ORDOVICIAN AND SILURIAN STRATIGRAPHY IN THE INTERLAKE AREA, MANITOBA

A Thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree of

MASTER OF SCIENCE

in the Department of Earth Sciences

University of Manitoba

by

John R. Cowan

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ABSTRACT

The Manitoba Mines Branch in 1969 and 1970 drilled a number of core holes in the Ordovician and Silurian strata in the Interlake Area of Manitoba. This core has provided a complete lithologic section from the top of the Middle Ordovician, Winnipeg Formation, to the base of the Middle Devonian, Ashern Formation.

Previous studies were limited to poorly exposed outcrops, and a relatively small number of quarries. Data obtained from this core permit placement of most of the strata exposed in the outcrops and quarries into their correct stratigraphic position, and define the lateral variations in both thickness and lithology of the stratigraphic units involved in this study.

The carbonate depositional environment varied from infratidal (basinal) to supratidal. Deposition is believed to have occurred primarily in an infratidal to intertidal environment on a slowly subsiding basin with numerous transgressions and regressions.

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CHAPTER I

INTRODUCTION

General Statement

Work on the Ordovician and Silurian stratigraphy in the Interlake area of Manitoba was initially confined to outcrop studies. More recently, chip samples and cored sections from oil exploration test wells have added to the subsurface stratigraphic knowledge. During the summers of 1969 and 1970, the Manitoba Mines Branch was involved in the drilling of eighteen core holes between Townships 13 to 35 and Ranges 7 West to 6 East of the Principal Meridian. The cores provide a composite for the complete Lower Paleozoic section from the upper part of the Middle Ordovician, Winnipeg Formation to the base of the Middle Devonian, Elk Point Group. The location of these core holes is shown in Figure 1.

The purpose of this thesis is to describe the lithology of the cored Ordovician and Silurian Formations. Further purposes are to establish a complete and detailed stratigraphic succession and show or determine the detailed correlation of all outcrops and type sections within the reference section, to determine any lateral changes in lithology, and to determine the environment of deposition.

Previous Stratigrathic Work and Evolution of Nomenclature

The nomenclature that has evolved from previous studies of the Ordovician and Silurian strata of Manitoba and of the Williston Basin is summarized in Table 1.

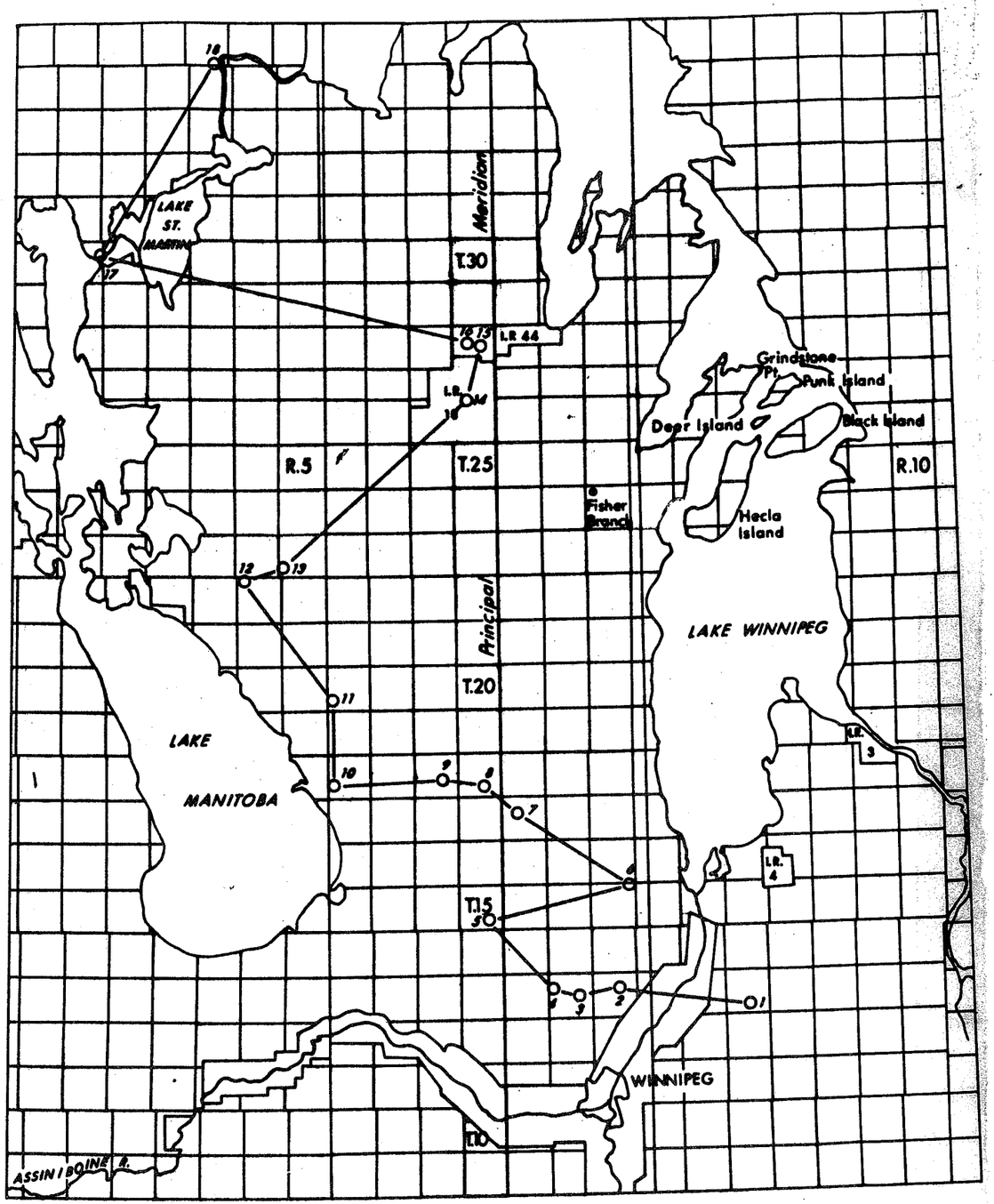
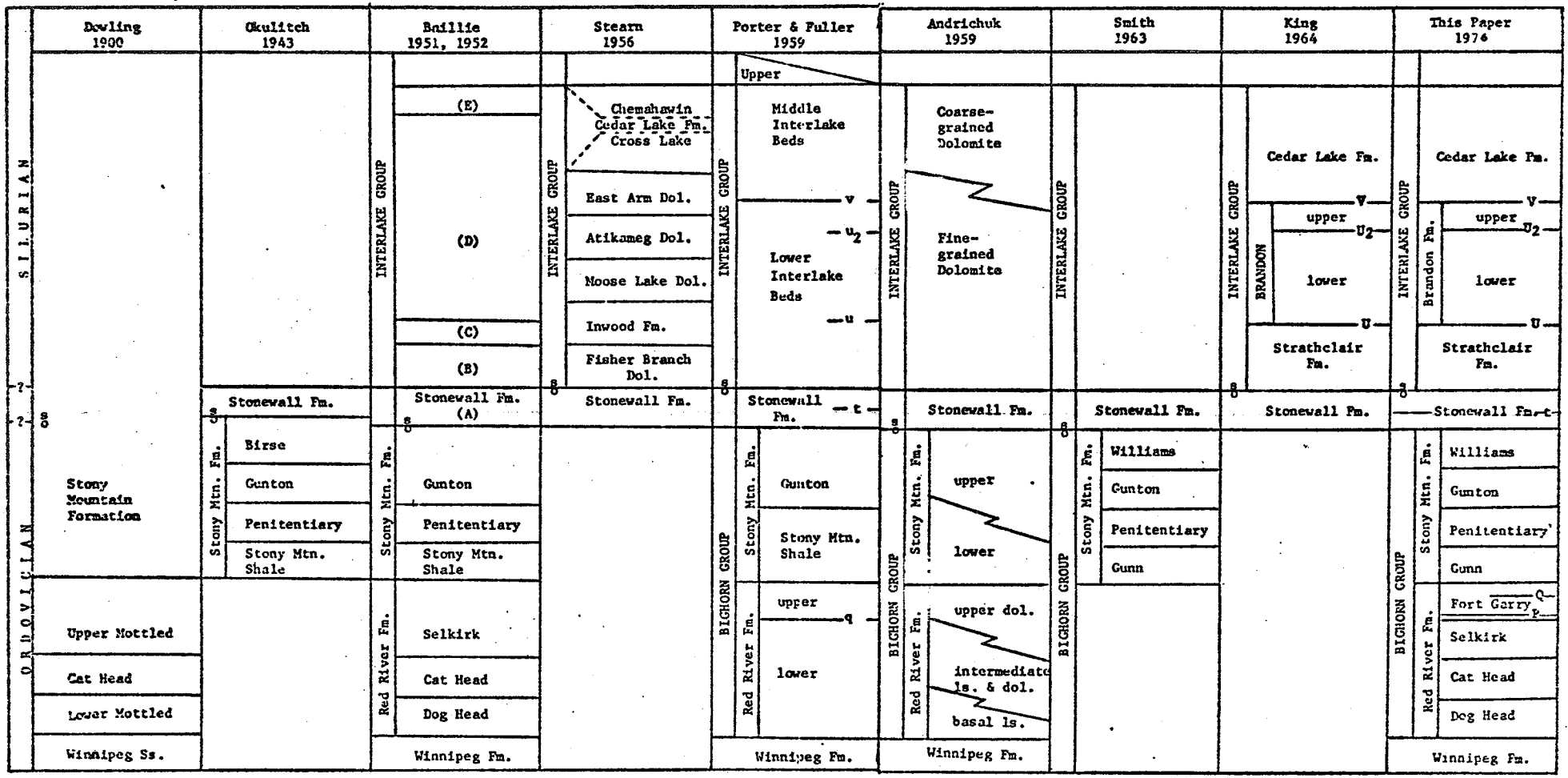


FIGURE 1

INDEX MAP

CORE HOLE NUMBER	NAME
1.	(M-3-69) Garson Quarry
2.	(M-1-70) Mulder Bros. Mowatt Farm Quarry
3.	(M-2-69) City of Winnipeg Quarry, Stony Mountain
4.	(M-1-69) Southeast Quarry at Stonewall
5.	(69-2) Woodroyd Core Hole
6.	(69-4) Petersfield
7.	(69-3) Norris Lake
8.	(M-4-69) Inwood Quarry
9.	(M-5-70) Inwood West
10.	(69-1) Oak Point Quarry
11.	(M-8-69) Lundar North Quarry
12.	(M-6-9) Mulvihill West Quarry
13.	(M-7-69) Mulvihill East Quarry
14.	(69-5) Pequis
15.	(69-6) Pequis
16.	(69-7) Pequis
17.	(LSM-13) Lake St. Martin
18.	(LSM-11) Lake St. Martin

TABLE I - STRATIGRAPHIC NOMENCLATURE



s/o indicates Silurian/Ordovician contact as proposed by various authors.

TABLE I: Table showing the evolution of stratigraphic nomenclature as applied to Ordovician and Silurian strata in the Interlake Area, Manitoba.

Dowling (1900) mapped the outcrop belt of southwestern Manitoba and named and defined the Winnipeg Sandstone, the Lower Mottled Limestone, the Cat Head Limestone, the Upper Mottled Limestone and the Stony Mountain Formation.

In 1912, Kindle proposed the name Stonewall Limestone for all of the Silurian beds occurring between the Ordovician strata on the western side of Lake Winnipeg and Devonian beds on the east side of Lake Manitoba; total thickness was estimated to be over 250 feet. He designated the quarry on the north side of the town of Stonewall as the type section for the lower portion of the Silurian beds.

Foerste (1929) revised the Ordovician succession, including Dowling's Lower Mottled, Cat Head and Upper Mottled units as members of the Red River Formation and renaming the Lower and Upper Mottled the Dog Head and Selkirk Members, respectively.

In 1943, Okulitch subdivided the Stony Mountain Formation from bottom to top into the Stony Mountain Shale, Penitentiary, Gunton and Birse Members.

Baillie (1951) proposed the name "Interlake Group" for the Silurian strata, which he subdivided into five lithologic units A to E. He re-defined and restricted the term Stonewall Formation to include only Unit A.

In his Ordovician report of 1952, Baillie assigned Okulitch's Birse Member into the Gunton Member of the Stony Mountain Formation. He sub-divided the Winnipeg Formation into two units; a basal sandstone and an upper unit of interbedded shale and arenaceous shale.

The Winnipeg Formation was subdivided by Genik in his master's thesis of 1952 into three informal units which are in ascending order: Black Island, Grindstone Point and Deer Island.

In 1955, on the basis of faunal evidence, Macauley assigned the Winnipeg Formation to the Upper Ordovician.

Stearn (1956) subdivided the Silurian outcrop section into six formations which are in ascending order: Fisher Branch, Inwood, Moose Lake, Atikameg, East Arm and Cedar Lake. On the basis of faunal studies, he placed the Stonewall Formation in the Ordovician rather than in the Silurian.

The term Bighorn Group was proposed by Ross (1957) to include the Red River, Stony Mountain and Stonewall Formations.

The Stony Mountain Shale Member of Okulitch (1943) was renamed the Gunn Member by Sinclair and Leith (1958) to conform to the stratigraphic code and to avoid nomenclature confusion that might arise from a member having the same name as the formation.

In southern Manitoba, Andrichuk (1959) in a subsurface study of the Ordovician and Silurian strata, subdivided the Red River Formation into three informal units. The upper unit consists of dolostones with minor interbedded anhydrites; the lower and intermediate units consist of limestones and limestones with interbedded dolostones, respectively. The Stony Mountain Formation was divided into Lower and Upper units, with the contact placed at a point stratigraphically equivalent to the Penitentiary-Gunton contact. He included the Stonewall Formation in the Interlake Group, and subdivided the remainder of the group into a lower fine-grained dolostone unit and an upper coarse grained dolostone unit.

Porter and Fuller (1959) also subdivided the Stony Mountain Formation into upper and lower units, correlative with the units used by Andrichuk (1959). They placed the Stonewall Formation in the Ordovician Bighorn Group, disagreeing with Kindle (1912), Baillie (1951) (1952) and Andrichuk (1959). The Interlake Group was subdivided into lower, middle and upper "Beds" on the basis of non-sequential marker beds. [1]

Smith (1963) studied the Stony Mountain and Stonewall Formations exposed in outcrops and quarries in the Stony Mountain and Stonewall areas of Manitoba. In his thesis he proposed the name Williams Member for the argillaceaous, arenaceous dolostone unit at the top of the Gunton Member. The Williams Member was included as the upper part of the Gunton Member by Baillie (1952).

In a combined surface and subsurface study of the Interlake Group, King (1964) for his master's thesis subdivided Porter and Fuller's (1959) Lower Interlake Beds into the Strathclair Formation and Brandon Formation. He also redefined Stearn's (1956) Cedar Lake Formation to include the upper portion of the East Arm Dolomite. The Cedar Lake Formation, as defined by King and as used in this report, is equivalent to the Middle Interlake Beds of Porter and Fuller (1959).

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[1] The term "non-sequential beds" was introduced by Porter and Fuller (1959, P. 160) to donote key beds which reflect an interruption of sedimentation. In this sense the key beds are not "in sequence" when considered in relation to the thick successions of dolostones. The horizons are utilized as para-time-rock markers.

McCabe and Bannatyne (1970) proposed the name Fort Garry Member for the uppermost dolomitic beds of the Red River Formation; these beds had not previously been recognized in outcrop. Andrichuk (1959) included these beds as the upper dolomite unit in the subsurface but thought they represented a facies equivalent of the Selkirk Member.

This thesis incorporates the findings of many previous workers. Discrepancies, where they exist, are described in chapter 2. It agrees with Baillie (1952) concerning the stratigraphy of the Winnipeg and Red River Formations. The Fort Garry Member of the Red River Formation, which was named by McCabe and Bannatyne (1970), is included. This work agrees with Smith (1963) in his designation of the Stony Mountain and Stonewall Formations. King's (1964) designation of the Silurian strata is incorporated. The non-sequential beds described by Porter and Fuller (1959) were seen in the core and are included in this work.

Method of Study

This project consisted of a study of cores from eighteen core holes in the Interlake Area of Manitoba (Figure 1). The total footage cored was 4648'8" with almost one hundred percent recovery. The core was logged by the author and descriptions are included in Appendix I. Folk's (1959) and Payne's (1942) classifications were used in the description of limestones and dolostones, respectively. Etched sections, cut perpendicular to bedding, were examined by the author under a binocular microscope. Dolomite and calcite, where intermixed, were differentiated by staining with alizarine red (Friedman, 1959).

Residue studies were carried out by the author on all formations except

the Winnipeg and Stony Mountain; data for the residues in the Stony Mountain Formation are included in Smith (1963). Ten to forty gram samples were taken every five feet, except for the Red River Formation, where samples were taken every ten feet. Samples were dissolved in dilute muriatic acid, the percent of insoluble residue calculated and described. Representative samples were X-rayed by the author to determine the mineralogy. The results of this study are listed in Appendix II.

Lithologic strip logs were compiled for each of the core holes, and from these, correlations were made for all Ordovician and Silurian strata. Correlation of the Ordovician strata was based on lithology; correlation of Silurian strata was based on lithology and the non-sequential marker beds of Porter and Fuller (1959). A stratigraphic cross-section (Figure 2) was prepared showing these correlations and indicating lateral variations in thickness and lithology of the various strata in the study area.

No new paleontological studies were carried out during this project. The publications of Jones (1891), Tyrrell (1892), Kindle (1914), Okulitch (1943), Baillie (1951 and 1952) and Stearn (1956) supply complete faunal lists.

Acknowledgements

The research for this thesis was done in the Department of Earth Sciences of the University of Manitoba during the 1969-70 academic year and during the summer of 1970.

The author is indebted to Professor E. I. Leith and Dr. H. R. McCabe for the guidance, suggestions and constructive criticisms they provided throughout the term of work.

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CHAPTER 2

STRATIGRAPHY

General Statement

The area of study is located on the northeast flank of the Williston Basin, a major tectonic feature which underwent more or less continuous subsidence throughout Ordovician and Silurian time. This pattern of subsidence was the principal factor controlling the nature and distribution of the Ordovician and Silurian strata in Manitoba.

Limestones and dolostones are predominant throughout most of the Ordovician-Silurian section, except for the basal Ordovician Winnipeg Formation which consists of quartzose sands, shales and arenaceous shales. The strata dip gently and fairly uniformly to the west-southwest at about 10 feet per mile. The only anomalous areas are in the vicinity of the Lake St. Martin crypto-explosion structure (McCabe and Bannatyne, 1970) and in the vicinity of Highrock Lake, where a Precambrian window exposes rocks that indicate the possibility of a second crypto-explosion structure.

The contact between the Silurian Interlake beds and the overlying Ashern Formation of probable Middle Devonian age is an angular unconformity, considering the overall basin structure. In Manitoba, there is little evidence of any angular discordance despite the development of extensive breccia beds at the contact. All the Upper Interlake Beds were removed from the study area during the period of later Silurian - early Devonian uplift and erosion.

Ordovician Stratigraphy

Winnipeg Formation

The Winnipeg Formation was not cored completely because of jamming problems arising from the poor consolidation of the sandstone. The maximum thickness obtained was the top fifty-nine feet in hole number 6.

The cores consist of shale beds, two inches to six feet thick, interbedded with arenaceous shale and argillaceous sandstone; contacts between beds are gradational. Colors range from light greenish grey to reddish brown with minor green patches (Plate I A and I B, respectively). The sand grains are well rounded, pitted, frosted, fine to medium grained and consist of quartz. The sand occurs both as disseminated grains and as one-half inch lensoid concentrations in the shale. Some beds have up to eighty percent sand lenses with paper thin shale bands separating the lenses. The disseminated grains commonly comprise less than five percent of the rock. Randomly oriented, dark brown, chitinous, brachiopod bioclasts and phosphatic oolites occur sparsely throughout the shale beds.

These beds comprise the upper sandstone and shale of the Winnipeg Formation and correlate with the Upper Unit of Baillie (1952). Data from nearby wells indicate that the remainder of the formation consists of clean quartzose sandstone. Baillie (1952) found this lower sandstone unit exposed at Black Island (Section I) and Punk Island (Section 2).

The Winnipeg Formation overlies the Precambrian surface (Baillie, 1952). The apparently conformable contact between the Winnipeg Formation and the overlying Dog Head Member of the Red River Formation is placed at the base of the first dolomitic limestone bed, correlative to that found at Grindstone Point, Deer Island and Punk Island (Baillie, 1952).

Red River Formation

For this report, the Red River Formation is considered to consist of four members, which are in ascending order: the Dog Head, Cat Head, Selkirk and Fort Garry (Figure 2). This formation consists essentially of two different lithologic types reflecting two distinctly different depositional environments. Mottled dolomitic bioclastic limestone is the predominant lithologic type comprising most of the Dog Head and Selkirk Members and occurring to a lesser extent in the Cat Head Member. The second lithologic type, represented by the Fort Garry Member, consists predominantly of lithographic to sublithographic dolostone.

Dog Head, Cat Head and Selkirk Members

The massive thick-bedded dolomitic limestone of both the Dog Head and Selkirk Members is a brachiopod crinoid biomicrite with a minor amount of interbedded brachiopod crinoid biosparite. Horn corals, gastropods, cephalopods, bryozoans and trilobites are less common. Fossil content in the rock ranges from ten to seventy percent, averaging about forty percent. The fossils are fragmented and usually randomly oriented.

Dolomite content ranges from ten to forty-five percent and averages about thirty percent. The dolomite occurs as finely crystalline irregular medium yellowish brown mottled areas (Plate I D and III A & B). Tubular structures, which are possibly sediment-filled worm burrows, commonly form cores for dolomitized areas (Plate III A).

The color of the dolomite patches is medium yellowish brown and the limestone is light yellowish brown (Plate III A). Hematite staining is not uncommon in both the Dog Head and Selkirk Members (Plates I E and III A, respectively).

In the vicinity of the Lake St. Martin crypto-explosion structure at hole 18 the lithology of the Selkirk Member is anomalous to the rest of the study area in that it has undergone neither dolomitization nor mottling. The predominant lithologies are brachiopod biosparite and light grey micrite (Plate III C and D, respectively). Brachiopod crinoid intrabiomicrite and intrabiosparite are present to a lesser extent. Bedding varies from massive in the biosparites and biomicrites to laminar in the micrites.

In the southeastern portion of the study area, the Cat Head Member differs from the underlying and overlying members in having a higher percentage of dolomite and chert. Dolomite content varies from approximately fifty to seventy percent (Plate II A). Chert occurs as earthy nodules and as pseudomorphic replacement of fossils (Plate II B). To the northwest, the Cat Head Member becomes an interbedded, dark grey, very finely crystalline dolostone and light grey, dolomitic, micritic limestone with chert nodules (Plate II C). Hole 16 shows a transitional facies with the dolomitic micrite and very finely crystalline dolostone, typical of the northern area, underlying the mottled calcitic dolostone, typical of the southern area. Tubular structures which are possibly due to the burrowing organisms are present in the dolomitic micrite (Plate II D).

The insoluble residue is composed of predominantly illitic clay with minor amounts of silt sized quartz found in the Selkirk Member. Chert is commonly found in the Cat Head Member to a varying degree. The percentage decreases from twenty-four percent at the base of the Dog Head Member where grey shale is interbedded with argillaceous, dolomitic limestone (Plate I C) to three percent in the Selkirk Member.

Fort Garry Member

The second major lithologic type in the Red River Formation, the fine grained dolostone, is restricted to the Fort Garry Member which consists of four separate stratigraphically continuous intervals.

The basal unit, approximately 100 feet thick, consists of dense grey and red lithographic dolostone with minor interbedded fine to medium crystalline dolostone (Plate IV D). The dolostone is often structureless, although laminar and nodular bedding is not uncommon (Plate IV A & C, respectively).

Overlying this dense dolostone interval is a seventeen to twenty-one foot interval of interbedded red and grey, partly argillaceous, cherty, vuggy, fossiliferous, calcitic, finely crystalline dolostone, medium crystalline dolostone and minor amounts of light grey, micritic limestone and shale (Plate IV E). The fossils present are tabulate corals and stromatoporoids that are not oriented in the beds. The upper contact of this zone appears to be correlative with Porter and Fuller's (1959) Q-horizon.

This interval is overlain by ten to twenty feet of light grey, dense, sublithographic dolostone.

The upper most unit of the Fort Garry Member throughout most of the Winnipeg-Stony Mountain area consists of up to ten feet of relatively pure limestone which is a light grey to white brachiopod biomicrite (holes 3 and 5). The unit grades laterally, in a north-westerly direction, to a dolomitic micrite, pinching out north of hole 7. The brachiopod biomicrite is thin-bedded (1 - 1½ inches) with the brachiopods oriented parallel to bedding. The northern dolomitic micrite is massive, having a gradational

contact with the underlying dolostone. Baillie (1952) described a calcitic dolostone exposed in the Fisher Branch area (Section 24) which he believed correlative to the Selkirk Member. This outcrop may be correlative to this upper unit of the Fort Garry Member.

In the Lake St. Martin Area (hole 18) the middle portion of the Fort Garry Member consists of coarse sand to pebble sized, angular, poorly sorted fragments of light grey sublithographic dolostone suspended in a sparry calcite matrix; this highly anomalous breccia zone could be due to solution breccia or structural disturbance associated with the crypto-explosion structure.

The insoluble residue of the Fort Garry Member, excluding chert, consists of illite and decreases from bottom to top of the member. At approximately the middle of the member, there is a thin highly argillaceous zone that is correlative with Porter and Fuller's (1959) P-horizon.

Contact Relationships

The upper contact of the Red River Formation with the Stony Mountain Formation is sharp, marked by an increase of insoluble residue, due to the change in lithology from a light grey carbonate of the Fort Garry Member to the darker grey green and red argillaceous limestone of the basal Stony Mountain Formation.

The contacts between the four members of the Red River Formation are gradational over two to five foot thick intervals, except in the southern portion of the study area, where the upper and lower contacts of the Cat Head Member are gradational over a ten foot thick interval reflecting the gradual increase in dolomitization. All the members of the Red River

Formation thin in a north-westerly direction, except the Cat Head which maintains a relatively uniform thickness of sixty feet, the exception is found at hole 14 where it thins to thirty feet. The Dog Head Member thins from one hundred and twenty-five feet in hole 14 to ninety-four feet in hole 18. The Selkirk Member thins from one hundred and thirty-eight feet in hole 7 to sixty-two feet in hole 18. The Fort Garry thins from one hundred and thirty-eight feet in hole 5 to ninety-four feet in hole 18.

Stony Mountain Formation

The Stony Mountain Formation consists of four members which are in ascending order: Gunn, Penitentiary, Gunton and Williams.

Gunn Member

The Gunn Member is composed of interbedded red and green, argillaceous brachiopod, horn coral biomicrite, calcareous shale and brachiopod, horn coral biosparite (Plate V A). Beds range in thickness from one to three inches. Bryozoans, colonial corals, cephalopods and gastropods occur as poorly sorted, randomly oriented, very fine grained to pebble sized bioclasts. Some beds show numerous tubular structures with a dolomitic center, probably representing infilled worm burrows. In beds without tubular structures, the brachiopods are horizontally oriented. In beds with tubular structures, the brachiopods are randomly oriented. This suggests that the worms burrowing action disrupted the orientation of the brachiopods.

The Gunn Member is thickest in the southern portion of the study area (sixty-nine feet at hole 3), thinning to the northwest and pinching out north of the hole 7. The contact with the overlying Penitentiary Member is

diachronous and gradational over an interval of two to five feet. The thinning is primarily the result of a lithofacies change rather than a depositional thinning. The Gunn Member alters laterally into the Penitentiary Member.

Penitentiary Member

The Penitentiary Member consists predominantly of red and green argillaceous, sublithographic to finely crystalline dolostone with minor interbedded calcitic dolostone. Infilled tubular structures, possibly worm burrows, are common in the sublithographic dolostone (Plate V B). In the basal five feet of the member, the transition zone with the Gunn, the micrite matrix is dolomitized leaving fossils composed of calcite, suspended in a finely crystalline dolomite matrix. Above this zone, the fossils have been selectively removed by solution, leaving a vuggy dolostone (Plate V B & C).

The Penitentiary Member thickens to the northwest coincident with the thinning of the Gunn Member. As noted previously, this thinning results primarily from facies change as indicated by the relatively uniform thickness of the total Stony Mountain section and the contact between the Gunn and Penitentiary Members is diachronous. Baillie (1952) found Ordovician dolostone overlying the Red River Formation in section 33 (Mafeking No. 1) which is probably correlatable to the Penitentiary Member. The upper contact is marked by a decrease in insoluble residue over an interval of two feet.

Gunton Member

This member is composed of sublithographic to finely crystalline

relatively pure dolostone which shows great variation in structure and texture. The bottom two-thirds of the member consists of dense, light grey, massive, sublithographic dolostone with minor intervals of laminar and nodular bedding. The upper third of the member contains both vuggy and intraclastic, sublithographic to finely crystalline dolostone beds (Plate V, D & E respectively). The type section at the Gunton Quarry, a mile south of the town of Gunton, has the lower twenty-six feet five inches exposed of the Gunton Member.

The Gunton Member thickens to the northwest from thirty feet in hole 4 to fifty-five feet in hole 10. This thickening is primarily the result of a facies change with the overlying Williams Member. The contact with the overlying Williams Member is marked by an increase in insoluble residue over an interval of between one and two feet.

Williams Member

This member consists of interbedded arenaceous, argillaceous, sublithographic dolostone and shale, the dolostone commonly has thick bedding but in places is thinly bedded and intraclastic. The sand grains are disseminated, quartzose, well rounded, frosted, and range in size from medium to coarse grained. In the southern portion of the study area, where Smith (1963) placed the type section at the Winnipeg Supply and Fuel Company quarry at Stonewall, the maximum thickness is twenty-one feet (hole 4). There are two zones, the lower one is light grey and the upper one is reddish brown. The lower light grey zone pinches out in a northwesterly direction, coincident with the thickening of the Gunton Member, until in hole 10 only the red zone is present (Plate VI A). The Williams Member

pinches out in the vicinity of hole 17. The contact with the Stonewall Formation is marked by a decrease in insoluble residue at the interface of the argillaceous, arenaceous beds of the Williams Member and the pale yellowish brown dolostone of the Stonewall Formation.

Insoluble Residue

According to Smith (1963), the insoluble residue content of the Stony Mountain Formation is high in the Gunn, Penitentiary and Williams Members. The residue content of the Gunn and Penitentiary ranges from eight to twenty-five percent in the limestone to eighty percent in the calcareous shale. The insoluble residue content of the Gunton Member ranges from one-half percent to five and one-half percent, except for the basal transitional zone where the residue rises to eleven percent.

In the Williams Member, the insoluble residue content varies from eighteen to thirty-four percent. Throughout the study area the residue consists primarily of sand and silt. The mineralogy of the insoluble residue is quartz and iron oxides with minor amounts of illite.

Stonewall Formation

The Stonewall Formation may be subdivided into two units with different lithologies. These are referred to in this report as the lower and upper Stonewall which are separated by the T-horizon of Porter and Fuller (1959). The T-horizon is at the top of a marker bed which is a one to seven foot thick zone of light grey, red and green, argillaceous and arenaceous intraclastic, finely crystalline dolostone (Plate VI D). The sand grains are well rounded, coarse to fine grained and composed of quartz suspended in a

finely crystalline dolomite matrix. The intraclasts are subrounded and fine to coarse grained.

The lower Stonewall, which comprises the Stonewall Quarry beds (the type section) consists of light yellowish grey, slightly mottled, fossiliferous, vuggy, finely crystalline dolostone (Plate VI B). The fossils are predominantly tabulate corals and brachiopods. Some subrounded to subangular cobble to fine sand sized intraclastic dolostone is interbedded with the fossiliferous dolostone. Near the base of the unit, denser interbeds of red and green, argillaceous, nodular dolostone occur overlying the basal pale yellowish brown, fossiliferous dolostone.

The upper Stonewall is composed of dense, light grey, finely crystalline to sublithographic dolostone (Plate VI E). Much of the unit is structureless although some sections show laminar bedding and the base of the unit is slightly vuggy.

Throughout the study area, the formation is uniformly thirty feet thick, with the T-horizon occurring near the middle of the formation. The contact with the overlying Strathclair Formation is marked by a one to five foot thick bed of red, argillaceous, sublithographic dolostone which contains unusual spherical "blebs" of dolomite (Plate VI C).

Silurian Stratigraphy

Strathclair Formation

King (1964) named the Strathclair Formation, including Stearn's (1956) Fisher Branch Formation and the basal portion of the lower member of the Inwood Formation; it corresponds to Baillie's (1951) B and C lithologic

units. The lithology is dolostone showing a considerable variation in texture and structure. A complete section was cored in hole 8 and 10 where the thickness is seventy-eight feet and seventy-one feet, respectively.

The bottom six to fifteen feet consists of light yellowish grey, vuggy, fossiliferous, finely crystalline dolostone and contains randomly oriented Virgiana decussata and tabulate corals (Plate VII A). This fossiliferous interval correlates with Stearn's Fisher Branch Formation.

Overlying this fossiliferous interval is forty feet of interbedded light grey, fine to medium crystalline and sublithographic dolostone (Plate VII B). Beds range in thickness from two to six inches. The fine to medium crystalline dolostone beds contain small brachiopods and horn corals. The sublithographic beds commonly contain spherical "blebs" of dolomite one-eight to one-quarter inch in diameter that are less resistant to weathering than the surrounding dolomite. In the northwestern portion of the study area, the predominant lithology is sublithographic dolostone.

The upper ten to thirty feet of the formation consists of interbedded mottled light and darker grey, fossiliferous, sublithographic dolostone and light grey, oolitic, fossiliferous, intraclastic dolostone (Plates VII C & D respectively). The fossils are tabulate corals and brachiopods.

The insoluble residue content of the formation ranges from two to ten point five percent. The residue is illitic clay with a minor amount of kaolinite near the top of the formation.

The upper contact throughout all but the northern portion of the study area is at the top of a three foot thick green and red clay layer which correlates with Porter and Fuller's (1959) U-horizon. This horizon is apparently absent at hole 18 in the Lake St. Martin area. Consequently

correlation of the top of the Strathclair Formation in this area is uncertain.

The Inwood Quarry beds comprise the type section of Stearn's lower member of the Inwood Formation. These beds include a red and green clay zone. The core from hole 8, drilled at this location, indicates that this clay zone is Porter and Fuller's U-horizon which King used to mark the upper contact of the Strathclair Formation. King did not recognize that this clay zone correlates with the U-marker and erroneously included all the beds of the quarry in the Strathclair Formation. The beds overlying this clay zone in the Inwood Quarry should be included in the basal Brandon Formation.

Brandon Formation

The Brandon Formation (King, 1964) consists of an upper and lower member separated by the U_2 horizon which occurs at the top of a four-foot interval of green and red, argillaceous, arenaceous, intraclastic, sublithographic dolostone. This formation includes the upper portion of the lower member plus all the upper member of the Inwood Formation, the Moose Lake Dolomite, the Atikameg Dolomite and the lower portion of the East Arm Dolomite (Stearn, 1956). The formation correlates with the lithologic Unit D of Baillie (1951). The upper and lower contacts of the formation are marked respectively by the U and V-horizons of Porter and Fuller (1959).

The lower member is twenty-four feet thick at hole 9. The basal six feet consists of mottled light and darker grey, vuggy, fossiliferous, sublithographic dolostone (Plate VIII A) and the upper eighteen feet of the member is light grey and purple, massive dolostone with interbedded dense, lithographic to finely crystalline dolostone and slightly vuggy dolostone breccia. The massive lithographic to sublithographic dolostone commonly shows "blebs" of softer dolomite (Plate VIII B).

The upper member consists of approximately twenty-five feet of dense light grey and grey lithographic to sublithographic dolostone as seen in the core from hole number 11. Dolostone breccia beds are interbedded with laminar and thin-bedded dolostone (Plate VIII C & D, respectively). The laminar beds commonly contain the "blebs" of dolomite. The upper contact with the Cedar Lake Formation is at the top of a one to two foot thick red clay bed of the V-horizon (Porter and Fuller, 1959).

The dolostone of the Brandon Formation grades laterally in a northwesterly direction into a dense, uniform structureless, light grey, lithographic to sublithographic dolostone.

The insoluble residue of the upper and lower members ranges from one point seven to four point four percent illitic clay and quartz. The U_2 horizon contains twenty-four percent red and grey illitic clay.

Cedar Lake Formation

Stearn (1956) named the Cedar Lake Formation, dividing it into the Cross Lake Member and the Chemahawin Member which are a biostromal and reefal facies, respectively. Between these members, laterally replacing them and interbedded with them, is an interval which he called the middle part of the Cedar Lake dolomite. The formation correlates to the lithologic units D and E of Baillie (1951). The upper contact with the Devonian Ashern Formation is marked with red argillaceous dolostone (Plate IX A).

The basal one hundred feet correlates to the Cross lake and the middle portion of the Cedar Lake Dolomite (Stearn, 1956) and consists of interbedded light grey, medium crystalline, finely crystalline, sublithographic and

lithographic dolostones with variable fossil content. At core holes 10 and 11, the basal thirty feet of the formation consists of light grey, lithographic to finely crystalline dolostone (Plate IX B). At core hole 13, a twenty-four foot interval of nonbedded, fossiliferous, light and yellow grey, medium crystalline and lithographic dolostone is present (Plate IX C). Intraclastic dolostones are interbedded with the fossiliferous dolostones throughout the study area. The intraclasts are rounded to angular and range from medium sand size to pebble size. Brachipods, crinoid stems, stromatoporoids, ostracods and horn corals occur sparsely in many of the beds. Although much of the interval is nonporous, vuggy porosity is common to the fossiliferous beds and intercrystalline porosity is found in the medium and finely crystalline dolostone (Plate IX D).

The upper twenty-five to thirty-nine feet, the Chemahawin Member of Stearn (1956), consists of fossiliferous, light grey and yellowish grey, vuggy, finely crystalline dolostones as seen in the core from hole number 12. Bedding is almost absent and the rock is composed of tabulate corals and stomatoporoids in a sublithographic to lithographic dolostone matrix (Plate IX E). The solution of fossils has resulted in the development of vuggy porosity.

The insoluble residue ranges from two point two to eleven percent light brown illite clay with traces of quartz silt. The usual range is from three to five percent.

CHAPTER 3

SEDIMENTATION

Ordovician

Winnipeg Formation

Winnipeg sedimentation in the study area began in Middle or Late Ordovician time during a marine transgression from the south and southwestern portion of the Williston Basin (Genik, 1954; Macauley, 1955). The highly rounded, frosted, pitted, well sorted, quartzose sands of the Basal Sandstone indicate deposition in shallow seas after an extensive period of reworking (Andrichuk, 1959). The deposition of interbedded shales, arenaceous shales and sandstones during the latter part of Winnipeg time, indicates a decrease in energy possibly due to increased subsidence in the Williston basin and/or subsidence of the clastic sediment source area which was, according to Andrichuk (1959), the Cambrian rock found to the west and northwest and the Precambrian rock on the northeastern shores of the sea. The end of Winnipeg deposition was marked by further subsidence or rise in sea level, drowning the sediment source area and initiating deposition of Red River carbonates.

Red River Formation

The initiation of Red River sedimentation was marked by a transitional period during which only clay was brought into the depositional site. This

resulted in deposition of the argillaceous limestone with shaly partings and calcareous shale interbeds that comprise the basal part of the Dog Head Member. This transitional stage was followed by a period of relatively clean carbonate deposition in which the remainder of the Dog Head, Cat Head and Selkirk Members were laid down. During this time a prolific fauna consisting of crinoids and brachiopods and to a lesser extent horn corals, cephalopods, bryozoans and trilobites flourished in a moderately deep infratidal environment, forming brachiopod crinoid biomicrites and biosparites.

The Cat Head Member grades from predominantly mottled, fossiliferous, calcitic dolostone in the southeast to a thinly interbedded, grey, finely crystalline dolostone and light grey, lithographic dolostone in the northwestern portion of the study area. This change in lithology is due to a change from an infratidal environment in the southeast, where the Cat Head differs from the overlying and underlying members only in its slightly greater degree of dolomitization which is due to diagenesis, to a shallower more restricted marine environment in the northwest where dolomitization was intense and occurs more along bedding planes as shown by the thin interbedding of dolomite and limestone.

The end of Selkirk deposition was marked by the deposition of interbedded massive and laminar bedded dolostones of the lower part of the Fort Garry Member suggesting a shoaling of the sea and subsequent establishment of alternating intertidal and supratidal environments. These dolostones are overlain by the argillaceous dolostone interbeds which are correlative to the P and Q non-sequential beds, and reflect interruptions in sedimentation (Porter and Fuller, 1959). During deposition of the latter portion of the Fort Garry Member, stromatoporoids and tabulate corals flourished suggesting

a transgression of the sea creating an infratidal environment. In the southern portion of the study area as shown in holes 5 and 7, the light grey brachiopod biomicrite comprising the upper most unit was deposited in an infratidal environment which persisted to the end of Red River deposition.

Stony Mountain Formation

Deposition of the Gunn and Penitentiary Members of the Stony Mountain Formation was marked by a sudden influx of terrigenous detritus in which randomly oriented shells of brachiopods, horn corals, tabulate corals and bryozoans were laid down in a basin facies environment (Roehl, 1967). The random orientation of the shells and abundance of tubular structures indicate extensive post-depositional reworking by burrowing organisms. The decrease in argillaceous content to the north, coincident with the increase of dolomite content, indicates a shallower higher energy infratidal environment, permitting less deposition of argillaceous material than in the southern portion of the study area. The deposition of the dense, laminated dolostone of the lower part of the Gunton Member suggests a regression of the sea. The occurrence of tubular structures and salt hoppers provides evidence of deposition in an intertidal to supratidal environment.

Upper Gunton strata consisting of fossiliferous and intraclastic sublithographic dolostone indicate a return to deeper infratidal conditions. The end of Gunton deposition was marked by a regression of the sea and the establishment of a supratidal to intertidal environment, concurrent with the introduction of the terrigenous clastics of the Williams Member. Crossbedding is evident, in part, in these argillaceous, arenaceous dolostones

and Smith (1963) reported the cumulative frequency curve of the sediments in part of Williams Member similar to that of beach sands.

Stonewall Formation

Stonewall deposition began with transgression of the sea and establishment of a shallow infratidal environment in which tabulate corals and brachiopods flourished. Subsequent regression of the sea resulted in deposition of wind blown pitted and frosted sand grains, illitic clay, brecciated dolostone and carbonate mud in a very shallow marine to terrestrial environment. These shaly sandy beds comprise the T-horizon of Porter and Fuller (1959). Brindle (1960) stated that the top of the argillaceous beds possibly mark the Ordovician-Silurian boundary, although, there is no evidence of any appreciable sedimentation break. Subsequent deposition of massive and laminar bedded carbonate mud in an intertidal to supratidal environment continued to the end of Stonewall time. The end of Stonewall time was marked by an influx of illitic clay that could have been deposited in a restricted environment due to a further regression of the sea.

Silurian

Strathclair Formation

Strathclair sedimentation began in an infratidal environment relatively free of terrestrial material in which abundant brachiopods and tabulate corals flourished. The random orientation and poor sorting of the fossils suggest that deposition occurred under moderately deep water conditions. The overlying bedded and fossiliferous carbonates were deposited in a

shallow infratidal environment in which the high energy acted to sort and orient the brachiopods parallel to bedding. The oolitic and intraclastic beds in the upper part of the Strathclair indicate deposition under still high energy conditions, possible in a slightly restricted environment. The end of Strathclair sedimentation was marked by regression of the sea and deposition of red argillaceous beds; these beds comprise the U-horizon of Porter and Fuller (1959).

Brandon Formation

The fossiliferous beds of the basal Brandon Formation indicate a return to a deeper water infratidal conditions at the beginning of Brandon time. Deposition of flat pebble conglomerate and laminar bedding found throughout both the upper and lower members indicate that sedimentation occurred primarily in the very shallow marine to supratidal environments.

Regression of the sea resulted in deposition of the sand and clay marker beds between the upper and lower members, possibly under subaerial conditions; these beds are the U_2-horizon of King (1964). Brandon sedimentation terminated with deposition of a red clay zone which correlates to the V-horizon of Porter and Fuller (1959).

Cedar Lake Formation

Transgression occurred once again in early Cedar Lake time where lime muds showing laminar bedding and a few interbeds of flat pebble conglomerate were deposited in a very shallow restricted to a supratidal environment. Further transgression of the sea in later Cedar Lake time

resulted in deposition of intraclastic and bioclastic sediments in an intratidal to supratidal environment. Brachiopods, oriented parallel to bedding, horn corals and crinoids are particularly abundant. In latest Cedar Lake, Middle Silurian reefal buildup occurred which Stearn (1956) named the Chemahawin Member. Abundant tabulate corals and stromatoporoids in a rock, apparently devoid of bedding, form the reef core deposits and bedded bioclastic calcarenites form the reef flank beds.

The Cedar Lake Formation is overlain with marked unconformity by breccia-bearing argillaceous dolostone and shale of the Devonian Ashern Formation. Regional studies in the Williston Basin of Porter and Fuller (1959), Andrichuk (1959) and Roehl (1967) indicate that deposition of Upper Interlake Beds continued until Late Silurian time but subsequent erosion during early Devonian has removed these strata from the Interlake area. Regional truncation of the Interlake beds in the Williston Basin has produced an angular unconformity between the Devonian and Silurian strata in the deeper parts of the basin. In the study area, however, the strata at the unconformity appear essentially parallel with no evident angular discordance at the unconformity.

CHAPTER 4

Summary

The total Red River Formation and all the members, except for the Cat Head Member, thin to the northwest, suggesting facies control. The Cat Head Member changes from a mottled highly calcitic dolostone in the southeast to an interbedded dolomitic micrite and finely crystalline dolostone in the northwest. The Selkirk Member which is a mottled dolomitic limestone throughout most of the study area changes to an interbedded micrite, intrabiosparite and intrabiomicrite in the area north of Lake St. Martin at hole number 18 in the flank of the Lake St. Martin cryptoexplosion structure.

The upper dolomite unit of the Red River Formation, instead of comprising a facies equivalent of the Selkirk Member as suggested by Andrichuk (1959), is a separate member overlying the Selkirk Member and is named the Fort Garry Member (McCabe et al, 1970).

The Gunn and Williams Members of the Stony Mountain Formation thin in a north-westerly direction. The Penitentiary Member thickens to the north coincident with an equivalent thinning of the Gunn Member, suggesting a diachronous contact. To the northwest, clay content decreases and dolomite increases coincident with Gunn thinning a Penitentiary thickening although the total thickness of Gunn and Penitentiary is constant.

Silurian formation thicknesses as determined in this core study differ appreciably from those estimated by previous workers on the basis of incomplete data.

In particular, Stearn (1956) estimated that the lower Inwood was 25 feet thick; however, core hole No. 8 showed a thickness of 70 feet of lower Inwood beds. The Moose Lake, Atikameg and East Arm Dolomites could not be recognized as mappable lithologic units in the study area.

King (1964) included Stearn's (1956) lower portion of the Inwood Formation as exposed in the Inwood Quarry in his Strathclair Formation using the U-horizon of Porter and Fuller (1959) as the upper contact of the Strathclair Formation. This study reveals that the red and green shale that occurs within the lower Inwood Quarry is the U-horizon. The upper part of the lower Inwood thus comprises the lower part of the Brandon Formation rather than the top of the Strathclair as reported by King (1964).

Figure 2 shows the exact stratigraphic positions and correlation of the principal outcrop and quarry sections including type sections of the Selkirk, Fort Garry, Gunn, Penitentiary, Gunton, Williams, Stonewall and the Interlake Group. The core holes located at or close to these type sections provide reference sections allowing a more complete succession than was previously available.

Depositional environments varied from normal marine, infratidal during most of the early Red River deposition, to alternating infratidal and intertidal during late Red River time. This cycle was repeated during Stony Mountain time with the Gunn-Penitentiary and Gunton Members representing deposits in a basinal to infratidal and intertidal environment, respectively. Silurian strata were deposited under predominantly intertidal to supratidal conditions, indicating a general regression of the sea during

Silurian time, culminating in the major period of post-Middle Silurian-pre-Middle Devonian uplift or regression of the sea, either of which would have resulted in erosion which lasted until Middle Devonian deposition of the Ashern Formation.

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APPENDIX I

CORE DESCRIPTIONS

TABLE 2 WENTWORTH GRADE SCALE

Wentworth grade scale was used, as modified for crystalline sedimentary rocks by Payne (1942).

MEAN SIZE (mm)	FOR CARBONATE MINERALS
4-2	Granular crystalline
2-1	Very coarse crystalline
1-$\frac{1}{2}$	Coarse crystalline
$\frac{1}{2}$-$\frac{1}{4}$	Medium crystalline
$\frac{1}{4}$-1/8	Fine crystalline
1/8-1/16	Very fine crystalline
1/16-1/256	Sublithographic
Less than 1/256	Lithographic

TABLE 3

LIST OF CORES

NO.	NAME	LOCATION	ELEVATION	FORMATION	T.D.	OVERBURDEN
1 (M-3-69)	Garson Quarry	15-3-13-6E	800'	Red River	169	
2 (M-1-70)	Mulder Bros. Mowatt Farm Quarry	10-27-13-3E	770'	Red River	202'	20'
3 (M-2-69)	City of Winnipeg Quarry, Stony Mountain	2-14-13-2E	810	Stony Mountain Red River	99'	
4 (M-1-69)	Southeast Quarry at Stonewall	13-30-13-2E	825	Stonewall Stony Mountain	89'3"	
5 (69-2)	Woodroyd Core Hole	16-2-15-IW	870	Strathclair Stonewall Stony Mountain Red River	505'	60'
6 (69-4)	Petersfield	16-36-15-3E	755'	Red River Winnipeg	397'	25'
7 (69-3)	Norris Lake	4-28-17-IE	860	Stonewall Stony Mountain Red River	503	49'
8 (M-4-69)	Inwood Quarry	NE 4-11-18-IW	890	Brandon Strathclair Stony Mountain Stonewall	129	
9 (M-5-70)	Inwood West	SE 14-18-2W	875	Brandon Strathclair	60'	0'
10 (69-1)	Oak Point Quarry	4-18-18-4W	825	Cedar Lake Brandon Strathclair Stonewall Stony Mountain Red River	500'	
11 (M-8-69)	Lundar North Quarry	3-7-20-4W	860	Cedar Lake Brandon	181'	
12 (M-6-69)	Mulvihill West Quarry	15-31-22-6W	880	Ashern Cedar Lake	97'	
13 (M-7-69)	Mulvihill East Quarry	SW 3-7-23-5W	893'	Cedar Lake	135'4"	

NO.	NAME	LOCATION	ELEVATION	FORMATION	T.D.	OVERBURDEN
14 (69-5)	Pequis	NW 32-26-IW	750	Red River Winnipeg	403	87'
15 (69-6)	Pequis	NE 14-28-IW	750'	Red River	150'	47'
16 (69-7)	Pequis	NE 28-28-IW	745'	Red River	288'	26'
17 (LSM-13)	Lake St.Martin	NE¼ 24-30-10W	820'	Cedar Lake Brandon Strathclair Stonewall Stony Mountain	236'	22'
18 (LSM-11)	Lake St.Martin	SE¼ 2-35-7W	795'	Strathclair Stonewall Stony Mountain Red River Winnipeg	505	21'

HOLE NO. I (M-3-69) | Garson Quarry 15-3-13-6E Elevation: 800 | Cored 169'

Depth in Feet

RED RIVER FORMATION

Selkirk Member

0' - 32' Dolomitic limestone, dolomite mottles are brownish buff, finely crystalline, limestone brachiopod crinoid biomicrite, dolomite has a buff brown color, limestone has a light grey color, numerous soft white chert nodules, crinoid stems pseudomorphically replaced with chert, skeletal material, brachiopods, crinoid fragments, horn corals and tabulate corals, tight, stylolitic, dolomite (10% to 50% generally around 40%).

Cat Head Member

32' - 83' Mottled calcitic dolostone, dolomite finely crystalline, limestone brachiopod crinoid stem biomicrite, light greyish brown dolomite range from 50% to 95%, numerous chalk white chert nodules.

Dog Head Member

83' - 160' Mottled dolomitic limestone, buff brown and light grey, dolomite is finely crystalline, limestone is a brachiopod crinoid stem biomicrite with scattered gastropods and cephalopods, minor brown shaly partings, dolomite range 10% to 45%, usually 25% to 30%.

160' - 169' Mottled dolomitic limestone, as above but becoming more argillaceous.

* *

HOLE NO. 2 (M-I-70) | Mulder Bros. Quarry 10-27-13-3E Elevation: 770 | Cored 182' Overburden 20'

Depth in Feet

RED RIVER FORMATION

Fort Garry Member

20' - 72' Dolostone, sublithographic, light grey, reddish purple, laminar bedded, tight.

72'- 80' Dolostone, medium crystalline, yellow, cherty.

80' - 104' Dolostone, mottled light grey and light yellow, yellow is medium crystalline, grey is sublithographic, numerous white chert nodules.

Selkirk Member

104' - 202' Dolomitic limestone, mottled light grey and buff brown, dolomite buff brown is finely crystalline average percentage dolomite is 30%, limestone is a brachiopod crinoid stem biomicrite, a few 1 to 2 inch beds of biosparite.

* *

HOLE NO. 3 (M-2-69) City of Winnipeg Quarry
Stony Mountain
2-14-13-2E
Elevation: 810 Cored 99'

Depth in Feet

STONY MOUNTAIN FORMATION

Penitentiary Member

0' - 10'6" Dolostone, sublithographic to finely crystalline, light yellowish grey and red, argillaceous, tubular structures, vuggy fossil solution cavities.

Gunn Member

10'6" - 80' Limestone, mostly brachiopod biomicrite with minor amounts of interbedded brachiopod biosparite and calcareous shale, red and green, biomicrite argillaceous, skeletal material ranges from 5% to 80% of the rock. Where tubular structures (worm burrows?) are present fossils are randomly oriented.

RED RIVER FORMATION

Fort Garry Member

80' - 88'4" Limestone, brachiopod crinoid biomicrite, light yellowish grey, slightly vuggy, brachiopods oriented horizontally.

88'4" - 94' Dolomitic limestone, light buff brown and dark buff brown, mottled, laminar bedded, cherty.

94'9" - 99' Dolostone, finely crystalline, yellowish brown and greyish brown mottled, laminar bedded, fossiliferous.

* *

HOLE NO. 4 (M-I-69) Southeast Quarry at Stonewall
13-30-13-2E
Elevation: +825 Footage Cored 89'3"

Depth in Feet

STONEWALL FORMATION

0' - 3'2" Dolostone, sublithographic to finely crystalline, light grey.

3'2" - 4'2"	Dolostone, sublithographic, red, argillaceous, spherical "blebs" of dolomite which are lighter in color than the surrounding rock.
4'2" - 8'7"	Dolostone, sublighographic to finely crystalline, light grey, vuggy.

STONY MOUNTAIN FORMATION

Williams Member

8'7" - 18'6"	Dolostone, sublithographic, maroon, argillaceous.
18'6" - 29'8"	Dolostone, sublithographic, light grey, argillaceous arenaceous, breccia clasts 2mm to 20mm in length, laminar bedded.

Gunton Member

29'8" - 32'	Dolostone, sublithographic, light grey, vuggy, green shaly partings, laminar bedded.
32' - 45'	Dolostone, sublithographic, light grey, tight, tubular, structures (possibly worm burrows).
45' - 49'	Dolostone, sublithographic, light grey, vuggy.
49' - 60'4"	Dolostone, sublithographic, light grey and grey mottled, tubular structures, tight.

Penitentiary Member

60'4" - 84'8"	Dolostone, sublithographic to finely crystalline, light green, red and grey, argillaceous, tubular structures.

Gunn Member

84'8" - 88'	Dolomitic limestone, red and green, argillaceous, tubular structures.
88' - 89'3"	Limestone, brachiopod biomicrite, red, argillaceous, more dolomitic in areas of tubular structures.

* *

HOLE NO. 5 (69-2) Woodroyd Core Hole
16-2-15-IW
Elevation: 870
Cored 445'
Overburden 60'

Depth in Feet

STRATHCLAIR FORMATION

60' - 70'	Dolostone, finely crystalline, light yellow grey, fossiliferous, brachiopods, crinoid stems, brachiopods parallel to bedding, $\frac{1}{2}$ to 1 inch thick.

70' - 86'	Dolostone, finely crystalline, light yellowish grey, brachiopods, horn corals and tabulate corals, vuggy porosity.
86' - 100'	Dolostone, sublithographic, light grey, beds 1 to 2 inches thick, dense.

STONEWALL FORMATION

100' - 102'	Dolostone, red, argillaceous, tight.
102' - 113'9"	Dolostone, sublithographic to lithographic, light grey, laminar bedding, tight.
113'0" - 120'	Dolostone, sublithographic to finely crystalline, light grey and red, argillaceous and arenaceous, bedding 1 to 3 inches thick,
120' - 127'	Dolostone, finely crystalline, light yellowish grey, vuggy, tabulate corals and brachiopods, interbedded dolostone breccia.
127' - 131'	Dolostone, finely crystalline, light yellowish grey, drop in porosity from the above interval.

STONY MOUNTAIN FORMATION

Williams Member

131' - 146'	Dolostone, red, argillaceous, arenaceous, laminar bedding in the beds of greater argillaceous content, beds up to 3 inches thick in less argillaceous beds.
146' - 153'9"	Dolostone, sublithographic, light grey to white, bedding $\frac{1}{4}$ to 1 inch thick, tight, argillaceous.

Gunton Member

153'9" - 189'	Dolostone, sublithographic, light grey, vuggy and fossiliferous at top of interval decreasing to zero near the base where the rock is tight and massive, mottled.

Penitentiary and Gunn Members

189' - 210'	Dolostone, finely crystalline, red, argillaceous, tubular structures beds 2 inches thick, some beds vuggy and fossiliferous.
210' - 227'6"	Dolostone, finely crystalline, red and green argillaceous, tubular structures, intraclasts suspended in dolomite matrix, green shale bed 1 to 3 inches thick, fossiliferous, vuggy.
227'6" - 246'	Dolomitic limestone, red, green and light grey, argillaceous, limestone occurs and brachiopod biomicrite and biosparite, thickness of beds 1 to 2 inches, center of tubular structures is dolomitic.

246' - 255' Dolomitic limestone, same as above except less fossiliferous.

255' - 263' Limestone, brachiopod biomicrite, grey green and red, argillaceous, bottom 3' of interval consists of a calcareous shale.

RED RIVER FORMATION

Fort Garry Member

263' - 278' Limestone, brachiopod bromicrite, white to light grey, bedding 1½ inches thick, dolomitic matrix approaching base of interval, brachiopods oriented parallel to bedding.

278' - 292' Dolostone, finely to medium crystalline, light and dark grey, mottled, white chert nodules, brachiopods and tabulate corals, bedding 1 to 6 inches thick, vuggy, quartz and pyrite crystals in lining vugs.

292' - 302' Dolostone, finely and medium crystalline, light and dark grey, mottled, fossiliferous, no evidence of bedding.

302' - 314' Dolostone, finely crystalline, medium grey and light red, cherty, laminar bedded.

314' - 384'6" Dolostone, sublithographic to lithographic, laminar bedded, light grey and red.

384' - 401' Dolomitic limestone, light grey, laminar bedded, upper portion of the interval has minor interbedded sublithographic dolostone (10%) becoming a high calcium limestone towards the bottom.

Selkirk Member

401' - 505' Dolomitic limestone, light grey (limestone) and buff brown (dolomite), mottled, limestone brachiopod crinoid stem horn coral biomicrite, dolomitization radiates from tubular structures and found along bedding planes, dolomite range 30% - 40%, dolomite in finely crystalline.

* *

HOLE NO. 6 (69-4) Petersfield 16-36-15-3E Elevation: 755 Cored 372' Overburden 25'

Depth in Feet

RED RIVER FORMATION

Selkirk Member

25' - 151' Dolomitic limestone, yellowish grey and light grey and red mottled, limestone brachiopod crinoid stem dolomitic limestone, yellowish grey and light grey and red mottled, limestone brachiopod crinoid stem biomicrite and minor amount of biosparite, dolomite percentage range from 10% - 40% dolomite is finely crystalline, occurring in worm burrows and parallel to bedding planes.

Cat Head Member

151' - 211' Calcitic dolostone, yellowish grey and light grey mottled, dolomite finely crystalline, chert nodules chert pseudomorphic replacement of fossils (brachiopods and crinoid stems), limestone is a brachiopod crinoid stem biomicrite, dolomite accounts for 50% to 100% of the rock.

Dog Head Member

211' - 338' Dolomitic limestone, light grey and yellowish grey, dolomite accounts for 30% - 40% of the rock, occurs as finely crystalline concentrations, tight, becomes more argillaceous towards the base of the member, argillaceous material occurs as thin interbeds in a more argillaceous limestone (16% - 24%).

WINNIPEG FORMATION

338' - 355' Arenaceous shale, greyish green, medium grained, well rounded quartz sand occurs as small lenses being separated by green shale, tight.

355' - 397' Shale, green and dark brown, chitonous brachiopods occur in the shale (10%).

* *

HOLE NO. 7 (69-3) Norris Lake
4-28-17-IE
Elevation: 860

Cored 454'
Overburden 49'

Depth in Feet

STONEWALL FORMATION

49' - 62' Dolostone, finely crystalline, light yellowish grey, fossiliferous, vuggy, becomes tighter approaching the bottom of the interval.

STONY MOUNTAIN FORMATION

Williams Member

62' - 75' Dolostone, sublithographic, red, argillaceous, arenaceous.

Gunton Member

75' - 110' Dolostone, sublithographic, light grey, slightly mottled, vuggy at the top 10' of the interval becoming tighter near the bottom, fossiliferous at the top 10' to 15', laminar and nodular bedding at the bottom 2/3 of the interval.

Penitentiary and Gunn Members

110' - 190' Dolostone, sublithographic to finely crystalline, red, green and light grey, argillaceous, tubular structures, interbedded calcareous shale, vuggy, fossiliferous, bedding laminar to 3 inches thick.

190' - 200' Dolomitic limestone, light grey, green and red, argillaceous tubular structures, limestone brachiopod biomicrite, brachiopods are randomly oriented.

RED RIVER FORMATION

Fort Garry Member

200' - 203' Limestone, micrite, light grey, tight.

203' - 215' Dolostone, sublithographic, light grey, tight.

215' - 221' Dolostone, finely crystalline, light grey, cherty, fossiliferous.

221' - 238' Dolomitic limestone, light grey and reddish brown, vuggy, fossiliferous, cherty, dolomite is finely crystalline.

238' - 310' Dolostone, sublithographic to lithographic, light grey with minor red interbeds, laminar bedded and massive non-bedded.

310' - 335' Limestone, micritic, tight, light grey, slightly mottled.

Selkirk Member

335' - 473' Dolomitic limestone, light grey (limestone) and buff brown (dolomite), dolomite is finely crystalline, dolomite percentage range 30% - 40%, limestone is brachiopod crinoid stem biomicrite, tubular structures, dolomite radiates out from tubular structures and along bedding planes, minor amount of interbedded brachiopod biosparite.

Cat Head Member

473' - 503' Calcitic dolostone, light grey and buff brown, dolomite (buff brown) is finely crystalline, limestone (light grey) is brachiopod crinoid stem biomicrite, same as above interval except dolomite mottling has increased to over 50%.

* *

HOLE NO. 8 (M-4-69) Building Products and Lime Co.
Inwood Quarry
NE 4-11-18-IW
Estimated Elevation: 890 Cored 129'

Depth in Feet

BRANDON FORMATION

Lower Member

0' - 6'11" Dolostone, sublithographic, light grey, vuggy, fossiliferous, laminar bedded.

STRATHCLAIR FORMATION

6'11" - 9"	Deep red clay
9' - 15'	Dolostone, sublithographic, buff brown and lighter brown, mottled intraclastic breccia and laminar beds, slight vuggy porosity.
15' - 20'8"	Dolostone, light grey, intraclastic, oolitic, fossiliferous, interoolitic porosity.
20'8" - 25'6"	Dolostone, finely crystalline, yellowish grey, fossiliferous.
25'6" - 31'	Dolostone, sublithographic, brownish grey, fossiliferous favosites.
31' - 39'3"	Dolostone, lithographic, light grey, lighter colored 1mm "blebs" of dolomite throughout the rock.
39'3" - 42'11"	Dolostone, finely to medium crystalline, light grey, porous.
42'11" - 47'	Dolostone, sublithographic, light grey, tight, thin bedded ($\frac{1}{4}$").
47' - 54'8"	Dolostone, finely to medium crystalline, light grey, vuggy.
54'8" - 64'2"	Dolostone, sublithographic to finely crystalline, light grey, thin bedded (1 - 2"), fossiliferous.
64'2" - 69'2"	Dolostone, lithographic, light yellowish grey, intraclastic and fossiliferous.
69'2" - 85'2"	Dolostone, finely crystalline, light yellowish grey, tabulate corals and brachiopods, vuggy.

STONEWALL FORMATION

85' - 90'2"	Dolostone, lithographic to sublithographic, red, argillaceous, dolomite "blebs", laminar bedding.
90' - 101'	Dolostone, sublithographic to lithographic, light grey.
101' - 106'	Dolostone, finely crystalline, argillaceous, arenaceous, light grey, red quartz sand grains well rounded, floating in a dolomite matrix, dolomite breccia beds.
106' - 116'	Dolostone, finely crystalline, light yellowish grey, vuggy, fossiliferous.

STONY MOUNTAIN FORMATION

Williams Member

116' - 120'	Dolostone, sublithographic, argillaceous, arenaceous, maroon, laminar bedded.

Gunton Member

120' - 129'2"	Dolostone, sublithographic, light grey and grey mottled, vuggy, fossiliferous.

HOLE NO. 9 (M-5-70) Inwood Hole North Shoal Lake
SE 14-18-2W
Elevation: 875 Cored 60'

Depth in Feet

BRANDON FORMATION

Upper Member

0' - 14' Dolostone, interbedded sublithographic and finely crystalline dolostone, light yellowish grey, beds range from laminar to 1 inch in thickness, dolostone breccia found in the bottom five feet of the interval, the breccia clasts were composed of sublithographic dolostone.

Lower Member

14' - 17' Dolostone, sublithographic, purple, argillaceous, dolomite "blebs" present throughout the interval.

17' - 22'5" Dolostone, breccia clasts composed of lithographic dolostone in a finely crystalline dolostone matrix, light yellowish grey, vuggy.

22'5" - 32' Dolostone, lithographic, white, tight.

32' - 38' Dolostone, lithographic, mottled light grey and darker grey, vuggy.

STRATHCLAIR FORMATION

38' - 39' Red clay

39' - 48'8" Dolostone, finely crystalline, light buff brown mottled, laminar bedding, dolomite "blebs", tight with minor porosity.

48'8" - 53' Dolostone, fossiliferous, oolitic, intraclastic, light grey.

53' - 60' Dolostone, finely crystalline to sublithographic, light grey, fossiliferous.

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HOLE NO. 10 (69-1) Oak Point Quarry
4-18-18-4W Cored 500'
Elevation: 825 Logged 452'

Depth in Feet

CEDAR LAKE FORMATION

65' - 73' Dolostone, sublithographic to finely crystalline, light grey, tight, massive.

73' - 106' Dolostone, finely crystalline to sublithographic, light grey, vuggy, fossiliferous (stromatoporoids and tabulate corals).

106' - 132' Dolostone, sublithographic to finely crystalline, light grey, laminar bedded, tight.

132' - 182' Dolostone, medium to finely crystalline, light yellow grey, vuggy, fossil molds, laminar bedded and dolostone breccia, green shaly pockets.

182' - 221' Dolostone, finely crystalline to sublithographic, light grey, bedded laminar.

10' missing core between 204' and 224'

BRANDON FORMATION

Upper Member

221' - 243' Dolostone, sublithographic to lithographic, brown, intraclasts ranging in size from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, angular, laminar bedded, numerous green shaly pockets.

Lower Member

243' - 245' Dolostone, sublithographic, green, argillaceous, arenaceous intraclasts are angular suspended in a matrix of green argillaceous arenaceous dolostone.

11' missing cores from this interval.

245' - 261' Dolostone, sublithographic to lithographic, light grey, laminar beds.

8' missing core from this interval.

STRATHCLAIR FORMATION

261' - 267' Dolostone, sublithographic brownish grey, mottled upper contact marked with red clay, vuggy, fossiliferous.

267' - 300' Dolostone, sublithographic to lithographic, light grey, fossiliferous (brachiopods), intraclasts, dolomite "blebs" throughout interval.

12' missing section around 300'.

300' - 326' Dolostone, sublithographic to lithographic, light grey, tight.

326' - 332' Dolostone, finely crystalline, light yellowish grey brachiopods and horn corals, vuggy.

STONEWALL FORMATION

332' - 333'	Dolostone, sublithographic, red, argillaceous, dolomite "blebs".
333' - 349'	Dolostone, sublithographic to lithographic, light grey, laminar beds, generally tight except for a few fossiliferous beds exhibiting slight vuggy porosity, thickness of beds 2 to 3 inches.
349' - 350'	Dolostone, sublithographic, red argillaceous and arenaceous.
	7' of core missing between 350 and 359'
350' - 359'	Dolostone, sublithographic, grey.
359' - 364'9"	Dolostone, finely crystalline, light yellowish grey, fossiliferous, vuggy, brachiopods and tabulate corals.

STONY MOUNTAIN FORMATION

Williams Member

364'9" - 371'6"	Dolostone, sublithographic to finely crystalline, red argillaceous arenaceous, bedding 1 inch thick to laminar bedding.

Gunton Member

371'6" - 427'	Dolostone, sublithographic, light grey, slightly mottled, upper portion vuggy and fossiliferous, angular intraclasts, bottom portion tight, laminar bedding.

Penitentiary and Gunn Members

427' - 497'	Dolostone, finely crystalline to sublithographic, light green, grey and red, argillaceous, tubular structures (worm burrows) vuggy, fossiliferous, minor shale interbeds at bottom of the interval.

RED RIVER FORMATION

Fort Garry Member

497' - 500'	Dolostone, finely crystalline to sublithographic, light grey, brachiopods, numerous tubular structures adding to the porosity of the rock.

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HOLE NO. II (M-8-69) Lundar North Quarry
3-7-20-4W
Elevation: 860 Cored 181'

Depth in Feet

CEDAR LAKE FORMATION

0' - 13' Dolostone, finely crystalline, light yellowish grey, favosites (30%), intraclasts, no apparent bedding.

13' - 33'5" Dolostone, finely crystalline to sublithographic, light grey, stromatoporoids and tabulate corals, vuggy.

33'5" - 58'5" Dolostone, sublithographic, light grey, tight, laminar bedded.

58'5" - 62'5" Dolostone, sublithographic, light grey, tight, laminar bedded, "blebs" of dolomite.

62'5" - 72'5" Dolostone, sublithographic, light grey, laminar beds, interclasts (dolomite breccia).

72'5" - 76'10" Dolostone, sublithographic to finely crystalline, light grey, bedded.

76'10" - 83' Dolostone, light grey, interbedded sublithographic and medium crystalline dolostone, intraclastic zones being 1 to 3 inches thick.

83' - 91'8" Dolostone, finely crystalline, light grey, crinoid stems (1%).

91'8" - 102' Dolostone, light grey to buff brown, interbedded medium crystalline to sublithographic, thickness of beds from 1 to 3 inches.

102' - 106' Dolostone, finely crystalline, light grey, fossiliferous.

106' - 114' Dolostone, medium to finely crystalline, mottled, light grey and buff brown, fossiliferous, ostracods, corals, brachiopods and crinoid stems, laminar bedded and intraclastic.

114' - 139' Dolostone, finely crystalline to sublithographic, light grey to white, ostracods, brachiopods, and corals, total fossil content (10%), dolomite "blebs" present throughout interval.

BRANDON FORMATION

Upper Member

139' - 140' Clay, red.

140' - 144' Dolostone, sublithographic, light grey and grey mottled, fractured.

144' - 164' Dolostone, sublithographic to lithographic, laminar bedded with interbeds of dolostone breccia, light grey mostly massive containing "blebs" of dolomite.

Lower Member

164' - 168'	Dolostone, light grey green and red, argillaceous and arenaceous, laminar bedded, intraclastic beds.
168' - 181'	Dolostone, sublithographic to lithographic, light grey intraclastic beds, laminar beds, "blebs" of dolomite.

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HOLE NO. 12 (M-6-69) Mulville West Quarry
15-31-22-6W
Elevation: 880 Cored 97'

Depth in Feet

ASHERN FORMATION

0' - 6'10"	Dolostone, finely crystalline, red, argillaceous.
6'10" - 7'8"	Dolostone breccia, clasts 1/4 - 1 inch, composed of light grey sublithographic dolostone suspended in red argillaceous dolostone matrix.

CEDAR LAKE FORMATION

7'8" - 11'6"	Dolostone, sublithographic, light yellowish grey, tight.
11'6" - 17'2"	Dolostone, sublithographic, light yellowish grey, vuggy, intraclastic.
17'2" - 33'	Dolostone, finely crystalline to sublithographic, light yellowish grey, slightly porous and fossiliferous.
33' - 41'	Dolostone, finely crystalline to sublithographic, light yellow grey, vuggy, intraclasts, fossiliferous.
41' - 46'	Dolostone, finely crystalline and lithographic, vuggy, light yellow grey, fossiliferous, corals in growth position, no bedding.
46' - 50'8"	Dolostone, finely crystalline and sublithographic, light yellowish grey, tabulate corals present (10%).
50'8" - 66'9"	Dolostone, sublithographic, light grey, generally tight.
66'9" - 67'10"	Dolostone, powder, light grey.
67'10" - 71'4"	Dolostone, sublithographic, light grey, laminar bedded, green shaly pockets.
71'4" - 85'	Dolostone, lithographic, light grey.
85' - 89'	Dolostone, lithographic, light grey, laminar bedded, green shaly partings.
89' - 95'8"	Dolostone, finely crystalline, light grey, argillaceous, green shaly partings.
95'8" - 96'11"	Dolostone, lithographic, light green, green argillaceous dolostone at upper contact.

HOLE NO. 13 (M-7-69) Mulvihill East Quarry
SW 3-7-23-5W
Elevation: 893 Cored 135'4"

Depth in Feet	CEDAR LAKE FORMATION
0' - 25'	Dolostone, finely crystalline and sublithographic, light yellowish grey, corals (30%), intraclasts present (10%), fossils composed of finely crystalline dolomite in sublithographic dolomite matrix, generally non-bedded.
25' - 39'3"	Dolostone, lithographic, light brownish grey, laminar bedded, green shaly pockets.
39'3" - 42'6"	Dolostone, lithographic to finely crystalline, light grey mottled, upper contact marked with a red shale.
42'6" - 46'	Dolostone, sublithographic, light grey with minor red staining, tight, green shaly pockets.
46' - 48'	Dolostone, sublithographic, light brownish grey, vuggy, laminar bedded.
48' - 53'4"	Dolostone, sublithographic, light grey, tight, dolomite "blebs" present.
53'4" - 58'6"	Dolostone, finely crystalline, red, argillaceous.
58'6" - 65'	Dolostone, finely crystalline to sublithographic, light brownish grey, laminar bedded, vuggy, fossiliferous.
65' - 69'	Dolostone, sublithographic, light grey, slightly mottled, tubular structures.
69' - 95'	Dolostone, finely crystalline to medium crystalline, bedded having a range in thickness from 1 to 3 inches, brachiopods and corals, light grey to white, minor amounts of intraclasts, brachiopods and corals intermixed in beds.
95' - 107'	Dolostone, light grey, finely crystalline, tight, fossiliferous.
107' - 131'	Dolostone, finely crystalline and medium crystalline, light brownish grey, fossiliferous, stromatoporoids present as small mounds 1 to 2 inches high, composed of medium crystalline dolomite suspended in a matrix of finely crystalline dolomite.
131' - 135'4"	Dolostone, finely crystalline, light grey, bedded 1 to 4 inch thick.

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HOLE NO. 14 (69-5)

Pequis
NW 32-26-IW
Elevation: 750

Cored 316'
Overburden 87'

RED RIVER FORMATION

Fort Garry Member

87' - 95' Calcitic dolostone, light and dark grey, mottled, sublithographic, vuggy, pyrite filling the vugs.

95' - 100' Dolomitic limestone, light and dark grey mottled, dolomite, sublithographic, limestone, micrite, tight.

Selkirk Member

100' - 220' Dolomitic limestone, light and dark grey, mottled, brachiopod crinoid biomicrite with minor interbedded biosparite, beds of intrasparite, dolomite radiating out from tubular structures, dolomite finely crystalline, dolomite percentage from 20% - 40%.

Cat Head Member

220' - 250' Interbedded sublithographic to finely crystalline dolostone, and brachiopod biomicrite, dolomite percentage from 40% to 50%, beds are 4 inches to 1 foot thick, tubular structures numerous white chert nodules.

Dog Head Member

250' - 373' Dolomitic limestone, mottled light grey (limestone) and buff brown (dolomite), dolomite percentage 10% to 45%, averaging 30%, tight, white chert nodules, stylolites, bottom interbeds of shale 1 inch thick and the rock is more argillaceous (15% - 24%).

WINNIPEG FORMATION

373' - 377'6" Shale, green, tight.

377'6" - 384' Shale, arenaceous, oolitic, buff brown.

384' - 387' Shale, arenaceous, green.

387' - 403' Shale, green, arenaceous, sand occurs as small lenses and interbeds being 1/2 inch thick, and pitted frosted, green, very fine to fine grained.

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HOLE NO. 15 (69-6) Pequis
NE 14-28-IW
Elevation: 750 (estimated)
Cored 103'
Overburden 47'

Depth in Feet

RED RIVER FORMATION

Selkirk Member

47' - 150' Dolomitic limestone, light grey and buff brown, mottled, limestone biomicrite and intramicrite with a minor amount of bio- and intrasparite, vuggy, laminar bedded.

* *

HOLE NO. 16 (69-7) Pequis
NE 28-28-IW
Elevation: 745
Cored 262'
Overburden 26'

Depth in Feet

RED RIVER FORMATION

Fort Garry Member

26' - 39' Dolostone, light and dark grey, mottled, sublithographic, tight.

39' - 47' Dolomitic limestone, light grey, dolomite finely crystalline to sublithographic, percentage of dolomite decreases going down in the interval, slight vuggy porosity.

Selkirk Member

47' - 141' Dolomitic limestone, light grey and buff brown also slight red hematite staining around the rims of tubular structures, mottled, limestone brachiopod crinoid stem biomicrite, dolomite finely crystalline, dolomite percentage between 30% and 50%, cherty, vuggy.

Cat Head Member

141' - 150' Dolostone, finely crystalline, light brown, tight.

150' - 160' Calcitic dolostone, light grey and buff brown, mottled, cherty.

160' - 202' Interbedded light grey biomicrite and finely crystalline dolostone, thickness range of beds is 1/2 to 1-1/2 inches, cherty.

Dog Head Member

202' - 288' Dolomitic limestone, light grey and buff brown, limestone is brachiopod biomicrite and laminar bedded micrite, dolomite is finely crystalline radiating out from tubular structures, cherty, dolomite content 10% - 30%.

HOLE NO. 17 (LSM-13) Lake St. Martin
NE¼ 24-30-10W
Elevation: 820

Cored 214'
Overburden 22'

Depth in Feet

CEDAR LAKE FORMATION

22' - 52' Dolostone, finely crystalline, light grey, fossiliferous, slightly vuggy.

52' - 62' Dolostone, sublithographic, light grey, laminar bedded, tight.

BRANDON FORMATION

Upper Member

62' - 63' Dolostone, sublithogrphic, red, argillaceous, tight.

63' - 86' Dolostone, sublithographic to lithographic, light grey, tight, laminar bedded.

Lower Member

86' - 87' Dolostone, sublithographic, green, argillaceous, tight.

87' - 120' Dolostone, finely crystalline to sublithographic, light grey, laminar bedded.

STRATHCLAIR FORMATION

120' - 190' Dolostone, finely crystalline to sublithographic, light grey, laminar bedded, tight except at 180' where it is vuggy and fossiliferous.

STONEWALL FORMATION

190' - 191' Dolostone, sublithographic, green, argillaceous.

191' - 208' Dolostone, interbedded sublithographic and finely crystalline dolostone, thickness of bedding is 1 to 6 inches.

208' - 209' Dolostone, finely crystalline, light grey, arenaceous, medium grained quartz sand floating in the dolostone matrix.

209' - 216' Dolostone, finely crystalline, light grey, white.

STONY MOUNTAIN FORMATION

Williams Member

216' - 224' Dolostone, sublithographic, light greenish grey, argillaceous, tight.

Gunton Member

224' - 236' Dolostone, sublithographic, light grey, slightly mottled, tight.

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HOLE NO. 18 (LSM-11) Lake St. Martin
SE¼ 2-35-7W
Elevation: +795

Cored 484'
Overburden 21'

Depth in Feet

STRATHCLAIR FORMATION

21' - 33' Dolostone, finely crystalline, light yellowish grey, vuggy, brachiopods and tabulate corals.

STONEWALL FORMATION

33' - 58' Dolostone, sublithographic to lithographic, light grey, tight.

STONY MOUNTAIN FORMATION

Gunton Member

58' - 111' Dolostone, sublithographic to lithographic, light grey, and dark grey, mottled, vuggy and fossiliferous in upper 15' of interval becoming dense and having laminar bedding and green shaly pockets in the remainder of the interval.

Penitentiary and Gunn Members

111' - 176' Dolostone, finely crystalline to sublithographic, light grey to buff brown with light blue color lining tubular structures, slightly mottled, argillaceous, fossiliferous, tight.

RED RIVER FORMATION

Fort Garry Member

176' - 189' Dolostone, sublithographic, light grey to buff brown, cherty, tight, except one zone which has long tubular pores around 178'.

189' - 206' Dolostone, sublithographic to lithographic, grey, completely brecciated, matrix is composed of sparry calcite.

206' - 270' Dolostone, sublithographic to lithographic, light grey to light brown, slightly mottled, tight, laminar bedded, interbeds of dolostone breccia.

Selkirk Member

270' - 332' Limestone, interbedded biomicrite, intramicrite biosparite and laminar bedded micrite, light grey and brown, bedding ranges in thickness from 1/2 inch in the micrite to 2 inch in the biosparite.

Cat Head Member

332' - 399' Dolomitic limestone, interbedded light brown finely crystalline dolostone with light grey micrite, beds 1/4 to 4 inches thick, numerous white chert nodules, tight, dolomite 20% - 30% of the rock.

Dog Head Member

399' - 493' Dolomitic limestone, mottled light grey and buff brown, dolomite finely crystalline 10% - 20% of the rock, limestone brachiopod, crinoid stem biomicrite.

WINNIPEG FORMATION

493' - 505' Shale, red and green, arenaceous, quartz sand occurring in 1/4 inch long lenses and as disseminated grains, pitted and frosted and medium grained, percentage of sand 25% - 70%.

APPENDIX II

INSOLUBLE RESIDUE STUDY

TABLE 4

INSOLUBLE RESIDUE STUDY OF THE DOGHEAD MEMBER

PETERSFIELD

Location 69-4
16-36-15-3E

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
226	10.5	grey clay
236	15.5	grey clay
246	7.0	grey clay
256	10.0	grey clay
266	10.0	grey clay
276	10.3	grey brown clay
287	14.0	grey clay
297	13.0	grey clay and chalk with chert (1%)
307	23.5	grey clay
317	16.0	grey clay
327	19.0	grey clay

GARSON QUARRY

Location M-3-69
C-15-3-13-6E

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
87	6.5	grey clay
96'7"	4.3	grey clay and 5% white chert
106	6.9	grey clay and 5% white chert
115	5.8	grey clay and 5% white chert
138	10.5	grey clay and 5% white chert
149	4.3	grey clay and 5% white chert
158	4.0	grey clay and 5% white chert
167	24.8	grey clay

TABLE 5

RESIDUE STUDY OF THE CATHEAD MEMBER

LAKE ST. MARTIN

Location LSM-11
SE¼ 2-35-7W
Elev. = +795

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
340	5.8	grey clay and 30% quartz silt
350	9.5	light grey clay
361	13.2	light grey clay
371	11.2	light grey clay
381	12.0	light grey clay
391	12.2	light grey clay

NOTE: Because of the method of taking samples, chert nodules were not noted.

TABLE 6

RESIDUE STUDY OF THE SELKIRK MEMBER

NORRIS LAKE

Location 69-3
4-28-17-IE

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
341	5.7	grey clay and 20% quartz silt
351	4.2	grey clay
361	7.2	grey clay
371	2.6	grey clay and 10% quartz silt
381	1.9	grey clayand 30% quartz silt
390	4.3	grey clay and 20% quartz silt
401	2.6	grey clay and 10% quartz silt
411	3.3	grey clay and 20% quartz silt
421	3.6	brown grey clay and 10% quartz silt
431	3.1	grey clay
445	3.0	grey clay and 5% quartz silt
455	3.1	g rey clay and 10% quartz silt
465	6.3	grey clay and 10% quartz silt

LAKE ST. MARTIN

Location LSM-11
SE¼ 2-35-7W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
280	4.6	grey clay and 10% quartz silt
291	5.2	grey clay and 20% quartz silt
300	2.0	grey clay
310	2.0	grey clay
321	2.9	grey clay
330	4.0	grey clay and 20% quartz silt

TABLE 7

RESIDUE STUDY OF THE FORT GARRY MEMBER

NORRIS LAKE

Location 69-3
4-28-17-IE

DEPTH	RESIDUE PERCENT	RESIDUE DESCRIPTION
200	3.2	grey clay
210	3.4	dark brown clay
220	2.8	dark brown clay
230	1.3	brown clay
240	3.1	brown clay
250	2.3	brown clay
260	6.0	light grey clay
270	12.8	light grey clay
280	9.2	light grey clay
290	6.1	light brown clay
300	5.3	light brown clay
310	9.0	light brown clay
330	1.3	light grey clay

LAKE ST. MARTIN

Location LSM-11
SE¼ 2-35-7W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
164	14.2	light grey clay
174	2.8	light brown clay
184	4.0	light brown clay
194	2.0	light brown clay
204	13.7	light brown clay
215	11.4	grey clay
225	22.4	grey clay
235	7.4	light grey clay
245	9.0	light grey clay
255	8.4	grey clay
265	5.5	grey clay
275	4.7	light grey clay

TABLE 8

INSOLUBLE RESIDUE STUDY OF THE STONEWALL FORMATION

INWOOD QUARRY

Location M-4-69
NE 4-11-18 IW

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
87	24.4	deep red clay
91	2.5	grey clay
96	3.6	grey clay
101	3.2	grey clay
106	42.0	red clay and 50% sub-rounded quartz grains
111	3.7	brown clay
115	9.0	grey clay

TABLE 9

RESIDUE STUDY OF THE STRATHCLAIR FORMATION

INWOOD QUARRY

Location M-4-69
NE 4-11-18-IW

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
12	5.4	grey clay and white specks (iaolinite)
17	2.4	brown clay
22	2.0	brown clay
28	6.7	brown clay
33	7.5	grey clay
38	4.6	brown clay
43	4.4	brown clay
48	5.9	brown clay
53	3.4	brown clay
58	2.0	light grey clay
63	10.0	brown clay
68	2.6	brown clay
73	3.3	brown clay
78	3.8	brown clay
86	10.5	grey clay

TABLE 10

RESIDUE STUDY OF THE LOWER BRANDON FORMATION

LUNDAR NORTH QUARRY

Location M-8-69
3-7-20-4W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
164	22.0	light reddish brown clay
169	2.3	grey clay
174	3.5	light brown clay
179	3.8	light brown clay
181	10.0	light grey clay

INWOOD WEST

Location M-5-70
SE 14-18-2W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
14	28.0	yellowish brown clay
19	4.4	light grey clay
24	2.4	light grey clay
29	1.7	light grey clay
35	3.4	brown clay
38	5.2	light grey and green

TABLE 11

RESIDUE STUDY OF THE UPPER BRANDON FORMATION

LUNDAR NORTH QUARRY

Location M-8-69
3-7-20-4W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
139	65.0	70% red clay and 30% grey clay
143	2.8	grey clay
148	2.6	brownish grey clay
153	3.7	brownish grey clay
158	2.9	brown clay

TABLE 12

INSOLUBLE RESIDUE STUDY OF THE CEDAR LAKE FORMATION

LUNDAY NORTH QUARRY

Location M-8-69
3-7-20-4W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
0	5.1	grey clay
5	3.9	light grey clay
10	3.6	light grey clay
15	3.7	light grey clay
20	3.3	dark brown clay
25	2.2	light brown clay
30	3.4	dark grey clay
35	2.9	light brown clay
40	5.3	light brown clay
45	3.8	light brown clay
50	3.9	light brown clay
55	4.7	light brown clay
60	11.0	light grey clay
65	2.7	light brown clay
70	3.0	light brown clay
75	2.5	light brown clay
80	3.4	brown clay
85	5.3	brown clay
90	3.3	brown clay
95	2.7	light brown clay
100	5.1	light brown clay
105	3.1	light brown clay
110	3.7	light brown clay
115	3.6	light brown clay
120	8.5	light grey clay
125	4.5	light brown clay
130	6.3	light brown clay
134	7.4	light grey clay

OAK POINT

Location 69-1
4-18-18-4W

DEPTH IN FEET	RESIDUE PERCENT	RESIDUE DESCRIPTION
56	25.4	deep red clay
60	5.9	light grey clay
65	5.8	light grey clay and quartz silt
70	3.0	grey clay
75	4.5	light brown clay

SOUTH

DEVONIAN

ELK PT. GROUP

ASHERN FM.

SILURIAN

INTERLAKE GROUP

CEDAR LAKE FORMATION

BRANDON FM.

STRATHCLAIR FORMATION

V-HORIZON

U_2-HORIZON

U-HORIZON

ORDOVICIAN

RED ROCK CREEK FORMATION

STONEWALL FM.

T-HORIZON

DATUM : TOP WILLIAMS MEMBER

STONY MTN. FORMATION

WILLIAMS MBR.

GUNTON MBR.

PENITENTIARY MBR.

GUNN MEMBER

FORT GARRY MEMBER

Q-HORIZON

P-HORIZON

SELKIRK

1
M-3-69
15-3-13-6E

2
M-1-70
10-27-13-3E
Elev. 770

2A

3
M-2-69
2-14-13-2E
Elev. 810

3A

4
M-1-69
13-30-13-2E
Elev. 825

WILL

GUNT

PENIT

GUNN MEM

FORT GARRY MEMBER

SELKIRK

10
69-1
4-18-18-4W
Elev. 825

11
M-8-69
3-7-20-4W
Elev. 860

5
69-2
16-2-15-1W
Elev. 870

8
M-4-69
NE 4-11-18-1W
Elev. 890

8A

9
M-5-70
SE 14-18-2W
Elev. 875

7
69-3
4-28-17-1E
Elev. 860

6
69-4
16-36-15-3E
Elev. 755

4
-69
0-13-2E
825

4A

WILLIAMS MEMBER

GUNTON MEMBER

PENITENTIARY MEMBER

UNN MEMBER

ORT

ARRY

EMBER

ELKIRK

?

?

GUNTON M

PENITENTIAR

FORT GARR

SELKIRK ME

11
M-8-69
3-7-20-4W
Elev. 860

11 A

12
M-6-69
15-31-22-6W
Elev. 880

13
M-7-69
SW 3-7-23-5W
Elev. 893

ASHERN FORMATION

CEDAR LAKE FORMATION

17
LSM-13
NE 1/4-24-30-10W
Elev. 820

CE

V - HORIZON

U_2 - HORIZON

BRANDON FORMATION

18
LSM-11
SE 1/4-2-35-7W
Elev. 795

—BRAN

U - HORIZON

?

?

STRATHCLAIR FORMATION

S

F

T - HORIZON

STONEWALL FORMATION

ST

WILLIAMS MEMBER

GUNTON MEMBER

14
69-5
NE 32-26-1W
Elev. 750

PENITENTIARY MEMBER

15
69-6
NE 14-28-1W
Elev. 750

16
69-7
NE 28-28-1W
Elev. 745

PI

FORT GARRY MEMBER

SELKIRK MEMBER

NORTH

COMPOSITE SECTION

SPEARHILL

17
LSM-13
NE1/4-24-30-10W
Elev. 820

CEDAR LAKE FM.

V

18 —BRANDON FM.— U2

? LSM-11 SE1/4-2-35-7W Elev. 795 — U

STRATHCLAIR FORMATION

STONEWALL FM. — T

WILLIAMS MBR.

GUNTON MBR.

PENITENTIARY MBR.

GUNN MBR.

FORT GARRY MEMBER — Q / P

SELKIRK MEMBER

BROAD VALLEY SE1/4-22-23-2W

FISHER BRANCH E1/2-7-26-3W

POPLAR FIELD 3-13-22-2W

SANDRIDGE 14-28-18-1W

GUNTON QUARRY SE1/4-28-15-2E

FISHER BRANCH S1/2-19-24-1E PM

ORDOVICIAN

BIGHORN GROUP

RED RIVER FORMATION

MEMBER

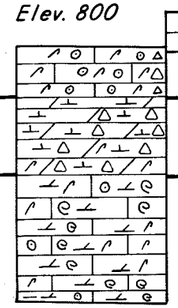
SELKIRK MEMBER

CAT HEAD MEMBER

DOG HEAD MEMBER

WINNIPEG FORMATION

1
M-3-69
15-3-13-6E
Elev. 800



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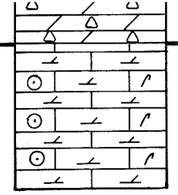


SELKIRK MEMBER

CAT HEAD

DOG HEA

WINNIPEG

EMBER

LKIRK

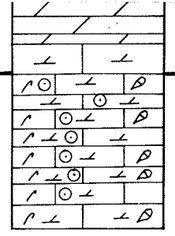
EMBER

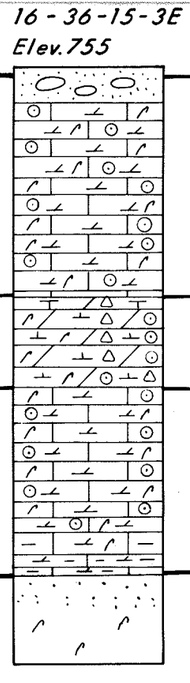
AT HEAD MEMBER

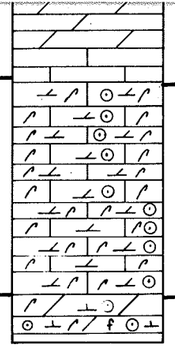
OG HEAD MEMBER

VINNIPEG FORMATION

16 - 36 - 15 - 3E
Elev. 755







SELKIRK ME

CAT HEAD M

DOG HEAD

QUARRY SECTIONS AT DRILLING LOCATIONS

1A GARSON QUARRY (Baillie, 1952)
2A MULDER BROS QUARRY (McCabe et al, 1970)
3A CITY OF WINNIPEG QUARRY (Baillie, 1952)
4A NORTHWEST QUARRY at STONEWALL (Baillie, 19
8A INWOOD QUARRY (Baillie, 1951)
11A LUNDAR NORTH QUARRY (Baillie, 1951)

LOCATIONS FROM BAILLIE, 1951 & 1952

GRINDSTONE POINT (Baillie, 1952)
PUNK ISLAND (Baillie, 1952)
DEER ISLAND (Baillie, 1952)
BLACK BEAR ISLAND (Baillie, 1952)
CAT HEAD (Baillie, 1952)
GUNTON QUARRY (Baillie, 1952)
FISHER BRANCH (Baillie, 1952)
FISHER BRANCH (Baillie, 1951)
BROAD VALLEY (Baillie, 1951)
POPLAR FIELD (Baillie, 1951)
SANDRIDGE (Baillie, 1951)
SPEARHILL (Baillie, 1951)

SELKIRK MEMBER

CAT HEAD MEMBER

DOG HEAD MEMBER

LEGEND

Overburden

Dolostone

Arenaceous Argillaceous Dolostone

Argillaceous Dolostone

Calcitic Dolomite

Limestone

Dolomitic Limestone

Argillaceous Limestone

Arenaceous Shale

v Vuggy

Brachiopods

Crinoid Stems

Chert

f Fossiliferous

Coral

i Intraclastics

Cephalopods

Blebs

S Stromatoporoids

Breccia

o Oolites

400
300
200
100
0 Feet

VERTICAL SCALE

RRY SECTIONS AT DRILLING LOCATIONS

A GARSON QUARRY (Baillie, 1952)
A MULDER BROS QUARRY (McCabe et al, 1970)
A CITY OF WINNIPEG QUARRY (Baillie, 1952)
A NORTHWEST QUARRY at STONEWALL (Baillie, 1952)
A INWOOD QUARRY (Baillie, 1951)
A LUNDAR NORTH QUARRY (Baillie, 1951)

TIONS FROM BAILLIE, 1951 & 1952

GRINDSTONE POINT (Baillie, 1952)
PUNK ISLAND (Baillie, 1952)
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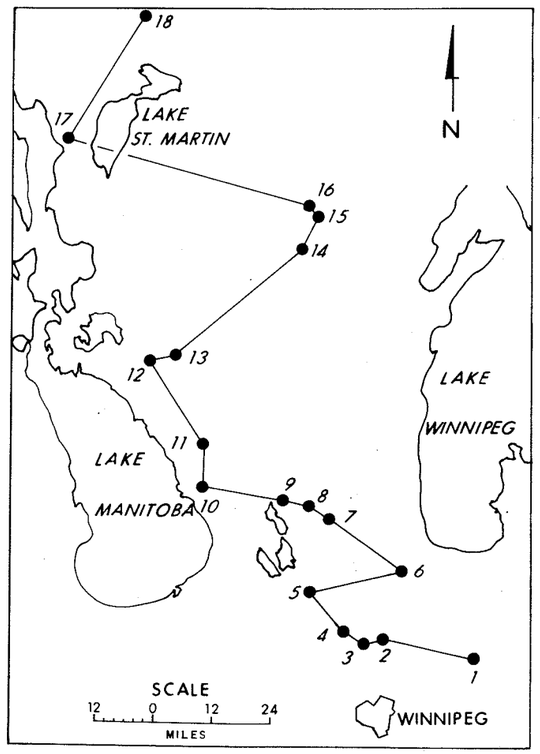
CAT HEAD (Baillie, 1952)
GUNTON QUARRY (Baillie, 1952)
FISHER BRANCH (Baillie, 1952)
FISHER BRANCH (Baillie, 1951)
BROAD VALLEY (Baillie, 1951)
POPLAR FIELD (Baillie, 1951)
SANDRIDGE (Baillie, 1951)
SPEARHILL (Baillie, 1951)

INDEX MAP



CORE HOLE NO.

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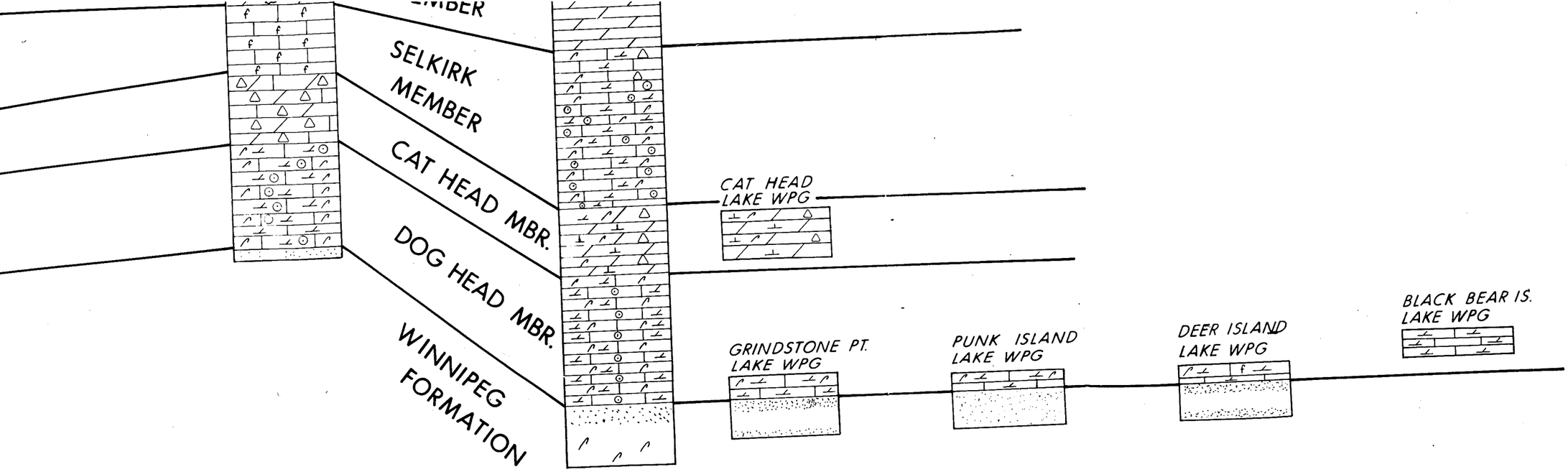

CORE HOLE NO.	NAME
1.	(M-3-69) GARSON QUARRY
2.	(M-1-70) MULDER BROS. MOWATT FARM QUARRY
3.	(M-2-69) CITY OF WINNIPEG QUARRY, STONY MTN.
4.	(M-1-69) SOUTHEAST QUARRY AT STONEWALL
5.	(69-2) WOODROYD COREHOLE
6.	(69-4) PETERSFIELD
7.	(69-3) NORRIS LAKE
8.	(M-4-69) INWOOD QUARRY
9	(M-5-70) INWOOD WEST
10	(69-1) OAK POINT QUARRY
11.	(M-8-69) LUNDAR NORTH QUARRY
12.	(M-6-9) MULVIHILL WEST QUARRY
13.	(M-7-69) MULVIHILL EAST QUARRY
14.	(69-5) PEQUIS
15.	(69-6) PEQUIS
16.	(69-7) PEQUIS
17.	(LSM-13) LAKE ST. MARTIN
18.	(LSM-11) LAKE ST. MARTIN

UNIVERSITY OF MANITOBA
DEPARTMENT OF EARTH SCIENCES

FIGURE 2

ORDOVICIAN AND SILURIAN STRATIGRAPHIC CROSS-SECTION

INTERLAKE AREA, MANITOBA

DATE : AUG 23, 1977

AUTHOR : J.R. COWAN