

## REPORT

OF OBSERVATIONS ON THE

### CARBONIFEROUS SYSTEM OF NEW BRUNSWICK,

IN THE

COUNTIES OF QUEEN'S, SUNBURY AND A PORTION OF YORK.

BY

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ASSISTED BY

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ADDRESSED TO

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FREDERICTON, NEW BRUNSWICK, May, 1873.

SIR,—The following Report embraces the results of observations made during the past season by Mr. George F. Matthew and myself, assisted by Mr. R. W. Ells, on portions of the Carboniferous System and older strata in central New Brunswick, and has been prepared in pursuance of instructions which I received in June last.

The first published Report on the coal formation in New Brunswick was made by Dr. A. Gesner in the year 1838. In this and the three following years he succeeded in determining its limits with some accuracy, embracing fully one-third of the entire area of the Province, and he likewise described the general lithological characters of the measures.

Ont-crops of coal had been discovered at several points; and from some of these, more particularly in the vicinity of Grand Lake, in Queen's county, it had been raised to a limited extent since 1825; but though the coal was of good quality, the seams were so thin that they offered no inducement for any extended investment of capital in their development. The proximity of the magnificent coal seams of Nova Scotia, however, encouraged the hope that other and thicker seams might be discovered at some lower level than had hitherto been reached in New Brunswick, and in 1837 it was determined to ascertain if possible, by boring, the existence or otherwise of such workable seams in the Grand Lake district. Operations conducted by a private company were accordingly instituted for the

Report by Dr.  
A. Gesner, 1838.

Coal seams of  
Grand Lake.

Boring opera-  
tions.

purpose on the left bank of Salmon River, about two miles north of its embouchure in the north-east arm of Grand Lake. The boring here was continued to a depth of 403 feet, but with the exception of one coal seam of one foot ten inches, near the surface, and which is supposed to be the same as that now generally worked, and a bed of "bituminous shale and coal" of eight feet thick, met with at a depth of 262 feet, no strata of any economic importance were reported. One foot ten-inch coal seam.

The method of boring, however, was of an unsatisfactory character, and even supposing it to have been scrupulously and carefully conducted, was such as might easily have led to erroneous conclusions. Under these circumstances it was felt that before any reliable conclusions could be reached respecting the productive capacity of this coal field, further explorations by boring must be made. In pursuance of this view a second boring was begun in 1806 on Coal Creek, about five miles distant from the one on Salmon River, in a direction of west 20° south. This boring attained a depth of ninety-six feet, but failed to shew the existence of other seams beneath that to which the title of "the surface seam" had come to be applied. In 1870-1871, another boring equally unsuccessful was made at Salmon River to a depth of 217 feet, at a point about half a mile to the north of the first. Unsatisfactory method of boring.

Notwithstanding these repeated failures, however, the belief was very general among those acquainted with the district, that other and thicker seams would eventually be found beneath that which had been opened and worked near the surface at so many different points. This belief found expression in the Local Legislature, and during its last session (1872) an appropriation of four thousand dollars was made for the purpose of again testing the question. At the same time application was made for such assistance on the part of the Geological Survey as might serve to guide the Government in the judicious expenditure of the money. It was with this object in view that I was directed in June last to proceed to examine the Grand Lake Coal Field. Assistance from the Geological Survey.

In the maps which are being prepared to illustrate the geology of the region we have examined, we have availed ourselves of such material as could be furnished by the maps and surveys of the Provincial Crown Land Department, and we would here acknowledge our obligations to the officers of the department for their ready assistance and courtesy. Maps.

The following sub-divisions of the Carboniferous system are the same as those proposed by Dr. Dawson and Sir W. E. Logan for the Carboniferous rock of Nova Scotia, with some unimportant modifications rendered necessary by the somewhat different associations and the greatly reduced thickness of the various groups of strata in the central Carboniferous area of New Brunswick. Thus Dr. Dawson's divisions: 2, Middle Coal formation, and 3, Millstone-grit series, are included in the present report Subdivisions of the Carboniferous system.

under division II, Middle Carboniferous Formation ; and division I, Lower Carboniferous Formation, includes Dr. Dawson's divisions 4 and 5, the Carboniferous Limestone, and the Lower Coal Measures.

### CARBONIFEROUS SYSTEM.

- I. Lower Carboniferous Formation.
- II. Middle Carboniferous Formation.
- III. Upper Carboniferous Formation.

#### *Lower Carboniferous Formation.*

The general position of the Lower Carboniferous strata, as well as the features which they present in the area under consideration, has already been briefly described (Geology of Canada, Report of Progress, 1870-71, p. 204-206). A more careful study of portions of the formation, during the past season, enables us to make some additional observations.

Position and  
area of Lower  
Carboniferous  
rocks.

Variety of  
colour and  
composition.

As stated in the Report above referred to, these Lower Carboniferous rocks in the great central Carboniferous area, are, for the most part, confined to the vicinity of the hills of older metamorphic rocks which border the latter, and among which are sediments of very different ages and great diversity of lithological characters. It is from the waste of these that the Carboniferous strata have been to a great extent made up, which accordingly exhibit a similar variety of colour and composition ; in some cases, indeed, so nearly resembling the older rock as to be not easily distinguished. In consequence of this diversity, as well as from the extremely variable character, both as regards the thickness and succession of its different members, no one description can be given which would be generally applicable to the whole formation. In that part of the Province to which our observations during the past season have been confined, the Lower Carboniferous series presents important differences from its character where examined nearer the coast. Thus the Lower Carboniferous grey rocks, Dr. Dawson's sub-division 5, *Lower Coal Measures*, though well developed in the valley of the Kenebecasis river, appear to be entirely absent from the central Carboniferous area. The limestones also (No. 4 of Dawson) which form so prominent a feature in the Lower Carboniferous formation in Nova Scotia, and which frequently attain a considerable thickness in the southern counties of New Brunswick, here appear to be limited to small patches of thin irregular beds, both westward and eastward of the St. John River. The red conglomerates and sandstones, however, which accompany these limestones, are universally distributed wherever the Lower Carboniferous rocks are found, and the whole group has a very close lithological resemblance to that which underlies the Pictou coal measures, and which has been described by Sir W. E. Logan under the designation of Millstone-grit, and stated to correspond to No. IX. of Dr. Dawson's subdivision of Sir W. E. Logan's section of the

Universal dis-  
tribution of red  
conglomerates  
and sandstones.

Carboniferous rocks exposed on the Joggins shore of Nova Scotia. The Lower Carboniferous red sediments, which we have been examining during the past summer, have contributed a portion of the material from which the Middle and Upper Carboniferous formations of central New Brunswick have been built up, in the same way that the lithologically similar Millstone-grit in Nova Scotia has, according to Sir W. E. Logan, contributed an abundance of fragments to the conglomerates at the base of the coal measures near New Glasgow. We have as yet, however, met with no evidence which would justify the separation of the red conglomerates, &c., bordering the central Carboniferous area of New Brunswick from the Lower Carboniferous limestones with which they are associated: they are, therefore, both included in the following remarks, as members of the Lower Carboniferous formation.

The beds which, though not the very lowest, are those most commonly met with at the base of this formation are conglomerates, these latter consisting of large or medium sized, seldom well rounded, but mostly sub-angular fragments, which are derived from neighbouring ridges of older rocks. A narrow belt of these conglomerates spans the space between the St. Croix and Magaguadavic Rivers, at a distance of about five miles south of the European and North American railway. It crosses the St. Stephen and Woodstock road just south of Trout Brook, a small stream flowing into the St. Croix, and rises towards a rather prominent hill in the direction of the St. Andrews and Quebec railway, having a dip N.  $20^{\circ}$  W.  $< 15^{\circ}$ . In most of the beds of this belt the paste, which is usually sandy, but often argillaceous, is of a red colour; but in fragments observed about the sources of the Digdeguash, where the conglomerate belt crosses the St. Andrews and Quebec railway, the matrix was observed to be in rare instances of a grey colour. In both varieties the pebbles are chiefly fragments of argillite and fine sandstone; both flecked with scales of silvery mica on the layers, and varying in colour from apple-green to grey. Some beds have white quartz pebbles freely scattered through the paste, and there are occasionally fragments of jaspery blood-red hematite. The argillite and sandstone fragments which most abound in the conglomerates are similar to those of Devonian age (Cordaites slates) which cover a large area to the southward. Besides the greenish fragments, however, there are many pieces of red argillite and sandstone, not differing otherwise than in colour from the green. We have found no ledges outside of the conglomerate belt corresponding in colour to these red fragments. Their hue may have arisen from the same causes which have universally given a red colour to the paste of the Lower Carboniferous conglomerates, and to the accompanying shales.

Beds at the base  
of the forma-  
tion.

Belt of conglom-  
erates.

Character of  
the pebbles.

In the western portion of the above described belt, the red conglomerates are the only rocks met with. Beyond the Digdeguash River, how-

Exposures in  
Upper Trout  
Brook and  
Brockaway  
Settlement.

ever, in an easterly direction, the formation covers a wide space, and embraces a larger number of divisions. Between this latter stream and the Maguadavic the exposures are but few, being limited for the most part to small ledges laid bare at two or three points in the bed of Upper Trout Brook. In the Brockaway Settlement these rocks again become more apparent. Their out-crop here bifurcates; one band, in connection with that above described, passes up the valley of the Maguadavic and thence along that of its tributary, the North-east Branch, through the northern part of Harvey Settlement, beyond which it is continued, though somewhat interruptedly, to the St. John River north of Fredericton; while the other sweeps around the southern side of the great central Carboniferous area. In the two belts there are some noteworthy differences.

Description by  
Mr. Chas. Robb.

In the Report of Progress for 1866-69 (pages 179, 180) a general description of the more northerly belt, together with a map illustrating its distribution, has been given by Mr. Chas. Robb. A detailed notice of the latter on our part is therefore unnecessary. There are, however, one or two points not alluded to by Mr. Robb to which we would call attention as bearing upon the structure of other portions of the Carboniferous area examined by us. The most important of these refers to the great mass of feldspathic rocks described by Mr. Robb as associated with the ordinary Lower Carboniferous red sediments in the settlement of Harvey, and the apparent want of conformity between these two groups, as evidenced by the marks of erosion to which that last named had been subjected at some period antecedent to the deposition of the former. The facts bearing on this are well exhibited a few rods west of Harvey station, where the railway cutting at the base of the high hill which here overlooks Cranberry Lake, presents the following ascending section:—

Section.

Feet.

- |   |    |
|---|----|
| Fine-grained and rubbly purple sandstones at base of cliff, including a one-foot bed of fine-grained feldspathic sandstone, with varying shades of green and purple. Exposed thickness about.....   | 17 |
| Pale purplish-red and red, highly feldspathic beds (sometimes becoming yellowish or green, or variously marked with irregular bands and blotches which are nearly colourless) which at the base are mostly fine-grained and sometimes vesicular; but above become a coarse conglomerate or breccia, in which angular fragments, mostly of small size, consisting of fine red felsite mingled with those of a soft deep green and somewhat translucent mineral, are imbedded in a feldspathic paste containing a large admixture of similar greenish material. In some portions of the mass are thin layers in which the feldspathic rock is largely mixed with purple sandstone, similar to that of the beds below, the thickness of the whole being about..... | 40 |
| Where the above measurements were made the conglomerates rest conformably upon the purple sandstones, which dip S. 20° E. < 20°; but a few yards to the westward the line of contact between the two becomes broken and irregular, the felsite breccias here resting upon the abruptly terminated edges of the arenaceous beds along a plane declining somewhat rapidly towards the foot of the cliff.  |    |

The latter from this point westward is mainly composed of the breccias, overlaid, however, towards the top and at the end of the hills by beds of purplish felsite or claystone, which is sometimes conspicuously divided into columns by a three-fold series of joints. The thickness of these felsites may be estimated at about.....

150

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With few exceptions, the fragments contained in the conglomerate or breccia above described, as well as a large proportion of the matrix in which they are imbedded, are of one kind only, viz. : a hard, dense and fine-grained felsite, such as in some portions of the metamorphic region nearer the coast is associated with rocks much older than those of the Carboniferous system.

Such an accumulation of fragments of so uniform a character within so limited an area seems capable of explanation in two ways only, viz. : either upon the supposition that there exists in the vicinity some ridge or nucleus of older rocks from which the fragments may have come, or else that they are the result of an igneous ejection. Upon the whole we are inclined to regard the latter as the more probable explanation; for although there are in some portions of the area occupied by these fragmental rocks—as for instance on Bald Mountain, and in some of the hills which lie to the northward of Harvey Settlement—dense and fine-grained beds, not differing greatly from the fragments in question, yet they are not clearly separable from those which are undoubtedly Lower Carboniferous conglomerates, and the whole would appear to be of contemporaneous origin.

Origin of the fragments composing the conglomerate.

It may be further remarked, that if the purple sandstones, which form the base of the above section, are really of Lower Carboniferous age, then, the felsite breccias which rest upon their eroded surface would appear to be of about the same age (or probably a little later) as the doleritic and amygdaloidal rocks, which near Fredricton, Boiestown, and elsewhere around the border of the Carboniferous area, are similarly associated with Lower Carboniferous sediments, a view first suggested by one of the authors in 1865, (See Observations on Geology of Southern New Brunswick, Fredericton, 1865, p. 99) nor are there wanting among the feldspathic beds themselves indications of at least a partially igneous origin; for besides being largely made up of angular fragments indicating a rapid accumulation, they are not unfrequently vesicular; the vesicles holding calcite, fluor spar, or delessite, and sometimes drawn out as it were into cylindrical or tubular forms, such as are often seen in ordinary amygdaloids. It seems difficult too, to account in any other way for the innumerable corrugations by which the higher beds are characterized and which resemble the effects of irregular flowing of semi-fluid matter, rather than such as would result from simple pressure upon beds previously horizontal. These corrugated beds are usually a feldspathic grit or claystone,

Age of the felsite breccias.

Corrugated strata.

finely and conspicuously banded with shades of grey, pink and purple, having small disseminated grains of limpid quartz, and small angular specks which may be decomposed crystals of feldspar. They are well exposed on the post-road to St. Stephens, just south of Harvey station, and in cuttings on the railway, two and a-half miles west of the latter dipping in opposite directions, and giving to the whole exposure the structure of a low anticlinal. They closely resemble beds to be presently described along the south border of the Carboniferous area.

Large size of  
the fragments  
in the breccia.

At Little's and Lister's mills, the latter about five miles south-west of Harvey station, similar felsite breccias occur. They are here remarkable for the large size of the imbedded fragments which sometimes attain a diameter of from two to three feet, and, as at Cranberry Lake, are almost wholly of fine-grained cherty felsite, imbedded in a soft, deep green or purplish-red matrix; with them occur also Lower Carboniferous sediments, more nearly approaching the usual type, being sandstone of a bright brick-red colour, (sometimes blotched and banded with grey,) and red conglomerates; but the relations of these to the first named beds are not very evident. Fragments of felsite are common in both; but while the red rocks, which are comparatively fine-grained, have for an exposed breadth of more than five hundred feet a uniform dip,  $S. < 60^\circ$ ; that of the felsite breccias, which probably overlie them, is extremely variable and irregular.

Pratt Brook  
and Wilson's  
Hill.

At the head of Pratt Brook, as well as in Harvey Settlement, at Wilson's Hill, the ordinary coarse red conglomerates of the Lower Carboniferous formation are separated from the grey grits at the base of the Middle coal formation only by thin beds of yellowish and grey sandstone or grit, which sometimes become reddish in the paste from an admixture of an imperfectly crystalline mineral resembling stilbite or heulandite.

Orthophyre  
hills.

In the belt of Lower Carboniferous rocks which borders the southern side of the Carboniferous area eastward of Brockaway Settlement, the strata are concealed in the low land about the Kedron Lakes, but again come into view in the upper part of the valley of the Piskahegan River, and its affluent Peltoma Brook. Here as well as on Shin Creek further eastward, the shales and the paste of the conglomerate have a bright Indian-red color, and the pebbles are of quite a different character from those of the corresponding member further west. Here they consist chiefly of blocks of the quartziferous orthophyres, which compose the bold range of hills extending along the south side of Shin Creek, and thence across to the Piskahegan; there are also many fragments of a grey trachytic rock which is found in situ in the latter stream, also of the dark red and purplish banded slates and of the pale grey or cream colored, fine-grained banded felsites of the same range. Pebbles of dark green dioritic schist and of black contorted slates are less frequently met with. Here as on the western

border of Charlotte county, the rock fragments, both soft and hard, but especially the latter, which occur in the conglomerate are only slightly worn on the angles, rounded pebbles being of rare occurrence.

These fragmental rocks and the shales which overlie them are well exposed in the bed of Piskahegan River, in Peltoma Settlement, and along the sides of Shin Creek. On both these streams there is also a fine breccia conglomerate, of deep red color weathering to orange-red, consisting of small angular pieces of dark red shale, imbedded in an argillaceous paste of paler hue. With it are associated beds of fire-clay, of amorphous structure and bright Indian-red color, some of which contain sufficient oxide of iron to be of value as an ochre or "mineral paint." A few of the more slaty beds in this portion of the series hold poorly preserved remains of ferns, and a small *Cardiocarpum*, too obscure for identification. From the St. Croix River eastward many of the conglomerate beds weather into a somewhat vesicular rock owing to the abundance of calc-spar occupying cavities and crevices in the stone. Fire-clay.  
  
Fossil plants.

This calcareous character becomes more marked at about seven miles from the mouth of Shin Creek, where a band of impure concretionary limestone exists in the upper part of the conglomerate. On the same stream a higher member of the series makes its appearance resting upon the red shales. It belongs to the same horizon as the dolerite rocks along the northern border of the Carboniferous area; but occurs here as an olive colored amygdaloid, which in parts of its distribution is associated with beds of compact trap of similar greenish hues. The cavities in the former rock, which is generally highly feldspathic, and also contains much iron, are usually filled with calcite, though oftentimes with a dark colored chloritic mineral and less frequently either with vitreous quartz or hematite. Usually also the rock is porphyritic with crystals, sometimes of half an inch but usually not more than one quarter of an inch in length, of pale olive-grey or flesh-red feldspar: the joints of the amygdaloid and of the compact trap are ordinarily occupied by thin veins of hematite. No important change in the appearance of the Lower Carboniferous series was observed on the South Branch of the Oromocto River, into which the Shin Creek discharges, with the exception that, at about half a mile south of Blissville station, the members above enumerated are covered by pale purplish lilac-weathering felsites. Concretionary  
limestone.  
  
Amygdoloid  
and compact  
trap.

From the South Branch of the Oromocto River the out-crops of the Lower Carboniferous series pass through a low belt of wooded land to the head waters of the Nerepis River. Here there is a considerable area of red rocks, including an out-crop of well developed Lower Carboniferous limestone which occurs in the lower Clones Settlement, about one and a-half miles east of the saw-mill on Kelly's Brook. *Terebratula Sacculus*, var: *sufflata* is very common here in the limestone, as well as a small species



Limestones  
holding fossils.

of *Serpula* ; there are also two or more species of small gasteropods, several lamellibranchs, including *Pterinea* and a cast of a *Cucullæa*-like shell, a large *Orthoceras* is also quite common. Much of the rock is compact and of a reddish-grey color, but portions are of a more open texture, the interior of the shells and spaces between them being occupied by crystalline calcite. Numerous fragments of dark red shale and sandstone, and a few of red petrosilex, porphyritic with white calcite, occur with the limestone blocks, but the surface of the country at this out-crop is so densely covered with a young growth of trees that the relation of the limestone and arenaceous beds could not be determined. That portion of the Nerepis Valley which lies to the north of the range of Devonian slates in Petersville (Report of Progress, 1870-71, page 199) has been eroded to the depth of several hundred feet through the Lower Carboniferous rocks, exposing the slates above named in the bottom of the valley as well as along the base of the enclosing eminence, while patches of felsite, such as occur on the South Branch of the Oromocto, appear at intervals along the tops of the hills on the south side of the valley, and rise to the surface from beneath the coal measures on the north side.

Anticlinal folds.

In the intervening space there are one or more breaks or anticlinal folds, one of which at Lower Clones, exposing friable red sandstone, sweeps over a ridge of Pre-Carboniferous slates, of which a small area is exposed to view. This is about half a mile eastward of the Lower Carboniferous limestones described above. About three miles farther up the valley, the red rocks leave the main Nerepis stream and pass into the valley of Summer Hill Brook, one of its branches. At the junction of the two streams, a small area of Pre-Carboniferous slates is exposed. Above this point on the Nerepis, there are no exposures for the space of about a mile. Then for a quarter of a mile, following upward along the stream, the red measures of the Lower Carboniferous series form a low cliff on the left bank. Here dark red conglomerates rise from the stream in a low anticlinal to a height of eight feet, capped by a dark olive-grey and reddish doleritic amygdaloid in loose shelly layers. For a distance of half a mile further up, the stream flows through alluvial flats without rock exposures, and beyond that point out-crops of the conglomerate and grit pertaining to the barren measures at the base of the Middle Carboniferous formation begin to appear.

Doleritic amygdaloid.

Exposures on  
Summer Hill  
Brook.

Better exposures of the Lower Carboniferous series occur on Summer Hill Brook, above an out-crop of vertical Pre-Carboniferous slates at its mouth. The first ledges of the former series, which come into view here, are red conglomerates, full of grey calcareous nodules, and holding fragments, chiefly of grey Pre-Carboniferous slates, flesh-grey and dark maroon colored felsites dotted with crystals of pellucid quartz and calcite, also fragments of dark grey petrosilex, and pebbles of white quartz. The conglomerates show in the left bank of the stream, and are covered by beds of hardened

red clay and shale, which in their turn are surmounted by a bed of red limestone, varying from six inches to two feet in thickness. In tracing these beds up the stream, the red shales which at first possess a thickness of ten feet, are in a distance of fifteen paces reduced to a few inches, permitting the limestone to rest almost directly upon the conglomerates. Two hundred paces further up the stream there is another bed of conglomerate resting on a second small out-crop of Pre-Carboniferous slates. Here, however, the conglomerate is grey and more calcareous. It is full of fragments of the slate, mingled with others of the hard purplish and flesh-grey felsite above described. And the paste of the conglomerate holds shells of the genus *Productus*. On the south side of the out-crop of pale green slates upon which these conglomerates rest, purple felsites similar to those seen elsewhere at the top of the Lower Carboniferous series appear, and rest against the slates. The felsites, which, alternately with doleritic amygdaloids and dolerites, are exposed for some distance up the stream, are mostly earthy in fracture, of a dark purplish-red color, and speckled with small white earthy spots of feldspar, and with grains of vitreous quartz; some masses, however, bear a close resemblance to the porphyries of Shin Creek, being denser, flesh-red in color, and having numerous imbedded crystals of pale red feldspar, and of glassy quartz scattered through the mass. Near the mill of Mr. John Corbitt, the felsites give place to dark purplish grey doleritic amygdaloids, more feldspathic than usual, which a short distance above the mill meet a third out-crop of slates, covered, after a space of about one hundred paces, by a thin sheet of dark red calcareous grit overlaid by a considerable mass of grey limestones, holding *Terebratula saeculus*, var. *sufflata* and a *Pterinea*. Fossiliferous conglomerates.

These beds are exposed about a quarter of a mile from the bridge at the Gagetown road. About two hundred paces up the hill to the eastward on this road, there is a small outlier of grey sandstones and shales, dipping N.W.  $> 58^\circ$ , beyond which the red rocks are again repeated and extend nearly to the top of Summer Hill, where they are capped by a doleritic amygdaloid, in all respects similar to that described as occurring on Shin Creek, except that the seams and veins of hematite are larger and more numerous. Grey fossiliferous limestones.

Over all the belt of country from the Maine border to this point the Lower Carboniferous rocks have a low dip to the northward (seldom exceeding five degrees) or are quite horizontal. There is on this, as on the north side of the Carboniferous area, evidence of a want of conformability between the trappean and associated feldspathic beds, which occur at the summit of the Lower Carboniferous formation, and the coarser red sediments of the same formation, which underlie them. On Shin Creek the trappean members are separated by thirty feet, or more, of hardened clay, shales and sandstones, from the Lower Carboniferous conglomerate. At Unconformability of the trappean beds.

Wilson's near the Clones coal-crops, where the trappean beds are wanting, similar friable members may be seen to intervene between the measures of the Middle Coal formation and the red conglomerates. There are points on Summer Hill Brook and on the main branch of the Nerepis in Clones, where the trappean beds rest almost directly upon the Lower Carboniferous conglomerate. Other evidences of unconformability between these two groups in the Lower Carboniferous formation are also to be met with further eastward.

Lower Carboniferous rocks in New Jerusalem and Hibernia settlements.

Between the Gagetown road and the St. John's River, opposite Long Island, the belt of Lower Carboniferous red rocks occupies a somewhat wider area, being met with through the greater part of the flourishing settlements of New Jerusalem and Hibernia (or New Ireland.)

Fossils.

They here present much the same features as those described above as characterizing this formation to the westward of the same thoroughfare, the most conspicuous members being coarse red conglomerates, which underlie much of Jerusalem, and the purplish-grey light-weathering claystone. In Hibernia Settlement, thin beds of limestone occur, and on the farm of James McConnicky have been removed for calcination. These limestones, which in some parts are rather abundantly filled with shells of *Terebratula*, are overlaid by soft yellowish-grey shales, and underlaid by pale reddish-grey feldspathic grits or earthy felsites, which are partly kaolinized and filled with grains of vitreous quartz, and by red conglomerates; while from beneath the whole series appears a low ridge of slates of grey and dark-grey colors, sometimes shading into pink, red and purple, and which include also beds of dark-grey to black carbonaceous shale. These lower beds, which are glossy and somewhat unctuous and hold interlaminated veins of quartz, have a general southerly dip of 70°, but with many corrugations, while the overlying Carboniferous strata, though dipping in the same direction, do not reach a higher angle than 20°.

Repetition of the beds by faults.

The out-crops of the Lower Carboniferous formation, as seen on the west bank of the St. John River below Long Island, have been described in the Report of Progress for 1871, page 212; the general arrangement of the beds at this point being similar to those of Hibernia Settlement above noted. The greatly increased area which they here occupy is probably the result of a series of low folds, and possibly of one or more faults by which the beds are repeated. Along the valley of Little River, and again near its mouth, bright red Lower Carboniferous conglomerates may be seen at several points, as well as beds of claystone, the latter more dense and compact than those near Long Island, but both are too much obscured to make their relations evident.

Parish of Wickham.

Along the post-road adjoining the St. John River, in the parish of Wickham, the Lower Carboniferous rocks exposed to view are chiefly purple felsites with disseminated grains of quartz, in every way like those

seen on the opposite side of the river in Hampstead, except that they are here more often highly inclined, usually at an angle of  $20^{\circ}$  but sometimes rising to  $45^{\circ}$ , and having a dip about N.  $10^{\circ}$  W. About the mouth of Washademoak Lake small ledges of Carboniferous red conglomerate appear, while a short distance in the rear or southward a considerable mass of reddish-grey limestone is exposed, forming a portion of the eminence known as Rush Hill. These limestones are like those previously described on the shore near Long Island, and like them contain shells of *Terebratula* in considerable numbers, and more rarely an *Orthoceras*. Here, however, the limestones appear to be the lowest member of the series present, being underlaid a few rods to the south by a heavy mass of dark green Huronian diorite. Out-crops of limestone, which are probably a continuation of the same belt, are also met with at several points further eastward, more especially near the county line on the southern part of Shannon Settlement, where they may be seen resting upon grey and green argillites of Devonian or Upper Silurian age, and are conformably covered by coarse red conglomerates, the limestones having an exposed thickness of about six feet. Both beds are well exposed about the head waters of a small stream flowing through the last named settlement, and entering the Washademoak at the head of Belyea's Cove. In descending this stream the conglomerates, which form a series of low bluffs, with a nearly uniform dip N.  $25^{\circ}$  E.  $> 6^{\circ}$ , were crossed for a distance of 1,511 yards measured from their first out crops; but in approaching Jones' mill there appear from beneath them thick beds of fine-grained flinty petrosilex, mostly of a pale grey color and weathering nearly white, but which exhibit also shades of flesh-red, grey and black, together with delicate bands of color which, if the result of sedimentation, indicate a northward dip of  $60^{\circ}$ . These rocks have a surface breadth of about 400 yards: they are very like some of those met with among the hills which lie to the northward of Long Reach in King's county, and are probably of Upper Silurian age. A few rods further down the stream and below the mills, the red conglomerates again appear upon the right bank, but on the left there are other beds of petrosilex differing from those first described only in being conspicuously divided by a series of joints into prismatic blocks and columns, many of which are quite perfect. From Jones' mill to its mouth in Belyea's Cove, the stream flows only through meadows or low land without rock exposures.

Limestones of  
Rush Hill.Huronian  
diorite.Devonian or  
Upper Silurian  
rocks.

Perhaps the most interesting view of the rocks in this vicinity is that furnished by the shore of the Washademoak Lake, between Belyea's Cove and Craft's Cove. The western side of Belyea's Cove shows only ledges of laminated grey sandstones, which are a portion of the Middle Carboniferous formation, and are nearly horizontal, though with much false bedding. Similar beds also crown the hills on both sides of the cove, but beneath

Belyea's Cove-  
to Craft's Cove.

them on the eastern side other beds are exposed which, both in color and lithological characters, resemble those of the Lower Carboniferous formation, viz.: bright red shales with thin beds of limestone, the latter with layers and nodules of bright red chalcedony.

Section.

The following ascending section, condensed from observations and measurements between the two coves, will serve to indicate the relations of these beds:—

	Feet
Bright red shales with grey marly layers and calcareous nodules, which at some points are replaced by thin beds of hard pale bluish and white nodular limestone, the latter containing much disseminated quartz, which is usually in small concretionary lumps, but sometimes in bands or layers conformable to the bedding. One of these layers attains a thickness of as much as two feet. This quartz, which is of a chalcedonic variety, is sometimes colorless, but usually some shade of red, and often a deep blood-red hue. In consequence of slight undulations, one of which discloses a small bed of brownish-red sandstone beneath the shales, the thickness of these, as exposed to view, varies considerably, but in the western part of the section, where it is greatest, is about.....	20

In following the shore to the eastward, the red shales, at a distance of about twenty paces, become reduced to an exposed thickness of about three feet, and are overlaid by the following beds dipping N. 15° W. > 20°, and which are probably of the Middle Carboniferous formation.

	Feet
Grey sandstone with <i>stigmæris</i> .....	10
Measures concealed.....	2
Black, rusty and carbonaceous shale.....	3
Soft bluish-grey rusty shale.....	10

No higher beds are visible at this point, but a little to the eastward, where the red shales and limestone are partly concealed by the beach, there are above them beds of grey conglomerates, holding many white quartz pebbles, succeeded by grey, flaggy sandstones, their dips being usually N. 30. E. from 2° to 10°, but with much false bedding, some thirty feet of these beds are exposed, but as similar rocks out-crop at intervals on the hills above, which cannot be less than one hundred and fifty feet high, their thickness must be much greater.

False bedding.

To the eastward of Belyea's Cove, the only rocks met with along the shores of the Washademoak are grey sandstones like the above, and which do not differ from the ordinary grey rocks of the Middle Carboniferous formation; but among the hills to the southward, Lower Carboniferous rocks are frequently met with, and at some points cover considerable areas. Such for example is the case in Henderson Settlement, three miles east of Shannon Settlement, where the red conglomerates, with some red shales, rise into prominent hills. A small stream flowing through this settlement, and entering the Washademoak at the head of Lewis Cove, in cutting through

Henderson  
Settlement.

these beds, has also exposed the older rocks from which their materials have been derived. These in the lower part of the stream are a grey highly micaceous schistose rock having veins of white quartz, and in some parts approaching a genuine mica schist, being much like certain beds of rocks also exposed by the denudation of Lower Carboniferous strata in the valley of Hammond River in King's county. Near the mill, where these schists are directly overlaid by the red conglomerates, large unworn blocks of the schist may be seen imbedded in the conglomerate, in some cases from two to four feet in length. The dip of the overlying conglomerate beds is N.  $80^{\circ}$  W.  $< 3^{\circ}$ .

A short distance farther up the stream they include some beds of deep red sandstone, and are overlaid by about twenty feet of deep brownish-red shales. These exposures are all to the south of the main mass of mica schists which are exposed upon the stream for a breadth of about six hundred paces. Beyond them in the same direction the bed of the stream is occupied by fine red sandstones which are conspicuously divided into two sets of joints by rectangular blocks from two to three feet in diameter, and dipping S.  $80^{\circ}$  W.  $< 2^{\circ}$ . No other exposures are met with on the main stream, but on a small branch which enters the latter near the cross roads in Henderson Settlement, the coarse red conglomerates again appear at and above Shaw's mills. Here also they contain pebbles of mica schist, imbedded with others of diorite, petrosilex and slate, in a deep red sandy paste. Some of these pebbles may have come from an underlying series of feldspathic schists which come into view a short distance above the mill, where they are interstratified with a feldspathic sandstone of greyish and greenish-grey tints, which are in some parts clouded with shades of purple; others may have come from beds of fine-grained greenish-grey schistose diorite, not observed upon this branch, but exposed to view about three quarters of a mile to the south-west, where on a second branch of the same stream they are associated with similar feldspathic schists. From this point, which is on the main road to Belleisle Bay, to within 800 yards of where the boundary of King's county crosses the latter, the hills on either side are composed of red conglomerates dipping N.  $35^{\circ}$  W.  $< 6^{\circ}$ . Beyond the county line the strata exposed are of Pre-Carboniferous age. Through the remaining portion of the parish of Wickham, within which the localities above described are included, as well as in that of Johnston, which lies immediately to the eastward, the opportunities afforded for the study of the Lower Carboniferous rocks are much less frequent than is the case to the westward. This is partly due to the fact that the country in this direction is but sparsely settled, but largely also to the fact that the formation itself has here evidently been subjected to great denudation, in consequence of which it is now represented only in limited and widely separated patches. A farther evidence of such denu-

Conglomerates with pebbles of diorite, petrosilex and mica schist.

Great denudation of the Lower Carboniferous rocks.

lation, and, at the same time, of the want of conformity between this formation and the succeeding members of the Carboniferous system, is to be found in the fact that the latter in this direction are often found resting directly on the older metamorphic hills, without the interposition of any red sediments whatever. Such for instance is the case in the settlement of Goshen, as well as along the Canaan river, and its tributaries on the southern side. There are, however, one or two points at which the Lower Carboniferous rocks are exposed to view, the most considerable being those of the Scotch and English Settlements, in the latter of which are good exposures of the conglomerates, as well as of the underlying limestones. The conglomerate beds, which may be seen in isolated patches on either of the streams, tributaries of Long Creek, which take their rise in this settlement, do not differ from the similar rocks seen to the westward. The limestones, however, seen only on the more southerly of these streams, and not far from the county line, are peculiar in containing a considerable admixture of dioritic material, distributed through portions of the rock in the form of thin shaly layers.

Limestone  
associated with  
dioritic material.

The source of this dioritic material is probably to be found in the waste of ridges of Huronian diorite, some of which are exposed a little to the southward at Pearson's mill, and through portions of the Irish Settlement in the adjoining county of King's. It is probably from a like source that the materials of certain conglomerates have been derived, which a few miles farther east cover a considerable area in the Snider Mountain Settlement. A portion of these are of a greenish-grey colour, containing pebbles of diorite, white quartz, and red slate in a dioritic paste, but others present the usual deep brownish-red tint so characteristic of the Lower Carboniferous formation. It is in the eastern part of this settlement that the rocks of this formation connect with those of the same age in the central and eastern parts of King's county, upon which our observations are still incomplete.

Snider Mountain  
Settlement.

Besides the areas to which the foregoing descriptions apply, and which in the form of two narrow belts mark, as has been stated, more or less continuously the rim or border of the great central Carboniferous area, there are several points over the interior of the latter, where the partial denudation of the Middle and Upper Carboniferous formation has exposed the underlying Lower Carboniferous strata. This is perhaps the case in the bed of Long Creek, near the junction of its two principal branches at McLean's mill, where certain greenish-grey rocks are exposed, which are more or less amygdaloidal and contain a considerable admixture of chlorite. They are here compact and tolerably homogeneous; but a few rods up the western branch, somewhat similar beds occur in the form of a conglomerate in which large fragments of amygdaloids, much like that first mentioned, are imbedded in a fine greenish-grey felspathic paste. In neither case,

McLean's mill.

however, do any distinctively Lower Carboniferous rocks occur in connection with these trappean beds, the only other rocks noticed in the vicinity being coarse grey and nearly horizontal sandstones, containing *Calamites* and *Sternbergia*, and which cover those first mentioned unconformably.

A second locality where beds which may be of Lower Carboniferous age thus exposed, is in the vicinity of Cumberland Bay, the more southerly of the two indentations at the eastern end of Grand Lake. About a mile southward of Cumberland Creek (and at its eastern end where it crosses the line of the projected great road from Grand Lake to New Canaan, somewhat closer to the creek,) is a long, and as compared with the generally low and flat character of the surrounding country, rather conspicuous ridge; it affords but few exposures of the rocks composing it, but judging from such as could be found, both at its eastern and western ends, as well as, from the debris with which it is thickly strewed, would appear to be almost entirely made up of purplish-grey claystones, in some parts fine-grained and homogeneous, but more frequently marked like the resembling beds described in preceding pages by the dissemination of particles of vitreous quartz through its mass, and sometimes assuming the aspect of a conglomerate. The country immediately surrounding it is mostly low and flat without rock exposures.

Less doubtful exposures of Lower Carboniferous rocks presenting their usual aspect of bright red calcareous conglomerates and sandstones occur to the northward of Grand Lake, at and above the Forks of Newcastle River, and are more particularly described further on, in connection with the coal measures which here partly cover them.

### *Middle and Upper Carboniferous Formations.*

The greater portion of the counties of Queen's and Sunbury, and also a portion of the adjoining county of York, is occupied by the series of grey rocks, including conglomerates, sandstones and shales, long since recognized by Dr. Gesner as the equivalent of the great coal formations of Britain and Nova Scotia.

Rocks of Queen's, Sunbury and York counties.

In New Brunswick these grey rocks in various parts of their distribution include beds of coal which, though thin, are in some instances workable, and are accompanied by the usual assemblage of coal-measure plants. Full lists of these have been given in the (Report of Progress for 1870-71, pages 214-216.) The rocks which in the area we have examined during the past season appear to form the lowest member of the Middle or Productive Coal formation, consist of heavy masses of grey conglomerates and coarse grey quartzose grits, alternating with thin beds of rather coarse grey sandstone and sandy shale, the last named beds not unfrequently containing ill preserved remains of plants. In their coarse-



Resemblance to  
Millstone-grit  
series of Nova  
Scotia.

ness and general aspect, and in the absence of workable coal seams, these rocks resemble very nearly a portion of those to which in Nova Scotia the name Millstone-grit has been applied, and which they probably represent. In New Brunswick, however, they are clearly separable from the great mass of red Lower Carboniferous sediments which underlie them, and for which, or for a somewhat similar series in Nova Scotia the same term has been employed; while upwards they appear to graduate insensibly into those of the productive coal-measures. Indeed, except in the comparative unfrequency of fine sediments and their more silicious aspect—many of the beds being a coarse conglomerate made up of well rounded grains and pebbles of quartz imbedded in a grey sandy or feldspathic matrix—these lower grey beds are scarcely distinguishable from those which overlie them, and to which they appear to be generally conformable. They are, however, as a rule harder, and hence, having resisted to a greater extent the influence of denuding agencies, they rise into ridges which, though usually of inconsiderable height, have nevertheless exerted an important influence upon the surface drainage of the districts in which they occur. Such ridges are not unfrequently met with along the north-western border of that portion of the Carboniferous area to which this report relates, and are not wanting over its interior, but along its southern margin they are for the most part inconspicuous. It is among the finer sediments which overlie the barren strata just described that the fossiliferous shales, underclays, and the associated coal seams are found, and which present the usual features observed in other coal measures. In this portion of the series also, beds of coarse character are by no means wanting, and where occurring alone, are not readily distinguished from those of the underlying barren measures, but besides being less common and of less thickness, they are also usually more variable in composition. They likewise resemble those beneath in the frequent occurrence of false bedding which to some extent is exhibited also by the associated sandstones which, though often more or less flaggy, are sometimes sufficiently massive and even-grained to be available for architectural purposes.

Fossils tree-trunks.

Both the conglomerates and sandstones abound with prostrate trunks of large trees, *Dadoxylon*, together with impressions of *Calamites Sigillaria*, and more rarely of *Lepidodendra*. The first named tree-trunks are usually mineralized through the infiltration of silica or sulphate of baryta or by conversion into a black crystalline calcite. The ferns which are abundant in the shales are regarded by Dr. Dawson as belonging to the Middle Carboniferous formation, though with an admixture of species pertaining to the Upper.

From the softer character of the productive measures they are less conspicuous than the underlying barren beds, and are usually met with in the hollows and depressions between the ridges formed by the latter;

where the strata are horizontal, are exposed only in river sections. The overlying soils which have been derived from them necessarily partake of their characters, and are either very sandy or very clayey, and hence often unfit for successful cultivation, while large tracts, especially in the eastern part of Queen's and Sunbury counties, for like reasons, together with imperfect drainage, are occupied by extensive sand plains, swamps and barrens. Over many portions of the region we have examined the only strata exposed to view are the grey rocks which make up the bulk of the Middle Carboniferous formation. But others occur in which this color graduates into or is replaced by a purplish or purplish-red tint, which sometimes, more particularly in the finer beds becomes a deep red color. Beds exhibiting a similar bright color are occasionally found among the lower as well as the upper measures of the Middle Carboniferous series, yet the bulk of these red and purple strata are probably altogether above the productive measures, and appear to represent that portion of the Carboniferous system to which Dr. Dawson has applied the name of Upper or Newer Coal formation, though the thin limestone beds which are associated with them in Nova Scotia are apparently wanting in New Brunswick. Dr. Gesner has referred some of these beds to the New Red Sandstone series; but besides differing lithologically from the latter they are marked by the presence, in the finer layers, of *Cordaites*, *Calamites* and ferns, characteristic of the Carboniferous system. The Upper Carboniferous rocks being, like the strata of the Middle Carboniferous formation soft and imperfectly consolidated, have been in a like manner largely affected by denudation. Their debris, easily recognised by its peculiar color, has been widely spread, especially over the central and southern portions of the region examined by us, and has produced a soil on the older rocks considerably more fertile than they would otherwise possess.

*Details of Observations in Queen's and Sunbury Counties, East of the St. John River.*

Though somewhat diversified by minor inequalities of surface, the most prominent topographical features of the above region may be described as embracing three parallel swells or ridges, separated by two corresponding basins or depressions, of which the more northerly and broader one is occupied by Grand Lake, an irregular sheet of water, about twenty-five miles long, and from four to seven miles wide. The second, which is narrower and deeper, is occupied by the Washademoak Lake and River and its tributary, the Canaan. Both basins, at their western extremity, are connected with the St. John River by small but navigable channels. To the north-east the dividing ridges gradually disappear and the basins merge into an extensive and nearly level tract which forms a portion of the

watershed between the St. John River and Northumberland Strait, and the greater part of which is wholly unsettled.

Grand Lake.

The shores of Grand Lake and of its affluents afford many facilities for the study of the rocks of the Carboniferous system. The most important of the tributary streams, both as regards size and the aid they afford in the study of the geological structure of the district, are Salmon and Newcastle Rivers. The former rises by numerous tributaries, mostly situated in the western part of Kent county, and the latter by two principal branches in the eastern part of Sunbury county, while both enter Grand Lake, by its north-east arm, at a distance of only six miles apart. A third stream, Coal Creek, enters the same arm at its north-eastern extremity; and along portions of its course also affords good exposures of the strata.

Salmon and  
New Castle  
Rivers.

Coal Creek.

Section on New-  
castle River.

*Newcastle River.*—Of the sections afforded by the above mentioned stream the most interesting and instructive are those on Newcastle River, the course of which for much of its length, is nearly at right angles to the dip of the beds, which are inclined at low angles, and differ but little in relative hardness. They are exposed along the banks of the stream in an almost continuous series of bluffs, varying from twenty or thirty to two hundred feet in elevation, and exhibiting an almost unbroken succession from the rocks of the Lower Carboniferous series up to the principal coal-seams and their associated beds. As these sections are of much importance in their bearing on the relations of the different members of the Carboniferous system, as well as on the question of the thickness of the Middle Carboniferous series, and the probable productiveness of the Grand Lake coal field, we shall describe them with some minuteness.

Important  
sections.

As represented in the accompanying map, the junction of the two main branches of Newcastle River is situated about one mile, in a straight line, below the point where the south branch is crossed by the road leading to the Emigrant Settlement, in the parish of Northfield. Between the bridge and the Forks, and for about two miles from the latter up the North Branch, the rocks exposed to view belong to the Lower Carboniferous formation, and are in every way similar to those which have already been described in other parts of the Carboniferous area, being a series of bright red, more or less calcareous, conglomerates and sandstones, capped by heavy beds of hard grey feldspathic and ferruginous dolerite, which is often more or less vesicular.

Above the Forks, on both branches, the beds present a succession of low undulations. Their dip seldom exceeds four or five degrees, and they are often nearly horizontal. Southward of the Forks the inclination is more uniform, being S.E.  $< 3^{\circ}$  or  $4^{\circ}$ . About 344 yards from the Forks, measured obliquely to the strike, a cliff, about one hundred feet

in height, affords a good vertical section, showing the following succession and thickness of strata :

	Feet.
<b>LOWER CARBONIFEROUS.</b>	
Pale red conglomerate and sandstone at base of cliff.....	10
Measures concealed.....	10
Bright red, coarse crumbling shales.....	10
Hard and compact fine-grained dolerite, of grey color.....	10
Soft and crumbling, somewhat gravelly shales.....	25
Measures partly concealed, but including beds of dark purplish-grey dolerite rock, which is more or less vesicular, the cavities being filled with a flesh-colored mineral resembling stilbite.....	10
Measures concealed.....	20
Doleritic rock, in part shaly, with seams and joints holding much red heulandite; the bedding distinct but much contorted.....	about 20
	<hr/> 115

The dolerite rocks which form the summit of this section represent the **Dolerite rocks,** highest member of the Lower Carboniferous series, and may be regarded as the equivalents of the trappean rocks already described as occupying a similar horizon at Hampstead, and also near Fredericton and elsewhere around the border of the Carboniferous area. They are directly overlaid, a short distance below the section above described, by the coarse grey beds which form the base of the Middle Coal formation. Their relations to the latter are better shown in a second bluff about 344 yards south from the last, in which the following vertical and ascending section is exposed :

	Feet.
<b>LOWER CARBONIFEROUS.</b>	
Measures concealed at base of cliff.....	60
Grey and dark grey dolerite rock, similar to that of the above sections.....	20
<b>MIDDLE CARBONIFEROUS.</b>	
Brownish grey shaly sandstones.....	15
Grey conglomerate and coarse grey grit.....	20
	<hr/> 115

In a bluff, a few rods further down the stream, the following ascending section is exposed :

	Feet.
<b>LOWER CARBONIFEROUS.</b>	
1. Red sandstone and conglomerate at base of cliff.....	30
2. Compact and somewhat columnar dolerite, the seams of which are coated with bright red heulandite.....	30
<b>MIDDLE CARBONIFEROUS.</b>	
3. Grey sandy shales, coarse grey sandstones and grits.....	25
	<hr/> 85

Along this portion of the stream the inclination of the beds is uniformly to the southward. Though not exceeding two or three degrees, it is nevertheless sufficient to cause the gradual declension of the successive beds to and beneath the level of the river. Thus at a distance of 889 yards measured at right angles to the strike from the bluff last described, the cliffs, which are here about one hundred feet in height show only a succession of grey sandstones and conglomerates from base to summit.

First out-crops  
of coal in the  
Newcastle  
district.

From this point to where the main road leading to the Emigrant Settlement crosses Newcastle River, a similar ascending series is exposed in the cliffs along its banks, and about 382 yards beyond the bridge the first out-crops of coal in the Newcastle coal district appear.

Limit of the  
barren mea-  
sures.

In the last section above described the lower grey members of the Middle Carboniferous formation are separated from the red rocks which are referred to the Lower Carboniferous formation only by beds of doleritic rocks, while no appreciable discordance between them in their dip is observable. The felsites, however, which at other points described in the remarks on the Lower Carboniferous formation, appear to be the highest member of that series are here wanting. From the point where the doleritic rocks No. 2 of the above section, are first covered by the coarse grey beds which mark the base of the Middle Coal formation, to the bridge over Newcastle River on the Emigrant Settlement road, the distance measured along the stream is 3,000 yards, or in a straight line about 1,000 yards. The beds in this interval have never a higher dip than two or three degrees, while they are often nearly or quite horizontal, and the bridge may be taken as marking the upper limit of the barren grey measures.

Numerous coal  
croppings.

Excavations.

From the bridge the country on either side of the Newcastle Creek to its embouchure in Grand Lake, is everywhere occupied by strata of the Middle Carboniferous formation, (productive coal measures), and the coal croppings are quite numerous. Indeed at almost every point where irregularities of the surface or tributary streams afford facilities for working, excavations have been made, seldom failing to disclose the existence of coal at moderate depths. Where the overlying deposits exceed eight or ten feet in thickness these openings are usually by adits driven on a slope till the coal is reached, and then following the latter nearly horizontal. But when the seam is nearer the surface it is simply laid bare by stripping. It was hoped that the positions of the openings, particularly of the latter kind, might throw some light on the structure of the basin in which the seams are supposed to lie. In this, however, we were disappointed; the thickness of the measures above the coal appearing to vary for the most part simply with the accidents of denudation.

Details of the  
principal exca-  
vations.

The following details of the principal excavations show the character and thickness of the measures in this coal field. The numbers attached correspond with those on the map :

Robert McDo-  
nald's.

*No. 1. Robert McDonald's.*—This opening is the first met with in descending Newcastle Creek from Emigrant Settlement road, from which it is about 360 yards distant.

	Feet	inches
Coal, partly covered by water.....	3	
Coal shale.....	2	

	Feet. Inches.	
Coal .....	1	1
Coaly shale.....		1
Grey, somewhat shaly sandstone, partly concealed.....		
	1	7

No. 2. *Robert Libby's*.—This opening is about 417 yards south-west from No. 1, and on the opposite or right bank of the stream. Robert  
Libby's.

	Feet. Inches.	
Shaly coal.....	0	5
Grey clay.....	0	8
Shaly coal.....	0	6
Grey clay .....	0	8½
Coal softened by weathering.....	1	8
Coal shale.....	0	1½
Grey sandstone.....	5	0
Shale.....	2	0
	11	1

No. 3. Is an old adit now closed ; its only interest arises from the fact Old adit. that the coal-crop here, which is about 711 yards south-west from the last, is about ten feet above the level of the stream, while those in Nos. 1 and 2 were at and below that level. This may, perhaps, arise from a slight eastward inclination of the beds, which, however, is not apparent, or it may be caused by a fault ; otherwise it would seem that there is more than one coal seam in this locality—a view which is supported by the marked differences in the thickness and character of the strata at the two first described out-crops. At No. 3, the coal-bed, the thickness of which we could not ascertain, is covered by ten feet of concealed measures, above which are ten feet of grey sandstones and six feet of gravel.

No. 4. Here, on a small brook about 1,400 yards S. 10° W. from No. 3, and six feet above the level of Newcastle Creek, there are several openings from which a considerable quantity of coal has been removed. These openings are now abandoned, and no observations could be made on the character of the measures. Abandoned  
openings.

No. 5. *Stone's*.—This is on the creek, not far from No. 4, and has also been extensively worked, but like the latter is now abandoned. Stone's.

No. 6. *Kennedy's*.—This is also on the bank of the creek, about three-quarters of a mile south of No. 5. In both No. 5 and No. 6, the coal is of good quality. There are other openings along the Newcastle Creek, between No. 6 and Yeoman's Post Office in Newcastle Settlement. In the northern part of the settlement there are several openings, the most important of which is

No. 7. *John Yeoman's*.—This, however, was closed at the time of our visit, and we are therefore without particulars. John  
Yeoman's

Principal workings in the district.

The principal workings now in progress in the district are in the western part of Newcastle Settlement, about 1,600 yards from Yeoman's Post Office. There are here twelve openings in a distance of 888 yards; they are all adits, driven first with a slight downward inclination and then nearly horizontally, and are along the south side of a slight valley or depression falling towards Newcastle Creek. The thickness of the coal in the most easterly of these openings is said to vary from one foot to eighteen inches. This is

Coal one foot to eighteen inches.

*No. 8, Coakley and Kennedy's.*

McMahon's.

*No. 9, MacMahon's.*—This is to the westward of No. 8, and was the only one being worked at the time of our visit. It shews:

Coal, including a six-inch parting.....2 feet 6 inches.

A better view of the measures is exposed at

O'Leary's.

*No. 10, O'Leary's.*—This is about 293 yards from No. 9, and exposes the following ascending section:

	Feet.	Inches.
Fire clay, thickness not known, but exposed for.....	4	0
Coal, of good quality.....	0	8
Shale.....	0	2
Coal, of which eighteen inches is good.....	2	4
Blue shale from.....	9 to 15	0

Along the road connecting the settlements of Newcastle and New Zion, there are numerous other openings, some of which are still being worked. Of these the two following are the most important:

Peter McKenzie's.

*No. 11, Peter McKenzie's.*—This is about 1,600 yards west from No. 10. The coal is stripped by the removal of about six feet of soil, and is said to be rather more than one foot four inches thick. As the trench was full of water no measurements could be made.

Coal one foot four inches.

John Maynard's.

*No. 12, John Maynard's.*—There are a number of openings here, most of them abandoned, but one of which shows the following ascending section:

	Feet	Inches.
Coal.....	0	6
Fire-clay.....	4	0 to 6 ft.
Black coal shale.....	0	2
Coal, with pyritous bands at top and somewhat shaly below	1	10 to 2 ft 3 in.
Yellow clay.....	6	0
Chocolate-colored clay.....	4	0

The coal from this opening is that generally employed for blacksmith's use. The seam dips E.  $10^{\circ}$  S.  $< 2^{\circ}$  3'.

A second and scarcely less interesting series of openings has been made a few miles further south, in the vicinity of Grand Lake, and contiguous to the road from the mouth of Newcastle Creek to that of Little River. Of these the following are the most important:—

McMahon's, near the steamboat wharf.

*No. 13. MacMahon's.* This is near the steamboat wharf.—The coal

here has been laid bare by stripping for a length of about forty feet. It is from two feet to two feet six inches thick, and rests upon white fire-clay. Above it is a similar material of which two inches only is white, and the remainder, from four to five feet, of a deep chocolate color. The seam rises slightly at the eastern end of the opening, and at the western end there is a low undulation, causing it to rise about two feet above its general level, while just beyond this bend the seam is abruptly cut off, as if by a fault, and is replaced by clay. The coal is of the variety locally designated fine or still water coal; it is much broken, but is well adapted for forge purposes.

Coal seam two feet six inches.

About 340 yards west from No. 13, there are several more openings, the walls of which have fallen in. One of these is a level, about twelve feet below the surface; in the other the coal has been reached by stripping.

Other openings.

No. 14. *Leonard Akerly's*.—This is a little to the westward of No. 13. The coal has been exposed by the removal of about three feet of chocolate-colored clay. It resembles in character that from No. 13, but the thickness of the seam is reduced to about one foot four inches. Further west about 177 yards, coal, probably the same seam, is again exposed, shewing a thickness of one foot six inches. It is underlaid by fire clay and covered by about three feet of yellow clay, with irregular pockets and thin seams of coal near the top, and succeeded by three feet of chocolate-colored clay and soil. The seam dips slightly to the north-west, in which direction, at a distance of about one hundred feet, it sinks to nine feet below the surface, and has been worked by a level.

Leonard Akerly's.

Coal seam, one foot six inches.

No. 15. *George Morrison's*.—This opening presents the following ascending section:

George Morrison's.

	Feet.	Inches.
Fireclay.....	2	0
Coal of good quality (blacksmith's)..	1	6 to 1·8
Shale and clay.....		8 " 10
Coal.....		6
Shale.....		6
Stratified gravel.....	10	0

The surface of the lower seam at this crop is slightly undulating, sinking a little to the westward where the upper or six-inch seam comes in. The latter appears to occupy a position similar to that of the upper seam in Akerly's opening, No. 14, and it is similarly broken and irregular. On its eastern extension, it becomes thinner and gradually disappears. In another opening, Richard Rogers', close to No. 15, the measures are much the same, except that the upper seam is less clearly defined, being represented only by several thin coaly layers mixed with shale, and covered by about three feet of sand and earth.

Richard Rogers' opening.

Throughout the district bordering the Little River road, out-crops of



Scarcity of exposures.

the strata other than those exposed in the coal openings are very few, and such as do occur are of the ordinary grey sandstone in beds which are nearly if not quite horizontal. In approaching Little River, however, from the eastward, these are partly covered and concealed by purplish-red sandstones, which are probably of the Upper coal formation. At Flower's Cove and Little River, the grey beds again appear, being horizontal flaggy sandstones of an olive-grey color, and much stained by decomposing pyrites. Coal has been removed at several points here. The openings are, however, now abandoned, and we could procure no details of the character of the measures.

Abandoned openings.

Beyond Little River no out-crops of coal so far as we are aware have yet been observed, the grey beds being in this direction mostly covered and concealed by the purple and reddish beds of the Upper coal formation. In addition to the above openings there are a few others on Back Coal Mine Brook, a small stream flowing into the Newcastle River, nearly midway between Grand Lake and Newcastle Settlement. In these, two seams are exposed, the lower of which has a thickness of eighteen inches, while the upper is eight inches; the intervening rock is a blue, flaggy shale, containing numerous remains of ferns. Beneath the lower seam, which is covered by from twenty-five to thirty feet of earth, is a thick bed of pyritous white fire-clay, the whole rising in a direction a little south of west about 6 inches in twenty feet. These openings are indicated upon the map as No. 16.

Coal seams on Back Coal Mine Brook.

Pyritous fire-clay.

*Salmon River.*—The section of the coal measures afforded by Salmon River are altogether less instructive and less important than those of Newcastle Creek. The exposures along its banks are much fewer and the coal crops less frequent. There are, however, several out-crops from which considerable quantities of coal have been removed, and it was from near the mouth of this stream that the first coal found in New Brunswick was mined by the French, nearly two centuries ago. It is here also that the boring for coal was made in 1837.

First coal mining in New Brunswick 200 years ago.

The principal coal crops are those about Iron-bound Cove and near McDonald's Landing. At the first named point there are three openings: two of them are on James H. Hazelwood's land and close to what is known as Francis Landing.

Opening near Francis Landing.

Coal seams fifteen and a half inches, and one foot eight inches.

The coal in one of these openings is fifteen and one half inches thick, and is about one and a-half feet above low water; while at the second, about twenty rods north-westward from the last, its thickness is one foot eight inches, and it is several feet above the same level. At the third opening, on Widow Arbuckle's land adjoining, the seam is as much as twelve feet above low water. The difference is probably due to faults, as the strata exposed upon the adjacent shore of the cove, which are coarse grey sandstones with much false bedding, do not show any appreciable

inclination. The opening near MacDonald's Landing is about one and a-half miles to the rear or eastward of the left bank of the river, and has yielded coal of good quality; but, as it was not being worked when we visited it, we could procure no further particulars respecting it.

In ascending Salmon River from this point to the junction of Lake Stream, beyond which our observations have not extended, the only rocks met with were grey sandstones usually in nearly horizontal beds, but sometimes, as at MacDonald's Landing, having a south-easterly dip of about  $5^{\circ}$ . Most of the country intersected by this river is low and flat, and extensively covered with sand, and showing few rock exposures. The same is also true to a great extent of that on either side of the Gaspereau River which up to Evan Burpee's, a distance of about nine miles above its confluence with Salmon River, shows along its banks only low bluffs of coarse grey sandstone and conglomerate. These beds are largely made up of small quartz pebbles, and appear to correspond with the barren grey beds on the upper part of Newcastle Creek, described page 199. Between Newcastle River and Salmon River, there are but few points at which the rock formations are exposed to view, and such out-crops as do occur, are for the most part those of the soft red and purple beds, which appear to belong to the Upper coal formation. Some out-crops of the latter may be seen a little east of Newcastle Creek, not far from where it is crossed by the road to Emigrant Settlement, as well as in the Middle Land Settlement, Iron-bound Cove, and Salmon Creek Settlement; but it is in the latter, or rather along the course of Salmon Creek itself, that the best exposures are to be seen.

This stream, which empties into Salmon River about three miles below the mouth of the Gaspereau, takes its rise by two principal branches not very remote from each other, in the central part of the parish of Northfield.

It is upon the North Branch that the more interesting exposures are to be seen, including towards its head, where the stream again forks, a small out-crop of coal. The latter occurs upon the Little West Branch, west of its junction with the main stream of the North Branch, and presents the following ascending section :

Coal and coal shale, partly covered		
by water.....	about	1 foot
Fire clay.....	"	1 " 6 in.
Shale.....	"	3 feet
Gravel.....	"	5 "
Stratified brown loam, with pebbles	"	10 "

About two and a-half miles up the North Branch is another crop, not visited by us, in which the seam is about fourteen inches thick, of good quality, with a one inch parting of coal shale. Fourteen-inch }  
coal seam.

On both these branches the rocks are grey, rather coarse and somewhat

flaggy sandstones, with some conglomerates, and more rarely with beds of shale, their attitude being nearly horizontal. At the bridge where the two smaller streams unite to form the main North Branch, the dip is N. 70° E. < 2°. From this point to where the stream turning southward passes from Sunbury county into Queen's county, similar rocks are exposed along its banks in bluffs from ten to forty or fifty feet in height, being as before nearly flat, but usually with a low south-east dip, which sometimes rises to 6° or 8°. On the land of John Best a bed several feet thick of soft bluish shale overlying a bed of fire-clay appears beneath the sandstones which make the mass of the bluffs. Though not exposed upon the surface a bed of coal may be looked for here. 440 yards below the bridge, at the forks of the stream, there is also a low bluff of purple sandstone, apparently of the Upper Coal formation. The rocks which we think to be of this age are, however, better seen in the lower part of the stream, *i. e.*, between the county boundary and the point where the North and South Branches unite in Salmon Creek, and along the course of the latter. The transition from the grey to the red and purple beds is an abrupt one, being marked only by a narrow depression filled with debris, and which probably indicates the line of a fault. Just below this depression, where the bank is some thirty feet in height, the rocks at its base are soft purple-grey sandstones, and thin papery but somewhat sandy shales, which are nearly horizontal. The shales contain in considerable numbers fragments of *Calamites* and *Cordaite*s and more rarely a fern, the latter being also but imperfectly preserved.

Fire-clay.

Fossil plants.

About two miles lower down a better view of similar strata may be seen on the main Salmon Creek, where a bluff about forty feet high exhibits the following ascending section :

Section on  
Salmon Creek.

	Ft.
Purple sandstone.....	3
Purple rubbly shale.....	4
Fine papery purple shale.....	3
Purple red sandstone.....	6
Purple shale, with thin beds of sandstone...	20

The shales contain numerous remains of *Cordaite*s and *Calamites*, while on the surface of the sandstone large fronds of ferns may sometimes be found, but usually in a poor state of preservation.

These fossil plants have been submitted to Principal Dawson, who has furnished the following note upon them :

Note by Dr.  
Dawson on the  
fossil plants.

"The plants from Salmon Creek and Cork Settlement, and a fossil labelled 'from the grey conglomerates' at Douglas Harbor, have a decided Upper Coal formation aspect. It is very possible therefore that the productive coal measures may underlie the beds containing them. In Nova Scotia such plants often occur several hundreds of feet above the highest workable coals, but as in New Brunswick, the whole formation

seems to be thinner; they may be more closely associated with the Middle Coal measures.

The plants from the other localities have more the aspect of the Middle Coal formation, and some of them even of the Millstone-grit formation.

I give below a list of those that are determinable arranging them <sup>List of fossil plants.</sup> according to localities: "

*Salmon Creek.*

*Calamites dubius*, Artis. *Cordaites simplex*. Dawson.

*Alethopteris nervosa*, Goeppert.

*Neuropteris Loshii*, Brongn.

*Pecopteris oreopteroides*, Brongn. (or similar). *Lepidodendron*.

*Neuropteris*, a species of which I have specimens from Grand Lake, and from Sydney, Cape Breton, and possibly new; but I have not yet sufficient material for its description.

*Cork Settlement.*

*Annularia sphenophylloides*, Zenker.

*A. longifolia*, Brongn.

*Douglas Harbor.*

*Dadoxylon materiarium* Dawson, labelled 'from grey conglomerate.'

*Dadoxylon Acadianum*, Dawson. The first of these species is characteristic of the Upper Coal formation, the second of the Middle Coal formation and Millstone grit.

*Ferris Cove.*

*Calamites Cistii*, Brongn.

*Cordaites, borassifolia*, Corda, specimens not well preserved.

*Clones.*

*Cordaites, borassifolia*, Corda.

*Trigonocarpum*.

*Jemseg.*

*Lepidophloios* (not determinable).

*Coal Creek.*—The interest which attaches to this stream arises from the numerous coal-openings along its banks, but chiefly from the information which it gives as to the probable shallowness here of the productive coal formations in this district. The openings are entirely confined to the lower portion of the stream, the first being about one and a-half miles, and the last about three miles above the bridge, at its mouth. They are evidently all in the same seam, the strata which form bluffs along the creeks have a slight inclination to the northward, just sufficient to free the levels of water; and consist, as far as could be seen, of a soft blue shale, crumbling readily on exposure, which is capped by about ten feet of soft grey and mostly thin-bedded sandstones, the shales being those from which most of

Evidence of the thinness of the productive coal measures.

the fossil plants alluded to in a previous Report were obtained, (Report of Progress, 1870-71, page 214).

Mines worked  
forty years ago.

The mines at this locality were worked more than forty years ago by Messrs. Hersey and Matthew for a period of three years, during which time about 800 chaldrons of coal were taken out and shipped to Boston. The work was then suspended owing to a duty of \$2.00 per ton being placed upon the coal by the United States Government. A few years since operations were again renewed by different parties, and considerable quantities of coal removed. It was here, also, that the ninety-six feet boring already mentioned was made in 1869, since when no further efforts have been made to develop the coal-seams, and the levels have for the most part fallen in. The only point at which a good view of the strata in this vicinity could be obtained was on the farm of William Hayes, four miles above the bridge, at the mouth of the stream. A bluff here shows the following ascending section :

Boring in 1869.

	Feet. Inches.	
Blue shale, of unknown thickness, being mostly beneath the level of the stream.....	—	—
Coal shale.....	2	0
Impure shaly coal.....	0	3
Grey shale, apparently about 20 feet in thickness, but partly concealed towards the top, where it is followed by a thin bed of coal. This is also partly concealed, but where uncovered shows a thickness of about 8 inches—thickness of whole.....	20	8
Grey shale.....	12	0
Grey sandstone to top of cliff.....about	8	0
	42	11

The above beds have a scarcely perceptible inclination to the eastward. About three miles up the stream there is another exposure of similar sandstone forming a second bluff, but here these nearly horizontal beds may be seen to rest upon beds of bluish-grey and purplish-grey micaceous slates, which are exposed in irregular ridges by the partial removal of the overlying strata, and dip S. 70° E. < 70°. These rocks are the first of a succession of similar beds, embracing argillites of various shades, together with considerable masses of hard grey sandstone, which are exposed, at short intervals, for a distance of seven miles at least along the course of the stream. They are often spangled with scales of mica, and at some points are charged with pyrites, or much stained with oxide of iron. In these as in their other features they resemble the argillites met with on the St. John River, in portions of Hampstead and Enniskillen, and which, as elsewhere shown (Report of Progress, 1871, page 197), are probably of Devonian rocks. Devonian age. The occurrence of such strata at this point, in the very heart of the coal-basin and over so extensive an area, is very significant, and, as will readily be seen, has an important bearing upon all questions

Devonian rocks.

connected with the thickness and productive capacity of the latter. The lateral limits of this island, if it may be so termed, in the Carboniferous sea, we have been unable to determine, the country on either side of the stream being nearly flat and covered with forest.

*Grand Lake.*—Although usually low, there are many points around the shores of Grand Lake where the strata are exposed to view, while occasionally they rise into bluffs, and show sections of considerable interest. Of these the most important are those which tend to illustrate the relations of the grey beds of the Productive or Middle Coal formation to the red and purple beds, supposed to represent the Upper or Newer Coal formation. These relations may be well seen at and near Scypher's Cove on the north side of the lake, and again at Ferris's Cove on its southern shore. Scypher's Cove is a small indentation about four miles west of the mouth of Little River. It has already been observed (page 204) that near the latter the purplish-red sandstones may be seen resting on the nearly horizontal grey sandstones of the Middle Coal formation; with this exception, the latter are the only rocks met with along this shore of the lake to the head of its north-east arm. In the opposite direction they also appear to be the surface rocks for some distance, but, the shore being low, few exposures are to be seen until Scypher's Cove is approached. Just east of the latter is another and smaller indentation, Butler's Cove; and between the two coves we find the following ascending section:

1. Grey sandstones, like those of the coal measures, rather coarse and pebbly, and containing sigillaria and other large prostrate trunks of trees, some of which are 15 feet and more in length. There is much false bedding, and the stratification is obscure.
2. Measures concealed for 382 yards in a westerly direction, then an exposure of fine conglomerate or coarse grit of a grey color, slightly tinged with green. This tint appears to be due to the frequent occurrence of small fragments of pale green slate, which with similar fragments of grey and purple colors, and a little quartz, make up the rock. These fragments may have been derived from the abrasion of Pre-Carboniferous argillites. Twenty-six yards eastward, the same conglomerates become purplish-grey, and are covered by coarse purplish grits and sandstones, which are irregularly bedded, but have a slight westward inclination. Allowing to the conglomerate the same dip as that of the beds mentioned below, they may be roughly estimated as having a thickness of..... 3 ft. 0 in.
3. Purple sandstones like the last, but becoming in a distance of 800 yards, measured along a curve changing from west to west 20° south, deep purplish-red and then dark purple. The dip of the beds in the latter part being regular, S. 30° W. < 2°. In consequence of this inclination the beds in ascending order sink successively to the water level, showing in a distance of 622 yards a thickness of about..... 20 ft.

Interesting sections of the strata around Grand Lake.

Ascending section of strata

In a similar way higher beds come successively into view as follows:—

4. Coarse purple sandstone and conglomerate..... 12 ft.
5. Grey grit and conglomerate, similar in composition to No. 2, but coarser, partly concealed for four and a-half feet at the base, but with an exposed thickness of about twenty-five feet, the upper part becoming shaly..... 30 ft.

6. Dark purple, shaly sandstone..... 10 ft.  
 7. Grey conglomerate, dipping as before, and having a thickness of about..... 12 ft.

Impressions of  
fossil plants  
and rain drops.

At some points there are thin beds of dark purple, papery shales associated with No. 6, which, together with the sandstones, contain a few impressions of *Calamites* and ferns, as well as of rain drops. The plants are similar to those of the purple beds of Salmon Creek upon which the observations of Dr. Dawson have been given.

Scypher's Cove.

Pebbles of chal-  
cedonic quartz.

The series of beds described in the foregoing section occupies a distance of about a quarter of a mile along the shore, extending quite to Scypher's Cove, on the eastern side of which the grey conglomerate (No. 7) appears in low vertical bluffs; a similar conglomerate bluff bounds the cove on its western side, the rock being coarse and crumbling, and made up mostly of small well rounded pebbles. A little to the westward, about 382 yards, purple beds again come into view, being rather coarse, shaly sandstones, overlying coarse, grey sandstones which are rusty and calcareous, and contain impressions of plants. A succession of similar beds is then met with; the sandstones, which vary from grey to olive-grey in color, and often contain trunks of trees, frequently alternating with and sometimes shading into the purple beds. The latter are also mostly sandstones, but half a mile westward of Scypher's Cove they include and are capped by a considerable thickness of soft, deep purplish-red shales. The beds along all this portion of the shore are nearly flat, or with very low undulations. The road which divides the upper and lower sets of grants on this side of the lake comes down to the shore here, and beyond it there is a curving beach thirteen hundred yards long, on which there are but few exposures of the subjacent rocks; but at its extremity they again form a conspicuous bluff twenty feet high. The lower five feet is composed of dark purplish-red sandstone, and the remainder of a rather coarse and rubbly chocolate-colored shale. The sandstones show much false bedding, they are also very variable in texture, and often pass into conglomerates, which are largely composed of well-rounded pebbles of chalcedonic quartz, with others of felsite, mica slate, etc. Similar chalcedonic pebbles are abundant in the materials of the beach, and are often brightly tinted, recalling the beds of this substance mentioned on page 192 as occurring in connection with the Lower Carboniferous rocks on the south shore of Washademoak Lake. Beyond this bluff, is another long narrow beach, shutting in the basin known as the Upper Keyhole, beyond which to Grand Point, a distance of two miles, the shore is similarly low and without rock exposures. On Grand Point, which is a long narrow spit mostly of shifting sand, projecting half way across the lake, a few flat beds of grey sandstone may be seen, containing trunks of fossil trees. Just beyond Grand Point is the Lower Keyhole, more commonly known as Douglas Harbor. On either side of its narrow entrance low ridges

may be seen, composed of grey coarse conglomerates, much stained with iron, and like those of the bluff last described containing numerous pebbles of chalcedonic quartz, together with others of grey quartzite, slates of various colors, and fragments of sandstone, the latter scarcely harder than the enclosing rock. Coarse beds of sandstone also occur; both rocks are very irregularly bedded, and both contain numerous prostrate trunks of trees, which have usually been converted into black crystalline calcite. Similar beds also appear near the steamboat wharf, at the head of the harbour, but are there overlaid by coarse, purple sandstones which have a very slight easterly inclination.

Fossil tree-trunks changed into black crystalline calcite.

To the north and west of Douglas Harbour the country is low and level, and rock exposures are but rarely met with. It is probable, however, that most of this region is covered by the purple beds above described; fragments of them are abundant over its surface, while ledges of similar rocks occur at some points around the shores of Maquaspit and French Lakes. Better exposures of these rocks may be seen a few miles further north, on Little River in Sunbury county. They occur in a bluff, and in the bed of the river about three-quarters of a mile south of the point where the New Zion road crosses it, and according to Mr. Ells, who examined them, the beds consist of about four feet of very hard, dark purple sandstone, overlaid by a bed of reddish-purple shale of finer texture; the latter interstratified with thin beds of fine, purple sandstone, extending up the whole face of the cliff, which is from fifty to seventy feet in height. The bluffs extend along the stream for four hundred and fifty yards with good exposures; beyond which, to the New Zion road, but little can be seen. About the same distance north-east of the road is a second bluff fifteen feet high; but here the beds are grey sandstones and conglomerates with a southerly dip of two degrees. They contain numerous embedded trunks of trees. On Number Eighteen Stream, about three-quarters of a mile above the portage-road bridge, and about one and a-half miles from the New Zion road, is a seam of coal apparently about fourteen inches thick. Another small seam, or a continuation of the same, also crops out at a point about four miles further up.

Maquaspit and French Lakes.

Number Eighteen Stream.

Two coal-seams.

The highest point reached by Mr. Ells on the main stream of Little River, was eight miles above New Zion bridge, where in a high bank, known as Whet-stone Brow, grey coal shales, full of plant impressions, are exposed.

On the southern side of Grand Lake, the best exposures are towards its western end, and more particularly about Robertson's and White's Points and White's Cove. On Robertson's Cove, the rocks are chiefly a coarse grey conglomerate about twelve feet in thickness, which rests, near the water level, upon beds of grey sandstone; the first named rock being largely made up of slaty fragments of various shades of color, together

Rock on Robertson's Cove.



with some quartz and more rarely a pebble of granite, the whole inclosed in a sandy matrix, through which are also scattered numerous white particles, which appear chiefly to be a kaolinized feldspar. Similar conglomerates and sandstones may be seen along the beach westward of the point, and towards the outlet of the lake, and occasionally alternate with purple beds; but their relations to the latter are best seen in Robertson's Cove, a small indentation just east of Robertson's Point. There is here a series of vertical bluffs about thirty feet in height, which at their base show beds of soft purplish-red sandstone, separated by soft dark red shales from overlying coarse greenish-grey grits and conglomerates. These are similar to those of the Point, but are more pyritous and yellowish stained, and are further distinguished by containing three or four thin layers of coal, from one eighth to one-quarter of an inch in thickness. Along portions of the bluff, which has a length of over seven hundred yards, the grey beds which are nearly horizontal, though exhibiting much false bedding and some faults, appear to rest conformably upon the purple beds, into which they may also be seen to graduate, but at others small angular ridges or points of the purple beds project upwards into the grey, as though the latter had been deposited on their eroded surface.

Thin layers of coal.

White's or Ferris' Cove.

At White's or Ferris' Cove, two miles east of Robertson's, similar beds may again be seen, here forming bluffs about fifteen feet in height, at the base of which are bright purple and purplish-red beds, and above, sandstones and rather coarse conglomerates, which vary from grey to purplish-grey in color. Both here and at Robertson's Point the grey beds are characterized by a pale shade of green, and often look as if made up of granitic debris, or the waste of such chloritic and granitoid rocks as occur at some points along the shores of the Long Reach of the St. John River, and which have been elsewhere referred to the Huronian series (Report of Progress, 1870-71, page 113). Mingled with these materials of metamorphic origin, small pieces of unaltered sandstone are also met with, and occasionally small fragments of coal.

Vertical bluffs at Wiggins Cove.

The two sets of beds above described, *i. e.*, the greenish-grey and purple, appear to border the whole southern side of Grand Lake, at least as far eastward as Cumberland Bay; the one or the other being the most prominent in accordance with slight undulations by which they have been affected. At Wiggins Cove they are well exposed in vertical bluffs, about twenty-five feet in height, of which the upper part is a soft rubbly chocolate-colored and somewhat marly shale, the base being a flaggy sandstone, similarly tinted. Along the shore west of Young's Cove they also form low bluffs (pale purplish-grey sandstones overlying grey pebbly sandstone) and contain ill-preserved remains of plants (*Calamites*, *Cordaitea* and ferns,) similar to those of Salmon Creek.

The most easterly point at which they have been observed is Branscombe's

Point at the mouth of Cumberland Bay, on the southern side of which they again form low cliffs, but do not present any features differing from those already noticed.

At the head of Cumberland Bay, and near where Cumberland Creek is crossed by the high road from Cox's Point and the North-west Arm, are a few ledges of dark grey, rather fine-grained sandstones, which are somewhat doleritic in aspect, and may be the equivalents of the doleritic rocks which near the Forks of Newcastle Creek constitute the highest beds of the Lower Carboniferous formation. The only other beds observed in this vicinity (excepting those of the claystone ridge south of Cumberland Creek, described in connection with the Lower Carboniferous formation, page 195) resemble those of the ordinary coal measures, being grey sandstone and conglomerates, the latter sometimes much stained with oxide of manganese. Doleritic sandstones.  
Conglomerates stained with oxide of manganese

Over the region which lies immediately to the southward of Grand Lake it is often difficult to infer the character of the subjacent strata, owing to the extent to which they have been covered by debris derived from the rocks of the Upper Coal formation which lies to the northward. It would seem, however, from such observations as we have been able to make, that the Upper Carboniferous rocks are for the most part confined to the vicinity of Grand Lake, not having been met with in situ along the shores of Washademoak Lake, nor through the low ground separating the two, in their central and eastern portions. To the westward in Cambridge, however, the Upper Coal formation covers a more considerable area, including the hills between Ferris' Cove and the depression of the Den Creek, as well as a portion of those overlooking the valley of the Jemseg. Here too, unless extensively faulted, they must have a considerable thickness, seeing that their upper beds, which are greenish-grey conglomerates, much like those of the cove last mentioned, though still nearly horizontal, are at an elevation of fully two hundred feet above the latter. Below the mouth of the Jemseg, and west of the road between it and the Narrows of Washademoak Lake, the slope of the hills exhibits repeated alternations of dark purplish-red to chocolate-colored slates, with grey and greenish sandstones, both nearly horizontal, and both containing numerous but ill-preserved remains of plants. Cambridge.

The depression occupied by the Washademoak Lake and River contrasts with that of Grand Lake in being surrounded by much higher land, while the depression itself is at the same time narrower and deeper; it is also nearer the southern border of the coal field, and in consequence the strata have usually a low northward inclination, though still often nearly horizontal. They may be seen at many points both on the northern and southern shores of the Lake, but with the exception of the red calcareous beds at Belyea's Cove, noticed on page 192 as probably of Lower Carboniferous age, they appear to belong for the most part to the Middle Carboniferous for- Washademoak Lake.

Reported coal-seam.

Coal-seam on Long's Creek.

mation. This is indicated alike by their color, which is almost uniformly grey, as well as the occurrence of coal-seams at various points. One of these is said to occur at the Narrows (where the beds are coarse grey grits and conglomerates dipping a little east of north  $< 4^{\circ}$  or  $5^{\circ}$ ) and to have been struck in sinking a well, but no explorations have been made. Still further eastward another seam of coal has been exposed upon Long's Creek near its confluence with Washademoak River. It is on the land of Samuel Starkey, Esq., and was being proved at the time of our visit. Strata consisting of about 12 feet of sandstones, overlying grey shales, with *Calamites* and about one foot of impure shaly coal were exposed. The dip at the opening is W.  $10^{\circ}$  S.  $< 3^{\circ}$ ; but along the high-way near by, leading up to McLean's mill, the beds which are of similar character are nearly horizontal, though with much false bedding. At the mill mentioned, where they rest on chloritic rocks which have been described on page 194, they include a considerable mass of purple shales.

It has been already remarked that in this portion of its distribution the coal measure series appears to have often but an inconsiderable thickness, forming indeed a mere capping to the older rocks. One instance of this has just been pointed out in the case of Long Creek. A similar occurrence may be seen higher up on the same stream, and in the Settlement of Goshen, where on the higher lands, the grey Carboniferous sandstones are the only beds visible, while the bed of the stream is composed of hard Pre-Carboniferous argillites; and again on the Canaan River, which joins the Washademoak at its eastern end, as well as on several of its northern and southern tributaries.

Carboniferous sandstone on Pre-Carboniferous argillites

Thus about three miles below the mouth of the Canaan North Fork, the banks of the river, which are about thirty feet in height, are at the base composed of highly inclined Pre-Carboniferous argillites, upon the top of which, but in nearly horizontal layers, are about fifteen feet of grey Carboniferous sandstone, the inferior beds along the line of contact being all bent and flattened to the eastward, as if from the pressure of the superincumbent rocks.

Canaan North Fork.

Mr. Ells ascended the Canaan North Fork, by wading, to a distance of eleven miles from its mouth. For nearly two miles up he observed Pre-Carboniferous beds consisting of grey argillites and quartzites, the former marked by darker colored bands and often containing white quartz. At some points these beds rise into bluffs completely denuded of overlying deposits, but at others capped by thin beds of sandstone, which are mostly grey and not readily distinguished from those of the productive coal formation, except that they are occasionally of a pale greenish tint like certain beds of the Upper Carboniferous formation. The view that they belong to this formation is supported by the occurrence at many points of purple sandstones and shales, much like those of Grand Lake, and which

contain similar fossils. These purple beds occasionally hold spherical <sup>Breccia of mica-</sup>concretions, and are at some points overlaid by beds of grey sandstone. <sup>schist, diorite, &c.</sup> Beneath them, on the upper part of the stream, shale and fire-clays were also observed, but no beds of coal. In its lower portion, and just north of the most northerly exposure of the argillites above mentioned, is a bed of breccia which is rusty and full of large and small angular pieces of mica schist, diorite, quartz and quartzite, without evident stratification, and looking as if poured over the subjacent rocks. This breccia may be of Lower Carboniferous age.

The dip of the slates on the North Fork is about N. 65° W. < 60°; that of the Carboniferous strata being very variable, but always low, usually at angles of only 2° or 3° and with much false bedding. Rocks similar to the latter were also observed by us on Alward Brook, which is not laid down on the Provincial map, but is a stream of considerable size running nearly parallel to the North Fork, and entering the Canaan River a little below the mouth of Thorn's Brook. The beds on Alward Brook are said to contain a thin seam of coal, but such, if really present, must at the time of our visit have been concealed beneath the water.

The rocks exposed along the streams which enter the Washademoak River on its southern side, (such as Rider's Brook, Porcupine Brook, &c.,) appear to belong entirely to the Middle Coal formation, being mostly grey sediments of a very coarse character, such as pebbly conglomerates and grits, often stained with oxide of manganese, but embracing also some finer beds, such as shales and fire-clays. The occurrence of the latter renders that of coal not improbable; but, though several of the streams which traverse this almost wholly unsettled district were examined, none was found.

We may conclude this review of the Carboniferous formation east of the St. John River by a brief reference to a series of beds which, though not within the limits to which our attention has been devoted during the past season, is yet deserving of notice in connection with the question of coal supply, the investigation of which was the principal object of our labors. The strata referred to occur near Dunsinane station, on the line of the European and North American railway, in the eastern portion of King's county. A short notice of these beds, not one, however, based upon any personal examination, together with an analysis of the associated coal, was given by one of the authors in 1865 in their "Observations on the Geology of Southern New Brunswick," and they were then considered to be probably of Lower Carboniferous age.

A visit to the locality, however, since made, has shown that although the greater part of the valley in which these beds occur is occupied by rocks of the age in question, yet that these are here covered by an outlier of the true or productive coal measures. The ground in the

vicinity being low and swampy as well as densely wooded, the opportunities afforded for a study of the formation are but scanty, and its extent and thickness are therefore still undetermined; but that it belongs to the Middle Carboniferous formation is apparent from the character of the rocks (grey sandstones and soft blue and grey shales) and also of the associated organic remains. In the shales there are numerous and well preserved impressions of *Calamites* and ferns, *Alethopteris lonchitica* being especially abundant.

Twenty-inch  
coal-seam.

Some eight or ten excavations have been made, and the coal-bed which is believed to be the same in all, has usually a thickness of twenty inches, though at some places including a one inch parting of coal shale.

At one of the pits the rock removed is a soft red shale. Excavation to a depth of about sixty feet failed to show the existence of other seams of coal.

*Details of Observations in Queen's and Sunbury Counties, West of the St. John River.*

The following observations on the Middle and Upper Carboniferous formations embrace a description of them as seen in the region watered by the Oromocto River and its tributaries, and in that bordering the St. John River in the neighbourhood of Gagetown. To these are added a few notes on portions of York county; chiefly along the line of the Fred-ericton Branch railway.

Exposures on  
the Nerepis  
River.

On page 188 the Lower Carboniferous strata were described as extending one and a quarter miles up the principal branch of the Nerepis River above Summer Hill Brook. Above the last out-crops of that series, the river runs through gravelly and alluvial land for a distance, measured along its course, of about one mile and a quarter, and affords a few exposures of the grey conglomerates and grits of the barren measures. For a further distance up the stream of about one and a quarter miles, the out-crops become more frequent, and the strata consist usually of coarse sandstones alternating with beds of conglomerate, of a grey color and abounding in thoroughly rolled pebbles of white quartz, with less numerous ones of hard grey slate and sandstone. The sandstones are also grey and olive-grey in color, and become more abundant in ascending the stream. The measures dip at a very low angle, and both sandstones and conglomerates shew much false bedding. At and above the point last described, the beds assume a different aspect, being largely derived from the Lower Carboniferous series. Grey and olive-grey sandstones are seen to alternate here with irregular layers of conglomerates made up of pebbles of red shale and limestone imbedded in a matrix, which in some places is a red mud, and in others is grey and more sandy. The limestone pebbles contain *Terebratula sacculus*, var *sufflata*,

Limestone  
pebbles holding  
fossils.

and an *Orthoceras*. These beds extend nearly to the mouth of Wilson's Brook, about a quarter of a mile. For a distance of three-quarters of a mile along the stream above Wilson's Brook there are no rock exposures; but the soil is a red clay abounding in several places with angular pieces of Lower Carboniferous red shales. Above this, grey sandstones with poorly preserved remains of large coal-measure plants shew in the bed of the stream, and the strata dip N. N. E.  $< 2^\circ$  or  $3^\circ$ . At a distance of one hundred and seventy-seven yards further up, there are dark grey and black shales lying horizontally, and enclosing *Cordaites borassifolia*, *Cardiocarpum* (Sp.)?, obscure ferns, and a carpolite (?). The same beds hold also a small species of *Naiadites*. 623 yards up the stream, above the exposure of black shales, are the out-crops of the Clones coal-seams. Should coal-seams of sufficient importance to be economically worked be found here, two natural outlets for the product of the mines exist. One of these is to the eastward, through the valley of the Otnabog, which rises within a mile or two of the Clones coal-crops, crosses the Gagetown road and discharges into the River St. John; the outlet of the lake at the mouth of this stream being about ten miles from Clones. The other available approach is through the valley of the Nerepis River, near the source of which the seams lie. From Welsford station, on the Western Extension of the European and North American railway, there is an easy ascent along the Nerepis valley through a settled country in a north-easterly direction to the Clones coal-field; a distance of fourteen miles. The crops of some of the seams in this field were discovered about four years ago, but no attempt to ascertain the value of the seams was made until the summer of 1872. Then some small excavations were made in the left bank of the Nerepis River (near its source) just below the driving-dam, a mile and one eighth north of Mr. Hugh Wilson's house on the Upper Clones road.

The most considerable seam exposed was found to be about three feet in thickness, and to consist of:—

	Feet.	Inches.
Coal.....	1	0
Parting of grey clay.....	0	2
Coal.....	1 foot 8 inches to 1	10

It is a coking coal of good quality, and yields a light porous coke. This seam may be seen in a trench cut in the bank, about twenty-five yards below the dam, and it is here on a level with the bed of the brook. The seam is separated by an inch or two of shale from a roof of grey sandstone several feet in thickness; the rock beneath the coal could not be seen, being considerably beneath the water level. About twenty feet to the south of this trench, another has been made, exhibiting a seam which, on the edge of the bank, shows only a few inches of coal, but when followed a short distance into the hill becomes more compact, and attains

a thickness of one foot. Like the first described, it is overlaid by an inch or two of shale covered by grey sandstone. After the completion of these examinations, which were made by Mr. G. F. Matthew, further explorations were made by Dr. W. S. Harding of St. John, and at a depth of about six feet beneath the smaller seams examined by Mr. Matthew, he found another which he estimates at two feet or more in thickness.

Examination by  
Mr. G. F.  
Matthew and  
Dr. W. S.  
Harding.

About twenty feet up the stream, above the uppermost of the two trenches, a square pit was made, and the top of the three-foot seam reached; but owing to the influx of water this opening was abandoned. A fourth excavation, made in the bed of the stream near the right bank, shewed the existence of a considerable seam of coal, which is probably the three feet seam, as it is on the line of strike of that bed.

The coal-seams exposed in these trenches and pits furnish data for a rough estimate of the direction and amount of dip of the strata. They incline to the north at an angle of about  $18^{\circ}$ , a dip considerably higher than has been observed in the strata exposed further down the brook, and to the south-westward of the coal-crops.

Going up the brook, from the points last described, for about fifty feet, indications of another seam were seen in the left bank, at the level of the pond below the gate of the driving-dam. Since Mr. Matthew's visit to this place, a twelve-inch seam has been exposed here by Dr. Harding and Mr. Andrew Corbitt. These gentlemen also had the water pumped out of the pond at the foot of the dam, and were thus enabled to examine a second seam which was found to lie at a depth of about four or five feet below that last mentioned, from which it is separated by beds of grey sandstone. The coal is a firm and brilliant, highly bituminous variety, and the bed is said to have a thickness of fourteen inches. The bottom of the hole, on the sides of which it appears, is filled with gravel; and as the water could not be kept out long enough to explore below the seam, it is not known whether any other seams appear here or not. From the abundance of grey shale thrown out on the bank opposite the dam, it is probable there are soft measures below the seam. It was the breaking up of this seam which led to the discovery of the coal at this place.

Exploration by  
Dr. Harding  
and Mr. Andrew  
Corbitt.

The relations of the coal-beds at the pond to those seen at the trenches and pits further down the stream is doubtful, if the dip of the measures seen in the latter is maintained in the intervening distance, and there are no faults breaking the continuity of the beds, the seams seen at the trenches should pass at a depth of six feet or more, beneath those visible at the pond. Further examination, however, is necessary to prove that the latter are not the seams seen at the lower excavations, repeated by a fault and downthrow of the measures on the south side; such breaks are of common occurrence along the south side of this coal-field.

Probable repetition of the  
seams by faults.

No other out-crops were discovered within half a mile of the dam, but

on the Wilson road, about a mile to the west, there are coarse grey sandstones, having a northward dip of only three degrees; and on the Corbitt or Upper Clones road, one mile west of the Wilson road, there are ledges of similar sandstones with poorly preserved remains of plants. These are close to the base of the series; for at Wilson's they rest almost directly upon red indurated clays of Lower Carboniferous age.

The Nerepis River, above the driving-dam where the coal appears, becomes a small sluggish water-course, running through low land covered with drift deposits, and it affords no exposures of the subjacent sandstone and shales. At a distance of about two miles to the north it issues from a low tract of land, in which both the Otnabog and the Mercereau Brooks have their sources; the former flowing to the St. John River and the latter to the Oromocto. On both these latter streams out-crops of coal exist, but we could not find them owing to the high water in the streams. Between the point where the Otnabog is crossed by the Gagetown road and the marshes at its mouth, it is bordered for a distance of over three miles by bluffs of grey sandstone from ten to fifty feet high. The dip of these sandstones is usually about N.  $30^{\circ}$  E.  $< 10^{\circ}$ , declining at some points to three degrees. The strata are mostly coarse and occasionally pebbly with much false bedding, but are sometimes finer and somewhat flaggy with thin beds of shale.

Coal crop on the Otnabog and Mercereau Brooks.

Westward of the area to which the above remarks relate, the Carboniferous conglomerates rise into a somewhat elevated and uneven swell of land which where it crosses the old post-road from St. John to Fredericton, presents good exposures of grey pebbly beds and grits, in the hill known as Stony Ridge. The pebbles here are such as may have been derived from the slates and sandstones on the north side of the Carboniferous area, and are like those of the conglomerate of Tweedside, Cork Settlement and other ridges on its northern border. For a distance of one and a-half miles from the corner of the Lower Clones road, the northern slope of this ridge is covered with fine grey, shaly and flaggy sandstones of the productive coal measures, dipping northward at an angle of six degrees. Here they are crossed by the Mercereau Brook and extend down the course of the stream for about five miles, where they are covered by purple sandstone and shales, probably of the Upper Carboniferous formation. The stream appears to run along the contact of these with the productive measures, to within a mile of the bridge near Mercereau's, where it is again bordered by the grey beds of the latter. The measures here dip N.  $20^{\circ}$  W.  $< 10^{\circ}$ . They consist of grey sandstones underlaid by grey and dark shales, and include a small seam of coal at the water level, some of which has been used in a neighbouring forge.

Beyond the south branch of the Oromocto River the grey measures cover a considerable breadth, and extend up the North-west Branch be-



yond Hart's mills to the junction of the Fredericton branch with the European and North American railway. Here the beds are chiefly olive-grey thin bedded sandstones of the productive measures; but in going southward from the mills, grey conglomerates with intercalated sandstones form a long ridge sloping gently to the river. Behind this ridge the finer measures, including beds of soft olive-grey shale, are repeated, and in like manner slope northward from another ridge of conglomerate, southward of which only repetitions of these grey sandstones and conglomerates were seen to within a mile of Shin Creek, where red sediments of the Lower Carboniferous formation rise from beneath them along the northern slope of the valley of that stream. Throughout this tract of grey rocks the beds dip northward, at angles of from two to three degrees, varying in direction from N. to N. 20° W. Westward of the sources of Morancy Brook, which joins the North-west Oromocto on the south side a little below Tracy's mills, the grey rocks are coarser, and at Otter Brook the surface abounds with blocks of grey conglomerate and sandstones, and there are exposures of the latter dipping N. 20° E. < 15°. In this part of the Carboniferous area the shales form but an insignificant part of the grey measures, and conglomerates with coarse sandstones and grits abound. Such is the condition also of the rock masses of the Middle Carboniferous formation south of the Little and the Great Oromocto Lakes, where the measures resume their normal dip of about four degrees or less to the northward. From Otter Creek westward they form the dividing ridge between the Magadavic and Oromocto waters. The character of the beds of this formation, as seen to the westward and northward of the Great Oromocto Lake, has been already described by Mr. Charles Robb, Report of Progress 1866-69, pp. 179-180. From the vicinity of Hart's mills several tongues of grey sandstones of the Middle Carboniferous formation extend westwardly along the valley of the Oromocto, and may also be traced eastward of that stream in out-crops along Brizzly Creek and the small streams flowing in an opposite direction to the River St. John. One of these crosses Morancy Brook about two miles south from the road, along the south side of the Oromocto. This is probably the same band as that which crosses the North-west Oromocto, below the mouth of Hardwood Creek, where it contains a seam of coal of good quality about five inches thick resting on a bed of under-clay. Other grey sandstones of the type of those usually found in connection with the productive measures are exposed at the junction of Lyon's Stream with the main North-west Oromocto; and also on the Yoho, above and at the mouth of Porcupine Brook. Elsewhere the rocks observed in the flat valley extending from Great Oromocto Lake down the main North-west Branch below Tracy's mills, are purplish-red shales and lilac sandstones, of the Upper Carboniferous formation.

No evidence has yet been obtained of the existence of the Upper Car-

Conglomerate  
ridges.

Shin Creek,  
Tracy's mills  
and Otter  
Brook.

Hart's mills.

Five-inch Coal-  
seam.

Tracy's mills.

boniferous formation west of the Great and Little Oromocto Lakes. A considerable area, however, on Lyon's Stream (the first northern feeder of the North-west branch of the Oromocto River) is occupied by purplish-red shales, and sandstones with lilac-red conglomerates at the base, which are judged to be of this series. A more southerly belt of those beds probably connected with that in the low lands on Lyon's Stream, opposite Otter Creek, covers the northern slope of the ridge of grey sandstones and conglomerates, already described as forming the divide between the valley of the North-west Branch of the Oromocto on the one hand, and Shin Creek and Peltoma Stream on the other. It runs out upon the North-west Branch at Hart's mills, and the beds composing it dip northerly, at angles of from  $3^{\circ}$  to  $5^{\circ}$ . A parallel band of grey sandstones divides it from another area of purplish rocks which lies along the centre of the valley through which the North-west Branch flows. At several points the shales in this area have been eroded, exposing, especially in the valley of the river and along its banks, horizontal beds of grey thin-bedded sandstone. Similar purplish rocks extend along the road from Tracy's mill, and crop out along the Rusagonish River. They may also be seen along the line of the Fredericton Branch railway, both south and north of that stream, as well as in the vicinity of Fredericton itself. At Three-tree Creek, where the fossils, a list of which is given on page 216, Report of Progress 1871, were found, the beds are massive even-grained sandstones. At the base, where they rest upon the fossiliferous shales, they are of a grey color, but above become clouded and banded with a purplish tint, and a few rods up the stream are covered by purplish-grey sandstones and sandy shales; the whole dipping N.  $15^{\circ}$  W.  $< 10^{\circ}$ . Near Rusagonish station similar purple beds are apparently overlaid by rather coarse purplish-red conglomerate, with pebbles of quartz and metamorphic rocks, dipping W.  $20^{\circ}$  N.  $< 4^{\circ}$ .

Through the district lying to the eastward of the Oromocto River, between that stream and the River St. John, the country is mostly uncleared, and there being but a few small streams, the opportunities for a study of its rock formation, apart from those already mentioned, are but meagre. Purplish-red rocks of the Upper Carboniferous formation show, however, extensively along the banks of Brizzly Brook, and judging from the character of the soil, probably also over considerable areas to the west and south of Gagetown. To the northward of the latter, the only beds observed between it and Swan Creek, and upon this stream for one and a half miles above the lake at its mouth, are grey grits and sandstones of the productive coal measures.

### *Thickness of the Middle and Upper Coal Formations.*

To determine with any degree of accuracy the thickness of the several groups of strata included, in New Brunswick, in the above division of

the Carboniferous system; is a task of much difficulty, arising partly from the unsettled character of much of the country over which they are distributed; but chiefly from the fact that over large areas, as already stated, the strata are nearly horizontal, and are only very rarely inclined at an angle of more than four or five degrees. In consequence of this slight inclination of the beds, and the general absence of prominent ridges, the opportunities afforded for their study are not numerous. And such exposures as do occur along the banks of the rivers and creeks, and upon the shores of the lakes, or in artificial excavations, generally afford a very partial view of the formation, while from the very variable character of the strata, even within short distances, and the exposures being separated by intervals more or less considerable, it becomes almost impossible to determine the relations to each other of the beds exposed in the various sections. Besides the difficulty in estimating the thickness of the coal formation, arising from the above causes, and also from the fact that it rests unconformably on all the older rocks, including the Lower Carboniferous formation, and therefore, though thin in some parts, may be much thicker in others, it is also impossible to say to what extent the beds have been affected by faults which are concealed by the general flatness of the country and its superficial covering of drift. In the foregoing details, however, their general succession has been presented, so far as our observations enable us to do so, and we may now offer such conclusions as seem warranted by these data as to the probable thickness and productive capacity of the region examined. The productive coal-measures not being separated by any well-defined line of demarcation either from the barren grey beds beneath, or from the strata of the Upper Coal formation above, no positive or exact statement can be given of their respective thickness. The barren measures are marked chiefly by the more frequent occurrence of coarse sediments, and especially silicious conglomerates, while the Upper Carboniferous formation seems to be indicated by the common occurrence of purple and other brightly tinted beds. So far as we are able to judge at present, the following estimate may be taken as approximately correct:

Barren grey beds.....	200 feet
Productive measures.....	200 feet
Upper Coal formation.....	200 feet

Whole series  
exclusive of  
Lower Carbon-  
iferous forma-  
tion 600 feet.

Making for the whole series exclusive of the Lower Carboniferous formation, a total thickness of only six hundred feet. And it is to be observed that the above may be regarded as the maximum thickness of the different members. At several points, and apparently over considerable areas, if not over the entire coal-field, the thickness must be much less. The occurrence of such islets of older rocks as that on the upper part of Coal Creek in the very centre of the coal basin, and again on the Canaan

River and its tributaries, to say nothing of the Lower Carboniferous outcrops both on Newcastle River and Cumberland Creek, certainly cannot be looked upon in any other light than as indicating an originally very uneven surface over the area in which the Carboniferous strata were deposited, and either that they never attained any considerable thickness, or else that they have suffered extensive denudation. That a large amount of erosion by glacial and atmospheric agencies has affected this area in common with other portions of the Province is certain; but as strata which, both lithologically and in the species of plants which they contain, correspond to those of the Upper Coal formation, are widely spread over the region, it may be doubted whether such erosion has anywhere removed much of the Middle or Productive Coal series. The coal measures already stated lie unconformably on all the pre-existing formations, including the Lower Carboniferous series, and as these islets of older rocks represent the summits of hills or ridges, in the intervening troughs or hollows, the coal measures may occasionally have attained a much greater thickness. This supposition is of course possible, still when the very slight inclination of the Lower Carboniferous strata, not only around the border of the basin, but also over its interior on Newcastle Creek is considered, we cannot but think that the facts, so far as they are known, are unfavourable to the view that the coal formation has a greater thickness in any part of the area than that above given, or that extensive seams of coal are likely to be found beneath those which are now being worked at Grand Lake and elsewhere.

Probable amount of denudation.

Unconformity of the coal measures to pre-existing formations.

Improbability of extensive coal-seams beneath those already known.

While, however, our observations of the past year are certainly opposed to any opinion which would assign a great thickness to the coal formation within the region examined by us, or even to a belief in the occurrence of workable seams beneath that which has been so long known and removed near the surface in the Grand Lake district, it should not be forgotten that the area over which the surface seam may be presumed to extend is itself a large one, and that, even supposing the thickness of the seam to be nowhere greater than is shown in the openings already made, its possible yield of coal, more particularly when the facility with which it may be obtained is considered, is such as to confer upon it very considerable value. The following estimates based upon our explorations of the region may serve to render this more apparent.

Possible yield of coal from the "Surface seam"

The total area occupied by the rocks of the Middle and Upper Carboniferous formation in that portion of the Province which lies to the westward of the eastern boundaries of Queen's and Sunbury counties, (embracing the whole of Sunbury and portions of Queen's and York counties), and of which we have personally examined the larger portion, may be approximately estimated at 2854.6 square miles. Of this about one-third, or 952 square, miles is apparently covered by the coarse grey beds which form the

Total area of the Middle and Upper Carboniferous formations.

inferior portion of the Middle Carboniferous formation, and which, so far as known, are destitute of any workable coals; thus leaving a residue of about 1,900 square miles, over which productive seams may be reasonably looked for. We are not yet possessed of sufficient data to justify the assertion that the various out-crops of coal met with over this area and at widely separated points, (such as Clones, the Washademoak, Otnabog, Little River, Nashwaak River, etc.) belong to the same seam as those at Grand Lake, though there are facts which favor such a supposition; there is, however, no reason to doubt that those in the neighbourhood of the last named lake are all of the same seam, and that consequently the area over which it may be safely regarded as extending is a very considerable one. Thus the area of the Newcastle coal-field (adopting the position of the actual coal openings as marking its limits about thirty-two square miles; that of Salmon River as also about thirty-two square miles; while that of Coal Creek is about forty-eight square miles, making a total for the three of about one hundred and twelve square miles. Adopting twenty inches as the average thickness of the coal-seam, and 79.4 lbs. as the weight of a cubic foot of coal, (the specific gravity being 1.27) and deducting one-fourth for the areas occupied by Salmon River and Grand Lake, the total amount of coal within the areas in question would be (at the rate of 2,000 lbs. to the ton) not less than 154,948,147.2 tons.

Total area of  
Coal-seam.

Area probably  
larger than  
stated.

Thickness of the  
Clones coal-  
beds.

Possible yield  
from a coal-  
seam twenty  
inches thick.

It is, however, to be observed that the true area of the coal-fields in question, and more particularly that of Newcastle River, is probably much larger than has been stated above; the line which has been chosen as marking its western limits really indicating only the point where the rocks of the Middle coal formation pass beneath those which form the highest member of the Carboniferous system, and under which they could probably be reached at no great depth. The occurrence of a coal-seam on Little River in Sunbury county, having about the same position and thickness as those of Newcastle, render this supposition highly probable. Moreover, the thickness of the coal-beds at Clones does not differ very greatly from that of the beds at Grand Lake, and it is not improbable that a large part of the area occupied by the productive measures, and more particularly where the Newer coal formation exists, is underlaid by the same seam. Supposing this to be the case, and deducting one-third for the area occupied by the barren measures at the base of the Middle Carboniferous formation, or rendered unavailable by being covered with lakes, the possible total yield of coal from a seam of twenty inches covering the remaining area would be not less than 8,510,436,357.12 tons. Setting aside, however, this supposition as confessedly based upon too imperfect data, we can still hardly doubt that the area over which the principal seam of coal in the Grand Lake region may be reasonably supposed to extend, is at least

two or three times greater than that employed in the above calculations, and that therefore the estimate of its productive capacity may be fairly increased in a corresponding ratio.

In conclusion, it may be worth while to review more fully the history and results, already briefly stated in the first part of our report, of the earlier attempts to discover coal by boring in the Grand Lake district. The first and most important boring was that of 1837, which reached a depth

History and results of earlier attempts to discover coal in the Grand Lake district.

of 403 feet, and of which a synopsis from the third report of Dr. Gesner to the Legislature of New Brunswick is given in an appendix. In the above depth, coal is indicated at several levels, but at two only, in quantities sufficient to be deserving of attention. The first was struck at a depth of twenty-one feet, and was one foot ten inches in thickness, being evidently that which is known as "the surface seam;" while the second, reported as eight feet of "bituminous shale and coal," was struck at the depth of 262 feet, the intervening strata being conglomerates, sandstones and shales, mostly grey but sometimes blue or red and marly, together with several beds of clay-ironstone, slate and a three feet bed of limestone. Considerable uncertainty has always attached to this record of a second seam of coal, and the confirmation of it has been the object sought in all subsequent borings. There is no doubt that the whole return of these borings, so far as the names applied to the strata penetrated are concerned, is untrustworthy and deceptive; many of these, such as the three feet bed of limestone immediately above the coal, and the beds of quartz and slate immediately below it, are not known to occur anywhere in the true coal measure rocks of the Province. There are, however, pebbles of such rocks in the coal measure conglomerates, and therefore if correctly named their occurrence in the boring would indicate that an horizon beneath the coal measures had been reached. The same remark will also apply to the beds of whinstone and limestone found at still lower depths, and to the "blue slate" with which the borings terminated. It is, however, quite impossible, judging from such specimens of the boring as have been submitted to us, and which are mostly in the state of a fine powder, to apply to them any such definite names as those alluded to, while the coal reported as associated with them at several levels, and of which there are but faint traces in the actual specimens, is only such as might readily have been washed from above, and have become mixed with the other materials in the process of sinking. It is certainly remarkable that limestones, red shales, slates, quartz and ironstone, all of which occur in rocks which at no great distance are known to underlie the coal measures, should have been reported here, and tends to confirm the conclusion already arrived at from surface indications, that the coal measures in this neighborhood are of no great thickness. It is also worthy of note that the depth assigned to the deeper bed of shale and coal, viz., 260 feet, exceeds but

First boring 403 feet.

Thickness of the coal measures not great.

little the estimate already given as probably that of the productive measures.

Second boring  
on Coal Creek;  
ninety-seven  
feet.

The second boring on Coal Creek, five miles above the head of Grand Lake, and between five and six miles from that above described, was made in 1866, and attained a depth of ninety-seven feet; but the drill having then become jammed in the hole, the work was abandoned, and has not since been renewed. It has already been stated that, at a distance of not more than five miles from this place, the older Pre-Carboniferous slates reach the surface, and are exposed over a considerable area.

Third boring  
218 feet.

The third boring was commenced in May, 1870, about a mile to the north of that of 1837, but, owing to some difficulty amongst the members of the company, was carried to a depth of only 218 feet. At the depth of ninety-six feet from the surface, a thin seam of impure coal, about six inches thick, was found; otherwise these borings, as might be expected from their proximity, corresponded.

Convinced of the uncertainty attending all these operations and of the impossibility of reaching any definite conclusions from the study of the surface features of the region, I, in July last, recommended the Provincial Government to purchase a suitable apparatus to test the question by boring. In the first instance it was proposed to decide the matter by sinking a shaft in the vicinity of Newcastle. The amount appropriated for the purpose by the Legislature, however, was entirely inadequate to meet the cost of sinking a shaft of sufficient depth; and if in the depth to which it might have been carried, no seam had been reached, the question would have been no nearer solution than before, whereas by boring, while the result would be less costly and equally satisfactory at any one point, the apparatus employed could in the event of failure, be used to test the question at any number of other and widely separated localities.

Diamond-  
pointed rock-  
drill.

Duly considering these facts, the Government adopted my recommendation, and has purchased an American diamond-pointed rock drill. This is now in operation at Newcastle, and Mr. R. W. Ells has been directed to superintend the work, and to carefully observe and note the character of the rocks penetrated. We would only remark, in conclusion, with reference to the so called "surface-seam" and its yield of coal, that the careless and desultory mode of working, too generally adopted throughout the district, is such as to greatly depreciate its value, both by increasing the cost of production, and by rendering the supply variable and uncertain. No method whatever is followed, each man sinking on his own property and extracting only as much coal as he thinks proper, or as he has occasion to use, working the seam for a short time and then neglecting it, allowing the roof to tumble in, and thus necessitating considerable expense to clear it out or to run a new level. As regards the quality of the coal, it is not unfrequently contaminated with pyrites, and as brought to market,

Careless and  
desultory  
manner of  
working.

Quality of the  
coal.

there is often a considerable admixture of coal-shale; but when care is taken to have it thoroughly screened, this does not seriously impair its value, while at a number of points the coal is already free from such impurities, and of excellent quality. The cost of production is nearly as follows: <sup>Cost of production.</sup>

Cost of labor.....	Twenty dollars per month with maintenance.
Hauling.....	Six shillings per chaldron, or less, according to distance.
Freight to St. John.....	Six shillings per chaldron.
Wharfage.....	Ten cents per chaldron.

During the winter season, when the greater part of the mining is done, a considerable quantity of coal is hauled directly to Fredericton. The price of blacksmiths coal, delivered at St. John, varies from \$4.50 to \$7.00 per chaldron; \* that of the "rapid coal," preferred for household use, being from \$5 to \$8.00.

### ECONOMIC MINERALS.

Besides coal a few other minerals of economic importance were observed within the region to which this report relates, and may be mentioned here.

*Iron Ores.*—In the region about the sources of the Nerepis a large amount of iron is generally diffused through the strata. Veins of spathic iron from one to four inches in thickness occur in the lower beds of the St. John group, and according to Dr. Abraham Gesner, a large bed of hematite exists on one of the upper branches of the Nerepis stream, near Coot Hill on Head-line road. <sup>Iron Ores.</sup>

The overlying Devonian slates are also, in places, largely charged with spathic iron intimately mingled with the argillaceous and calcareous particles, of which they are to a great extent composed. The Lower Carboniferous rocks partake of this metalliferous character, but the ores observed were impure ochre and veins of hematite. On Summer Hill, in Jerusalem Settlement, the amygdaloid near the summit of this formation is often largely charged with veins of hematite varying from half an inch to a line in thickness, which traverse the rock both horizontally and vertically. Ochreous iron is freely disseminated through the fine soft beds of the series, in a number of places producing beds of ochreous earth, usually called mineral paint; such localities occur in Peltoma, on Shin Creek and on the branches of the Nerepis. <sup>Spathic iron.</sup> <sup>Hematite.</sup>

In the valley of Coal Creek, Queen's county, within the limits of the Newcastle coal-field, where this stream has been described as traversing an area of Pre-Carboniferous argillites, the coarse gravel forming the bed of the creek was at one point found to contain numerous well-

\* The chaldron is a somewhat variable measure in New Brunswick. At Grand Lake it is about twenty-eight or twenty-nine hundred weight.



rounded masses or nodules of hematite, varying in size from that of a pea to two or three inches. Their source is unknown, for though the argillites in question are here as elsewhere much stained with iron, no distinct veins of this mineral could be discovered. Similar nodules of hematite were also met with on Thorn Brook, one of the principal tributaries of Canaan River, but here they are probably derived from the dioritic rocks of the dark argillite series.

#### **Limestones.**

*Limestones.*—At a locality on the cross road from the Lower Clones road to Kelly's mill, there is an out-crop of Lower Carboniferous limestone. This rock has been calcined in former years to a considerable extent, but the kiln is now abandoned. The lime produced is said to have been strong and of good quality, but rather dark for finishing. There is another out-crop of limestone near Kelly's Stream, about a mile above the mill. At this point the rock is red in color, like a thin bed exposed on the side of Summer Hill Brook, near the forks of the North Clones Brook. On the former brook, about two hundred yards below the Gagetown Road, there are also some beds of grey limestone five feet or more in thickness.

In Hibernia Settlement, thin beds of limestone have been described, page 190 as occurring on the farm of James McConnicky, where they are also removed and calcined in considerable quantities. The product is said to be of fair, though not of the best, quality.

The other points at which limestones have been observed, and referred to in the earlier pages of this report, are the west shore of the St. John River, opposite Long Island, Rush Hill and Shannon Settlement, in the parish of Wickham, and the English Settlement in the parish of Johnston. In each of these localities lime has been burnt to a greater or less extent, but only for local use, the product being inferior to that of the metamorphic limestone so abundant nearer the coast.

#### **Fire-clay.**

*Fire-clays.*—In describing the coal-crops of the Newcastle district, reference has been made to the beds of clay very generally associated with them, and some of which are true fire-clays. As is usual in other coal districts, the fire-clays are generally met with immediately beneath the seams of coal, and are to some extent indications of their presence, though sometimes they overlies them, or may even occur when the coal is altogether absent. Their thickness in the openings examined by us varies from a few inches to four feet or more. The colour of the clays in the Newcastle coal field is also very variable, some portions being yellowish from an admixture of ochreous iron, and therefore unsuited for the manufacture of fire-bricks, and others of a deep chocolate-brown color; but much of the clay is nearly white, and apparently free from both iron and sulphur. Considerable quantities of this clay have been removed at different times and shipped to St. John, where its employment was found to be generally satisfactory, but less attention has so far been devoted to it than its value would seem to justify.

*Marble*.—The limestones opposite Long Island, on the west side of the Marble. St. John River, have been at some points altered, apparently by the intrusion of dykes of dolerite, into an imperfect marble. Small blocks of the latter are of considerable beauty, taking readily a fine polish, and possessing a rich chocolate or purplish-grey color. A want of firmness, however, in the rock, and the occurrence of frequent flaws, render it difficult to obtain pieces sufficiently large for economical purposes. The beds at this point were opened several years since by Hon. S. L. Tilley, but for the reasons mentioned, the quarries have been abandoned.

*Porphyries*.—Some of considerable beauty are to be met with in the Prophyry. hill south of Shin Creek, they vary from a cream color to flesh-red and dark greyish-purple. Some of the schistose beds connected with them are handsomely banded with dark lilac and cream colored layers.

*Jasper, Chalcedony, &c.*—In connection with the red sandstones and shales of the Lower Carboniferous formation, there are at numerous places irregular layers and concretionary masses of red jasper, carnelian and Jasper, carnelian, and chalcedony. chalcedony. At Lower Clones there is a fine close-grained brick-red petrosilex resembling jasper, porphyritic with crystals of calcite. On the shore of Washademoak Lake, between Belyea's and Taft's Coves, limestones associated with red shales of the Lower Carboniferous formation have been described as containing nodules and layers—and at one point a bed two feet thick—of chalcedonic quartz. Much of this rock is very beautiful, its color varying from cream color, through pink, to a rich red, these shades being sometimes distributed in bands. Pebbles derived from these, or similar beds, are common in some of the conglomerates of the coal measures, and are abundant in the beaches bordering the shores of Grand Lake.

*Fluor*.—The feldspathic rocks at the summit of the Lower Carboniferous series in Harvey Settlement contain, as first pointed out by Mr. Chas. Robb, numerous small veins of fluor. At Lister's mills, on the north-east branch of the Magaguadavic, two varieties of this mineral occur, viz., a deep purple and rich emerald green; both well crystallized and associated in veins with quartz and white calcite. In the museum of the University of New Brunswick is a specimen of nearly pure dark purple granular fluor from this neighbourhood, over six inches in diameter, but the exact locality from which it was obtained is not known.

*Building Stones*.—The sandstones of the coal measures are usually too Building Stones. irregularly bedded and of too coarse a character to yield good building materials. At some points, however, the beds are thicker and more massive, and blocks of large size are readily removed. This is the case for instance, at Three Tree Creek, four miles east of Fredericton Junction, and immediately adjacent to the Fredericton Branch railway, also on Salmon River, whence the materials for the construction of several of the

public buildings in the city of Fredericton were obtained. They often contain nodules of pyrites, which on exposure, produce by alteration to oxide of iron, rusty brown spots, or even a disintegration of the rock itself; but otherwise they are very durable, and are said to withstand fire much better than granite or marble.

I have the honor to be,

Sir,

Your most obedient servant,

(Signed,)

L. W. BAILEY.

## APPENDIX.

### RETURN OF BORINGS OF THE SALMON RIVER COAL MINES FROM Dr. A. GESSNER'S 3RD. REPORT TO THE LEGISLATURE OF NEW BRUNSWICK.

	Ft.	In.		Ft.	In.
Section of strata bored through near Salmon River.			Vegetable soil.....	1	0
			Sand and gravel.....	6	2
			Broken shale and clay.....	4	7
			Shale with impressions of ferns, &c.....	9	5
			Bituminous Coal.....	1	10
			Marly Clay.....	1	0
			Do and shale.....	2	0
			Shales.....	7	0
			Shaly sandstone.....	1	0
			Sandstone (blue grit).....	32	0
			Conglomerate.....	8	8
			Shale (with a little coal).....	4	6
			Sandstone and conglomerate.....	0	8
			Conglomerate.....	8	0
			Shale with thin seams of coal.....	3	8
			Sandstone and shale.....	2	6
			Conglomerate and sandstone.....	1	0
			Sandstone and shale.....	1	0
			Conglomerate.....	18	0
			Sandstone (blue grit).....	2	0
			Grey sandstone.....	5	0
			Sandstone and shale.....	2	0
			Do interstratified.....	2	0
			Sandstone (blue grit).....	6	0
			Sandstone, shale and fire-clay.....	1	0
			Do and red marl.....	1	0
			Slate clay and sandstone.....	2	0
			Shaly sandstone and marl.....	1	0
			Red and blue shaly marl.....	6	0
			Marly shale and sandstone.....	1	0
			Sandstone (blue grit).....	9	0
			Sandstone with 1 inch of coal.....	1	0
			Conglomerate.....	1	0
			Sandstone and shale.....	1	0
			Conglomerate.....	4	0
			Shale and conglomerate.....	1	0
			Conglomerate with a little coal.....	2	0
			Do and sandstone.....	1	0
			Shale.....	2	0
			Red marly and blue shale.....	1	0
			Red marly shale.....	5	0
			Red and blue sandstone.....	1	0
			Sandstone (blue grit).....	39	0
			Clay ironstone.....	2	0
			Quartz and pyrites.....	3	0
			Clay ironstone.....	1	0
			Conglomerate.....	1	0
			Shale and quartz.....	1	0
			Conglomerate.....	1	0
			Clay ironstone.....	3	0
			Shale and quartz.....	1	0
			Clay ironstone.....	4	0
			Shale.....	1	0
			Limestone.....	3	0
			Conglomerate.....	2	0
			Clay ironstone.....	4	0
			Quartz and shale.....	3	0
			Clay ironstone.....	18	0
			Slate and quartz.....	1	0
			Clay ironstone.....	4	0
			Argillo-ferruginous limestone.....	1	0
			Shale, with vegetable impressions.....	2	0
			Bituminous shale and coal.....	8	0
			Quartz, slate, ironstone and fire clay.....	1	0
			Clay ironstone.....	3	0
			Do with slate and quartz.....	1	0
			Slate, shale and coal.....	1	0
			Slate, quartz and shale.....	4	0
			Slate, shale and ironstone.....	1	0
			Clay ironstone.....	5	0
			Do (very red color).....	1	0
			Do with coal.....	1	0
			Do.....	4	0
			Sandy shale and slate clay.....	1	0
			Clay ironstone.....	1	0
			Whin-stone.....	1	0
			Sandstone and coal.....	1	0
			Coarse sandstone.....	10	0
			Sandstone, shale and coal.....	1	0
			Clay ironstone.....	8	8
			Coarse sandstone.....	1	0
			Bituminous shale.....	1	0
			Coarse sandstone with quartz.....	2	0
			Shale and quartz.....	4	0
			Shale and coal.....	1	0
			Hard blue shale.....	1	0
			Sandy shale and kiesel.....	2	0
			Coarse sandstone.....	6	0
			Soft blue shale.....	2	0
			Clay ironstone and sandstone.....	1	0
			Soft shale.....	6	6
			Coarse sandstone.....	6	0
			Soft blue shale.....	1	5
			Coarse sandstone.....	4	2
			Soft shale.....	4	11
			Sandstone.....	0	6
			Soft shale.....	2	0
			Coarse sandstone.....	2	1
			Mundic (pyrites).....	0	9
			Limestone.....	0	6
			Shale and freestone balls.....	6	4
			Fine sandstone.....	2	8
			Coarse sandstone.....	1	8
			Sandstone (blue grit).....	15	0
			Limestone.....	2	1
			Shale.....	1	8
			Sandstone.....	3	6
			Ironstone.....	4	11
			Shale.....	0	8
			Ironstone.....	1	0
			Shale.....	0	5
			Ironstone.....	2	6
			Shale.....	2	8
			Ironstone.....	5	7
			Grey Slate.....	1	8