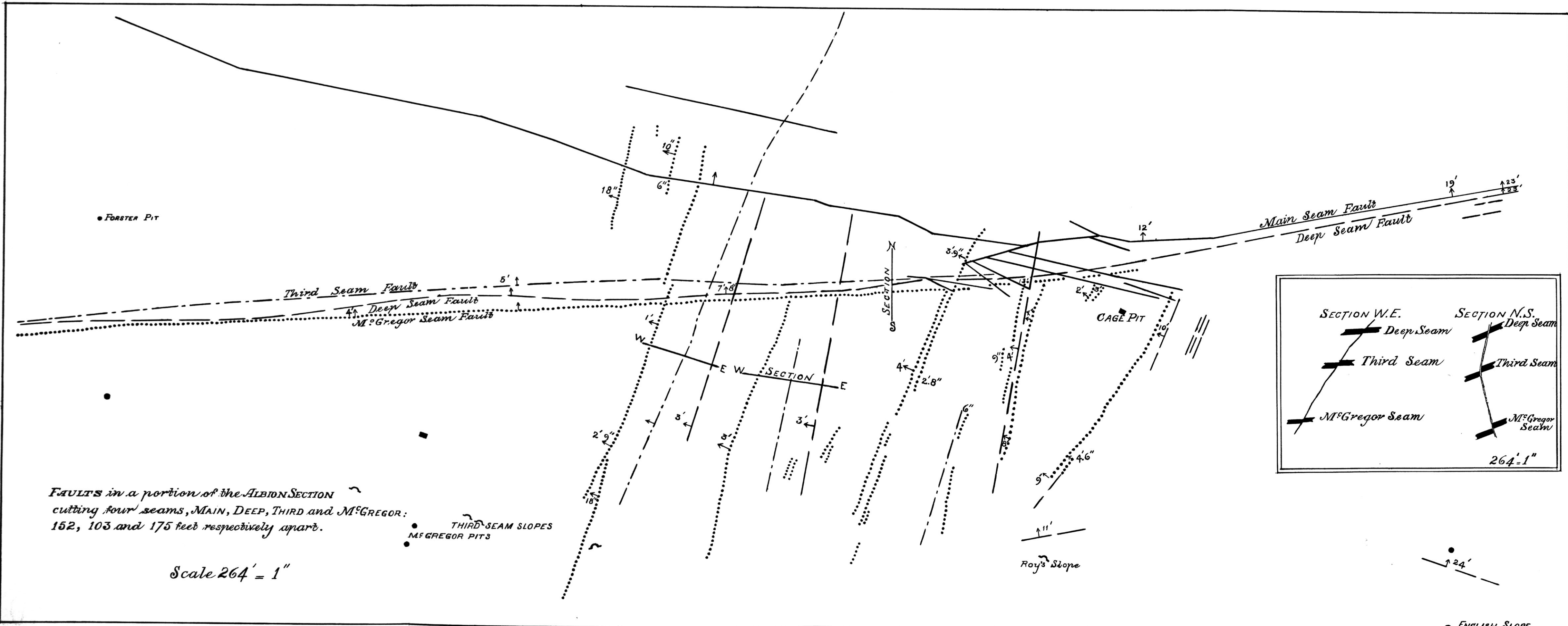
of the several rock formations found in Pictou County within the restricted limits of this paper will be briefly referred to in their chronological order with the exception of the productive Coal Measures, which although older than the Permian beds will be left to the last. First, however, reference will be made to the rocks which are

INTRUSIVE.—The proximity to the coal field of an extinct centre of volcanic activity has not before been specially noticed, but there is evidence in the surrounding older rocks of eruptions having taken place at different palæozoic periods prior to the Coal Measures, and even subsequently in the Triassic epoch at no great distance to the westward, on both sides of the Cobequid hills.

Some of the higher points and more isolated peaks of the ranges of Weaver's and McLellan's mountains are igneous. There



FAULTS AND LYPES
 IN THE
 BURNT AND CRUSHED MINES, MAIN SEAM
 ALBION MINES, PICTOU COUNTY N.S.
 Scale 10 Chains to an inch



FAULTS in a portion of the ALBION SECTION
 cutting four seams, MAIN, DEEP, THIRD and M^cGREGOR:
 152, 103 and 175 feet respectively apart.

Scale 264' = 1"

is the summit south of D. McLean's house that overlooks all the country to the eastward, while the depressions among the hills to the southward are looked down on from the elevation near the Mountain church. Then at Mountville from the top of a neck of trap a view of the valley of McLellan's brook and the East river is commanded.

A dark hornblendic rock, partly vesicular, full of fine crystals of felspar, hereinafter spoken of as 'trap,' supplied many boulders to the Lower Carboniferous conglomerate that rests on the Silurian slates at the grist mill on McLellan's brook; and on the flank of Weaver's mountain a similar material forms a paste for what appears to be a tufaceous conglomerate of greater age.

McLellan's brook on entering the ravine that separates Weaver's and McLellan's mountains cuts through a low isolated knoll of crystalline rock associated with Cambro-Silurian strata, and through the same series eastward of this point project many masses of diorite. Those by the side of the east branch of McLellan's brook, which for convenience may be called Stewart's brook, furnished material for the brecciated conglomerates that rest on them.

At the base of the western escarpment of Weaver's mountain the surface is covered with debris of altered rocks identical with the most highly metamorphosed beds cut through by the East river at Fish-pools, which makes it probable that the intervening unexposed ground is likewise occupied by a continuous series of these beds traversed by dykes similar to that seen at Chisholm's culvert on the west bank of the East river, elsewhere mentioned. This dyke could not of course have produced the induration that there extends over so wide an area, but doubtless it was contemporary.

On the north side of the field the range of high land records a line of volcanic activity which probably extended to the westward, though now overlaid by the New Glasgow conglomerate of Green hill. Waters' brook Mr. Fletcher found to cut through trap at Powers' quarry and green felsites are exposed at the Intercolonial railway bridge over McCulloch's brook.

CAMBRO-SILURIAN.

The waters of Sutherland's river leave the hill country that overlooks the coal field from the south and tumble through a picturesque gorge of metamorphic rocks at Park's mills to flow among carboniferous strata to the sea. These rocks have been described by the Survey and classed as Cambro-Silurian.⁽¹⁾ They are almost immediately succeeded above the falls and to the west by fossiliferous Silurian beds, Medina and Clinton that trend to the southwest. On leaving the river the hill range rises to the westward with a steep declivity to the north, and the rounded surface is covered with fragments of pale green slates weathered to whiteness.⁽²⁾ Passing westward these barren Silurian strata continue to the flanks of the high peak that rises to a height of 635 feet behind D. McLean's house, there they give place to trap that crowns the summit on the eastern side. On the western face, which is somewhat the highest, Cambro-Silurian slates and grits again come in and occupy the north front of the range as far as McLellan's brook. The crest of this peak is smoothed but only very partially planed down by glacial erosion, and unexpectedly no striæ recording the direction of the ice flow were found. The peak marks the south-east corner of the coal field, and from it northward may be assumed to extend a concealed spur on which rest the Carboniferous Limestone series that form the eastern rim of the basin. Immediately westward of the peak among the hills are collected the head waters of McLean's brook, and beyond them rises the still higher mass of McLellan's mountain, attaining altitudes of 760 and 790 feet. Rocks of many colours compose the series: bright red argillites, grey whins closely intersected by quartz veins, coarse purple grits and intrusions of diorite, may in turn be seen. Strwn on the surface are to be found fragments that to the casual glance might be mistaken for Millstone Grit, but which under the hammer ring with a sound that cannot be mistaken.

On the south side of the spur of McLellan's mountain that stretches to the brook of the same name, a well defined fault.

(1) Geol. Sur. Reports. Fletcher 33 P. 1886. (2) Logan p. 5, 6, 1866-9. Honeyman Trans., N. S. Instit., Vol. III, p. 105.

passes from the high ground to the westward and separates the spur from the wide extent of Carboniferous Limestone that fills the valley to the southward. Along the course of this fault Stewart's brook has cut its way in the softer measures. The fault continues westward along the southern base of Weaver's mountain thence across the East river and appears to be of great magnitude, possibly having much of the influence on the coal field imputed by the Survey of 1869 to the great South fault. Knolls of diorite project at several points on the north side of this fault along Stewart's brook, while limestones are in contact on the south side. A boss of diorite belonging to this series is exposed on McLellan's brook underlying Carboniferous Limestone on the south flank of the range, and again at Mountville rocks probably of the same age lock in an outlier of Carboniferous Limestone between Silurian hills. With these exceptions this system is not known west of McLellan's brook.

Dr. Honeyman⁽¹⁾ apparently classes all these rocks with the Silurian, but his descriptions of neighbouring localities are so general that without other assistance than his writings it is not in all cases clear his references do include all the portions of older rocks alone here referred to,—those immediately skirting the coal field.

SILURIAN.

Besides the fossiliferous beds exposed near Park's mills, which are classed as Medina, there is the wide stretch of barren slates ascending to the summit already referred to as of this age, and on the south side of the spur of Cambro-Silurian approaching McLellan's brook occurs an outlier of these beds which were mistaken for carboniferous shales and prospected for coal thirty years ago. But the largest exposures are westward, on the west bank of the brook. Soft, foliated slates holding fossils, directly underlie Lower Carboniferous conglomerate,² and loose fragments of grit beds are full of remains of trilobites, corals, shells and encrinites. Whether this formation is continuous in

(1) Trans. N. S. Instit. pp. 67, 73 of 1870 ; pp. 105, 141 of 1871 ; p. 459 of 1877 ; p. 73 of 1878.
(2) Geol. Survey Report, 1886, pp. 33, 36, 48. Honeyman, Trans. N. S. Inst., Vol. III, p. 64.

the range west to Mountville, is doubtful, but there are no other exposures until the summit near the post office is reached. Possibly the intervening ground is all Lower Carboniferous as defined on the map, or it may be thinly capping Silurian as at the brook.

The summit at Mountville, 490 feet, exposes fossiliferous rocks that weather white, and it presents a bold escarpment to the south. To the north and east a depression with surface fragments of sandstone suggests a succession in those directions of Lower Carboniferous, of which series beds mentioned elsewhere are seen lying to the west between it and the succeeding knoll where fossils also are easily found. At the high road the Lower Carboniferous can be seen, but westward again 200 yards from the road the penultimate knoll of the ridge that overlooks the East river is also Silurian.

Dr. Honeyman unhesitatingly classes as Middle Silurian the rocks of Waters' hill, and were it not that Sir W. Dawson mentions having found pinnularia in the slates of this range at Alma, others also would have concurred in his view; in part at least, as for instance regarding the slates which rest on the northern slope of Waters' hill nearest the Drummond railway. The black and bluish grey slates containing occasional fragments of plants would likely, however, be still considered Devonian even should a more thorough investigation relegate portions of this northern range to the Silurian, and the crest of Waters' hill to the Cambro-Silurian.

DEVONIAN.

Rocks of this age⁽¹⁾ occupy a large section of country to the westward of the Middle river and are crossed by that stream a short distance above the bridge at Union Centre. Between this point and Weaver's mountain their extent has not been well defined. Whether they should include the beds seen on the East river north of Riverton is open to question. Yet although presumably Devonian, for convenience these deposits may be called the Fish-

(1) See the references to the Pre-carboniferous of Picton County by Dr. Honeyman in these Transactions Vol. III, 2 p. p. 106, 141; Vol. V, 1 p. 72, and Sir W. Dawson's reply to the Dr.'s criticisms in the *Canadian Naturalist* February, 1879. *Acadian Geology*, p. 502; Supplement, p. p. 48, 70; Hartley, p. 53.

pools series. The most westerly exposure of Silurian already referred to protruding immediately west of the Mountville post office is in line east and west with exposures of grey conglomerate in parts cemented by volcanic ashes and the neck of trap that forms the western escarpment of the crest of Weaver's mountain. This neck has limestone lying against it to the south and a conglomerate similar to that just mentioned on its north flank. The age of this deposit is undetermined. Apparently it is contemporary with that of the trap and prior to that of the Lower Carboniferous conglomerate.

The lowest of the series are seen north of Riverton and nearly as far as the mouth of McKay's brook, where the section begins which is given as No. 2, page 61 of the Report of 1869. These Fish-pools beds are highly inclined and disturbed, much metamorphosed, of a bright brick red, with greenish patches and numerous veins of quartz shewing siderite and specular iron. They appear to dip southward where nearest to McKay's brook and opposite to the dip of No 2 section, but up the river at Chisholm's culvert on the I. C. R., where the colouring is not so vivid, the dip is reversed. Fifty-five yards above the culvert a dyke of dark greenish felsite containing spherules of quartz and zeolites runs east and west. At 200 yards above the culvert there is an anticline which is immediately succeeded by an east and west fault, and the strata then resume the northern dip until at Riverton siding the limestone comes in with its lowest rocks dipping to the southward.

The less altered of these beds include those of McKay's brook, are seen on Finlay Cameron's farm, the next farm to the south, about 150 yards west of the Hopewell road, and are assumed to be separated from the Millstone Grit lying to the west of this point by the extension of the great break which crosses the coal field and is known as the McCulloch's brook fault. Contact of these two groups to the north of McKay's possibly takes place near the line indicated on the map. The contact with the overlying Millstone Grit is well seen lower down on both banks of the river, the line between them having a bearing N. 20° W., the basal bed on the north bank being a grey conglomerate dipping east 25° with a lessening inclination. It seems hardly

possible that a dislocation of the great magnitude assigned to the South fault can pass at this point. The contact seems rather one of unconformity with slight local faulting.

Passing now to the northwest corner of the coal field and eastward from the boss of these rocks that occur on the Middle river, at the mouth of Brown's brook, and which is evidently brought up by an east and west fault that gave the conglomerate at Alma its steep inclination to the south, the next exposure is on the crest of the hill range where the Pictou Town Branch of the Intercolonial Railway has a cutting. The same patch is exposed on both sides of McCulloch's brook under Horn's bridge, as the iron railway bridge is called, and is surrounded by red conglomerate dipping southward towards the North fault.

Higher up the brook the Devonian rocks again come in and extend to the base of Waters' hill where Lower Carboniferous are for a short distance found, the Devonian then reappears in the bed of the brook which has cut its channel through these old rocks on crossing the North fault and leaving the Carboniferous over which it flows from its source until it reaches at the base of Waters' hill this point where it is sharply deflected to the west.

To what extent the range is composed of the several formations mentioned between Alma and where the Drummond railway skirts Waters' hill, has not been made out further than by the exposures along the brook; and the limitations shown on the map between the North fault and the southern slope of the range are very largely conjectural, though surface indications have to some extent been utilized.

Mr. Hartley implies* that the red beds with conglomerates found on the southern slope of this range are of the same formation as the greenish brecciated felsites and altered beds classed as Devonian, but the later Survey† does not hesitate to call them Permian or at least of the same age as the New Glasgow conglomerate.

Comparison was drawn by Sir W. Logan between rocks of this

* Geol. Survey 1869, p. p. 57, 58. † Fletcher, 94 P., 1886.

range and some of those of the south range at Park's mills and McLellan's mountain, although he did not himself examine both localities. The similarity is marked and yet it is not without question that they are identical. Perhaps the least dissimilar are the compact greenish grey rocks of Park's mills and those on the top of Waters' hill. The slates also on the north side of the latter hill while resembling the Silurian of McLellan's mountain are not so fine nor do they weather so friable and white as those of the mountain. Neither are the brecciated felsites and greenish conglomerate nor the bluish slates with imperfect cleavage of the north range known elsewhere in the neighbourhood. Some of the slates are light coloured and micaceous, others are reddish, probably stained by the Permian rocks that at one time overlaid them, while elsewhere the slates are bluish black, much shattered and veined with calcite.

On descending McCulloch's brook and leaving Waters' hill some forty chains behind, it is found to flow over New Glasgow conglomerate which appears to rest on a nearly horizontal surface of old rock and to occupy an ancient ravine, which the brook again intersects further down at other two points.

The bed of the brook averages fifty feet in width while the gorge or channel has a breadth in many parts of three times that distance, with banks ranging up to 115 feet in height. Covered largely with moss there are no rills to give exposures, but so far as can be judged of the debris the hills surrounding the conglomerate of the gorge are of metamorphic rocks capped probably on the northern side of the brook for the most part by conglomerate.

Returning to Waters' hill it has its highest knolls of the altered rocks overlaid on the north side by Lower Carboniferous and on the south side there is seen the outcrop of altered limestone which the Survey considers Devonian,* though Dr. Honeyman contended that it is Lower Carboniferous. The central knoll which presents the steepest escarpment to the south has at its base Power's quarry, which is in the sandstones of the carboniferous, and from which they are separated by

*Acad. Geol., p. 502.

the great North fault, clearly marked to this point by the course of Waters' brook. From the limestone quarry the crest of the range extends to the south-east without escarpment on either side until it overlooks New Glasgow town, and for this distance, about one mile, there is no exposure or record of trial pit now known that will demonstrate it to be as the Survey map has it, Devonian. The surface indications rather point to Upper Carboniferous or Permian, with nothing to shew of the North fault until the conglomerate again presents an escarpment to the south from a point half a mile to the west of New Glasgow.

LOWER CARBONIFEROUS.

This series occupies a large extent of country southward of the altered rocks of McLellan's and McGregor's mountains. It extends westward across the East river to the Middle river, and is found also on the northern flanks of the south range. Its outline is in parts obscure.

Basal beds of coarse conglomerate are seen to rest on Silurian strata on the west side of McLellan's brook at the head of the grist mill pond. There they hold many boulders of trap possibly derived from the deposits of McGregor's mountain. A coarse conglomerate, largely composed of fragments of diorite from the Cambro-silurian on which it rests, is also seen. These exposures are brought in contact with the limestone mentioned by Logan on Stewart's brook, that flows by Alexander Fraser's house to join McLellan's brook.

The exposures of this series are limited and shew few succeeding beds, though doubtless many parts put down as belonging to the limestone series really should be grouped with the basal conglomerates.

On Sutherland's river at Park's mills and extending up McLean's brook under the Carboniferous Limestone are conglomerate beds which Mr. Fletcher is disposed to consider as unconformable deposits.⁽¹⁾ Thus regarded, the removal of the South fault of the Survey of 1869 to a more southerly position is facil-

(1) Geol. Sur. Report, vol. IV, 69 P.

itated. The same conclusion may be drawn on examination of points further west along the hill range on the north slope of the older rocks, with a further suspicion that the old line of the South fault is for the whole distance one of minor dislocations only along an overlap of coal measures. A break of great magnitude and continuity occurs on the south side of the rim of the coal fields and to it as has been said may properly belong the prominence given to the South fault.

Carboniferous Limestone:—Within this system are included both the beds associated with compact limestones of McLellan's brook and those of the East river from Riverton to Hopewell but besides both containing limestone with obscure fossils they present no features in common, and it is not at all improbable that the latter, more altered and shattered than the former, may yet be classed as a distinct group, or possibly Upper Devonian.

Overlying the basal conglomerates just referred to on Sutherland's river is a bed of gypsum and one of limestone, and similarly above the bridge on McLean's brook there is the deposit at Finlay McDonald's mentioned by Logan,⁽¹⁾ which higher up is deflected across the brook just below the saw mill dam, below which gypsum is also seen. In 1869 this locality was obscured by a pile of slabs. Now the rocks are well exposed and shewn to be vertical and parallel with the dislocation that limits the coal measures east of the Vale area. Higher up McLean's brook the limestone is again seen with gypsum near grey conglomerate at the base of the hill range, where they do not seem to have been noted by the Survey of 1869.

The last exposure indicating the presence of beds of this series directly underlying coal measures on the north side of this range is on McLellan's brook at the head of the mill pond. The basal conglomerate already referred to appears in the bank of the brook both above and below the Silurian rocks. Grey rubbly sandstones overlie the conglomerate and then comes the bed of compact grey limestone,⁽²⁾ in turn succeeded by beds of sandstone and red argillite, dipping N. 45° W. 30° down the brook to the point below the grist mill where the South fault was placed

(1) Logan's Report, p. 40, line 7. (2) p. 8, line 34.

That a fault of the magnitude assumed should pass at this point and produce no appreciable disturbance seems doubtful. The rocks are well seen at the point in question and both above and below it the strata have approximately the same dip and strike, although the course given to the assumed heavy fault is oblique to the strike. A grey conglomerate bed dipping N. 20°, W. 50°, there crosses the brook and is succeeded by some thirty feet of reddish strata that appear to represent the whole of the Millstone Grit series; in turn they are succeeded by grey sandstones lying conformably on them and unquestionably Coal Measures.⁽¹⁾

Turning eastward and crossing the range of Cambro-Silurian rocks, limestone is found on its flank along the small branch that joins Stewart's brook, and an interbedded band also is to be seen lower down as described by Logan.⁽²⁾ The road too follows beside this brook and at a narrow pass near an old mill dam and between the two exposures of limestone it is directly over the fault, coursing parallel with the range and giving direction to the brook, where it has Cambro-Silurian as a wall on one side and Lower Carboniferous as a wall on the other side. The next exposure⁽³⁾ with a southerly dip is on McLellan's brook, resting on Cambro-Silurian near the mouth of a small brook corresponding in its relation to the range to Stewart's brook, but running along the flank of the hill range in an opposite and easterly direction. In many places on this brook this series of beds is seen associated with limestone bands dipping from 40° to 70° southward.⁽⁴⁾ Next in a depression of Silurian at Mountville and then to the south of the trap escarpment of McGregor's mountain.

The yellowish grey and reddish sandstones and crumbly red argillites associated with the grey compact limestones of McLellan's brook are with difficulty distinguished from those of the Millstone Grit, but there are also, on the East River, beds associated with limestones that are more altered and possibly belong to a lower horizon. These beds are first met with close

Geol. Rept., 1869. (1) p. 52. (2) p. 7, line 24. (3) p. 8, line 18. (4) *ibid.*, p. 9, line 12. Trans. Vol. V., p. 213.

below Riverton railway siding on the bank of the river and with a southerly dip rest on strata elsewhere described as the Fishpool series and possibly Devonian. Up the river and about Ferrona exposures of these rocks are numerous. Below Riverton close to the Intercolonial railway, above the mouth of McKay's brook, an aggregation of limestone blocks has been quarried. There is probably here an outlier of the Lower Carboniferous resting on the Fishpool series.

Half a mile to the westward of the Riverton siding on Simon McKay's farm a contact of the older limestone series is seen. The limestone is fossiliferous but the forms are obscure, and the rock is much shattered. From this point along the southerly rim of the Westville coal basin no exposures are known until Highfield farm is reached. Here a hill of older rock protrudes with several groups of the carboniferous lying on its flanks. The central portion has rocks identical with those north of Fishpools on the East river, and presumably Devonian. They are to be seen at the small cemetery on Munro's farm. The contact of the Limestone series with the Millstone Grit is possibly indicated to the west of the hill on McLeod's brook 100 yards below Pickens street bridge where rubbly sandstones overlie thin bedded ripple marked red rocks dipping N. 10°, W. 72°, and are succeeded within a short distance by strata that contain remains of plants, and are sufficiently well bedded to answer for foundation stone, a quality which does not belong to the stone higher up the brook. The hill is assumed to have the limestone series on the southern flanks. On its northern slope there are no exposures.

To the west of McLeod's brook the surface of the land slopes to the northward and is drained by a brook that flows by Ross and Urquhart farms to the Middle river. The branches of this brook supply several exposures of conglomerates sandstones and red shales, indicating by the various directions in which the strata dip, that the rocks are there much disturbed. At the forks of the brook are grey conglomerates associated with sandstones containing fragment of plants; beds that are assumed to belong to the base of the Millstone Grit, while higher up the branches

the rocks of the older system include slaty red argillites and compact conglomerates with pebbles of vermilion slates very similar to some conglomerate boulders found in the newer conglomerate deposits at Alma.

Debris in the brook would indicate the presence of Devonian strata not far to the southward. At Union Centre, on the Middle river, compact limestone of this series is to be seen just below the bridge associated above the bridge with strata shewing well preserved calamites, calamodendron and cordaites and of ferns, sphenopteris and archæopteris; the locality offering the best opportunity in the district for the study of the flora of this series. Higher up the close to the contact with the Devonian a band of agglomerated limestone crosses.

Passing over the coal field to the hill range that bounds it on the north, and going eastward up McCulloch's Brook, Lower Carboniferous rocks are met with at the most northerly point the brook reaches at the foot of Waters' hill. They are in a sharp anticline on the northern side of older rocks and appear to occupy the depression between Waters' hill and the next western elevation of Devonian similarly to the gypsiferous beds that fill the depressions between the peaks of Waters' hill. The anticline indicates an east and west fault to have thrown the knoll of old rock that lies immediately west of Waters' hill out of line with the range and to the southward, leaving carboniferous strata between them.

The gypsum associated with these beds is often semi-fibrous and stained red and green. It is to be seen at several points in the hollow of the road south of Jardine's house; in a shallow well close to the house of J. McDonald by the side of Waters' brook, and also on the crown of the hill 80 yards west of Waters' house in contact with Devonian strata; again on Waters' brook 100 yards above the railway. McDonald's house is close by the western exposure of Devonian limestone already referred to.

Along this range and especially at a point some 300 yards west of the limestone fragments of limonite have been found. They are possibly from a deposit similar to that at Bridgeville at the contact of Lower Carboniferous with older systems, but

no search has been made, nor can it be said that the float is of a quality to warrant it. To the westward these rocks, including limestone and gypsum, occur under the New Glasgow conglomerate of Green Hill near the church.

How far eastward this series extends is in doubt, but the narrow slip of disturbed brecciated mottled red sandstone lying on the west side of the East river, between the conglomerate escarpment and the North fault may be of this age and if it be then probably are also the rocks at D. McPherson's and the Pent road on the border of the North fault going towards the Vale colliery.

MILLSTONE GRIT.

According to the Geological Map of 1869 heavy faults on all sides separate the Millstone Grit from the Coal Measures⁽¹⁾. Mr. Fletcher in his report recalls to mind that Mr. Richard Brown successfully contended that these groups were found conformable in Cape Breton as they are in Pennsylvania. There can be no doubt they are so at the Joggins, and Mr. Fletcher is doubtless correct in saying nowhere as yet have they been found unconformable in Nova Scotia. Proof to the contrary has certainly not been found in the Pictou coal field, either at Westville or Stellarton where the transition beds are best exposed.

The coal measures of the Albion section are preceded in descending order by beds that repeated examination along the line of the reputed McLeod fault failed to find otherwise than conformable. Hence, as there seemed to be no natural division a limit to the coal measures had to be assumed, and the top of the Millstone Grit has been taken at the small seam of coal 30 feet below the Fraser oil coal,⁽²⁾ which Mr. Hartley in error puts at 15 feet 2 inches.

In the section given by Mr. Hartley in descending order from this horizon, a series of coal seams are shewn, but not one has been since exploited and proven to be of the thickness named. A well pierced stratum C, but found only two layers of coal, each

Acad. Geol., p. 285. Sup., p. 51. Gilpin, Trans. Vol. IV., p. 138. Honeyman, *ibid*, Vol. V, p. 213. Geol. Report, (1) p. 59. (2) Pages 70 and 76.

one inch thick. This section terminates on the railway leading from Stellarton to Westville at McAdam's cut, the highest point on the railway, and here a north and south fault crosses. Followed to the south-east the beds of this section change somewhat in composition and weather a more decided red. They are again exposed on the same railway as it nears Stellarton, and on the small brook by its side, and again on the west bank of the East river, where all trace of interbedded coal seams has disappeared. The series is continuously exposed on the western bank of the river, and consists of chocolate sandstones, alternating with marly shales weathering red as far up as the Stellarton pumping station. Just before reaching the station a fault crosses the river S. 80° E., and above it the dip of the strata is reduced from 19° to 13°, and even less under the filter-trenches. This slight inclination probably extends to the head of the intervalle, where exposures are renewed, with indications that this course is the axis of a sharp deflection of the strike, the dip on the river being eastward, while exposures on the bank of the intervalle dip to the northward. The absence of serious dislocation separating these diverging dips seems to be proved by the presence in each section of apparently the same bed of black shaly fireclay dipping in the one case N. 5° E., and in the other, only one hundred yards to the eastward, N. 80° E. The axis of the anticlinal apparently lies N. 60° E. towards the point where the continuity of the crop of the main seam was lost just west of the McLeod pit, and possibly it over-rides a spur of the older rock that projects northward from McKay's brook. The bed of black shale appears continuous upstream until it is sharply deflected by a fault coursing S. 5° E. The fault has thrown the crop to the westward some 150 feet, giving the black shale a dip N. 85° E. 9°, which again sends it across the river approximately parallel to the line of contact between the basal carboniferous strata and the unconformable underlying Fishpool beds. Underlying the black are grey shales and near the ford of the river are fine bedded grey sandstones which have fissures holding crystals of calcite and drops of elastic bitumen. Then lower strata are shewn in places in the river bed to be lying flat or crumpled with the axes of local sharp de-

flections in the direction of the dip but with a general strike S. 5° E. Among them a bed of grey conglomerate which crosses the river and abuts against the older series on the right bank. On the line of contact a few inches of soft and broken "gouge" separate the horizontal carboniferous from the vertical older rocks, through which the river has cut a bed 200 feet wide with walls of 20 to 40 feet in height before entering the coal basin. Exposures of other strata below this bed of conglomerate shew on the western side basal beds of conglomerate resting unconformably on the steeply inclined Fishpool rocks. The whole series of the Millstone Grit thus exposed on the East river give to it a total thickness of only some 900 feet.

On the eastern bank and succeeding in ascending order exposures are few. The overlying beds at Plymouth while having the same strike as the Coal Measures of which they appear to be continuations are in some cases red in colour, and they are associated with a grey conglomerate about five feet thick at Fraser's quarry where the dip is due E. 19°. This conglomerate does not shew further northward in the coal field in what is assured to be the same horizon, although it probably can be traced southward to the foot of the hills.

On the abandoned branch railway of the Drummond mine which joins the Intercolonial railway near the county asylum, on that part which overlooks the valley of McCulloch's brook, exposures shew a dip S. 85° W. 32°, and on the east side of the ridge where a small brook on Alex. Culton's farm crosses, dips N. 5° E. 18°, are seen. Higher up this brook the dip is round to N. 40° W. 38°, thus giving to the tongue of Millstone Grit that lies east of the southern part of the Westville section the general form of an anticlinal having a broad base resting against the upper Fishpool beds of McKay's brook.*

* In the Trans. Vol. IV, page 92, referring to this ground here classed as Millstone Grit, Mr. Gilpin says "Between these faults (the theoretical McLeod and South faults) no measures of an age older than the productive are known to exist, and the coal strata with every appearance of reason considered to run across this interval without undergoing disturbance," and again, page 92, "Enough to show that the synclinal form is preserved from the Bear Creek (the Drummond mine) area to the McLeod seam * * * a district one and a half miles wide yet unexplored, and * * * would allow of a development little if at all inferior to that attained by the seams of the middle or Albion synclinal" p. 97.

Westward of the range of altered rocks at Fishpools beyond the East river there are no good exposures for some distance after leaving the head of McKay's brook, where rocks assumed to be Millstone Grit are seen dipping at an inclination of 28° northward, regularly with the overlying measures at Culton's adit. The formation can only be conjectured to be Millstone Grit. On reaching the Foxbrook road a range of high land is found to run northward and to form to the south of Westville the western rim of the coal basin. Across the range prolonged northward pass the Coal Measures but at so slight an obliquity that it is only as they approach the junction of McCulloch's brook with the Middle river near Alma that they are found on the western side of the range in the valley of the Middle river. Parallel with this range of higher land to the west runs a brook in a course almost due north, called Skinner's or McLeod's brook. In it, half a mile above the upper mill dam of John Oliver, beds of soft sandstone dip at a low angle to the east 14° . On following the brook down and approaching the head of the pond, vertical rocks are exposed in many places. Again just at the mill and round the turn of the brook below the mill, in all for a distance of some 500 yards, with a width of some 150 yards, they have a uniform strike about N. 8° E. They are more altered than other beds lower down the brook in which are conglomerates holding pebbles of red argillite that appear to have been derived from them. They are veined and break obliquely, and do not even supply stones suitable for rough foundation walls. They are considered to be Lower Carboniferous, certainly older than Millstone Grit. From the range of higher ground to the eastward a branch joins the main brook at the mill, 50 yards up it bright red slates have a dip S. 45° E. 55° , and at 100 yards further hard grey sandstones are seen dipping S. 60° E. 45° .

In the next lateral the exposures are obscure, but in the one below dips are to be found N. 10° W. 50° in the same rocks as those of Oliver's mill. Up this branch another hundred yards to the eastward sandstones and red shales of a softer nature are found dipping S. 70° E. 40° . Further down McLeod's brook, on the right bank, 200 yards below the bridge, bedded sand-

stones containing calamites and stigmara roots have a dip of N. 10° to 35° E. with a dip of 40° increasing lower down the brook to 60° , and 65° at the turn in the brook where an older mill was situated, and here the rocks have an inclination N. 10° W. and include beds of grey conglomerate.

How far north the Lower Carboniferous extends towards the Acadia pit has not been determined, but the color of the soil being redder on the range than on the flanks may indicate an extension for some distance in that direction.

The great extent of conglomerates and false bedded sandstones seen at McDonald's mill site on the same brook suggests that these beds are basal and closely overlie an older formation which has not been exposed. The section No. II given in the Report begins at McDonald's mill dam with coarse conglomerates interbedded with sandstones. Some of the lower of these interbedded sandstones contains numerous remains of plants with roots and rootlets. The dip is about N. 10° W. 40° , which is continued for 600 feet down the brook, and when the highest of the conglomerate beds is past the inclination is found to be N. 40° E. 30° . This dip and direction appears to be the average for some distance along the main brook and in a lateral branch from the east. Although exposures are numerous it is difficult to get the correct average inclination as there is much false bedding. To what extent the rocks of this section have been repeated by faults has not been made out, but it is probable that the series of faults proved along the crop of the Acadia seam extending over to French's tunnel are continued. Certainly there is a fault of some moment passing under Squire McLeod's house where the brook crosses the Middle river road.

The valley of the Middle river affords the best exposures of these rocks, alternating beds of dull red sandstones too much cleaved to supply good building stone, and argillites having a characteristic mottled appearance. At French's tunnel the coal measures weather a yellowish grey, a colour which gives place to reddish tints at the higher turn of the river where beds of coarse red conglomerates are seen. These beds 8 and 3 feet thick and 150 yards apart are not readily distinguishable from the heavy beds

of New Glasgow conglomerate at Alma. On the left bank of the river 5 chains above French's tunnel is the lowest of the black fireclays with a little coaly matter, the probable equivalent of the second seam of the Westville series. A marked band of brown fireclay, however, occurs at the great sweep of the river half a mile higher up, and a coal seam of an inch or two still higher near the base of the section.

The exposures of red rocks duplicate the series on McLeod's brook and are in many places continuous for hundreds of feet, but shew no dislocations. The dip is uniformly eastward of north and consecutive until the conglomerate beds and sandstones containing, as at McDonald's mill dam on McLeod's brook, remains of plants and roots in situ are met at the mouth of the brook (Duncan McDona'd's) that joins the river 65 chains below the bridge at Union Centre.

On this horizon there is probably some disturbance and the probability is that the conglomerates rest on altered rocks not brought to the surface and exposed.

On the river the rocks are not again seen until at the sharp turn, 18 chains below the Union Centre bridge, thin bedded compact grey sandstones dipping N. 45° E. 85° , are immediately preceded by vertical red argillites and rocks of the Carboniferous Limestone.

Across the Gairloch road beyond the base of Hartley's section on McLeod's brook the high dips seen at Oliver's abandoned mill dam would indicate the passage there of an east and west fault and that the beds higher up McLeod's brook cannot be placed below the base of Hartley's section.⁽¹⁾

If it is assumed that N. 40° E. is an average dip of the rocks of the lower part of McLeod's brook this direction is some 30° more to the northward than that of the overlying coal measures and certainly suggests an intervening fault, as supposed by Mr. Hartley in his West fault, but the change it is now contended is associated by minor dislocations only as the beds pass over the northward extension of the altered rocks of Highfield farm range.

(1) Report 1869, p. 62.

The conglomerates on the Middle river that occur at the bend of the river next above French's tunnel dip N. 42° E. 50° . This is at a much steeper angle than that of the beds on McLeod's brook, but it corresponds with the increased inclination of the overlying beds in the extension of the equivalents of the coal bearing beds of Westville, as they pass westward and approach the North fault. Along the lower part of Brown's brook which joins the Middle river half a mile above Alma bridge the dip is well shewn and the general trend is east and west, inclining directly towards the New Glasgow conglomerate. South of the bridge over that brook the rocks appear to be vertical and within 100 yards of this exposure, upstream, there are beds of red conglomerate probably the extension of the beds seen on the Middle river.

Passing now back into the coal field there will be noticed conformably underlying the measures exposed on McLellan's brook just below the grist-mill a series of beds some 30 feet thick of which the lowest members are conglomerates and these it is suggested represent the Millstone Grit but greatly reduced in thickness.

Further east the series at the Vale, given in section number vii, page 31, is reached and contact of the coal measures and the Lower Carboniferous without any Millstone Grit is again met with in section number ix, page 37.

Pine Tree Brook Section:—To the description by Sir Wm. Logan of the triangular area which has its apex at New Glasgow, its base at Sutherland's river, the slope of Fraser's mountain for its northern side, and to complete the boundary has the higher ground along which Logan places the course of the great North fault of the coal field, may be added further information respecting the side last named that suggests an alternative conclusion to that of the Survey.

Pine Tree Brook rises near New Glasgow and flows along the strike of strata that have a general dip northward towards the conglomerate ridge and appear to be continuous to Pine Tree Gut. Large slabs of the rock called "black bastard limestone" are scattered from one end of the section to the other and at a

few points are in situ and in line. They indicate equally with the regularity of the overlying conglomerate the absence of serious north and south dislocations passing through this part of the country. This rock is unknown west* of the East river and to the south of the North fault. It is an agglomeration sometimes parti-coloured of fragments largely siliceous which on weathering acquires its characteristic black tint. Where shewn on Logan's map near the house of Mr. A. McGregor, the land owner says it has never been quarried, and he is doubtful if it be in position. The exposure is very small. But on the side of the telegraph road to Merigomish it is undoubtedly undisturbed as also on Pine Tree brook, and on the same course further east in a depression north of the house of Mr. Barton where it stands up above the surface in beds of 20 feet or more in thickness N. 35° E. 25°. The exposures in the brook from the house of Mr. J. Andrew Fraser eastward are described by Logan. Apparently he failed to notice some 150 yards higher up the brook soft red and grey sandstones dipping directly in the opposite direction S. 25° W. 43°, which necessitate an anticlinal or east and west fault intervening between the base of his section and this point. A quick turn of the brook and a bluff marks the change. Forty paces higher up the brook black limestone is seen dipping at a light angle to the eastward and apparently cut off by a fault in sandstone S. 20° E. Higher up on a lateral branch, at the house of Mrs. Roy, thin-bedded red and grey ripple-marked sandstones resume the northerly dip, N. 23° E. 75°; here begins the slope of the higher ground of the range bordering the North fault, and on following along it at other points similar steep inclinations are to be met with, and fields of very red soil suggest the presence below of the red sandstone and marls elsewhere seen. The direction of the more northerly of these high inclinations seems to coincide with the general dip of the strata that succeed at lesser angles in the direction of the conglomerate ridge, while nearer to the North fault the tendency of the vertical dips is to the southward. The rocks there

* Beds somewhat similar in appearance, but harder, occur in the Lower Carboniferous of the Middle river above Union Centre.

found, identical with those dipping northward, are red and greenish grey sandstones with bands of the black limestone. One of the latter is exposed in the narrow pass through which flows the south branch of the brook, and the road from the Vale extends to Pine Tree. It succeeds the conspicuous chocolate-coloured rocks of the pass that dip N. 25° W. 80° . In the centre of this section grey beds predominate, while red rocks succeed near the base of the conglomerate and are also more numerous among the vertical rocks of the North fault range. The accompanying diagram implies the pre-existence of a great anticlinal fold that brought down to the North fault the rocks immediately underlying the conglomerate, and of which the crown has been since denuded.

Immediately south of these vertical rocks lies a narrow strip of bright red coarse conglomerate which is believed to be an outlier of the New Glasgow conglomerate. Here it is made up of quartz pebbles chiefly mixed with fine grains of argillite, apparently from the Lower Carboniferous, and cemented with material that gives a blood-red stain. It extends eastward past the old pent road, and westward on to the hill on McGlashen's farm, the highest land between Fraser's mountain and the range of Cambro-silurian to the south. It is succeeded southward unconformably by a mottled red sandstone dipping N. 60° E. 30° , that resembles the strata underlying the New Glasgow conglomerate at Blackwood's old mill dam. The strip of these sandstones is narrow and succeeded to the southward by Coal Measures from which they are separated by the great North fault.

The red sandstones of this section are brighter than any in the representative measures of the Millstone Grit, and they possibly are of the same horizon as the strata with a southerly dip exposed at Ross' bridge on Sutherland's river, described by Logan but outside the field of this paper.

This section is, so far as known, quite barren of fossils other than a few comminuted fragments of plants in some of the laminated grey sandstones. Logan put it as Millstone Grit,* but the

*Pp. 9-13.

strata do not resemble those of McLean's brook to which he also gave the same horizon, nor yet those of the Middle river which are now considered to be typical of that series. He noted the coincidence of the dip with the overlying beds of New Glasgow conglomerate, but the absence of contact exposures leaves it still unproved whether there be along the base of Fraser's mountain a marked unconformable overlap or no.

It is possible that the conglomerate escarpment east of the river is slightly oblique to the strike of this group, and their assumed but unproved unconformity would account for this, but the absence of contact exposures and the gradual change in the direction of the strike and the flattening of the dip of the underlying beds towards the base of the triangle leave the question still in doubt.

On the west side of the river, however, at Blackwood's dam, the rock lying there exposed unconformably below the conglomerate appears to belong to this section and to form the very apex of the triangle. The presence at this point also in the conglomerate of boulders of the black limestone and of "bull's eyes,"* unknown in beds of greater age than these of this field, seem to confirm this view, for here the conglomerate rests on the very lip of the coal measures and has to the southward none of these strata as a source of supply for these characteristic constituents. As to the horizon of this group of beds there is a disposition to assign them to the Upper Coal Measures, there being a greater similarity to the beds of the overlying Permian than of any other possible horizon, a position also more in keeping with the theory here presented in preference to that of clean cut faults of magnitude circumscribing the coal field. Here it is assumed that the faulting along the north margin of the field arises from the obstruction to a uniform curvature of strata by protruding older rocks of greater hardness and resistance similar to the condition at High Field farm where the West fault of the Survey has given place to a hill of older rock round which the Coal Measures of Westville have broken. On the high land of Love's, McGlashen's and Jackson's farms the older rocks, Lower Carboniferous, it

* Report, p. 10.

was assumed, have been the obstruction against which the softer and newer rocks of this series have become faulted and broken. This view is not entirely abandoned, although now less confidently held, the evidence of age not being convincing.

The partial section given by Logan is put as 1000 feet. Reddish sandstones of the upper parts are exposed on the Merigomish road ten chains west of Wier's mill, dipping N. 30° E. 31°. They appear to be part of the series seen at the dam.

	Feet.	Feet.
Greenish grey sandstones and band of nodular limestone	?	
Red sandstones and shale in brook below the mill	200.0	
Greenish grey freestone, dipping due N. 12°	30.0	
Red rocks	?	
		400
Grey freestone at bridge over south branch of the brook underlaid by bed of nodular limestone, repeated at Pine Tree Bank :—		
Nodular limestone	?	
Coal one inch.		
Red shale or marl and red flaggy sandstones	20.0	
Red thick bedded sandstones	12.0	
Massive grey freestone, dip N. 10° W. 14°	15.0	
On the main brook above the dam :—		
Freestone at a quarry	20.0	
Sandstones	80.0	
Impure limestone	0.8	
Soft light grey calcareous sandstone	2.0	
Sandstones greenish grey with "bull's eyes"	130.0	
Strata concealed	90.0	
Impure nodular limestone	3.0	
Grey freestone	270.0	
Nodular limestone, N. 30° E. 34°	1.6	
		600
		1000

This section ends at an east and west anticline or fault that marks the crown of the arch and is succeeded by red rocks dipping S. 25° W. 43°.

Mr. Hartley discusses⁽¹⁾ the probability of unconformity of the conglomerate⁽²⁾ with its base and refers to imperfect exposures north of Fraser Ogg's quarry road on the small water-run that flows along the base of the conglomerate escarpment to the west

(1) Survey Report, 1868, p. 66, also referred to by Logan, p. 13.

(2) Supplement Acadian Geology, p. 36, line 16, doubts the existence of unconformity.

of the New Glasgow and Stellarton road; but now, on the same rill, the overflow from Blackwood's dam close to the road has clearly laid bare the line of contact and the unconformity. The base is a close grained fine grey and mottled red sandstone much brecciated. Its dip is N. 55° E. 45° , and its smooth eroded surface appears to have an average inclination to the northward of about 15° . If this inclination can be taken as correct it is quite possible that some of the seeming high dips, 30° and 40° in the superimposed conglomerate, may be due to false bedding.

At the imperfect exposures higher up the dips of the underlying sandstones were noted as N. 20° to 60° E. 10° to 25° , differing somewhat from Mr. Hartley's figures,⁽¹⁾ but the discrepancy only goes to confirm the statement that they are much disturbed.

Intermediate but somewhat south of these two points near the athletic grounds red and grey sandstones of the same age dip S. 16° W. 30° , then at a distance of only 12 feet east at S. 2° W. 60° , and at 36 feet further at S. 25° E. 65° , on the margin of the great North fault which here brings them in contact with black shales, fireclays and two small seams of coal, beds of the Productive Coal Measures.

Whatever may be the true horizon of these disturbed sandstone beds, they were consolidated, elevated, dislocated and denuded prior to the deposition of the conglomerate and they supplied the major part of the well rounded boulders and pebbles that compose the deposit at this point. Such an unconformity must mark a very protracted break in the sedimentation,⁽²⁾ and no such break occurs between the base of the Millstone Grit and the Upper Coal Measures.

NOTE.—Since the above was in type a quarry has been opened at a hitherto obscure contact on the left bank of the brook 16 chains above Blackwood's dam. The surface of contact has a general dip of N. 60° E. 55° almost the same as that of the unconformable subjacent beds. These beds the quarry has shewn to be identical seemingly with the greenish grey sandstones of a quarry on the Merigomish road 140 chains east of the river and the suggestion that they differ is abandoned. Their underlying beds are mottled red from percolations from associate beds of chocolate arenaceous shales, and the right bank of the brook supplies fragments of dark reddish brown sandstones similar to those of the pass from the Vale to Pine Tree besides a band of black limestone, the distinctive rock of Pine Tree Section. This identity of base on both sides of the river may be said to prove the unconformity in doubt on the east side, bringing as it does the conglomerate in contact at the new quarry with beds some distance from its base at the older quarry on the Merigomish road. The concluding paragraph under the heading Lower Carboniferous, page 261, should be deleted, and so also the words "possibly Lower Carboniferous" referring to this spot on page 240.

(1) Report 1869, p. 66, also referred to by Logan, p. 13.

(2) Acadian Geology Supplement, 1878; page 39, line 4; page 49, line 3.

PERMIAN.

While Sir W. Dawson is understood to be still unwilling to call Permian the strata which stretch westward up the coast from Merigomish, and from the straits of Northumberland inland to the Cobequids and the hill country of Pictou, the term is convenient for reference to the district in question and to distinguish the horizon of strata indubitably above the New Glasgow conglomerate from groups and formations now supposed to be entirely below; and in that sense the term Permian is here used.

New Glasgow Conglomerate.—About Alma to the northwest of the coal field lies a great expanse of coarse red conglomerate dipping eastward at a slight inclination. It extends northward on the west side of the Middle river with the same general character of dip and strike it makes Green Hill and neighbouring elevations, and is found repeated to the westward and along the northern flanks of the Cobequids. Its outcrop also extends in the other direction under the town of New Glasgow—hence its name—and over Fraser's mountain to the waters of the gulf at Merigomish. At Alma the deposit is again repeated by a fault on the east side of the Middle river, and extends up from Granton with the same gentle dip to the eastward until it reaches within half a mile of Alma bridge, where the inclination changes to N. 23° E. 5° to 25°, and it appears to be abruptly cut off. When next seen close below the bridge it dips heavily in an opposite direction, and the continuous exposure up stream from this point given by Mr. Hartley⁽¹⁾ in Section III shows some 1372 feet of strata dipping due south 74° to 54° and abutting against a patch of altered rocks elsewhere spoken of as Devonian. This patch of old rock is evidently brought to the surface by a fault apparently coursing parallel to the strike of the strata N. 84° E. and presumably cut off from the great mass of conglomerate with a light easterly dip by a north and south fault crossing near the mouth of Brown's brook. The patch of Devonian has a width of only 14 chains, to the southward it is overlaid by the

(1) Report of Progress, 1869, page 64.
Dr. Honeyman speaks of the New Glasgow conglomerate as of the Lower Carboniferous system Trans. 1879, p. 193.

conglomerate, still dipping southerly though at a lighter angle, and here composed of finer material with layers of fragments torn from the strata on which it rests. The unconformable contact with a surface of deposition is well exposed above the dam that spans the river at this spot.

The age of this conglomerate has been a subject of much speculation and is not without interest of a practical character in connection with a possible extension of the Productive Coal Measures beneath it, provided only it can be proved to be of later deposition. Sir W. Dawson in his papers prior to 1860 assumed it to be the base of deposits either later than or contemporary with the Productive Coal Measures. His arguments are given in full in the second edition of his *Acadian Geology*, both for the views held prior and subsequent to that date. Sir W. Logan in his portion of the Report tacitly dismisses the subject, apparently accepting Sir W. Dawson's later views.⁽¹⁾ Mr. Hartley goes more into the matter and is more definite in expressions of opinion, considering the conglomerate as the base of Sir W. Dawson's Middle Coal Formation. Both writers it is fair to assume from the context, presuppose an unconformity between the Millstone Grit and the Productive Coal Measures, and rightly conjecturing that there is to the westward of New Glasgow an unconformity between the conglomerate and its base see no reason to question the horizons assigned.

But yet when it is proposed to consider the conglomerate as a beach deposit⁽²⁾ contemporary with the beds here classed as Millstone Grit and to place it under Productive Coal Measures as Sir W. Dawson was disposed to do in 1868, it must be remembered that there is no recognized unconformity between these two groups in Nova Scotia, and that there are no beds equivalent to the conglomerate known in the south-west part of the field where the Millstone Grit is best exposed in regular sequence under the Productive Coal Measures. Sir W. Dawson seems to have accepted without question what was said by explorers in

(1) *Geo. Report*, 1869, pp. 13, 65 last lines.

(2) *Acad. Geol.*, pp. 322, 343.

1866 that "the underlying strata of the Richardson seam rested on the conglomerate dipping to the southward,"⁽¹⁾ and he may hence have in part at least based his remarks on their statements. No evidence of the kind was, however, found, the nearest approach being the exposure of a broad belt of conglomerate dipping vertically on the southern face of the escarpment, possibly on the edge of the North fault, 25 chains east of the river. The conglomerate may be also seen vertical on the southern escarpment of Green Hill. In his argument contending for an horizon equivalent to that of some member of the Coal Measures stress was laid by Sir W. Dawson on a southerly dip to the conglomerate, but the only known exposures having this direction are at Alma on the Middle river and on the lower stretches of McCulloch's brook where it overlaps metamorphic strata, and as already mentioned has been brought in contact with the Coal Measures by the North fault, plainly to be seen in the bed of the Middle river.

Although on account of the unconformity between the conglomerate and the underlying sandstones, and the absence of unconformity in the relation of the Millstone Grit and the Productive Coal Measures, it is now clear that one or other or both of these disputed members must be given an horizon other than the Millstone Grit and the Coal Measures. Several alternatives are stratigraphically possible. Either the rocks underneath may be Lower Carboniferous and the overlying Coal Measures or strata higher in the series, or the lower beds may be Millstone Grit or Coal Measures, and the upper Permian. There can be no question about the base being Lower Carboniferous⁽²⁾ at Green hill where Gypsum bearing rocks near the church underlie the conglomerate. The superposition of the conglomerate at Alma on metamorphic rocks, and the presence of Lower Carboniferous on Waters' hill with possible overlapping of conglomerate on its northern flanks, all tend to confirm the conclusion derived from the changes noticed in the character

(1) Trans., Vol. 2, Pt. I, p. 96; also Vol. 2, Pt. 3, p. 156.

(2) Geol. Sur. Report 1886, Vol. IV, 93 P., H. Fletcher.
Supplement Acad. Geol. pp. 34, 49. Geol. Jour., 1853.

of the deposits within the coal field, that a ridge of older rock existed and furnished protecting lines behind which the beds of the field were deposited.

Along the rim of the basin between Alma and New Glasgow north and south faults seem either to cross the range into the coal field, or as spurs of the great North fault to disturb the latter, but east of New Glasgow the conglomerate apparently is not similarly affected. Coincident with this change the line of disturbance leaves the neighbourhood of the conglomerate escarpment, and so far as can now be seen, eastward of the town of New Glasgow less decided unconformity divides the underlying rocks from the conglomerate, and the difference in age is greatly reduced.

Logan mentions the apparent conformity along this range which he examined, the dip of the conglomerate nearly agreeing with that of the substrata. Where seen a little west of the house of A. McGregor the latter are red marls and thin bedded chocolate coloured sandstones, strongly resembling the series to the eastward toward Pine Tree.⁽¹⁾

Sir William speaks of finding in the conglomerate pebbles of the black agglomerate limestone which is such a characteristic rock of the latter series. This puts the question of the later deposition of the conglomerate beyond a doubt. In it are also to be found large circular boulders of sandstone, the "bull's eyes" he mentions as common in the sandstones of Pine Tree brook. Similar bull's eyes, it may be noted, are found in the quarries of Pictou, but not, so far as known, in the Middle Coal Measures or Millstone Grit.

While it is evident that many of the serious disturbances in this field were subsequent to the deposition of the conglomerate, the apparent conformity of the latter with its underlying strata in the district of Pine Tree, contrasts very strongly with the conditions seen west of New Glasgow. There it is only the eroded surface of the rock that approximately coincides with the dip of the conglomerate. The rock itself is thoroughly unconf ormable. It undoubtedly suffered dislocation and was greatly

(1) Geol. Report, 1869, p. 13.

disturbed prior to the deposition of the conglomerate. It contains imperfectly preserved calamites which Sir W. Dawson considers may be *C. radiatus* or *C. undulatus*. Overlying these sandstones the conglomerate is easily traced for half a mile west of the East river, and it is then lost at the foot of a hill marked Devonian on the map of 1869, and it is an open question whether it skirts the north side of that hill and is covered by drift, or is buried under Permian deposits and its outcrop hidden by the North fault. Where the Drummond mine railway emerges from behind Waters' hill the conglomerate is said to have been cut, but its presence is in doubt until the Middle river is approached. It is seen well⁽¹⁾ exposed in the gorge of McCulloch's brook, filling ancient ravines in the Devonian rocks which compose the hill range, and passing over the high ground it appears to then underlie the triangular district of country to the northeast of Alma Bridge that was marked on the map of 1869 as Millstone Grit. Logan refers to a white sandstone overlying the conglomerate east of the East river as a characteristic rock. The sandstone of Fraser Ogg's quarry immediately west of New Glasgow weathers white and can easily be distinguished from that of all other localities except along the extension of the hill range near Alma bridge, and the triangular patch of country just referred to where fragments of very similar looking rock cover the surface.

The probability, both lithologically and stratigraphically, having been accepted that the basal rocks to the westward are Lower Carboniferous, the question is how low down among the more modern groups can the conglomerate and its succeeding strata be placed. The evidence so far obtained is not decisive, but it may be found in the fish remains⁽²⁾ which are preserved in the black shales of the assumed Permian system at the mouth of Smelt brook and the quarry at Deacons' cove.

It has been mentioned that the Devonian rocks of Waters' hill probably protruded as a hill range even as far back as the Carboniferous period. They are certainly not overlaid by deposits of an age intermediate between the Lower Carboniferous and the

(1) These deposits were in error included as members of the Devonian in the Geol. Report 1869, p. 58.

(2) Acadian Geology, 2nd Ed., p. 322, lines 3-6.

conglomerate, and as yet the conglomerate has nowhere been found to rest on Coal Measures, nor has the reverse been seen. Such an absence may favour the contention that the New Glasgow conglomerate is attenuated and appears in the Millstone Grit beds at the bend of the Middle river above French's tunnel, but such a disposition is not here advocated.

When endeavouring to reconstruct the conditions which existed prior to the time when the dislocation known as the North fault occurred and brought the coal measures in contact with the conglomerate it seemed clear that the beach on which the conglomerate was formed and collected must have had to the south of it at the time of its formation a shore or cliff of rocks less easy of erosion than the soft strata now so close to the escarpment on the west side of the East river.⁽¹⁾ So clean a base as is shewn at Blackwood's mill dam could not have been in deep water, but must have been at that time exposed to a strong surf or tideway.

Respecting the rocks under the conglomerate east of New Glasgow the conclusion is that they are Upper Coal Measures, being distinguishable from the Middle Coal Measures by having red sandstones and marls intercalated with the grey rocks and having in other respects no resemblance to the red rocks of the Millstone Grit or Lower Carboniferous within the limits of the field.

The key to the relation of this conglomerate with the rocks on which it rests is possibly to be found to the eastward of the coal field where the Productive Coal Measures are absent and the strata of Pine Tree predominate and come in direct contact with Lower Carboniferous and metamorphic rocks. Mr. Fletcher states, 92 P. Vol. IV., the conglomerate of Glenshee along the telegraph road yielded a pebble of earthy red hæmatite. The New Glasgow conglomerate contains many such small pebbles at New Glasgow and eastward, while at Alma pebbles of compact red hæmatite an inch in diameter are numerous, associated with occasional boulders of a conglomerate marked with pebbles of red jasper, such as occurs on Urquhart's farm between Oliver's

(1) Acad. Geol. p. 342 notices coal preserves its character close to the original margin of the trough near New Glasgow.

mill and the Middle river. Red hæmatite is a prominent constituent of the unconformable red conglomerate on Sutherland's river above the mouth of McLean's brook, where it is sufficiently abundant to cause the question to be asked, would it pay to work? The basal part of the bed below Angus Robertson's barn carries the greatest number of ore pebbles and even of small boulders six inches in diameter. This bed rests on Lower Carboniferous. It extends westward across McLean's brook and it may be a severed extension of the bed that skirts north of the Vale coal lease from McGlashen's farm eastward to the high lands behind Barton's on Olden's road.⁽¹⁾

The strata overlying the conglomerate are, with the exception of the till, the highest in the field. They are comparatively little disturbed. Sir W. Logan⁽²⁾ gives those immediately above the conglomerate on the top of Fraser's mountain in a section, beginning with 20 feet of grey limestone which has been quarried for burning, and ending with 18 inches of good coal and three feet of black shale which was at one time used for burning the limestone. The dip is given as N. 13° E. 47° and belief is expressed that the same series can be recognized on Small's brook three miles to the eastward where the dip is deflected to due N. 9°.

Westward on the East river the measures immediately overlying the conglomerate are concealed, but on the left bank 39 chains below the bridge and 50 yards below the last exposure of conglomerate there are near a spring fragments of the agglomerated and botryoidal limestones peculiar to this horizon. They prove the continuation of the same series also westward, and at this point under the white fine bedded sandstones⁽³⁾ and succeeding deposits of which as the river is descended numerous exposures are noticeable. The inclination of the strata is northward at right angles N. 25° E. 5° undulating in parts and possibly repeated, traversed by few faults they are nowhere uptilted in mass.

When in 1860 there was a general exploration for coal and oil bearing shales pits were put down at Sinclair's cove,⁽⁴⁾ at the

(1) Fletcher Geol. Surv. Vol. IV, 86: 69, 92, '97 P.

(2) Geol. Report 1869, p. 14.

(3) Logan, 1869, p. 15.

(4) Trans. March 1863, p. 9; also H. Poole, Canadian Naturalist, August 1860.

mouth of Smelt brook,⁽¹⁾ where the Forge works now are, and opposite on the west side of the river at the Basin on the strike of the same beds. The bituminous shale at the latter place was found to "yield upwards of sixty gallons of crude oil of superior quality to the ton."⁽²⁾ Then lower down the river, but higher in the series, on Matheson's farm, opposite the Loading Ground, a fifteen inch seam of good coal was found. Later explorations have re-exposed some thin seams beside a small brook where the road to Abercrombie Point crosses on the farm of Hugh A. Fraser.

Explorations round the shore at Skinner's Point, near the mouth of the Middle river, shewed a one-inch seam of coal; then higher up the estuary but a short distance inside the mouth of Begg's brook, some coal was dug near the surface; again on the shore between the coal wharves, and yet again on the bank above the brick-yard on Stuart's farm, the August gale of 1873 swept clear the crop of some thin coal beds dipping to the eastward. Besides the coals mentioned to the north of Fraser's mountain some beds were also found at Little Harbor; but at all these points they are thin and irregular without promise of value.

The lower series of these beds are perhaps more fossiliferous than is usual with strata classed as Permian, and those that succeed the coal seam were evidently deposited in shallow waters. It is common to find *stigmara* roots in position with their rootlets passing down through several layers of thin bedded earthy sandstones. The black shales are laminated and similar to the more compact shales of McLellan's brook. They are full of fish remains, ferns and cordaites, &c. The sandstone beds at Deacon's Cove are quarried, but the stone is not so good as higher in the series.

The plants of these beds are described in *Acadian Geology and its Supplement*.

(1) *Acad. Geol.*, p. 322, line 3.

(2) From a pit 26 feet deep the oil shale being 6.5 inches thick. At Deacon's cove a seam 14 inches thick dipped N. by E. 5.

COAL MEASURES

When treating of this coal field it is convenient to speak of it as a basin, or trough, or valley, for although these terms may not be strictly accurate, they are sufficiently so to express the form it assumes, since the general dip of the beds is towards the central axis of the field more especially from the east, south and west sides. From the north it is not so, and yet the southerly dip is referred to by several writers. There are spots along the northern margin of the field where beds dipping to the south may be seen, but they are of the higher measures disturbed by proximity to the great North fault; and they are not there in such continuous series as on the edges of the basin in other parts.

Speaking broadly, the western end of the coal field seems, in the final elevation of the country, to have been most raised, for beyond it are exposed the lower members of the formation. These are in part repeated to the eastward at McCulloch's brook by the fault which crowds the axis to the northern side of the trough and almost cuts it in two. On passing still further to the eastward, along the central line of the valley, higher horizons are met with, barren measures which are succeeded by another series of coal seams, and the highest not far short of the eastern margin of the basin. These higher members are deflected back towards the west, along the northern edge, in broken ground, as far as McCulloch brook fault. Elsewhere reference will be made to the positions to which the more prominent patches in this strip are assumed to belong relatively to the regular series of strata that compose the Middle Coal Formation.

From the time of Mr. Richard Smith, who superintended the earlier operations of the General Mining Association in the twenties, speculations have been rife as to the possible present and past extent of the coal field. The early miners recognized the existence of the great North fault crossing the East river at New Glasgow, but its influence on the workable area was variously estimated, and conjectures carried the bounds of the field even so far as the town of Pictou.

Mr. R. G. Haliburton⁽¹⁾ in early numbers of our transactions

(1) Trans. Vol. II, (1) 93.

gave expression to views held in 1866. Then came the Geological Survey of Sir W. E. Logan, and in 1876 under the direction of Sir W. Dawson, a borehole 734 feet deep was put down at Sutherland's Point below New Glasgow, on the East river, through rocks overlying the conglomerate. This borehole, it is understood, told nothing more than the section exposed on the river's bank.

From a practical point of view all data bearing on the possible extent of the field is of value, and it is worth while to review the facts so far made known which may appear to justify a conclusion being formed either that the field is part of a deposit originally but little larger than the one we know, or it is only a fragment of one of vast extent. In the latter case the question may be asked, can reasonable hopes be entertained of workable coal being found in any other part of Pictou county. Now the facts connected with this enquiry are these: The known workable seams are in all cases conformably underlaid by Millstone Grit beds. They are not found to remain uniform for any great distance and especially is this noticeable in the neighbourhood of the older rocks that form the hills of to-day; within the short distance even of a mile some of the seams change very decidedly in character, composition and thickness, and so do their associate beds of sandstone and shale. Mr. H. Poole in his exploration map of 1852 shows a line to represent where the sandstone comes in to the westward of the Albion Mines, and begins to replace some of the black shales which in a continuous series for 1000 feet are alone found to overlie the main seam where it is worked near the East river. When these sandstones were first met with in the Coin pits it was feared a fault separated the two localities and cut off the coals, so further sinking of these pits was suspended. This view seemed to be confirmed by the dip of the sandstones varying somewhat from that of the black shales. Numerous trial pits were then put down, those along the crops of the seams found them, however, to be continuous into the district where the sandstone almost entirely replaces the black shales. Now the special

interest which this line of substitution has for our question lies in the direction given to it, it is parallel to the range of metamorphic rocks that extends from Waters' hill to the Middle river. A similar parallelism has been since then found in the deterioration in thickness of the Acadia seam in the Westville section of the field, and in the size of the grains in the sandstones and grits of the associated rocks. Indicative it would seem of the existence at the period under review of the hill range as an island or cape behind which in quiet waters the sedimentation of the Coal Measures took place. A view that is strengthened by the discovery that the New Glasgow conglomerate, the base of the assumed Permian, is known in the country about Green hill and the Middle river to rest only on metamorphic and Lower Carboniferous rocks which it is hence surmised then lay in shallow waters or exposed above the surface of the sea. That the older and the newer rocks of this section of the County are now divided by the North fault from the Coal Measures does not conflict with this view of past conditions while it may account for the absence of Coal Measures inclining from them towards the southward.

Transferring our attention to the east end of the field we find the Vale coal seams where they lie near the old rocks carry more ash than when further away and their associated strata include some pebble beds not repeated in sections more remote.⁽¹⁾ The McBean seam coarse in the western ground which is undisturbed by faults rapidly improves in quality as it leaves the hills although at the same time in its trend to the eastward it gets among faults and approaches the northern limit of the field. That the limit at this point is not one of deposition the quality of the coal would indicate, just as at the western end of the field the superior character of the coal in the middle portion suggests its formation away from the contaminating influence of littoral sediments which deteriorated the seams at their extreme north and south outcrops. In both localities this condition implies an original extension of the seams east and west to a distance at present undetermined.

(1) Logan, p. 35.

Under approximately similar conditions the Spring Hill basin is found in Cumberland County, and between this point and the Pictou field lie other and subordinate deposits of the coal measures, in all cases on the flanks of the metamorphic rocks, so that it would appear further discoveries of workable seams will, if ever, in all probability be made along this range of country.

Elsewhere in some detail reference will be made to the changes found to occur in beds of the same horizon as they are traced across the country, and from the data obtained doubts have arisen whether the field of deposition was very much larger than that which now remains. In fact the disposition is rather to consider the Pictou field with features distinctive from those of the other fields of Nova Scotia as an isolated deposit cut off from the broad seas that left such extensive records around the shores of Cape Breton of luxurious plant life in Carboniferous times.

In treating of the coal measures those of this field may conveniently be divided into separate portions having the following limits:—

The Westville Section; to include all the coal bearing strata lying west of McCulloch's brook and Water's hill;

The Albion Section; succeeding to the eastward as far as the Interco'onial Railway bridge and the mouth of Potter's brook;

The Potter's Brook Section; from the points mentioned on the East river to the town of New Glasgow;

The Fraser Adit Section; lying eastward of New Glasgow, and the last-named section;

The McLellan's Brook Section; an overlying extension eastward of the Albion;

The Marsh Pit Section; the further continuation of the series upwards including the highest in the Middle Coal Formation. The rocks of this section are in part repeated in the subordinate syncline which may be styled

The Vale Section; which takes in the most eastwardly lying portion of the field and its extension westward on the flanks of the McLellan's mountain to McLellan's brook forms

The Mountain Section, and completes the area so far as is known of these deposits.

Westville Section ;—This includes the area occupied by the Acadia and underlying coal seams ; it extends from the North fault near Alma to the Culton adit, and from Westville to McCulloch's brook. It includes the Bear creek synclinal of Hartley,⁽¹⁾ who considered this portion to have a depth only of 800 or 900 feet from the surface to the Acadia seam. Further working since Mr. Hartley's day by the Intercolonial Coal Mining Company shows no characteristics sufficiently marked to warrant the continuance of this division of the section. In fact it will be seen on the map that the line of levels in the range of pit workings at a depth of 1,000 feet is practically straight across the three areas for a distance of nearly three miles. At a lesser depth the deflections in the levels in the southern limits of the Intercolonial Coal Mining Company's workings (the Drummond mine) are due to faults, downthrows to the east, the influence of which brings the Acadia seam to the surface at Culton's adit. From data obtained in mining it appears that a dislocation having a throw of 200 feet passes in front of this adit, and it is one of the Drummond series of faults elsewhere referred to.

In this neighbourhood the dip of the strata is about 10° increased to 22° at the south-east corner of the Acadia Coal Company's area, to 30° when the north side line of the latter area is crossed by the same level, to 45° at the further end of the levels in the Black Diamond area, to 46° where the seam crops out on the Middle river at French's tunnel, and to 60° where measures believed to be the equivalent of the Acadia seam, greatly reduced and deteriorated, show on Brown's brook on the west side of the Middle river close to the contact with the New Glasgow conglomerate. Along the crop of the Acadia seam the dip at the Drummond slope is 16° , at the Acadia slope 24° , and at the Black Diamond slope 28° . Following the dip in a course at right angles to that just given and taking for a midway line the Acadia slope, at the surface the inclination is 24° increased at 1600 feet distant to 26° and at 3600 feet to 27° . This latter

(1) Report of Progress 1863 ; foot of pages 75 and 77.

inclination probably continues to the McCulloch brook fault, as a trial pit at a distance of 4092 feet from the outcrop in a line with the slope found the dip 26° .

If this assumption be correct, it gives at the west corner of the Albion area a total throw to this great fault of 2600 feet. The Survey report at the top of page 77 puts it at 1600 feet.

Overlying the Acadia seam in the Black Diamond area strong sandstone beds are exposed on the Middle river, in the railway cuttings, and in the sinking of the Black Diamond furnace pit, while to the eastward in the pumping pit, 326 feet deep, at the Drummond Mine only black and grey argillaceous shales were met with,—the substitution of shales for sandstones being similar to that observed in the Albion area and commented on elsewhere.

No seams are known to overlie the Acadia though the survey map dots the three and a half feet seam in that position. On the assumption that the Acadia is the equivalent of the main seam in the Albion section, there should also be found in the Westville section the equivalents of those seams found overlying the main in the Albion syncline at Tupper's. But whether equivalent seams so found would have any commercial value is another matter, the near approach to the older rocks makes it doubtful; at the same time some encouragement might be had from the finding of numerous pebbles of good coal in the till near where the Middle river road is shown to cross the Drummond railway just west of the McCulloch brook fault. But as the drift of the district has been from the south, and these pebbles are well rounded, they may have come from the outcrop of the Acadia seam a mile away.

A southerly dip is given by the survey to the coal measures along the North fault to the west of McCulloch's brook. It is based only on exposures in the brook, but as the brook is now regarded to lie between the fault and these exposures their inclination has not the weight given to it twenty years ago. Since then operations in the Acadia seam for a distance of 4000 feet on a line nearly parallel to the North fault have disclosed the Black Diamond series of faults, a series invariably with a hade westward, and coursing parallel to one another. So far as

can be judged from the extent to which they have been exposed, they increase in strength as they pass northward. It will further be noted that their approximate beginnings coinciding with a deterioration of the seam make a line roughly parallel to the North fault, and it has hence been assumed that this series are laterals of the Fletcher fault. It is almost certain that the southern dip of the measures on the brook at the Drummond railway bridge does not continue far to the west of the brook or across the position assumed for the great fault, the probability being that the Black Diamond series of faults carry the measures of the Westville section with an easterly dip up to the Fletcher fault or with a flexure if any to the north as they approach it. Positive proof of any one contention respecting these overlying measures and the lay of the northern portion of the section cannot readily be had, the surface cover being deep, 60 and 80 feet have been met with, and natural exposures are few.

Of the measures underlying the main or Acadia seam sections were obtained by boreholes and trial pits in the neighbourhood of the collieries. The records of the former are given below but of the latter details are not now available. The Scott pit, a sinking to the second seam close to the Drummond slope, gives between the seams dipping at an inclination of 16° a depth in the shaft of 230 feet, no compact sandstone being met with as in the same zone in the Black Diamond area at a spot only one mile to the northward. In the same locality, the anticlinal of Hartley, a third seam and a fourth seam have been found but the quality of the two latter has not warranted further explorations on them.

Mr. Fergie, the manager of the Drummond Mines, kindly supplies the following section of the second seam at a distance of 1800 feet down the slope below the bottom of the Scott pit:—

	Ft.	In.
Coarse coal	1	$4\frac{1}{2}$
Good "	0	$11\frac{1}{2}$
Shale and coal	0	2
Strong coal	1	4

	Ft.	In.
Strong good coal	3	1
Soft "	0	7
" "	1	3
Parting irregular	0	2
Good coal	2	9
Coarse coal	0	2
Total	11	10

When the Scott pit reached the seam in 1881 the section of it at that point was found to be :—

	Ft.	In.
Top coal	?	?
Coal		6
Parting		6
Coal		5
Parting		3
Coal		3½
Parting		3½
Coal	1	10½
Parting		1½
Coal		5
Parting		5
Coal		10
Coarse coal		2
Coal		6
Coarse coal		3
Coal		7
Coarse coal		3
Coal		2
Parting		1½
Coal	1	0
Total	7	4

So far as workings have proved the ground northward all the faults increase in strength as they go in that direction, all are upthrows to the eastward accompanied by an increasing dip of the measures. In part of the position assigned to the West fault of the Survey (pages 62 and 102 of the Report of 1869), a fault of the Black Diamond series is found, but it disturbs the strata to no great extent and the crop of the

Acadia seam has been since worked to the south of it, to the west of the corner of the Acadia area. Following the same direction to the bank of the Middle River, an outcrop of black shales and coal is there met with and on which French's tunnel in 1860 was driven about N. 45 E. for 1040 feet. By driving an adit eastward on them it was hoped an improvement in the quality of the seam would be found, but within the limits of the workings no material change for the better took place. The coal is evidently the prolongation of the Acadia seam but reduced at that point to three feet nine inches in thickness of which only 4 inches were considered superior coal. Of this there can be no doubt, the face of the extreme north level of the Black Diamond pit workings showed the seam greatly altered from what it was at the slope and rapidly approaching in character that of the seam in French's tunnel, yet on Hartley's map the tunnel was put in the Millstone Grit and separated by an assumed fault of great magnitude.

None of the faults of the Black Diamond series extend southeast beyond the heart of the village of Westville. Leaving them and following southward the course laid down for the West fault S. 10 E. a strip of higher ground is first crossed in which no faults are known, and then the broken measures of the Drummond area are encountered. Here the disturbance is produced by the Drummond series of faults, which have characteristics directly opposite to those of the Black Diamond series; they dip to the east and increase in strength to the south, and cause the crops of the seams to be thrown to the surface more quickly than the dip would account for, and so produce the basin-shaped terminus to this Section at its southern end that was styled the Bear Creek syncline.

The following sections of strata are from diamond drill holes at Westville. No. I was put down from the fourth lift by the side of the main slope of Acadia; No. II from the bottom of the Black Diamond furnace pit, 2,400 feet apart. The greater inclination of the measures in No. II accounts in part for the greater thickness shown. The dips of No. 1 is 26° and No. II, 30°.

BOREHOLES.	I.		II.	
	Ft.	In.	Ft.	In.
Argillaceous shale	2	0	12	0
Sandstone	31	0	31	0
Shale	14	0	99	0
Sandstone	6	0		
Shale	10	6		
Sandstone	10	6		
Shale	6	0		
Sandstone	9	0		
Shale	115	0		
Shale and sandstone			30	0
Sandstone	8	0	20	0
Shale and sandstone			20	0
Shale	26	0	31	0
Sandstone	11	0	13	0
Shale	8	0	7	6
	<hr/>		<hr/>	
	257		262	
Coal, } Seam worked at the	5	0	2	10
Shale, } Scott Pit of the	3	0	1	2
Coal, } Drummond Mine...	11	8	3	11
Dark Shale			0	7
Coal,			1	8
Shale and fireclay	13	0	4	2
Sandstone	6	0	....
Shale	8	0	....
Sandstone	28	0	80	0
Shale	6	0		
Shale and sandstone			26	0
Sandstone	9	0		
Shale	41	0		
Dark shale	15	7		
Coal	2	9		
Fireclay	0	4		
Coal	1	4	39	0
Fireclay		2		
Coal	1	0		
Shale	2	1		
Coal	1	0		
Shale		2		
Shale		2		
	<hr/>		<hr/>	
	155		159	
Sandstone stained red; mottled			75	

SECTIONS OF THE ACADIA SEAM AT THE SEVERAL POINTS INDICATED.

	North side of Acadia. Third lift.	North face. Eighth lift.	Main slope. Eighth lift.	South side of Acadia. Third lift.	Drummond slope, 4200 ft. from Crop dip 18 to 20.	Drummond, 3167 Level, 940 ft. vertical, 1900 ft. in Holmes area.
	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.
Roof coal	5			10	2 3	
Good coal	2 3	2 2	} 5 8	5 2	3 6	} coarse 1 2 1 0
Parting.	$\frac{3}{4}$	6				
Good coal	4 0	{ 2 6 coarse 1 3	} 0 3	3	6	} coarse 7
Fireclay.	5	0 4				
Good coal	3 2	coarse 1 3 Shaly	3 3	4 6	6 6	{ coarse 4 1
{ Bottom coal with Stone	3 9 (8" to 22)"	5 7	5 7 (10")	4 6	4 9 (9")	5 3 (1 7)
Good coal	1 10					

DRUMMOND SECTION OF STRATA.

	Ft.	In.
Main Seam	17	0
Measures	184	0
Second (Scott pit)	12	0
Measures	107	9
Third Seam. } Coarse coal	3	0
} Good coal	3	0
Measures	90	0
Fourth Seam (Poor coal)	8	0

The quality of the main coal has proved not to be uniform across the Section. The south levels in the Drummond Mine found the coal become inferior as they neared the south corner, and those to the deep that are shown driven across into the Holmes area were stopped before striking the expected McCulloch's brook

fault for the same reason, the line of inferior coal being parallel to the rising ground of Millstone Grit beyond the fault. At the opposite end the deterioration led to the stoppage of the upper levels in the Black Diamond area, and the lowest levels north in the Acadia area. The Black Diamond exploratory level No. 4 followed the seam until it was reduced to 2 feet of coal. At the slope bottom of that Colliery No. 10 level cut a fault an upthrow 47 feet to the east that only began at the Acadia barrier 400 feet distant, and which coincides on the surface with the foot of rising ground that extends in the same direction northward. The fire-clay band, which is persistent in the Acadia seam, is not represented in the Albion main seam. It rapidly thickens as the seam goes northward in the Black Diamond area, and forms the bottom of all the workings north of the furnace pit. At number 8 chute, the furthest north, it was found to be 9 feet thick with no coal below it. The section of the seam above it being there as follows:—

	Ft.	In.
Coarse coal	1	0
“	1	0
Fair coal	1	4
Splint.....		4
Grey fireclay.....		5
Splint.....		3
Fair coal	2	2
Coarse coal		3
Fair coal		7
Coarse coal	1	0
Total	8'	4"

The same change for sandstones to shales noted in the measures overlying the Acadia seam has been proved in those beneath, the borehole at the fourth bottom on the Acadia slope side pierced sandstones and tapped water, so did the horizontal stone drift started at a point 1260 feet down the Black Diamond slope on the north side, while a drift driven back from the Acadia seam

to the second or Scott pit seam in the Drummond area was dry and altogether in grey shale and fireclay. The thickness of the intervening strata was at the Black Diamond furnace pit 227 feet, and at the Drummond drift 276 feet at right angles to the inclination.

In the Transactions for 1867 Mr. Haliburton speaks of coal and fireclay having been found by explorers a mile to the south of the Drummond area, but no discoveries of value have been since made in the ground referred to, prospecting is difficult on account of the great depth of the superficial deposits. Nothing has been done since then at Culton's adit which is six chains outside the south corner of the Drummond area, and where the coal was said to be six feet thick but faulted. The workings of the Drummond Mine in the proximity leave little doubt of the broken character of the ground and the quality of the seam.

Of the underlying seams in this neighbourhood indication of one only was got in a trial pit dipping S. 80 E., while behind the Black Diamond slope the crops of two seams were opened both being of a quality to discourage development, except it may be in the central portion of the section where an improvement in quality may be looked for in depth.

Albion Section.—Leaving the Westville section on the west side of McCulloch's brook, this division is entered on crossing the great fault that brings to the surface strata from a depth of half a mile.

It was in this portion of the field that coal was first discovered early in the century.* Since then it has been well exploited and found to extend from a point 5 chains west of the west corner of the lease of four square miles known as the Albion area, thence over the McCulloch's brook and across the East river without a dislocation of serious moment as far as the pit on Grant's farm 23 chains N., 80 W. from the south corner of the same area. Beyond this point the continuity is lost, and it is probable a fault of some 286 feet—see page 50 of Logan—here comes in accompanied by a turn which changes the direction of the dip to nearly

* Dr. Paterson's History of Pictou County.

due east, and gives a course that is continued to the flanks of Weaver's Mountain.

Numerous trial pits were put down in early days along Coal brook, and the record of these pits is given in Haliburton's History of Nova Scotia. In the exposures below the crop of the Main seam the presence was then discovered of several coals lying between the Main and McGregor seams. A surface cut 860 feet long was made in 1828 down the valley of the brook, and the measures immediately overlying the Main seam found to be barren of coal. The timber used in covering this cut was found to be sound when again exposed after a period of 60 years; a branch from it drained the Patrick pit and its crop workings until the Dalhousie pit crushed after the fire of 1867.

From the banks of the East river levels were driven in on the Main and Deep seams, but to what extent there is no record. When the Deep seam level was driven it gave off a great deal of gas, and cut off the source of supply to the river's bank, where previously gas had bubbled up so freely that it would maintain a fire, and had been utilized by women for washing purposes as late as the fifties. On the east bank of the river, Adam Carr, in 1818, had driven an adit, and worked it for Mortimer & Smith, the lessees, but at a loss it was subsequently claimed, as the seam had so deteriorated in that direction. It was in these old workings that Avrick, the overman, was badly burnt by gas in November, 1849, when looking for stolen goods. The explosion on that occasion was sufficiently violent to be heard across the river half a mile away. Later on, in 1867, a German company (Hartley's Report, p. 74) re-opened the place and drove to the deep, but failed to find the coal improve in quality, only some two feet being regarded as good. The level extended to the east probably 400 feet, and the slope to a depth of 130 feet.

Carr also sometime previous to 1827 worked to a small extent the crops of both the Main and Deep seams on Coal brook, selecting the better portions of the seams. The published section 4, page 68 of the Report gives the thickness of the measures found in this locality, and it is interesting to compare it with

sections of the same horizons taken at other points herewith recorded, and see wherein it varies from them.

In abstract the Survey Section is as follows:—

	Ft.	In.
Three and a half feet seam (1 ft. 4 in. good coal).....	3	6
Measures, chiefly black and brown shales.....	1126	7
Main seam	34	7
Measures, with black shales in upper part and chiefly fireclay next to the	148	1
Deep seam	22	11
Measures	106	8
Third seam	5	7
Measures, include some sandstones.....	113	0
Purvis seam	2	6
Measures, pierced by Fleming pit	130	0
Fleming seam	3	3
Measures, black shale	4	3
McGregor seam	11	7
Measures containing an impure 4 ft 6 in coal	211	7
Oil, coal and Stellar oil shale	5	0
Measures exposed in railway cutting.....	15	2
Coal A impure	11	0
Measures chiefly arenaceous	110	6
Coal B.....	2	0
Measures arenaceous	75	0
Coal C	10	0
Measures arenaceous	58	0
Coal D	0	6
Measures include purplish sandstones	35	0
Coal E	0	6
Measures somewhat rust coloured	39	0
Coal F	4	0
Measures	9	0
Coal G	2	0
Measures include indications of two seams	150	0

This section ends at the fault in McAdam's cut on the Pictou

Town branch railway. Noticeable points in it are the exclusive presence of shales and fireclays in the upper part, the coming in of arenaceous beds below the Deep seam, and the acquisition of reddish colour below the Oil Coal by the measures elsewhere assumed to belong to the Millstone Grit series. Not one of the several mentioned seams A to G has yet been proved to be of the thickness stated in the section or to be of any commercial value. Possibly at some future time a drift southward from the McGregor seam in depth may find workable coal in one or more of these seams, for it is not unreasonable to expect the marked improvement both in thickness and quality found in depth to take place in the worked seams might also be found to affect them.

Having reason to suspect incorrect the common view as shown on the Survey map regarding the position of the crops of the coal seams in the west corner of the Albion area, west of the hill to where the explorations in the trial pits O and Q ceased in 1852,* other trial pits were in 1889 put down in this doubtful ground. The result of this later exploration accounts for the difference between the Survey map and the present one respecting this locality. The Main seam was traced west as far as shown, to a point sufficiently far to overlap a series of exposures along the crop of the Deep seam and make it clear that it was an extension of the latter and not of the former, as previously supposed, that crossed the brook in two places and which had been found 5 chains west of the west corner of the area at a depth of 32 feet dipping N. 10° E. 15°. When this was satisfactorily proven, data relating to lower seams dropped easily into place. The crop known next in descending order at the mouth of a small branch on the east side of the brook in the same locality and which had been stripped for some distance for local consumption years ago, necessarily was that of the Third seam. It also had been proved by a borehole across McCulloch's brook at the mouth of Grog brook. It may here be noted that the crop of the Deep seam is exposed on the east side of the brook

* Quart. Jour. Geol. Soc.

on the side of the hill where two water runs have cut gullies. At both of these spots the coal has been at one time on fire but at what period there is no record; curiously enough between them and the brook there are several patches of burnt soil which suggest that some forest fire ignited gas freely given off from the faults that pass through this ground. It is known that gas was lit at the surface over a fault beyond the brook near the McKenzie pit when explorations were first begun. This also could be done on the intervalle of the East river over the main seam, and can still be done on McCulloch's brook a hundred yards below the Stellar slope. The crop of the main seam also had been at some remote period on fire on both sides of Coal brook. The coal having burnt along on the west side for 1000 feet down to the drainage of the brook. The first pit sunk through it for the Dalhousie workings furnace pit had to be abandoned because it was in burnt coal.

The position of the Third seam on the brook being established by the explorations of 1889 it follows that the McKenzie pit, by the side of the old Middle river road 7 chains west of the brook is on the McGregor and not on the Deep seam as hitherto supposed. The McKenzie air pit was on the south side of the old road passing through 19 feet surface clay. The east workings of the McKenzie pit abutted against a fault, an upthrow probably of a few feet. The crop of this seam is next seen at the crossing of the old road over the brook. Then it was found faulted by a trial pit 130 feet further to the east and again in line 22 chains east of McKenzie pit by level and the Purves slope which corresponded with trial holes P and Q of 1852. This slope is spoken of page 76 of the Report as on the Third seam. The ground along the brook to the southward was pierced by trial pits recorded in Mr. H. Poole's paper in the Transactions for 1863 and was again gone over by the Acadia Coal Co. at a later date confirming the previous conclusions that several minor faults ran parallel with the brook and increasingly deflected the crops of the underlying measures to the southward.

Passing south to the railway and to McAdam's cut fault there lies on the west side a broad belt of fireclay succeeded at the

mouth of the cut by black shales and coarse coaly bands dipping westwardly. These probably represent some of the A. to F. seams of the section on the east side of fault and they are again exposed still further east on the heavy down grade of 131 feet to the mile on the railway entering Stellarton, and the black shales yet again to the eastward on the river's bank below the sharp bend at the old brickyard. Seam A of the report, next below the oil coal, was given as of 11 feet in thickness, but where found under the Brown row of houses at Asphalt it was only three feet. This may have been the seam opened in 1860 below the Stellar oil coal on McCulloch's brook and there found to be 5 feet thick. But the lowest continuously traced bed was the oil coal. On the west side of McCulloch's brook, 4 chains north of the railway, it was found on edge near a pit where the dip of the strata was N. 45 E., almost that of the Westville section; and it was worked under the brook and along the East bank with a dip of N. 65 W., and then after passing through a step where it had an inclination of N. 72 W. 19°. Thence it was followed to the old Middle river road and sweeping round McAdam's cut fault, which is there lost in an anticline, the crop thence onward was proved to conform with the general direction of the Albion section as far as the main street of Stellarton. On Coal brook it was worked longwall in conjunction with the bat and coal associated with it. Where opened near the modern Stellar street it yielded most richly, samples giving 190 gallons of crude oil to the ton. Car water on a small brook below the railway station probably marks where it crosses towards the East river.

Below the McKenzie pit coal and above the Stellar oil coal on McCulloch's brook a three feet seam was opened and traced across the old Middle river road at Black hill and eastward behind the present Back mines to Coal brook and onwards across Acadia avenue.

All the coals of this locality in the neighbourhood of McCulloch's brook seem to be of a quality for which there is at present no great demand, they run high in ash, but nevertheless contain a reserve of fuel that some day will be utilized.

The McKenzie pit was 45 feet deep, and from it bords were

worked eastward to the small fault already spoken of. Beyond the fault the coal was got at 16 feet, dipping N., 40 E., 12°, and at the bridge in the same direction 18°.

Going eastward past the Purves slope the next openings are the present extensive operations which lie to the deep of the crop levels that were in old times driven westward from Coal brook, and locally known as "Stinking Tom." Immediately east of the brook the seam was found to rapidly deteriorate so much so that a trial pit 35 chains east found only two and a half feet of coal. Red water on the East river bank is supposed to mark the position of this seam which is last seen in a brook at Miller's below the road on the opposite side of the river. The most eastwardly exposure of the Third seam was by trial pit on the East river. On coal brook the crop was at one time on fire, and a small slope was there made in 1881. The present workings found a deterioration to occur both to the east and west of the main slopes, the extreme distance apart of the level faces in the best coal being about one mile. Marked improvement in all the coals takes place in depth accompanied by a thickening of the seams. And in this locality, as the workings proceed in depth, it is found that the levels in the lower curve more quickly than those in the upper seams over the prolongation of the anticline, which is barely noticeable in the top levels. The axis of this anticline is not opposite, nor is it a continuation of the ridge that was proved by the Foord pit west levels to cross at Tupper's the main syncline of the field. The ridge in question seems rather to be a lateral of the hill range to the north.

To the west of the Back Mines, the measures between the seams are in some cases thinner than at this point, for example between the Deep and Third seams the thickness is reduced from 82 feet in the stone drifts to 45 feet over the pillar working in the Third seam, where fire came through in 1888, and where the explorations of 1850, mistaking the seams, gave 158 feet.

In early days, but at what time is unknown, there was driven from the Burnt mines workings, which were closed in 1839, a tunnel in a south-westwardly direction to prove the underlying

measures, and it was supplemented by trial pits and bore-holes. The tunnel was 930 feet in length, and probably was driven from below the level of No. 3 pit at a depth of 175 feet from the surface, but its true location is in doubt.

The section made from it was as follows:—

	Ft.	In.	Ft.	In.	
Unworked bottom coal of the Main seam	24	6			
Black shale	1	0			
Bituminous shale	14	6			
Black shale with Ironstone balls	4	9			
Blue clay	38	0			
Blue clay vegetated	9	6			
Dark blue clay	5	0	165	9	
Strong white clay grit	2	6			
Dark blue clay	90	6			
Bituminous coal	}	3	6		
“ shale		3	0		
“ coal		3	0		
“ shale		3	9	15	9
“ coal		2	6		
“ shale		8	0		
Strong dark clay ..	11	0			
Strong clay grit	7	7	39	7	
Fireclay embedding—Patrick balls	10	0			
Bituminous shale	3	0			
Coal (Third seam)	1	6	1	6	
Strong dark clay	6	1			
Fireclay	69	3			
Strong fireclay	3	6			
Dark fireclay	5	6			
Black bat.....	1	9			

In 1820 was published Haliburton's History of Nova Scotia, in which reference was made to the extent of the coal field and its geological relations. It contains a section in minute detail

from the Main seam down to within 60 feet of the Fraser oil coal.

In abstract it is as follows :—

	Ft.	In.
Main seam	37	0
Strata	128	8
Deep seam	35	1
Strata	62	6
Third seam	23	6
Strata	27	0
Purves seam	2	0
Strata	77	6
Coal		6
Strata	67	6
McGregor seam	25	0
Strata (No. 80)	72	7
Coal	10	4
Strata	21	6
Black ring	3	0

This section gives a total thickness of 593 ft. 8 in. which is less than the correct thickness of the measures exposed on Coal brook. The Survey report showing for the same ground a thickness of 759 feet 6 inches.

At only half a mile to the west of the brook a modification of part of this section was obtained in sinking the present McGregor pit where the dip of the strata is 20°.

The sinking record is as follows :—

	Ft.	In.
Crop of the Third seam	5	0
Sandstone	10	0
Fireclay	4	0
Shale	3	0
Coal	1	7
Shale	14	3
Coal	4	0
Black shale	4	8

	Ft.	In.
Coal	1	3
Black shale	6	0
Fireclay	31	0
Black shale	9	0
Coal of fair quality	0	5
Dark fireclay	35	1
Black fireclay (good)	5	8
Black shale	7	2
Coal, coarse	3	10
Slaty band.....		3
Coal Fleming seam	5	6
Black Shale	4	0
Fall coal, good ...	{	3
Band		1
Bench coal, good .		3
Coal, coarse.....		3
Coal, good		2
Band of shale		8
Coal, good		1
Coal, good		6
} McGregor seam ..		
Fireclay and a small seam of coal below it.		

A thousand feet deeper the seam presents this modified section :—

	Ft.	In.
Fall coal	4	3
Band		3
Bench coal	4	8
Coarse coal		11
Good "	1	5
Coarse "	1	8
Good "	1	10
Coarse "		11
Good "	1	4
Band	1	6

A modification of another portion of Section 4, page 67, of the Survey Report was proved by a pair of stone drifts driven across the measure between the Third and Deep seams at a distance down the Third seam slope of 1880 feet, where the vertical depth

is 707 feet and the strata have an inclination of 23°. Reduced to dimensions at right angles to the dip the thickness of the beds at this point is as follows in descending order:—

	Ft.	In.	Ft.	In.	
Fireclay overlying.....	?				
Coal good, Little seam.....	3	0			
Coal cannel.....	1	3			
Ironstone band replacing coal.....		6			
Coal rich.....		3			
Ironstone compact band.....		7			
Very coarse coal... ..	3	4	40	5	
Coal good (Deep seam proper).. ..	14	4			
Coal coarse.....	3	10			
Grey shale with Ironstone nodules.....		11			
Coal coarse.....	8	7			
Coal fair, 13 p. c. ash.....	3	10			
Brown Shales.....	9	10			
Compact very hard grit.....	20	00			
Flaky hard fine sandstone	21	7			
Coal.....		7			
Fine sandstone, hard.....	1	0			
Black shale	1	5			
Hard arenaceous shale	2	3			
Coal.....	2	6			
Arenaceous shale with small lumps of solid bitu- men and patches of petroleum.....	8	3			
Shale with plies of Ironstone nodules.....	6	0			
Fireclay.....	5	3			
Grey shale and coal roof	2	10			
Impure coal	}	5			
Good coal		11			
Coarse coal		10			
Shale parting		3			
Good coal		5	0		
Coarse coal band		1	4		
Good coal		3	0		
Grey shale, with very coarse coal	7	4			
Coal, 2 feet of fair quality	3	0			

This section it will be noted shows that the Deep seam has, in this locality, a total thickness of 40 ft. 5 in. which is in excess of any measurement in the Main seam; although that seam hitherto has had the reputation of being the thickest in the field, and was found to be 39 ft. 11 in. in the Cage pit shaft sunk to the Deep seam by the side of Coal brook.

Another modification is shewn in the section of the Deep seam taken at the bottom of the English slope, 2700 feet on the incline and about 900 feet vertical.

	Ft.	In.	
Coal, coarse	0	5	
“ fairly good	1	0	
“ coarse	0	6	
“ good	1	9	Little seam.
Ironstone band, coaly		10	
Coal, very impure.....	2	8	
“ good	1	6	
Shale roof of workings		9	
Coal, very good.....	1	0	
“ good	1	0	
“ fairly good	1	3	
“ very coarse	1	4	stone bench.
“ very good.....	3	9	
“ coarse	4	0	
“ fairly good	2	4	
“ coarse	1	0	
	<hr/>		
Pavement, fireclay.....Total..	24	1	

The explorations in 1852 already referred to (Proceedings of the Geol. Soc., 1853, page 47), disclosed an increasing substitution of arenaceous for argillaceous beds overlying the Main seam as the crop was followed westward from the river. The Forster pit, section 5, on page 72 of the Report, confirmed the change which the Colin pits had previously discovered. When the seam was traced in the opposite direction a similar substitution was also found to occur. Section 6, page 74, of the Report shows

beds of sandstone were pierced in sinking the German pit 340 feet deep to the Main seam on Grant's farm east of the river. And the following section was obtained in

Borehole, No. 1, made by the Diamond Drill Co. in 1878 for the Acadia Coal Co. at a point some 1900 feet to the deep of the McLeod pit and 1300 feet due south beyond the south corner of the Albion area :—

	Ft.	In.	
Boulder Clay	31	6	
Black shales	10	0	
Black shales with fireclay	21	0	
Black shales with partings	44	0	
Black shale	64	0	
Fireclay with black shale partings	42	6	
Dark shale and fireclay with ironstone nodules	36	0	
Dark shale with sandstone partings	27	0	
Dark shale with ironstones nodules	54	0	
Shale	42	0	
“	35	0	
Light coloured shale	29	0	
Dark shale with ironstone nodules	97	6	
Dark shalé	22	0	
Soft dark shale	26	0	
Dark shale	55	0	
Black shale	12	0	
Coal	} Main seam 655' 3"	1	0
Black shale		3	0
Coal		2	9
Black shale		1	3
Black shale and fireclay		9	4
Fireclay with ironstone nodules		10	4
Light coloured shale with ironstone		36	10
Shale “		12	11
Dark shale “		17	8
Dark shale with fireclays		51	11
Dark shale		19	8

	Ft.	In.
Black shale—Deep seam	31	0
Dark shale with ironstones	16	0
Light shale "	47	8
Grey ironstone shales	50	9
Dark shale	12	0
Grey sandstone	30	9
Dark shales	3	0
Light shale	5	0
Dark shale with ironstones	20	0
Dark shale	69	0
Sandstone beds	78	1
Soft dark shales	70	11
Shale with sandstone partings	12	4
" "	20	0
Light very soft shales	22	5
Light shales and sandstone beds	24	5
Very soft shales	8	3
Total depth of borehole		1337' 1"

To the rise of this borehole is the outcrop of the main seam on which a number of shallow pits have been put down; among them the McLeod pit mentioned on page 50 of the Survey report, in which an 8 feet seam was got, but of the coal only 2 feet 6 inches was good. The seam was also opened on a small brook about half a mile to the south, and found to have very much the same section; and again on the north flank of Weaver's mountain a coarse coal dipping N. E. was opened by Mr. A. McBean, and believed to be the same seam.

The Deep and other underlying seams have not been traced so far, and it is thought they sooner lose their coal than the Main seam. Both in the Crushed mines and the Foord pit the east levels were when stopped in coal of a greyish cast and thinner, so that it is evident the influence that deteriorated the seams east of the river extended for some distance in towards the centre of the valley. Whether it left from the centre northward, and possibly

under the lea of Weaver's mountain where the seams would be in depth, coal of good quality, there are at present no means of knowing. Hartley gave a fault at the McLeod pit an east and west course, but on evidence no longer available, while in one of the adjoining pits a small fault was seen which had a bearing parallel to the Stair pit and the upper English slope fault, which it may here be mentioned have a down-throw to the northeast of 28 and 23 feet respectively.

Reverting to the west side of the East river and the structure of the higher measures that occupy the bottom of the trough above the 1,000 feet of barren beds that directly overlie the Main seam, and which came under review of the Survey in connection with the three and a half feet seam. This seam is said (pages 77 and 83 of the Report) to have been cut in a fault 2 chains north of the culvert of the Intercolonial Railway over Coal brook, close to the Foord pit, and to be dipping north. At this point, the shallow entrance to a cutting, there is now no trace of coal, but at a distance of 6 chains a seam does show dipping in the reverse direction S. 20, W. 24°.

The northerly dip of this seam is no longer exposed on Coal brook, nor is it now to be seen on the Albion branch railway, but trial pits near the stone retaining walls of that railway at Hungry Hole proved a continuation westwardly of the southerly dip which became deflected more and more to the westward on a small water run as it was followed northward. These reverse dips show a narrow syncline opening westward into the trough of the field further proved in 1877 by the Foord pit dip slants, Muir's, which also negatived the assumed westward extension of Potter's brook fault previously discussed. This synclinal fold, though opened out and flattened, is still noticeable on Muir's slants by an undulation in the pavement. To the eastward it seems to have carried its influence across the river and to show as a shallow undulation immediately south of the mouth of Potter's brook. On the southern rise of this undulation on the river's bank crops a black compact cannel like band that was mined in 1860 for oil shale. It is also exposed by the undulation at the mouth of Potter's brook, dipping in the reverse direction, and repeated on the side

of Potter's brook fault; followed eastward in regular course with the underlying coal seams, it is seen in two laterals of McLellan's brook, where it was also opened in 1860, and again where it crossed McLellan's brook, just below the mouth of Steep brook.

This last exposure gives this section:—

	Ft.	In.
Cannel.....	0	10
Strong bituminous black shale	2	6
Cannel of better quality.....	1	0

Here the dip is S. 70, E. 10°, but further south where the highway to McLellan's mountain crosses Steep brook it is increased to 26°.

Whether this band is an extension of the so-called 3' 6" seam or a closely underlying bed is not now clear, its value lies in showing the unbroken character of this central portion of the field.

Returning to the starting point and going westward the northern dip of this seam is not known. But at a lower horizon near the Colin pits a three and a half foot seam overlies the Albion quarry sandstone, dipping N. 45, E. 24°. (1) It has been traced to the westward, and is probably the same as that opened on a branch of McCulloch brook near where the Truro road crosses the latter stream, but it seems to have thinned out with the sandstones and disappeared to the eastward for it was not cut as it otherwise would have been in sinking the Foord pit. The first exposure of coal west of the Foord pit is on the side of the Truro road near D. Tupper's house, where this seam, 5 feet thick, dipping S. 17, W. 35°, was opened. This seam is believed to be repeated westward 700 feet at a small brook where it is on edge, on a line that corresponds with a fault found in the Foord pit workings beneath. Southwest from here by the brook on the south side of the road the same seam is seen dipping S. 20, W. 48°, and although the opposite dip is south within 400 feet of the spot the coal is not found on the upheave. It is underlaid by a series of sandstones and overlaid by black

(1) Trans. Vol. I., Pt. I., p. 35.

shales. The reverse dips of this locality correspond to the bottom of the basin as disclosed by the workings of the Foord pit. Continuing to the westward, surface indications of the existence of a narrow synclinal are soon lost and only continuations of northerly dips are known. These seem to be continuous until the Hard-scrabble coal seam is reached on the Smoky Town road where the side line of the Albion area crosses 3,700 feet from the north corner of the area. From which point to the corner a southerly dip is met with. The Hard-scrabble seam is a strong coal, 5' 3" thick, dipping N. 37, E. 38°. It is immediately succeeded by a reverse dip of 50°, also shewing coal. The course of the intervening fault or axis of syncline between these opposite dips agrees closely in direction with the change in dip seen below Muir's on McCulloch brook, and in the other direction with the opposite dips of 50° and 70° lately found between Tupper's and Fraser Ogg quarry. Still the structure of the intervening ground cannot be taken as regular for the narrow syncline inclining west in the "swamp" workings of the Foord pit must be cut off by a heavy fault probably directed towards the east end of Waters' hill if the bottom of the basin at Tupper's is to be thus thrown to the northward to agree with that at Hard-scrabble. However, on the east side of the broken ground at Tupper's this seems to be the case, but the structure even here is complicated and sufficient is known of it only to suggest a probability that the structure varies from that previously assumed and dotted on the Survey map. An average inclination of 30° would place this seam 1,800 feet above the Main at the Forster pit, or nearly on the same horizon as assumed for the Stewart seam on Potter's brook, both underlaid at the same depth by a bed of oil shale. The ground succeeding to the west is in part explained by the arrows on the accompanying map, showing the dips down the McCulloch's brook; the black shales and overlying sandstones dipping northward at Muir's and then the reverse dip repeating the black shales and coal on the Smoky-Town road, and the coarse grits and sandstones on the brook.

Where the Albion land line crosses the Smoky-Town road and the road makes a sharp turn, a bed that was called an oil coal

was opened and traced for some distance. With these exceptions the measures of this neighbourhood appear barren of coal. On McCulloch's brook no coal is known until the bridge of the Inter-colonial Coal Mining Co. is reached, here a 3 feet seam was got dipping southward. Mr. Hartley carries a line to represent the crop of this seam over the Westville section, but it is unknown in that direction. The measures exposed in the brook between Muir's and the bridge in question are sandstones with some coarse grits; and round the turn below the bridge the broken measures of a great fault are seen to cross. This fault, elsewhere called the Fletcher fault, which may be the North fault, does not seem to have been detected by the first survey, but it is important, and has already been discussed. The beds north of it are nearly flat except as they approach the great fault which separates them from the Lower Carboniferous and metamorphic rocks of Water's hill. They contain some coarse grits, mottled red and grey sandstones and argillaceous beds of a red colour.

Cannel like beds similar in appearance to that opened on the East river above Potter's brook, though not in all cases so compact, are found on McLellan's brook between Black's mill site and Patrick's oil coal, and are in the Section described as compact black carbonaceous shales; their compact structure gives them a marked appearance and readily distinguishes them from the ordinary black shales. A similar bed is also seen on the river bank north of Potter's brook dipping S, and lower down N 60 E 22°. To reach and test it in depth a pit was sunk by the General Mining Association in 1860 east of the old graveyard that lies near the iron railway bridge, and it seems that the band was reached in the sinking and found of fair quality. At a depth of 45 feet the beds dipped E 13°, and at 72 feet the inclination was S 80 E 25°, the measures being very wet. On the opposite side of the river below pensioner Calder's a similar bed 10" thick rests on the top of arenaceous measures dipping S 40° E 28° and it is overlaid by black shales. This order of superposition is the reverse of what is found near the iron bridge and again at Chisholm's (Connolly's) mill pond, where black shales are succeeded by sandstone beds.

It has already been shown that the northerly dip of the Albion Section ends 10 chains north of the Foord pit where a narrow syncline succeeds, of which the opposite dip in its westwardly course terminates within a short distance by a gradual deflection first to the westward and ultimately by faults, one coursing east and west an apparent extension of the Bridge fault, and other two north and south parallel to Muir's slants.

To the eastward measures of higher horizons than those of the syncline continue in ascending series to be exposed up McLellan's brook as the Foord pit dip N 40° E becomes deflected more and more to the eastward, and divergent from the opposite southerly dip which is continued across the East river. It is seen at the mouth of Potter's brook on the north side, and again 7 chains up the brook where Potter's brook fault crosses, then the dip of the measures is deflected to the east, and ultimately to the northward, thus bringing up in the trough of the field a knoll of measures of which the lowest correspond probably with those exposed on McLellan's brook near where the east side line of the Albion area crosses that brook. The Survey on page 49 gives no detailed section of these black and grey shales nor, indeed, of the measures lying between the top of the Foord pit shaft and the base of Section 4, page 23, at Black's mill site, except in the reference to the 3' 6" seam.

Chapel knoll.—The northern rise of the strata opposite the Foord pit forms a protuberance in the bottom of the basin. It is crowned by the Roman Catholic Chapel, and may conveniently be designated as Chapel knoll. It has its longer axis extending about due east from a point northward of the stone retaining walls of the Albion branch railway, thence over the Hopewell and New Glasgow road across the river and beyond the crop of the Stewart seam at Connolly's pond probably to the New Glasgow and Marsh high-road. At and beyond the pond the dip of the measures averages N. 80 E. 30°, but when the road is crossed the dip of the sandstone quarry ridge is due north, so that a fault, probably running north and south, terminated Potter's brook section at this point.

The heavy faults met with in the Foord pit east levels increase

as they approach Chapel knoll, and either dislocate it or butt against its southern steep slopes. In the absence of positive knowledge it is impossible to estimate the relative horizon with the Foord pit section of the lowest exposures on the river bank, east side, of the Chisholm's pond section given on pages 47 and 48 of the Report.

The syncline to the north of the Foord pit that opens out round the western end of Chapel knoll may be regarded as the southern fork of the main syncline that passes westward to the south of D. Tupper's, a northern fork passing north of the knoll towards the iron Railway bridge over the East river. The bottom of the syncline was proved in Muir's slants 92 feet below the Foord pit levels, and also further west where the levels turned round over a ridge running north and south that crosses and elevates the bottom of the syncline. The ridge is the termination of a fault that comes from the northern rim of the field. The position of the bottom of the basin is again shown east of Tupper's by the low dips in Jones' brook that flows by the Chapel; and its northern upheave is seen higher up the brook. How far east the northern fork extends has not been made out but it seems to be represented in part by the Bridge fault and change of dip that evidently passes between the Stewart and Richardson seams across the river.

Between Tupper's and the river lies a tract of country indifferently known. It has been explored but the exposures have done little to disclose the structure. The Survey dots in possible lines of crop and mentions the sinking of the Haliburton pit and other exposures. North of Tupper's, Fraser Ogg's quarry furnishes a fine white close-grained sandstone that extends at least 1400 feet and dips N. 10° E. 8°. This strip it may be noted lies on high ground immediately north of the district at Tupper's which is bounded by faults known in the Foord pit workings to dip in opposite directions, and from which it is dis severed by cross faults.

The next exposures eastward are those mentioned in page 82 referring to the southeast corner of the Sutherland area and the Haliburton pit, page 105, in the Montreal and Pictou area.

In these areas there have been no later developments, only better knowledge of the ground adjoining to the south suggests other suppositions. It is surmised that either the faults which cut the Foord pit east levels also cross Chapel knoll or that other faults starting from the knoll, as faults in the basin to the westward are known to do, and running a continuation of the same course strike the North fault west of where the New Glasgow conglomerate is lost against the eastern end of the hill that the Survey map shews as Devonian. These faults are further assumed to account for the presence of the strata found along the banks of the East river.

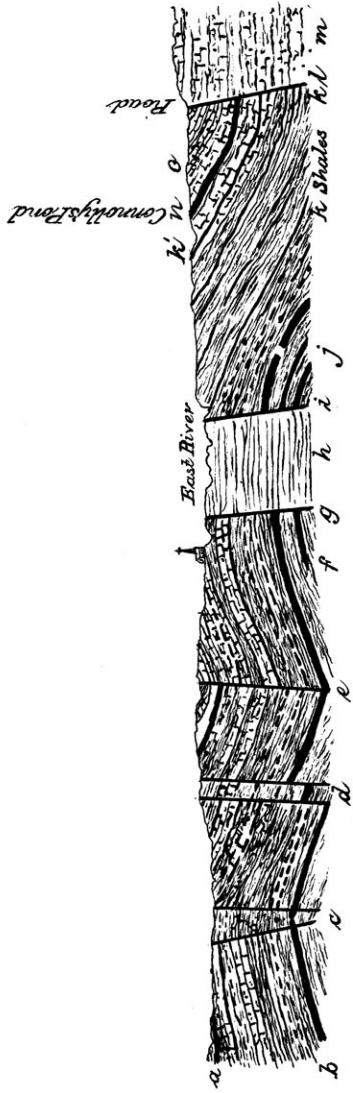
A fault of the north and south series was lately exposed on the west bank of the river near Duff's burial ground with a course S. 6° W., or nearly parallel with one of the faults at Fraser's adit, west of New Glasgow.

With respect to the extent of drift in the district, coal was found in 1850 to have been carried northward from number 18 trial pit 107 feet.

When reference was made to the chief faults of the field, but little was said on page 247 of the North fault, about which it is desired to add something more. The northern boundary of the eastern and western divisions of the field as separately studied by Logan and Hartley was in both cases spoken of as the North fault, but a general acquaintance with the whole field has led to a supposition that the North fault of Logan may extend northward of the metamorphic rocks of Waters' hill leaving the North fault of Hartley as a contemporaneous branch on the south side of the range of old rocks with spurs passing off into the coal measures. It is of interest to consider in connection with the general structure of the district the wide extent northward to Plainfield of the conglomerate with a pre-coal measures base and the radiation from Pictou harbour of a series of heavy faults repeating the outcrops of the conglomerate in that locality. On the other hand eastward of Logan's North fault the conglomerate lies unbroken on a post-Lower Carboniferous base, and the fault appears to define the rim of the mesozoic settlement of the newer from the palæozoic strata. The importance of this fault and its

relation to the age of the rocks of the Sutherland area over Fraser Ogg's quarry has not been overlooked, especially since the statement of the Survey in 1869, placing them as Devonian has been questioned. On the accompanying map this portion of the field is marked "undetermined," although on the outline map of four inches to the mile shewn at the meeting of the Institute it is coloured doubtful Permian. The reasons for believing this possible are many:—Immediately north of this ground the New Glasgow conglomerate is lost, nor has any drift from it been found. The beds dip northward at a light inclination. To the eastward they apparently terminate against a north and south fault, hading eastward, that is assumed to extend from the bottom of the basin, where it was cut, to the swamp that bounds the conglomerate escarpment to the west. On the south lie Coal Measures very much disturbed, and the anticline that crosses the basin marks the line where the series of westwardly downthrows give place to eastwardly downthrows, in the north and south faults. The grain, colour, and fracture of the quarry stone are unlike any known among the Coal Measures, but they do resemble those of the lowest members overlying the conglomerate. At both localities are distinctive beds that weather a dead white. Both contain nodules of limestone which on weathering out leave the rock resembling discoloured and rejected Gruyere cheese. The nodules of limestone vary up to masses three feet in length, and weathering shows they are very arenaceous and their structure to be concretionary. Should pebbles of the conglomerate or fragments of the botryoidal limestone distinctive of the lowest beds of the Permian ever be found along the quarry ridge the question would then be set at rest.

Potter's Brook Section:—Where Potter's brook joins the East river a fault with an eastwardly course divides McLellan's brook section, continuous over that of the Albion Mines, from this section under review. The extent of the dislocation, Potter's brook fault, is probably not great at this point, but it sharply reverses the dip repeating the series of grey shales associated with a marked band of compact black shale which is thought to be the



Section from D. Trippen's on Middle River Road past Chapel Knoll up Potter's Brook

- a = Four-foot Coal near D. Trippen's
- b = Main Seam in the Swamp
- c = Faults cut in Flood Pit Level crossing the trough
- d = Faults by Muirs Sluice
- e = Assumed Fault
- f = Chapel Knoll
- g = Fault heavy
- h = Unknown ground

- i = Heavy fault cut in South level
- j = Assumed position of Main Seam
- k = Oil Shale among thick beds of Black Shale
- l = " " Sandstone beds
- m = Fault assumed
- n = Quarry Sandstone dipping North
- o = Stevens St. Seam
- p = Quarry Sandstone dipping East

Scale 2200'-1 inch

same as that exposed on McLellan's brook near the east line of the Albion area, and which the anticline repeats on the north side of Chapel knoll under the old cemetery as the iron bridge of the Intercolonial railway is approached. The grey shales are overlaid by a continuous series of black shales up the brook as far as the highway bridge and they contain some bands more compact than others. Those on the edge of the fault have been on fire, while on one a hundred yards below the highway bridge an adit was driven to the southward for oil shale in 1860 and the strata found to continue the curve of the anticline towards Potter brook fault. These black shales are also exposed below the iron bridge on the right bank of the river but dipping to the eastward having again had their dip reversed by the bridge fault, which is parallel to Potter's brook fault, and which is in line with the main fault of the Fraser adit section higher up the brook, and the lypes of the Richardson seam lying intermediate. The black shales both on Potter's brook and on the East river bank are succeeded by a series of sandstone beds confirming the unity of the horizon given to these broken sections. On the East river the series is lost against the North fault, but on Potter's brook it continues and yields the section given by Logan, p. 47. This section, however, is affected by a north and south fault passing halfway between the Cannel and the Stewart seams, but of what influence is unknown. East of the Stewart seam a north and south fault of some magnitude terminates the section near the Sherbrooke road as shewn on one of the accompanying sketches. The abutting rocks are heavy sandstones which underly the Fraser adit and Marsh pit sections and which cross McLellan's brook below the Widow Chisholm seam.

The Richardson seam has been lately reopened by a slope 260 feet long dipping S. 20 E. 21°, some 14° south of the true dip, with levels off 85 feet east and 285 feet west past the shaft mentioned by Logan, page 47. It yield 2' 6" of good coal. It was assumed to be distinct from the Stewart seam, but the latter is not open for comparison and the point is in doubt. If the horizon here given to the lower strata on the river bank be correct the depth at this point to the main seam would not be over 1100

feet, and the total thickness of black shales over the main seam under 2000 feet.

McLellan's Brook Section.—The rocks of this section overly in regular sequence the Albion measures which are intersected by the Foord pit sinking. The brook yields a continuous exposure of the same series of shales, which vary in colour from light grey to black. They extend up to Black's mill site at A. Walker's, where they are succeeded by grey shales and the sandstone series that predominate in the higher beds. On page 241 of this paper the thickness of the mass of black shales over the Main seam was taken from Logan at 1740 feet, but a recomputation would put it at less, or about 1520 feet. An extension of the horizon of these shales finds sandstones substituted both to the north and south; this replacement is elsewhere referred to. In many parts the shales contain bands and nodules of clay ironstone, but seggregated and unworkable. The blacker shales are of great thickness, some are compact, break with a cubical fracture, and might be classed as inferior Cannel coals. They give a black streak. Some were dug as "oil coals" in 1860, but the demand for oil-bearing shales which then sprang up quickly ceased with the enormous development of the oil wells in Pennsylvania. Analyses of these shales on Marsh brook and on McLellan's brook at Patrick's pit are given in the Survey report of 1869, page 394. The samples are somewhat richer in volatile matter than one casually selected from the shales of the Albion measures which yielded Mr. Smaill of the Londonderry Iron Co

Volatile matter	27.50
Fixed carbon	6.50
Ash	66.00
	100.00

In all the amount of fixed carbon is low.

Several of the more compact beds of black shale are of many feet in thickness and furnish striking lines for tracing out the structure of the section. The one at the mouth of Shale brook shews the curve which the strata take on approaching the anticline at Black's mill site. Generally on McLellan's brook the

McLellan's Brook.



Scale 20 Chains.

- a = Carboniferous Limestone*
- b = Diorite*
- c = Carboniferous Conglomerate*
- d = Silurian*
- e = Millstone Grit*
- f = Coal Measures*
- g = Coal Seam*
- m = Grist Mill Site*

inclination is light, 9° to 12° , and the series that are spread out along the winding course, are crowded into half the distance between Irishtown and the grist mill by the steeper dip that there prevails.

The oil coal of Patrick's pit on McLellan's brook was one foot thick at the crop, but decreased to seven and a half inches at 70 feet down the slope, which had a course N. 45 , E. 30° . The second working dipped N. 20 , E. 29° , and at 150 yards to the north the direction changed to S 20 , E. 25° . No change in the structure of this locality as described in the report is now suggested, the only note that may be added being to suppose that the three feet seam, behind which the Fulling mill fault no doubt runs close by, is one of the Widow Chisholm group of small seams crossed lower down by McLellan's brook. Of the actual thickness and value of this seam nothing definite now seems to be known.

The anticline at Black's mill site, which was made plain by the exposures along the adjoining Sherbrooke road, is also indicated by the diverging dips seen in the small lateral water course from the north that joins McLellan's brook just west of G. Walker's. Where the culvert of the Vale railway passes over it an increased dip shews a slight fault, or it may be only a local squeeze similar to those seen on the right bank of the brook some 200 yards above the old Mill dam which is now washed away. There the strata take the form of small basins with local dips nearly vertical, and deflected from an easterly to nearly a southerly direction. The irregularity is only local, for the influence of the squeeze does not extend to the left bank of the stream.

Logan gives the major part of this section in detail, the deep ravine through which the brook flows furnishing exceptional opportunity for study. No dislocations of moment are met with; the small faults cut in east levels of the Foord pit are for the present obscured by a land slide, but the disturbances at the mouth of Marsh brook and higher up at the oil coal pit are plainly to be seen. No check measurements of the section have been made as it is evidently barren of workable coal, except of the Marsh pit portion by borehole which gave the following record:—

Acadia Company's borehole No. 2 of 1878 at a point some 900 feet due west beyond the west corner of the Vale area lease:—

	Ft.	In.
Surface clay	26	0
Shale	1	10
Soft blue shale.....	54	3
Carbonaceous shale.....	9	4
Oil shale	2	0
Light grey shale	46	0
Dark shale	17	6
Light shale	9	6
Dark shale	85	6
Light arenaceous shale	11	0
Sandstone	3	6
Sandstones and arenaceous shales, light colored.....	94	0
<i>Coal</i> , one mch thick, included in the last 30 feet		
Dark arenaceous shales and sandstones, strong band ..	25	0
Light argillaceous shales	16	0
Dark carbonaceous shale	8	0
Light shale	12	0
Dark carbonaceous shale	40	
Shale with ironstone nodules	24	6
Carbonaceous shale.....	10	
Light arenaceous shale. Some of these beds are mot- tled with red stains	15	6
Sandstones	23	0
Light shale	4	10
Sandstone, in parts covered with petroleum.....	7	6
Light shale	29	8
Dark hard carbonaceous shale, burns freely.....	8	0
Dark carbonaceous shale	9	0
<i>Coal</i> , good	1	0
Light shale	1	6
Sandstone	18	0
Light shale	17	6
<i>Coal</i> . Widow Chisholm seam, worked	1	0

	Ft.	In.
Fireclay and shale	1	6
Sandstone—a quarry stone	72	6
Arenaceous shale	7	4
Splint coal	1	3
Arenaceous shale	4	3
Sandstone	2	3
Arenaceous shale	2	0
Sandstone	3	0
Arenaceous shale	2	6
Sandstone	5	0
Sandstone and shale	19	8
Arenaceous shale	10	0
Sandstone	15	0
Arenaceous shale	20	3
Light argillaceous shale	7	0
Dark argillaceous shale	32	6
Light very soft argillaceous	7	0
Dark carbonaceous shale	9	0
<i>Oil shale</i> —burns freely	3	0
Light argillaceous shale	41	0
Dark hard carbonaceous shale	18	0
Light argillaceous shales and fireclays	12	0
Sandstones	8	0
Shales and fireclays	7	0
Light arenaceous shale	20	0
Sandstones	5	0
Total depth of borehole.....	1008	5

Unfortunately in this and other sections the terms used to describe similar beds are not identical, and they are consequently difficult to compare. In this particular section some of the sandstone beds were found to be so compact that cores even ten feet long were withdrawn whole.

Fraser Adit Section.—Potter's brook takes its rise east of New Glasgow where the Merigonish high road crosses the North fault-

It flows over out-croppings of coal that were worked by A. Fraser in 1840, and subsequently prospected by Mr. Kirby and others, who found the ground much disturbed, but with a general form of a basin. Sir William Logan describes the locality on pages 44 and 45 of his report, and Mr. H. Poole in these Transactions, Vol. I, page 43, refers to the opening where Fraser worked as Wright's adit, shewing 4 feet 7 inches of good coal containing 17.5 % of ash. The adit was driven north under the road for a hundred yards and then turned west and was affected by the faults, which shew in the small brook, which joins Potter's a little lower down and cut off the coal in that direction. The dip at the adit was N. 10 E. 18°. Up the brook, parallel with the adit, a level was driven as low as the bed of the brook would allow for some 140 feet to a disturbance, and workings to the deep continued for some 40 feet on an inclination, which was succeeded by 20 feet of flat ground, and then met a sharp upturn which cut off the coal to the north-east. If a small patch is repeated in that direction it has not been found. Above the adit 10 chains on the same side of the brook, sandstone beds having a dip of N. 80 W. 35° overlie a foot of coal, and at three chains higher black shales appear lying N. 40 E. 5°, while in the opposite bank the grey shales dip 12° to the westward of south.

Further up the brook, 15 chains from the adit, Kirby's pits near the main road cut a foot of coal, which is thought to be the same as the seam found lower down. Here the dip is N. 25 E 15°. The adit is on the north side of an arch of coal that repeats the same seam dipping southward under the old telegraph road. Here it also was worked from the brook on both sides to the north only some 120 feet, and to the south one hundred or more yards, the inclination being about one in three. An east and west disturbance again at 400 yards to the south brings the seam to the surface where worked by A. McKay in 1840, and where it was 3 feet 6 inches thick and dipped N. 60, W. 13°. On the same range later small workings found the inclination to the south, giving an impression that down the brook this group of seams may exist in greater quantity, especially as a crop of a coal

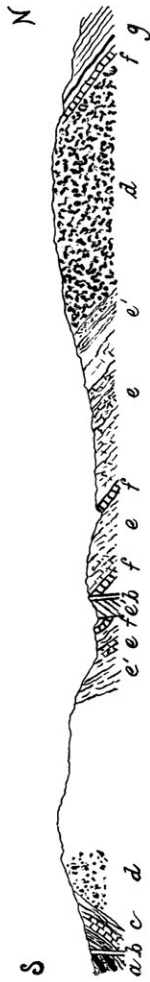
discovered 400 yards below the adit, has been assumed to be the equivalent of the overlying Captain seam of the Marsh pit group.

Under the coal of the adit there is a calcareous underclay 22 inches thick containing shells. This limestone pavement distinguishes this seam from all others, and is found under the several patches worked on the south side of the brook. It is also found under the coal of the George McKay slope and the McLeod pit near the Marsh pit, and hence may be considered to confirm the opinion of Sir William that the seams on Potter's brook are the extensions of the Marsh pit group, disturbed by laterals of the North fault. The intervening ground has for a base the strong sandstone beds that form the high land eastward from the east corner of the Albion area to Black springs, and it is probable coal will yet be found along this range in which there are crop-pings of several bands of black shales. The sandstone bed referred to appears to belong to the horizon of the heavy sandstones that either curved or broken cross McLellan's brook below the Widow Chisholm seams and course towards McGregor's mountain. Logan on page 43 says he has no evidence of the effect northward beyond Black's mill site of the supposed Mill-road fault, but we now know that a series of exposures along the contiguous highway crossing the assumed northerly extension of that fault line indicate the passage of a crest of a gentle anticline east and west which repeats to the northward the lower members of the sandstone series that immediately overlie the great mass of black shales of McLellan's brook.

Immediately over the seam at Fraser's Adit a bed of black bat is full of impressions of ferns, fish teeth and scales.* A similar shale occurs on the south or opposite side of the brook, and also higher up on the branch of the brook from the eastward, but the presence of coal below it has not been proved. Above it the Lawson slope dipping due south worked a three feet eight inch seam† to a depth on the slope of 200 feet, and on either side for some 8 chains. On all sides the coal was again brought to the surface by faults, and a repetition of this seam,

† Analysis is given, p. 391, Geol. Report, 1869.

* Can. Nat., 1860, p. 8.



Linnacy. From D. McPherson's Northward to Fraser's Mountain.

- a = Coal Measures
- b = Fault
- c = Millstone Grit, or possibly Lower Cambrian
- d = Red Conglomerate
- e = Greenish Gray Sandstone with red argillites at e'
- f = Limestone agglomerate
- g = Coal Seam in Permian

Scale 20 Chains.

deep, on the George McKay seam, fifty feet south of the Vale pit railway and 1900 feet west from the Marsh pit shewn on the Survey map.

	Ft.	In.
Light grey very fine argillaceous fireclay	3	0
Sandstones having micaceous streaks	7	6
Light grey micaceous sandstones	6	0
Strata more argillaceous with plant fragments	6	6
Strata similar but more arenaceous	6	6
Shaly sandstone more compact	2	0
Grey argillaceous shale		3
" fine wavy sandstone		9
" argillaceous shale	1	10
Darker "	6	8
Similar but more arenaceous	6	0
Light grey wavy sandstone with plants	6	0
Similar but coarser with wavy blackish bands	7	0
Dark grey argillaceous shale	3	0
Lighter fine arenaceous argillaceous shale	3	0
Light and dark grey argillaceous shales	18	0
Black argillaceous shales	2	0
Tender fireclay	1	0
Very fine light grey sandstone	5	0
Streaked grey shale and striped sandstones	19	0
Light grey very fine sandstone	2	0
Streaked grey argillaceous shale	11	0
" with sandstone partings	10	0
" " thin layer "	13	0
" " black calcareous partings		
full of shells, coprolites and fish remains	10	0
Dark grey shales	6	0
" calcareous	12	4
"	2	0
Black carbonaceous shale	1	0
Dark grey fireclay	2	6
Light grey very fine argillaceous sandstone	5	10

	Ft.	In.
Light grey very fine shale with carbonaceous streaks	10	4
Dark grey argillaceous shale	2	10
Very fine micaceous clayey sandstone	7	2
Dark argillaceous shale	2	0
" sandstone dip 18°	8	7
Dark argillaceous shale	4	1
Coal		8
Underclay with rootlets	3	8
Light arenol-argil. shale	6	4
" more arenaceous	14	7
Coal streaks in underclay with rootlets	1	0
Light grey wavy sandstone	15	8
" " with black streaks	9	0
" very fine sandstone with veins of calc spar,	12	0
Grey argillaceous shale	8	0
Black bituminous "Oil shale" with fish remains	9	6
Dark underclay	10	6
Dark grey argil. shale with light partings	12	9
Dark grey and black shale with brown streak with ironstone and calcareous threads	9	4
Black bituminous "oil shale" with plants	12	0
Underclay	1	0
Dark argillaceous shale	12	0
Streaked argillaceous shale with ironstone modules	47	7
Similar with some beds black, giving dark brown streaks, fish remains and slickensided	64	5
Grey striped argillaceous shales	9	0
Grey striped argillaceous shales but more arenaceous	10	0
Light grey sandstones	2	0
" arenaceous shales, coaly partings	2	0
Dark argillaceous shale with ironstone	4	2
Black shales	3	0
Grey striped arenaceous shale	4	0
Dark argillaceous shale	9	4
Black argillaceous shale with plants, in parts carbona- ceous with brown streak	22	2

	Ft.	In.
Dark argil., shale, light partings, fern marks.....	20	8
Black shales often carbonaceous, giving a brown streak, cordaites and fish remains.....	42	8
Black carbonaceous compact "oil shale" with dark brown streak, plants and fish remains.....	6	10
Black coaly shale.....		5
Light argillaceous shale with ironstone nodules.....		7
" more arenaceous.....	1	3
Light, very fine, sandstone.....	3	10
Light argillaceous shale.....	2	0
Coaly underclay.....		4
Light grey sandstone with ironstone nodules.....	2	8
" very fine argil. sandstone ".....	8	0
Quarry sandstone uniform grit.....	10	4
Whitish hard sandstone.....	9	1
Bluish grey argil. shale with ironstone.....	9	4
" " with micaceous sandstone partings.	11	9
Similar with black partings.....	10	3
Light grey wavy sandstone and argil. shale.....	10	7
Dark argil. shale with ironstone.....	10	5
" with shells, fish remains, cordaites.....	1	3
<i>Coal</i>		1
Dark underclay.....	3	0
Light fine sandstone.....	4	9
Fine quarry sandstone with plants.....	19	3
Light grey sandstone with argil. wavy partings.....	12	0
Grey sandstone with argil. shales.....	14	0
Bluish grey argil. shale with sandstone bands.....	22	0
Dark argillaceous shale full of fossils.....	4	3
Black carbonaceous "oil shale," streak brown, with shells, plants, fish and ironstone bands.....	4	3
Black carbonaceous shale.....	11	7
Dark blue argil. shale, fossils.....	9	1
Blackish argil. shale, slickensided, fossils.....	10	9
Black carbonaceous "oil shale," dark brown streak...	10	3
Dark argil. shale, plants, fish, cythere.....	6	0

	Ft.	In.
Dark argil. slate, with ironstone nodules	14	10
Black shale with brown streak, plants, fish.....	7	0
Fine light grey argil. sandstones	4	0
“ arenaceous shales.....	11	0
Argil. shale with dark purplish tinge, with ironstone nodules.....	3	2

(In borehole No. 2 of 1878 a series of rocks stained red were also cut immediately overlying the series of small coal seams.)

	Ft.	In.
Indian red marl		4
Mottled red compact areno-argil. shale	7	6
Indian red soft marl	1	0
Mottled red, purple, greenish, dark grey shale.....	3	6
Dark argil. shale.....	1	0
Light fine sandstone.....	1	6
Grey argil. sandstone.....	5	0
Red marl with rootlets.....		7
Grey sandstone weathering rusty, plants	2	0
Dark argil. shale.....	7	5
“ slickensided, fossils	8	0
“ with plants and nodules.....	8	0
“ full of fossils.....	10	0
Black carbonaceous shale with dark brown streak ...		9
“ “ cordaites abundant.....	9	1
<i>Coal</i>		6
Dark underclay.....	1	4
“ with nodules	2	0
Light argil. shale with fine sandstones	9	0
Grey argil. shale.....	3	6
Mottled argil. underclay with nodules.....	2	0
“ shale.....	5	9
Grey argil. shale with sandstone partings	7	0
<i>Coal</i> . Widow Chisholm seam ?		5
Light sandstones.....	2	7

This section, reduced to right angles to the dip of 14° , is equal to 981 feet.

In part the above section is used in the following comparative abstracts of strata proved by the Acadia Company's boreholes Nos. 2 and 3 in 1878, the borehole of the New Glasgow Iron Co. in 1889, and the Survey record 1869 :—

Great thickness of shales, frequently black, 334' 5" below oil coal, page 18 of Logan's report.	Survey Record, 1869.	No. 2 Borehole of 1878, 251' 11".	No. 3 Borehole of 1878.	1889 Borehole. 654' 7".
Sandstone beds	113.0	108.6	.....	91.2
Chiefly shales	31.8	25.0	.....	53.0
Sandstones	25.0	.....	.....	267.3
Prominent carbonaceous shale	8.6	8.0	.....	4.3
Shales .....	.....	102.6	.....	69.6
Beds mottled with red .....	.....	43.4	.....	31.6
Sandstones	178.8	7.6	.....	9.1
Dark shales		46.8	71.4	43.3
Coal seam .....	.7	1.0	.8	.6
Shales	28.4	37.0	40.0	30.7
Coal—Widow Chisholm seam ?	1.0	1.0	.10	.5
	386.3	380.6	.....	359.6
Shale .....	.....	.....	16.0	.....
Sandstone .....	.....	.....	84.2	.....
Shale .....	.....	.....	3.2	.....
Coal .....	.....	.....	1.0	.....
Fireclay .....	.....	.....	0.1	.....

Other than this borehole the only work done in this section has been on the George McKay seam along the crop west of Marsh brook, and towards the McLeod pit. The coal there mined is a free burning coal that will not coke. It contains a lower percentage of ash than is usual in the Pictou field. At the brook the dip of the seam is N. 50 E. 14° , but followed eastward the crop flattens to 5° on entering the Vale area, and is carried by ascending ground round to the south into the neighbourhood where Logan gave on pages 15 and 16 the probable highest coal seam of the measures. That the Six Feet seam so given near A. McLean's, Jr., and the George McKay are one and the same is now concluded from finding midway in a trial pit south of St. Mary's Road at J. McDonald's, turner, the coal to be dipping northward at less than 2° . Southward of the Vale lease these

measures are supposed to be repeated in the Mountain section with an inclination that again brings in the highest members of the Marsh pit syncline.

The Survey map gives the Potter brook fault as passing to the north of the Marsh pit, and a fault or series of troubles probably does pass between the pit and the northern upheave of the group, but its course is assumed to differ somewhat and to parallel the easterly strike of the measures which extend to D. McPherson's. Faulty ground is indicated by the dislocation met with in the slope referred to in page 27 sunk for the Merigonish Company, where the dip is given as S. 3 W. 17° , increased by a fault at 80 feet down the slope to 22° . Behind this slope a borehole was put down in 1889 for some 300 feet, but the inclination was found too high to encourage further exploration. Eastward of this point in the small brook, McPherson's, referred to on page 28, late openings have been made in both the Captain and George McKay seams, but in both cases only 2' 6" of coal was found lying at a steep angle, 45° . It is worthy of note that an extension of the strike of these steep measures into the Section of Pine Tree meets a series of vertical dips parallel to the escarpment of New Glasgow conglomerate, and leaves all the known exposures of black agglomerate limestone to the north. The 10-inch seam overlying the Captain seam some 200 feet has not again been opened, but in the flat ground at the head of the pond the *wash* of a good coal has been lately discovered in a line with the crop of the seam on Marsh brook described at the head of page 29. This seam also has been examined and found to dip to the west at a low angle, and to yield only 8 inches of good coal. It is succeeded 100 yards higher up Marsh brook by sandstone beds that dip 3° in the opposite direction.

Eastward of McPherson's brook the coal seams have not been followed, but a grey conglomerate is met in that direction, and in the brook that cuts the northeast lease line on its way to Pine Tree sandstones dipping northward are exposed; a change in direction that indicates proximity to the great North fault.

Boreholes Nos. 2 and 3 of the Acadia Company referred to in the preceding section were put down in the Pictou area in 1878.

No. 2 near the south-west corner of the Vale area, and No. 3 on Marsh brook some 15 chains from its mouth, both cut strata of the same horizon as the later borehole from the McLeod pit in 1889.

Besides the opening on the George McKay seam three slopes were put down near the Marsh pit on the Captain seam, and their direction indicates a curving round to the east of the crop of this overlying seam. The slope nearest to the pond went down some forty feet, the next dipping N. 50 E. 14° some 110 feet, and the most westwardly N. 40° E. for some 80 feet. The irregularity in the direction of the slightly inclined strata to the east is considered due to rolls, and not to faults.

The Vale Section.—This includes the St. Lawrence and McBean areas of Logan and the ground adjacent to the west. It contains a syncline of which a fork runs into the Marsh pit section. The main syncline extends westward along the base of McLellan's mountain under McLellan's brook to the eastern foot of McGregor's mountain. In sections numbers 6, 7, 8 and 9 of his report, Logan gives a record of some of the measures that dip towards the northwest. These sections require some readjustment due to information since obtained by the veteran explorer of this locality, Mr. A. McBean, but the records here given are still very incomplete and far from accurate. The bottom of the syncline in the Vale area is approximately under Marsh brook in its course before it is deflected westward by the high ground on the borders of the North fault. The axis of the syncline dips eastward and as it proceeds the fold is sharper, the legs dip at higher and higher angles and are more disturbed by cross faults. These cross faults are upthrows to the east and increase in strength as they approach the axis. In the extreme eastern corner, the St. Lawrence area, the ground is so disturbed that little hopes are entertained of the finding of patches of workable coal, though among the faults of the east end of the Vale area there is a piece of unwrought good coal but it is steep. Sir William discusses at the foot of page 42 whether the fault that there disturbs the seams is an upthrow or downthrow. Every member of the series of faults in that locality disclosed since 1869 has been found to

be an upthrow to the eastward and in sympathy with the great North fault. In spite of the intervening breaks being upthrows, the impression is that the coal of the St. Lawrence pit belongs to the McBean or eight feet seam, and this it may well be since the dip of the strata approaching the North fault increases with the depth from the surface and thus causes the eastward deflection of the outcrop. A broken band of red rocks crosses the coal measures at this point, the east corner of the Vale area, and if they can be shewn to overlie the coal measures the question of relation would at once be set at rest.

The section given by Logan, page 30, begins with the Six Feet seam, which he calls the equivalent of the George McKay seam of the Marsh pit group.* But this is a mistake, the workings of late years have followed this seam down to the bottom of the basin under a cover of 607 feet and also beyond on a rise of 4° to the northward for 600 feet and then meeting with an inclination due W. 9° . No complete section of the strata above the Six Feet seam has been made, but a partial exposure of some 150 feet of strata occurs in the rock cutting of the Vale railway near the mine, grey arenaceous shales predominating with a band of sandstone under the highway bridge stratigraphically succeeded at 10 feet by 5 feet of black shale overlaid by 85 feet of grey shales and then by another band of black shale of equal thickness, with a 6 inch band lying midway between these so-called oil shales.

On the line of the Six Feet slope the highest strata are under marshy ground and include a seam of coal called four feet thick but consisting of only two feet of coal that is good next the pavement. The seam is also known to be 22 inches thick at Grants, near the North fault where the brook turns sharply to the westward. Here also on the brook are two beds of black compact (oil) shales which Mr. McBean recognized as identical with those shewn in the railway cutting and again westward on the highway near the Whitburn school house. Above the oil shales and 100 feet below the four feet seam a coal stratum .8 inches thick has been got by borehole.

*Logan, pp. 33 and 34.

The slope on the Six Feet seam begins with an inclination of some 22° which at a depth of 1800 feet is reduced to 11° and the bottom at the basin is reached at a distance of 2460 feet. The workings westward find the seam varies in thickness, the thinning being brought about by the substitution of lenticular masses of compact black shales next the roof of the seam which is not disturbed. These masses may be outliers of a regular replacement of shale for coal in that direction where all coal seams appear to thin.

Westward of the working Six Feet slope the seam has been followed nearly to the Vale lease line, where the ground rapidly rises and deflects the out-crop to the south, assisted perhaps by some east and west dislocations parallel possibly with the Lawson fault. West of the lease line the crop has been proved as the Mountain seam along a ridge of high ground that borders the old rocks, and it is underlaid by a small seam discovered near where the road at Finlay McDonald's crossed McLean's brook. Still further west in the mountain section, and up against the old rocks on A. McLean's farm, the same seam shews, but it is not believed to come to the surface beyond this point, although the syncline extends past McLellan's brook for a short distance.

Eastward of the slope in the Vale area the crop is doubtless broken by the several faults proved in the workings of the underlying McBean seam, but it has not yet been mined. The coal got in a pit on the northeast side line of the area where Marsh brook takes its turn, is thought to be of this seam, and so also with the latest exposure on the new road 20 chains northwest from the pit on the side line where a five feet seam dips at a high angle in the opposite direction towards the south. The northern and western outcrops of this seam are not known with certainty, any where on McLellan's brook.

Of the strata lying between the Six Feet and McBean seams nothing new has been discovered since Sections 6 and 7 were compiled, except that the total thickness, instead of being 800 feet, appears to be proved by the workings in both seams to be something less and about 700 feet, with a tendency to thicken to the westward. Throughout the series of beds having a west-

wardly inclination the association of greenish grey and ochrey stained conglomerates with coal bearing strata is a distinctive feature, the conglomerates seem to replace certain of the sandstone beds on the slopes of the older rocks, and from the presence of surface boulders it may be assumed that the substitution extends all the way to Plymouth on the East river, where the presence of grey conglomerates in situ among coal measures has already been noted. In the centre of the field conglomerates are not known, so that they seem to belong only to the skirts of the old rocks and to owe their origin to deposition in littoral waters. This feature tends to throw doubts on the suggestion that the coal field originally extended southward for some distance.

The underlying workable seam, the McBean, has been proved nearly to the east corner of the Vale area, where it is eleven feet in thickness and is inclined at an angle of 40° at the crop and 46° in the workings in depth. At the surface of the hoisting slope the inclination is 32° , down the slope 2000 feet the dip decreases to 28° , and at 3000 feet to 20° . At a further distance of a 1000 feet the bottom of the basin, proved in the six feet seam, would have been reached. The thickness of the seam reduced from 7' 6" at the slope mouth to 6 feet in the lowest levels, but the quality at the same time greatly improved. To the westward the dip flattens and the levels curve towards the south. The upper levels passed through a fault of some width having the course given to the Lawson fault of the Survey, but this fault thinned and disappeared in depth. They also crossed the line of the Lawson fault, finding only a disturbance of little moment at the crop, so that the importance of this fault discussed on page 36 of Logan's report must be abandoned and all the conclusions built on it given up. Ten chains further west and the crop is exposed on McLean's brook, and the series given in section 9 is entered on. This series included the McLean seams, regarded as a distinct group, but the difference in quality and thickness which the seams here present may be accounted for by their greater proximity to the hills and a continuance of the changes found to occur in the McBean seam as it was worked to the westward.

Where the seams crop out on McLean's brook the dip has again increased to 27° , as mentioned by Logan in section 9, and on following down that brook to the base of the section the inclination of the strata is found to increase to 58° . Further on, near the south corner of the Vale area, the dip of the crop flattens to 13° , and this group of measures is lost at the foot of the Cambro-Silurian hills, where rests a strip of Lower Carboniferous of the gypsiferous series with limestone. But the overlying six feet seam has been traced as the Mountain seam half a mile further to the westward on a course changing from S. 50° W. to S. 80° W. The limestone occurs on the left bank of McLean's brook above the fork at John McDonald's farm, it is agglomerated like that found on the West river, a mile above Union Centre bridge. It appears to be in place and to be associated with red rocks, fragments only of which are found in the brook. Below this point the brook enters on the coal measures, of which the lower beds roughly conform to the line of contact with the hill of trap that here forms a shoulder to the mountain range.

In the Report for 1869 the Sections 6 and 7 are correlated with Number 8, but this view is now abandoned and belief in a simpler structure is held. Sections 8 and 9 are regarded as detailing similar horizons with constituents varying greatly, the localities referred to being some distance apart. In both, beds of greenish grey conglomerate generally with rusty pebbles are characteristic but they often appear to be local substitutes for arenaceous shales, and not persistent. The bluish black oil shales, however, seem to be more uniformly distributed, and two of them that lie between the six and eight feet seams have been recognized extending from the small brook at A. McLean's, past the Whiteburn school house, where a bed of grey conglomerate is intercalated, shewing in the railway cutting at the crossing of the highway bridge, and finally on Marsh brook at Grant's, having been seen midway in trial pits.

Behind the village of Thorburn recent explorations have shewn the following modification of the measures below the eight feet seam :

	Ft.	In.
Measures	17	0
Coal		2
Measures	19	10
Coal { poor		6
{ fair	2	0
Measures	19	7
Drab sandstone	5	0
Coal seam { splint		$\frac{1}{2}$
{ good coal	2	$10\frac{1}{2}$
{ coarse		3

This latter seam evidently thins behind the engine-house to 3 inches, though it thickens again on reaching McLean's brook. The engine-house section is as follows:—

McBean, or 8 feet seam:

	Ft.	In.
Measures	58	0
Coal		3
Measures, bluish grey	40	0
Coal, inferior	1	10
Measures, sandy shales	33	0
Coal, inferior	1	9
Clay shale	2	0
Fireclay	2	0

On McLean's brook, a partial check survey varied somewhat from Logan's section 9, page 37, and Mr. McBean says that after Sir William had left the field a small fault was found between the two exposures of coal called the Widow McLean ten and thirteen feet seams, and that they are on the same seam. The partial examination shewed:—

	Ft.	In.
Compact sandstone	2	3
Coal, <i>Thirteen feet seam</i>	1	6
Measures	45	0
Drab sandstone	5	0
Coal { shaly	1	0
{ coarse	1	5

	Ft.	In.
Grey shales with 5 ft. bed of compact sandstone	69	0
Coal of fair quality	2	0
Measures	87	0
Grey conglomerate	4	0
Measures	22	0
Sandstone dip N. 70°, W. 30° over concealed measures	54	0
Measures	50	0
Black shales	4	0

Underlaid further down the brook by quarry sandstone dipping at an angle of 50°.

The base of Logan's section 9 is a greenish drab conglomerate dipping 58° at a sharp double turn of the brook where a fault of 4 ft. coursing N. 85 E. cuts the tilestones which in turn are overlaid by a foot of black shale containing fish remains, then 4 ft. of flaggy sandstones and other 6 in. of black shale. These, by the measures described, which include over a compact band of grey sandstone, an arenaceous argillite that weathers brick red. Below the base some 200 feet another bed of greenish conglomerate appears among the vertical measures that rest against the red rocks and purple conglomerates of Lower Carboniferous.

The measures of Section 7 behind the village of Thorburn likewise dip at an increasing angle, as they are followed southward from 32° to 55° at their base. These latter rocks, Sir William notes, (page 34) "contain many bands of sandstone which weather to various tints of red giving them externally the aspect of beds belonging to the Millstone Grit, and without careful examination they might be mistaken for such." In an earlier part of this paper, when referring to the Red Rocks of the field, it was suggested that this mistake had been made in Mr. Hartley's division. The supposition thrown out by Logan, page 33, that the McBean seam might be sought for on the western side of the syncline, near the mouth of Marsh brook, was carried out in 1878 by the Acadia Coal Co.; and again, ten years later by

Mr. Graham Fraser and his associates, who put down the bore-holes elsewhere referred to without attaining their object.

The vertical measures resting on the Lower Carboniferous are well exposed on a branch of McLean's brook on both sides of the Sherbrooke road near the south-east corner stone of the Vale area; below the road they hold five bands of the grey conglomerate dipping N. 42 to 55 W. 70° to 80°. Followed west these measures flatten to 35° before being lost on the strip of gypsiferous carboniferous limestone that flanks the mountain westward to the main branch of the brook

The Mountain Section.—This section follows west of the Vale from which it is probably separated by an east and west fault, coursing from the south corner of the Vale area to the centre of the syncline near the house of A. McLean, Jr., where a coal seam appears to dip in opposite directions in two contiguous ravines, and referred to by Logan on pages 15 and 16. The assumed structure is shewn on the map. The lesser inclination near this assumed fault is succeeded to the westward by higher dips as the strata are crowded against the old rocks and their lower members cut off. Sir William, on pages 34 to 36, gives reasons for believing this district parallels the strata lying between the six and eight feet seams of the Vale. Later explorations on the small brook where the *coal wash* he refers to modifies his number 8 section, and makes it read as follows:—

Arenaceous shales :	Ft.	In.
Greenish grey conglomerate with semi-angular pebbles of white quartz with sandstone bands.....	7	0
Arenaceous shales, soft fireclay bands, with carbonaceous partings.....	16	0
Black shales resting on ripple-marked sandstones, (6in.)	5	0
Conglomerates similar to the bed overlying	12	0
Measures concealed, including grey shales	22	0
Coal, coarse, <i>Captain seam</i> ? <i>Coal wash</i> of section 8..	4	0
Measures, in part flaky, greenish and bluish grey arenaceous shales and sandstones.....	70	0
Coal	1	3

	Ft.	In.
Measures	60	0
Coal, coarse, <i>Millrace seam?</i>	3	0
Measures	60	0
Coal, coarse, <i>George McKay seam?</i>	3	0
Measures	50	0
Oil shale, arenaceous		10
Measures	60	0
Coal, at A. McLean's barn, <i>The 10-inch seam?</i>	1	8
Grey conglomerate, exposed at and west of McLean's house	37	0
Measures	25	0
Coal very shaly	2	0
Measures, arenaceous shales	15	0
Black shales	13	0
Coarse greenish conglomerates and flaggy sandstones..	48	0
Black shale	3	0
Strong thin-bedded sandstones	16	0
Strong conglomerate overhanging the ravine	8	0
Measures, arenaceous, partly conglomerates	55	0
Bedded sandstones with plants	5	0
Coal. <i>The Mountain seam or Six Feet seam</i>	4	0

Underlaid by quarry sandstones, dipping 55° , and abutting against Cambro-Silurean rocks.

The brook on which this section is taken leaves the old rocks some 200 yards west of the Vale area corner, and naturally exposes the coal and other beds over which it flows in its rapid descent to McLean's house. It presents no exposure of Lower Carboniferous intervening between the coal measures and the metamorphic rocks as found round the shoulder of the mountain eastward on McLean's brook, and westward on McLellan's brook.

Along the slope of the ancient sea wall of Cambro-Silurian there are no exposures from this point west to McLellan's brook, the surface being covered with thick deposits brought by the Glacial drift through this pass in the hills. The overlying con-

glomerate beds that are rusty and carry pebbles of white quartz are easily traced from A. McLean's house across four ravines westward for 30 chains and are then supposed to be lost against a fault coming from a shoulder of the hills and extending to J. Reeve's in the valley, parallel to the fault at Patrick's oil coal pit. At least it may be assumed that the influence of the pair of Fulling Mill faults reaches this line and the regularity of the syncline onward to McLellan's brook is seriously disturbed. At Reeve's, where the McGregor slope and fault of Logan's Report are to be found, the opposite dip is met with and both the George McKay and Captain seams are supposed to be recognized, but their outcrops have not been traced eastward to connect there with better known ground.

MINERALS.

Within the circumscribed limits here dealt with the only mineral of present economic importance other than coal is fire-clay, but short reference may be made to others of interest on account of their association.

Coal.—Analyses of many of the coals are given in the Survey report for 1869, page 365; in How's Mineralogy of Nova Scotia, 1869; in the Coal Fields of Nova Scotia by John Rutherford, 1871; in Dr. Gilpin's papers in these Transactions and in Prof. Johnson's oft quoted report of 1843 and referred to, page 411 of the Survey report of 1869. The variation in the composition of the several seams in different parts of the field has already been mentioned and the analyses published in Acadian Geology illustrate the variations met with in the several layers that go to make up some of the large seams. The only note of interest that may be added is that while the coals of the lower series, chiefly found to the west of the East river will all coke, those of the upper series to the east are much drier and are non-coking coals. All the coals of this field are non-caking.

Fireclay.—Beds of fireclay are numerous. Few have been analysed and their value determined. Most of them contain nodules of clay ironstone which, however, on weathering, readily

separate. In a small way several beds have been used for making ground clay and even for firebrick, in some cases promising success, as for instance, a bed underlying the McGregor seam. In other cases as the thick bed immediately overlying the Deep seam the percentage of alkalis is evidently too large. A thorough examination of the clays of the district would be warranted for the demand for ground fireclay and firebricks of fair quality is large.

Petroleum.—Inspissated drops in some cases plastic, but more often hardened, are found associated with dog tooth spar at the quarry ford of the East river immediately north of the South fault; in the calcareous pavement of the George McKay seam, and the limestone of Fraser Ogg's quarry. Blotches of petroleum weighing a few ounces have been found associated with calcite in fireclay beds under both the Main and Deep seams.

Alum stalactites have formed from roof drippings in the Acadia slope.

Saline springs at a depth of over 1000 feet furnish samples of sea water of Carboniferous times. These occur in both the Acadia and McBean seams.

Zinc blende⁽¹⁾ in some of the clay ironstones nodules and in fissures of the measures. *Pyrite* both filamentous and cockscomb occurs in cavities, while in massive form it accompanies clay iron stone in the coal of the Main and Deep seams.

Galena in small crystals is associated with the zinc blende.

Clay iron-stone in nodules and bands is very generally diffused throughout the shales.

Blackband iron-stone underlies the cannel of the upper part of the Deep seam.

Limonite on Waters' Hill is probably at the contact of the Devonian and Lower Carboniferous.

Specular and *Spathic* ores in very thin veins appear in the indurated beds at Fish pools.

Hæmatite pebbles occur in the New Glasgow conglomerate at Alma and elsewhere. Conglomerate near the junction of

(1) Geol. Report 1873-4 p. 189.

McLean's brook on Sutherland's river is full of excellent ore, some of the pieces being large, six inches in diameter.

Limestone.—On the top of Fraser's mountain, immediately over the New Glasgow conglomerate, are beds massive but arenaceous that were worked half a century ago. They are overlaid by the botryoidal bed that is so characteristic of this horizon, and higher in the series by the 4 inch band of agglomerate seen just above the mouth of Smelt brook. Nodules of limestone occur in the sandstones under the cemetery on the bank of the East river, and also in Fraser Ogg's quarry. The coal measures and the rocks of the Millstone Grit are seldom calcareous, an exception being the pavement of the George McKay seam. The Lower Carboniferous carries many interbedded and massive beds occasionally shewing obscure fossils, and the Devonian of Waters' hill also exposes a large deposit.

Gypsum.—Is found at several spots on Waters' hill, on McLean's brook, and near the church at the base of Green hill.

Chalcocite and *Malachite* are associated with lignite in the Permian sandstones.

Oil Coal.—The curled shale lying below the McGregor seam were at first thus so-called. Then it was named *Stellar coal* by Mr. H. Poole, and subsequently on analyses *Stellarite* by Professor How. Richer portions gave 11,000 cubic feet of 36 candle gas, and picked samples yielded up to 190 gallons of crude oil to the ton. The return of one cargo sent to Boston was 54 gallons and the value put at \$8.75 per ton. At the same time Albertite from New Brunswick yielding 87 gallons sold at \$15.00, and Boghead coal from Scotland, giving 125 gallons, at \$14.00 per ton. The shale associated with the "bat" and generally shipped with it gave about 44 gallons to the ton. It may here be noted that the colliers working it were paid 6s. per 22 (long) cwt. and 3d. extra for close side in long wall work.

Oil coal was also worked on McLellan's brook and west of Blackwood's mill dam.

Oil Shale.—In 1859 and 1860, before the development of the oil wells of Pennsylvania, there was a very active search for oil-producing shales. Bands were found at Deacon's cove mill dam

and at the mouth of Smelt brook* in the strata over the conglomerate. In the coal measures of McLellan's brook there was Patrick's slope below the Fulling mill and numerous trial pits in other beds. The band that overlies the Main seam about 1000 feet was opened at several places, its course shewn by a line on the map, approximates to the position given to the Three and a half feet seam of Hartley, west of the East river. On Potter's brook a level was run in on a bed 100 yards below the highway where the black shales are overlaid by the sandstone series. A shaft was sunk on the Rev. A. Stewart's farm, near the junction of the Vale Railway with the Intercolonial, and south of the coal chute, where the dip at 72 feet was S. 80° E. 25°.

Fossils.

As the Transactions of the Institute contain descriptions and lists of most of the known fossils of this district, it is only proposed to here briefly summarize the chief localities where those characteristic of each system may be found.

Cambro-Silurian.—No organic remains have as yet been detected in the rocks classed as of this age.

Silurian.—Dr. Honeyman† has already enumerated many of the fossils known in the rocks of this system, some of which may be found south of Park's mill on Sutherland's river, on McLellan's brook, above the Grist mill, and at Mountville, on McGregor's mountain, at exposures on both sides of the main road.

Devonian.—On the north side of the coal field near the mouth of McCulloch's brook and at the foot of Waters' hill on the same brook a few fragments of plants have been detected.‡ And on the south side, in the McKay brook beds, Hartley's No. 2 section, imperfect remains of plants have lately been found at the base of the section where some beds are stained by copper.

Lower Carboniferous.—The limestones supply no such collections as can be made at Windsor and Shubenacadie, all the

* Vol. I, page 36.

† *Am. Trans.*, Vol. I, Part 2, Sec. Series.

‡ Honeyman, *Trans.*, Vol. V, p. 209.

Acad. Geol., p. 502.

forms seen are obscure even on the weathered surfaces. They are, however, worthy of a close examination, for it is possible their fossil contents may shew that the rocks thus classed are of two distinct divisions. Plant remains are best seen on the south side of the Union Centre bridge, over the Middle river.

Millstone Grit.—The great mass of these beds seem to be absolutely barren, but the basal ? beds associated with conglomerates at McDonald's mill dam on McLeod's brook and also on the Middle river carry numerous remains of plants. Higher up on McLeod's brook also they are to be found close below Picken's Street bridge.

*Coal Measures.**—Cypris shells are found in the black shales over the Albion main and Acadia seams and at many points. The grey shales over the Acadia seam have preserved fine specimens of lepidodendron, one of which is in the Geological Survey Museum at Ottawa. Most of the coal seams shew many forms in their roof shales which unfortunately are generally of such a friable nature that they cannot be preserved, but in situ broad stems can be seen to extend for many feet. The best preserved specimens have been got from the bat associated with the stellar oil coal.† The iron stone balls partly sulphurous occasionally shew the form of corals, and it was from the roof of the 9' 3" coal of the Dalhousie pit that Dr. Dawson obtained his unique specimen, *Baphetes planiceps* and teeth of *Diplodus acinaces*.

The black bats of the Upper Coal Measures on McLellan's brook and at Fraser's Adit on the Merrigomish road supply remains of ganoid fishes, scales, spines, teeth and coprolites.

Permian.—The concretionary limestone close above the mouth of Smelt brook, on the East river, contains fish scales. The white arenaceous band below the concretionary limestone to the eastward on the top of Fraser's mountain holds the *Spirorbis arietina* described by Dawson and figured page 14 of Logan's report. In the sandstones at the mouth of Smelt brook *Stigmaria* roots with rootlets in position are numerous, again at the mouth of Rear brook the quarry there shews the rootlets running down

*Trans. Vol. 1, p. 30.

†See H. Poole's collection in the Provincial Museum, Halifax.

and piercing several distinct layers of shale and sandstone. In the same locality the black shales contain *cordaites*, ferns and seed vessels, and of fish remains, teeth of *Diplodus penetrans*, whole lower jaws, scales, sabre-shaped spines and coprolites.

Boulder Clay.—In this deposit no fossils have been found, but fragments of wood were in 1850 found at a depth of 10 feet in a trial pit north of the Albion Mines quarry.

MAP:—As already noted a map is in course of preparation on a scale of 20 chains to one inch. A tracing of it has been sent to the office of the Geological Survey at Ottawa, where also are retained the original plotting sheets of the field, which in many parts are in minute detail.