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GEOLOGICAL SURVEY

W. H. COLLINS, DIRECTOR.

Summary Report, 1920, Part E

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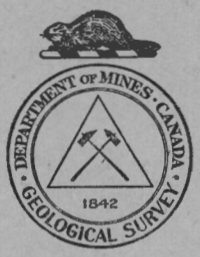

No. 1870.

SUMMARY REPORT, 1920, PART E

COAL SEAMS OF GLOUCESTER COUNTY, NEW BRUNSWICK

By G. A. Young.

Thin coal seams outcrop at a few localities in Gloucester county, N.B., in the area of Carboniferous strata occupying the northeastern part of the province. The occurrences have long been known and periodically have attracted considerable local attention. Interest in one such occurrence has recently been revived and, as a result, the writer was instructed to visit the field. Several weeks of the 1920 field season were spent examining a number of reported coal outcrops and some of the more accessible exposures of the measures containing the coal. Little or no information was gained that is not scattered through various publications, but, because of the significance locally given to the coal occurrences, it seems desirable to give here a connected account of the situation.

The district in question forms the extreme northeastern portion of New Brunswick. Its western boundary is defined by the northward flowing, lower reaches of Nipisiguit river discharging at Bathurst into Chaleur bay. The northern boundary is formed by Chaleur bay, the mainland shore extending northeasterly from Bathurst for 40 miles, beyond which, continuing the shoreline for 20 miles, lie Pokesudi, Shippigan, and Miscou islands. The eastern boundary is the southeasterly-trending St. Lawrence Gulf shore, for a distance of 40 miles from Miscou island on the north to beyond Tracadie on the south.

The district is low, its surface broadly rolling. Probably no part rises to a height of more than 600 feet above sea-level. The higher ground lies in the interior towards the west, and the general level falls to the northeast where the large islands perhaps nowhere rise more than 75 feet above the sea. On the Chaleur Bay side, the shore for long distances is very low, but elsewhere it rises in cliffs in places 75 feet or more high. The drainage is largely to the northeast and east. The streams for the greater part occupy wide, shallow valleys.

Rock exposures, except along Nipisigut river, certain stretches of the Chaleur coast, and part of the shoreline of the islands, are few and are practically confined to the stream valleys where they only occasionally occur. The rocks, on the whole, are nearly flat-lying. Along the shore of Chaleur bay they dip easterly at an average rate of about 20 feet to the mile. In other places they dip in other directions, but never at an angle greater than 10 degrees. It is apparent that the measures are gently folded, the folds are broad, and presumably the axes have an easterly trend.

The rocks are conglomerates, sandstones, sandy shales, and shales. The lowest members are exposed in the west, along Nipisiguit river and some of its tributaries, where the beds rest on an area of granite and vary from shales to fine conglomerates, all of which, save for occasional thin, nearly black, shaly beds, have a red colour. Higher in the series, the red colour is not so prominent and some sandy quartzose beds are grey.

Still higher, beds are exposed continuously along the Chaleur Bay shore for 25 miles from the vicinity of Janeville to Maisonnette point. The strata are chiefly dark, purplish grey shales and shaly sandstones with thin beds of grey sandstones and thicker beds of pale, faintly yellowish, fine, even-grained sandstone. The purplish beds form zones 10 to 30 or 40 feet thick, the intervening sandstone zones vary from a few feet to possibly 60 or more feet in thickness and these beds increase in thickness in the higher part of the formation. The individual zones of shales and sandstone thin and thicken, divide and re-unite in a remarkable fashion. Occasional thin zones of dark green or of black shales occur.

The total thickness of the partly exposed strata from their base on Nipisiguit river to the highest exposed bed on Maisonnette point can scarcely be less than 650 feet and may be as great as 1,000 feet. The lowest beds as displayed on Nipisiguit river have been considered by some to belong to the Bonaventure formation which, well shown along the south shore of Chaleur bay west of Bathurst and along the north shore, is generally assumed to be of early Carboniferous age. But the basal strata are lithologically unlike the Bonaventure beds and for this and other reasons are considered to grade into and to be of the same general age as that of the overlying strata[1]. The upper beds have been indifferently called either Middle Carboniferous or Millstone Grit. The precise age of the strata is still a matter of doubt. A shale horizon outcropping near Clifton yields good plant materials and according to a list prepared many years ago by Sir William Dawson it is possible that the measures belong to a horizon high up in the Carboniferous.

Strata similar to those displayed on the shore east of Bathurst are well exposed along the south shore of Caraquet bay and, still farther east, along the southeast side of Shippigan island and are reported to occur elsewhere. It may be that all these exposures belong to the same general horizon repeated by gentle folds, that the beds of Maisonnette point are the youngest Carboniferous measures in the district, and that the total thickness of the Carboniferous strata is 1,000 feet or less, but the available evidence scarcely warrants drawing such conclusions.

Many years ago, a thin seam of coal was reported to have been penetrated in a bore-hole sunk near Janeville on the Bay of Fundy coast. Near Clifton, 15 miles northeast of Bathurst, coal outcrops in the cliffs along the seashore. The coal occurs in a zone of black shale in places 8 to 10 feet thick and thinning in a westerly direction. The cliffs in which the coal-bearing strata occur are inaccessible for the most part. The dark shale zone outcrops for about 2 miles along the coast and doubtless is coal-bearing throughout. At one place a 3-inch coal seam shows at the base of the shale band, farther east two coal seams were seen, one 2½ inches, the other 7½ inches thick, separated by 4½ feet of shale. Still farther east, only one coal seam is present. It lies within the black shale zone and varies in thickness between 3 and 5 inches.

On the south shore of Caraquet bay east of the above localities, at Middle Caraquet and Lower Caraquet, coal occurs in the lower part of a heavy band of fine-grained, pale grey sandstone. The coal does not form a continuous seam but occurs in discontinuous patches a few inches thick and 5 to 25 feet long dipping at low angles in various directions unrelated to the general dip of the containing sandstone. The manner in which the coal occurs here, on Caraquet bay, is so different from that of the coal in the vicinity of Clifton, as to suggest that there are at least two distinct coal-bearing horizons.

Coal also occurs southward of Caraquet bay at a locality on a road leading inland from Upper Caraquet and about 6 miles distant, by road, from the railway station. In this neighbourhood some fifty years ago, the coal was worked in a very small way. More recently, attempts were made to explore the seam both by drilling and trenching. In 1920 the coal was no longer visible but in 1916 it was seen by Hayes[2] who states that in a trench, the coal horizon occurs in dark shales and consists of 8 inches of clay with coal stringers underlain by 15 inches of thinly-bedded coal and shale with iron pyrite. About 100 yards away from the trench is a pit, and it was stated that in this pit the seam was found to be 12 inches thick. Three diamond-drill holes were sunk in this neighbourhood. According to the drillers' records, in one of these, located 800 feet south of the pit, at a depth of 41½ feet, a coal seam only 1½ inches thick was penetrated; in a second, located 170 feet northeast of the pit, 8 inches of coal was passed through at a depth of 5½ feet; in a third, sunk 2,170 feet northeast of

[1] Young, G. A., Dept. of Mines, Geol. Surv., Can., Mem. 18 E, "Bathurst district, New Brunswick," 1911, p. 53. Owing to a misapprehension of the nature of the evidence, the present writer, in Mem. 18 E, proposed to class the Bonaventure as Devonian, he now prefers to consider it Carboniferous.

[2] Hayes, A. O., Geol. Surv., Can., Sum. Rept., 1916, pp. 269-270.

the pit, 3 inches of coal and slate were penetrated at a depth of 395 feet in a horizon of sandstone which for a thickness of 9 feet held much coal or coaly matter. The mode of occurrence of the coal in sandstone as recorded by the driller of the third hole is similar to that of the coal on the beach at Caraquet. Possibly, then, there are at least two coal-bearing horizons separted by an interval of some 300 or 400 feet.

Farther east, on Pokesudi island, at the northeast point, near a lighthouse, small fragments of coal occur loose along the shore. It is reported that at low water, by digging to a depth of about 1 foot below the water, a coal seam 4 to 6 inches thick can be found. The same seam, it is stated, was found at a depth of 8 feet in a pit sunk nearby and was also penetrated by a drill hole a short distance back from the shore. The only rock visible is one very small outcrop of sandstone. The whole of Pokesudi island is very low and no other rock outcrop on it has been reported. It is stated that coal occurs on the shore at a second locality to the westward.

Coal has been reported to occur near Pigeon hill, on the east side of Shippigan island. On visiting this locality, the only coal that could be found was a layer about 6 inches thick of small, rounded fragments of coal resting on mud in a wet hollow beside a small stream. Most of the coal fragments were well rounded and mainly between ¼ and ½ inch in diameter. The coal appears to have been carried by water to its present position. It may have been derived from a nearby seam, but if so the seam no longer outcrops, for no rocks are anywhere exposed in the vicinity except along the shore where the usual nearly flat-lying, reddish and purplish shales and sandstones are visible. Information was received that a somewhat similar bed of coal occurs at another locality on the island near the east shore but farther north.

Loose coal, perhaps derived from a submerged seam, is reported near the southwest point of the northwest shore of Miscou island, which lies north of Tracadie island. It is further stated that a drill-hole sunk in the bank failed to give any evidence of the presence of a coal seam. In this vicinity sandstone outcrops in a low bank and this is said to be the only rock outcrop on the island.

At a locality some 6 miles west of Tracadie, on the North branch of Little Tracadie river and 1½ miles east of Tilley Road, coal, it is stated, has been found outcropping on the top of a low ridge bordering the stream and also in the banks of the stream. A heavy bed of fine-grained, grey sandstone overlying reddish shales and sandstones outcrops along the stream and a short distance downstream is a poor exposure of dark, in part coaly, shale. On the hill top, similar dark, in part coaly, shale is visible at the mouth of a short, abandoned tunnel and several shallow pits and trenches. No definite coal seam was anywhere seen but in all probability one or more thin seams do occur in the dark, carbonaceous shales at the old workings on the hill top and in the valley bottom. It was stated that a drill-hole sunk on the top of the ridge passed through 48 inches of coal at a depth of 400 feet. Possibly the thickness of 48 inches was mainly of the dark, carbonaceous shale. The associations obtaining at this locality are sufficiently different from those of the other coal occurrences to suggest that the coaly shales may represent a horizon distinct from and perhaps younger than the coal-bearing horizons at Caraquet or near Clifton.

The writer heard of no other coal occurrences in the district than those referred to above; it is probable that other occurrences are known but it is improbable that any seam thicker than those mentioned has been discovered and not been made known. The slight amount of evidence available indicates the existence of two or more coal horizons and not of one only as has been held by some. It seems possible that the coal-bearing strata have a much greater thickness than was supposed at one time and that, in a general way, higher beds are exposed as the district is crossed from west to east or from north to south. At present no definite conclusion can be reached regarding the total thickness of the strata or the number of the coal-bearing horizons and, possibly, no satisfactory conclusions regarding these matters can ever be attained except by resorting to drilling, for, except in a few favoured localities, rock exposures are few and widely scattered.

It was made apparent to the writer that most of those who have interested themselves in the coal occurrences have done so because they thought it reasonable to expect a thin coal seam to increase rapidly in thickness when followed back, under cover, from its outcrop; or because they assumed that the occurrence of thin seams of coal indicated the presence of thick coal seams; or because they thought the coal-bearing strata were equivalent in age to measures elsewhere holding thick coal seams, and that, therefore, the strata in Gloucester county should also contain thick coal beds. These assumptions and conclusions do not agree with what is known concerning coal, as the following statements show.

Coal beds are composed of vegetable matter that accumulated at the surface of the earth on a foundation of sandy or muddy material. The masses of plant remains were eventually covered by layers of mud, sand, or other material. In the course of time the layers of vegetable matter were consolidated and changed into seams of coal and the overlying and underlying beds of mud, sand, etc., were altered to shales, sandstones, and other types of rock found associated with coal beds. The coal-bearing strata in most cases were buried beneath measures void of coal seams.

Once the accumulations of vegetable matter had formed and received a protecting cover, their growth ceased. The manner and depth of burial of the coal-bearing strata and all subsequent events were in no way influenced by the presence of seams of coal. The present attitude of a coal seam, the thickness and character of the portion respectively outcropping, concealed, and lost by erosion, the presence or absence of other seams and their characters, are all features which, so far as the seams themselves are concerned, have occurred haphazard.

Three general conditions were requisite for the formation of coal seams: (1) climatic and other factors favouring plant life; (2) natural conditions permitting the accumulation of considerable volumes of plant matter; (3) the burial and subsequent preservation of the accumulated matter beneath a cover of rock-forming material. Only where all these conditions were conjointly operative did coal seams form and, therefore, only during certain periods of geological time—and then only in certain regions—did coal seams originate. Even within the favoured regions, coal seams did not everywhere form. Conditions were not absolutely uniform over any one region and, therefore, the number of coal seams, their thickness and other individual characters, and the horizons at which they occur, vary from district to district and even within the limits of a single district.

The foregoing generalizations are all applicable to the case of the coal-bearing, Carboniferous strata of Gloucester county. These measures may be of the same age as beds which elsewhere carry thick coal seams, but even if they be, it does not necessarily follow that thick coal seams are present. The presence of thin coal seams indicates neither the presence nor absence of thicker seams. There are no logical grounds for believing that a coal seam at its outcrop is probably thinner than in the portion concealed from view. The probabilities are that for long distances the average thickness of a seam does not materially vary from its thickness at the outcrop and if a notable change does take place it is as probable that the seam thins as that it thickens.

Most of the Carboniferous area of Gloucester county is a drift-covered district in which rock outcrops are exceedingly scarce except along portions of the seashore. It is possible, therefore, that one or more relatively thick coal seams are somewhere present. As yet the maximum thickness of the measures is unknown; nowhere are all the beds exposed along one line of section; and it is not yet possible to piece together the various partial sections. Other observers have suggested that possibly all the different coal outcrops belong to one horizon, perhaps to one seam. So imperfect is the present knowledge of the general section and structure that it seems impossible to evaluate this suggestion.

The presence or absence of coal seams of commercial value could be determined by properly conducted drilling operations, but such work should not be undertaken until a close examination of the whole territory has been made. Such an examination would require much time and possibly the information obtained would not nearly compensate for the money and energy expended, for the district is largely bush-covered and unsettled, and rock exposures are few in number.

In the past whenever prospecting work has been undertaken in connexion with outcrops of thin coal seams, the tendency seems to have been to conduct the work under the assumption that either the thin seams may reasonably be expected to rapidly increase in thickness a short distance away from their outcrops or that thicker coal seams may confidently be expected to underlie the thin seams. As already pointed out, no natural relation exists between the characters of a coal seam and the thickness of the cover. The present outcropping portion was once buried just as deeply as any still concealed, still covered portion. If a coal seam does change in thickness the chances that it decreases are just as great as that it increases and in most cases any change in thickness takes place very gradually.

Before undertaking drilling or shaft-sinking operations, the relatively inexpensive plan of tracing and examining the outcropping portion of the seam should be adopted. By following such a plan, precise information can be obtained regarding the character of the coal as fuel, the thickness of the seam and the manner in which this feature tends to vary, the nature of the roof and other matters bearing on mining operations. The information thus obtained will indicate whether further exploratory work should be undertaken and, if so, where and in what form it should be carried on.

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GEOLOGICAL MAPPING OF BERWICK AND LAKEVIEW MAP-AREAS, KINGS AND ANNAPOLIS COUNTIES, N.S.

By E. R. Faribault

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INTRODUCTION

The geological mapping of Nova Scotia carried on some years ago in Kings and Annapolis counties was interrupted on September 23, 1909, by the untimely death of Hugh Fletcher, the geologist in charge, who died at Lower Cove from pneumonia contracted while performing his field duties.[1] In 1908, the writer, assisted by Wyatt Malcolm and J. McG. Cruickshank, spent two months in the southern part of Kings county and completed the geological structure of the Palæozoic rocks comprised in the Gaspereau map-area, previously surveyed by Mr. Fletcher.[2]

With a view to resuming the mapping of that region, A. O. Hayes examined in 1916 the Middleton map-area, Geological Serial Map No. 103,[3] also previously surveyed by Mr. Fletcher, in order to complete that map for publication and obtain further geological information regarding the Nictaux-Torbrook iron mines.[4]. After Mr. Hayes' resignation the writer continued this work in 1920, completing the geological mapping of the Berwick map-area, Geological Serial Map No. 98, and the Lakeview map-area, Geological Serial Map No. 97. A base map covering these two areas had been surveyed under the direction of Mr. Fletcher, and the original plottings of the surveys on the scale of 40 chains to 1 inch, as well as the partly completed manuscript of the map on a scale of 1 mile to 1 inch, were used in the field.

Special attention was also directed to the occurrences of economic minerals included in the area. At the end of the season, examination was made of deposits of infusorial earth in Colchester and Cumberland counties, including that being worked at Silica Lake; and a visit was paid to the salt deposits operated at Malagash.

The writer was assisted in the field by J. McG. Cruickshank, C. A. Brown, and M. F. Goudge, who all rendered very satisfactory service.

GENERAL CHARACTER OF THE DISTRICT

The Berwick map-area lies immediately east of the Middleton area surveyed by Fletcher and Hayes, south of the Hall Harbour Sheet, published in 1910,[5] and west of the Gaspereau area previously mapped and reported on by Fletcher and Faribault.[6]

The Lakeview map-area lies south of the Berwick area, west of the New Ross area,[7] and north of Springfield area.[8]

The area covered by the two sheets measures 18 miles east and west, and 24 miles north and south, and extends from North mountain between Coldbrook station and

1 Geol. Surv., Can., Sum. Rept., 1909, p. 225.
2 Geol. Surv., Can., Sum Rept., 1908, pp. 150-153.
3 Geol. Surv., Can., Sum. Rept., 1916, p. 271.
4 Geol. Surv., Can., Ann. Rept., vol. XVI, 1904, pp. 302-318 A.
5 Geol. Surv., Can., Ann. Rept., vol. XVI, pp. 293-295 A.
6 Geol. Surv., Can., Sum. Rept., 1908, p. 150.
7 Geol. Surv., Can., Sum. Rept., 1908, p. 154.
8 Geol. Surv., Can., Sum. Rept., 1911, p. 248.

Morden road southward across Annapolis valley and South mountain to the old Dalhousie road between Forties Settlement and Dalhousie station. Surveys were also extended westward beyond the western limit of the two sheets to the line of the Halifax and Southwestern railway between Nictaux and Dalhousie stations, and some distance beyond the railway between Dalhousie and Springfield stations.

The predominating features of the landscape of the Berwick area are the highland of North mountain, 700 feet in elevation, and South mountain, 700 to 900 feet, between which has been deeply entrenched the broad valleys of Annapolis and Cornwallis rivers which flow westward and eastward, respectively, from Berwick to the bay of Fundy. The southern part of the area occupied by South mountain is drained by Fales river, South branch of Annapolis, and the headwaters of Gaspereau rivers, and includes also Gaspereau, Aylesford, George, and Fourmile lakes. The beautiful Annapolis valley, 5 to 6 miles wide, and the northern slope of South mountain afford excellent fertile soil, and the land protected from the rigour of the north wind by North mountain is intensively cultivated and especially adapted to fruit-growing, chiefly apples, plums, and pears; but the plateau of South mountain is mostly rocky, swampy, or partly wooded and uninhabited.

The Lakeview area occupies the height of land of the interior plateau which gently slopes southward, with undulations of long and narrow lateral moraines and elliptical drumlin hills which have a north and south trend and rise 100 to 200 feet above the general level of the country. In the intervals between the hills are a great number of lakes and small streams forming the headwaters of Lahave river that flows southward to the Atlantic. The country is rocky, very rough, and strewn with granite boulders; for the most part well wooded with pine, spruce, and hemlock, with areas of burnt land and second growth. Most of the large lumber, however, has recently been culled by the Davison Lumber Company operating a mill at Springfield. A few farms are located on the hills of boulder clay at Lake Paul along the road traversing the area from north to south between Aylesford and Dalhousie road, and along Donellan road to Lakeview. Outside of these two roads the region is uninhabited. Crossburn, once the site of operations of the Davison Lumber Company, is now deserted.

GENERAL GEOLOGY

The rock series represented in the two areas under study are as follows.

Table of Formations

Era	Period	Formation	Lithological characters
Cenozoic	Recent	Superficial deposits	River silt, humus, peat, diatoms.
	Pleistocene		Boulder clay, stratified clay, sand, gravel.
Mesozoic	Triassic	Volcanic	Basaltic flows and amygdaloidal trap.
		Sedimentary	Red, friable sandstone and shale.
Palæozoic	?.....	Intrusive dykes	Gabbro and diorite.
	Devonian	Plutonic intrusives	Granite batholith and minor intrusions.
		Oriskany	Slates, quartzites, and ferruginous and calcareous beds (Nictaux-Torbrook iron series).
	?.....	Dictyonema slate series.	Slate, and quartzite beds, apparently conformable to the underlying series.
?.....	Gold-bearing series.	Halifax	Slates, knotted slates, and schists.
		Goldenville	Quartzites ("whin") and slates, metamorphosed in part to quartz-mica, mica, and other schists.

The geology of the region was partly described by Fletcher in the Summary Reports of the Geological Survey from 1904-1907. The geological work done by the writer consisted chiefly in tracing out more accurately and with greater detail the boundaries of the different formations, and in working out the structure of the Palæozoic series of slates and quartzites along the northern slope of South mountain.

An intimate relationship exists between the surface features and the character of the underlying rocks. The plateau of South mountain, covered by Lakeview area and the southern portion of Berwick area, is all underlain by granite of Devonian age. Along the northern slope of South mountain the granite comes in contact with the non-fossiliferous Goldenville grey quartzites ("whin") and Halifax slates of the Gold-bearing series, which are succeeded northwards by the Dictyonema slate series including beds of white quartzites, thence by the fossiliferous slates and quartzites that have been correlated with the Oriskany stage of the Devonian period and include to the westward the Nictaux-Torbrook iron beds. These Palæozoic sediments are generally much metamorphosed and are penetrated by numerous dykes of gabbro and diorite, and tongues of granites. The Annapolis and Cornwallis valleys are floored by red, friable sandstone and shale of the Triassic dipping gently northwards to North mountain, where they are overlain, generally conformably, by basaltic flows and amygdaloidal trap which present a precipitous escarpment facing the valley to the south. The summit of North mountain is comparatively flat and is floored by the truncated edges of a number of flows.

Thick glacial and alluvial deposits of clay, sand, and gravel cover the Annapolis valley and conceal nearly everywhere the underlying Triassic sediments. Terraces of stratified marine sand and gravel occur on the side of the mountains, attaining an elevation of about 200 feet above sea-level. Conclusive evidence was obtained of the general movement of the ice-sheet from north to south over North and South mountains and of the movement of local glaciers at the later stages of the Glacial period from South mountain northward across North mountain.

The upper part of the northern slope of South mountain has been eroded deeply by glaciation into smoothly curved contours and glaciated surface of unweathered rocks, but along the lower part of the slope, areas of dull, light-coloured, weathered slates occur which evidently have partly escaped glacial erosion. When traced along the strike southwesterly up the mountain these weathered slates are found gradually to change to shiny, dark-coloured and unweathered glaciated rocks. This change in the lithological character of the rocks due to weathering has already been observed by the writer in the Gaspereau valley[1]. On account of this change and of the fact that *Dictyonema* and a few other obscure forms of fossils were found in the dull, light-coloured slates and not observed in the shiny, dark-coloured slates, these rocks were supposed by previous observers to be of different age.

The line of contact between the granite and the Gold-bearing series is very sinuous and—in places—difficult to locate on account of the heavy covering of drift. To the south of Waterville and South Harmony it comes north to within a short distance of the old Canaan road and runs east and west. But south of Factorydale, between these two places, the boundary turns southwards and runs far up South Annapolis river, where the Gold-bearing rocks spread out in the shape of a bay, 5 miles deep and 3 miles wide, extending southwards beyond Palmer and Twin lakes on West branch of South Annapolis river, and Boot Lake brook and Horseshoe meadow on East branch, and easterly across Lake George road to the bridge over Mumford brook and the head of Hutchinson brook. South of Prospect post office the granite boundary turns southwards up Sharpe brook to Big Bend on Gaspereau river, thence easterly between McGee and Gaspereau lakes to the eastern limit of the map-area. From South Harmony, the boundary runs southwesterly through Conquerall Settlement to the southwestern corner of the Berwick map-area.

1 Geol. Surv., Can., Sum. Rept., 1908, p. 152.

One-half mile northwest of the main granite mass at Conquerall Settlement, a detached band of fine-grained, grey granite, one-half mile in width, outcrops along the south side of Gracie brook and extends southwesterly across West branch of Fales river at Gordon's sawmill and beyond into the adjoining area. On Hutchinson brook south of Morristown another detached mass of granite, over one-half mile in diameter, occurs at a short distance to the northwest of the main mass.

On the other hand, isolated areas of Gold-bearing rocks also occur in the main granite mass. One, possibly 1 or 2 miles in extent, was located to the north of Fox lake at the head of East branch of Fales river, at a distance of 3 miles from the main area; and another smaller area was found at the north end of Hamilton lake on North Lahave river, in the centre of the granite area. Several such outliers occur, no doubt, which have escaped observation.

The boundary line between the Palæozoic and the Triassic sediments follows very closely the foot of South mountain; that between the Triassic sediments and the basaltic flows is found well up the abrupt southern face of North mountain, generally following the contours of the hills between the steep brooks flowing south into the valley.

Structure of the Palæozoic Sediments

Fletcher, in his last report on the geology of this region, says[1]: "Dr. Ells, with Mr. Faribault, again spent some time with Mr. Fletcher in an examination of the sharply folded Palæozoic sediments of Kings county, where the scarcity and obscurity of fossils and the contorted structure render exact determination difficult. The slates are generally so cleaved and closely folded that even when well exposed in considerable thickness and over large areas it is only by the most careful inspection that the folds can be distinguished. In any estimate of the thickness and geological age of these slates, the few fossils being, as already stated, obscure and referable to any horizon from Cambrian to Devonian, the working out of these folds is of the utmost importance, and in order to determine their structure certain conspicuous bands of quartzite about Whiterock were surveyed and mapped on a scale of 20 chains to 1 inch to confirm the evidence collected from the dip of the slates; but there is still much that is obscure and requires further elucidation."

Referring later to the mapping of these bands of quartzite, Fletcher concludes,[2] "the map suggests that the quartzites rest unconformably upon the Dictyonema slates."

In 1908, therefore, the writer assisted by Wyatt Malcolm mapped with still more detail the geological structure of these rocks in the area covered by the Gaspereau sheet.[3] The bands of pinkish-white quartzite were traced with greater precision, and they were found everywhere to be conformably included in the slates; the apparent unconformity suggested by Fletcher being due to a system of numerous step-faults running obliquely to the stratification in a southeasterly direction, with horizontal displacements on the northeast side almost invariably towards the southeast, varying from a few feet up to 900 feet. Furthermore, it was found that all the Palæozoic sediments exposed in the Gaspereau map-area, to the south of Kentville and Wolfville, with the exception of a small area of fossiliferous Silurian between New Canaan and South Alton, form a continuous conformable series sharply folded into three major anticlines and three intervening synclines extending in a northeasterly direction from the granite batholith to the overlying sediments of the Triassic. The total thickness of the slates overlying the Goldenville whin formation was estimated at 14,500 feet.

Of the three major anticlines exposed in the Gaspereau map-area, the north one only, the Kentville anticline, extends southwesterly into the Berwick map-area, where it forms a great uplift pitching northeasterly. The folds to the south of the Kentville anticline are cut off by the granite before reaching that area.

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[1] Geol. Surv., Can., Sum. Rept., 1906, p. 141.
[2] Geol. Surv., Can., Sum. Rept., 1907, p. 4.
[3] Geol. Surv., Can., Sum. Rept., 1908, p. 151.

The Kentville anticline has been traced from Kentville southwestwards along Beech hill near North Alton, and across Tupper lake to Sharpe brook, where it is cut by the granite. But it reappears beyond the granite, 6 miles farther west, on Lake George road at the bridge over the head of Mumford brook, and apparently undisturbed by the granite intrusion it continues in the same direction, crosses East branch of South Annapolis river above Shinglemill fall, passes north of Palmer lake, and is finally cut by granite on the West branch of the river. This great uplift is the main structural feature of the area. The fold plunges northeasterly along its whole length, at an angle gradually decreasing from 20 degrees at the east end to nearly horizontal at the west. Along the apex the Halifax slates occur first, in several small flexures from Kentville to near Tupper lake, where they are underlain conformably by the grey quartzites of the Goldenville formation that are brought up along the central part of the uplift and spread out southwesterly, attaining a width of over 3 miles on South Annapolis river.

On the southern limb of the Kentville anticline, the quartzites are also overlain conformably by the Halifax slates which dip steeply to the south and extend to the granite between McGee and Gaspereau lakes. Near the granite, at a distance of 1½ miles south of the grey quartzites, the slates conformably include a band of white quartzite that had been traced easterly into the Gaspereau map-area by the writer in 1908. In that area the white quartzite attains a considerable thickness, and outcrops prominently on several anticlinal and synclinal folds pitching westerly in the vicinity of Whiterock.

On the north limb of the Kentville anticline, the grey quartzites of the Goldenville formation are likewise conformably overlain by the Halifax slates, and these are succeeded northward, apparently conformably, by the Dictyonema slates including beds of pink-white quartzites similar to those of Whiterock that extend to the Triassic at the foot of South mountain. On Fales river between the Dictyonema slates and the Triassic occurs a small outcrop of fossiliferous quartzite and slate, referable to the Oriskany, extending westerly into the adjoining area. A section of these series of sediments, measured at right angles to the stratification on South Annapolis and Fales rivers from the anticline to the Triassic, gives a width of over 5 miles of strata that dip steeply to the north, across the whole section. Small, sharp monocline flexures were observed, however, on South Annapolis river below the first fall above Factorydale, also on Jones brook and Fales river, all pitching easterly and apparently increasing in amplitude towards the west.

It is remarkable how little the structure of the Gold-bearing rocks has been affected by the granite intrusion. The strata preserve their original attitude in strike and dip right up to the granite contact. This is observed even in the isolated outliers found in the interior granite batholith, far remote from the main area. The field evidence suggests that the granite was formed by the gradual crystallization of the sedimentary rocks in situ, without any translation or disturbance of the portions immediately adjoining on both sides of the contact.

One prominent belt of pink-white quartzite composed of several thick lenticular beds, similar to the Whiterock quartzite, was traced westward for 6 miles from South Annapolis river 1 mile below Factorydale to McMaster sawmill on Fales river, showing the presence of several transverse faults. This and other beds of quartzites included in the slates, and the line of division between the Goldenville quartzites and the Halifax slates, form well-defined horizon-makers by which to work out with certainty the geological structure and the true order of succession of the different slate series of the region.

Dictyonema fossils, fucoids, annelid trails and burrows were found by Fletcher in the slates on several streams, apparently at different horizons in the upper part of the slate series in which are generally included beds of pink-white quartzite; therefore, this series has been generally referred to as the Dictyonema slate series overlying

the Halifax slates. The light-coloured, reddish weathered slates on Sharpe and Best brooks in which Fletcher collected *Dictyonema,* appear, however, on structural evidence to be the eastern continuation of the dark-coloured, unweathered slates of the Halifax formation outcropping to the westward.

More field work still remains to be done in the southwestern part of the Berwick map-area, to complete our knowledge of the structure of the Palæozoic rocks. The most prominent beds of quartzite, the dykes of gabbro and granite, and the small, sharp monocline crumples already located in the sections made along the brooks, have yet to be mapped, and thus locate and trace out, if possible, the numerous transverse faults affecting the structure.

Of the geological work done to the west of the Berwick map-area, mention may be made of the sections surveyed along Torbrook and Nictaux rivers and the railway above Nictaux Falls, in connexion with the structure of the beds of iron ore that have been worked in that district. The sections show that the north and the south beds of iron ore which outcrop about one mile apart and dip steeply towards one another are probably the same beds repeated on the opposite limbs of a complex synclinal fold composed of at least two minor synclines and one intervening anticline. The arch of the anticline is well exposed on the railway half-way between mile-posts 47 and 48, and also one-half mile to the northeast on the east bank of Nictaux river where a full view of the fold may be observed in a bluff rising above the water's edge. The strata are sharply folded, dipping north vertically 50 feet to the north of the apex and southerly at an angle of 80 degrees, 50 feet to the south, and the fold pitches northeasterly at an angle of 7 degrees. Beds of ferruginous and of calcareous quartzite are exposed interstratified with the slates. The bed of iron ore, 11 feet thick, uncovered on Heathly's property a little to the southwest of the railway here, may be situated on this anticline. It is possible that the iron ore beds of the Nictaux mines are brought up near the surface on this fold, and may be increased in thickness along the apex so as to form ore-shoots pitching northeasterly. In the Wheelock shaft, the shell-ore bed was found to increase in thickness from 6 to 12 feet on a fold and to form a lens 21 feet deep pitching westerly at a low angle.[1] A knowledge of the structure of the ore-beds may thus be of great assistance in their development. The south syncline lies 1,200 feet southeast of the anticline and is well exposed in a cliff along the west side of Nictaux river for a distance of nearly one-half mile. The north syncline, too, is well exposed on Torbrook river, a short distance below the gorge and fall opposite Wheelock shaft.

The structure of the rocks in the Torbrook and Nictaux district is complicated by faults cutting the stratification obliquely in a northwesterly direction. One fault with a right hand, horizontal displacement of 800 feet was located a short distance west of No. 2 shaft of the Nictaux iron mines and traced northwestwards across Nictaux river at Nixon's old dam where the displacement is increased to about 1,500 feet.

ECONOMIC GEOLOGY

The economic minerals so far discovered in the area under study occur in the different geological formations as follows:

In the Palæozoic rocks of South mountain are found gold, copper, manganese, iron, calcareous rock, silica, and garnets; in the Triassic trap of North mountain are copper, magnetite, and excellent road material; and in the superficial deposits are infusorial earth, peat, bog managanese and iron, ochres, clay, sand, and gravel.

The only deposits exploited at present are gravel and sand used in small amount for the manufacture of cement blocks at Aylesford, and also for road material.

Red clay was used, several years ago, at Aylesford, for the manufacture of common brick. Bog manganese and iron, and ochres have been dug in small

[1] Parsons, W. F. C., Jour. Can. Min. Inst., vol. IX, p. 32.

amounts at North Alton and Morristown, and used mostly for pigments. Calcareous dyke rock occurring on Cold brook has been calcined to lime of inferior quality. Some of the peat of Caribou bog near Berwick is said to have been utilized. A copper-bearing vein has been developed to a depth of 165 feet at Dalhousie East.

Some of the non-metallic minerals susceptible of many industrial applications, such as infusorial earth, white quartzite as silica, white and red clays, and peat for litter and fuel, should receive special attention, because they can be utilized for the manufacture of many products that are for the most part imported. Most of these deposits are situated near the railway, in a well-settled region, where labour is plentiful and work is scarce at certain times of the year, and the establishment of new industries should be encouraged.

Gold

Occurrences of free gold quartz have been reported at a few places on South mountain in the Gold-bearing rocks.

Float of rich gold quartz from a 10-inch vein is said to have been found 1½ miles to the south of Morristown, on Hutchinson brook. About the year 1895, Charles Keddy and Watson Hutchinson spent part of two or three seasons searching for the parent vein. Two hundred and fifty feet south of a 20-foot fall they cut three or four veins, one of which—2 inches wide—is auriferous. One ton of ore crushed at Whiteburn yielded 6 pennyweights of gold. The veins are interbedded in whin rock dipping north, near the base of the Halifax slate formation on the north and the granite on the south.

Half a mile south of Prospect road, at the head of Ratchford brook, a test pit was sunk many years ago on a 3-inch gold-bearing vein in metamorphosed slate dipping north near the granite contact. Other larger quartz veins, apparently barren, were also uncovered. The geological conditions at these two localities were not considered favourable for the occurrence of important gold deposits.

A gold-bearing vein of 10 inches is reported to cross South Annapolis river about one-half mile above Shinglemill fall, and to extend easterly towards the head of Mumford brook. The vein occurs there in the whin formation, probably near the axis of the Kentville anticline and under favourable conditions for the occurrence of gold-bearing quartz veins. On account of the scarcity of the rock exposures and the metamorphosed character of the rocks, however, the structure of the anticline could not be studied.

Manganese

A deposit of manganese has been opened on South mountain, 1½ miles west of Nicholsville, on Burton Nichols' farm. In 1885, Alex. McPhail stripped the vein for a length of 400 feet along Zebe brook, and three barrels of ore were taken out. In 1918, W. E. Bishop, of Aylesford, reopened the deposit and sunk a test pit 25 feet at the western end of the surface openings, and two years later organized the Aylesford Manganese Mining Company, Ltd., with the intention of resuming the development work. The vein occurs in soft, laminated slates of the Dictyonema series, strikes south 75 degrees west magnetic, and dips south almost vertically, following very closely the stratification. North of the vein is an intrusive mass of gabbro, succeeded at 250 feet by the large belt of pink-white quartzites that has been traced from South Annapolis river westerly to McMaster mill on Fales river. At the time of the writer's visit the openings were filled with water and the vein could not be seen, except where it crosses the brook. Ten feet west of the shaft the vein is said to be cut by a fault that appears to extend northwesterly along the eastern side of Palmer road and to cut the belt of quartzites with a right-hand displacement of over 100 feet. The ore occurs in streaks and small lenses, and the largest body is said to have been found in the shaft and to be about 3 feet in width. The ore from the shaft consists of manganese oxide, mostly pyrolusite in massive and crystalline form, mixed with iron oxides, decomposed

country rock, and calcite. At the shaft, the gabbro comes in contact with the vein and includes calcite that extends along the north wall of the vein. The main ore-body apparently occurs in close association with the calcite and is genetically related to the gabbro intrusion. Specimens of the associated minerals collected at the mouth of the shaft and submitted for examination are reported by E. Poitevin to consist of white crystalline calcite holding small irregular crystalline masses of siderite, and groups of spheroidal masses showing a nucleus of radiating fibrous goethite surrounded by a zone of dark brown limonite, which in turn is often surrounded by a reddish hematite.

Half a mile south of Morristown on the east bank of Gould brook, a test pit 25 feet deep was sunk, about the year 1910, on a vein reported to contain manganese ore.

Iron

On North mountain, one-half mile north of Welton Corner, on the east side of Merden road, on Wm. Johnson's farm, a small vein of siliceous magnetite has been uncovered. The vein strikes in an easterly direction and dips gently northwards between basaltic flows. Float from this vein can be traced eastward for one mile to W. E. Bishop's farm, where two similar veins outcrop at the head of McGee brook, 25 feet apart in trap rock. An analysis of the ore made at the Mines Branch, gave: iron, 34·43; manganese, trace; and insoluble silica, 48·00 per cent.

Similar veins of siliceous magnetite have been uncovered at several points farther east, outside of the map-area, along the south face of North mountain to the north of Buckley Corner and Lakeville. These deposits are too siliceous and too small to be of economic value.

Antimony

Several loose pieces of pure stilbite, or sulphide of antimony, were found by Kenneth Morrow to the east of Welton Corner on McGee brook. Specimens were obtained by the writer from John Dunright and Wm. Holland. Stibnite can not have originated from the underlying Triassic sediments, nor probably from the Triassic trap of North mountain; these specimens must, therefore, have been carried north by glaciation from South mountain, probably from the Gold-bearing slates, in which antimony ore is known to occur elsewhere and has been mined extensively at West Gore, Hants county. The stibnite may, however, have been transported south from the Palæozoic rocks of New Brunswick, possibly Prince Williams antimony mines, across the bay of Fundy and North mountain, but this is very improbable.

Copper

At Dalhousie East, Kings county, in the southwest corner of the Lakeview area, on the west side of Alton road and three-quarters of a mile north of Old Dalhousie road, a shaft has been sunk to a depth of 165 feet on a copper-bearing vein in granite At the surface the vein appears to strike south 25 degrees east magnetic, and to dip vertically. Samples from the dump show the ore to be chalcopyrite and chalcocite in a gangue mostly composed of granite and quartz. An analysis of the samples made at the Mines Branch gave 1·05 per cent of metallic copper, but did not show the presence of gold, silver, nickel, tin, or tungsten, for which elements they were tested. Irving Smith, who occupied the farm on which the shaft was sunk, and also worked at the mine, furnished the following information. The vein was discovered about the year 1876 by Ainslie Wilson; the shaft was started in 1890 by a Bridgewater company, and carried to a depth of 165 feet. At the cropping the vein was 12 inches wide, and proved rich to a depth of 20 feet, where large crystals of quartz were found, after which it decreased in size and value, and at the depth of 100 feet where it began to dip towards the east, its size was less than 2 inches. At a depth of about 20 feet, cross-cuts were driven a few feet each way. The vein has not been traced at the surface,

because its outcrop is probably of very limited extent, as in the case of the tin-bearing ore-body prospected by Neil A. King at Lake Ramsey, near New Ross. Drift of similar ore is reported, however, to have been found half a mile farther north in the direction of the vein, mid-way between Irving Smith's present house and Sixtymile lake, where, also, traces of copper were found on an outcrop of granite.

An unimportant occurrence of copper ore is reported on North mountain, on Wm. Johnson's farm, on the west side of Morden road.

Graphite

On South mountain, 1½ miles south of Nicholsville, and one-half mile south of Wm. Ward's house on Old Canaan road, a test pit 30 feet deep has been sunk for graphite in what appears to be black crushed slate and gouge in a fault. The fault runs northwesterly and crosses South Annapolis river at the head of Creamer pond, where it is well exposed on the western bank showing 2 or 3 feet of crushed slate and quartz between two perpendicular, slickensided walls. The quartz is said to carry free gold and the crushed material has been dug for a few feet. The slates adjoining the fault are much metamorphosed and contorted, and carry small quartz veins. One mile to the northwest of the river several cold water springs and depressions are in line with the direction of this fault and the fault located between the manganese deposit and Palmer road, already referred to above.

Ochres

Half a mile south of Morristown, and 300 feet west of Lake George road, a surface deposit of bog iron and manganese, and red ochre occurs along the steepest part of Fox mountain. A considerable amount of the material was dug, for three seasons, about the year 1890, by Watson Hutchinson's father. The material was roasted in a kiln, ground dry to powder between burrstones, then mixed with oil, and afterwards sold as pigment, for the most part locally.

One mile to the southwest is a small deposit on Mumford brook near Old Canaan road, and several others have been observed along the northern slope of South mountain. Deposits occur also on Beech hill to the south of Coldbrook, from which a certain amount has been shipped.

Quartz (Silica)

The remarkably large belt of white quartzite that outcrops prominently in the slates one mile south of Mineville along the north slope of South mountain for a length of 6 miles, from South Annapolis river near Bennett Corner to McMaster mill on Fales river and farther, may be of economic value as a source of silica for certain purposes. Some of the beds consist of silica, apparently free from impurities. The deposit is situated 3 miles from the railway and the supply is unlimited. High-grade silica rock is used in the manufacture of glass, ferro-silicon, carborundum, abrasives, silica-brick, and tube mill liners and pebbles; the rock used being in large part dependent upon its composition and structure.

Clays

Brick was manufactured for some years, about 1870, on the properties of the Harris estate and A. P. Graves in the village of Aylesford. Pleistocene deposits of clay, sand, and gravel, lying horizontally, floor the Annapolis valley. Red clay outcrops at several points along Annapolis river and some of its larger tributaries. The large number of bore-holes drilled for water in various parts of the valley by the Trask Artesian Well Company, Ltd., of Berwick, B. F. Spurr, of Aylesford, and others

has proved that the superficial deposits of sand and gravel, which attain great thicknesses over large areas, are underlain by beds of clay; and that deposits of the white clay occur in the vicinity of North Kingston and extend eastward, in part, along the northern portion of the valley bordering North mountain.

Limestone

No true limestone occurs in the area. An intrusive body of calcareous diabase on Cold brook, one mile southeast of Coldbrook station, was calcined for lime many years ago, and a kiln can still be seen close by.

At Rockville Notch, 150 feet above the iron bridge over Fales river, a belt of calcareous quartzites carries a little pyrites and pyrrhotite and weathers to fine cavernous rock. The amount of carbonate of lime, pyrites, and pyrrhotite varies in the different beds of the belt, and some of the beds may be rich enough in lime to be crushed for fertilizers. The quartzites dip southerly in a syncline and are repeated a little farther south on the opposite side of the fold. A large quantity of crushed limestone is used in the valley for fertilizers, also lime for fertilizers and spraying fruit trees, most of it coming from Windsor, N.S.

Infusorial Earth

A deposit of infusorial earth (called also diatomaceous earth and kieselguhr) has been discovered recently 3 miles south of Nicholsville on West branch of South Annapolis river one-quarter mile below Beech Hill dam. The deposit occurs in a marsh, through which passes a run from the main stream, and appears to cover quite a large area. Last summer, Lloyd Johnson of Aylesford dug two holes 3 feet deep, without reaching the bottom of the deposit, exposing a section of 2 feet of pure white diatomaceous earth covered with 1 foot of decomposed vegetable matter. The locality is reached from Old Canaan road by the Tupper portage road, a distance of 2½ miles.

Another deposit is reported by Chas. Tupper and others to occur at the Horseshoe meadow on the east branch of South Annapolis river, one mile above Shinglemill fall. It is said that a pole can be driven down to a depth of 10 feet in the deposit.

Daniel Francis, an Indian of Millville, reports having discovered what appears from his description to be infusorial earth, 3 miles east of Lake George road, on South brook of Fourmile lake, at a point on that brook situated 1 mile above the lake and a short distance below Lower Round lake where the waters from a cold spring come in from the northeast.

On North mountain, one-quarter mile east of Morden road, on James McGarvie's farm, a deposit occurs in a swamp. The area of this deposit is unknown, but it appears to be fairly large. Mr. McGarvie claims it is 20 feet in depth. A specimen collected near the surface was of a greyish white colour and contained a little organic matter.

It is probable that deposits of infusorial earth occur in many of the shallow lake bottoms and marshes of the interior plateau drained by the headwaters of Gaspereau and Lahave rivers, and an examination of that area with the aid of a large auger might lead to the discovery of more important deposits than those above described.

On account of its physical and chemical properties, infusorial earth is susceptible of many industrial applications and lately its uses have been considerably extended.[1] There is a steadily growing demand for it and the price of the product ranges from $20 to over $100 per ton according to its purity, the uses for which it is employed, and the degree of preparation when put on the market.

The Silica Lake deposit, at the head of Bass river, Colchester county, has been in operation for twenty-seven years, and is the only one worked in eastern Canada. The bulk of the output of last summer was used for the manufacture of rubber goods, and the purest grade for silver polish and talc powder.

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[1] Geol. Surv., Can., Sum. Rept., 1915, pp. 189-192.

Peat

Many bogs occur on the headwaters of Gaspereau and Lahave rivers in the interior plateau of South mountain, and some cover large areas between the largest lakes and the lateral moraines. Some bogs have a uniformly convex surface showing the presence of a considerable thickness of sphagnum mosses and a few other plants, accumulated for years and partly decomposed to peat. These deposits, owing to their location, are at present of no economic value, and they have not yet been mapped.

Caribou peat bog in the Annapolis valley deserves special attention, however, as it offers an important deposit of peat that might be exploited profitably for moss litter, if not for fuel. It is favourably situated, one mile west of the town of Berwick on the line of the Dominion Atlantic railway, and on the watershed between Annapolis and Cornwallis rivers, at an elevation of 140 feet above sea-level.

An investigation of the economic value of Caribou peat bog was made in 1913 by Aleph Anrep for the Department of Mines. The bog was surveyed, a large number of drill-holes were put down, samples from different depths were examined to ascertain the character of the peat, and a report, accompanied with a map, was published by the Mines Branch in Bulletin No. 11, pages 38-40. The report gives a description of the deposit and the tonnage of moss litter, and of fuel peat available. As this report is now out of print, the following extracts are given:

The bog covers an area of 887 acres, and contains two kinds of peat, namely, peat litter and peat fuel.

The peat litter occupies the centre of the whole area, and covers, approximately, 200 acres. Of this area, allowing 2 feet decrease in depth due to shrinkage in draining the bog, we have:

90 acres, with average depth of 14 feet=2,032,000 cubic yards
75 acres, with average depth of 20 feet=2,427,000 cubic yards
35 acres, with average depth of 24 feet=1,355,000 cubic yards

giving a total volume of 5,815,000 cubic yards of peat litter. Calculating that one cubic yard of such drained bog will produce 120 pounds of dry peat substance, the total available tonnage of dry peat is 349,000 tons, or 436,155 tons of peat litter, 20 per cent moisture.

Inasmuch as this peat bog has all the advantages of high-grade peat litter, and is situated in a great fruit producing country, it would be of great advantage to erect thereon a peat litter plant of modern type. This should be, at once, a feasible and beneficial undertaking, as there would be an open market for fertilizer and packing substances.

On account of its physical and antiseptic properties peat litter is used for sanitary purposes in hospitals; bedding for horses and cattle; packing fruits, vegetables, eggs, and butter; and in the manufacture of wallboard and other products.

The total area covered by peat fuel in the bog is about 687 acres. The volume of peat fuel contained is:

Area with depth less than 5 feet, 1,666,000 cubic yards
Area with depth more than 5 feet, 2,456,000 cubic yards
Area with depth more than 10 feet, 250,000 cubic yards

Allowing 2 feet decrease in depth due to shrinkage after the bog has been thoroughly drained, and omitting the area having a depth of less than 5 feet, we have a total volume of 1,960,000 cubic yards of peat fuel. Assuming that 1 cubic yard of such drained bog will furnish 200 pounds of dry peat substance, the total tonnage of dry peat fuel is 196,000 tons, or 262,000 tons of peat fuel, 25 per cent moisture.

An analysis of four samples of peat fuel shows that the content of ash is comparatively low, and the calorific value satisfactory.

The whole bog is favourably situated as regards transportation and market, being traversed at the south end by the Dominion Atlantic railway. This part of the country is thickly populated, and as the prices of coal and wood for domestic fuel are very high and steadily increasing, it is probable that with proper treatment peat fuel could be favourably placed on the market. By producing peat litter in the winter and manufacturing peat fuel in the summer, employment could be found for labourers the year round.

THE CARBONIFEROUS STRATA OF SYDNEY DISTRICT, CAPE BRETON, NOVA SCOTIA

By W. A. Bell

GENERAL STATEMENT

The writer was engaged during the field season of 1920 in an investigation of the Carboniferous strata of Sydney district, Cape Breton. The purpose of the work was the study of the fossil plant and animal remains in order to determine their value as guides to the further stratigraphical subdivision of these rocks and their use as local indices to individual horizons.

The need for a finer subdivision of the great thickness of strata comprised in the Carboniferous system of the Maritime Provinces, that will aid in the more accurate diagnosis of horizons, becomes increasingly more pressing. This results from the growing economic exploitation of the upper division of these rocks for their contained coal, of the lower division for its bedded salt and gypsum deposits, and from the possible future value of certain shales as a source of oil.

The Sydney district, by reason of the relative simplicity of its geological structures, affords one of the most suitable terrains in the Maritime Provinces for the geologist to determine criteria for a more practical subdivision of the Carboniferous based on the actual chronology of historical events and on the arrival, abundance, and extinction, of plant or animal species. The primary requirement for an extensive investigation of this character is the detailed examination of the fossils as they occur from the base to the summit of the stratigraphic column. Consequently, the greater part of the past season was spent in gathering specimens of the included fossil remains from the excellently exposed coast sections of this region and from the roofs of the productive coal seams.

The writer was efficiently aided in this work by Maurice Haycock and D. D. Foster, and he is indebted to the officials of the Dominion Coal Company for courtesies extended.

GENERAL GEOLOGY

The area comprised in the field work has as its centre the city of Sydney and extends from Mira river, 10 miles to the southeast, to Big Bras D'Or channel, 16 miles to the northwest, and is underlain entirely by Carboniferous, Pleistocene, and Recent sediments.

The Carboniferous measures are folded in open anticlines and synclines with axes trending in general northeast-southwest in such manner that the productive upper beds of the series lying in the synclines are separated from one another by barren rock of the intervening anticlines. As a result of the physiographic history of the region, there are at the present time three major productive synclinal coal basins, the Morien or Cow Bay basin on the southeast, the central Glace Bay basin, and to the northwest the Lingan or Sydney Harbour basin with its subsidiary Cape Dauphin basin. As the axes of these synclinal troughs pitch gently northeastwards beneath the Atlantic, the productive portions of the section lie in areas, with concave margins, that fringe the coast line, so that the larger bodies of coal, as well as the youngest sediments, lie beneath the sea. Of the three main synclines enumerated, the most southern, or the Morien syncline, is peculiar in its more easterly trend and in its stronger compression.

Group Classification

Heretofore, the Carboniferous strata of this district have been mapped according to the following legend:

C_3: Coal Measures.
C_2: Millstone Grit.
C_1: Carboniferous Limestone Series.
CM_1: Carboniferous Conglomerate Series.

This generalized classification, originally based on analogies with the coal fields of England and Wales, is in conformity with a similar usage throughout the Maritime Provinces. Unfortunately these terms imply correlation, and as the lithological characters of the sediments have been relied on most frequently for correlation purposes, the foregoing nomenclature as used in the Sydney district represents groups of strata that are not necessarily synchronous or even approximately synchronous to the groups comprised under the same terms in other parts of the province. They simply represent a succession of similar rock facies.

For example, it has generally been tacitly assumed that the productive coals of the various coal districts of Nova Scotia, e.g., the Stellarton-Thorburn, the Springhill, and the Sydney-Glace Bay, belong to the same epoch of sedimentation. On the contrary, the productive portions of these fields may represent several individual epochs. Deposition of the Stellarton coals, for instance, may long have preceded the deposition of any workable coal in the Sydney-Glace Bay areas, and during the intervening interval productive coals may have been accumulating elsewhere in the province, e.g., in the Cumberland County basins.

As the term "Millstone Grit" has been used for barren sandstones of similar lithological types lying below these productive measures of diverse ages, it has likewise no value as an indicator of stratigraphic position.

For mapping purposes it is generally expedient to employ lithological units of strata, the so-called *formations,* assigning to them local names derived from geographic localities where they are typically developed. It is then the function of the palæontologist, when sufficient evidence has accumulated, to aid in the correlation of the various geographic formations thus delineated. Formations of this nature have been but imperfectly established in the Carboniferous areas of Nova Scotia. As regards the Sydney district further field work in the inland tracts is necessary before a satisfactory formation grouping can be advanced.

ECONOMIC ASPECTS

The demand for coal in consequence of the present fuel situation has awakened new interest in prospecting for workable seams. In the Sydney district the main productive areas are developed by the Dominion Coal Company and the Nova Scotia Steel and Coal Company. Their pits are located in the fertile synclines that fringe the coast, and much of the coal is extracted from submarine workings. There are, however, inland tracts lying between Sydney river and Mira river whose potentiality as a source of coal is still unproved. On account of the wooded character of the terrain and the paucity of outcrops, further prospecting will of necessity depend on drilling. East of Sydney much of the ground has already been drilled systematically with the result that only thin coal seams have been encountered below the horizon of the Mullin's seam. Although much work remains to be done before the structure of the rocks in these inland areas is deciphered, the palæobotanical evidence favours a fault and crush zone along Wash brook to Gilholmes lake east-southeast of Sydney, as indicated many years previously by C. Robb and H. Fletcher. The further continuation of this fault zone, however, was not traced by the writer. Higher beds lie to the south of the fault and in drilling for the continuation of the Tracy seam in this area it would seem advisable to sink a few well-chosen holes in the area south of the fault, commencing some two-thirds of a mile westward of Middle lake and spaced along a line that will cut across the rock structures towards Gilholmes lake.

It is quite possible, however, that the lower seams of the district, such as the Tracy, will thin in their continuation northwards and westwards towards the source of supply of the sediments, as the lower groups of strata below the Mullin's seam are represented in the Sydney Harbour district almost entirely by massive, barren sandstones, grits, and conglomerate.

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The annual Summary Report of the Geological Survey is issued in parts, referring to particular subjects or districts, and each designated by a letter of the alphabet. A review of the work of the Geological Survey for the year, with lists of reports and maps published during the year, forms part of the Annual Report of the Department of Mines