DEVONIAN STRATIGRAPHY
OF LAKE MANITOBA-LAKE WINNIPEGOSIS AREA, MANITOBA

A Thesis

Presented to

the Faculty of Graduate Studies

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Andrew D. Baillie

May 1950

CONTENTS

PAGE

PAGE

ILLUSTRATIONS

DEVONIAN STRATIGRAPHY OF LAKE MANITOBA-LAKE WINNIPEGOSIS AREA, MANITOBA

INTRODUCTION

GENERAL STATEMENT

During the field season of 1949 the writer studied and mapped the Devonian strata outcropping in the Lake Manitoba-Lake Winnipegosis area of Manitoba. The Devonian formations constitute the bedrock in a linear belt that extends in a northwest direction from the east shore of Lake Manitoba, at about latitude 50° 20' North, to the west shore of Dawson Bay at latitude 53° 10'. The belt is approximately 240 miles long and from 25 to 45 miles wide. The area includes all the known Devonian outcrops in Manitoba.

PREVIOUS WORK

The first detailed geological report that includes the area was made by Tyrrell(1892) for the Geological Survey of Canada. This excellent account describes in detail the Palaeozoic outcrops on the shore and islands of Lake Manitoba and Lake Winnipegosis and has proved an invaluable aid to the writer during the field season.

Tyrrell(p. 199E) divided the Devonian strata in Manitoba into three divisions as follows:

Upper Devonian . . . . . Manitoban formation

Middle Devonian. . . . . Winnipegosan formation

Lower Devonian . . . . . red argillaceous shales

The report also contains lists of the fossils collected from the Manitoban and Winnipegosan formations.

Detailed palaeontological work on the fossil faunas of the Devonian of Manitoba was done by J. F. Whiteaves of the Geological Survey of Canada who visited the area with Tyrrell. He determined many new species and among the fossils collected he identified Stringocephalus burtini Defrance. Whiteaves pointed out the close relationship between the faunas of the Devonian of Manitoba and the Devonian of Europe(Whiteaves 1890 and 1892).

Kindle(1914 pp. 251-255) reported further on the Devonian stratigraphy and established the Elm Point limestone as the oldest Devonian formation outcropping in Manitoba. He assigned the red argillaceous rock, stated by Tyrrell to be Lower Devonian, to the upper part of the Silurian. He also showed that the fauna of the upper part of the Manitoban formation was unlike that of the lower and divided the formation into two faunal zones.

In 1925, Wallace published a summary of the geological formations in Manitoba in which the Devonian stratigraphy is summarized. He described the doming which occurs in the Devonian formations but stated that there was no adequate explanation of the structures. A very complete bibliography is included in the report.

Dr. S. R. Kirk of the Geological Survey of Canada studied the area between the International Boundary and latitude 52 degrees during 1928, 1929, and 1930. His work on the Palaeozoic has not been published, but his manuscript map was made available to the writer.

GENERAL CHARACTER OF THE AREA AND ACCESSIBILITY

The area lies within the interlake plain of the Manitoba Lowland. The physical features of most of the area have been described in detail by Johnson(1934). The surface material consists of stony clay and gravel and some alluvial or clay deposits. Lakes Manitoba and Winnipegosis occupy a large part of the area; all drainage is into one or the other of these lakes. The area is poorly drained, and much of it is marshy.

The surface of the area is low and gently undulating. In places, where the superficial deposits are thin, the topography is controlled by the bedrock, and ridges and domes are numerous. The domes are particularly abundant in the vicinity of Dawson Bay, and they rise from 70 to 80 feet above the level of the lake. On the islands and shores of the lakes, cliffs from 30 to 90 feet high are common.

Brine springs are numerous along the west shore of Lake Winnipegosis north as far as the Red Deer River. Barren salt flats as much as 50 acres in area are associated with many of the springs(Cameron 1949).

Outcrops on the east side of Lake Manitoba and south of Lake Winnipegosis are accessible by road. The western shore of Dawson Bay, the Red Deer River, and the mouth of the Steeprock River may be reached by road from The Pas-Mafeking Highway. Road construction near completion will make Barrows, on the south shore of Red Deer Lake, accessible by road in 1950. The outcrops in Dawson Bay may be reached by canoe or small boat, but for this vicinity, as well as for the remainder of Lake

Winnipegosis, the use of a larger boat is recommended. Water transportation is available at several fishing stations.

PRESENT WORK

All outcrops of Devonian rock exposed on the shores and islands of Lake Manitoba, Lake Winnipegosis, Red Deer Lake, and Swan Lake, as well as strata exposed by recent road construction and quarrying operations were mapped and elevations taken. The lower part of the Swan River, and the Red Deer River from Dawson Bay to Red Deer Lake were traversed.

Elevations were determined by plane table survey from established survey posts where geodetic data were available. On the islands and shores of the lakes a hand level was used employing a previously established lake level. Elevations along The Pas-Mafeking Highway were determined from a road profile obtained from the Department of Public Works, Province of Manitoba.

On the map accompanying this report an attempt has been made to indicate formational boundaries. Owing to the scarcity of outcrop and the inaccessibility of much of the inland area these boundaries are tentative. The western limit of the Devonian outcrop area is based in part on the manuscript map of Kirk.

Two new rock unit names, the Ashern formation and the Point Wilkins member of the Manitoban formation, have been introduced. These units are described in detail below.

The laboratory investigation was conducted at the Graduate School

of the University of Manitoba. Polished sections and thin sections of many of the samples collected were prepared and examined. Insoluble residues were also investigated. As many of the limestones in the area contain dolomite, X-ray diffraction powder photographs were used to establish the dolomite-calcite ratio. A series of photographs was prepared using known proportions of dolomite and calcite. By comparing photographs of a dolomitic limestone with the prepared series of photographs the ratio of the two minerals could be established within about ten percent(Figure 1).

The faunal lists included in this report are based on identifications made by Dr. P. S. Warren, University of Alberta.

Figure 1

X-ray powder diffraction photographs of calcite-dolomite mixtures. Percentage of the two minerals is by weight. The top photograph in the series is 100 percent calcite. The lines of greatest intensity for calcite are marked A and B. As the percentage of calcite decreases these lines show less intensity and when the amount of calcite is less than ten percent the lines disappear. The bottom photograph in the series is 100 percent dolomite. Lines A^1 and B^1 are the two strongest lines for the mineral dolomite. These two lines decrease in intensity as the percentage of dolomite decreases.

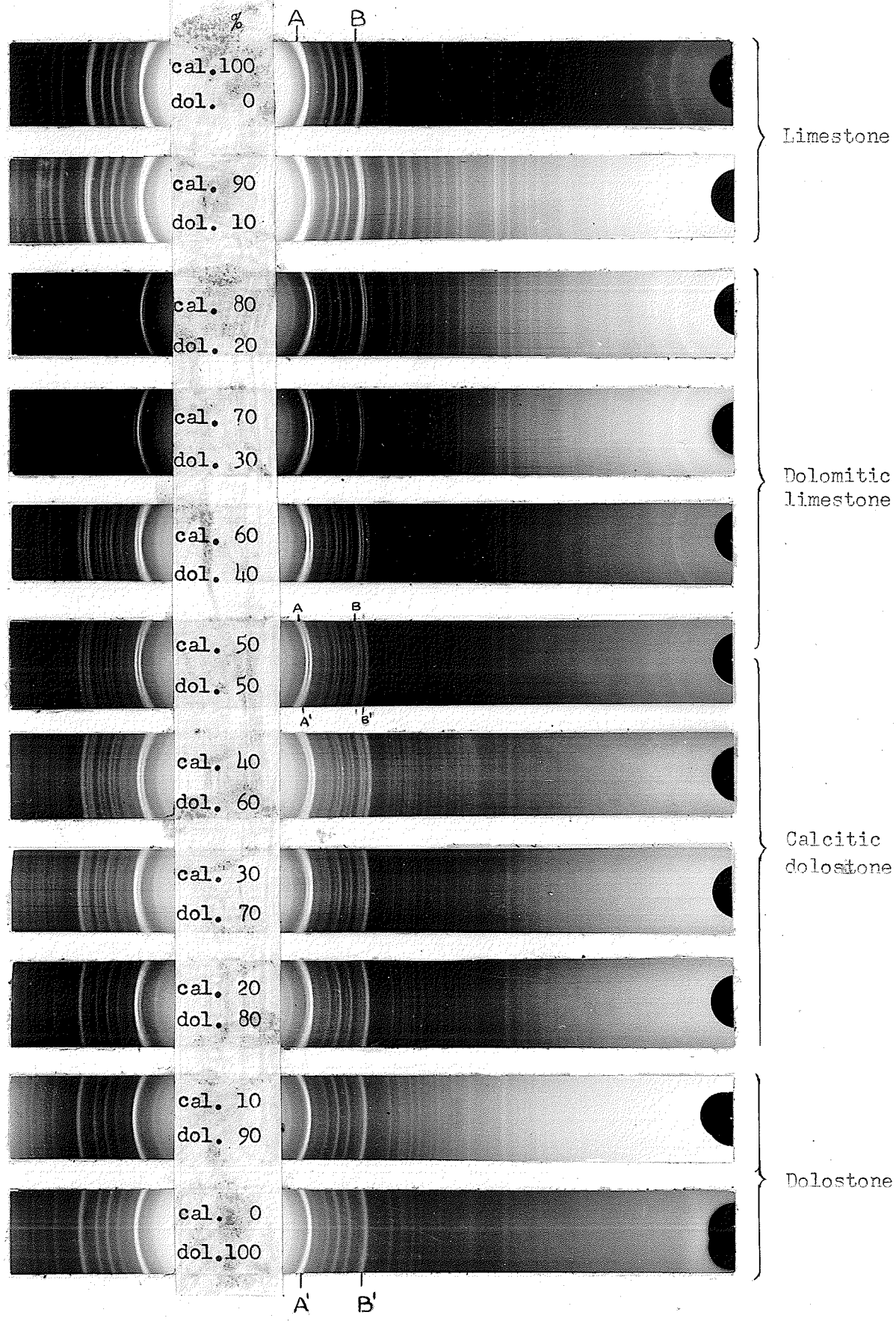

%
A
B
cal.100
dol. 0
cal. 90
dol. 10
cal. 80
dol. 20
cal. 70
dol. 30
cal. 60
dol. 40
cal. 50
dol. 50
cal. 40
dol. 60
cal. 30
dol. 70
cal. 20
dol. 80
cal. 10
dol. 90
cal. 0
dol.100
A'
B'
Limestone
Dolomitic limestone
Calcitic dolostone
Dolostone

Figure 1

STRATIGRAPHY

GENERAL STATEMENT

The Devonian strata in the area have been divided into three formations: Elm Point limestone, Winnipegosan formation, and Manitoban formation.

The Elm Point limestone is the oldest known Devonian formation outcropping in the area. It consists of at least 43 feet of yellowish grey(5Y7/2)[1] distinctly mottled bedded fossiliferous limestone. An erosional unconformity separates the formation from the underlying argillaceous dolostone[2] of the Ashern formation. This argillaceous rock, generally brick-red in colour, has a wide distribution and may be used as a marker in the study of well cuttings.

The Winnipegosan formation, which overlies the Elm Point limestone, consists of about 250 feet of dolostone. Organic reefs or bioherms are characteristic of the Winnipegosan. The massive, tough bioherm cores outcrop as cliffs or klintar[3] in the Dawson Bay area. These contain an

---

[1] The symbols in parentheses following a rock colour refer to the numeral designation used in the Rock Color Chart(1948) distributed by the National Research Council, Washington, D.C.

[2] The term "dolostone" as proposed by Shrock(1948 p. 126) is used throughout this report to indicate rocks consisting largely of the mineral dolomite.

[3] The term "klint"(plural "klintar") is applied to "any erosional remnant composed essentially of the unreduced portion of an eroded organic reef"(Shrock, 1929, p. 18).

abundant and varied fauna which includes Stringocephalus burtini Defrance, an excellent index fossil. The interbioherm rock is a greyish yellow poorly fossiliferous saccharoidal dolostone.

The basal beds of the Manitoban formation include a series of shales, argillaceous and dolomitic limestones, and limestones. Several distinct lithological units are present, but owing to the scattered nature of the outcrops and to the incomplete sections, the various units are difficult to delimit.

The upper strata of the Manitoban formation include at least 50 feet of yellowish grey (5Y8/1) massive to thick-bedded limestone of the Point Wilkins member. A marked lithological and faunal change is evident in these strata which have been designated as the Athyris fultonensis zone by Kindle (1914, p.256).

Overlying the thick-bedded limestone is at least ten feet of yellowish brown dolostone to dolomitic limestone. These beds, together with poorly exposed coarsely crystalline limestone and a fragmental oolitic limestone, are believed to be the youngest Devonian strata outcropping in Manitoba.

The Devonian strata in the area have a regional dip which averages 12 feet per mile to the southwest. The formations may be mapped as linear belts which trend towards the northwest. In general, successively younger strata are encountered from east to west, but as the beds are almost flat-lying and undulate somewhat, outliers are present several miles to the east of the main belts. For example, in the Dawson Bay area the basal beds of the Manitoban formation are exposed on the shores

of Pelican and Cameron Bays, and more than 20 miles to the west, similar beds are exposed on the west shore of Dawson Bay.

Thicknesses recorded in the table of formations are derived in part from a study of well sections. As the upper limit of the Devonian strata in Manitoba is marked by an erosional unconformity, the Manitoban formation shows a considerable range in thickness in different wells, and strata not represented in outcrop may be present in some well sections.

TABLE OF FORMATIONS

ERA	PERIOD OR EPOCH	FORMATION	LITHOLOGY	THICKNESS IN FEET
	Erosional Unconformity			
PALAEOZOIC	Upper or Middle Devonian	Manitoban	yellowish brown dolomitic limestone and dolostone	+ 10
			yellowish grey thick-bedded dense limestone (Point Wilkins member)	50-60
	Middle Devonian		limestone, argillaceous to dolomitic limestone, and shale	+ 120
		Winnipegosan	saccharoidal dolostone and massive bioherm facies	250*
		Elm Point	yellowish grey bedded mottled limestone	50*
	Erosional Unconformity			
	Devonian or Silurian	Ashern	brick-red to greyish orange argillaceous dolostone	0-25
	Erosional Unconformity			
	Silurian	Stonewall	bioherm zone greyish yellow finely crystalline dolostone	? ?

* Thickness obtained from well sections

DESCRIPTION OF FORMATIONS

Ashern Formation

Definition

The term Ashern formation is proposed for the brick-red to greyish orange argillaceous dolostone strata between the overlying Elm Point limestone and the underlying dolostone of known Silurian age. The name is derived from the village of Ashern in the vicinity of which are several outcrops of the formation.

Distribution

The formation is exposed in scattered outcrops within a narrow linear belt trending southeastward from the east shore of Portage Bay. The most southerly outcrop of the formation is exposed about six miles west of the village of Mulvihill. The rock is poorly exposed and no appreciable thickness is visible in most of the outcrop area. Near the northern end of the belt on sec.2, tp.30, rge.10, W. Principal mer., a prospect pit exposes a section eight feet thick. Two miles northwest of the village of Spearhill a section six feet thick is exposed near an abandoned quarry. The exposure represents an outlier about six miles east of the main outcrop belt.

Character

As exposed in outcrop the formation consists of brick-red to greyish orange (10YR7/4) unfossiliferous argillaceous dolostone in poorly defined beds 3 to 12 inches thick. In some outcrops the rock

is predominantly brick-red, and the orange colour occurs as bands along fracture planes, whereas in other outcrops the red and orange colours occur in small to large irregularly shaped patches. The argillaceous content is variable, and many samples gave small residues of coarse silt to very fine sand-size quartz. The slightly argillaceous phases have poor vugular porosity, and the small vugs are lined with an orange friable material. Small nodules of pyrite occur here and there throughout the rock.

The upper limit of the formation is exposed at the Canada Cement Company quarry near the village of Steep Rock. Recent deepening of the quarry shows a bed of red to greyish green(5G5/2) mottled shale, one foot to two feet thick, between the Elm Point limestone and the brick-red argillaceous dolostone. Iron sulphide and clay-like material marks the contact between the Elm Point limestone and the shale. In the writer's opinion the contact represents an erosional unconformity.

The lower limit of the formation is believed to be exposed in an abandoned quarry on sec. 28, tp. 27, rge. 7, W. Principal mer. about two miles northwest of the village of Spearhill. The brick-red argillaceous dolostone is two feet thick and forms the upper part of the quarry walls. The brick-red rock is separated from the underlying strata by an erosional unconformity. Angular fragments of the underlying rock occur throughout these basal beds of the Ashern formation. Similar angular fragments were found in the brick-red rock in outcrops north of Moosehorn, and in outcrops west of the village of Mulvihill about 30 miles to the south.

Thickness

The thickness of the Ashern formation is nowhere obtainable by direct measurement. Wells drilled for water in the vicinity of Steep Rock village intersect the formation and show thicknesses ranging from a few inches to 25 feet. As the top of the formation is an erosional surface the thickness probably differs from place to place, and the formation is probably absent in some places.

Age

The strata constituting the Ashern formation were originally assigned a Lower Devonian age by Tyrrell (1892, p.200E). Kindle (1914, p.251) included them in the Stonewall formation of Silurian age. The strata appear to be unfossiliferous, and as erosional unconformities mark the upper and lower limits of the formation either a Devonian or Silurian age is possible.

Underlying Strata

The strata underlying the Ashern formation are exposed at the abandoned quarry northwest of Spearhill village. On the north wall of the quarry, just below the erosional unconformity and the basal breccia there is a highly porous lenticular mass of dolostone (Figure 2). This lenticular mass is twelve feet long and three feet high, and is plano-convex with the convex side upward. Much of it has been removed by quarrying. It consists of tiny irregularly shaped vertical pillars firmly cemented together (Figure 3). It is believed that the lens is an organic structure, and the vertical pillars are probably formed by

Figure 2

Organic lens in strata between the underlying Stonewall formation and overlying Ashern formation. Upper 18 inches of strata shown are the basal beds of the Ashern formation.

Figure 3

Showing porosity of organic lens shown in Figure 2.

Figure 2

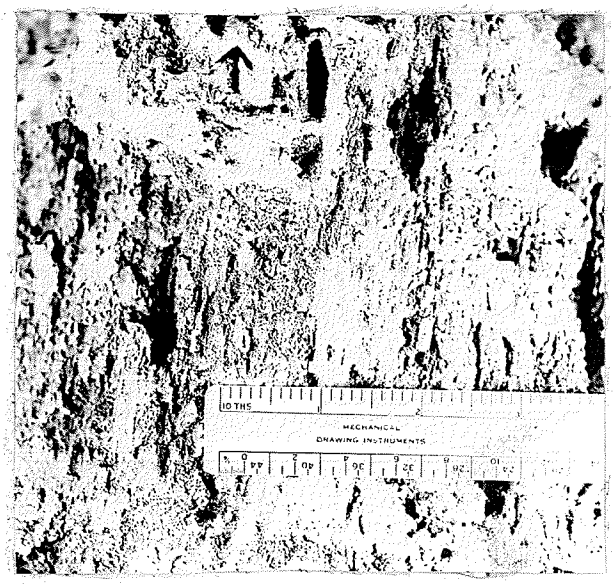


Figure 3

lime secreting algae. The beds flanking the lens are massive to thick bedded, and they thin considerably above the lens. The rock of the flanking beds is formed largely of detrital material derived from the structure. Beds of detritus four to six inches thick may be traced laterally from the lens. The lens probably represents a remnant of a bioherm structure.

North of the village of Moosehorn a similar porous rock is exposed on a ridge. The many low ridges and knolls in this vicinity are probably underlain by similar bioherm structures.

A well-bedded greyish yellow (5Y8/4) finely crystalline dolostone underlies the bioherm zone in the abandoned quarry. This dolostone resembles the rock exposed on the Fairford River which was described by Kindle (1914, p.250) as the Leperditia hisingeri zone of Silurian age.

Along the highway north of the village of Hilbre, yellowish orange porous dolostone is exposed in several places. The dolostone is fossiliferous and contains Fletcheria ? sp., Brachyprion robustum Twenhofel, Isochilina sp., Leperditia sp., and many gastropods. This rock is probably similar to the "massive stromatoporoid magnesian limestone" of Silurian age described by Tyrrell (1892, p.203E) as overlying the finely crystalline dolostone of the Fairford River outcrop. More detailed work is necessary in this area before the position of these beds can be established.

Elm Point Limestone

Definition

The Elm Point limestone was named by Kindle (1914, p.251) for the limestone exposed in cliffs near Elm Point on the eastern shore of Lake Manitoba. Tyrrell (1892, p.194E) had previously described the limestone exposures and included them in the basal part of the Manitoban formation. The Elm Point formation consists of the limestone strata between the overlying Winnipegosan dolostone and the underlying brick-red argillaceous dolostone of the Ashern formation.

Distribution

The formation occurs in a narrow belt, averaging about six miles wide, along the eastern shore of Lake Manitoba. Except for the cliffs at Elm Point, natural outcrops are surface exposures which have no appreciable thickness. The most complete sections are exposed in the Canada Cement Company quarry near the village of Steep Rock, and in the Winnipeg Supply and Fuel Company quarry at the village of Spearhill. No exposures were found north of the Elm Point cliffs, but Wallace (1925, p.24) reported that outcrops of the formation occur on an island in Waterhen Lake. The most southerly exposures of the formation are in the vicinity of the Oak Point quarry on the SW$\frac{1}{4}$ of sec. 18, tp. 18, rge. 4, W., Principal mer.

A diamond-drill hole, just north of the outlet of the Steeprock River on the west shore of Dawson Bay, intersected about 50 feet of mottled

limestone between 252 and 300 feet, which is believed to be equivalent to the Elm Point formation.

Character

In outcrop and in the quarries, the formation consists of a yellowish-grey (5Y7/2) finely granular limestone in beds two to five inches thick. Generally the rock is strikingly mottled (Figure 4); the mottles are pale yellowish brown, appear finer grained than the yellowish grey part, and have well-defined boundaries. Chemical analyses show a higher percentage of MgO, and X-ray diffraction powder photographs reveal the presence of dolomite, in the yellowish grey areas. Partial dolomitization is indicated.

Stylolitic surfaces are a characteristic feature of the formation and are present on the uneven bedding planes (Figure 5) and joint surfaces. Vugs and veinlets of secondary calcite are abundant. Pits filled with iron oxide are present, and iron sulphide nodules as much as one inch in diameter are found in the lower three feet of the section as exposed in the Canada Cement Company quarry. Fossils are abundant throughout the formation and several highly fossiliferous thin beds contain many species of well preserved Atrypa arctica Warren showing extraordinary development of the marginal frill.

The best exposures of the Elm Point limestone may be seen near the village of Steep Rock on the east shore of Lake Manitoba. In this vicinity drift cover is thin, and the glaciated surface of the limestone is exposed over large areas. At the lake shore directly west of the village several

Figure 4

Elm Point limestone showing bedding and mottling, Canada Cement Company quarry.

Figure 5

Polished surface of Elm Point limestone showing stylolites.

Figure 4

Figure 5

cliffs of limestone expose a thickness of 19 feet. The weathered surface has a rough checked appearance, and the mottling is not evident on the cliff face (Figure 6). Vertical joints and faults of a few inches displacement were observed.

The Canada Cement Company quarry is located on the NW$\frac{1}{4}$ of sec. 34, tp. 28, rge. 10, W. Principal mer. near the village of Steep Rock. A section 21 feet thick was measured to the main quarry floor, and recent deepening of the quarry has exposed an additional 22 feet, giving a total section of 43 feet.

The quarry floor is gently undulating with no extreme dips. The strata, as seen on the quarry walls, show gentle arching and sagging but are essentially flat-lying. Small lenses of sand and/or clay are evident in places, but generally these can be traced upward to the eroded surface. Little lithologic change is evident in the section.

The Elm Point limestone at the quarry is underlain by a greenish grey dolomitic shale which is mottled to a dark reddish brown (10R3/4). Cable tool samples indicate that the shale is two feet thick. This shale is underlain by a brick-red friable shaly rock which breaks easily under the cable tool so that the cuttings are reduced to a red mud.

Figure 6

Cliffs of Elm Point limestone on east shore of Lake Manitoba, west of Steep Rock village.

Figure 7

Distorted strata of Elm Point limestone, Winnipeg Supply and Fuel Company quarry near Spearhill village.

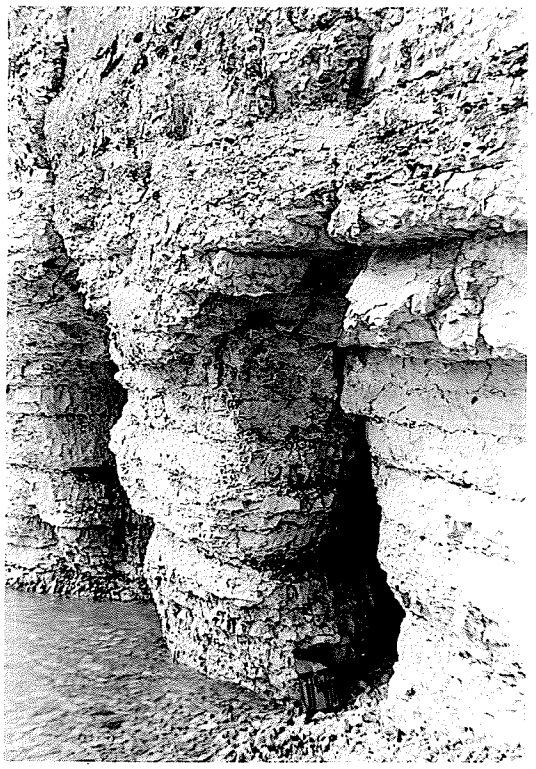


Figure 6

Figure 7

Section at Canada Cement Company Quarry

Unit	Thickness Ft.	In.
Elm Point Limestone		
7. Limestone, yellowish grey(5Y7/2) mottled to a pale yellowish brown(10YR6/2), finely granular, in three to five inch beds, bedding planes uneven with stylolitic surfaces, secondary calcite in veins and vugs, some joint planes contain pits of iron oxide, *Atrypa arctica* Warren and small stromatoporoids.	15	
6. Limestone, pale yellowish brown with no mottling, breaks with even fracture, unfossiliferous.		6
5. Similar to unit 7.	5	2
4. Similar to unit 7 in beds up to 11 inches thick, thin shaly partings between beds, some pinkish to greyish purple(5P4/2) patches.	20	
3. Limestone, yellowish grey, mottling not well developed, thick-bedded, finely granular, some pinkish crystalline layers near bottom of unit. Nodular masses of iron sulphide abundant and a thin layer of iron sulphide is present on the lower surface of the unit. A layer of greenish grey clay separates the limestone from the underlying shale.	3	
Erosional Unconformity		
Ashern Formation		
2. Dolomitic shale, greenish grey, mottling to a brownish red, breaks in slabby fragments.	2	
1. (cable tool cuttings) Brick-red friable argillaceous dolostone.	2	
Total thickness of section.	47	8

The Winnipeg Supply and Fuel Company quarry adjoins the village of Spearhill on the SE $\frac{1}{4}$ of sec. 22, tp. 27, rge. 7, W. Principal mer. The quarry is on a hill which rises about 50 feet above the surrounding country and which has a slight escarpment on the north and east sides. This is the most easterly exposure of the formation in this vicinity and represents an outlier about 12 miles east of the Elm Point limestone belt.

The formation has an exposed thickness of 20 feet in the quarry and the rock is similar to that in the Canada Cement Company quarry. The walls and floor of the quarry are extremely irregular owing to steep local dips which are as much as 40 degrees; arching and downwarping are common. (Figure 7). Vertical joints and faults with slight displacement are numerous. Masses as much as 12 feet across, of angular fragments of limestone cemented by drusy calcite occur here and there.

Other irregularly shaped masses consisting of close-set fragments of pale yellowish brown dense fine-grained dolostone are present in several places in the quarry. This rock appears to be a rubble type of breccia the fragments of which are probably from the underlying dolostone which is exposed in a small drainage excavation near the centre of the quarry. In this excavation, two feet of Elm Point limestone is underlain by an exposed two feet of a pale yellowish orange fine-grained dolostone. Parks(1916 p.121) described a similar dolostone which underlies the limestone at this locality, and a photograph published in his report shows the contact. It is believed that the rock shown in the photograph is now obscured by the kilns and loading platforms. Parks considered that the dolostone is of Silurian age. The presence of the brachiopod Atrypa

arctica Warren in the dolostone suggests that it is a phase of the Elm Point limestone not hitherto seen.

An abandoned quarry two and one half miles north of Oak Point village exposes about seven feet of the Elm Point limestone. Stylolitic surfaces are well developed on the bedding and joint planes. Many well preserved specimens of Atrypa arctica Warren are present in thin beds.

In the vicinity of Lily Bay, nine miles west of Deerhorn village, the overburden is thin, and many small outcrops of the limestone may be seen.

Several domes of Elm Point limestone occur throughout the outcrop area. One of the larger domes is located about half a mile south of Silver Bay on sec. 32, tp. 25, rge. 8, W. Principal mer. It is elliptical in shape, 3000 feet long, and trends north 40 degrees west. The top of the dome has an undulating surface and the strata dip away from the crest at five to ten degrees.

Bannock Hill, three and one half miles southwest of Ashern, is a small dome covering about 15 acres. The beds outcropping on the crest of the dome are highly fossiliferous. The dome represents an outlier several miles east of the main belt of Elm Point limestone.

Thickness

The total thickness of the Elm Point limestone can not be measured directly. A thickness of 43 feet was measured at the Canada Cement Company quarry, and probably some of the upper strata are missing. The log of the diamond drill hole near the mouth of the Steeprock River at Dawson Bay shows 50 feet of mottled limestone that is probably Elm Point.

Fauna

The Elm Point limestone fauna listed below includes the forms collected by the writer and those listed by Kindle(1912 p.251). The fringed brachiopod Atrypa arctica Warren, described by Kindle as Atrypa reticularis variety A, is the most abundant species present. As this form is also found in the Winnipegosan formation and is abundant in the lower Manitoban beds it should not be considered a zonal fossil for the Elm Point limestone as suggested by Kindle.

Atrypa arctica Warren
Atrypa cf. arctica Warren
Atrypa mascula Stainbrook
Büchelia tyrrelli Whiteaves *
Callonema cf. lichas Hall *
Cyathophyllum ? sp.
Cyrtoceras
Elytha cf. fimbriata (Conrad)
Euomphalus cf. subtringonalis Whiteaves
Hexagonaria sp.
Mourlania cf. itys (Hall)
Orthoceras sp. *
Pleurotomaria ? sp. *
Productella spinulicostata *
Proetus mundulus Whiteaves *
Schizophoria striatula Schlotheim *
Straparolus sp.
Stromatoporoid ?

*. Forms listed by Kindle(1912 p.251), not collected by writer.

Relation to Overlying Strata

A possible contact between the Elm Point limestone and the Winnipegosan formation is poorly exposed on the road to Dolly Bay along the south boundary of ls. 1, sec. 4, tp. 25, rge. 9, W. Principal mer. At this locality yellowish grey(5Y8/1) fossiliferous limestone is exposed along the road for a distance of several hundred feet. At each end of the limestone exposure, but not in contact with it, saccharoidal dolostone of the Winnipegosan formation is exposed. At the western limit of the limestone outcrop, trenching showed that the limestone beds dip at about 20 degrees and underlie the saccharoidal dolostone. The contact between the limestone and dolostone is sharp. An inch or two of thinly bedded impure dolomitic rock directly overlies the limestone and grades upward to saccharoidal dolostone. The limestone is probably a domed structure overlain by the dolostone. Erosion has removed the dolostone from the crest of the dome exposing the limestone.

The fauna of the limestone includes the following forms:

Pinacotrypa marginata Whiteaves
Bryozoa sp.
Martinia sublineata Meek
Productella sp.
Gypidula comis ? Owen
Atrypa cf. andersonensis Warren
Atrypa cf. arctica Warren
Crispella sp.
Cyphaspis bellula Whiteaves
Ostracod sp.

All the above species excepting Crispella sp. are present in the Winnipegosan formation. The similarity of this fauna with the fauna of the Winnipegosan formation suggests that the outcrop of limestone is not

Elm Point but is possibly a phase of the Winnipegosan. Further field work is necessary before the age of these strata can be established.

Wallace(1925 p. 26) reported that red shales underlie the Winnipegosan dolostone at Devil Point and Pemmican Island. At these localities, the writer saw red clay and brick-red pebbles on the shore but nowhere was any shale seen in place. No evidence of red shale separating the two formations was observed in the diamond drill core from the Mafeking No. 1 hole located at the mouth of the Steeprock River. The writer believes that no shales are present. At two localities in the southern part of the map area the Elm Point and Winnipegosan, although not seen in contact, outcrop a few hundred feet apart, and no evidence of shale is present.

Winnipegosan Formation

Definition

The Winnipegosan formation consists of the strata between the underlying Elm Point limestone and the overlying Manitoban shales and limestones. The name was first used by Tyrrell(1892 p. 200E) for the exposures of the dolostone on the islands and shores of Lake Winnipegosis.

Distribution

The formation is best exposed on the islands and shores of Dawson Bay in cliffs as much as 40 feet high. Hill Island, Roderick Point on Birch Island, Pemmican Island, and Devil Point on Lake Winnipegosis also show good exposures of the dolostone. South of Birch Island, scattered outcrops show that the formation forms a belt trending towards the south-

east. In the vicinity of The Narrows, Lake Manitoba, the belt is only eight to ten miles wide. Two small outcrops, a few miles south of Dog Lake, were the most southerly exposures found.

Several of the outcrops in the southern part of the belt are in the form of long low ridges two to three miles in length that trend parallel to the trend of the outcrop belt. The rock composing these ridges is highly fossiliferous and porous and is similar to the massive bioherm cores exposed in Dawson Bay.

Character

Two rock types are present in the Winnipegosan formation. Massive to thick-bedded dolostone, which is largely organic in origin, constitutes the bioherm facies; saccharoidal bedded dolostone, present in the interbioherm areas, constitutes the normal facies of the formation. The two facies and their relations to one another are described below.

Interbioherm Facies: The normal or interbioherm facies of the Winnipegosan formation consists of greyish yellow(5Y8/4) to yellowish grey(5Y8/1) uneven-bedded saccharoidal dolostone with intergranular to slightly vugular porosity. The strata are poorly fossiliferous; large crinoid stems, poorly preserved brachiopods, and scattered corals are the most abundant forms. The beds range in thickness from a few inches to three feet. Two-to five-inch shaly bands are present in some localities. The rock weathers to a light yellowish grey and generally the weathered surface is irregular.

The principal outcrops of the interbioherm facies are in the vicinity of The Narrows, Lake Manitoba, and on Lake Winnipegosis at Devil

Point, Pemmican Island, Roderick Point on Birch Island, and on Hill Island.

In the section exposed at Devil Point, given below, the lower four feet are probably part of the bioherm facies.

Section

Unit	Thickness Ft.	In.
3. Dolostone, yellowish grey(5Y8/1) to pale orange, finely crystalline to saccharoidal, poorly fossiliferous, in indistinct beds ranging from three to five inches thick, pin point porosity with some vugs possibly caused by weathering out of fossils.	13	
covered interval.	16	
2. Dolostone, yellowish orange, finely crystalline, massive, weathers with an irregular surface.	2	
1. Dolostone, greyish orange(10YR7/4), massive, highly fossiliferous, porous, resembles bioherm core rock of the Dawson Bay area. exposed.	2	

In other outcrops the following thicknesses of the interbioherm facies were measured:

	Ft.
Roderick Point, Birch Island.	11
Pemmican Island.	18
Hill Island.	20
Grand Island.	12
Macoun Point.	10
McCaulay Harbour.	7
Quarry at The Narrows, Lake Manitoba.	12
Quarry south of Richard Point.	75

Bioherm Facies: The cliffs of thick-bedded to massive dolostone that outcrop in the area are considered to be eroded remnants of organic reefs or bioherms.

Erosion has stripped away most of the flanking beds and the bioherm cores are all that remain(Figure 8). These structures are similar in many respects to Silurian bioherms in Wisconsin described by Shrock (1939 pp. 529-562). Although previous investigators have examined and described these exposures none have attributed their origin to sedentary organisms or suggested that they were originally organic reefs or bioherms.

In general the rock composing the bioherm core is a tough hard yellowish grey(5Y8/1) dense thick-bedded to massive dolostone which is commonly highly fossiliferous. External and internal molds are the most common type of fossil preservation but generally the fossils are poorly preserved. Corals and Stromatoporoids are abundant in some outcrops and absent in others.

Lamination is a feature of much of the rock and is most evident on the weathered surface(Figure 9). Small aligned vugs paralleling the laminations in places enhance the layered appearance. These laminated rocks were probably formed by lime secreting algae. Fossil remains are not abundant in the algae dolostone.

Part of the rock is made up largely of fossil fragments, and form a tightly cemented coquina. Detrital material of sand size is commonly associated with the coquina.

In places the rock is cavernous, and some caves are as much as twelve feet long and four feet high. The larger caves appear to be caused by solution. The roof and walls are irregular, and much drusy calcite is present. Smaller cavities up to two feet across are partly

Figure 8

Klint or eroded remnant of bioherm core, Winnipegosan formation, Rowan Island, Dawson Bay.

Figure 9

Weathered surface of algal dolostone, Winnipegosan formation.

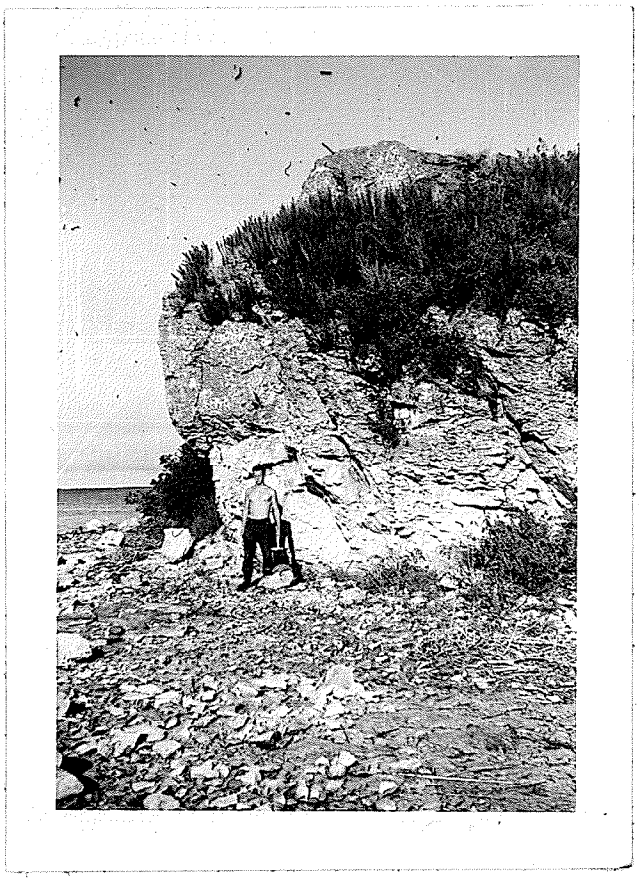


Figure 8

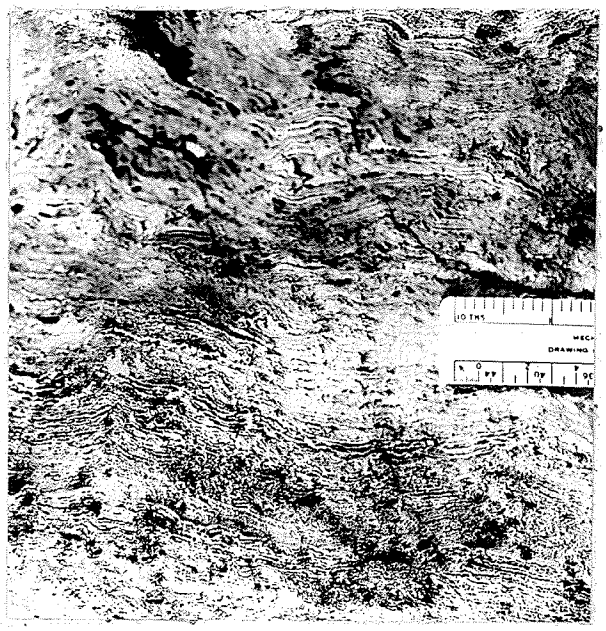


Figure 9

filled with a highly porous tightly cemented mass of fossil debris. These smaller cavities are probably an original feature of the growing bioherm. Many other small voids are caused by weathering or by the dissolution of fossils.

In one small cave, which is a few feet in diameter and about 15 feet above the level of the lake, several spherical pisoliths were found resting unattached in a carbonate sand which covered the bottom of the cave(Figure 10). The pisoliths range from half an inch to one and a half inches in diameter. A polished section through the centre of one of the spheres shows a concentric banding of light and dark calcite. These pisoliths appear to be similar to the cave oolites or "cave pearls" described by Pond(1945 pp. 55-58).

Lenses of well-bedded unfossiliferous dolostone as much as three feet thick and twenty feet long occur here and there. These lenses either pinch out laterally or grade abruptly into massive rock.

Fractures, joints and some faults are commonly present in the bioherm structures. Near-vertical joints extend from top to bottom of some outcrops.

Many of the structures are arched slightly and dips increase towards the flanks(Figure 11). Flanking beds are generally not present, but in places strata of fine-grained dolostone dipping at 15 to 30 degrees were observed on the margins of the main structure. These beds grade laterally into the core rock or are in the form of thick wedges which thin considerably toward the core.

The klintar range from small mounds thirty feet in diameter and

Figure 10

Pisoliths or "cave pearls", bioherm facies, Winnipegosan formation.

Figure 11

Klint or bioherm core on north side of Salt Point, Dawson Bay.

Figure 10

Figure 11

fifteen feet high to large masses several hundred feet long and 40 feet high.

The highly resistant klintar form many prominent headlands and islands on Lake Winnipegosis and Lake Manitoba. Completely denuded klintar are seldom found. Generally the island or headland is almost covered by drift and the massive rock is exposed only at some extremity.

The various klintar and their dimensions are listed in the following table:

LOCATION	REMARKS
Dawson Bay Area	
Whiteaves Point	Cliff 20 feet high extends about half a mile along the shore.
Island, one and a half miles north of Whiteaves Point	Vertical cliff, about 40 feet high and 500 feet long on northwest side of island.
Big Rock Island, two miles west of Whiteaves Point	Prominent cliff, 40 feet high on northwest side of island.
Island, one mile southwest of Whiteaves Point	Small rounded hill 20 feet high composed mainly of Actinostroma.
Island, half a mile northwest of Dog Island	Cliff, 20 feet high on northeast side of island, contains many colonial type corals.
North side of Salt Point	Several cliffs form prominent headlands along shore, largest klint is 38 feet high(Figure 11).
Sugar Island, three miles north of Salt Point	Cliff 19 feet high at northeast extremity of island, contains many colonial type corals.
Two and a half miles northeast of Red Deer River outlet	Several promontories of massive rock, as much as 27 feet high.

Rowan Island	Cliff 20 feet high exposed at south end of island(Figure 8).
Two miles west of Rowan Island	Promontory formed of massive fossiliferous dolostone. Saccharoidal dolostone of interbioherm facies is exposed on east side of cliff.
About one mile east of mile 22, The Pas-Mafeking Highway	Flat-topped hill, 10 feet high and 600 feet across. Composed mainly of stromatoporoids and algal dolostone. Contains many nodules of pyrite.
Lake Manitoba	
Babe Island, Toutes Aides Bay	Highly fossiliferous cliff, 11 feet high, extends 60 feet along the shore.
Big Sandy Point, 7 miles east of Crane River	Cliff 11 feet high and 75 feet long exposed at extremity of point. Small klint, shaped like an inverted bowl, 8 feet high and 50 feet in diameter is exposed 300 feet inland from point.
Richard Point	Massive cliff, 12 feet high, forms promontory on west side of point.

Along the north side of Salt Point, Dawson Bay, the bioherm facies is directly overlain by the lower shales of the Manitoban formation, and the upper beds of the bioherm can be examined. The dolostone grades upward through an impure dolomitic limestone, slightly argillaceous in places, to a yellowish white limestone. The limestone is distinctly crystalline, friable in places, and contains minor amounts of pyrite in the upper few inches. In the transition beds secondary calcite is abundant in small vugs. Just below the transition zone yellowish brown con-

centrically banded pisoliths are abundant in some beds, giving a mottled appearance to the rock. The limestone of these upper beds has, here and there, the laminated appearance which characterizes much of the biohermal dolostone. The limestone strata are considered to be part of the bioherm and not a separate sedimentation unit.

Relations of the Two Facies: Tyrrell(1892 p. 200E) described the saccharoidal dolostone as occurring only in the lower part of the Winnipegosan formation and underlying the "hard tough generally compact dolomite". As the former rock was found by the writer to occur overlying and apparently grading into the bioherm facies, it is believed that the saccharoidal dolostone is the normal facies of the formation in which the bioherms occur.

The following descriptions of several of the outcrops will serve to illustrate the relations of the two facies.

The peninsula south of Richard Point and east of Manitoba Island is underlain by the saccharoidal dolostone, which can be seen in numerous outcrops as the superficial deposits are thin. The area directly east of Manitoba Island SW $\frac{1}{4}$, sec. 35, tp. 24, rge. 10, W. Principal mer. is locally known as Red Deer Island. Low circular mounds, shaped like inverted bowls, averaging thirty feet in diameter and four feet high, outcrop on the western half of the island(Figure 12). The mounds are unfossiliferous and are composed entirely of a laminated dolostone. The laminations are uneven and wavy, giving a characteristic appearance to the weathered surface(Figure 13). These mounds are believed to be formed

Figure 12

Mounds of algal dolostone in Winnipegosan formation on Red Deer Island, vicinity of Narrows, Lake Manitoba.

Figure 13

Weathered surface of algal dolostone, Winnipegosan formation, Red Deer Island.

Figure 12

Figure 13

by lime secreting algae. About twenty of the mounds outcrop in the space of a few acres.

Trenching at the edge of one of the mounds exposed the underlying saccharoidal dolostone of the interbioherm facies. A two-inch fossiliferous band marks the contact between the two rock types.

One mile directly east of the southern tip of Manitoba Island the saccharoidal rock is exposed in a quarry on ls. 16, sec. 26, tp. 24, rge. 10, W. Principal mer. The beds of the quarry strike north 50 degrees east and dip 20 degrees towards the northwest. A thickness of 60 feet may be directly measured, but the true thickness is probably more than 100 feet.

Several hundred feet southeast of the quarry a section is exposed in a pit 16 feet deep on the top of a small knoll. The upper 15 inches of the section is of rock similar to the rock in the quarry. The underlying rock is tough hard thick-bedded to massive fossiliferous dolostone similar to the rock in the bioherm cores. In this locality the bedded strata are probably draped over a large bioherm, the draping causing the abnormal dips noted.

Three miles southeast of the quarry the road between Nina Lake and The Narrows crosses a northwest trending ridge several miles long which rises about 35 feet above lake level. Saccharoidal dolostone of the Winnipegosan formation forms the ridge. Several irregularly shaped mounds, as much as 50 feet across, are exposed along the crest of the ridge. Erosion has removed the upper beds from the centre of one of the larger mounds and shows that massive fossiliferous dolostone underlies

30 inches of bedded saccharoidal rock. The bedded rock is draped over the massive rock thus forming the mound. The massive dolostone contains many Stringocephalus burtini and is similar to the rock of the bioherm cores in the Dawson Bay area.

The section in Figure 14 illustrates the relations of the facies in the vicinity of The Narrows.

Thickness

The thickness of the Winnipegosan formation can be determined only by a study of well samples. In the Mafeking No. 2- H. Johnson well[1] in the Dawson Bay area, the top of the Winnipegosan formation is placed at about 390 feet. The Elm Point limestone, presumably is encountered at 620 feet, giving a thickness of 230 feet for the Winnipegosan formation. The published log(Kerr, 1949, p. 102) indicates that the main constituent between 500 and 600 feet is limestone. X-ray powder diffraction photographs show that the cuttings of this interval contain considerable dolomite and are largely dolostone.

The diamond drill hole, Mafeking No. 1, on sec. 14, tp. 44, rge. 25, W. Principal mer. just north of the Steeprock River outlet begins in limestone that marks the upper limit of the Winnipegosan formation in that vicinity. The grey limestone with brownish mottles at 252 feet is probably Elm Point limestone, so that 250 feet of Winnipegosan were

---

[1] The log of this well appears in Publication 49-1, The Stratigraphy of Manitoba with Relation to Oil and Natural Gas Possibilities, p.102, under the heading Northern Manitoba Oil No. 3. The location of this well is ls. 4, sec. 23, tp. 43, rge. 26, W. Principal mer.

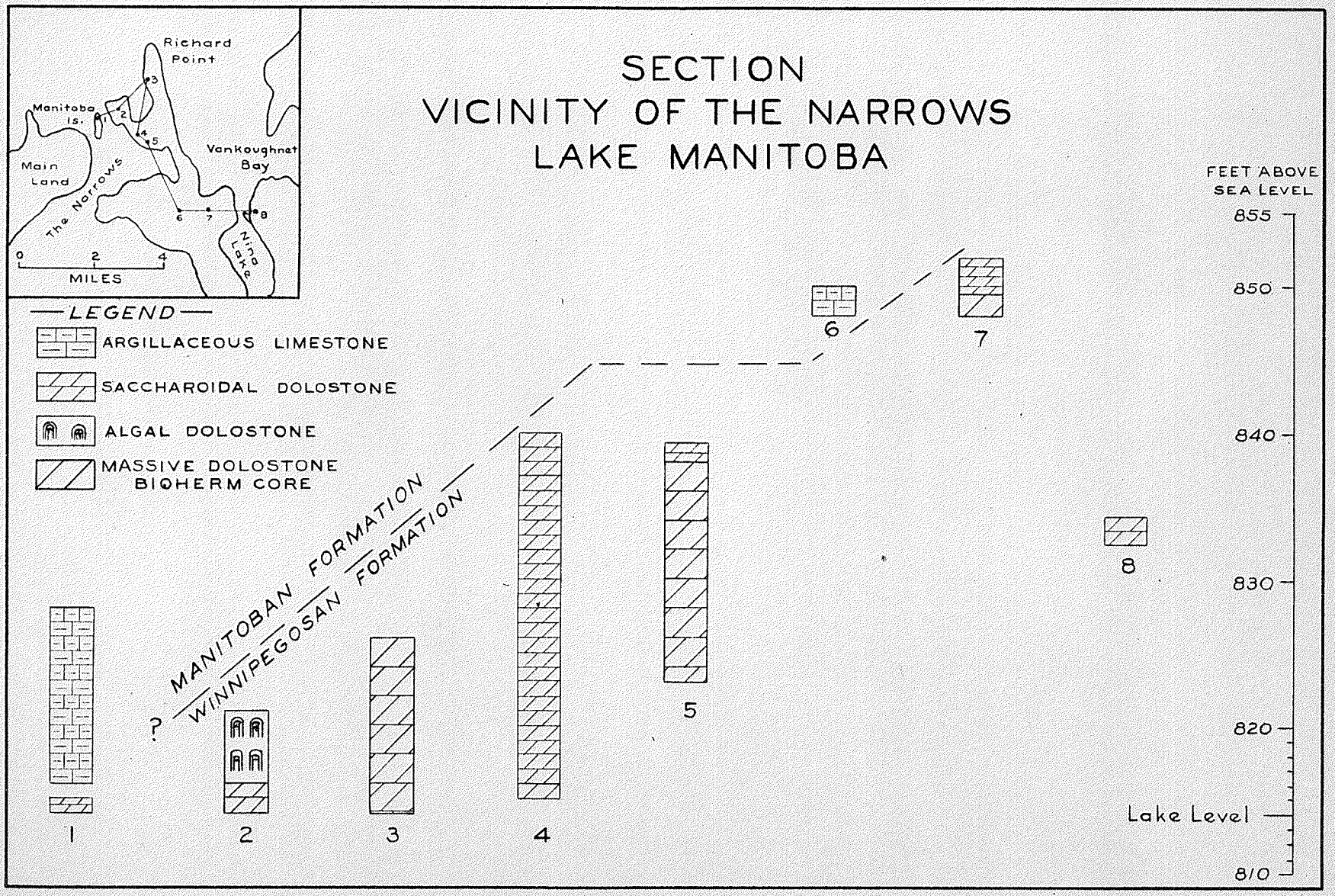

SECTION
VICINITY OF THE NARROWS
LAKE MANITOBA
Richard Point
Manitoba Is.
Main Land
The Narrows
Vankoughnet Bay
Winnipegosis Lake
0 2 4
MILES
LEGEND
ARGILLACEOUS LIMESTONE
SACCHAROIDAL DOLOSTONE
ALGAL DOLOSTONE
MASSIVE DOLOSTONE BIOHERM CORE
MANITOBAN FORMATION
WINNIPEGOSAN FORMATION
?
1
2
3
4
5
6
7
8
FEET ABOVE SEA LEVEL
855
850
840
830
820
Lake Level
810

Figure 14

encountered in that hole. The log of the Mafeking No. 1 was made available to the writer by the Geological Survey of Canada.

In the Winnipegosis No. 4 well on sec. 29, tp. 30, rge. 17, W. Principal mer.,(Wickenden, 1934, p. 165B) the strata between 70 and 340 feet are probably Winnipegosan giving a thickness of 270 feet, which agrees fairly closely with the thickness at Dawson Bay.

Fauna

The fauna of the Winnipegosan formation is large and varied. The forms in the following table are those collected by the writer and the list is not considered complete. A more complete faunal list is contained in Tyrrell's report(1892 p. 205E). In the distribution table below, locality occurrences marked T indicate that the species is listed by Tyrrell as occurring at that locality.

The fossil localities are as follows:

Vicinity of The Narrows, Lake Manitoba.

1. East of Nina Lake, ls. 9, sec. 15,tp. 24, rge. 9,W. Principal mer.

2. Ridge, half a mile west of Nina Lake, ls. 10, sec. 18, tp. 24, rge. 9W.

3. Rose Hill Quarry, ls. 16, sec. 26, tp. 24, rge. 10, W. Principal mer.

4. Road to Dolly Bay, ls. 1, sec. 4, tp. 25, rge. 9, W. Principal mer.

Lake Manitoba.

5. Richard Point

6. Big Sandy Point, 7 miles east of Crane River

7. Monroe Point, 1 mile north of Crane River.

8. Pentamerus Point, 4 miles north of Crane River.

9. Babe Island, Toutes Aides Bay.

Lake Winnipegosis

10. McCaulay Harbour.

11. Devil Point.

Dawson Bay, Lake Winnipegosis

12. Whiteaves Point.

13. Island, 1½ miles north of Whiteaves Point.

14. Big Rock Island, 2 miles west of Whiteaves Point.

15. Small island, north west of Dog Island.

16. Sugar Island, 3 miles north of Salt Point.

17. North side of Salt Point.

18. Point south of Red Deer River outlet.

19. Two and one half miles north east of Red Deer River outlet.

20. Two miles north of locality 19.

21. Rowan Island.

22. Point, 2½ miles west of Rowan Island.

Fauna of the Winnipegosan Formation

Genera and Species	Localities 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
PORIFERA																						
Sphaerospongia tessellata (Phillips)	.	.	.	.	.	.	T	T	.	.	.	.	T	T	.	T	T	X	T	.	X	.
Sphaerospongia sp.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.
STROMATOPOROIDEA																						
Actinostroma sp.	.	.	.	.	.	.	.	X	X	.	.	.	.	X	X	X	X	.	.	.	X	.
Clathrodictyon sp.	X	.	X	.	.	.	.	.	.	.	.	X	.	.	.	.	X	.	.	.	.	.
Stromatoporoid	.	.	.	.	.	.	.	.	.	.	.	.	T	X	X	.	.	.	.	.	.	.
ANTHOZOA																						
Alveolites vallorum Meek?	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	X	T	.	T	.	.	.
Alveolites sp.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
Cladopora sp.?	X	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
"Columnaria" disjuncta Whiteaves	.	X	X	.	.	.	.	T	.	.	.	.	.	.	.	.	X	.	X	X	.	.
Cyathophyllum cf. lonense Stumm	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.
"Cyathophyllum" sp.	.	.	X	.	.	.	.	.	X	.	.	.	.	X	.	X	X	.	.	.	.	.
Disphyllum? disjunctum (Whiteaves)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
Disphyllum sp.?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.
Favosites alpenensis Winchell	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.
Favosites cf. alpenensis Winchell	.	.	.	.	.	.	.	.	.	.	.	X	X	X	.	.	.	.	.	.	.	.
Favosites limitaris Rominger	.	.	X	.	X	.	X	.	.	X	.	.	.	X	.	X	X	X	.	.	.	.
Favosites cf. limitaris Rominger	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
Favosites sp.	.	.	.	.	X	.	.	.	.	.	.	.	T	X	X	.	.	.	.	.	.	.
Favosites? sp.	.	X	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hexagonaria sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.	.	.	.	.	.
Corals (unidentified)	.	.	X	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CRINOIDEA																						
Stems and columnals	X	.	X	.	X	X	.	X	.	.	.	X	X	.	.	.	.	.	.	.	.	.
BRYOZOA																						
Bryozoa sp.	.	.	.	X	.	.	.	.	X	.	.	.	.	.	.	.	X	.	.	.	.	.
Cystodictya hamiltonensis Ulrich	.	.	.	.	.	.	T	.	.	.	.	T	X	.	.	.	.	.	.	T	T	.
Fenestella sp.	.	.	.	.	.	.	.	.	.	.	.	X	T	X	.	T	.	.	.	T	T	.
Pinacotrypa marginata Whiteaves	.	.	.	X	.	.	.	.	.	.	.	.	X	T	.	.	.	.	.	.	.	.
Pinacotrypa sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.

Fauna of the Winnipegosan Formation (continued)

Genera and Species	Localities 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BRACHIOPODA																						
Athyris? sp.						X																
Atrypa arctica Warren				X																		
Atrypa cf. arctica Warren				X				X				X										
Atrypa sp. cf. borealis Warren												X										
Atrypa cf. andersonensis Warren				X					X													
Atrypa cf. independensis Stainbrook													X									
Atrypa cf. mascula Stainbrook				X	X																	
Atrypa new species					X																	
Atrypa sp.		X	X			X			X	X				X				X	X			X
Atrypa? sp.								X														
Cranaena? sp.																		X				
Crispella sp.				X																		
Elytha fimbriata (Conrad)							X					X	T						T		T	
Elytha cf. fimbriata (Conrad)														X								
Gypidula comis(Owen)		X			X	T	X	X			T		T	X		T	X	T	X	T	T	
Gypidula comis? (Owen)				X																		
Martiniopsis sublineata (Meek)				X								X										
Martiniopsis cf. sublineata (Meek)									X													
Orthotetes chemungensis (Conrad)											X	T	T									
Productella cf. spinulicosta Hall.													X									
Productella new species			X	X																		
Schizophoria manitobensis Whiteaves									X			T	T		T	T			T			
Schizophoria cf. manitobensis Whiteaves													X									
Schizophoria sp.								X														
Spirifer? sp.					X						X											
Stringocephalus burtini Defrance		X					X	X				X	T	X		T	X	X	X	X	X	
Stropheodonta? sp.					X																	

Fauna of the Winnipegosan Formation (concluded)

Genera and Species	Localities 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
PELECYPODA																						
Anodontopsis affinis Whiteaves	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Modiomorpha compressa Whiteaves	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	X	.	.	.	.	.
Modiomorpha parvula Whiteaves	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	T	T	.	X
Modiomorpha tumida Whiteaves?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.
Paracyclas elliptica var. occidentalis Billings	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Pelecypod	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X
GASTROPODA																						
Bellerophon pelops Hall	.	.	.	.	.	.	T	.	.	.	T	.	.	.	.	.	.	.	.	.	X	.
Büchelia tyrrelli (Whiteaves)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.
Dentalium? sp.	.	.	.	.	.	.	.	.	.	.	X	.	T	.	.	.	.	.	.	.	T	.
Loxonema altivolvis Whiteaves	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.
Loxonema cingulatum Whiteaves	.	.	.	.	T	.	T	.	.	.	X	T	.	T	.	.	.	.	.	.	T	.
Macrochilina pulchella Whiteaves	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.
Pleurotomaria spenceri Whiteaves?	.	.	.	.	.	.	.	T	T	.	.	.	.	.	.	.	X	T	T	.	T	.
Straparolus cyclostoma (Hall)	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Straparolus sp.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	X	X	.	.	.	.
Tentaculites sp.	.	.	.	.	.	.	.	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.
Omphalocirrus manitobensis Whiteaves	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	T	T	T	.	.	.	.
CEPHALOPODA																						
Cypricardella producta Whiteaves	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthoceras sp.	.	.	X	.	.	.	T	T	.	.	.	T	T	.	.	.	T	.	.	.	.	.
TRILOBITA																						
Cyphaspis bellula Whiteaves	.	.	.	X	.	.	.	.	.	.	.	.	T	T	.	.	.	.	.	.	.	.
Proetus cf. haldemani	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.
Proetus mundulus Whiteaves	.	.	.	.	.	.	.	.	.	.	T	X	X	T	.	T	T	T	.	.	.	.
OSTRACODA																						
Ostracod	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FOSSIL PLANTS																						
Calcareous algae	.	X	.	.	.	X	.	.	X	.	.	.	X	X	.	.	X	.	.	.	X	X

Relation to Overlying Strata

In the Dawson Bay area the contact between the Winnipegosan formation and the overlying shales of the Manitoban formation is exposed in several places along the north shore of Salt Point(Figure 15). The upper beds of the Winnipegosan formation are finely crystalline limestone grading downwards to dolostone. The contact between the limestone and the Manitoban shale is sharp, and no transition zone is evident. The shale has been eroded from the tops of the bioherms and is found only on the flanks of the arched structures. Near the Bell River and near the mouth of the Steeprock River, where the bioherms underlie domed strata of the Manitoban formation, the shale is 30 to 40 feet thick.

In the Bell River area several small outcrops of Winnipegosan dolostone are exposed at lake level. These beds are near the top of the upper limit of the formation, as Manitoban strata outcrop close by. The dolostone is unfossiliferous and contains numerous small angular cavities that are undoubtedly mineral moulds. The crystal habit of the mineral that formed the moulds could not be determined, but the shapes of the cavities indicate a tabular crystal habit such as exhibited by gypsum(Fig.16).

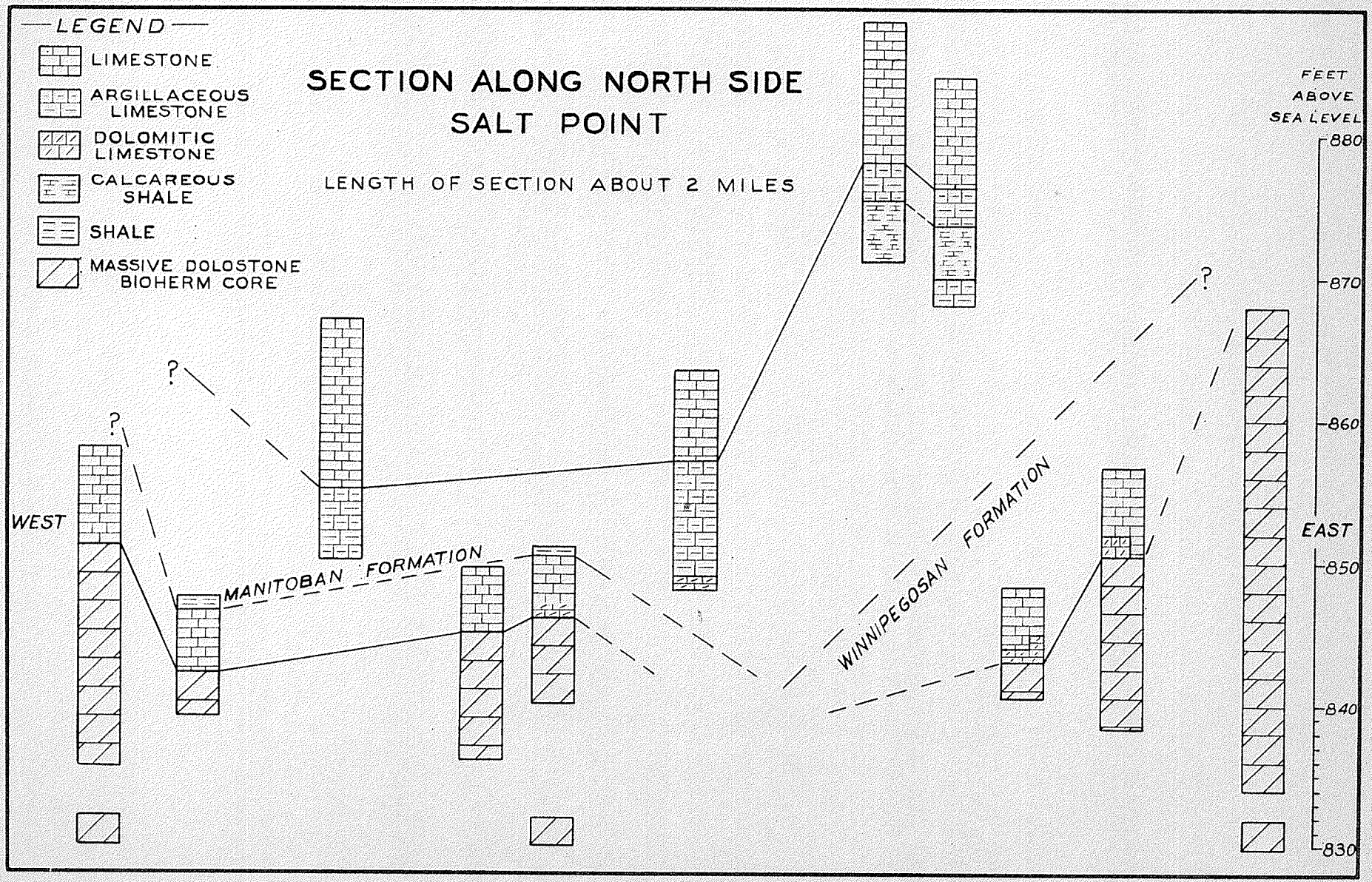

LEGEND
LIMESTONE
ARGILLACEOUS LIMESTONE
DOLOMITIC LIMESTONE
CALCAREOUS SHALE
SHALE
MASSIVE DOLOSTONE BIOHERM CORE
SECTION ALONG NORTH SIDE
SALT POINT
LENGTH OF SECTION ABOUT 2 MILES
FEET ABOVE SEA LEVEL
880
870
860
850
840
830
WEST
EAST
MANITOBAN FORMATION
WINNIPEGOSAN FORMATION
?
?
?

Figure 15

Figure 16

Mineral molds in Winnipegosan dolostone.

x 5

Figure 16

Manitoban Formation

Definition

The term Manitoban was introduced by Tyrrell(1892 p. 199E) for the shales and limestones of Devonian age which overlie the Winnipegosan formation. Kindle(1914 p. 256) divided the Manitoban formation into two faunal zones. A preliminary study of the fauna collected during the field season indicates a faunal change from a lower to an upper division of the formation, and several species not represented in the lower division are present in the upper. These two divisions correspond to Kindle's two faunal zones. A distinct lithological difference is also apparent between the two divisions. Revised nomenclature for the strata constituting the Manitoban formation is not attempted in this report but further field work and faunal studies will probably indicate the advisability of adopting new formational names. For purposes of description the lower and upper divisions will be referred to as lower and upper Manitoban.

Distribution and Character of lower Manitoban

Outcrops of lower Manitoban strata occur in a belt 15 to 30 miles wide that trends northwest from the vicinity of The Narrows, Lake Manitoba, to the west shore of Dawson Bay and the banks of the Red Deer River.

Several lithological units are present in the lower Manitoban. The stratigraphic relations of the different units are best exposed in the Dawson Bay area. Numerous domes are present near the southwest corner of the bay and where shore line erosion has cut through the domes complete

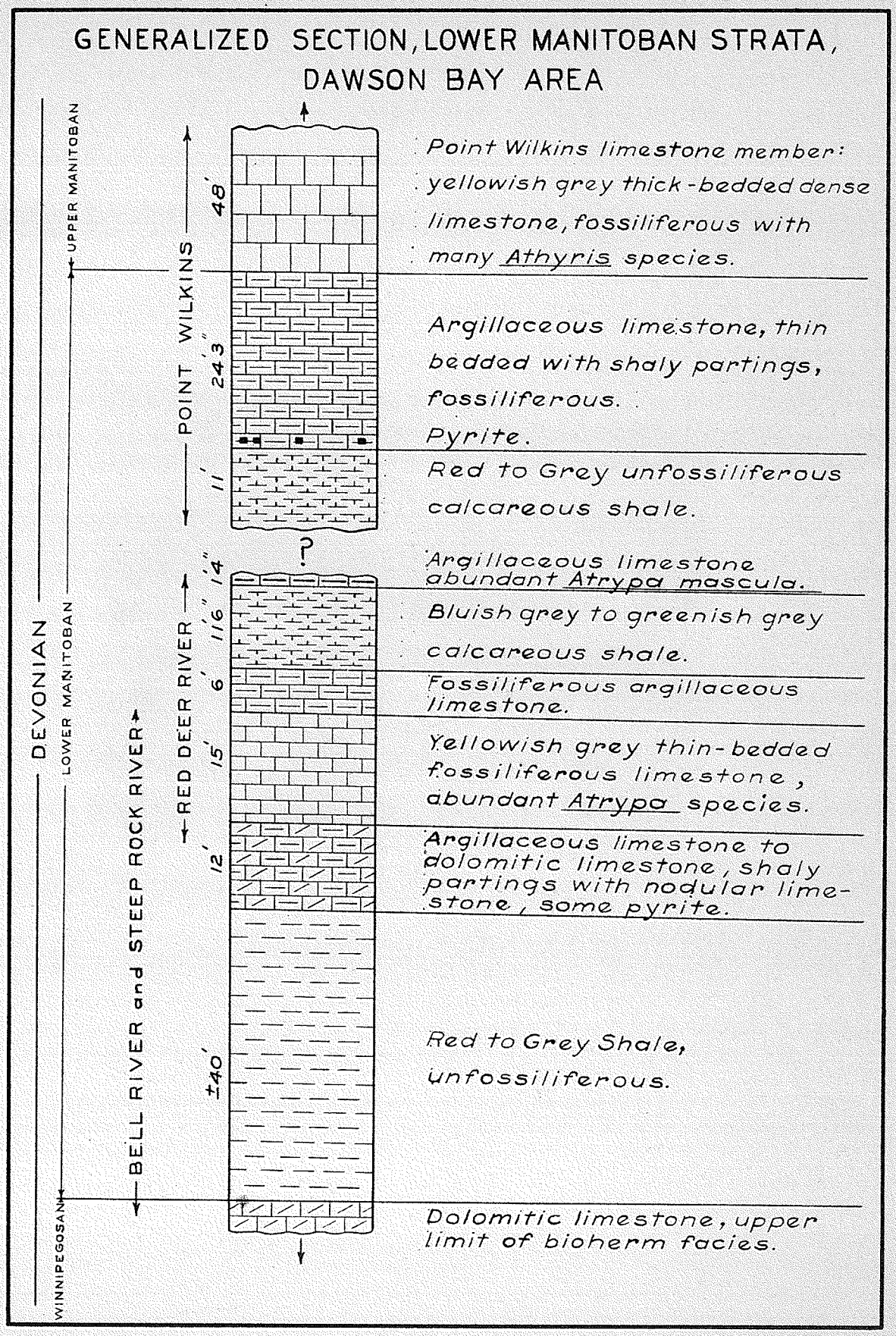

GENERALIZED SECTION, LOWER MANITOBAN STRATA, DAWSON BAY AREA
DEVONIAN
WINNIPEGOSAN
LOWER MANITOBAN
UPPER MANITOBAN
BELL RIVER and STEEP ROCK RIVER
RED DEER RIVER
POINT WILKINS
48'
24' 3"
11'
?
14"
1' 16"
6'
15'
12'
±40'
Point Wilkins limestone member: yellowish grey thick-bedded dense limestone, fossiliferous with many Athyris species.
Argillaceous limestone, thin bedded with shaly partings, fossiliferous.
Pyrite.
Red to Grey unfossiliferous calcareous shale.
Argillaceous limestone abundant Atrypa mascula.
Bluish grey to greenish grey calcareous shale.
Fossiliferous argillaceous limestone.
Yellowish grey thin-bedded fossiliferous limestone, abundant Atrypa species.
Argillaceous limestone to dolomitic limestone, shaly partings with nodular limestone, some pyrite.
Red to Grey Shale, unfossiliferous.
Dolomitic limestone, upper limit of bioherm facies.

Figure 17

sections are exposed. The columnar section in Figure 17 gives a generalized picture of the stratigraphic sequence for the Dawson Bay area.

The basal strata of the lower Manitoban are red to grey unfossiliferous shale. The shale is at the base of the cliffs and much of it is covered by rock fall and vegetation. A thickness of 30 to 40 feet was established by trenching in several places. The shale is bedded in places and breaks into blocky fragments, elsewhere it is fissile. The colour varies somewhat, but generally the lower beds are red grading upwards to grey or yellowish grey.

These basal shales are not evident in the southern part of the map-area. The log of the Winnipegosis No. 4 well (Wickenden 1934, p. 165B) shows no indication of shale above the Winnipegosan dolostone. The contact between the Winnipegosan and Manitoban formations is not directly exposed in the southern part of the area although the two formations outcrop in close proximity in several places. The argillaceous to dolomitic limestones described below are presumably the lowest Manitoban strata present in the area from Weston Point to the southern limit of the outcrop area, and the basal shales probably pinch out somewhere between Dawson Bay and Weston Point.

Ten to twelve feet of argillaceous to dolomitic limestone overlies the basal shales. Shaly bands as much as two feet thick are present. A knobbly weathered surface seen in places is due to the presence of nodules of limestone in an argillaceous matrix. In general the rock is a grey argillaceous limestone, but in places it grades laterally to a greyish yellow finely crystalline dolomitic limestone or to dolostone. Here and

there the argillaceous rock is mottled to a greyish yellow. X-ray diffraction photographs show the presence of dolomite in the greyish yellow phases, and dolomitization is thus indicated. In one outcrop, small nodules of white chert are present in the argillaceous limestone but no chert was found at corresponding horizons in other outcrops. Pyrite forms narrow bands in some of the rock. The rock becomes denser and less argillaceous near the top of the unit and grades upwards to the limestone described below.

Overlying the argillaceous limestone are about 15 feet of yellowish grey(5Y7/2) to pale yellowish brown(10YR6/2) finely granular fossiliferous limestone in beds three to five inches thick. Fossil fragments are abundant, and layers of finely comminuted fossil material are commonly present. Crinoid stem fragments show up as light coloured blebs throughout much of the rock. Secondary calcite is present in vugs and veinlets. The upper strata of all the domes examined in the area are composed of this bedded limestone.

The yellowish grey bedded limestone is exposed in several places along the banks of the Red Deer River. At one locality the bedded limestone is overlain by about 19 feet of shale and argillaceous limestone.

At Point Wilkins the lower part of the section is composed of shale and argillaceous limestone. Eleven feet of red to grey unfossiliferous calcareous shale forms the base of the cliff. About 24 feet of bedded argillaceous limestone overlies the shale. These strata are presumably the upper limit of the shales and argillaceous limestone exposed in the Red Deer River section and represent the youngest beds of the lower

Manitoban sequence. The argillaceous limestone at Point Wilkins is overlain by 48 feet of the Point Wilkins limestone member of the upper Manitoban.

The detailed lithology of the lower Manitoban strata can best be illustrated by describing typical outcrops and sections from various parts of the area.

Section at east side of point about three quarters of a mile northeast of the Bell River outlet

Unit	Thickness Ft.	In.
3. Yellowish grey(5Y7/2) fossiliferous bedded limestone. .		12
2. Argillaceous to dolomitic limestone, unevenly bedded, shaly partings. Bottom of unit is greyish yellow highly dolomitic limestone grading upwards through a mottled rock to olive-grey argillaceous limestone. . .	9	
1. Calcareous shale, dirty yellow to olive grey, weathers with a knobbly surface, fissile in places. . . exposed.		11
Total thickness of section. .	21	11

About half a mile southeast of the point where the above section was measured and a mile east of the Bell River outlet a prominent cliff exposed a section through an eroded dome. Several sections were measured along the face of the cliff. These are shown in Figure 18. A generalized section is given below.

Near the east end of the outcrop, the beds dip steeply to the west, and small faults are present. At least 35 feet of shale overlie the Winnipegosan strata and represent the lowest strata of the Manitoban formation.

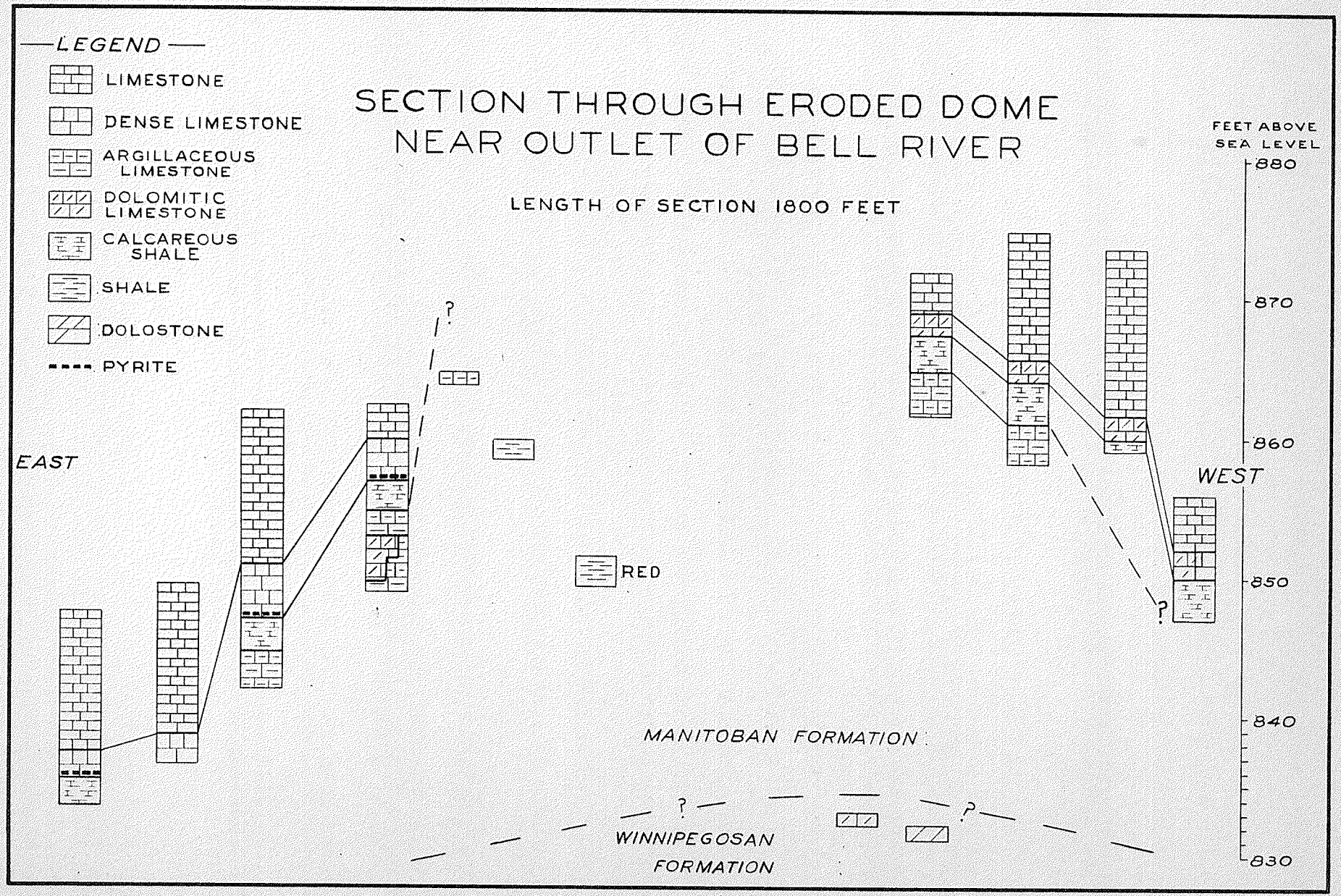

LEGEND
LIMESTONE
DENSE LIMESTONE
ARGILLACEOUS LIMESTONE
DOLOMITIC LIMESTONE
CALCAREOUS SHALE
SHALE
DOLOSTONE
PYRITE
SECTION THROUGH ERODED DOME
NEAR OUTLET OF BELL RIVER
LENGTH OF SECTION 1800 FEET
FEET ABOVE SEA LEVEL
880
870
860
850
840
830
EAST
WEST
RED
MANITOBAN FORMATION
WINNIPEGOSAN FORMATION
514

Figure 18

Generalized Section

Unit		Thickness Ft.	In.
	Lower Manitoban		
6.	Yellowish grey fossiliferous bedded limestone. . . .	11	
5.	Limestone, slightly argillaceous, olive grey, dense thick-bedded, grades laterally to greyish yellow dolomitic limestone. In places a well-defined band of pyrite crystals is present two inches above the lower limit of the unit.	3	
4.	Argillaceous limestone to calcareous shale, some dolomitic phases, shaly bands weather with a knobbly surface. Small solution caves, lined with banded onyx-like calcite nodules and large calcite crystals occur near the east end of the outcrop. Near the caves the strata show evidence of slumping. . . . . exposed. . .	9	
	covered interval. . .	6	
3.	Greyish yellow shale. . . . . exposed. . .	2	
	covered interval. . .	9	
	Red shale. . . . . exposed. . .	2	
	covered interval. . .	18	
	Winnipegosan Formation		
2.	Greyish yellow dolomitic limestone in four-inch beds. . . . . .exposed. . .	2	
	covered interval. . .	3	
1.	Dolostone, greyish yellow, massive, porous; much of the rock is made up of masses of tiny corals. . . . . .exposed. . .	1	

Near the mouth of the Steeprock River an extremely uneven topography results from numerous domes throughout the area. A section was measured about half a mile north of the river outlet. This is the site of a diamond-drill hole known as Mafeking No. 1. The drill hole begins in the upper

beds of the Winnipegosan formation which outcrop at the base of the cliff.

Section

Unit	Thickness Ft.	In.
Lower Manitoban		
5. Yellowish grey fossiliferous bedded limestone. . . .	8	6
4. Slightly argillaceous limestone, light olive grey, in two to three-inch beds, highly fractured. .	2	6
covered interval. . .	5	
3. Argillaceous limestone, greyish yellow(5Y8/4), in well-developed thin beds as much as three inches thick, beds appear slightly laminated owing to colour changes. . . . . .exposed. . .	2	
2. Shale, light olive grey(5Y6/1), breaks up readily into small fragments, 11 feet of the grey shale is present grading downwards to at least 15 feet of red shale.	26	
covered interval. . .	15	
Winnipegosan Formation		
1. Limestone, finely granular to saccharoidal, slight laminated appearance. Several saline springs are flowing from this horizon. . . . . exposed. . .	1	

The limestone unit forming the upper beds of the sections just described is also exposed in several places along the banks of the Red Deer River. A few hundred feet west of The Pas-Mafeking Highway bridge a good section is exposed that shows the strata that overlies the limestone. The lower beds occur at the east end of the outcrop as the beds dip 6 degrees to the west.

Section

Unit	Thickness Ft.	In.
5. Argillaceous limestone, dirty olive yellow, weathers with a powdery surface, in beds seven to ten inches thick, fossiliferous, many large Atrypa mascula, minor black chert.	1	4
4. Calcareous shale, pale olive(10Y6/2), breaks in slabby fragments, lower part of unit is more fissile and becomes bluish in colour, few fossil fragments.	11	6
3. Argillaceous limestone, light greenish grey(5GY8/1), shaly in places, unevenly bedded, minor pyrite, fossiliferous, many large Atrypas including A. arctica and A. mascula, fossils generally concentrated in thin beds.	6	
2. Yellowish grey fossiliferous bedded limestone. . . .	10	5
1. Argillaceous limestone, yellowish grey(5Y8/1) to greyish yellow(5Y8/4), finely granular, friable, in beds one inch to two inches thick, poorly fossiliferous. . . . . exposed. .	3	
Total thickness of section. . .	32	3

About a mile up the river from the place where the above section was measured, an outcrop in the form of a small anticline is exposed on the south bank. Yellowish grey bedded limestone constitutes the lower eight inches. This is overlain by about nine feet of argillaceous limestone that has shaly partings. The upper beds of this unit are shaly. The limestone at the bottom of this outcrop is probably equivalent to the upper part of unit 2 in the above section(Figure 19).

Half a mile farther up the river the yellowish grey limestone is again exposed. The rock is highly faulted, and no estimate of the thickness could be made. On some of the fault planes and in small fissures,

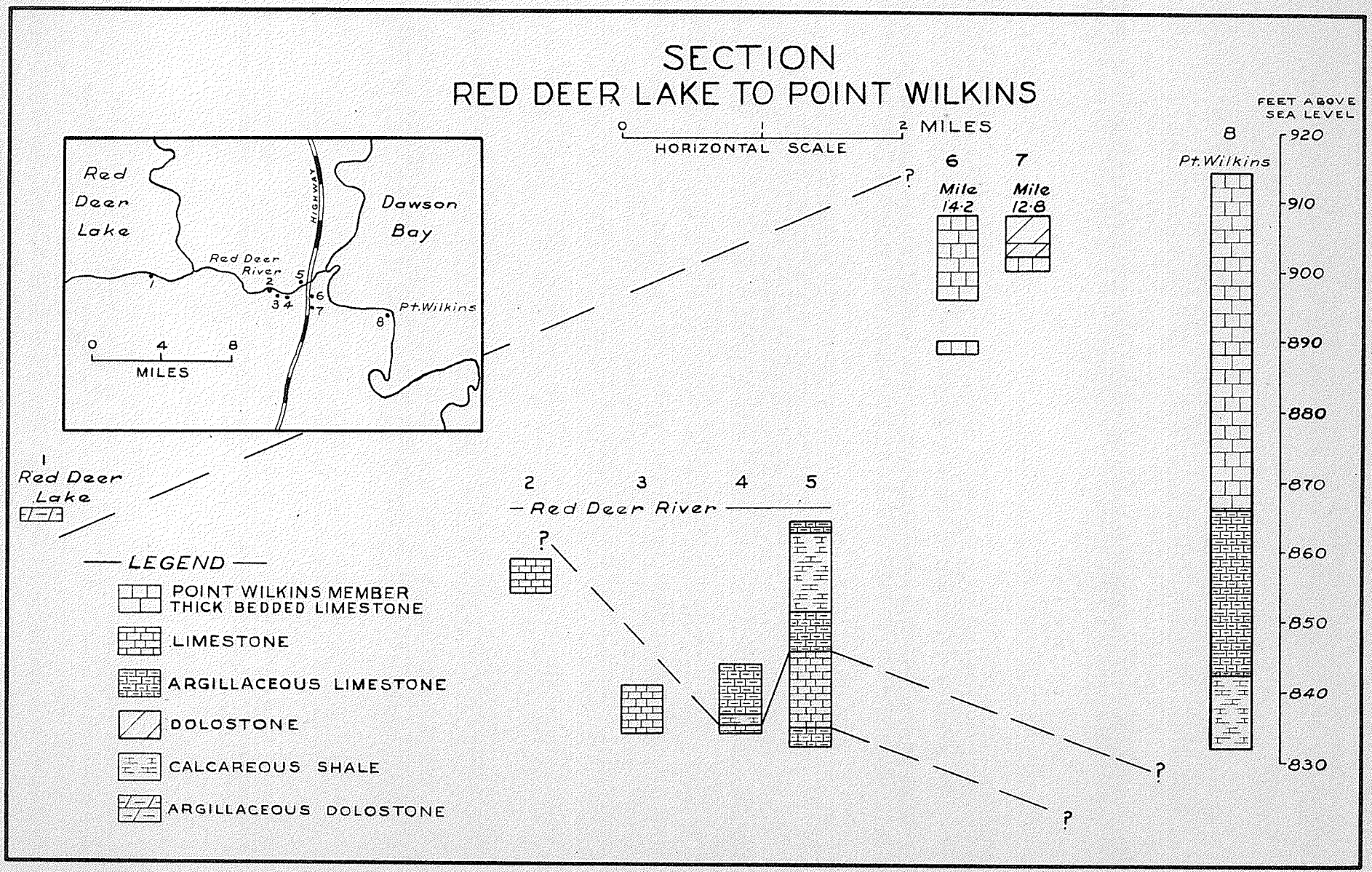

SECTION
RED DEER LAKE TO POINT WILKINS
0 1 2 MILES
HORIZONTAL SCALE
FEET ABOVE SEA LEVEL
920
910
900
890
880
870
860
850
840
830
Red Deer Lake
Dawson Bay
Red Deer River
HIGHWAY
Pt. Wilkins
0 4 8
MILES
1
Red Deer Lake
2 3 4 5
Red Deer River
6
Mile 14·2
7
Mile 12·8
8
Pt. Wilkins
LEGEND
POINT WILKINS MEMBER THICK BEDDED LIMESTONE
LIMESTONE
ARGILLACEOUS LIMESTONE
DOLOSTONE
CALCAREOUS SHALE
ARGILLACEOUS DOLOSTONE

Figure 19

a sandstone consisting of small rounded quartz grains was seen.

The largest exposure of rock in the Dawson Bay area is at Point Wilkins on the west shore of the bay about four miles north of the Steeprock River outlet. Sheer cliffs as much as 90 feet high extend about two miles along the shore(Figure 20). Tyrrell(1892 p. 183E) described the cliffs in detail. The beds are essentially flat-lying with broad undulations. In two or three places a jumbled mass of huge blocks of limestone, as much as six feet across, form a coarse breccia and fill in what were apparently large fissures. Many of the blocks are from the top beds of the cliff. The matrix of the breccia is generally a rubbly appearing argillaceous limestone, but in one disturbed area near the south end of the cliffs much of the cementing material is a micaceous sandstone.

Point Wilkins Section

Unit	Thickness Ft.	In.
Upper Manitoban(Point Wilkins member)		
3. Limestone, yellowish grey(5Y8/1), dense, in beds as much as five feet thick, fossiliferous with many species of Athyris.	48	
Lower Manitoban		
2. Argillaceous limestone, yellowish grey(5Y7/2) with shaly partings, near base of unit well-formed pyrite crystals are abundant, fossiliferous with some fragmental fossil layers.	24	3
1. Calcareous shale, red to grey, breaks in small blocky fragments, fissile in places. . . . . exposed. .	11	0
Total thickness of section. . .	83	3

Figure 20

Point Wilkins on the west shore of Dawson Bay. Cliff is 100 feet high at its highest point and extends for more than two miles along the shore.

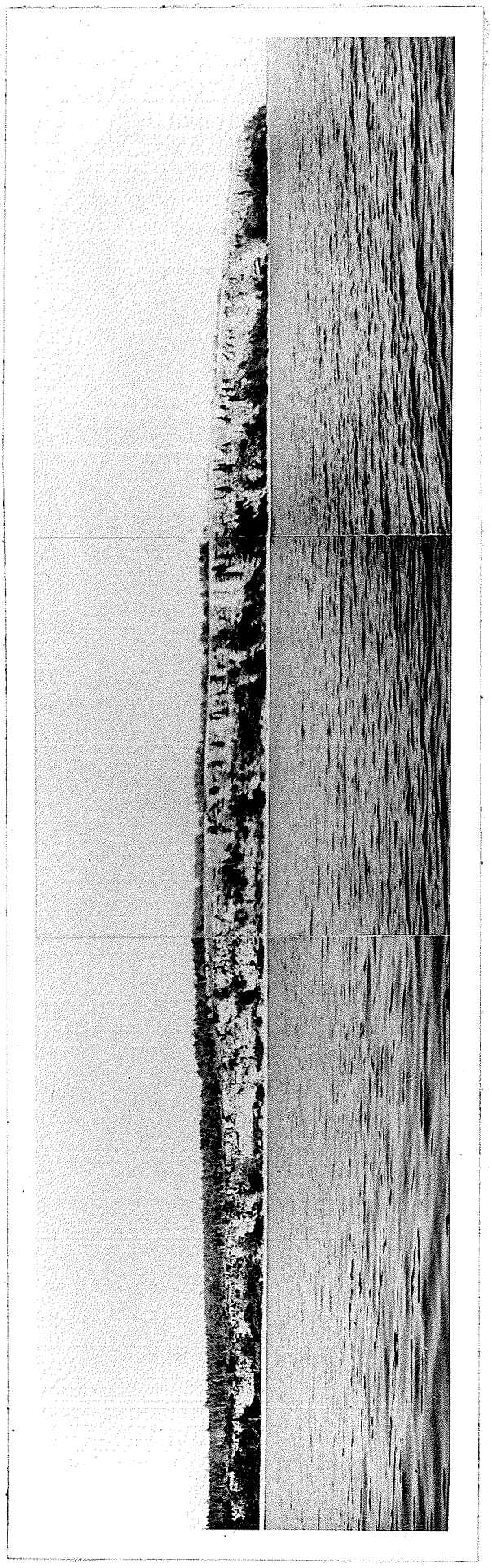


Figure 20

The shales and argillaceous limestones of unit 1 and 2 are believed to correspond to the upper limit of similar strata which overlie the yellowish grey bedded limestone in the Red Deer River section.

The contact between units 2 and 3 could not be examined closely owing to the sheer cliff, but it is distinct as viewed from the base of the cliff.

On the west shore of Pelican Bay about latitude 52 degrees 44 minutes, lower Manitoban beds are exposed in cliffs which extend 300 feet along the shore.

Section

Unit	Thickness Ft.	In.
2. Yellowish grey bedded limestone, concentrations of fossil in beds, Atrypa arctica abundant.	7	
1. Argillaceous limestone, greyish orange(10YR7/4), slightly mottled to a pale olive green, some fossil fragments, poorly bedded, stringers of secondary calcite. . . . . exposed. . .	4	
Total thickness of section. . .	11	

Fifteen miles northwest of the outcrop at Pelican Bay the following section was measured on the west shore of Cameron Bay.

2. Dolomitic limestone, slightly argillaceous, pale yellowish orange mottled to a yellowish grey, finely granular to crystalline in beds one inch to three inches thick, breaks in slabby fragments. A highly fossiliferous layer is present about eight inches from the bottom.	13	
1. Highly dolomitic limestone, greyish yellow(5Y8/4), finely crystalline, in beds up to 12 inches thick with shaly partings. . . . . exposed. . .	2	9
Total thickness of section. . .	15	9

Nearly sixty miles southeast of Dawson Bay, at South Manitou Island, Brabant Point, and along the east side of Weston Point, are several outcrops of the lower Manitoban beds. The sequence of beds in this part of the area is similar to that of the Dawson Bay section but the lower shale which is 30 to 40 feet thick in the Dawson Bay section is not present. No evidence of this shale is found in any of the exposures in the southern part of the area.

The largest exposure of Manitoban limestone in this vicinity is in cliffs at Brabant Point. The exposure extends along the shore for about half a mile, but it is discontinuous owing to slumping and erosion. Irregularity of dip and the presence of faults make it difficult to trace the beds laterally.

The following section measured near the north end of the outcrop area at Brabant Point illustrates the lithology of the several units present.

Section

Unit	Thickness Ft.	In.
4. Argillaceous limestone to calcareous shale, yellowish grey, highly fractured.	3	
3. Limestone, yellowish grey to pale yellowish brown, in uneven beds, fossiliferous.	13	
2. Dolomitic limestone to argillaceous limestone, greyish yellow, fossiliferous, slightly mottled, contains stringers of secondary calcite, the lower one foot of this unit is argillaceous with shaly partings.	3	

Section(cont'd)

1. Dolostone, greenish grey(5GY6/1), dense to finely granular, even textured, in beds five to ten inches thick, grades upwards to a greyish yellow finely crystalline dolostone, minor pyrite. . . . . .exposed. . . 9

Total thickness of section. . . 28

Several smaller sections that were measured showed a similar sequence of beds. Several hundred feet to the south of the measured section the argillaceous limestone of the top unit is thicker and grades upwards to a calcareous shale. Although not directly measured, at least 20 feet of shale is believed to be present.

Near the centre of the outcrop area a low cliff of dolostone, typical of the bioherm facies of the Winnipegosan formation, is exposed near the shore. The exposed thickness is two feet, and the rock is greyish orange massive tough porous finely crystalline dolostone which contains nodules of light grey chert. No other rock is exposed within 300 feet, but the dolostone is probably near the top of the Winnipegosan formation, and the strata described in the section represent the basal beds of the Manitoban formation in this vicinity.

On South Manitou Island, rock is exposed in discontinuous cliffs for about 1600 feet along the north shore. Several lithological units are represented but owing to faults and irregular dips the stratigraphic sequence is difficult to establish. Presumably the lowest beds of the section are exposed at the base of a cliff about 1000 feet west of the most easterly cliff. These beds are greyish yellow(5Y8/4) dolomitic

limestone containing argillaceous phases. Many lateral changes occur, and mottling due to partial dolomitization is seen at several places. At least seven feet of this unit is exposed. Several feet of yellowish grey argillaceous dense bedded limestone with shaly partings overlies the greyish yellow rock. This limestone grades upwards to a yellowish grey fossiliferous limestone which is at least ten feet thick. Grey calcareous shale appears to be the highest rock in the section. At the western end of the line of cliffs several small domes of the yellowish grey bedded limestone are overlain by calcareous shale.

On the eastern side of a small island about half a mile west of the northern tip of Weston Point, cliffs of limestone 12 feet high extend for several hundred yards along the shore. The rock is yellowish brown to yellowish grey unevenly bedded fossiliferous limestone with several thin clastic beds containing many fossil fragments. The beds dip towards the west at 20 to 28 degrees. The cliffs are eroded remnants of domes. Half way up the east side of Weston Point is a small cliff, eleven feet high, of limestone similar to that just described.

South of Weston Point, on the west shore of a small bay locally known as Barney's Bay, a long cliff of limestone is exposed. The lower eight feet is composed of three-to five-inch beds of greyish yellow(5Y8/4) finely granular dolomitic limestone. In places the rock is argillaceous with several two-inch shaly bands. The beds contain scattered fossils and highly fossiliferous bands form the tops of some beds. The lower eight feet are overlain by three feet of pale yellowish brown(10YR6/2)

finely granular bedded limestone which contains many fossil fragments.

Near the town of Winnipegosis, limestone is exposed in several places along the banks of the Mossy River. At the bridge, about two miles from the mouth of the river, a section 16 feet thick was measured. The outcrop is in the form of an anticline that strikes North 25 degrees east, and the crest and east limb are exposed. Several small faults are present, and some of the rock is brecciated. The lower few feet are of irregularly fractured yellowish brown massive limestone. The upper beds consist of yellowish brown finely granular limestone in thin even beds, one half to one inch thick. Slight colour changes give the rock a laminated appearance.

Several hundred yards down the river on the west bank the thin-bedded rock is again exposed. The beds dip steeply into the river and are faulted. The laminated beds are distorted, and small healed fractures indicate that deformation took place before the beds were consolidated.

One and a half miles west of the town of Winnipegosis on the N.W.$\frac{1}{4}$ of sec. 9, tp. 31, rge. 18, W. Principal mer., a small abandoned quarry exposes the following section:

Unit	Thickness Ft.	In.
2. Limestone, yellowish grey(5Y8/1), in poorly defined beds one inch to two inches thick. The lower three feet is dense and unfossiliferous but grades upwards to a more fossiliferous rock with much clastic material. Rounded masses, as much as one foot in diameter, of finely crystalline hard limestone that shows concentric laminations, are present in places. . . .	4	4

Section(cont'd)

l. Limestone, yellowish grey(5Y7/2), dense, in even thin beds. The beds become thinner towards the top of the unit. Slight change in texture and colour give a laminated appearance. The top of this unit forms the quarry floor and small mounds as much as three feet in diameter protrude three to five inches above the quarry floor. The mounds are tough and hard, and have slight vugular porosity. An irregular layered appearance suggests algal origin. The top beds of this unit have a weathered appearance and desiccation figures are present. . . . . exposed. . .	2	10
Total thickness of section. . .	7	2

The strata in the Mossy River exposures and in the quarry are probably somewhat higher than the Snake Island and Charlie Island strata.

The topography of the area south of Lake Winnipegosis, including Snake and Charlie Islands, is irregular owing to the presence of domes in the underlying strata. On the crests of many of the domes and ridges the soil mantle is thin, and the bedrock is exposed. In general, the rock exposed is yellowish grey bedded fossiliferous limestone similar in character to the strata which forms the tops of the domes in the Dawson Bay area. In two localities however, the upper beds are composed largely of stromatoporoid limestone, so no doubt some of the uneven topography is caused by underlying resistant masses of the stromatoporoid rock.

Large spherical masses of Actinostroma sp. are exposed in an abandoned quarry on the northeast $\frac{1}{4}$ of sec. 29, tp. 30, rge. 17, W. Principal mer. Eight feet of limestone is exposed in the quarry, and the rock is almost entirely of organic origin. Stromatoporoid limestone constitutes most of the rock exposed, but recrystallized crinoidal limestone which has

strongly developed calcite cleavage is present in considerable amount. Several different types of corals are also abundant.

Red clay grading downwards to a red calcareous shale is exposed on a low ridge along the north boundary of ls. 13, sec. 10, tp. 30, rge. 17, W. Principal mer. The shale is similar to that exposed near the end of Steeprock Lake described below, and it probably overlies the bedded fossiliferous limestone that forms the domes in this area.

Snake Island in Lake Winnipegosis is about five miles east of the town of Winnipegosis. The strata outcropping on the island are considered typical of the yellowish grey bedded limestone unit that occurs throughout the area. The rock is exposed in cliffs at several places on the island; the largest exposure is on the northwest shore. At this point the cliff extends for several hundred feet along the shore, and the beds dip gently away from the centre of the exposure giving the appearance of a low anticline.

The following section was measured at the highest point of the cliff illustrates the lithology of the Snake Island beds.

Unit	Thickness Ft.	In.
5. Limestone, pale yellowish brown(10YR6/2) to yellowish grey(5Y7/2), finely granular fossiliferous with many fossil fragments, breaks with irregular fracture.	11	2
4. Limestone, light brownish grey(5YR6/1) to pale yellowish brown(10YR6/2). The bottom of this unit consists of a one-inch fragmental band made up largely of comminuted fossil fragments. The lower surface of the band is an even bedding plane.		

Section(cont'd)

4. (cont'd) The fragmental band grades upwards to a dense unfossiliferous rock which is topped by another two-inch fragmental layer. The upper surface of this layer is ripple-marked as described by Kindle(1914 p. 254).	1	2
3. Limestone, pale yellowish brown mottling to a pale yellowish orange, finely granular, highly fossiliferous, many fossil fragments in one-to three-inch beds, less resistant than overlying unit.	1	5
2. Light brown argillaceous limestone with some fissile shale.	0	2
1. Limestone, slightly argillaceous, yellowish grey to pale yellowish brown, dense to finely granular, in beds as much as seven inches thick, fossiliferous, with many fossil fragments, slightly mottled, some small nodules of iron sulphide. . . exposed. . .	5	5
Total thickness of section. .	19	4

On Charlie Island and on the mainland west of the island are many small cliffs of lower Manitoban limestone. These exposures are parts of eroded domes. As exposed the rock is a pale yellowish brown to yellowish grey dense to finely granular, fossiliferous limestone in uneven beds. Some bands are composed largely of fossil fragments. In places the beds are faulted slightly and some parts are brecciated. The beds dip as much as 18 degrees away from the crests of the domes.

The following section measured at the north end of Charlie Island illustrates the lithology.

Unit	Thickness Ft.	In.
4. Limestone, pale yellowish brown(10YR6/2), weathering to a light grey, in one-to five-		

Section(cont'd)

	Ft.	In.
4. (cont'd)inch beds, fossiliferous with many fossil fragments, some secondary calcite.	5	
3. Limestone, pale yellowish brown, mottling to light brown(5YR5/6), dense, highly fractured, slightly fissile in places, fossil fragments.	1	11
2. Limestone, pale yellowish brown, dense to finely granular in even beds two to three inches thick, poorly fossiliferous except for a two inch band of fossil fragments. The top surface of the band is even, whereas the bottom surface is highly irregular.	1	11
1. Limestone, yellowish grey to pale yellowish brown, dense, conchoidal fracture, poorly bedded, unfossiliferous. . . . . exposed. . .		9
Total thickness of section. . .	9	7

At Steeprock Lake a section 15 feet, three inches thick was measured. An elongated dome with a greatly undulating crest forms a prominent point at the south end of the lake. The section was measured on the west side of the point and is as follows:

Unit	Thickness Ft.	In.
4. Limestone, yellowish grey(5Y7/2), dense with some parts containing clastic material and many fossil fragments, highly fractured.	6	4
3. Limestone, pale yellowish brown with pale orange and reddish mottling and streaks. The upper four inches of this unit is highly fossiliferous with many brachiopods.	0	8
2. Limestone, yellowish brown, mottling to dark yellowish orange, dense to finely granular, brachiopods and crinoid stems.	4	3

Section(cont'd)

	Ft.	In.
1. Limestone, slightly argillaceous, yellowish brown with many purple streaks and mottles, dense.	4	0
Total thickness of section. . .	15	3

Red residual clay grading downwards to a red calcareous shale is exposed about 100 feet east of the place the above section was measured. This outcrop is about 20 feet lower in elevation than the top of the dome. If the dip of the beds on the east flank of the dome is consistent the calcareous shale overlies the beds forming the dome. The shale is probably equivalent to similar strata which overlie the well-bedded limestone at Brabant Point and on the Red Deer River.

At Onion Point, a cliff 300 feet long exposes about 10 feet of a yellowish grey dense to finely granular limestone in beds two feet thick. The upper few feet are highly fossiliferous with many species of Atrypa, and poorly preserved cephalopods and gastropods. Greyish purple flecks and streaks are abundant. The streaks are associated with fracture planes.

The strata exposed at the two localities last described are considered to be equivalent to the beds at Snake Island.

The most southerly exposures of the Manitoban strata are in the vicinity of The Narrows, Lake Manitoba. The following section was measured on the north end of Manitoba Island.

Unit	Thickness Ft.	In.
5. Argillaceous limestone, pinkish grey(5Y8/1), with reddish purple streaks and mottles, dense to finely granular, in one-to three-inch beds, minor pyrite.	5	2

Section(cont'd)

	Ft.	In.
4. Argillaceous limestone to calcareous shale, fissile in places.	0	$5\frac{1}{2}$
3. Argillaceous limestone, very pale orange(10YR8/2), dense to finely granular, in one-to three-inch beds, shaly parting one inch thick at bottom of unit.	0	10
2. Limestone, yellowish grey to pale yellowish brown, dense, breaks in slabby fragments, slight mottling to a pale orange. . . . . exposed. . .	6	
covered interval. . .	1	
1. Dolostone, very pale orange, finely saccharoidal, intergranular porosity, some vugs filled with secondary calcite. . . . . exposed. . .	0	10
Total thickness of section. . .	14	$3\frac{1}{2}$

The dolostone in unit 1 of this section resembles that of the Winnipegosan formation which outcrops on the mainland east of the island. As dolostone also underlies argillaceous limestone in the Manitoban formation in the northern part of the area, it is doubtful whether unit 1 is Winnipegosan. On the west side of Manitoba Island, several hundred yards south of the measured section, a small cliff exposes about six feet of dusky yellow(5Y6/4) dense silty dolomitic limestone. This is probably part of the lower Manitoban, but its relation to the argillaceous limestone of the measured section is not clear. If the dolomitic limestone underlies the argillaceous limestone, then unit 1 of the above section is probably Manitoban.

On the mainland, one mile west of the island, three feet of pale red(10R6/2) dense bedded limestone with a reddish purple streak and mottles is exposed in a low cliff. This limestone is probably equivalent to

similar limestone at the north end of Manitoba Island.

Three miles east of Manitoba Island, on the road to The Narrows, limestone similar to that of unit 5 of the Manitoba Island section outcrops. Many well preserved fossils are present in these beds. Pale yellow silty dolomitic limestone similar to that exposed on the west side of Manitoba Island is exposed in a small outcrop about half a mile north of the road; again, its relation to the argillaceous limestone could not be ascertained.

Distribution and Character of Upper Manitoban

The upper strata of the Manitoban formation are exposed at Point Wilkins, on islands in Swan Lake, along The Pas-Mafeking Highway between mile 10 and mile 14.5, on the south shore of Red Deer Lake, and on the road between Sagemace Bay and Pine River.

On the map accompanying this report the assumed geological boundary between the upper and lower Manitoban strata is shown only in the Dawson Bay area.

Point Wilkins Member: The lowest beds included in the upper Manitoban consist of yellowish grey(5Y8/1) to pale yellowish brown dense limestone in beds as much as four feet thick. Much of the rock has a peculiar mottled appearance. The mottling is caused by small subrounded to angular fragments of extremely fine-grained limestone in a matrix of slightly coarser grain size. Athyris and Atrypa are the most abundant fossils in these beds. Here and there the rock is brecciated, and breaks

easily into small irregular fragments.

In places the rock is finely crystalline and may be broken into extremely thin beds. A concentration of small gastropods marks each bedding plane.

As the rock described above has considerable areal extent and is so distinctive in outcrop it is proposed to name the unit the Point Wilkins member for the good exposures at Point Wilkins on the west shore of Dawson Bay. The member has an exposed thickness of 49 feet at Point Wilkins. Owing to the sheer cliffs the section exposed could not be examined closely. The following section was measured one and a half miles south of Point Wilkins and will serve to illustrate the lithology of the member(Figure 21)

Unit	Thickness Ft.	In.
4. Limestone, yellowish grey(5Y8/1), dense, thick-bedded with distinctive mottled appearance described above, fossiliferous, many Athyris sp. and small gastropods.	34	9
3. Limestone, pale yellowish brown, finely crystalline, appears thick-bedded but breaks into half-inch beds. A layer of small gastropods is present between each thin bed. Some shaly partings.	3	5
2. Limestone, yellowish grey, dense, in poorly defined beds three to five inches thick.	2	8
1. Limestone, similar to top beds of section. .exposed. .	5	4
Total thickness of section. . .	46	2

At mile 14.2 on The Pas-Mafeking Highway ten feet of Point Wilkins limestone is exposed in a quarry. A few hundred feet north of the main

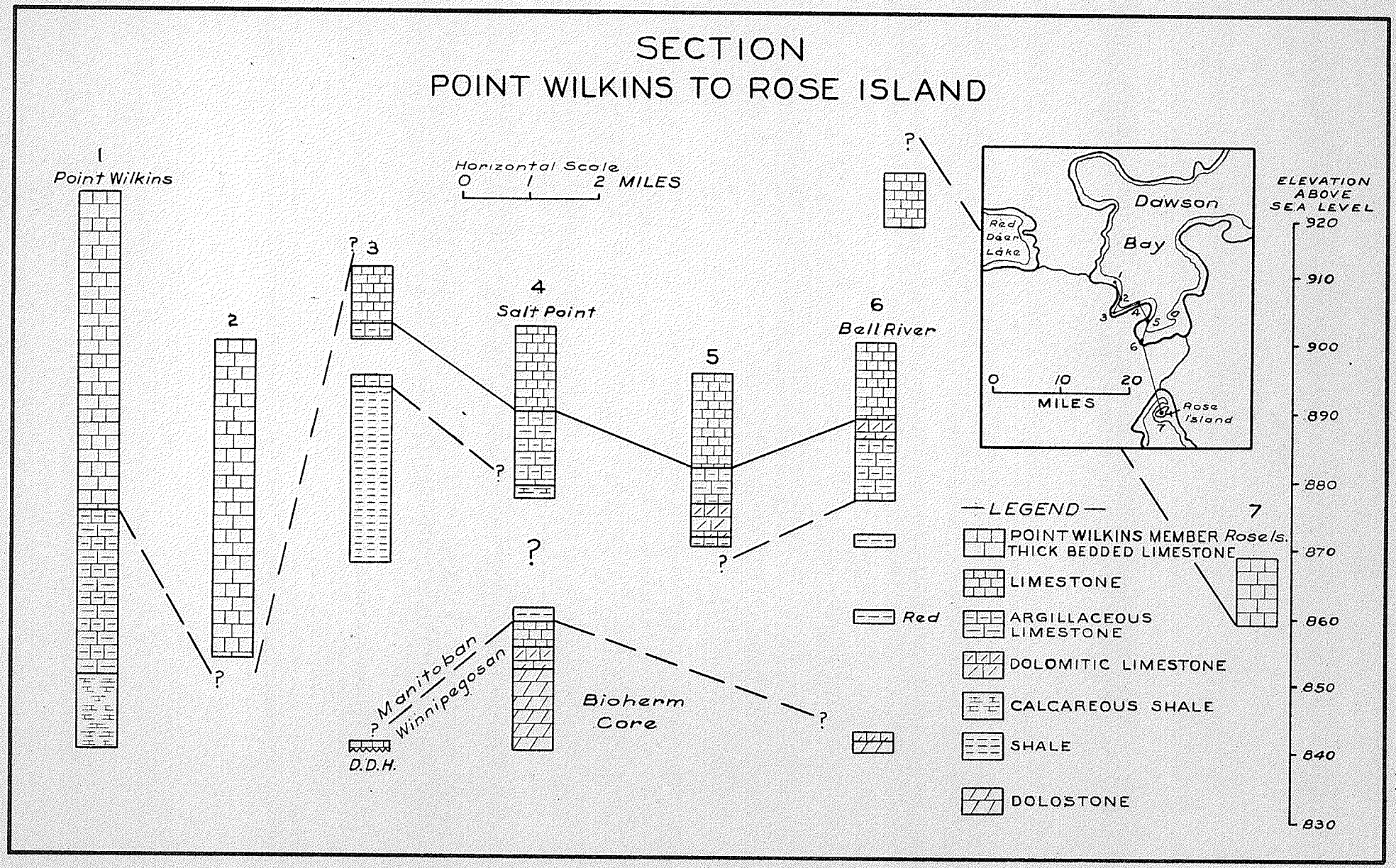

SECTION
POINT WILKINS TO ROSE ISLAND
1
Point Wilkins
2
3
4
Salt Point
5
6
Bell River
7
Horizontal Scale
0 1 2 MILES
D.D.H.
? Manitoban
Winnipegosan
Bioherm
Core
Red
Dawson
Bay
Red Deer Lake
Rose Island
0 10 20
MILES
ELEVATION ABOVE SEA LEVEL
920
910
900
890
880
870
860
850
840
830
— LEGEND —
POINT WILKINS MEMBER Rose Is.
THICK BEDDED LIMESTONE
LIMESTONE
ARGILLACEOUS LIMESTONE
DOLOMITIC LIMESTONE
CALCAREOUS SHALE
SHALE
DOLOSTONE

Figure 21

exposure and at a lower elevation, one foot of yellowish brown finely crystalline limestone containing many small gastropods outcrops.

Near the north end of Swan Lake, yellowish grey dense limestone with the mottling typical of the Point Wilkins limestone, is exposed in cliffs. On the northwest end of Rose Island a section ten feet thick was measured. The rock is brecciated in places and breaks easily into fragments. Minor pyrite is present.

Beds Overlying Point Wilkins Member: Overlying the Point Wilkins limestone is a yellowish brown finely crystalline unfossiliferous dolostone. This rock is massive to thick-bedded and the weathered surface has a rough gritty appearance. Commonly it is brecciated and the close-set fragments are cemented by drusy calcite. Several outcrops of coarsely crystalline limestone seem to be closely associated with the dolomitic rock, but owing to limited exposures the relation between the two could not be ascertained.

At mile 13.2 six feet of the finely crystalline dolomitic limestone is exposed. The relation between the limestone and the dolomitic limestone is seen at mile 12.8 about a hundred feet east of the highway. At this point three feet of the Point Wilkins limestone is overlain by six feet of highly brecciated dolostone which weathers to a mass of fragments.

East of the highway at mile 10.6 several small outcrops may be seen on the road to the Steeprock River outlet. The dense rock of the Point Wilkins limestone is exposed in several places. Other outcrops of the yellowish brown dolostone and the coarsely crystalline limestone are

present, but owing to poor exposures the contacts between the various rock types were not observed.

On the NE $\frac{1}{4}$ of sec. 7, tp. 40, rge. 23, W. Principal mer., about 350 feet east of the Swan River and a few miles from its mouth, a section nine feet thick, is exposed on the northwest side of a low dome. The lower four feet is composed of pale yellowish orange medium crystalline limestone in well defined beds one inch to two inches thick. This limestone is overlain by five feet of pale yellowish orange coarsely crystalline porous brecciated limestone in poorly defined beds five inches thick. These upper beds are porous and brecciated and are similar in character to rock that outcrops near mile 10.6 on The Pas-Mafeking Highway.

On the south shore of Red Deer Lake, near the east end, a low cliff exposes 18 inches of moderate yellowish brown argillaceous dolostone. The rock has a layered appearance that is caused by thin bands of the dolomitic rock alternating with thin uneven layers of a softer more porous rock. The upper two inches consist of tightly cemented angular fragments of the dolomitic limestone. The sandstone mentioned by Wallace(1925 p. 26) was not found. A study of insoluble residues shows that a small amount of fine quartz sand occurs in the rock, but as the rock is highly weathered and porous the sand could have been introduced from some higher horizon.

West of Sagemace Bay about 16 miles northwest of the town of Winnipegosis outcrops occur on the road at the crests of several northwest trending ridges.

The most easterly outcrops, along the eastern boundary of sec. 21,

tp. 32, rge. 19, W. Principal mer., are yellowish grey finely granular slightly argillaceous limestone which contains many fossil fragments. These beds are somewhat similar to the argillaceous limestones in the lower beds at Point Wilkins.

Along the north boundary of sec. 32, tp. 32, rge. 19, W. Principal mer., three miles northwest of the last described outcrop, the bedrock is exposed at the top of a small ridge. The rock is a yellowish brown slightly argillaceous dolomitic limestone. Thin layers of fine-grained dolomitic limestone are separated by uneven bands of yellowish orange friable rock which results in a banded appearance. This rock is strikingly similar to the highly weathered dolomitic limestone that outcrops on the south shore of Red Deer Lake to which it is probably equivalent.

Several miles west of the above described outcrops, rock of different character is exposed. Along the north boundary of ls. 13, sec. 34, tp. 32, rge. 20, W. Principal mer., pale yellowish brown limestone that contains many stromatoporoids is exposed. Some of the rock is a breccia consisting of fragments of stromatoporoid and small corals in a matrix of sand-size carbonate grains. The matrix resembles an oolitic limestone.

The oolitic texture is well developed in the rock exposed on another ridge a mile to the west. On this ridge the rock is made up largely of rounded carbonate grains and fragmentary fossils, and small masses of greenish black chert. The rounded grains range from 1/32 to 1/8 inch in size and in places show graded bedding. In thin section

many of the rounded grains show concentric banding and appear to be oolites. About eight feet of the oolitic rock is exposed(Figure 22).

This fragmental and oolitic rock represents the highest Devonian strata exposed in the area. The rock would be recognized easily in well cuttings and if it is wide spread it would serve as an excellent marker.

Thickness

The complete section of the lower Manitoban is not present at any one locality so an estimate of its thickness is based on measurements taken at several outcrops. The Bell River and Steeprock River sections expose 67 feet of shales, argillaceous limestones and limestones. Along the banks of the Red Deer River about 18 feet of shales and argillaceous limestone overlie and equivalent of the upper beds of the Bell and Steeprock River sections. At Point Wilkins, the 35 feet of shales and argillaceous limestone in the lower part of the section are believed to overlie the equivalent of the Red Deer River section. The above interpretation indicates that the lower Manitoban is at least 120 feet thick. Although a similar sequence of 11 feet of shale overlain by argillaceous limestone is present in the Red Deer River and Point Wilkins sections, the two shales are not believed equivalent(Figure 18). The shale at Red Deer River is fossiliferous and contains little or no pyrite, whereas the shale at Point Wilkins is unfossiliferous and contains considerable pyrite at its upper contact.

The logs of the wells in the Mafeking area offer little help in estimating the thickness, as the various lithological units present in

Figure 22

Polished surface of oolitic limestone, Manitoban formation.

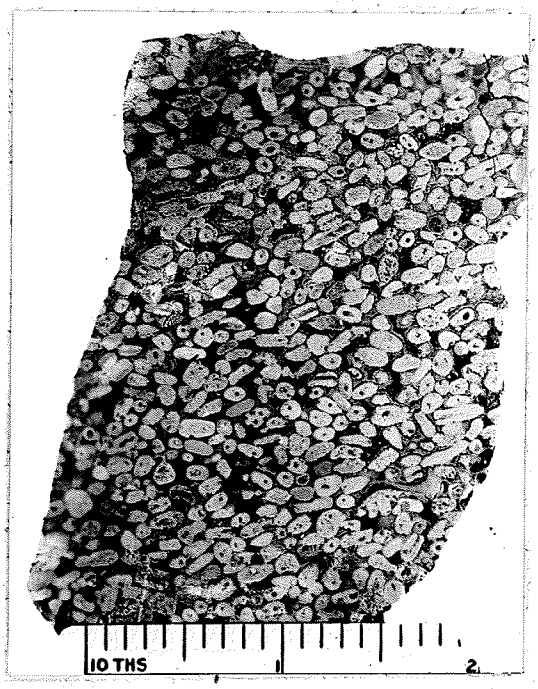


Figure 22

outcrop are not distinguishable in the well sections.

As an erosional unconformity occurs at the top of the Devonian strata in Manitoba, the upper Manitoban will probably show considerable variation in thickness in different well sections. As exposed, the Point Wilkins limestone member of the upper Manitoban sequence is 48 feet thick. At least 10 feet of dolostone to dolomitic limestone overlies the Point Wilkins member.

Fauna

The following fossils were collected from the lower Manitoban strata. A more complete list is given by Tyrrell(1892 p. 205E). In the distribution table, locality occurrences marked T indicate that the species is listed by Tyrrell as occurring at that locality.

The fossil localities are as follows:

1. Vicinity of The Narrows, Lake Manitoba.
2. Onion Point, Lake Manitoba.
3. Snake Island, Lake Winnipegosis.
4. Charlie Island, Lake Winnipegosis.
5. South shore, Lake Winnipegosis.
6. Quarry, 1½ miles west of Winnipegosis.
7. South Manitou Island, Lake Winnipegosis.
8. Brabant Point, Lake Winnipegosis.
9. Cameron Bay, Lake Winnipegosis.
10. Pelican Bay, Lake Winnipegosis.
11. Bell River outlet.
12. North side of Salt Point.
13. Steeprock River outlet.
14. Red Deer River.
15. Point Wilkins, lower 35 feet.

Fauna of the Lower Manitoban Strata

Genera and Species	Localities 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
STROMATOPOROIDEA															
Stromatoporoid	.	X	T	T	X	X	.	.	.	.	.	.	.	X	.
ANTHOZOA															
Coenites (Cladopora sp.)	.	.	X	.	.	.	.	.	.	.	.	X	X	.	.
Cyathophyllum sp.	.	T	X	T	X	.	T	T	T	.	.	.	T	T	.
Favosites limitaris? Rominger	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Favosites sp.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
CRINOIDEA															
Stems and columnals	.	X	X	X	X	.	X	X	.	.	X	X	X	X	.
BRACHIOPODA															
Athyris vittata? Hall	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
Atrypa arctica Warren	X	.	.	.	.	.	.	X	.	.	.	.	X	X	.
Atrypa cf. arctica Warren	X	X	.	.	.	X	X	X	X	X	X	X	.	X	X
Atrypa independensis Stainbrook	.	.	.	X	X	X	.	.	.	.	.	.	.	.	.
Atrypa cf. independensis Stainbrook .	X	.	X	.	.	.	.	.	.	.	.	X	.	.	.
Atrypa mascula Stainbrook	X	X	X	X	X	.	.	.	.	.	X	.	X	X	X
Atrypa cf. mascula Stainbrook	X	.	.	.	.	.	.	.	.	X	.	.	.	.	X
Atrypa new species	X	X	.	X	X	X	.	.	.	.	X	X	.	X	.
Atrypa sp.	.	.	X	.	X	.	.	.	.	.	.	X	.	X	.
Chonetes sp.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chonetes? sp.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.
Cranaena cf. littletonensis Stainbrook	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
Cranaena sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyrtina hamiltonensis	.	T	T	.	.	.	T	T	T	X	.	X	.	X	X
Gypidula comis Owen	.	.	.	.	.	.	.	.	T	T	.	.	.	.	.
Martiniopsis sublineata (Meek?).....	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
Productella spinulicosta Hall	X	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Productella cf. spinulicosta Hall ...	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
Productella new species	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Fauna of the Lower Manitoban Strata (concluded)

Genera and Species	Localities 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
BRACHIOPODA (cont'd)															
Spirifer cf. cardinalis Belanski	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
Strophonella?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PELECYPODA															
Paracyclas elliptica Hall	X	T	X	X	.	.	T	T	T	T	T	.	T	X	T
Paracyclas cf. elliptica Hall	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Paracyclas elliptica var. occidentalis Billings	.	T	T	.	.	.	.	.	.	.	.	.	.	X	.
Paracyclas sp.	X	.	.	.	.	.	.	.	.	.	.	.	X	.	X
Paracyclas? sp.	X	.	.	.	X	.	.	.	.	.	X	.	.	X	X
GASTROPODA															
Bellerophon pelops? Hall	.	T	X	.	.	.	X	.	X	X	.	.	T	.	.
Bellerophon sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Büchelia tyrrelli (Whiteaves)	.	X	T	X	.	.	T	X	T	.	X	.	X	X	.
Euomphalus subtrigonalis Whiteaves ...	.	.	T	T	.	.	.	.	.	.	.	X	.	.	T
Hyolithes alatus Whiteaves	.	T	X	X	X	.	T	T	T	.	T	.	T	T	.
Loxonema altivolvis Whiteaves	.	.	X	X	X	.	T	T	T	.	X	.	.	T	.
Loxonema priscum? Munster	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
Loxonema sp.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.
Omphalocirrus manitobensis Whiteaves..	.	T	X	X	X	.	.	T	T	.	T	.	.	T	.
CEPHALOPODA															
Cyrtoceras sp.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.
"Orthoceras" sp.	X	.	.	X	X	.	X	X	X	.	.	X	.	X	.
TRILOBITA															
Proetus cf. mundulus Whiteaves	.	X	.	.	.	.	.	.	T	X	.	.	X	X	.

The Point Wilkins limestone member of the Manitoban formation yielded few fossils; Spirifer allani, Atrypa independensis and Athyris species are common and the latter particularly abundant. The forms collected are as follows:

Athyris vittata Hall

Athyris various species

Atrypa clarkei

Atrypa independensis Stainbrook

Bŭchelia tyrrelli Whiteaves

Cranaena cf. iowensis Calvin

Gastropods

Spirifer allani Warren

CORRELATION

Correlation of much of the Devonian strata outcropping in Manitoba is based on the occurrence of Stringocephalus burtini in the Winnipegosan formation. Stringocephalus is one of the index fossils of late Middle Devonian(Givetian) age in Europe. As the genus has a restricted range the several North American occurrences are probably equivalent.

The first recognition of Stringocephalus in North America was made by Whiteaves in 1890 from a study of faunal collections of Tyrrell and Whiteaves from Manitoba and of R. G. McConnell from the Ramparts of the Mackenzie River, 1300 miles to the northwest(Whiteaves 1890, pp. 93-110, 1891, p. 235). In 1917 Kindle(1921, p.21) found the genus in the Great Slave Lake area which is about half way between the Ramparts and the Manitoba outcrops. Kirk(1927, p. 219) reported that Stringocephalus occurs in the United States in western Utah, Nevada, and southeastern Alaska.

Atrypa arctica, Proetus mundulus, Atrypa mascula, Productella spinulicosta and Bücheliа tyrrelli are present in the Elm Point limestone and in the lower Manitoban. The first two species named are also found in the Winnipegosan formation occurring with Stringocephalus. This fauna present above and below the Stringocephalus horizon suggests that the Elm Point, Winnipegosan and lower Manitoban strata can be associated for correlation purposes and included in the Stringocephalus zone.

The Rogers City limestone in Presqu'ile County, Michigan, can be related to the Manitoba Stringocephalus zone. The gastropod fauna of the

Rogers City contains many species similar to those found in the Winnipegosan formation. It also contains Büchelia tyrrelli, an Elm Point species, and Omphalocirrus manitobense, a lower Manitoban species(Ehlers and Radabaugh, 1938 p. 444). Because of these similarities Cooper places the Rogers City limestone in the Stringocephalus zone.

The position of the Rogers City limestone below the Bell shale and above the Dundee limestone, which is an equivalent of the Marcellus, establishes the age of the Rogers City limestone and the Stringocephalus zone of Manitoba as lower Hamilton, between Marcellus and Skaneatles(Cooper 1942 p. 1784).

Correlation of the Devonian formations in Manitoba with formations at Great Slave Lake and the Ramparts of the Mackenzie River is based on the occurrence of Stringocephalus in the three sections. Lithological and other faunal similarities are also present. The correlation has been discussed by several writers(Kindle and Bosworth, 1920 p.44B; Cameron, 1921 p. 13B; Kindle, 1921, and Warren, 1949) and is reviewed briefly here.

The following table lists the formations and their thicknesses in the three sections:

MANITOBA	GREAT SLAVE LAKE	MACKENZIE RIVER "The Ramparts"
Lower Manitoban shales and limestones +120 feet	Slave Point limestone 200 feet	Beavertail limestone 350 feet
Winnipegosan dolostone 250 feet	Presqu'ile dolostone 375 feet	Ramparts limestone 250 feet
Elm Point limestone 50 feet	Pine Point limestone 595 feet	Hare Indian River shales 300 feet

The Pine Point limestone contains Atrypa arctica,(A. reticularis var. A Kindle), Productella spinulicosta, Paracyclis elliptica, Eumophalus sp. and Pleurotomaria, all of which are present in the Elm Point limestone. As both limestones occur directly below Stringocephalus-bearing dolostones they are no doubt equivalent.

The Hare Indian River shales occur below Stringocephalus occurrences in the Ramparts section. The shales contain abundant Martinia which are also found in the Pine Point limestone, and Kindle and Bosworth equate the two formations.

According to Merriam(1940 p. 77) a Martinia zone underlies Stringocephalus in the upper part of the Nevada formation in the State of Nevada, and he suggests that the Ramparts section could possibly be correlated with the Nevada occurrence of Stringocephalus.

The Winnipegosan formation, Presqu'ile dolomite and Ramparts limestone all contain Stringocephalus and are considered equivalent.

The Slave Point limestone contains Cyrtina hamiltonensis and various Atrypa species that are present in the lower Manitoban. Cameron states that the Slave Point is probably equivalent to the Manitoban formation.

The Beavertail limestone which occurs above the Ramparts limestone is poorly fossiliferous. Kindle and Bosworth however have correlated the Beavertail with the Slave Point formation.

The fauna collected from the upper Manitoban strata contains many species not present in the lower Manitoban beds. This fauna, containing

Atrypa independensis and Spirifer allani has been examined by Dr. P. S. Warren. He states(personal communication) that this fauna is very similar to the Waterways fauna where A. independensis and S. allani are leading species. The Waterways formation is exposed at McMurray on the Athabaska River and is considered Upper Devonian by Warren(1933 p. 149). Recent work by Crickmay(1950 p. 221) shows that the fauna of the Waterways formation contains several species typical of the Cedar Valley limestone of Middle Devonian age. Further collecting and study of the Point Wilkins fauna is necessary before a definite age determination can be established for the upper Manitoban beds.

Correlation of the major section measured within the area are shown in Figure 23(ln pocket).

STRUCTURAL GEOLOGY

The regional dip of the Devonian formations in the area as shown by the areal distributions of the formations is in a southwest direction. In the absence of exposed key horizons, bore-hole records must be used for calculating the amount of dip. The contact between the Ashern formation and the Elm Point limestone may be recognized in several bore-holes in and close to the map area, and this horizon was used in the calculations. It is realized that the top of the Ashern formation probably represents an unconformity, but lack of other recognizable horizons necessitated its use.

The following table lists the localities and the elevations used in the calculations:

Location	Elevation of Key horizon	Remarks
Diamond drill hole ½ mile north of Steeprock River, Dawson Bay	530 feet	well log, surface elev. 831 feet
Floor of Canada Cement Co. quarry, NW¼, sec.34, tp.28, rge.10, W. Prin. mer.	790 feet	alidade
Bore-hole, sec.29, tp.30, rge.17, W. Prin. mer., south shore of Lake Winnipegosis	480 feet	well log, surface elev. approx. 840 ft.
Bore-hole, SE¼, sec.14, tp.24, rge.20, W. Prin. mer., vicinity of Dauphin	40 feet	well log, surface elev. about 1100 ft.
Bore-hole, ls.9, sec.33, tp.14, rge.15, W. Prin. mer., vicinity of Neepawa	-155 feet	well log, surface elev. 1205 feet

Calculations based on the elevations of these localities give a regional strike of the strata as north 40 degrees west and an average regional dip of 12 feet per mile to the southwest. Dips as much as 20 degrees are common throughout the area, but they have local significance only.

The most significant structural feature of the Devonian strata in the area is the occurrence of numerous domes in all Devonian formations. Most of the domes are roughly circular to elliptical, but several of them are in the form of anticlinal ridges. The domes range in size from small structures covering an acre or two and from five to ten feet high to long ridges as much as two miles long and 1000 feet across. In general the elongated structures roughly parallel the regional strike.

In the Elm Point limestone domes are rare and are probably a result of deposition on an irregular erosion surface. A bioherm zone in the Silurian beds below the Ashern formation no doubt contributes to this irregularity. In the area underlain by Silurian strata just east of the Elm Point outcrop belt, some ridges are underlain by the bioherm rock.

In the Winnipegosan formation the domes and ridges are in general associated with the bioherm facies. The bioherm cores described above generally have an arched form. In the vicinity of The Narrows, Lake Manitoba, one prominent anticlinal ridge is composed of bedded dolostone underlain by massive bioherm rock. This ridge has been described above.

Domes are particularly well developed in the lower Manitoban strata. In the southwest corner of Dawson Bay several of the domes near the lake

shore have been partly eroded exposing sections through the domes. The sequence of beds in the arched strata is similar to the sequence where the beds are flat lying. In two localities, one near the mouth of the Bell River, the other, half a mile north of the Steeprock River outlet, the rock which underlies the domed strata is exposed. This rock is similar to that at the top of the bioherms that are exposed in massive cliffs nearby. At the Steeprock River location, the core of the diamond drill-hole, Mafeking No. 1, reveals the nature of these underlying beds. The well begins in Winnipegosan strata at lake level at a point that would be about the centre of the dome before erosion. As shown by the well log, the first 100 feet of material penetrated are composed of fossiliferous porous highly dolomitic limestone. This rock is probably a portion of a bioherm core. On the flanks of the domes joints and minor faults are common, and in general the strata appear to be more disturbed.

In the writer's opinion most of the doming in the lower Manitoban is a reflection of the underlying bioherm zone, and each dome or arch is underlain by a bioherm core. The basal Manitoban sediments were probably deposited on a sea floor that had considerable relief owing to the presence of bioherms. A draping effect of the sediments over the bioherms and the subsequent greater compaction in the interbioherm areas is probably the cause of the present structures.

Wells drilled during 1949 in the extreme southwest corner of Manitoba intersected at least 1000 feet of Devonian strata which is overlain by about 900 feet of Mississippian beds. These wells are located on

the northeast flank of the Williston(Moose Jaw) Basin. If the basin was present during Devonian time and the adjoining shelf area was dipping gently basinwards, fluctuations in sea level with corresponding fluctuations in depositional environment could account for the facies changes that appear to be present. The growth of bioherms on the margin of the basin during regression of the seas could form small restricted basins in which evaporites were deposited(Link 1949 p. 393). Anhydrite is present in the wells at a horizon believed to be equivalent to the Winnipegosan formation, but subsurface data are too meagre to ascertain whether the Winnipegosan bioherm zone is wide spread and whether the evaporites are associated with it.

A red bed zone which contains some evidence of salt and gypsum near the top of the Devonian section in these wells suggests a relation to the Potlach anhydrite horizon in the Jefferson limestone of Upper Devonian age, but here again conclusions cannot be drawn for lack of data.

ECONOMIC GEOLOGY

At present the Elm Point limestone is the only Devonian formation in Manitoba from which economic materials are being commercially obtained. The limestone has a high calcium content and is suitable for the manufacture of lime and cement.

The Canada Cement Company Limited, obtain limestone for the manufacture of cement from a quarry on the NE $\frac{1}{4}$ of sec. 34, tp. 28, rge. 10, W. Principal mer., near the village of Steep Rock. The stone is crushed at the quarry and shipped to the company's cement plant near Winnipeg. Clay is obtained near the plant, and gypsum is shipped from Silurian deposits near Gypsumville.

Considerable reserves of limestone are present in the vicinity of the quarry. The formation is 40 feet thick and is exposed over several square miles. The drift cover is thin, and little or no stripping is required.

The chemical composition[1] of the Elm Point limestone from the Canada Cement Company's quarry is as follows:

SiO_2	1.26 percent
Al_2O_3	0.61 percent
Fe_2O_3	0.06 percent
CaO	54.79 percent
MgO	0.25 percent
MnO	0.024 percent
P_2O_5	0.021 percent
TiO_2	trace

[1] Rock analyses in this section are by the Mines Branch, Province of Manitoba.

The Winnipeg Supply and Fuel Company Limited, operates a quarry adjoining the village of Spearhill on ls. 7, sec. 22, tp. 27, rge. 7, W. Principal mer. The stone quarried there is utilized as a flux at metallurgical plants, by pulp and paper mills, and in the manufacture of beet sugar. Much of the lime produced is supplied to mining companies where it is used in the refining process. The lime is also used for stucco and other building products. The following analysis shows the chemical composition of the limestone at the quarry:

SiO_2	0.74 percent
Al_2O_3	0.81 percent
Fe_2O_3	0.06 percent
CaO	54.17 percent
MgO	0.16 percent
MnO	0.024 percent
P_2O_5	0.025 percent
TiO_2	trace

Elm Point limestone was also quarried previous to 1923 on the SW $\frac{1}{4}$ of sec. 18, tp. 18, rge. 4, W. Principal mer., two and one half miles north of Oak Point village. In this vicinity the limestone is at least 15 feet thick and is exposed over a considerable area. As the quarry floor is about the same level as Lake Manitoba, continuous pumping was necessary during quarrying operations. The property is owned by the Winnipeg Supply and Fuel Company Limited. An analysis is as follows:

SiO_2	0.08	percent
Al_2O_3	0.73	percent
Fe_2O_3	0.09	percent
CaO	51.64	percent
MgO	2.61	percent
MnO	0.021	percent
P_2O_5	0.025	percent
TiO_2	trace	

The dolostone of the Winnipegosan formation, although burned locally for lime, has not been developed commercially. Early in the century an attempt was made to produce lime commercially from rock quarried near The Narrows, Lake Manitoba; difficulties in water transportation made the venture unsuccessful. On sec. 26, tp. 24, rge. 10, W. Principal mer., the site of the Rosehill quarry, several hundred acres are underlain by the dolostone under a thin cover of drift. An analysis of rock is as follows:

SiO_2	1.44	percent
Al_2O_3	0.54	percent
Fe_2O_3	0.05	percent
CaO	30.58	percent
MgO	21.45	percent
MnO	0.012	percent
$P2O_5$	0.007	percent
TiO_2	trace	

The Manitoban formation contains considerable high calcium limestone, but at present none is being quarried.

On the NW $\frac{1}{4}$ of sec. 9, tp. 31, rge. 18, W. Principal mer., one and a half miles west of the town of Winnipegosis, quarrying has been done on a small scale. The drift cover is thin, and at least 70 acres are underlain by the rock. A seven foot thickness is exposed in the quarry. An analysis of the rock is as follows:

SiO_2	0.61 percent
Al_2O_3	0.44 percent
Fe_2O_3	0.20 percent
CaO	54.83 percent
MgO	0.13 percent
MnO	0.014 percent
P_2O_5	0.018 percent
TiO_2	trace

At mile 14.2, The Pas-Mafeking Highway, a small quantity of Point Wilkins limestone has been quarried, crushed, and sold as a calcium mineral food for livestock. This rock has a high calcium content. The rock has possibilities as a field stone, but its tendency to part along planes parallel to the bedding makes it undesirable for a building stone. An analysis is as follows:

SiO_2	1.38 percent
Al_2O_3	0.84 percent
Fe_2O_3	0.29 percent

CaO	53.91 percent
MgO	0.34 percent
MnO	0.017 percent
P_2O_5	0.023 percent
TiO_2	trace

INSOLUBLE RESIDUE STUDY

A study of the insoluble residues of the Devonian formations was made in order to ascertain whether diagnostic residues could be obtained from the surface units that would assist in correlating outcrop sections with subsurface sections.

Samples were taken at five foot intervals except where lithology necessitated sampling at smaller intervals. More than 250 samples were investigated.

METHOD

The method of preparing the residues was modified from that outlined by McQueen(1931), who was one of the first to use insoluble residues in stratigraphic work.

The test samples, averaging 30 grams, were crushed to -4 mesh and digested in commercial hydrochloric acid diluted to half strength. The digestion was done in 250 millilitre beakers arranged on steel trays to facilitate handling of many samples at one time. From 100 to 150 millilitres of the dilute acid was used for each sample. The acid was added slowly at first to prevent loss by foaming. After all the acid had been added the trays containing dolostone samples were placed on the hot plate and warmed slightly. When digestion was complete the residues were washed thoroughly. Fine silt and clay were decanted during the washing process. The residues were transferred to watch glasses and placed on the hot plate to dry and subsequently transferred

to small vials.

DESCRIPTION OF RESIDUES

The lack of clastic or detrital material above silt size was a feature of all the residues examined. The residues from the limestones and dolostones were very small; many samples contained no insoluble fraction, and in general the residues were less than one percent. The shales and argillaceous rocks gave large residues of silt and clay that were decanted.

A study of the residues obtained indicates that no single residue constituent is sufficient to recognize a stratigraphic horizon and that it is unlikely that the residues will be of assistance in correlation studies. Typical residues cannot be described for most of the formations tested as the residues obtained from outcrops of equivalent strata were often quite different in character. The descriptions given below for the several units tested are generalized.

Ashern Formation

The residues of the argillaceous dolostone of the Ashern formation averaged about one percent of the total sample after the clay and silt had been decanted. The fraction retained was largely quartz of coarse silt to very fine sand size. A few small grains of pyrite and flakes of hematite made up the remainder of the residues.

Elm Point Limestone

Residues of the Elm Point limestone were extremely small and always less than 0.5 percent of the total sample. No residues were obtained from some samples. A few nodules of pyrite, some very fine quartz sand grains, and aggregates of spongy hematite constituted the insoluble fraction.

Winnipegosan Formation

The bioherm facies of Winnipegosan formation gave little residue. Many of the samples tested were completely dissolved by the acid. A few fragments of lacy to dolomorphic white chert were present in some samples. In one sample 20 percent of bluish white smooth chert was obtained but this cherty zone was not found elsewhere. The samples from the upper part of the bioherm facies along the north side of Salt Point, Dawson Bay, gave one percent residues consisting of pyrite of very fine grain size.

The interbioherm facies also gave very small residues and some samples gave no residue. Generally there were a few grains of very fine quartz sand, spongy hematite and a small amount of white to tan lacy chert. A fragment or two of a fibrous, colourless mineral was present in some of the residues. Optical tests showed that the fragments were composed of anhydrite and gypsum.

It does not seem possible to distinguish between the two facies of the Winnipegosan formation by their residues.

Manitoban Formation

The basal shales of the Manitoban formation gave large residues of silt and clay which were decanted. A few grains of fine quartz sand were obtained from some samples.

The argillaceous limestone overlying the shales gave residues of well-formed pyrite crystals, white nodular chert, and a few grains of quartz sand. The amount of chert and pyrite obtained varied and neither was present in some residues. Some samples contained 2 to 3 percent chert but no persistent chert horizon could be determined from the samples tested. The pyrite in these strata is concentrated in bands which accounts for the variability of the pyrite content in the residues.

The well-bedded limestone overlying the shales gave very little or no residue. A few grains of quartz sand, pyrite and spongy hematite, and an occasional nodule of white chert constituted the residues for these strata.

The argillaceous limestone and shale overlying the bedded limestone at the Red Deer River outcrop contained much silt and clay which was decanted. A few grains of very fine quartz sand, aggregated of spongy hematite and pyrite were obtained from some samples.

Samples from the argillaceous limestone from the lower part of the section at Point Wilkins gave residues up to one percent and contained well-formed pyrite crystals and spongy hematite aggregates. Some residues contained silicified fossil fragments.

The Point Wilkins member of the Manitoban formation was characterized by the absence of residue. In a few samples however a grain or two of pyrite and hematite were present.

The dolostone and argillaceous dolostone overlying the Point Wilkins member contained a small amount of silt that was decanted. In some samples a few grains of angular quartz sand and nodules of pyrite were present. The upper few inches of the outcrop on the south shore of Red Deer Lake gave a one percent residue of angular quartz grains.

The oolitic limestone outcropping west of Sagemace Bay gave residues ranging from one half to one percent that consisted of white rounded nodular chert. Although masses of black chert were observed in hand specimens, no black chert was present in the residues obtained.

BIBLIOGRAPHY

Cameron, A.E.(1922): Hay and Buffalo Rivers, Great Slave Lake and Adjacent Country; Geol. Surv., Canada Sum. Rept. 1921, Pt. B. pp. 1-44.

Cameron, E.L.(1949): Salt Potash and Phosphate in Manitoba; Manitoba Mines Branch, Bull. 48-9.

Cooper, G.A. et al(1942): Correlation of the Devonian Sedimentary Formations of North America; Bull. Geol. Soc. Am., vol. 53, pp. 1729-1794.

Crickmay, C.H.(1950): Devonian Spiriferidae, Journal of Paleontology, vol. 24, no. 2, pp. 219-225.

Dapples, E.C., Krumbein, W.C., and Sloss, L.L.(1948): Tectonic Control of Lithologic Associations; Bull. Geol. Soc. Am., vol. 32, pt. 2.

Ehlars, G.M., and Radabaugh, R.E.(1938): The Rogers City Limestone, a New Middle Devonian Formation in Michigan; Mich. Acad. Sci., Arts and Letters, Papers vol. 23, pp. 441-446.

Ireland, H.A.(1949): Insoluble Residues; Subsurface Geologic Methods, Quart. Colorado School of Mines, vol. 44, no. 3, pp. 111-128.

_____ et al(1947): Terminology for Insoluble Residues; Am. Assoc. Petroleum Geologists Bull., vol. 31, no. 8, pp. 1479-1490.

Johnston, W.A.(1934): Surface Deposits and Ground-water Supply of Winnipeg Map-area, Manitoba; Geol. Surv., Canada, Memoir 174.

Kerr, L.B.(1949): The Stratigraphy of Manitoba with Reference to Oil and Natural Gas Possibilities; Manitoba Mines Branch, Pub. 49-1.

Kindle, E.M.(1914): The Silurian and Devonian Section of Western Manitoba; Geol. Surv., Canada, Sum. Rept. 1912, pp. 247-261.

_____ (1921): Distribution of Stringocephalus burtini in Canada; Trans. Roy. Soc., Canada, 3rd ser., vol. XV.

_____ and Bosworth, T.O.(1921): Oil Bearing Rocks of the Lower Mackenzie River Valley; Geol. Surv., Canada, Sum. Rept. 1920, pt. B.

Kirk, Edwin(1927): New American Occurrences of Stringocephalus; Amer. Jour. Sci., Series V, vol. XIII.

Link, Theo. A.(1949): Leduc Oil Field, Alberta, Canada; Bull. Geol. Soc. Am., vol. 60, pp. 381-402.

McQueen, H.S.(1931): Insoluble Residues as a Guide to Stratigraphic Studies; Appendix 1, Missouri Bureau of Geology and Mines; Biennial Report for 1931, pp. 102-131.

Merriam, C.W.(1940): Devonian Stratigraphy and Paleontology of the Roberts Mountain Region, Nevada; Geol. Soc. Am., Special Paper 25.

Parks, W.A.(1916): Building and Ornamental Stones of Canada, vol. IV; Canada, Dept. of Mines, Mines Branch.

Pond, A.W.(1945): Calcite Oolites or Cave Pearls; Jour. Sed. Pet., vol. 15, no. 2.

Shrock, R.R.(1929): The Klintar of the Upper Wabash Valley in Northern Indiana; Jour. Geol. vol. 37, pp. 17-29.

_____ (1939): Wisconsin Bioherms; Bull. Geol. Soc. Am., vol. 50, pp. 529-562.

_____ (1948): A Classification of Sedimentary Rocks; Jour. Geol., vol. 56, no. 2, pp. 118-129.

Tyrrell, J.B.(1892): Report on North-Western Manitoba; Geol. Surv., Canada, Ann. Report, 1890-91, pt. E.

Wallace, R.C.(1925): Geological Formations of Manitoba; Nat. Hist. Soc. of Manitoba, pp. 55.

_____ and Greer, L.(1927): The Non-metallic Mineral Resources of Manitoba; Ind. Dev. Board of Manitoba.

Warren, P.S.(1933): The Age of the Devonian Limestone at McMurray, Alberta; Canadian Field Naturalist, vol. 48, no. 8, pp. 147-148.

_____ (1949): Fossil Zones of Devonian of Alberta; Amer. Assoc. Petroleum Geologists Bull., vol. 33, no. 4, pp. 564-571.

Whiteaves, A.E.(1890): Descriptions of Some Previously Unrecorded Species of Fossils from the Devonian Rocks of Manitoba; Trans. Roy. Soc., Canada, vol. VIII, sec. IV.

_____ (1891): Fossils of the Devonian Rocks of the Mackenzie River Basin; Contr. Can. Pal., vol. 1, pt. III.

_____ (1892): The Fossils of the Devonian Rocks of the Islands, Shores of Immediate Vicinity of Lakes Manitoba and Winnipegosis; Contr. Can. Pal., vol. 1, pt. IV.

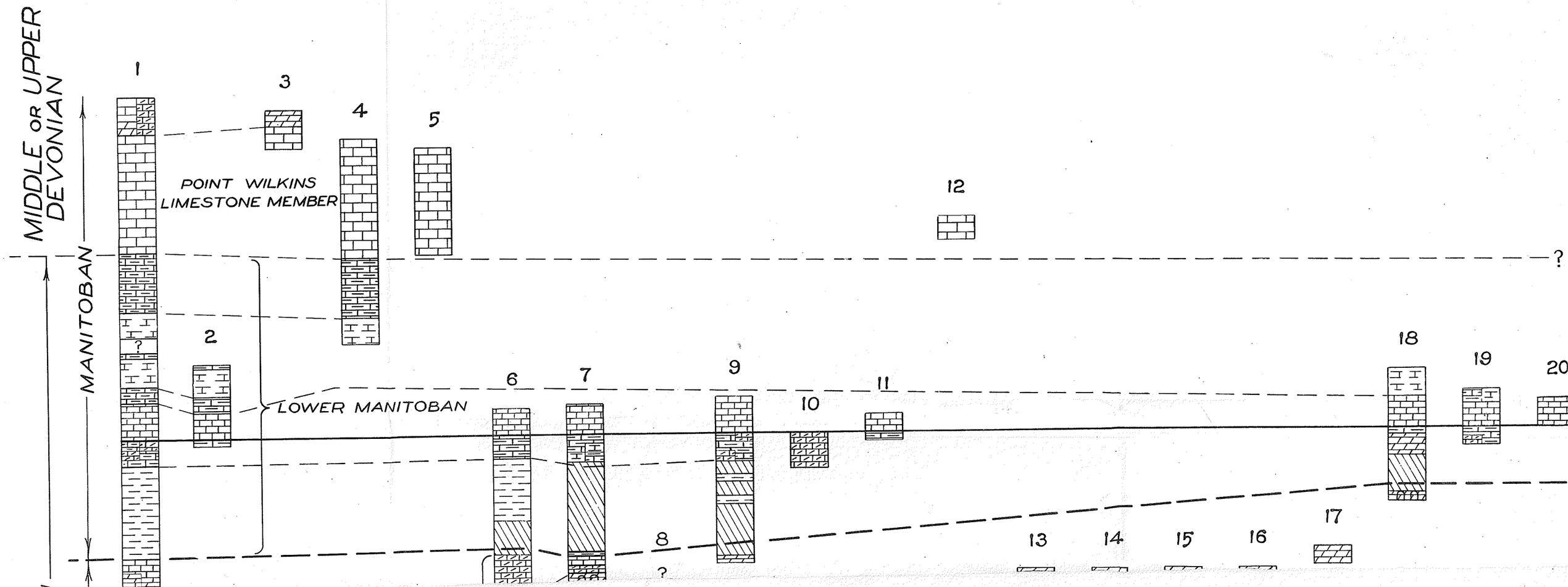
Wickenden, R.T.D.(1934): Palaeozoic and Jurassic Formations in Well Sections in Manitoba; Geol. Surv., Canada, Sum. Rept., 1933, pt. B.

Ma
Department of Mines
MINES

CORRELATION of DE

LAKE MANITOBA - LAK

— FIGU

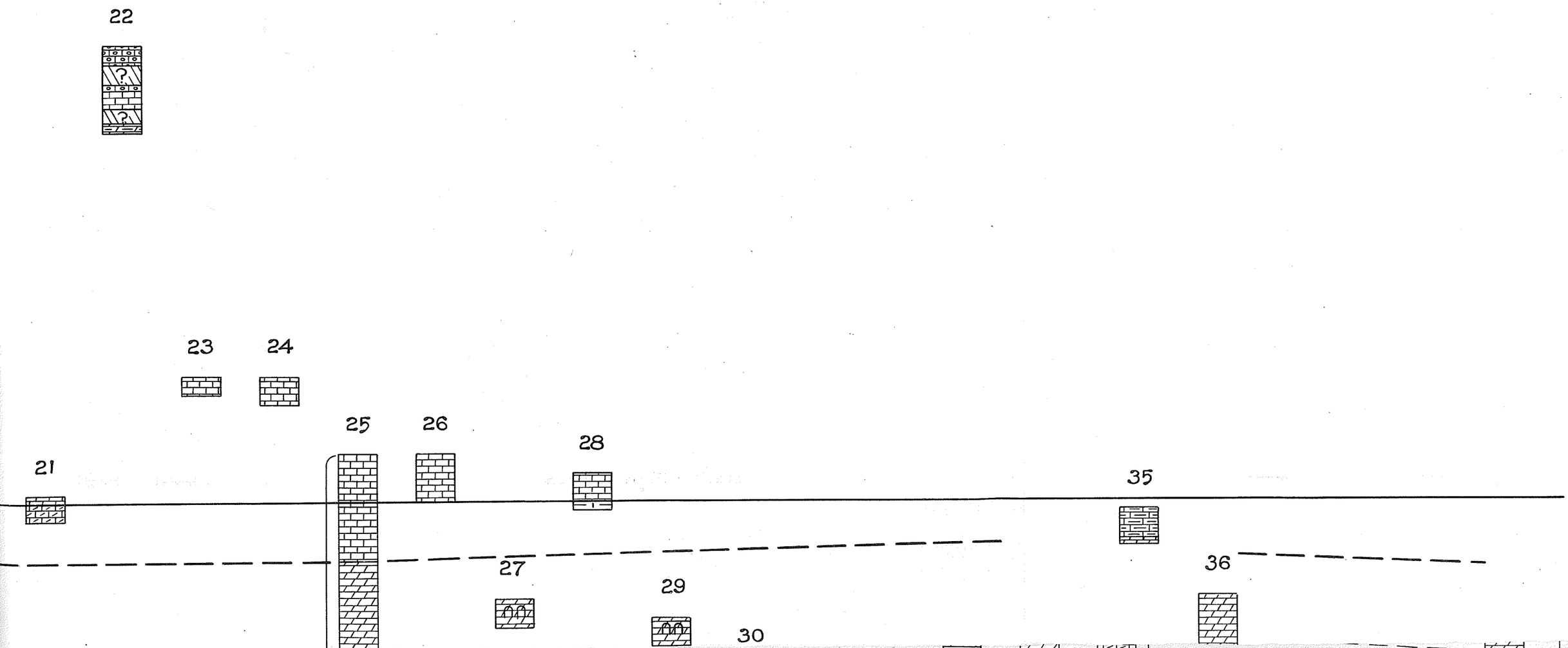


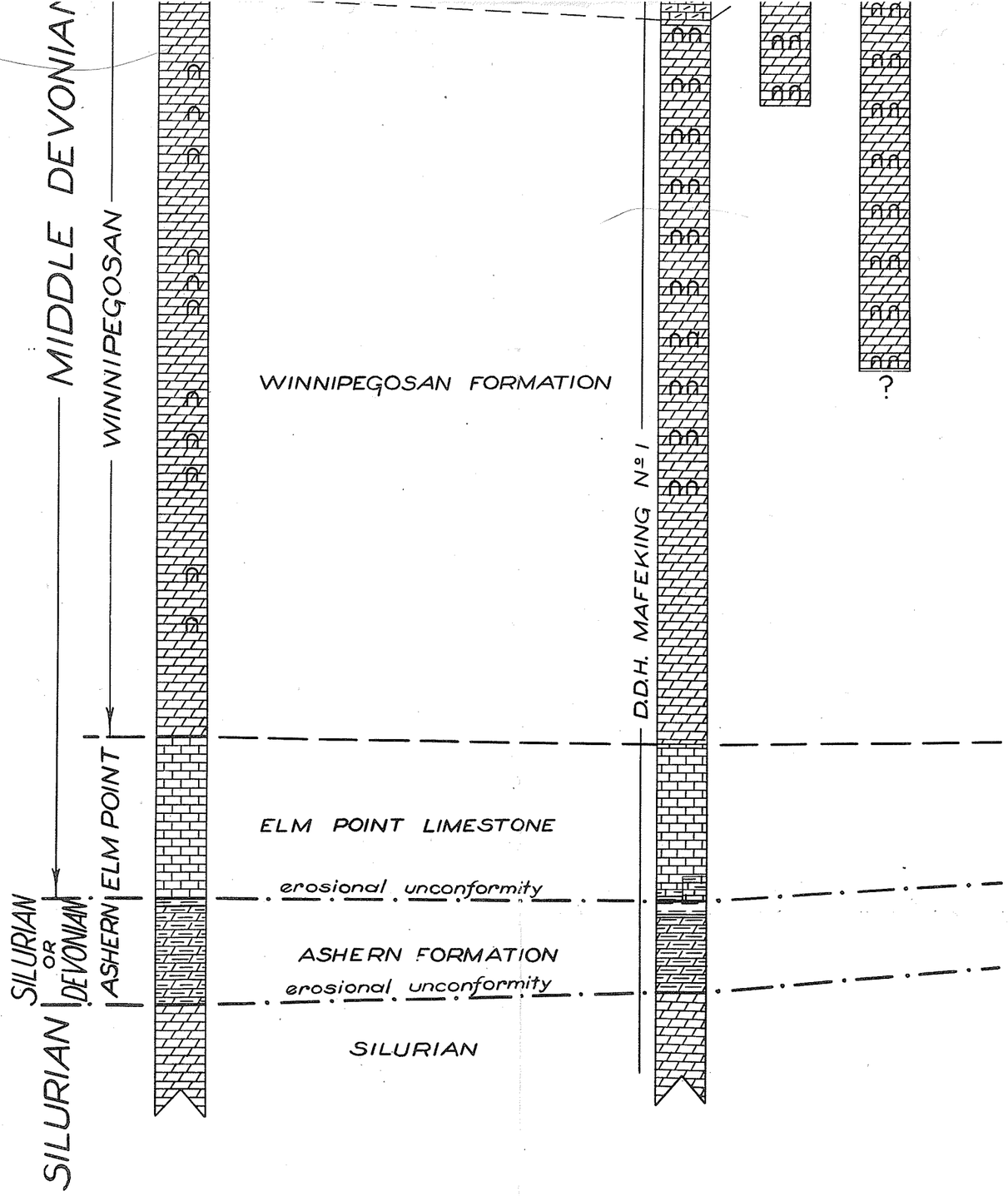
itoba
and Natural Resources
BRANCH

EVONIAN SECTIONS

E WINNIPEGOSIS AREA

RE 23—





1. Generalized Columnar Section.
2. Red Deer River.
3. Mile 12-14 The Pas - Mafeking Highway.
4. Point Wilkins.
5. South of Point Wilkins.
6. Steeprock River Outlet.
7. North Side of Salt Point.
8. Islands in Dawson Bay.
9. Bell River Outlet.
10. Cameron Bay.
11. Pelican Bay.
12. Rose Island, Swan Lake.
13. Devil Point.
14. Pemmican Island.
15. Birch Island.
16. Hill Island.
17. Mc Caulay Harbour.
18. Brabant Point.
19. South Manitou Island.
20. Weston Point Island.
21. Bay South of Weston Point.
22. East of Sagemace Bay.
23. Quarry Near Winnipegosis.
24. Mossy River.
25. Bore Hole, Winnipegosis Nº 4.
26. Snake Island.
27. Babe Island, Toutes Aides Bay.
28. Steeprock Lake.
29. Monroe Point.
30. Big Sandy Point.
31. Fairford Trail.
32. Canada Cement Co. Quarry.
33. Winnipeg Supply & Fuel Co. Quarry.
34. Quarry North-West of Spearhill.
35. Manitoba Island.
36. Rose Hill Quarry. The Narrows.
37. Prospect Pit near Rose Hill Quarry.
38. Richard Point.
39. Oak Point Quarry.

LEGEND

- Thick Bedded Lim
- Limestone.
- Argillaceous Lime
- Dolomitic Limeston
- Dolostone.
- Argillaceous Dolos
- Calcareous Shale.
- Shale.
- Bioherm.
- Oolitic Limestone.
- Covered Interval.

DATUM PLANE
Base of Thin Bedded Foss
M

"To Accompany Publ
by Andrew D.

urveys Branch, Dep't. of M. & N.R. Winnipeg, March 1950.

stone.

tone.

ne.

erous Limestone,
itoban Formation.

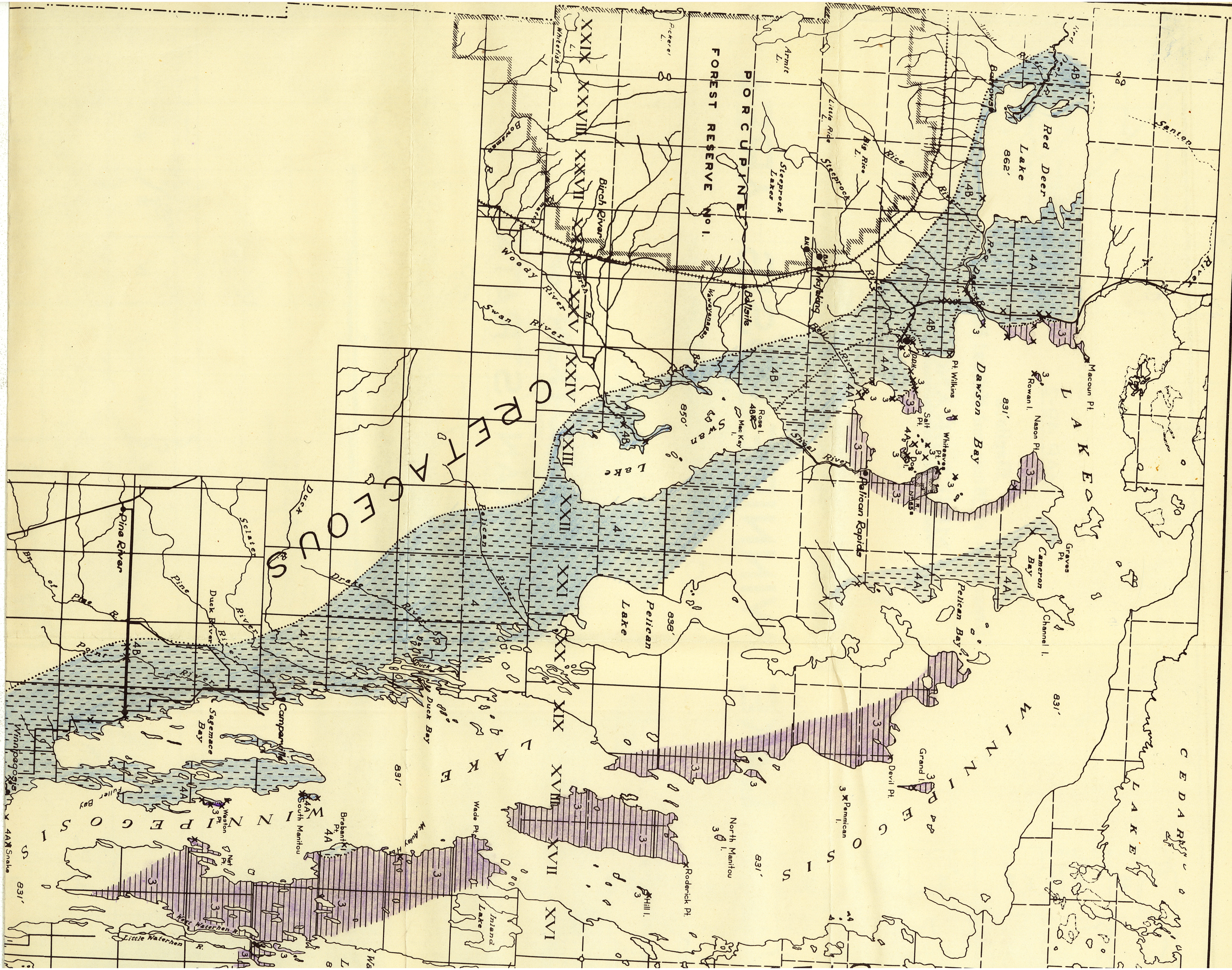
ation 49-2"
illie

BOREHOLE WINNIPEGOSIS Nº 4

?
?
?
?

37
38
32
33
39
31
34
?

100
200
300
400


CRETACEOUS
PORCUPINE
FOREST RESERVE No I.
Red Deer
Lake
862'
Dawson Bay
Swan
Lake
850'
Pelican
Lake
838'
Pelican Rapids
Pelican Bay
Cameron Bay
LAKE
WINNIPEGOSIS
831'
CEDAR
LAKE
Swan River
Woody River
Pine River
Duck Bay
Camperville
Sagemace Bay
Little Waterhen R.
Inland Lake
Steeprock Lakes
Red Deer
Snake I.
Shoal River
South Manitou
North Manitou
Devil Pt.
Rowan I.
Macoun Pt.
Channel I.
Graves Pt.
Roderick Pt.

MAP 49-2

Manitoba
Department of Mines and Natural Resources

MINES BRANCH

LAKE MANITOBA–LAKE WINNIPEGOSIS AREA

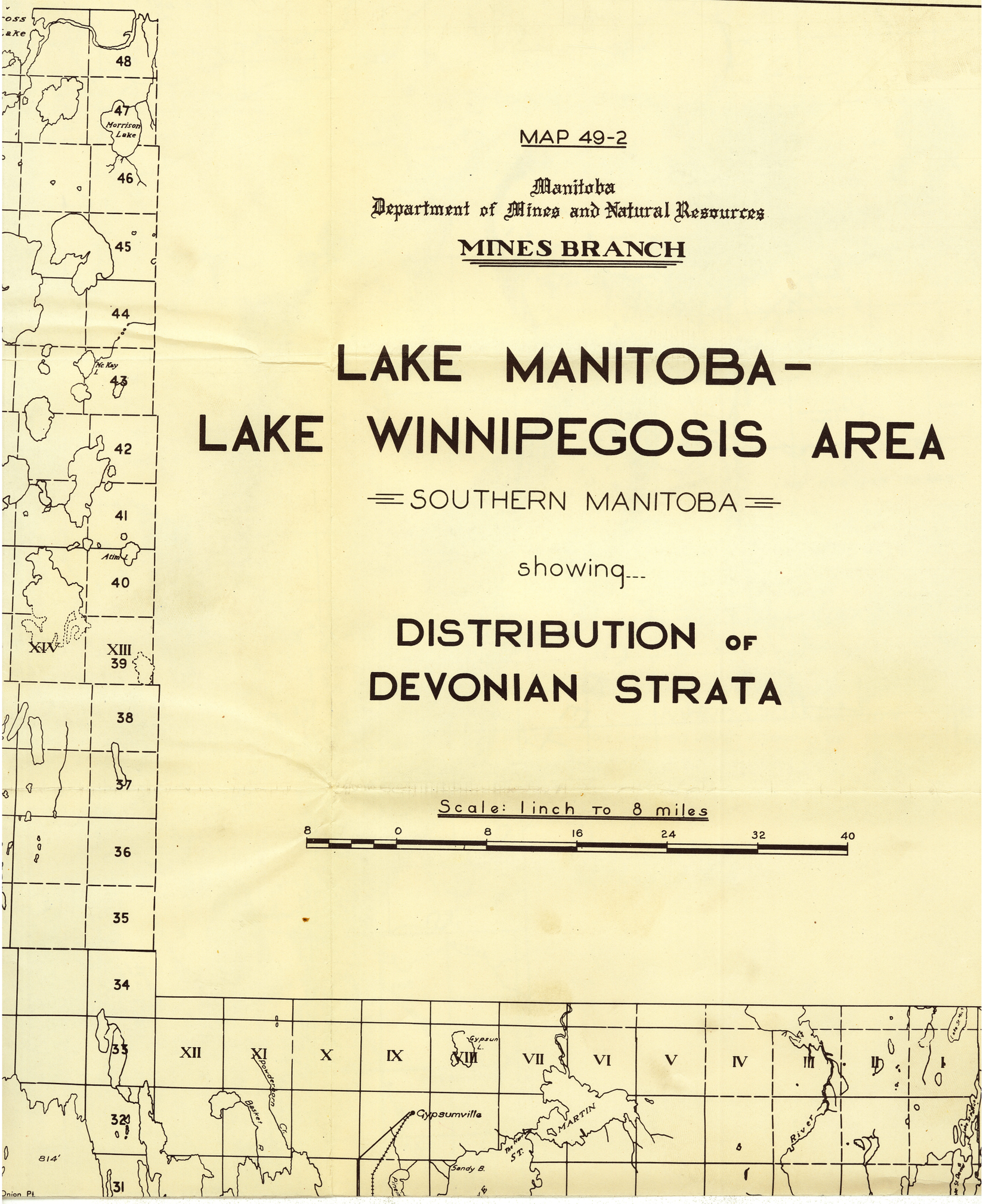
SOUTHERN MANITOBA

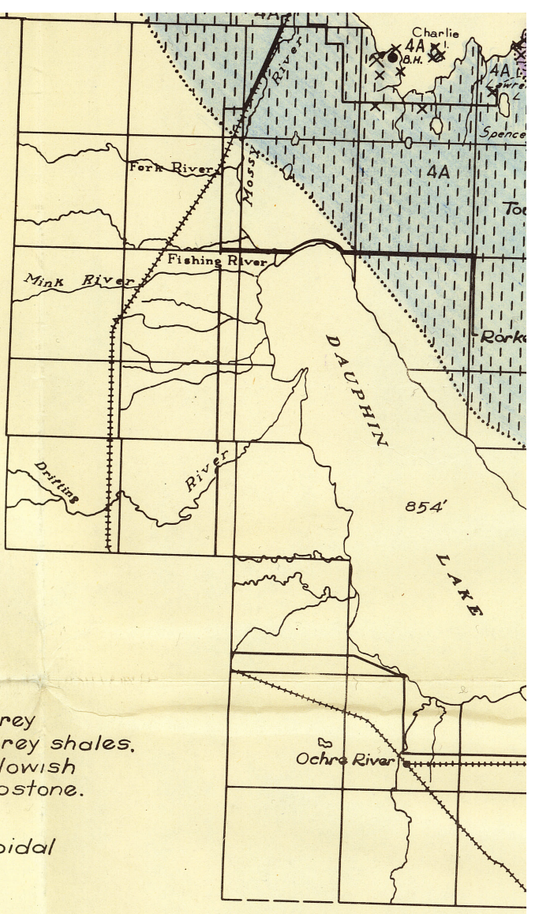
showing...

DISTRIBUTION OF DEVONIAN STRATA

Scale: 1 inch to 8 miles

8 0 8 16 24 32 40





LEGEND

DEVONIAN

MIDDLE AND ? UPPER DEVONIAN

PALAEOZOIC

4A | 4B — **MANITOBAN FORMATION**: 4A. Middle Devonian; yellowish grey limestone, argillaceous and dolomitic limestones, red and grey shales. 4B. Probably Upper Devonian; light-colored limestone, yellowish brown dolostone.

MIDDLE DEVONIAN

3 — **WINNIPEGOSAN FORMATION**: Yellowish grey saccharoidal dolostone, massive biohermal dolostone.

2 — **ELM POINT LIMESTONE**: Yellowish grey mottled limestone.

SILURIAN OR DEVONIAN

1 — **ASHERN FORMATION**: Brick-red to greyish orange argillaceous dolostone.

SYMBOLS

Geological boundary (approximate, assumed) ---

Rock outcrop ×

Quarry ⚒

Borehole ● B.H.

Diamond drill hole ● D.D.H.

Road

Trail

Height, in feet, of Lakes above Sea Level 814'

TRUE NORTH

10° 20'

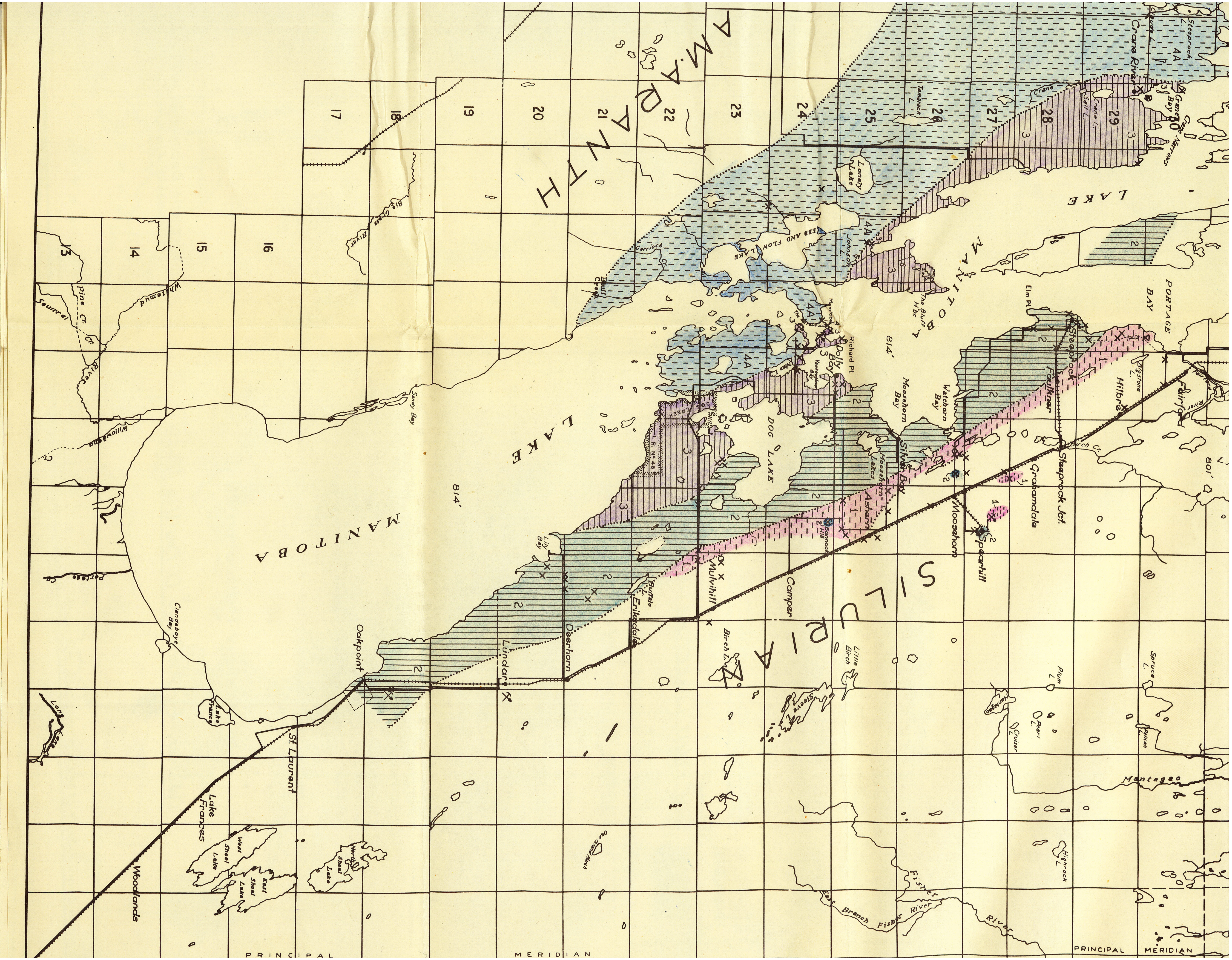
MAGNETIC NORTH

Magnetic Declination 10°
Decreasing 4 minutes a

"To accompany Publication 49-2"

Geology by Andrew D. Baillie 1949

Surveys Branch, Dep't. of M. & N.R. Winnipeg, Feb. 1950.



AMARANTH
SILURIAN
MANITOBA
LAKE
LAKE
MANITOBA
DOG LAKE
PORTAGE BAY
EBB AND FLOW LAKE
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
Crane River
Steeprock Jct.
Faulkner
Grahamdale
Hilbre
Fairford
Spearhill
Moosehorn
Ashern
Camper
Mulvihill
Eriksdale
Deerhorn
Lundar
Oakpoint
St. Laurant
Lake Francis
Woodlands
Moosehorn Bay
Watchorn Bay
Richard Pt.
Elm Pt.
Birch L.
Little Birch L.
Fisher River
East Branch Fisher River
Whitemud
Squirrel Cr.
Pine Cr.
Big Grass River
West Shoal Lake
East Shoal Lake
Clandeboye Bay
PRINCIPAL MERIDIAN
PRINCIPAL MERIDIAN