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PAPER 67-29

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DEPARTMENT OF ENERGY,
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STRATIGRAPHY AND SPORE ASSEMBLAGES, MONCTON MAP-AREA, NEW BRUNSWICK

(Report and 2 figures)

P. A. Carr

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ABSTRACT

Geological studies and spore determinations in Moncton map-area have shown the need for clarification and modification of stratigraphic terms long in use in this area. Four of the seven mainly Carboniferous units above the Basement Complex – the Memramcook, Boss Point, Salisbury, and Richibucto Formations – are time-transgressive, so that it seems advisable to stop using the terms Pictou, Riversdale, and Horton in this area, because of their time-stratigraphic aspect. Additionally, the writer advocates dropping the name 'Scoudouc Formation', because the rocks in the lower half of this unit have now been included in the Salisbury Formation, and the upper half in the Richibucto Formation.

The spore determinations reveal that the Memramcook Formation ranges from latest Devonian to earliest Mississippian time; the Boss Point Formation in New Brunswick ranges from Namurian to Westphalian B age; the Salisbury Formation ranges from Westphalian C to Stephanian age; and the Richibucto Formation ranges from Westphalian D to Stephanian age. The names, ages, and locations of the spore samples identified are given in an appendix to this report.

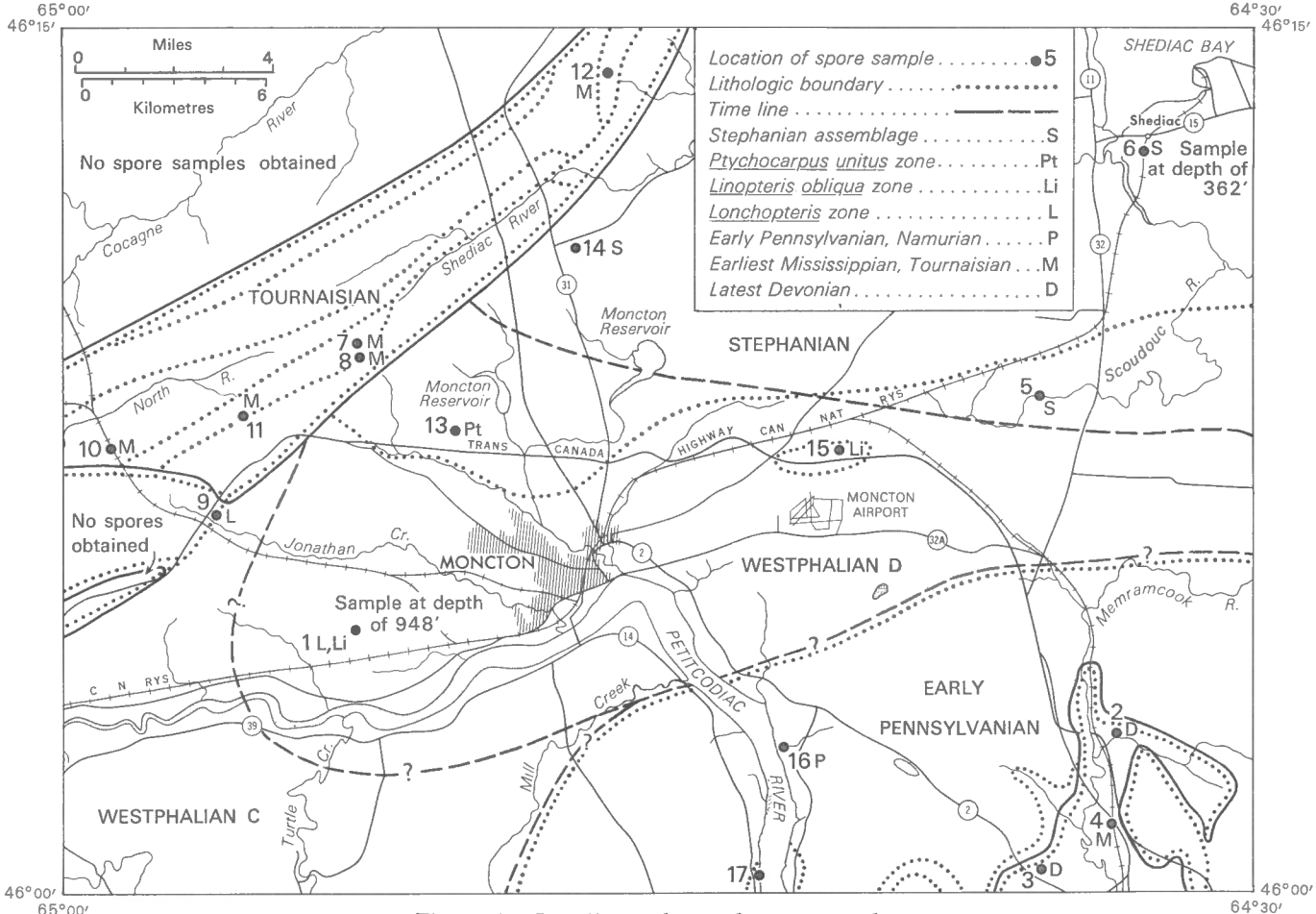

Figure 1. Location and age of spore samples

STRATIGRAPHY AND SPORE ASSEMBLAGES, MONCTON MAP-AREA, NEW BRUNSWICK

INTRODUCTION

GENERAL SETTING

Moncton map-area lies between latitudes 46°00' and 46°15'N and longitudes 64°30' and 65°00'W, and comprises about 400 square miles of parts of Albert and Westmorland counties, New Brunswick. The map-area is easily accessible by paved and secondary roads. It is well wooded and rock exposures are limited. Most of the rock sections occur in the stream valleys, in road cuts, and along the coast of Northumberland Strait. Additional bedrock information was obtained from geological logs of the boreholes (Appendix A).

The main physiographic feature of the map-area is the Kingston Uplift. This is a series of ridges having a maximum elevation of about 675 feet and situated northwest of Moncton (see Fig. 2, in pocket). It is composed mainly of steeply inclined Mississippian and earlier rocks. North of the uplift is the New Brunswick shelf, and to the south of the uplift is the Moncton Basin. Both of these areas are filled with nearly flat-lying Pennsylvanian rocks, which form an undulating plain, rarely having more than 250 feet of relief. A thin veneer of glacial drift covers the map-area.

PREVIOUS WORK

Many geologists such as Gesner, Logan, Dawson, and Bailey have recorded geological observations as they passed through this area. Perhaps the most interesting geological work carried out during the last century was by Hind (1865). His maps show the western half of the map-area as nearly all red sandstone and the eastern half as nearly all grey sandstone. This two-fold colour difference is still valid today and has been used in this report to differentiate between the red Salisbury Formation and the grey Richibucto Formation.

Wright (1922) investigated the geology of what was then termed the Moncton map-area according to the National Topographic System of that day. His map covered a large part of the present Hillsborough map-area (21 H/16) to the south and included less than one quarter of the present Moncton map-area. His report was the first detailed attempt to establish the stratigraphic positions of the rock units of the Moncton Basin.

In 1931, Norman (1941a) made the first geological map of the present-day Moncton map-area.

Miller (1940) of the Dominion Observatory made magnetic and gravity profiles through this area, and later Miller and Garland (1953) published a series of gravity profiles across the Moncton Basin.

In the late 1940's and early 1950's, the Shell Oil Company of Canada Ltd. made a thorough study of the Carboniferous rocks in south-eastern New Brunswick. This work was assessed and compiled by Gussow (1953).

ACKNOWLEDGMENTS

The writer was ably assisted in the field by R.K. Jull, M. Hone, and K. Daughtry during the summer of 1961; and by D.E. Lawson, A.S. Pedersen, and D. Gamache during the summer of 1962. The advice and criticisms of Professor G.W. White of the University of Illinois, and of Dr. D.G. Kelley and Dr. D.G. Benson, both of the Geological Survey of Canada, were greatly appreciated.

The author is also grateful to M.S. Barss of the Coal Research Section of the Geological Survey of Canada for separating all the spores from the rock samples, and for identifying and dating all of the spores except sample numbers 2, 3, and 4. The latter samples had Devonian or lowermost Mississippian affinities and were identified and dated by Dr. D.C. McGregor of the Palaeontology Section of the Geological Survey of Canada.

PROBLEM OF NOMENCLATURE

Wright, Norman, and Gussow each used a different table of formations for the rocks in the Moncton map-area. Their tables of formations (see Table I) are the results of the classification of stratigraphic units of their day, and of the amount of previous geological work done in the map-area. Time-stratigraphic and rock-stratigraphic units have been intermingled in such a way that time-stratigraphic units have been used as rock-stratigraphic units.

Dissatisfaction with the classification of the Carboniferous rocks in the Maritime Provinces is generally acknowledged by field geologists who have worked with these rocks. Belt (1964) has suggested a revision of the middle Carboniferous units in Nova Scotia, and Poole et al. (1965) have discussed some of the inadequacies of the present classification of the Carboniferous strata in the Maritimes.

The terms used by the author in this report have been selected to conform with the principles of the Code of Stratigraphic Nomenclature of 1961. This selection took into account whether the term is a time-stratigraphic or a rock-stratigraphic term, and whether it is applicable to the map-area. The terms are discussed in order of their appearance in the literature.

WRIGHT'S CLASSIFICATION

Only the upper part of Wright's table of formations (1922, p. 2) applied to the Moncton map-area. Wright included all the nearly flat-lying Pennsylvanian rocks in the "Petitcodiac Series". This "Series" was divided, mainly on the basis of colour, into three lithologic zones, which correspond

TABLE I

COMPARISON OF NOMENCLATURE

WRIGHT 1922 as applies to map-area		NORMAN 1941a		GUSSOW 1953 as applies to map-area			THIS REPORT	
Series	Zone	Group	Formation	Group		Formation	Group	Formation
		Petitcodiac undivided		Pictou		Richibucto	Petitcodiac	Richibucto / Salisbury
						Scoudouc		
	Zone No. 3					Salisbury		
				Disconformity			? Disconformity ?	
Petitcodiac	Zone No. 2			Riversdale		Boss Point	Petitcodiac	Boss Point
	Zone No. 1	Hopewell		Canso	Hopewell		Hopewell	
Unconformity		Unconformity		Unconformity			Unconformity	
		Moncton		Horton Series	Moncton		? Moncton ? Boulder conglomerate unit	
			Albert			Albert		Albert
			Memramcook			Memramcook	? ?	Memramcook
		Unconformity		Unconformity			Unconformity	
		Palaeozoic or Precambrian		Basement Complex			Basement Complex	

to the red Hopewell Group, the grey Boss Point Formation, and the red Salisbury Formation of later writers.

NORMAN'S CLASSIFICATION

Norman (1941a) used the Memramcook and Albert Formations, and the Moncton and Hopewell Groups as lithologic units in the map-area. Also he restricted the term "Petitcodiac Group" to the rocks overlying the Hopewell Group, but he did not subdivide the Petitcodiac Group. All of these terms used by Norman are rock-stratigraphic units.

GUSSOW'S CLASSIFICATION

Gussow's table of formation (1953, p. 1717) applies to all of southeastern New Brunswick; however, Table I shows only his nomenclature that applies directly to the map-area. He retained Norman's rock-stratigraphic units – the Memramcook and Albert Formations, and the Moncton and Hopewell Groups – but dropped the term Petitcodiac Group. He then introduced Bell's units from Nova Scotia: the Horton series (Bell, 1929), and Windsor, Canso, Riversdale, Cumberland, and Pictou Groups (Bell, 1944). All of these terms are time-stratigraphic terms and were originally defined as "series" by Bell (1929, 1940), who redefined them as Groups (1944), presumably to conform with the Stratigraphic Code of 1933, but they were still differentiated on the basis of hiatuses and fossils and hence are actually time-stratigraphic units.

The term "Horton Group" has been applied by geologists in Nova Scotia (Kelley, 1957, 1958; Murray, 1960, p. 1) to the non-marine sediments that rest upon the pre-Carboniferous, metamorphic, and igneous rocks, and are overlain by marine Windsor rocks. Similarily, the term "Windsor Group" has been applied to a sequence of marine limestone, evaporites, and red beds in the Carboniferous of Nova Scotia. Although both of these terms were originally defined as time-stratigraphic terms, they are now used mainly as rock-stratigraphic units in Nova Scotia. Similarily, the "Pictou Group" has a time-stratigraphic connotation as originally defined by Bell, but like the Horton and Windsor Groups, it is often used as a rock-stratigraphic unit in Nova Scotia (Kelley, D.G. and Benson, D.G., personal communications).

Gussow discarded the rock-stratigraphic term "Petitcodiac Group" in favour of the terms "Riversdale" and "Pictou Groups". No fossils correlative with the Cumberland Group were found between the Riversdale and Pictou Groups; thus a disconformity was indicated on his table of formations (Table I). The Pictou Group was divided into three formations: the Salisbury (red beds), the Scoudouc (buff sandstone), and the Richibucto (buff sandstone). The last two were separated by a zone of red beds having a weathered zone of bluish green clay.

PRESENT CLASSIFICATION

The writer has used the rock-stratigraphic terms "Memramcook and Albert Formations", and "Moncton and Hopewell Groups" as Norman and

Gussow did. Bell's terms "Horton", "Windsor", "Canso", "Riversdale", "Cumberland" and "Pictou Groups" are still time-stratigraphic terms, in spite of later usage of some of them as rock-stratigraphic terms. Because of the confusion arising from this duality of use, they are avoided as much as possible in this report.

Norman's use of "Petitcodiac Group" has been reinstated to include the rocks in the map-area overlying the Hopewell Group. Subdivision of the Petitcodiac Group on the New Brunswick shelf was not possible, because of the limited number of exposures. However, subdivision of the group was possible in the Moncton Basin where rock exposures are more common. The Boss Point Formation was found to be more extensive than previously shown by Gussow. The term "Salisbury Formation" is retained and used to refer to a sequence of rocks that are predominantly red beds, and it has been extended to include approximately the lower half of Gussows's Scoudouc Formation. The term "Richibucto Formation" is retained and used to refer to a sequence of rocks that are predominantly grey sandstone, and this formation has been extended to include the upper part of Gussow's Scoudouc Formation.

GENERAL GEOLOGY

GENERAL STATEMENT

The oldest rocks in the map-area are the granite and greenstone of the Basement Complex (Table II). Where they are overlain by the Memramcook Formation their age is known to be only pre-latest Devonian. They have been deformed by the Acadian orogeny (Neale et al., 1961) and are unconformably overlain by steeply dipping sediments of latest Devonian and earliest Mississippian age. The Memramcook Formation (latest Devonian and earliest Mississippian age) and the Moncton Group (earliest Mississippian age) consist of terrestrial red and green-grey siltstone, sandstone, and conglomerate. They are separated by the grey shale and siltstone of the Albert Formation (earliest Mississippian age). The above sediments are overlain with an angular unconformity by the nearly flat-lying Hopewell (age uncertain) and Petitcodiac Groups (Pennsylvanian age), which mainly consist of grey arkosic sandstone, and red claystone and shale. An unconformity occurs between these rocks and the overlying surficial deposits.

DESCRIPTION OF FORMATIONS

Devonian and/or older

Basement Complex

Definition

The Basement Complex (map-unit 1) is a general term applied to the deformed igneous and metamorphic rocks that underlie the steeply dipping Carboniferous sediments.

TABLE II

TABLE OF FORMATIONS

Period or epoch	Group	Formation	Lithology	Thickness[1]
Recent			Tidal mud and beach sand.	36
Pleistocene			Till and sand.	160
Unconformity				
Pennsylvanian	Petitcodiac	Richibucto	Yellowish orange to grey sandstone, claystone, pebble conglomerate, and red claystone.	448
		Salisbury	Red claystone and siltstone, some red sandstone and conglomerate.	1,100
		? Disconformity ?		
		Boss Point	Yellowish orange to grey-green sandstone, well rounded pebble conglomerate, and some red claystone.	240
– ? – ? – – ?	Hopewell		Red shale and granite pebble conglomerate and breccia. Some red and green sandstone, siltstone, and claystone.	550
Unconformity				
Mississippian	? Boulder conglomerate unit ? Moncton		Red and grey siltstone, sandstone, and conglomerate with a minor amount of shale.	3,200
		Albert	Grey to black shale and siltstone, some grey to yellowish orange sandstone, minor amounts of limestone and dolomite.	5,700
Devonian		Memramcook	Red and green shales, siltstone, and sandstone. Basal part: grey pebble conglomerate and sandstone.	3,000
Unconformity				
?	Basement Complex		Red sheared granite porphyry, greenstone, and granite.	

[1] Maximum known thickness in feet.

Distribution

The Basement Complex outcrops in two main areas, the Memramcook Valley near Calhoun and the Kingston Uplift south of Stiles Village. In both these areas the rock is well exposed in quarries. Two small outliers also occur, one in the Shediac River valley, and the other 3 miles northeast of Memramcook Village.

Lithology

Pale red to green, sheared granite porphyry occurs in the quarry on the west side of Memramcook River. It is composed of large red phenocrysts of potash feldspar, and small amounts of quartz, interspersed with green to brown mica, epidote, and chlorite. As a result of shearing action, epidote has flowed and formed a green coating on the walls of the fault zones. Some calcite occurs within these fault zones. Slightly metamorphosed granite porphyry that grades into syenite porphyry outcrops in a small stream about half a mile south of Calhoun. There granite veins, which in places have segregated into veins of syenite porphyry and quartz, have intruded a greenstone schist.

On the east side of Memramcook River the granite porphyry is mainly unsheared, and a few well developed pyrite crystals and some bornite are present. A small outlier of sheared granite is exposed in the Stony Creek valley 3 miles northeast of Memramcook village.

Metamorphic greenstone, some granite porphyry, syenite, and granite outcrop near Stiles Village. Examination of thin sections showed that the metamorphic greenstone is a sheared diorite gneiss composed of large inequigranular orthoclase, some plagioclase, hornblende, epidote, chlorite, and quartz.

South of the quarry granite gneiss is overlain by a regolith (map-unit 2a) composed of angular boulders. A small outcrop of sheared pink granite occurs in Shediac Creek faulted against boulder conglomerate.

Where they are overlain by the Memramcook Formation, the Basement Complex rocks are known only to be older than latest Devonian.

Devonian and Mississippian

Memramcook Formation

Previous Use and Definition

The Memramcook Formation (map-unit 2a and 2), was first named by Norman (1941a) for the rocks near the village of Memramcook. They consist of a lower conglomerate (map-unit 2a), and an upper red shale and sandstone (map-unit 2). This formation lies unconformably on the Basement Complex and is conformably overlain by the Albert Formation. The upper contact occurs within alternating red and grey beds and is not clearly apparent; it is arbitrarily placed at the uppermost red bed in this sequence.

Distribution and Thickness

The Memramcook Formation occurs at four locations within the map-area: in Memramcook Valley; on the northwest side of the Kingston Uplift; on the south side of the Basement Complex about 1 mile south of Stiles Village; and at the northeastern edge of the Kingston Uplift. Norman (1941a) estimated this formation to be greater than 3,000 feet thick at its type area.

Lithology and Petrography

The basal part of the formation (map-unit 2a) is exposed about 2 miles south of Calhoun, in Memramcook Valley. The dominant rocks are steeply dipping, interbedded, grey sandstone and pebble conglomerate. The grey to brown conglomerate comprises poorly sorted; subangular to subrounded pebbles, and a few cobbles and boulders of orthoclase, granite, quartz, greenstone, green argillite, grey shale, syenite, and basalt, in a poorly sorted matrix of feldspar, quartz, and chlorite. The sandstone, which is grey to green, is thinly bedded, fine to coarse grained, micaceous, arkosic, and poorly sorted. It contains numerous plant fragments and in places exhibits festoon crossbedding.

The upper part of the formation is exposed near Memramcook Village. It is finer grained and has a flatter dip (10° to 60°) than the lower part (30° to 80°). The dominant rock types are red shale and siltstone, with minor grey sandstone. The shale contains oscillation ripple-marks and occasionally outcrops in large channel structures. Limestone nodules, ranging from three quarters of an inch to 6 inches in diameter, occur in the shale. Locally the rock has been faulted, and barite, quartz, and calcite have been deposited in the fault zones.

On the northwest side of the Kingston Uplift, the Memramcook Formation, although poorly exposed, is composed of red sandstone, siltstone, and shale.

On the south side of the Basement Complex, about 1 mile south of Stiles Village, a small area of Memramcook Formation outcrops between the Basement Complex and the Albert Formation. At this locality the Memramcook Formation is a regolith composed of granite gneiss and sheared diorite, overlain by a conglomerate of red angular feldspar pebbles in a green shale matrix.

The Memramcook Formation also outcrops on the south side of the syncline at the northeast end of the Kingston Uplift, where it is mainly red siltstone and shale. However, south of this area, in map-unit 2 and 3, grey siltstone and limestone of the Albert Formation alternates with the red siltstone and shale. Separation of the Memramcook and Albert Formations is not possible, owing to limited exposure and numerous small faults, which are too small to show on the geological map accompanying this report.

The sandstone grains are subrounded to subangular, poorly sorted, and have an intact framework. The quartz is dominant and contains some strained and some unstrained grains. Orthoclase, which is always partly altered to sericite and kaolin, comprises 15 to 25 per cent of the rock.

Plagioclase (An_{25-30}), lithic fragments (mainly quartzite and shale), muscovite, and chlorite occur in minor amounts. The matrix is composed of sericite, kaolin, chlorite, and hematite. The hematite is often well distributed throughout the rock and forms a coating on the grains and acts as a cement.

Age

In Memramcook Valley, spores (sample numbers 2 and 3) collected from this formation have a probable latest Devonian age and spores (sample number 4) have an earliest Mississippian age (D.C. McGregor, personal communication, 1962). Thus the deposition of the Memramcook Formation continued from latest Devonian to earliest Mississippian time.

In the Kingston Uplift, spores (sample number 12) collected from this formation yielded an earliest Mississippian age (M.S. Barss, personal communication, 1963).

The locations of the spore samples are shown on Figure 1, and the spores identified are listed in Appendix B.

Mississippian

Albert Formation

Previous Use and Definition

The name "Albert" was applied during the last century to the oil-bearing shales occurring at Albert Mines, about 16 miles south of Moncton. Rocks of Albert lithology were first found in the map-area by Bailey (1900, p. 14M).

Gussow (1953, p. 1730) gave a general definition of the Albert Formation, which applies to the entire Moncton Basin, ..."those beds of a predominantly gray color which overlie the red beds of the Memramcook Formation and are overlain by the red shale or conglomerate of the Moncton Group".

This definition is adopted by the writer for the map-area. The upper contact is placed at the lowest red bed.

Distribution and Thickness

The Albert (map-unit 3) outcrops at four localities in the map-area; north and south of the Lutes Mountain fault; between the Petitcodiac River and Memramcook Village; and in the northern branch of the Shediac River (map-unit 2 and 3). In the Kingston Uplift, north of the Lutes Mountain fault, a section having a thickness of about 5,700 feet, is present.

Lithology and Petrography

North of the Lutes Mountain fault, the base of the Albert Formation is composed of black calcareous siltstone and grey calcareous shale, cut by thin white calcite veins. Some pyrite and chalcopyrite are

disseminated throughout the shale, causing it to weather to a rusty brown colour. Minor amounts of limestone and dolomite are present. The formation becomes coarser towards the top. There, blue-grey shales are interbedded with grey to yellowish orange sandstone, grit, and a small amount of conglomerate containing quartz pebbles.

South of the Lutes Mountain fault, the Albert Formation is composed of grey to green and some pale red micaceous shale and siltstone. Limestone and dolomite are present in smaller amounts. Small folds and faults are common. Towards the east, at the Gorge, the shale is interbedded and has a gradational contact with the boulder conglomerate (map-unit 5). Adjacent to the resistant conglomerate, the Albert Formation forms topographic 'lows'.

About 2 1/2 miles east of the Petitcodiac River, just outside the map-area, a conglomerate having red and green shale pebbles and blue-green limestone nodules occurs in a green mudstone matrix. This outcrop is part of an area that is situated between Memramcook West, St. Joseph, and the Petitcodiac River in Hillsborough map-area, and is underlain by the Albert Formation (Norman, 1941b). The Albert Formation was extended northward into the Moncton map-area (after Norman, 1941a) to conform approximately with the 250-foot topographic contour, which was determined by Norman (1941b) to be the approximate elevation of the contact between the Hopewell Group and the Albert Formation.

The siltstone and shale are composed of poorly sorted, angular to subangular grains. Quartz predominates; orthoclase partly altered to sericite comprises about 15 to 30 per cent of the rock. Muscovite, chlorite, apatite, magnetite, and leucoxene occur in minor amounts. The shale is well banded and has a varve-like appearance.

Age

Spores (sample numbers 7, 8, and 11, Appendix B) indicate an earliest Mississippian age for the Albert Formation. Many of the spores are similar to those found in the Horton Group of Nova Scotia and are tentatively considered to be older than the upper half of the Craignish Formation on Cape Breton Island (M.S. Barss, personal communication, 1963).

Moncton Group

Previous Use and Definition

This group was first named by Norman (1941b) and refers to the red shale, sandstone, and conglomerate in the Hillsborough map-area, which are underlain by the grey Albert Formation and are overlain by the marine Windsor Group. There, the group was divided into the Weldon (lower) Formation comprising red shale and sandstone, and the Hillsborough Formation, which mainly comprises red conglomerate. Gussow (1953, p. 1738) reported an angular unconformity between these two formations.

In Moncton map-area the Moncton Group does not contain an angular unconformity but forms a conformable sequence of rocks with the underlying Albert and Memramcook Formations. This suggests a structural correlation with the Weldon Formation. However, the group includes considerable conglomerate and breccia, which is not characteristic of the Weldon Formation but the Hillsborough Formation. Thus in the map-area this group could not be subdivided.

Distribution and Thickness

The Moncton Group (map-unit 4) outcrops in the area of the Kingston Uplift immediately north of the Lutes Mountain fault, where it is about 3, 200 feet thick.

Lithology and Petrography

This group consists of grey to red siltstone, conglomerate, sandstone, and a small amount of shale. The conglomerate contains subangular pebbles of quartz, granite gneiss, greenstone, shale, and orthoclase, in a red to grey sandstone matrix. The pebbles are imbricated in some places. Near Stiles Village, a distinctive, sedimentary breccia occurs, which contains angular lath-like fragments of feldspar, partly altered to limonite or hematite in a fine-grained red matrix.

The grains of the breccia are unsorted and angular. Quartz grains are generally more abundant than orthoclase grains. Plagioclase comprises up to 8 per cent of the sandstone. Rock fragments, muscovite, and chlorite occur in minor amounts. The matrix is composed of hematite, magnetite, limonite, chlorite, and sericite.

Age

Spores (sample number 10) indicated an earliest Mississippian age for this group. The spores are similar to those found in sample numbers 7 and 8 of the Albert Formation (M.S. Barss, personal communication, 1963).

Boulder Conglomerate Unit

Definition

The informal name 'boulder conglomerate unit' (map-unit 5), used here for the first time, refers to a high ridge of rock about 10 miles long and three quarters of a mile wide on the south side of the area of the Kingston Uplift. It is composed mainly of boulder conglomerate and is best exposed at the Gorge.

Only at the Gorge is a contact of this unit well exposed. To the north it is terminated in part by the Lutes Mountain fault and in part by the Albert Formation, and to the south this unit is covered by onlapping Pennsylvanian sediments.

Lithology and Petrography

The conglomerate is pale red to greyish red and consists of subrounded to angular boulders, cobbles, and pebbles, up to 18 inches in diameter. They consist of granite gneiss, greenstone, quartz, schist, and shale in a matrix of red to grey siltstone or sandstone. The boulders appear to be very similar to the Basement Complex near Stiles Village. The conglomerate has been greatly sheared and the bedding is not readily apparent. Towards the south, this unit becomes finer grained, more crossbedded sandstones appear, and the smaller pebbles show stream lineation.

The matrix of the fine-grained conglomerate and the sandstone grains are angular to subangular and are poorly sorted. Rock fragments of diorite, quartzite, gneiss, granite, schist, siltstone, and shale comprise most of the rock. Plagioclase is more abundant than orthoclase; some medium-grained quartz occurs. Minor amounts of chlorite, zircon, muscovite, biotite, calcite, and hematite are also present.

Stratigraphic Relations

Norman (1941a) assigned the boulder conglomerate and the Albert Formation south of the Lutes Mountain fault to the Moncton Group. He noted, however, that the conglomerate resembled the lower part of the Memramcook Formation, that outcrops of grey shale occurred within this area and that this may be part of the narrow belt that occurs to the southeast in Salisbury map-area. Gussow (1953) assigned these rocks to the Memramcook Formation.

Better and more recently exposed outcrops have revealed more grey shale and have enabled the differentiation of the Albert Formation from the boulder conglomerate. However, owing to a lack of bedding features and to numerous small faults within the shale and the conglomerate, the tops of the beds could not be ascertained. Thus, north of Lutes Mountain, it is not known if the boulder conglomerate overlies the Albert Formation and is part of the Moncton Group, or if the whole sequence has been overturned and the conglomerate is part of the Memramcook Formation.

At the Gorge, grey shale of the Albert Formation alternates with the boulder conglomerate over a distance of a quarter of a mile. There the Albert and the laterally adjacent conglomerate are intertongued. The fine-grained, grey Albert sediments were deposited in a lacustrine environment and the conglomerate unit was deposited at the same time in the adjacent subaerial position under piedmont and fluvial environments. Elsewhere, the Albert lacustrine environment did not encroach on the terrestrial environment and a continuous clastic sequence of deposition resulted in sediments similar to the Memramcook Formation and the Moncton Group being laid down without the intervening Albert Formation. In these localities differentiation between the two red lithologic units is impossible. It is interesting to note that in Hillsborough map-area both Norman (1941b) and Gussow (1953, p. 1727) reported a conglomerate facies in the Albert Formation.

Consequently, the boulder conglomerate unit is part of the Lower Mississippian red bed sequence of the Moncton Basin; part of the unit is in facies relationship to the Albert Formation, and the rest of the unit belongs

to the Memramcook Formation and/or the Moncton Group, depending on whether the beds are overturned or not. Until complete correlation of this unit can be ascertained, it is not known if it is part of the formation, group, or a supergroup.

Age

The conglomerate at the Gorge must be of earliest Mississippian age because it is interbedded and has a gradational contact with grey shales of the Albert Formation, which yielded spore samples 7 and 8 (Fig. 1 and Appendix B).

Mississippian or Pennsylvanian

Hopewell Group

Previous Use and Definition

The Hopewell Group (map-unit 6) was first defined by Norman (1941b) in Hillsborough map-area to include the red shale, sandstone, and conglomerate underlain by the marine Windsor Group and overlain by the Boss Point Formation.

On the Maringouin Peninsula in Hillsborough map-area, this group was divided into the Maringouin (lower), Shepody, and Enrage Formations. However, over a large part of the Moncton Basin including the map-area, the nearly flat-lying Hopewell Group cannot be divided. The lower contact is not exposed in the map-area. The upper contact was placed by Gussow at the bottom of the first greenish grey sandstone, and can be seen on the west bank of the Petitcodiac River at the southern edge of the map-area.

Distribution and Thickness

The Hopewell Group is exposed in the southeastern corner of Moncton map-area, where its maximum known thickness of about 550 feet occurs in borehole number 11 (Appendix A).

Two areas situated immediately east of the Petitcodiac River are shown on the geological map accompanying this report to be underlain by the Hopewell Group, although no outcrops were found in these areas. This is based on the existence of Hopewell rocks lying immediately south of the map-area. The boundaries have been extended into the map-area conforming approximately with the topographic contours between which these outcrops occur.

Lithology and Petrography

In Moncton map-area, the Hopewell Group consists of soft red shale and red conglomerate to breccia, and minor amounts of red and green sandstone, siltstone, and claystone. The shale locally contains limestone

concretions and exhibits ripple-marks. The conglomerate, which is confined mainly to the lower part of the group, is composed of granite pebbles generally one quarter to one half inch in diameter. The pebbles are angular to subangular in shape and are coated with hematite. The rock is poorly cemented and thus weathers easily to a reddish white gravel. This is one of the most distinctive conglomerates in the area; however, the outcrops are generally poorly exposed and well weathered, and it is not always possible to establish if the rock is in place or if it has been moved slightly by the ice.

The sandstone appears relatively equigranular. Quartz grains, some of which exhibit pressure welding, predominate. Lithic fragments of granite, quartzite, and schist are present along with minor amounts of orthoclase, chlorite, muscovite, magnetite, ilmenite, and hematite.

Age

No age has been established for this group within the map-area. Spores (sample number 17) from the Boss Point Formation 12 feet stratigraphically above the conformably underlying Hopewell Group are of Pennsylvanian age, which suggests that a Pennsylvanian age is likely here also. However, until fossil evidence becomes available the age of this group within the map-area will remain uncertain.

Pennsylvanian

Petitcodiac Group

Previous Use and Definition

The term Petitcodiac Group was first used by Norman (1941b) in Hillsborough map-area and referred to grey sandstone, quartz-pebble conglomerate, red shale, and sandstone overlying the Hopewell Group. The Petitcodiac Group, situated on the southern and eastern flanks of the Caledonia Highlands, was divided on the basis of an angular unconformity into the tilted Boss Point Formation and the overlying Grand Anse Formation. The remainder of the group, situated north of the Caledonia Highlands, does not contain the angular unconformity and thus was not subdivided by Norman. The term is used in this report to refer to a sequence of clastic sediments composed of red and grey sandstone, claystone, siltstone, and conglomerate. The group conformably overlies the Hopewell Group; the upper contact is unknown for it is covered by the sea.

Distribution and Thickness

Undifferentiated Petitcodiac Group occurs north of the area of the Kingston Uplift and in the western part of the uplift near Berry Mills. At the former locality, Miller and Garland (1953, p. 225, Fig. 11) show the thickness on a gravity profile to be about 400 feet.

Lithology

North of the uplift, this group consists of thinly bedded yellowish orange to grey arkosic sandstone, red claystone, and red, fine-grained sandstone.

In the western part of the area of the uplift, near Berry Mills, a grey to yellowish orange, fine-grained, slightly calcareous and micaceous sandstone, some red claystone, siltstone, and grit are present.

Stratigraphic Relations

Gussow mapped the rocks at Berry Mills as part of the Boss Point Formation. However, the pebble conglomerate assemblage characteristic of the Boss Point Formation was not found; thus the area was mapped by the writer as the Petitcodiac Group.

Age

Sample number 9 taken from this group contained spores of the Lonchopteris zone of Westphalian C age (M.S. Barss, personal communication, 1963).

Boss Point Formation

Previous Use and Definition

This formation (map-unit 7) was first named by Bell (1914) for Divisions VI and VII of Logan's section at Joggins, Nova Scotia. It is composed of a lower part of red clastic rocks and an upper part of grey-yellow sandstone with some interbedded brick red shale. The upper part occurs at Boss Point, Nova Scotia.

Norman (1941b) used the term in Hillsborough map-area and confined it to a grey sandstone and a quartz pebble conglomerate, which is separated by an angular unconformity from overlying Grand Anse Formation. Gussow (1953) extended it into Moncton map-area and throughout the entire Moncton Basin. The angular unconformity was found to occur only near Shepody Bay and has been disregarded as a criterion for separating the Boss Point Formation from the overlying strata.

The Boss Point Formation, as used in this report, refers to the grey to yellowish orange, arkosic sandstone and pebble conglomerate that overlies the red beds of the Hopewell Group and is overlain probably disconformably by the red beds of the Salisbury Formation.

Distribution

This formation outcrops in the southeastern part of the map-area and has a maximum known thickness of about 240 feet, occurring in borehole number 13 (Appendix A).

Lithology and Petrography

The unweathered arkosic sandstone is grey and slightly calcareous; however, after being weathered, it loses its calcite cement, becomes friable, and acquires a yellowish orange colour due to limonite staining. The sandstone is strongly crossbedded to massive, and bedding may show channel structures.

The rudaceous components form a distinctive assemblage, which often occurs as channel conglomerate. They are composed of subrounded to rounded pebbles of white quartz, grey, pink, and purple rhyolite, grey to black quartzite, and red jasper in an arkosic matrix. Quartz is the most abundant type of pebble, which led previous investigators to describe the conglomerate as a quartz pebble conglomerate. However, in Moncton map-area the pebble assemblage is polymictic and the less abundant types of pebbles, such as the rhyolite and jasper, are the distinctive components of the conglomerate. Where this rock is exposed to weathering, it decomposes readily into gravel.

A minor amount of red claystone is interbedded between these two rock types. There are a few beds of grey claystone and manganiferous sandstone. Near the top of the formation a hard, more quartzose than usual sandstone occurs, which forms a distinctive bed that can be traced intermittently across the map-area.

The sandstone is medium grained and fairly well sorted. Quartz grains predominate, some of which show pressure welding and secondary overgrowths. The matrix comprises 10 to 30 per cent of the rock, and is composed of muscovite, biotite, chlorite, sericite, epidote, and clay minerals. The lithic fragments, 5 to 20 per cent, are composed of schists, quartzite, basalt, argillites, and siltstone. Minor amounts of hematite, leucoxene, and magnetite occur.

Age

Rock samples from this formation yielded spore assemblages listed in sample numbers 16 and 17 (Appendix B). The spores of sample 16 have early Pennsylvanian affinities and are older than the spores found in the Port Hood Formation of Cape Breton Island (M.S. Barss, personal communication, 1963); they are similar to microspore zone D of the Mabou Group of Nova Scotia (Belt, 1962, p. 311). Several spores of sample 16 are restricted to the Namurian in other parts of the world (M.S. Barss, personal communication, 1963). The spores of sample 17 were ascertained to be Pennsylvanian, but were not diverse enough to permit a more specific age determination.

Salisbury Formation

Previous Use and Definition

The name Salisbury Formation was proposed by Gussow for the red beds near the town of Salisbury, about 13 miles southwest of Moncton.

Gussow (1953, p. 1755) thought this formation was disconformably underlain by the Boss Point Formation and conformably overlain by the Scoudouc Formation.

The writer uses the term Salisbury Formation to refer to a predominantly red bed sequence at approximately the same stratigraphic position as originally proposed by Gussow. However, the nature of the basal contact is uncertain and is taken at the first grey quartzose sandstone or typical grey pebble conglomerate of the Boss Point Formation. The upper contact has been extended to include the lower part of Gussow's Scoudouc Formation and is therefore taken at the base of the grey sandstone of the Richibucto Formation.

Distribution and Thickness

The Salisbury Formation, which is mainly red claystone and siltstone, is not very resistant to erosion, and the few outcrops that are present are found mainly in creek beds. The formation underlies a large low area, which extends across the centre of the map-area, characterized by poor drainage and extensive swamps. A maximum known thickness of 1,100 feet occurs in borehole 14, 4 miles southwest of Moncton.

Lithology and Petrography

Red claystone and siltstone are the most abundant rock types observed in outcrop; they are interbedded with minor amounts of red and grey arkosic sandstone. A considerable amount of arkosic sandstone and conglomerate is present in the section cut by boreholes 14 and 15 (Appendix A). The conglomerate seen in the cores was composed of subangular, red and green claystone, quartzite, siltstone, schist, sandstone, argillite, and gneiss pebbles in a coarse arkosic sandstone matrix.

The sandstone is fine to medium grained and fairly well sorted. Subangular grains of quartz comprise 50 to 60 per cent of the rock; orthoclase is the dominant feldspar and makes up 20 to 25 per cent; it is generally partly altered to sericite. Rock fragments, biotite, amphibole, plagioclase, and muscovite occur in minor amounts. Hematite cement is disseminated throughout the rock.

Stratigraphic Relations

Gussow (1953, p. 1756) introduced the name Scoudouc Formation for strata composed of mainly grey, buff, and greenish arkosic sandstone, some quartzose sandstone and conglomerate, and several zones of red beds. It was based on the relative abundance of exposures on the headwaters of the Scoudouc River. The formation's lower contact was conformable with the Salisbury Formation and its upper contact was believed to be disconformable with the Richibucto Formation. The upper contact was marked by a zone of red beds, which have a weathered zone a few inches thick composed of stiff greenish to bluish green clay.

The writer was unable to verify in the field Gussow's lithologic criteria for introducing the name Scoudouc Formation. The headwaters of Scoudouc River are underlain by red claystone and siltstone, not grey sandstone. The greenish blue clay of the red beds of the upper contact does not represent a disconformity. This phenomenon is produced by groundwater percolating downward through a permeable sandstone until it intersects a highly impermeable claystone bed. There the groundwater flows laterally along the top of the claystone, creating a reducing environment and a change of colour from red to blue-green. For these reasons, the name Scoudouc Formation was discarded in this report, and the lower part of that formation containing the red beds in the Scoudouc River was included in the Salisbury Formation, while the upper part containing the grey-green arkosic sandstone was included in the Richibucto Formation.

Age

Spore sample number 1 was obtained from borehole 14 between depths of 948 and 1,109 feet in the western part of the map-area. Spores characteristic of the Lonchopteris zone were present in this sample along with spores characteristic of the Linopteris obliqua zone (M.S. Barss, personal communication, 1962). The enclosing strata were therefore deposited between Westphalian C and D times (Hacquebard, 1961, p. 239). Spores from sample number 5, taken from this formation in the eastern part of the map-area, are of Stephanian age (M.S. Barss, personal communication, 1963). Thus the Salisbury Formation is transgressive and becomes younger towards the eastern part of the map-area.

Richibucto Formation

Previous Use and Definition

The Richibucto Formation was proposed by Gussow (1953, p. 1757) for the good exposure of buff sandstone at the town of Richibucto, 36 miles north of Moncton. Gussow indicated that it disconformably overlay the Scoudouc Formation and that it was overlain by the red beds of the Tormentine Formation.

In this report the name Richibucto Formation (map-unit 9) is used for the yellowish orange to grey sandstone lying at approximately the same stratigraphic position. However, the underlying contact has been lowered stratigraphically to the top of the red beds of the Salisbury Formation and thus includes the upper part of Gussow's Scoudouc Formation. The lower contact is transitional, not disconformable. The upper contact with the red beds of the Tormentine Formation does not occur within the map-area.

Distribution and Thickness

The Richibucto occurs in the northeastern part of the map-area. The maximum known thickness within the map-area is 448 feet, in borehole number 7; however, this hole did not fully penetrate the formation. Since the sandstone is more resistant than the underlying claystone of the Salisbury

Formation, small cuestas are present at the contact. The hills within this area are underlain by sandstone.

Lithology and Petrography

The unweathered sandstone is grey and slightly calcareous, whereas the weathered sandstone is yellowish orange and friable. The sandstone is generally crossbedded, although in some places it is massive, and some channels are present. Manganese is disseminated throughout the rock, and numerous plant fragments, often broken and unidentifiable, occur within the sandstone. Along the coast, hard calcareous lenses of arkosic sandstone are well exposed; the periphery of these lenses is coated with manganese. Pyrite nodules, which often appear to be fossil remains, occur within the sandstone. These nodules have a white powdery rim, which was determined by X-ray analysis to be hexahydrite ($MgSO_4 \cdot 6H_2O$).

Red claystone is the next most common rock and some green and grey claystone is also present. A claystone pebble-conglomerate is often found overlying these rocks. Very minor amounts of coal are present in thin seams.

The weathered sandstone is composed of poorly sorted, equigranular, subrounded grains with minor amounts of matrix and little or no carbonate cement. The grains are commonly lithic fragments of schist, argillite, siltstone, quartzite, gneiss, and basalt, with 30 to 40 per cent subangular quartz grains. There are minor amounts of lithic fragments, muscovite, hematite, magnetite, chlorite, and leucoxene in the matrix.

Age

Sample number 15 was taken from an outlier of the Richibucto Formation in the centre of the map-area and contained spores characteristic of the Linopteris obliqua zone and the Ptychocarpus zone of Westphalian D time (M.S. Barss, personal communication, 1963).

Spore assemblage (sample number 13) of the Ptychocarpus zone, Westphalian D time, was obtained from the southwestern part of this formation. Spore assemblages (sample numbers 6 and 14) of Stephanian age (M.S. Barss, personal communication, 1963) were obtained from the remainder of the area. Thus the deposition of the beds of the Richibucto Formation started in Westphalian D time and transgressed into Stephanian time.

GEOLOGICAL IMPLICATIONS OF SPORE DATES

Analysis of the spore samples has yielded some interesting facts concerning the correlation, stratigraphic relations, and structural history of the rocks in the map-area. The time-stratigraphic zones established by these spore dates are delineated in Figure 1, and the correlation chart of the rock-stratigraphic units is shown in Table III.

TABLE III

CORRELATION CHART OF THE SEDIMENTS IN MONCTON MAP-AREA

Period	Formation or Group		Floral Zones (after Hacquebard et al., 1961)	European Time Stratigraphic Units
PENNSYLVANIAN	Petitcodiac Group	Richibucto Formation .6, .14, 5, 13, 15		Stephanian
			Ptychocarpus unitus zone	Westphalian D
		Salisbury Formation .1	Linopteris obliqua zone	
	.9		Lonchopteris zone	Westphalian C
		? Disconformity ?		Westphalian A and B
		Boss Point Formation .16, .17		Namurian
— ? — ? —	Hopewell Group			?
?				
Unconformity				
MISSISSIPPIAN	Boulder conglomerate unit	? Moncton Group .10		Tournaisian
		Albert Formation .7, .8, .11		
		.2, .4, .12 Memramcook Formation		
Devonian	?	.3		Famennian

.8 represents spore sample number.

MEMRAMCOOK FORMATION

In Memramcook Valley, the deposition of the Memramcook Formation transgressed from latest Devonian to earliest Mississippian time. This formation represents the first post-Acadian-orogeny sedimentation in the map-area, and indicates that the orogeny here ended prior to latest Devonian time.

In Cape Breton, the clastic sediments of the Horton Group represent the first deposition after this orogeny. The base of these sediments was laid down on an uneven pre-Carboniferous rock surface and thus transgresses throughout most of the Tournaisian age (Poole et al., 1965, Fig. 3).

It is reasonable to expect that as more spore dates become available from the Memramcook Formation throughout the Moncton Basin, its geometry with respect to its base and the uneven underlying surface of the Basement Complex and its time-transgressive nature, will be analogous to that of the base of the Horton Group in Cape Breton.

KINGSTON UPLIFT

In the area of the Kingston Uplift, five spore samples were obtained from the Memramcook Formation (number 12), the Albert Formation (numbers 7, 8, and 11) and the Moncton Group (number 10). All of these samples are very similar in spore content and are considered to be lowermost Mississippian in age. They are considered older than the Horton Bluff type section in Nova Scotia and are tentatively dated as older than the upper half of the Craignish Formation (lower Horton Group) on Cape Breton Island (M.S. Barss, personal communication, 1963).

The nearly flat-lying Petitcodiac Group (map-unit 10) overlies the Kingston Uplift at Berry Mills. These spores from sample number 9 yielded a Lonchopteris assemblage of Westphalian C age. Thus all that can be determined about the timing of the formation of the Kingston Uplift here, is that it was deformed after earliest Mississippian time and prior to Westphalian C time.

BOSS POINT FORMATION

In Moncton map-area, the spores from sample number 16 yielded a Namurian age; this is the oldest age recorded for this formation in New Brunswick.

South of the map-area two spore samples were collected by the author from this formation: number 18 at Slack's Cove on Chignecto Bay, and number 19 near Johnson Mills on Shepody Bay. They yielded spore assemblages similar to those found in the coal at Joggins of Westphalian B age (M.S. Barss, personal communication, 1963). Sample 19 is dated by Hacquebard and Donaldson (1964, p. 1168) as middle Westphalian B age; the same age is assumed by the author for sample number 18, which contains almost all the same spores as sample 19. This is the youngest known age found so far for this formation.

In the Cumberland structural basin of Nova Scotia, Belt (1965, Fig. 2) shows that the Boss Point Formation ranges from Namurian time into Westphalian A time. Thus in both Nova Scotia and New Brunswick the Boss Point Formation is a transgressive unit ranging from Namurian time to Westphalian A time, and in New Brunswick it ranges up to Westphalian B time.

Disconformity

Gussow (1953, p. 1755) on the basis of Bell's and Wright's fossil evidence, indicated a disconformity between the Boss Point and Salisbury Formations in which the sediments of Westphalian B age were missing. In the map-area, a relatively large time gap, Westphalian A to C, occurs over a short distance between the site of sample number 16 of Namurian age and the sites of samples 1 and 15 of Westphalian D age (Fig. 1). A time line (Fig. 1) has been drawn to coincide with the lithologic contact of these two formations implying a disconformity here; a disconformity is shown on Tables II and III.

SALISBURY AND RICHIBUCTO FORMATIONS

Facies Relationship

Neither the Salisbury nor the Richibucto Formation is an isochronous deposit. The Salisbury Formation is known to range from the Westphalian C and D contact up to Stephanian time, and the Richibucto Formation is known to range from Westphalian D to Stephanian time. Thus their deposition was not contemporaneous everywhere, but became progressively younger towards the east during the Pennsylvanian Period.

Parts of both the Salisbury and Richibucto Formations were deposited in Westphalian D and Stephanian time, lie in laterally adjacent positions, and become younger towards the east. Thus, throughout this common time interval, they are in facies relationship to one another; this is indicated in Tables II and III. An environment that might produce this situation could be a braided river system in the main channel of which grey sandstone was transported and deposited under reducing conditions, and in the adjacent backswamp areas of which silts and clays were exposed to dominantly oxidizing conditions.

Time Lines

Insufficient spore samples are present in the southeast corner of the Salisbury Formation to delineate clearly the boundary between Westphalian C and D time. In Figure 1, a dotted, curve line is drawn around sample 1. The position of this boundary is most uncertain; also the relationship between the base of this formation and the suspected disconformity is unknown.

Sample number 5 from the Salisbury Formation and sample numbers 13, 14, and 15 of the Richibucto Formation enable the delineation of the time line between Westphalian D and Stephanian time. Using this time

line here and its position in Prince Edward Island from Figures 1 and 2 in Barss et al. (1963), it is possible to calculate the dip of the time plane along various sections trending in a northeasterly direction from Moncton map-area to Prince Edward Island. The calculated dips vary between 0.29 and 0.36 minutes. This agrees with the dip, calculated from Figure 3 in Barss et al. (1963), which is 0.29 minutes for the same time plane north of the Kingston Uplift.

Although these values are apparent dips of the time plane, one of the sections is probably close to the true dip. As more spore dates become available for this interval, better estimates of the dip can be made. However, existing information permits one to suspect that at the beginning of Stephanian time the sediments were deposited on a regional slope of approximately half a degree.

SUMMARY

In mapping and describing the stratigraphy of Moncton map-area it became apparent that, in the past, time-stratigraphic and rock-stratigraphic units had been intermingled. These terms were separated, and to minimize confusion the time-restrictive terms, which had been used as lithologic units, are avoided as much as possible in this report.

The areal extent, the lithology, and the facies relationships of the rock types have been described. Knowledge of the facies relationships assists greatly in the comprehension of the environments and deposition of these rocks. The grey shales of the Albert Formation are intertongued with the boulder conglomerate, indicating lacustrine and piedmont environments occurring side by side. Also, these particular facies indicate the difficulty in using marker rocks, such as the grey shales of the Albert Formation, for subdividing other rocks. In the Moncton Basin, subdivision of the Mississippian red beds into the Memramcook Formation or the Moncton Group is made possible by determining whether the strata underlie or overlie the grey shales of the Albert Formation. However, the Albert Formation was found not to be deposited throughout the entire basin. In the Kingston Uplift, the red beds of the boulder conglomerate interfinger with the grey shales of the Albert Formation and extend stratigraphically above and/or below it. Thus, these rocks cannot be labelled as the Memramcook Formation or the Moncton Group and this criterion for subdividing these red beds is not valid throughout the basin.

The rock-stratigraphic units have been related to European time-stratigraphic units by means of spore assemblages determined by M.S. Barss. The dates obtained from the spore assemblages were indispensable in achieving a meaningful evaluation of the stratigraphy. The planes of time equivalence do not always parallel the boundaries between rock types, but often cut across them. The Memramcook, Boss Point, Salisbury, and Richibucto Formations all transgress the time transgressive zones, indicating that the lithologic entities are not isochronous deposits. Belt (1965) and Poole et al. (1965) have shown that some of the Carboniferous sediments in Nova Scotia are time transgressive also.

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APPENDIX A

GEOLOGICAL LOGS OF THE BOREHOLES

BOREHOLE NUMBER 1

Water well site number 1 — Drilled by G.S.C., June 1961
Elevation: 108 feet — Depth: 250 feet
Latitude, 46°02'55"N — Longitude, 64°47'20"W

0- 20	Overburden, sandy till.

SALISBURY FORMATION

20- 40	Conglomerate having a medium-grained matrix of quartz sand, stained reddish brown. Mainly quartz, greenstone, and feldspar pebbles, subangular to subrounded.
40- 50	Sandstone, red, medium to fine grained, minor amount of claystone.
50- 70	Claystone, reddish brown; minor amount of grey siltstone.
70- 80	Sandstone, grey to red, slightly calcareous, fine grained, mainly quartz, some red claystone.
80- 90	Claystone, sandstone, and siltstone, reddish brown.
90-120	Sandstone, red to grey, fine grained; subangular quartz grains; minor amounts of siltstone and claystone.
120-133	Claystone, red; some red siltstone.
133-138	Sandstone, yellow, very friable.
138-150	Claystone, reddish brown.
150-160	Claystone, reddish brown; siltstone, grey; sandstone, yellow, friable.
160-190	Claystone, red; siltstone, grey.
190-213	Claystone, red; minor amount of brown siltstone.
213-240	Sandstone, yellow; claystone, reddish brown.
240-250	Claystone, red and green; siltstone, grey.

BOREHOLE NUMBER 2

Water well site number 2 — Drilled by G.S.C., June 1961
Elevation: 130 feet — Depth: 400 feet
Latitude, 46°05'50"N — Longitude, 64°52'10"W

0- 50	Overburden, brown clay with rock fragments.

SALISBURY FORMATION

50- 60	Claystone, red to brown; siltstone, blue and red; minor amount of sandstone, red, arkosic.
60- 65	Claystone, red, soft to hard.
65- 70	Sandstone, grey, fine grained, with quartz and feldspar fragments.
70- 80	Sandstone, red, fine grained, arkosic, calcareous cement; claystone, red.
80-100	Sandstone, red to grey, angular quartz fragments; claystone, green.
100-120	Claystone, red; siltstone, red and blue.
120-190	Claystone, maroon; claystone, green; siltstone, red and blue; some quartz fragments present.

190-210	Siltstone, red; sandstone, red to white, medium-sized quartz and greenstone fragments.
210-240	Claystone, reddish brown; siltstone, red.
240-250	Claystone, red and green; siltstone, red; and a few quartz pebbles.
250-280	Claystone, reddish brown; sandstone, arkosic.
280-290	Claystone, red and green; sandstone, light brown, with quartz fragments.
290-340	Claystone, reddish brown; siltstone, micaceous; and a few very fine grained, grey sandstone fragments.
340-370	Claystone, reddish brown to grey; sandstone, grey, fine grained; some angular quartz pebbles.
370-390	Claystone, reddish brown; sandstone similar to above.

BOREHOLE NUMBER 3

Water well number 3 — Drilled by G.S.C., June 1961
Elevation: 7 feet — Depth: 195 feet
Latitude, 46°05'30"N — Longitude, 64°45'20"W

0- 36	Overburden, brownish red clay.

SALISBURY FORMATION

36- 45	Claystone, brown to grey, non-friable; sandstone, medium grained.
45-100	Claystone, dominantly red, some grey-green, friable; silty lenses present up to 10%, some subangular quartz grains present.
100-120	Claystone, reddish brown and grey-green, friable; siltstone, red and grey, poor parting, grading up to a fine-grained sandstone containing greenstone and pink feldspar grains, some coal present.
120-190	Claystone, dark brown, occasionally greenish brown, moderately friable; minor amounts of siltstone and sandstone composed mainly of quartz and greenstone.
190-195	Sandstone, greenish grey, very fine grained, calcareous cement, whitish grey quartz and greenstone.

BOREHOLE NUMBER 4

Water well site 4 — Drilled by G.S.C., July 1962
Elevation: 192 feet — Depth: 181 feet
Latitude, 46°09'35"N — Longitude, 64°40'40"W

0- 7	Overburden, sandy till.

RICHIBUCTO FORMATION

7- 33	Sandstone, green to grey, fine grained, micaceous, equigranular, subangular quartz and greenstone fragments, slightly calcareous; minor amount of red claystone.

33- 44	Sandstone, green, micaceous; claystone, red and green.
44- 77	Sandstone, blue-grey, fine grained, hard mainly quartz fragments; some red claystone.
77- 95	Claystone, green, calcareous; siltstone and sandstone containing grey quartz and pink feldspar fragments.
95-117	Claystone, green and red; quartz and mica fragments, some coal.
117-135	Sandstone, green, fine to medium grained; claystone, red and green; some coal.
135-155	Claystone, red, about 50%, some green claystone; sandstone, green, fine grained; some coal.
155-175	Sandstone, green, fine to medium grained, mainly quartz.

SALISBURY FORMATION

175-181	Claystone, red.

BOREHOLE NUMBER 5

Water well site number 5 — Drilled for G.S.C., July 1962
Elevation: 170 feet — Depth: 260 feet
Latitude, 46°04'15"N — Longitude, 64°40'40"W

0- 3	Overburden.

SALISBURY FORMATION

3- 44	Sandstone, red, fine grained, composed of quartz, greenstone, feldspar and mica grains, some red claystone.
44- 74	Claystone, red and green; sandstone, red to white, fine grained.
74-107	Sandstone, red to grey, medium grained; siltstone; claystone, red and green.
107-129	60% siltstone to fine-grained sandstone, red; 15% sandstone, green, medium grained, 15% sandstone, grey to white; 10% claystone, green.
129-162	Claystone, red to grey, micaceous; siltstone to fine-grained sandstone, green to white.
162-204	Claystone, dominantly reddish brown, some green; siltstone, greenish white.
204-238	Sandstone, red, medium grained, soft, mainly subangular quartz; claystone, reddish brown.
238-248	Claystone, red and green, hard; a few quartz fragments present.
248-260	Sandstone, red, fine grained.

BOREHOLE NUMBER 6

Water well site number 6 — Drilled for G.S.C., August 1962
Elevation: 105 feet — Depth: 282 feet
Latitude, 46°10'15"N — Longitude, 64°32'40"W

0- 10	Overburden, red clayey till.

RICHIBUCTO FORMATION

10- 46	Sandstone, white to green, fine grained, mainly quartz, some greenstone; claystone, red.

SALISBURY FORMATION

46- 81	Siltstone and claystone, red, slightly calcareous.
81- 93	Claystone, red; siltstone, green to grey, slightly calcareous.
93-139	Claystone, red; 10% siltstone, grey, slightly calcareous.
139-172	Claystone, red; sandstone, dark grey, fine grained.
172-183	50% claystone, red; 50% sandstone, grey, fine grained, quartz and greenstone fragments present.
183-205	Claystone and siltstone, red.
205-260	Sandstone, grey, fine grained; claystone, reddish brown.
260-271	Sandstone, grey, fine grained; claystone, reddish brown.
271-282	Sandstone, grey to green, fine grained.

BOREHOLE NUMBER 7

Shediac's water well — Drilled by Eastern Drillers, Fall 1961
Elevation: 65 feet — Depth: 448 feet
Latitude, 46°12'50"N — Longitude, 64°32'50"W

RICHIBUCTO FORMATION

0- 44	Sandstone, yellow to grey, fine grained, subangular quartz and greenstone fragments.
44- 64	Claystone, reddish brown having a little green mottling; siltstone, reddish brown.
64-150	Sandstone, grey to green, fine to medium grained, quartz, feldspar, and greenstone fragments.
150-177	Sandstone, grey to green; claystone, grey.
177-212	Claystone and siltstone, reddish brown.
212-244	Sandstone, reddish brown, fine to coarse grained; claystone, maroon; some coal fragments.
244-256	Claystone, reddish brown; siltstone, reddish brown and green, slightly calcareous; some coal and pyrite fragments.
256-361	Sandstone, grey to green, fine to medium grained, mainly quartz, some mica, feldspar, and greenstone.
361-382	Sandstone, siltstone, and claystone, grey to green; some coal fragments. Spore sample number 6.
382-395	Claystone, siltstone, and sandstone, grey to green; some reddish brown claystone; coal and pyrite fragments.
395-403	Sandstone, grey to green, fine grained, angular fragments. Spore sample number 6.
403-448	Coarse-grained sandstone, siltstone, and claystone, grey to green, calcareous; coal and pyrite fragments. Spore sample number 6.

BOREHOLE NUMBER 8

Water well site 8A
Elevation: 215 feet
Latitude, 46°11'25"N

Drilled for G.S.C., August 1962
Depth: 176 feet
Longitude, 64°46'45"W

0- 10	Overburden

RICHIBUCTO FORMATION

10- 33	Claystone, reddish brown; sandstone, grey, fine grained.
33- 51	Sandstone, grey to green, fine grained, mainly quartz, feldspar, and greenstone.
51- 55	Claystone, green, calcareous.
55- 66	Siltstone and fine-grained sandstone, grey to green, mainly sub-angular quartz, mica, and feldspar fragments.
66-110	Sandstone, green to grey, fine to medium grained, mainly subangular quartz, feldspar, and greenstone; some coal fragments.
110-176	Sandstone, green to grey, medium to coarse grained, calcareous, micaceous; a few quartz pebbles.

BOREHOLE NUMBER 9

Water well site number 9
Elevation: 310 feet
Latitude, 46°06'05"N

Drilled for G.S.C., August 1962
Depth: 54 feet
Longitude, 64°59'55"W

0- 13	Overburden.

PETITCODIAC GROUP

13- 18	Sandstone, green to grey, fine grained, slightly calcareous; claystone grey; quartz pebbles.
18- 41	Sandstone to siltstone, grey to brown, mainly quartz, micaceous.
41- 46	Sandstone, brown, fine grained, calcareous, micaceous; a few subrounded quartz pebbles.
46- 57	Claystone, reddish brown, micaceous; siltstone maroon, calcareous, micaceous.

BOREHOLE NUMBER 10

Test well number 1
Elevation: 50 feet
Latitude, 46°06'05"N
Logged by O.P. Boggs

Drilled by Maritime Oilfields Ltd.
Depth: 1220 feet
Longitude, 64°43'50"W

1- 25	Overburden

SALISBURY FORMATION

25- 125	Soft red shale.
125- 130	Boulder conglomerate.
130- 285	Red shale.
285- 300	Grey sandstone.
300- 360	Red shale.
360- 550	Red sandstone.

BOSS POINT FORMATION

550- 670	Grey sandstone. Fourteen gallons per minute of salty water.
670- 685	Grey and red shales.

HOPEWELL GROUP

685- 975	Red conglomerate.
975- 985	Dark coloured limestone.
985-1220	Sandstone, feldspar fragments.

BOREHOLE NUMBER 11

Test well number 51
Logged by G.W.H. Norman
Elevation: 175 feet
Latitude, 46°00'20"N

Drilled by New Brunswick Gas and Oilfields Ltd. in 1918
Depth: 1292 feet
Longitude, 64°42'25"W

0- 18	Overburden.

BOSS POINT FORMATION

18- 59	Quartz pebble conglomerate.
59- 70	Grey shale.
70- 93	Quartz pebble conglomerate.
93- 102	Red shale.
102- 135	Medium-grained white quartz sandstone.

HOPEWELL GROUP

135- 185	Reddish brown shale and grey limestone.
185- 222	White quartz sandstone.
222- 293	Grey to red quartz feldspar grit.
293- 328	Coarse red feldspathic grit.
328- 334	Reddish brown shale.
334- 340	Grey fine-grained sandstone.
340- 365	Coarse red feldspathic grit.
365- 403	Grey coarse grit, white feldspar and quartz.

ALBERT FORMATION

403- 416	Grey, medium-grained sandstone.
416- 434	Grey shale.
434- 547	Coarse, grey to white feldspathic grit; grey, medium-grained sandstone and shale.

547- 596	Grey shale interbedded with grey, medium-grained sandstone.
596- 615	Coarse, white feldspathic grit and grey sandstone.
615- 632	Interbedded grey sandstone and shale.
632- 672	Coarse, grey to white feldspathic grit, minor grey sandstone interbeds.
672- 704	Grey sandstone, minor grit.
704- 837	Greyish black shale and interbedded grey sandstone.
837- 854	Grey shale and medium- to coarse-grained, grey sandstone.
854- 862	Coarse grit.
862- 968	Grey shale interbedded with medium- to coarse-grained, grey sandstone.
968- 979	Light reddish brown sandstone.
979-1048	Grey, medium-grained sandstone interbedded with grey shale.

MEMRAMCOOK FORMATION

1048-1297	Reddish brown shale, light reddish brown, medium- to coarse-grained sandstone and coarse arkose.

BOREHOLE NUMBER 12

Test well number 52
Logged by G.W.H. Norman
Elevation: 68 feet
Latitude, 46°03'05"N

Drilled by New Brunswick Gas and Oilfields Ltd.
Depth: 2860 feet
Longitude, 64°44'00"W

0- 15	Overburden.

BOSS POINT FORMATION

15- 50	Reddish brown marly shale fragments to coarse grit.
50- 95	Quartzitic sandstone and grit.
95- 130	Reddish brown arenaceous shale.
130- 140	Coarse-grained reddish feldspathic sandstone.
140- 160	Reddish brown arenaceous shale.
160- 170	Grey fine-grained feldspathic grit.
170- 245	Coarse quartz grit and sandstone.

HOPEWELL GROUP

245- 280	Reddish brown shale, a little soft grey shale.
280- 300	Bright reddish shale interbedded with impure limestone.
300- 310	Reddish brown arenaceous shale.
310- 330	Fine-grained grey sandstone.
330- 350	Fine-grained grey sandstone and reddish brown arenaceous shale.

BASEMENT COMPLEX

350-2860	Red granites, chlorite schists. Small flow of salty water at 625, 1045, and 1700 feet.

BOREHOLE NUMBER 13

Test well number 92
Logged by G. W. H. Norman
Elevation: 114 feet
Latitude, 46°01'40"N
Drilled by New Brunswick Gas and Oilfields Ltd. in 1931
Depth: 758 feet
Longitude, 64°42'55"W

BOSS POINT FORMATION

0- 76	Reddish brown claystone and siltstone.
76- 120	Sandstone, greenish grey, fine grained, hard, and slightly calcareous.
120- 141	Quartz conglomerate, grey, well-rounded pebbles. Three hundred and sixty barrels per day of fresh water.
141- 173	Sandstone, dark brown to grey, fine grained, having bands of quartz pebbles.
173- 189	Sandstone, dark brown to red, fine grained; claystone, red and green.
189- 203	Claystone, dark red, some brown limestone and grey grit.
203- 243	Sandstone, light grey to green, fine to medium grained; red claystone and some white quartz pebbles.

HOPEWELL GROUP

243- 355	Grit and conglomerate, red, granitic, with greenish grey, fine-grained sandstone.

BASEMENT COMPLEX

355- 758	Granite, chlorite schists. Flow of brine encountered between 393 and 656 feet, flowed at a rate of 4 barrels per day.

BOREHOLE NUMBER 14

Moncton Hump Yard water well
Elevation: about 125 feet
Latitude, 46°04'25"N
Abstracted from log of R. D Howie
Drilled by W. Chappel in 1962
Depth: 1112 feet
Longitude, 64°52'35"W

Only information available between 0 and 856 feet was from the driller.

0- 35	Mud.

SALISBURY FORMATION

35- 856	Sandstone and soft shale.
856- 873	Claystone to siltstone, dark purplish brown with greenish grey mottling, rubbly fracture.
873- 882	Siltstone, yellow-grey to dark purple, some claystone purplish brown.
882- 887	Siltstone and claystone dark purplish brown or purplish grey.
887- 897	Sandstone, dark purplish brown to grey, fine to medium grained.

897- 927	Claystone to siltstone dark purplish grey, few greenish grey blotches.
927- 940	Siltstone to fine-grained sandstone, dark purplish grey. Dip about 10 degrees, little claystone.
940- 951	Sandstone, green to grey, medium to fairly coarse grained; little grey claystone and siltstone.
951- 956	Siltstone to fine-grained sandstone, purplish brown or purplish grey, calcareous. Dip about 10 degrees.
956- 974	Claystone and siltstone purplish grey and purplish brown.
974- 989	Claystone to siltstone, dark green to grey, contains pyrite and plant fragments.
989- 998	Sandstone, green to grey, medium to coarse grained to conglomerate, few pebbles up to 15 mm diameter of feldspar, greenstone, grey chert, and quartzite. Dip about 8 degrees.
998-1008	Siltstone to fine-grained sandstone, grey with purplish cast; claystone, purplish grey or brown.
1008-1019	Siltstone and claystone, mottled purplish grey.
1019-1030	Sandstone, very fine grained with thin interbeds of siltstone, purplish grey; highly crossbedded.
1030-1044	Claystone to siltstone, dark purple to grey, some pale greenish grey streaks.
1044-1112	Siltstone, pale grey to green, claystone dark purple.

BOREHOLE NUMBER 15

Diamond drill hole number 4 — Drilled by Spear and Northrup in 1963
Elevation: 148.6 feet — Depth: 235 feet
Latitude, 46°00'05"N — Longitude, 65°53'30"W

0- 90	Overburden.

SALISBURY FORMATION

90- 106	Claystone and siltstone, reddish brown; some mottled green claystone and siltstone.
106- 110	Sandstone, red, fine grained.
110- 113	Sandstone, green and red, fine grained, greenstone fragments present.
113- 117	Sandstone, red, fine grained, intercalated with red shale seams about 1 mm thick.
117- 118	Sandstone, green, medium grained.
118- 121	Claystone, mottled red and blue.
121- 133	Siltstone grading to a fine-grained sandstone, red.
133- 137	Claystone and siltstone intercalated, red.
137- 146	Sandstone, grey, medium grained, containing red claystone fragments.
146- 149	Conglomerate of red claystone fragments half an inch long by a quarter of an inch wide in a coarse sandstone matrix.
149- 152	Sandstone, light red to grey.
152- 156	Claystone, yellowish brown mottled in part to a blue-green colour.
156- 160	Claystone, blue-green, partly mottled red.
160- 192	Intercalated claystone and siltstone, red, some green mottling present.

192- 193	Siltstone, yellowish brown.
193- 203	Claystone, blue-green, partly mottled.
203- 206	Sandstone, grey to light red, fine to medium grained.
206- 207	Grit, angular quartz, feldspar and claystone fragments.
207- 212	Missing.
212- 222	Sandstone, grey to white, having occasional red claystone fragments; conglomerate, angular to subangular fragments of red, and green claystone, greenstone, quartz, and feldspar fragments.
222- 235	Claystone, red.

APPENDIX B

LIST, AGE, AND LOCATION OF SPORE SAMPLES IDENTIFIED

List and age of spores identified by M.S. Barss and location of the samples. The Devonian spores (sample numbers 2, 3, and 4) were identified by D.C. McGregor.

No. 1. Coal Research Section (C.R.S.) Nos. 446 to 449 and 452 to 454, taken from Borehole 14 at depths of 948, 988, 1105, 1107, and 1109 feet. Latitude 46°04'25"N and Longitude 64°52'35"W. Near the boundary between the Lonchopteris and Linopteris obliqua zones. Salisbury Formation.

Spores identified:

- Calamospora spp.
- Cyclogranisporites spp.
- Lophotriletes sp.
- Endosporites sp.
- Laevigatosporites spp.
- Raistrickia sp.
- Punctatisporites sp.
- Vestigisporites sp.
- Vestispora costata (Balme) Bharadwaj
- Apiculatisporis sp.
- Knoxisporites sp.
- Guthorlisporites sp.
- Punctatosporites sp.
- Leiotriletes sp.
- Granulatisporites spp.
- Verrucosisporites sp.
- Florinites sp.
- Dictyotriletes sp.
- Foveolatisporites spp.
- Convolutispora sp.
- Latensina sp.
- Acanthotriletes sp.
- Lycospora spp.
- Wilsonites sp.

No. 2. G.S.C. locality (loc.) 6452. On an azimuth of 350 degrees, 2.7 miles from Memramcook village. Probably latest Devonian. Memramcook Formation.

Spores identified:

- ? Ancyrospora sp.
- Cyclogranisporites sp.
- Emphanisporites rotatus McGregor
- Hystricosporites sp.
- Perotrilites = Hymenozonotriletes hyalinus Kedo
- Perotrilites (2 species)
- Stenozonotriletes sp.
- Veryhachium brevitrispinum Staplin (acritarch)

No. 3. G.S.C. loc. 6453. On an azimuth of 280 degrees, 1.6 miles from Memramcook village. Probably latest Devonian. Memramcook Formation.

Spores identified:

- cf. Archaeozonotriletes dedaleus Kedo
- Calyptosporites sp.
- Convolutispora sp.
- Cyclogranisporites sp.
- Dictyotriletes submarginatus Playford
- Emphanisporites rotatus McGregor
- Granulatisporites crenulatus Playford
- Leiotriletes sp.
- Perotrilites sp. cf. Diaphanospora riciniata Balme and Hassell
- Perotrilites sp. = Hymenozonotriletes hyalinus Kedo

Punctatisporites sp.
Retusotriletes simplex Naumova
Retusotriletes sp.
Verrucosisporites (3 species)

No. 4. G.S.C. loc. 6454, 0.8 of a mile due north of Memramcook village. Probably earliest Mississippian. Memramcook Formation.

Spores identified:
Acanthotriletes cf. A. hacquebardii Playford
Apiculatasporites sp.
cf. Archaeozonotriletes dedaleus Kedo
Grandispora (Spinozonotriletes) sp.
cf. Lagenicula devonica Chaloner
Perotrilites sp. = Hymenozonotriletes hyalinus Kedo
Punctatisporites sp.
Retusotriletes sp.
Verrucosisporites congestus Playford
V. papulosus Hacquebard
Verrucosisporites sp.

No. 5. G.S.C. loc. 6555, C.R.S. No. 506/B481. In Scoudouc River, on an azimuth of 262°, 1.2 miles from the intersection of the Scoudouc River and Highway 32. Stephanian age. Salisbury Formation.

Spores identified:
Foveolatisporites sp.
Laevigatosporites spp.
Granulatisporites spp.
Calamospora spp.
Punctatosporites sp.
Apiculatasporites sp.
Verrucosisporites sp.
Lophotriletes sp.
Florinites sp.
Potonieisporites sp.
Protohaploxypinus sp.
Lycospora spp.
Cyclogranisporites spp.
Triquitrites sp.
Thymospora sp.
Crassosporites sp.
Raistrickia sp.
Leiotriletes spp.
Vestigisporites sp.
Wilsonites sp.
cf. Latensina
cf. Pityosporites sp.
Gen. Nov. A.

No. 6. G.S.C. loc. 6556, C.R.S. No. 509/B482 and No. 510/B483. From Shediac's water well (borehole number 7) at depths of 362-382 feet and 389-428 feet. Latitude 46°12'50"N and longitude 64°32'0"W. Stephanian age. Richibucto Formation.

Spores identified: No. 509/B482
Speciosporites sp.
Lycospora sp.
Laevigatosporites spp.
Punctatosporites sp.
Crassosporites sp.
Leiotriletes sp.
Calamospora spp.
Raistrickia spp.
Foveolatisporites sp.
Triquitrites sp.
Florinites sp.
Vestigisporites sp.
Gen. Nov. A.
Protohaploxypinus sp.

No. 6. G.S.C. loc. 6556, C.R.S. No. 510/B483.
Spores identified; No. 510/B483

Punctatosporites sp.
Laevigatosporites spp.
Lycospora spp.
Raistrickia sp.
Triquitrites sp.
Speciosporites sp.
cf. Savitrisporites sp.
Thymospora sp.
Cyclogranisporites spp.
Foveolatisporites sp.
Apiculatisporis sp.
Reticulatisporites sp.
Calamospora spp.
Verrucosisporites sp.
Illinites sp.
Wilsonites sp.
Protohaploxypinus sp.
Potonieisporites sp.
Florinites sp.
cf. Pityosporites sp.

No. 7. G.S.C. loc. 6557, C.R.S. No. 511/B509. Azimuth of 168°, 1.0(5) miles from Stiles village. Earliest Mississippian. Albert Formation.

Spores identified:

Convolutispora spp.
Leiozonotriletes sp.
Punctatisporites spp.
Calamospora spp.
Retusotriletes spp.
Raistrickia spp.
Leiotriletes spp.
Verrucosisporites spp.
Lycospora sp.
Grandispora sp.
cf. Apiculatisporis sp.
Endosporites sp.
cf. Lophozonotriletes sp.
Convolutispora cf. finis Love
Leiotriletes tortilis Playford
Vallatisporites verrucosus Hacquebard
Raistrickia cf. baculosa Hacquebard
Corverrucosisporites parvinodosus Playford
Verrucosisporites cf. congestus Playford

No. 8. G.S.C. loc. 6558, C.R.S. No. 512/B510. Azimuth of 167°, 1.1 miles from Stiles village. Earliest Mississippian. Albert Formation.

Spores identified:

Leiotriletes spp.
cf. Knoxisporites sp.
Retusotriletes spp.
Gulisporites sp.
Verrucosisporites spp.
Punctatisporites spp.
Leiozonotriletes sp.
Stenozonotriletes sp.
Granulatisporites sp.
cf. Vallatisporites sp.
cf. Camptotriletes sp.
Vallatisporites cf. vallatus Hacquebard
Leiotriletes tortilis Playford
Reticulatisporites spp.
Apiculatasporites sp.
Grandispora spp.
Convolutispora spp.
Calamospora sp.
Endosporites sp.
Dictyotriletes sp.
Raistrickia spp.
cf. Triquitrites sp.
Foveosporites insculptus Playford
Perotrilites perinatus Hughes and Playford
Verrucosisporites congestus Playford
Lycospora cf. magnifica McGregor

No. 9. G.S.C. loc. 6848, C.R.S. No. 739/B586. In the blue clay on the high bank on the south side of the Trans-Canada Highway at Berry Mills. Lonchopteris zone, Westphalian C age. Petitcodiac Group.

Spores identified:

Leiotriletes sp.
Florinites sp.
Densosporites sp.
Apiculatasporites sp.
Cirratriradites sp.
Endosporites sp.
Lophotriletes sp.
Calamospora spp.
Camptotriletes sp.
Lycospora spp.
Foveolatisporites sp.
Raistrickia sp.
Punctatosporites sp.
Acanthotriletes sp.
Cyclogranisporites sp.
Punctatisporites sp.
Laevigatosporites spp.
Vestispora costata (Balme) Bharadwaj

No. 10. G.S.C. loc. 6849, C.R.S. No. 740/B590. On an azimuth of 239°, 5.4 miles from Stiles village. Earliest Mississippian. Moncton Group.

Spores identified:

Verrucosisporites spp.
Knoxisporites sp.
Leiotriletes sp.
Calamospora spp.
Stenozonotriletes sp.
Granulatisporites sp.
Punctatisporites spp.
cf. Retusotriletes spp.
Leiotriletes tortilis Playford
cf. Perotrilites spp.
Apiculatisporis sp.
Cyclogranisporites sp.

No. 11. G.S.C. loc. 6850, C.R.S. No. 741/B587. On an azimuth of 227°, 2.9 miles from Stiles village. Earliest Mississippian. Albert Formation.

Spores identified:

Leiotriletes tortilis Playford
Cyclogranisporites spp.
Leiozonotriletes sp.
Verrucosisporites spp.
Leiotriletes spp.
Endosporites sp.
Calamospora spp.
Knoxisporites sp.
Spinozonotriletes sp.
Converrucosisporites parvinodosus Playford
Stenozonotrilites extensus var. major Naumova
Retusotriletes cf. avonensis Playford
Stenozonotriletes spp.
Punctatisporites spp.
Retusotriletes spp.
Raistrickia sp.
Perotrilites spp.
Convolutispora spp.
Lycospora sp.
cf. Gulisporites sp.
Camptotriletes sp.

No. 12. G.S.C. loc. 6853, C.R.S. No. 745/B588. On an azimuth of 50°, 6.6 miles from Stiles village. Earliest Mississippian. Memramcook Formation.

Spores identified:

Convolutispora spp.
Grandispora sp.
Spinozonotriletes sp.
Gulisporites sp.
Verrucosisporites congestus Playford
Leiozonotriletes sp.
Perotrilites spp.
Verrucosisporites spp.
cf. Knoxisporites sp.
Retusotriletes spp.
Punctatisporites spp.
Cristatisporites cf. aculeatus (Hacquebard) Potonié
Acanthotriletes hacquebardii Playford
Convolutispora flexuosa Hacquebard

No. 13. G.S.C. loc. 6855, C.R.S. No. 747/B616. On an azimuth of 141°, 3.5 miles from Stiles village. Ptychocarpus unitus zone, Westphalian D age. Richibucto Formation.

Spores identified:

Speciososporites sp.
Verrucosisporites spp.
Leiotriletes sp.
Murospora Kosankei Somers
Laevigatosporites spp.
Florinites spp.
Lophotriletes spp.
Acanthotriletes sp.
cf. Guthorlisporites sp.
Triquitrites spp.
Vestigisporites sp.
Illinites sp.
Cirratriradites sp.
cf. Savitrisporites sp.
Verrucososporites sp.
Cyclogranisporites spp.
Lycospora spp.
Punctatosporites sp.
Calamospora sp.
Granulatisporites spp.
Dictyotriletes sp.
Latensina sp.
Convolutispora sp.
Endosporites sp.
Foveolatisporites spp.
Converrucosisporites sp.
Planisporites sp.
Anulatisporites sp.
Apiculatisporis sp.

No. 14. G.S.C. loc. 6856, C.R.S. No. 748/B617. On an azimuth of 242°, 0.4 of a mile from borehole 8. Stephanian age. Richibucto Formation.

Spores identified:

Potonieisporites sp.
Leiotriletes spp.
Protohaploxypinus sp.
Florinites spp.
Vestigisporites sp.
Cyclogranisporites spp.
Vesicaspora sp.
Latosporites sp.
Illinites sp.
Laevigatosporites spp.
Triquitrites sp.
Calamospora spp.
Converrucosisporites sp.
Endosporites sp.
Punctatosporites sp.

No. 15. G.S.C. loc. 6857, C.R.S. No. 749/B589. A coal seam on the south side of the Trans-Canada Highway on an azimuth of 96 degrees, 1.4 miles from the intersection of this highway and Highway 11. Linopteris obliqua or Ptychocarpus unitus zone, Westphalian C and D age. Richibucto Formation.

Spores identified:

Calamospora spp.
Triquitrites spp.
Foveolatisporites spp.
Granulatisporites spp.
Punctatosporites sp.
Florinites spp.
Speciososporites sp.
Crassosporites sp.
Apiculatisporis sp.
Verrucososporites sp.
Laevigatosporites spp.
Lycospora spp.
Cyclogranisporites spp.
Verrucosisporites spp.
Converrucosisporites sp.
Lophotriletes spp.
Endosporites sp.
Latensina sp.
Apiculatasporites sp.
Wilsonites sp.

No. 16. G.S.C. loc. 6858, C.R.S. No. 750/B591. On the east shore of the Petitcodiac River, on an azimuth of 205°, 2.3 miles from borehole 5. Pennsylvanian, Namurian. Boss Point Formation.

Spores identified:

Florinites sp.
Endosporites sp.
Granulatisporites spp.
Apiculatasporites sp.
Knoxisporites sp.
Perotrilites spp.
Acanthotriletes sp.
cf. Cristatisporites sp.
Knoxisporites seniradiatus Neves
Auroraspora solisortus Hoffmeister, Staplin and Malloy
Microreticulatisporites cf. fundatus Hoffmeister, Staplin and Malloy
Grandispora echinata Hacquebard
Cyclogranisporites spp.
Leiotriletes sp.
Calamospora spp.
Convolutispora spp.
Punctatisporites spp.
Verrucosisporites spp.
Leiozonotriletes sp.
Schopfipollenites sp.

No. 17. G.S.C. loc. 6561, C.R.S. No. 518A/B513. On an azimuth of 90°, 0.1 of a mile from borehole 11. Pennsylvanian. Boss Point Formation.

Spores identified:

Lycospora spp.
Cyclogranisporites sp.
Leiotriletes sp.
Granulatisporites sp.
Laevigatosporites sp.
Florinites sp.
Verrucosisporites spp.
Calamospora sp.
cf. Triquitrites sp.
cf. Callisporites nux Butterworth and Williams
Schopfipollenites ellipsoides (Ibrahim) Potonié and Kremp

No. 18. G.S.C. loc. 6562, C.R.S. No. 519/B484. From a coal seam at Slack's Cove on Chignecto Bay, approximately midway between Cape Maringouin and Rockport in the Alma map-area; Westphalian B, Boss Point Formation.

Spores identified:

Lycospora spp.
Lophotriletes sp.
Granulatisporites spp.
Verrucosisporites spp.
Raistrickia sp.
Laevigatosporites spp.
Punctatisporites sp.
Apiculatasporites sp.
cf. Callisporites nux Butterworth and Williams
Leiotriletes sp.
Calamospora spp.
Cyclogranisporites spp.
Florinites sp.
Apiculatisporis sp.
Punctatosporites sp.
Endosporites sp.
Convolutispora sp.
cf. Converrucosisporites sp.
Schopfipollenites sp.

No. 19. G.S.C. loc. 6563, C.R.S. No. 520/B514. In a coal seam exposed on the east shore of Shepody Bay midway between Cape Maringouin and Grand Anse Bay, about one mile south of Johnson Mills in the Hillsborough map-area; Westphalian B, Boss Point Formation.

Spores identified:

Lycospora spp.
Granulatisporites sp.
Calamospora spp.
Lophotriletes sp.
Cyclogranisporites sp.
Verrucosisporites sp.
Florinites sp.
Convolutispora spp.
Punctatisporites sp.
Leiotriletes sp.
Punctatisporites spp.
Laevigatosporites spp.
Apiculatisporis sp.