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P. G. KILLEEN
GEOPHYSICS

**ORDOVICIAN STRATA OF
THE HUDSON BAY LOWLANDS**

L.M. CUMMING

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ABSTRACT

Ordovician strata outcrop in two belts, each with different facies, along the southwestern and southeastern sides of the Hudson Platform.

Limestone and minor sandstone form a continuous belt, 840 miles long, extending from North Knife River, Manitoba to the Kenogami River, Ontario. The belt is from 10 to 40 miles wide and is truncated in the south by a major fault scarp. This remarkably uniform belt of Ordovician rocks represents the southwestern and western margins of the Hudson Bay and Moose River Basins respectively and includes the Bad Cache Rapids Group, the Churchill River Group and the Red Head Rapids Formation. The thickness of the strata varies, from southwest to northeast, from a few feet at the wedge-edge to over 600 feet in the subsurface. The average thickness of the composite Ordovician section in the northern part of the outcrop belt is about 300 feet.

Arkosic sandstone, calcareous sandstone, and shale comprise a smaller Ordovician outcrop belt, 30 miles long, near the southeastern extremity of the Hudson Bay Lowlands in Quebec. Toward central Moose River Basin these strata grade into dolomite, 300 feet thick.

In the Moose River Basin and along the southwestern edge of the Hudson Bay Basin, Archean crystalline rocks form the basement and the nonconformably overlying Ordovician strata are the oldest Paleozoic rocks.

RESUME

Des strates de l'Ordovicien affleurent dans deux zones, à faciès différents, le long des côtés sud-ouest et sud-est la plateforme d'Hudson.

Une zone continue de 840 milles de long, formée de calcaire et de grès accessoire, s'étend de la rivière North Knife au Manitoba, à la rivière Kenogami en Ontario. Cette zone est large de 10 à 40 milles et est tronquée au sud par un escarpement de faille important. Cette zone remarquablement uniforme de roches de l'Ordovicien représente les zones sud-ouest et ouest des bassins de la baie d'Hudson et de la rivière Moose respectivement et comprend le groupe de Bad Cache Rapids, le groupe de Churchill River et la formation de Red Head Rapids. La puissance des strates varie, du sud-ouest au nord-est, de quelques pieds au bord de l'escarpement à plus de 600 pieds dans le sous-sol. L'épaisseur moyenne de la section composite de l'Ordovicien, dans la partie nord de la zone d'affleurement, est d'environ 300 pieds.

Le grès feldspathique, le grès calcaire et les schistes argileux forment une plus petite zone d'affleurement de l'Ordovicien, de 30 milles de long, près de l'extrémité sud-est des basses-terres de la baie d'Hudson, au Québec. Vers le centre du bassin de la rivière Moose, ces strates se transforment graduellement en dolomie qui atteint 300 pieds d'épaisseur.

Dans le bassin de la rivière Moose et le long du côté sud-ouest du bassin de la baie d'Hudson, des roches cristallines de l'Archéen reposent à la base et les strates de l'Ordovicien qui les recouvrent en discordance angulaire constituent les roches paléozoïques les plus anciennes.

ORDOVICIAN STRATA OF THE HUDSON BAY LOWLANDS

INTRODUCTION

This report describes in detail the Ordovician strata of the Hudson Bay Lowlands observed during Operation Winisk, an air-supported geological reconnaissance survey of the lowlands embracing an area of about 130,000 square miles. The field component of the Operation was completed in 3½ months during the summer of 1967 (Norris and Sanford, 1968). The report is based on work by the writer, other members of Operation Winisk and previous workers.

Preliminary results of the survey are shown on Geological Survey of Canada Map 17-1967 (scale 1:1,000,000). The information on this preliminary map was incorporated into the new geological map of Canada (Map 1250A - scale 1:5,000,000, 1969). These maps show a major change in the distribution of Ordovician strata in the Hudson Bay Lowlands and, for the first time, portray the continuous belt of Ordovician strata that extends the entire length of the west side of the Hudson Bay Lowlands. Previously these strata were presumed to be missing or overlapped by Silurian strata in northern Ontario.

Outcrop areas of Ordovician strata as studied, sampled, and mapped during Operation Winisk extend for 840 miles, from North Knife River, Manitoba to Kenogami River, Ontario. In addition, Ordovician strata extend for approximately 15 miles, both east and west, of the Harricanaw River, Quebec.

Previous work

The most extensive and useful of the previous studies of Ordovician strata of Hudson Bay Lowlands were those of S.J. Nelson (1953, 1963, 1964). Also, the recent summary of geology of the Hudson Bay Region (Nelson and Johnson, 1966) provided valuable background information regarding the stratigraphy of the region.

An amazingly accurate early observation was that of Isbister (1855) who was able to delimit roughly the Paleozoic basin on the west side of Hudson Bay and commented on (ibid. p. 500) "the remarkable symmetry and unbroken condition of its sedimentary deposits, and to what an unusual degree they have apparently been exempted from ... igneous disturbance ...".

Isbister's report was based on traverses across the region for the Hudson's Bay Company.

In 1871, Robert Bell of the Geological Survey of Canada made a micrometer survey of the Albany River and mapped the position of four Ordovician outcrops.

Bell (1880) also briefly described the Ordovician strata on the Churchill and Nelson rivers. On the basis of the few fossils collected by Bell, Whiteaves referred these rocks to the Trenton limestone and considered them the equivalent of the Galena limestone of Wisconsin and Illinois.

Owen O'Sullivan (1908, p. 43-45) was the first to survey Gods River, then called Shamattawa River. He marked the position of several Ordovician outcrops and made two fossil collections. On July 4, 1908 he noted "ice 12 feet in thickness on the river bank" at a locality below Lower Rapids, 20 miles below Shamattawa.

J. B. Tyrrell (1913) traversed Gods River and recorded "... a long exposure of limestone in the form of low cliffs extending for several miles beside the banks of the stream. The limestone is thin-bedded and lies in a horizontal attitude and is usually mottled, very much like that at East Selkirk in Manitoba. The total thickness exposed is about twenty-five or thirty feet".

From this exposure (at and above Lower Rapids), Tyrrell collected fossils which were identified and briefly described by W.A. Parks (in Tyrrell, 1913, p. 189-192), who concluded that these strata were "about the age of the top of the Trenton of Eastern Canada".

Later, Parks (1915) described and illustrated specimens from Tyrrell's collection from the Lower Rapids of Gods River.

McInnes (1914) showed the then known distribution of Ordovician (Trenton) strata on the Churchill, Deer, Nelson and Gods rivers.

F.J. Alcock (1915) examined the lower Churchill River. He briefly described the Churchill (Proterozoic) quartzite and the "Ordovician limestone" overlying it.

Savage and Van Tuyl (1919) during the summer of 1916 made a study of Ordovician sections and collected fossils from exposures on the Nelson and Gods (Shamattawa) rivers. Their general subdivision of the Ordovician System was two-fold (a lower unit about 70 feet thick and an upper unit 75 to 80 feet thick) - as follows (ibid. p. 342): -

Cincinnatian Series

Shamattawa Limestone

Correlated with the Upper Ordovician (Stony Mountain) limestone in the vicinity of Lake Winnipeg; the Fish Haven dolomite of Utah; the Bighorn dolomite of Wyoming, and the upper and middle parts of the Fremont limestone of Colorado. Equivalent in time to some part of the Richmond and Maquoketa of the Ohio and Mississippi Valleys.

Mohawkian Series

Nelson River Limestone

Correlated with the lower Ordovician rocks of the Lake Timiskaming region; the Winnipeg limestone in the vicinity of Lake Winnipeg. About equivalent in time to the Galena limestone of the upper Mississippi Valley and the Trenton limestone of New York and eastern Canada.

Savage and Van Tuyl (1919, p. 349) described Ordovician limestones on the Gods River which occurred "at intervals for a distance of about 15 miles" beginning about 28 miles above the mouth of the river. They assigned all these limestones to the "Shamattawa limestone" and correctly considered them "to be about the age of the Maquoketa or Richmond strata of the Mississippi Valley". They also recognized (ibid. p. 352, Fig. 1) faunal similarities of the "Shamattawa limestone" with Stony Mountain Limestone of southern Manitoba, Bighorn Dolomite of Wyoming and Montoya Limestone of New Mexico.

Savage and Van Tuyl (1919) described the Ordovician beds exposed along Nelson River and recognized a succession of seven units as follows:

	Thickness (feet)
<u>Shamattawa Limestone</u>	
7. Limestone, grey to yellowish brown.	7
6. Limestone, grey, in beds 4" to 14" thick.	28
5. Limestone, grey, grading upward into dolomite.	15
<u>Nelson River Limestone</u>	
4. Limestone, grey, in beds 1" to 2" thick.	15
3. Dolomite and limestone, mottled grey, in layers 12" to 30" thick.	
2. Limestone dolomitic, mottled grey, in thin layers.	12
1. Dolomite, grey to brown, sandy, grading into calcareous sandstone.	18

Martison (1953, p. 18) interpreted the dolomitic limestones, exposed on the upper Albany River near the Precambrian contact, to be of Silurian age

(see Ontario Department of Mines, Geological Map No. 1952-3). He was unaware that fossils collected previously from these beds had been identified as Upper Ordovician (Richmond) age by V.J. Okulitch (written communication to V.K. Prest April 27, 1942). These identifications are as follows:-

Chondrites cuneatus Whiteaves, *Halysites gracilis* (Hall), *Halysites catenularia* Linnaeus, *Calapoecia canadensis* Billings, *Sowerbyella rugoda noquettensis* (Hussey), and *Chasmops sigmo-ocularis* Okulitch.

Similar Ordovician beds within the Province of Quebec were mapped in 1962 by the Quebec Department of Natural Resources on a scale 1 mile to 1 inch by C.J. Durden, Carnegie Museum, Pittsburgh, Pennsylvania, as part of a large helicopter assisted mapping project under the direction of J.H. Remick (Remick, Gillain, and Durden, 1963).

Present work

During May 15 - August 30, 1967, the Geological Survey of Canada conducted an air-supported reconnaissance of the entire Hudson Bay Lowlands. This project "Operation Winisk", named for the community of Winisk, was under the leadership of A. W. Norris. Six base camps were established within the Lowlands (Norris and Sanford, 1968b). Two Bell 47G-4 helicopters were used to transport geologists to upstream set-out points on rivers and streams, from which downstream traverses were made in inflatable rubber boats. These traverses were usually of 3 to 8 days duration. Where water level and outcrop conditions were favourable, helicopters were used during one day traverses from base camp. Major gas caches were assembled at the base camps and subsidiary caches established by de Havilland Otter.

Pleistocene deposits blanket the region and the interfluvial areas are typically muskeg and string bog. Phanerozoic outcrops are almost entirely confined to stream and river valleys. Thus, by traversing the major waterways, most of the outcrop within this 130,000-square-mile region could be studied within a single field season. During Operation Winisk the writer made boat traverses on parts of the Harricanaw, Kattawagami, Birthday (Malouin), Little Current, Drowning, Kenogami, Atikameg, Ekwan, Gods, Nelson, Weir and Churchill rivers; and helicopter traverses were made along parts of the South Knife, Churchill, Gods, Echoing, Swan, Ekwan, Sachigo, Muketei and Albany rivers as well as Herriot Creek. During the course of the summer's work starting at Moosonee and terminating at Churchill, five flights in an Otter aircraft were made. These flights, totalling over 800 miles, were from Moosonee to Albany Forks; Albany Forks to Attawapiskat, Hawley Lake to Shamattawa; Shamattawa to the Precambrian contact on the Nelson River; and Nelson River (at Weir River junction) to Churchill.

Traverses, totalling over 900 miles, were made in a Cessna 180 aircraft during a systematic search for outcrop in the Hudson Bay - James Bay watershed area, southwest from Hawley Lake. In addition, short traverses were made on foot along Joncas, Atikameg and

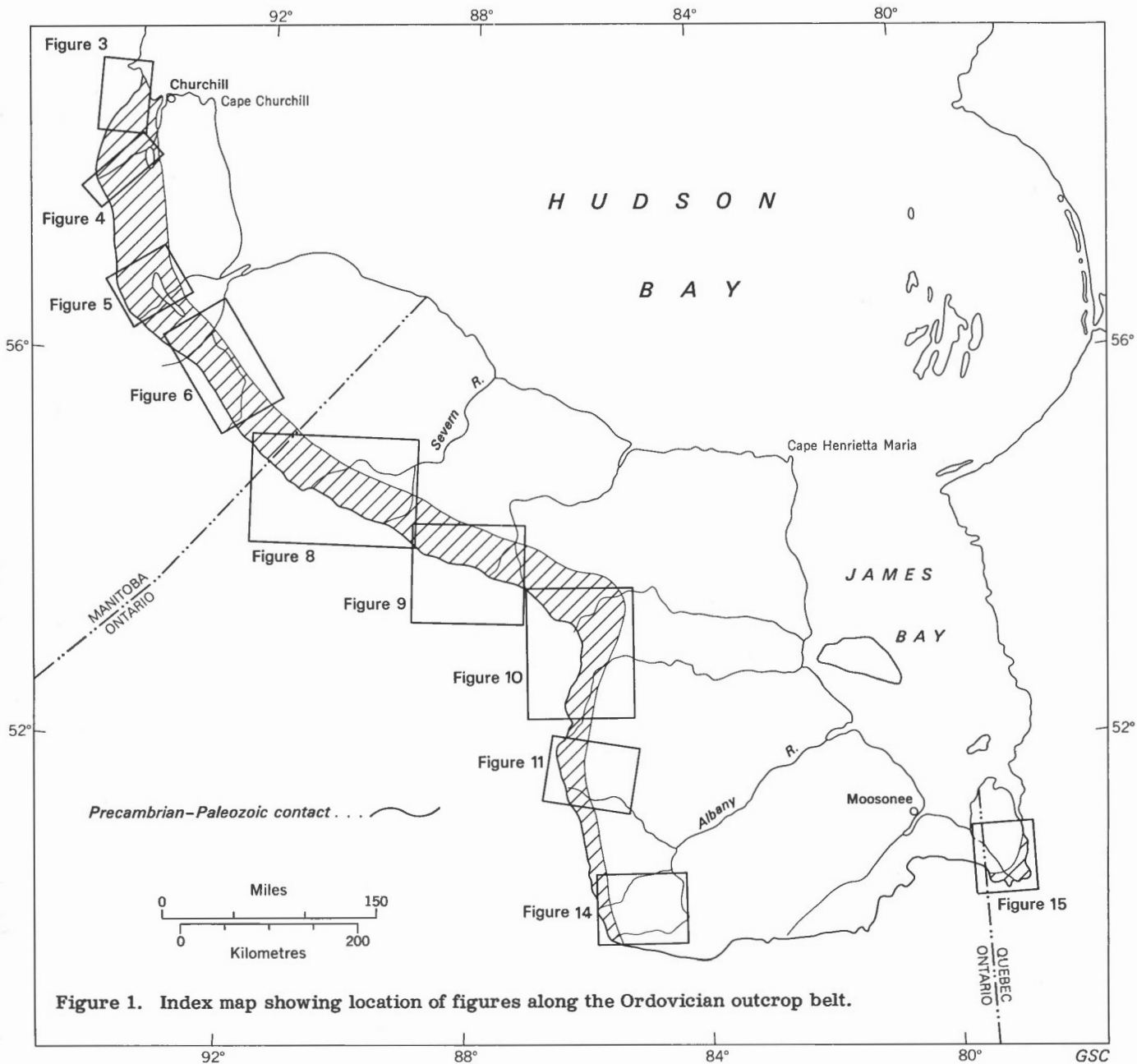


Figure 1. Index map showing location of figures along the Ordovician outcrop belt.

Angling rivers, Fossil Brook and Hidden, Surprise, Caution and Chasm creeks.

Measured sections, lithological samples, fossil collections, material for conodont analysis and photographs were obtained at most of the Ordovician stations. Locations were plotted on airphotos for transfer to 1:250,000 maps. A preliminary compilation of the regional geology has been published (Norris, Sanford and Bostock, 1967) at the scale of 1:500,000.

Acknowledgments

The writer is indebted to all members of Operation Winisk for logistic support that assisted in making field observations. In particular, R. Hillary, M. Wilson and J. Johnson provided excellent field assistance

during boat traverses of Hudson Bay Lowlands rivers.

The following Geological Survey of Canada members of Operation Winisk contributed data regarding Ordovician strata, collected from their own traverses in the following areas: A. W. Norris - Winiskisis Channel and tributaries of Echoing River; B. V. Sanford - North Knife River; B. S. Norford - Little Current River, Asheweig, and Attawpiskat rivers; H. H. Bostock - Thorne River and Fawn River areas. Helicopter traverses were made to Ordovician exposures on South Knife and Herriot Creek jointly with B. V. Sanford. Boat traverses to Ordovician exposures on the Harri-canaw and Nelson rivers were made jointly with B. S. Norford. A 400-mile traverse, in a Cessna 180 aircraft, during a systematic search for outcrop to delimit the Precambrian-Ordovician contact southwest of Hawley

Lake, was made jointly with H. H. Bostock.

Fossil identifications of field collections of Ordovician materials were made by Dr. G.W. Sinclair; and identification of samples collected for conodont analysis were made by Dr. T.T. Uyeno, both of Geological Survey of Canada; Dr. S.J. Nelson, University of Calgary, during a visit to Ottawa in February 1968, examined and provided helpful comments upon the writer's Ordovician fossil collections. Dr. R.H. Flower, New Mexico Institute of Mining and Technology, during a visit to Ottawa in October 1968, kindly identified a number of Ordovician cephalopods. Dr. D.E. Jackson, University of Alberta, kindly identified graptolite specimens. R.B. Elliott and S. Tella assisted in the preparation of maps and the compilation of faunal lists and stratigraphic data.

ORDOVICIAN STRATIGRAPHY

Throughout the Hudson Bay Lowlands strata of Upper Ordovician (Cincinnatian) age are mainly composed of limestone, dolomite, and sandstone. These rocks vary in thickness from 300 feet in the Moose River Basin of Ontario to 600 feet along the Manitoba part of the Hudson Bay Basin. All of these strata represent shallow water marine deposition.

Fine conglomerate, arkose, orthoquartzitic sandstone, and minor shale and some unconsolidated clay represent the initial deposits of the transgressive Ordovician sea in the Hudson Bay Lowlands region and were distributed as a thin veneer over the peneplaned surface of the Precambrian granitic and gneissic basement rocks. These Upper Ordovician detrital beds all appear to be of Edenian age and are succeeded conformably by mottled grey and brown, finely crystalline limestones and dolomitic limestones, also of Edenian age. This group of rocks (both detrital and carbonate units) has been named the Bad Cache Rapids Group by Nelson (1963, 1964) based on his studies in northern Manitoba. The Bad Cache Rapids Group is now recognized to be present throughout the Hudson Bay Basin and also to occur in parts of the Moose River Basin. The Bad Cache Rapids Group is similar in lithology and fossil content to the Red River Formation of Winnipeg and adjacent area of southern Manitoba (see Table I).

A period of broad continental upwarping (Maysvillian) presumably followed the first transgression of the Upper Ordovician seas. During this erosional interval some of the Bad Cache Rapids sediments may have been removed by erosion and redeposited in deeper parts of the existing sedimentary basins.

Yellowish grey and light brown, mottled limestones and dolomitic limestones were deposited during the successive transgressions of the Ordovician sea. These strata, all of which are of Richmondian age, have been named the Churchill River Group by Nelson (1963, 1964) based on studies of outcrops along the margin of the Hudson Bay Basin in northern Manitoba. The Churchill River Group is now recognized to be present throughout the Hudson Bay Basin and to occur in parts of the Moose River Basin. These strata presumably

interfinger and grade into dolomite, gypsum-anhydrite and evaporite deposits of the central parts of both sedimentary basins.

Increasing aridity in late Richmondian time is reflected in the deposition of a thin veneer of light yellow chalky dolomite (Red Head Rapids Formation).

Bad Cache Rapids Group

The Bad Cache Rapids Group rests upon the peneplaned surface of the Precambrian and is disconformably overlain by strata of the Churchill River Group. It is exposed on the North and South Knife, Nelson and Gods rivers, a tributary of the Echoing River, Sachigo River and tributaries, and the Ekwan River.

The lower unit of the Bad Cache Rapids Group is the Portage Chute Formation. The type section is on the south side of Bad Cache Rapids on the Churchill River where it is subdivided into two members in ascending sequence: (1) calcareous quartz sandstone (4 feet); and (2) light grey microcrystalline dolomitic limestone (71 feet). Bioclastic limestone is common and in many places the member has a nodular character.

The overlying Surprise Creek Formation, named after and typically exposed on a tributary of the Churchill River, consists of light yellowish grey, finely crystalline, cherty dolomitic limestone (63.5 feet).

Fossils are fairly numerous particularly in member 2 of the Portage Chute Formation which Nelson (1964) correlated with the Dog Head Member of the Red River Formation. The upper part of the Surprise Creek Formation is for the most part barren of fossils. The lower part of the formation is similar in lithological character to the Cat Head Member and Selkirk Member of the Red River Formation of southern Manitoba as defined by McCabe (1971, Table II, p. 173).

Churchill River Group

The Churchill River Group overlies the Bad Cache Rapids Group, and is in turn succeeded by the Red Head Rapids Formation.

The Churchill River Group is similar in lithology and fossil content to the Stony Mountain Formation of the Winnipeg area, and adjacent areas, of southern Manitoba.

The group outcrops on the South Knife, Herriot, Nelson, and Gods rivers, and possibly on the Ekwan River. A lower unit, the Caution Creek Formation is typically exposed on a tributary of the Churchill River where it consists of three members in ascending sequence: (1) bioclastic, grey to yellowish grey weathering, cryptocrystalline dolomitic limestone (18 feet); (2) grey to brown weathering, light yellowish grey, cryptocrystalline to microcrystalline dolomitic limestone (18 feet); and (3) grey, nodular, earthy weathering, light yellowish grey, microcrystalline dolomitic limestone (6 feet).

Fossils are present in all three members of the Caution Creek Formation, but are most abundant in member 1 which contains a varied fauna of corals,

TABLE I:

Table of formations and correlation chart

Hudson Basin, northern Manitoba, Ontario, Quebec		Outcrop Belt, southern Manitoba		Michigan Basin, Ontario			
Richmondian	Red Head Rapids	Stonewall		Queenston Kagawong			
	B Chasm Creek	Stony Mtn.	Gunton Member				
			Penitentiary Member				
Caution Creek	Gunn Member						
Maysvillian				Meaford - Dundas			
Edenian	A Surprise Creek	Red River	Fort Garry Member	Blue Mountain			
			Selkirk Member	Collingwood			
	Portage Chute		Cat Head Member				
			Dog Head Member				
Barneveld		Winnipeg Formation		TRENTON	Cobourg		
					Verulam		
					Kirkfield		
Wilderness				BLACK RIVER	Coboconk		
					Gull River		
					Shadow Lake		

B = Churchill River Group

A = Bad Cache Rapids Group

brachiopods, gastropods, and cephalopods. The formation is correlated with the Gunn Member, and in part with the Penitentiary Member of the Stony Mountain Formation of southern Manitoba.

The succeeding Chasm Creek Formation is not completely exposed at any one locality along the Churchill River, but consists of four composite members which are apparently conformable. These are in ascending sequence: (1) resistant, massive beds of light yellowish grey to buff, microcrystalline, iron-rich, fucoidal, variably dolomitic limestone (55 feet); (2) beds similar to member 1, but less massive and more rubby (100 feet); (3) beds similar to member 2 except that member

3 contains several 3- to 6-inch beds of grey weathering light grey dolomitic limestone interbedded with fucoidal, dolomitic limestone (15 feet); and (4) thin, uniformly bedded, fucoidal, microcrystalline light yellowish grey, dolomitic limestone, weathering light grey, dolomitic limestone, weathering light grey (20 feet).

Fossils are present in all four members of the Chasm Creek Formation. Member 1 has been correlated with the upper part of the Penitentiary Member and the lower part of the Gunton Member, and members 2 to 4 inclusive have been correlated with the upper part of the Gunton Member of the Stony Mountain Formation of southern Manitoba (Nelson, 1964).

Red Head Rapids Formation

The type section of the Red Head Rapids Formation is on the Churchill River (Nelson, 1963, p. 320), where it consists of two members. The lower member (25 feet thick) is a light yellow microcrystalline dolomite, well bedded, almost platy, in beds 1 inch to 2 inches thick. This unit is barren of megafossils but contains the conodont *Rhipidognathus* sp. indet. The genus *Rhipidognathus* has previously been reported from the Richmond Group of Kentucky and Indiana. This identification and regional correlation was established by T. T. Uyeno.

The upper member is about 20 feet thick, consisting of slightly calcareous, cream-coloured dolomite in beds 1 inch to 1.5 feet thick. Fossils occur rarely e. g., *Calopoecia* and *Kochoceras* (Nelson, 1964, p. 33).

The Red Head Rapids Formation weathers readily and outcrop sections of this soft carbonate unit are rare within the Hudson Bay Lowlands. Unfossiliferous Red Head Rapids Formation is similar in lithology to, and sometimes difficult to distinguish from that of the disconformably overlying Silurian dolomites of the Severn River Formation.

In Quebec, Ordovician strata consist of arkose conglomerate, siltstone, and clay succeeded by sandstone, argillaceous and calcareous sandstone with interbeds of aphanitic dolomite; in turn these are overlain by sandy dolomite, dolomite breccia, and dolomite with minor interbeds of sandstone. All of these relatively unfossiliferous strata probably correlate with the Red Head Rapids Formation.

Subsurface Information

Beds of Ordovician age have been penetrated by diamond-drill holes at Puskwuche Point, and at Moose Factory Hospital in the Moose River Basin. At Puskwuche Point, the Ordovician rests directly upon the Precambrian and includes, in the upper part of the succession, beds of the Red Head Rapids Formation. At Moose Factory Hospital, the entire Silurian sequence is missing due to pre-Devonian uplift and erosion, and the Ordovician sequence is overlain by rocks of Early Devonian age.

Ordovician strata penetrated in the Puskwuche Point well consist (in ascending sequence) of red, brown, and grey, medium-grained feldspathic and quartz sandstone with minor interbeds of shale (105 feet), succeeded by light to dark grey sandy and micaceous, finely crystalline limestone and dolomite containing interbeds of white gypsum (166 feet).

Several diamond-drill holes in the Nelson River area of the Hudson Bay Basin, including Kennco Nos. 1 to 5 and Selco Pennycutaway No. 1, have penetrated the Bad Cache Rapids Group. In each of these wells there is a basal sandstone up to 4.5 feet thick, overlain by fragmental limestone varying in thickness from 48 to 95 feet. The direction of increase in thickness is northeastward into the Hudson Bay Basin.

The Bad Cache Rapids and Churchill River groups have a combined thickness of 347 feet in the Kennco No. 5 well.

The Churchill River Group is composed of cherty limestones and dolomite, bituminous limestone and mottled dolomitic limestone. Some of the beds are crinoidal, and minor brecciated beds are also present. Thickness of this group varies from 70 feet in Kennco No. 1 to 236 feet and 291 feet in Selco Pennycutaway No. 1, and Kennco No. 5 wells respectively. In the Sogepet-Aquitaine Kaskattama Province No. 1 well, the interval between depths 2,190 and 2,293 feet which lies above a *Bighornia* fauna (2,310 feet) and below a *Virgiana* fauna (2,150 to 2,189? feet) is an equivalent of the Red Head Rapids Formation. These interbedded fine-grained limestones and dolomites contain minor amounts of anhydrite and shale (Nelson and Johnson, 1968). As might be expected in an evaporitic assemblage, these 100+ feet of beds are nearly barren of fossils. Norford (1972) correlated them with the Stonewall Formation of southern Manitoba.

DEPOSITIONAL ENVIRONMENT

The carbonate sediments of Ordovician age of the Hudson Bay Lowlands represent deposits accumulated upon a subsiding metastable platform. Conditions of crustal stability were similar to those of the Williston Basin to the southwest. A northern arid climatic zone was common to the two regions (Strakhov, 1967, Fig. 56, p. 231). This arid climatic zone was a broad belt, 3,500 km wide, whose trend was northeast parallel to the Ordovician equator which extended from eastern Cuba to eastern Newfoundland. The centre of this northern arid belt was 3,000 km north of the equator, that is near the centre of Hudson Bay (Fig. 2).

Original sedimentary fabrics preserved in the "lime mud" facies of the Hudson Bay Ordovician strata are analogous to features which characterize low-energy carbonate sedimentation of Recent intratidal, intertidal and supratidal deposits of the Bahama Islands (Roehl, 1967).

Laminated dolomite of the Red Head Rapids Formation reflect increasing aridity in the Late Ordovician. Lack of fauna in this formation suggests deposition on a broad supratidal flat. Extensively burrowed carbonate muds of the Churchill River Group in the Gods River area may reflect the position of a positive structural axis related to a basement high associated with the northern edge of the Superior Structural Province. Mottled limestone-dolomite muds of both the Churchill River and Bad Cache Rapids groups, which contain large orthocerid cephalopods remains, 4 to 5 feet in length, represent a carbonate facies of the intratidal zone.

Ordovician strata of the southeastern corner of the Hudson Bay Lowlands, to the south of James Bay, represent a detrital rim of terrigenous sediments. These mark the original southern limit of the Ordovician marine platform. This belt of terrigenous sediment, well exposed along the Harricanaw River, represents a transitional facies which grades basinward (to the north) into platform evaporites.

This Ordovician terrigenous belt is composed of conglomerate, mature quartz sandstone, and shale.

These rocks pass laterally into carbonaceous mudstones with interbeds of gypsum, towards the centre of the Moose River Basin. The terrigenous belt, in which sandstones are interbedded with carbonates, is located near the southern limit of an Ordovician arid climatic zone (see Fig. 2). This location is near the border of a moist southern Ordovician climatic zone as well as adjacent to an area of uplifted crystalline basement. A clastic sediment source as well as the appropriate rivers and gradients to transport and deposit Ordovician clastic sediments was provided by these environmental factors.

Since these conditions, within the Hudson Bay region, appear to be unique to the 'Quebec Embayment' in Ordovician time, it is presumed that the amount and purity of Ordovician evaporites in the Moose River Basin is less than that which accumulated in the central part of the Hudson Bay Basin. The broad belt of the northern arid climatic zone is reflected in the uniformity of Ordovician carbonate deposition in northern Ontario and Manitoba.

POSSIBILITIES OF LEAD-ZINC SULPHIDE MINERALIZATION

The Hudson Bay Lowlands have been recognized as a potential target area for large massive Pb-Zn deposits by Whitmore and Liberty (1968, p. 556), and Ohle (1970, Fig. II-I, p. 10). Previously, Robert Bell (1880, p. 26) reported a correlation of the Ordovician dolomite on the Nelson River with the "lead-bearing limestone of the Western States or about the horizon of the Utica formation".

A stratigraphic target for Mississippi Valley type of deposits within the Hudson Bay Lowlands is presented by the Ordovician strata near the Precambrian outcrop edge of the west sides of both the Moose River and Hudson Bay basins. These Upper Ordovician strata overlap onto the Precambrian basement and may be analogous to the situation in the Cordillera where the earliest Paleozoic strata provide the host carbonates for Mississippi Valley type Pb-Zn ore deposits. In the Cordillera, however, Cambrian beds are present and are mineralized (Sangster, 1970).

Perhaps the most promising prospecting areas within the Ordovician outcrops belt of the Hudson Bay Lowlands are at the intersections with the east-trending margins of large crustal blocks which subdivide the Superior Structural Province, as for example the north and south boundary of the Berens River Block and God's Lake Block (Wilson, 1971, Fig. 1, p. 41). These fault systems are several hundred miles long and provide dilatant zones for migration of ore fluids. Another promising prospecting target is in the Ordovician strata which overlie the subsurface trend of the boundary between the Superior and Churchill structural provinces. There the facies of the Ordovician strata reflect the occurrence of a possible basement ridge, which marks the southern boundary of the Churchill structural province.

The Ordovician strata are a burrowed - carbonate - mud-facies occurring in the northern part of exposures

of the Churchill River Group, on Gods River. This facies is similar to the burrowed carbonate strata of the lead-zinc district of Missouri (Cumming, 1969b).

OIL AND GAS POSSIBILITIES

The Hudson Bay Lowlands are a portion of an extensive area of Phanerozoic rocks which occupy 365,000 square miles of the Hudson Platform. The ultimate reserves of this vast region may be in the order of 2.27 billion barrels of oil and 13.5 trillion cubic feet of gas (Norris and Sanford, 1968b, p. 11). A more optimistic interpretation of the potential of the region has been presented by Johnson (1971, p. 52).

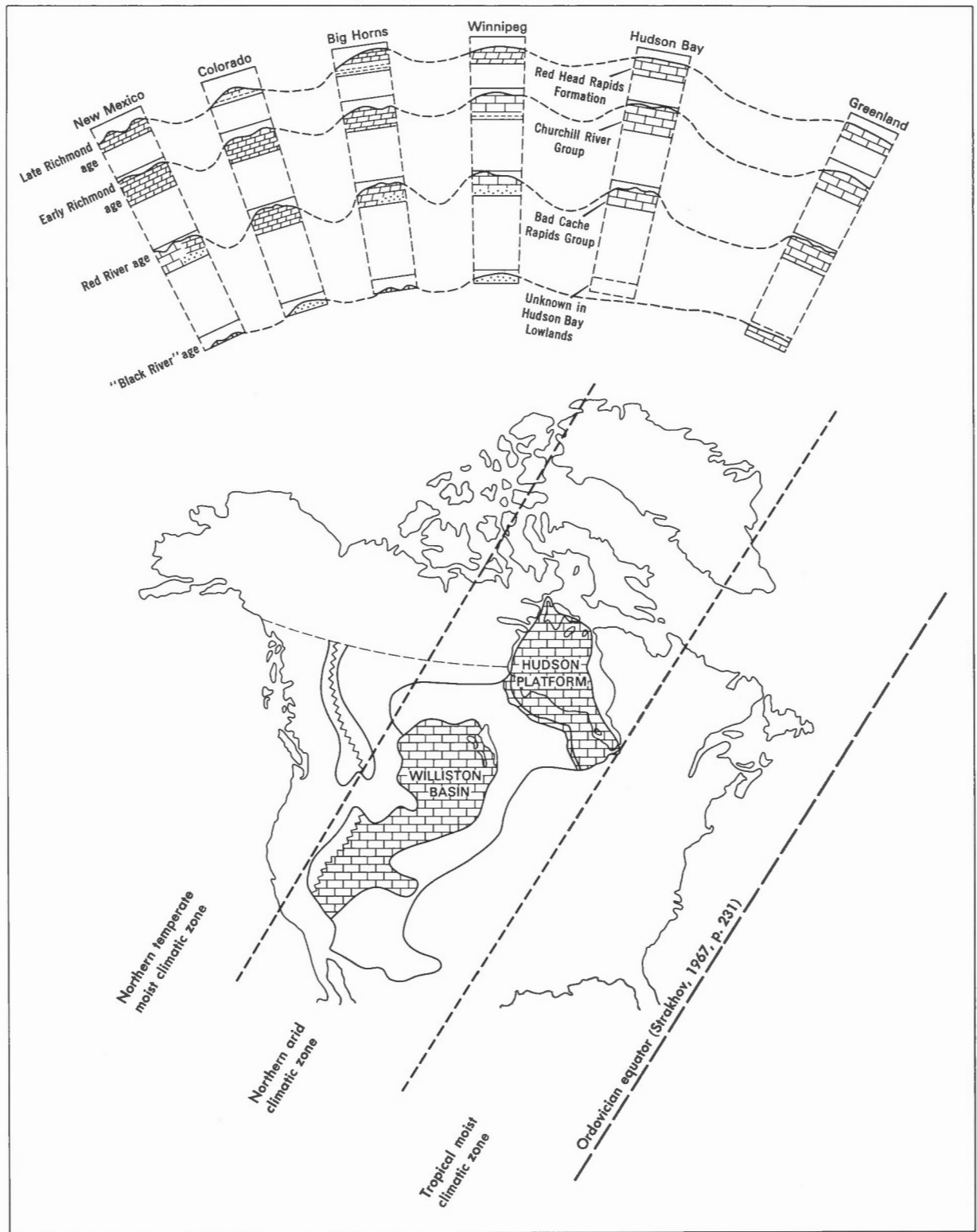
"Calculations of hydrocarbon potential for the Hudson Bay Basin are often grouped with the James Bay '(Moose River)' Basin. The best known of these figures are published by the Canadian Petroleum Association which calculates a Potential Crude reserve of about 2.9 billion barrels and 17.4 trillion cubic feet of gas for the combined region.

"The reserves for the Hudson Bay region have been separately calculated for this paper. These figures take into account the lithology, the probable thickness of section, and the favourable structural conditions. A recovery factor of 40,000 barrels per cubic mile is used. With these considerations, a conservative estimate of the reserves of the Hudson Bay Basin and its sub-basin Evans Strait is at least eight billion barrels of oil and 50 trillion cubic feet of gas. James Bay '(Moose River)' Basin represents an additional one billion barrels of oil and five trillion cubic feet of gas. The whole Hudson Bay region is conservatively estimated to contain over nine billion barrels of oil and 55 trillion cubic feet of gas".

At present a test well is being drilled near the centre of the Moose River Basin (51°01'15"N, 82°23'30"W) where "About 300 feet of Ordovician carbonates are expected. Similar rocks of the same age produce in areas of faulting in both southwest Ontario and Michigan". (Oilweek, Feb. 1, 1971, p. 10).

Ordovician strata in the Hudson Bay Lowlands offer three possible types of reservoirs:

1. Structural traps along faults; the coarse clastics of the Harricanaw River area of Quebec are related to the major north-south fault of the Hudson Bay Paleolineament and the east-west fault of the south border of the Moose River Basin. Similar clastics possessing favourable porosity and permeability may occur along the northwest trending Winisk structure (Northern Miner, Nov. 5, 1970, p. 1 and 2), and along the southern or northern extensions of this structure.
2. Stratigraphic traps; basal Ordovician quartz sandstones which may be present around prominent Proterozoic basement ridges e.g. east of Cape Henrietta Maria arch and east of the Churchill Proterozoic ridge. These basal Ordovician clastic beds might be expected to



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Figure 2, Distribution of Upper Ordovician carbonate strata in North America (after Flower, 1967, p. 124) and position of Ordovician equator and climatic zones (Strakhov, 1967).

be truncated and overlapped by Silurian carbonates.

3. Reefs; bioherms in the Red Head Rapids Formation may be abundant in the offshore region of Hudson Bay, particularly in the area near Southampton Island.

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APPENDIX

Descriptions of stratigraphic sections*

North Knife River (Fig. 3)

North Knife River is the most northerly river of the Hudson Bay Lowlands along which Ordovician strata are exposed (see Pl. IA, B). At a distance of 20 miles from Hudson Bay, the river cuts across the Precambrian contact and for 2 miles downstream, outcrops of Ordovician strata occur. Only the Portage Chute Formation is exposed, represented by both sandstone (member 1) and limestone (member 2). Member 1 rests disconformably on tightly folded, vertically dipping, east-striking Precambrian quartzite and argillite. The Precambrian erosion surface appears to be a peneplane sloping eastward. The basal beds of member 1 contain pyrite cement and pyrite replacements. The pyritic beds are about 1 foot thick and rest directly on the Precambrian.

Member 1 outcrops on the outside edge of various meanders of the river for a distance of about 1.5 miles. The maximum thickness is 19 feet. Member 1 is locally conglomeritic and highly fossiliferous. Fossils are exceptionally plentiful in the sandstones at the west end of the exposures, suggesting a nearshore deposition. Fossils identified from member 1 by Nelson (1964, p. 11-12), are regarded as the same age as the Portage Chute Formation at the Churchill River type section. These fossils are: -

Receptaculites sp.
Palaeophyllum halysitoides (Wilson)
Grewingkia robusta (Whiteaves)
Favistella alveolata (Goldfuss)
Nyctopora (?) *foerstei* Bassler
N. mackenziei Nelson
Calapoecia arctica Troedsson (?)
Plasmopora lambei Schuchert
Catenipora aequabilis (Teichert)
C. agglomeratiformis (Whitefield)
Diceromyonia sp.
Trochonema coxi Wilson
Maclurites manitobensis (Whiteaves)
Fusispira gigantea Wilson
Kochoceras sp. I Nelson
Lambeoceras kronlundii Miller and Youngquist

The upper beds of member 1 grade into limestones of member 2 which has a maximum exposed thickness of 7.4 feet (see station 205SA, Fig. 3). Fossils are rare in member 2. Nelson (1964, p. 11) identified *Receptaculites* sp., *Grewingkia robusta* (Whiteaves), and a *Diceromyonia* sp. and noted that the fauna was poorly preserved as casts. He also observed (ibid., p. 12) that:

"Along the lower part of North Knife River from the most easterly outcrop of the Portage Chute Formation to its junction with South Knife River outcrops are rare. A small outcrop of Precambrian gneissoid rock occurs about 6 miles downstream from the last sandstone exposure, approximately opposite the north end of Nowell Lake. Over a small area near this outcrop, abundant rounded limestone boulders containing dinorthis and strophomenid brachiopods similar to those of the Churchill River Group are found, which suggest the occurrence nearby of strata of that age. Downstream over the remaining 18 miles of river no outcrops were seen, but abundant rounded Precambrian boulders and very few Ordovician ones in the stream bed suggest that Precambrian rocks may underlie the lower part of the river. Only in the delta of North Knife and South Knife Rivers are Ordovician boulders abundant."

Fossils collected by Mr. Ed Kronlund and described by Miller and Youngquist (1947) from exposures approximately 35 miles above the mouth of North Knife River can now be interpreted to be from member 1 of the Portage Chute Formation. This collection is stored with the Geological Survey of Canada type collection. Each of the specimens from this locality is enclosed within a quartz sandstone matrix. These fossils are:

Kochoceras sp. State University of Iowa No. 6971
Lambeoceras cf. *L. lambii* (Whiteaves) S.U.I. No. 6965
Maclurina cf. *M. manitobensis* (Whiteaves) S.U.I. No. 6951
Lambeoceras kronlundii Miller and Youngquist of S.U.I. No. 6964
Endoceras sp. S.U.I. No. 6954-55
Calapoecia canadensis Billings S.U.I. No. 6947

*All bearings listed "in this" Appendix are true; current topographic maps should be consulted for appropriate magnetic declinations.

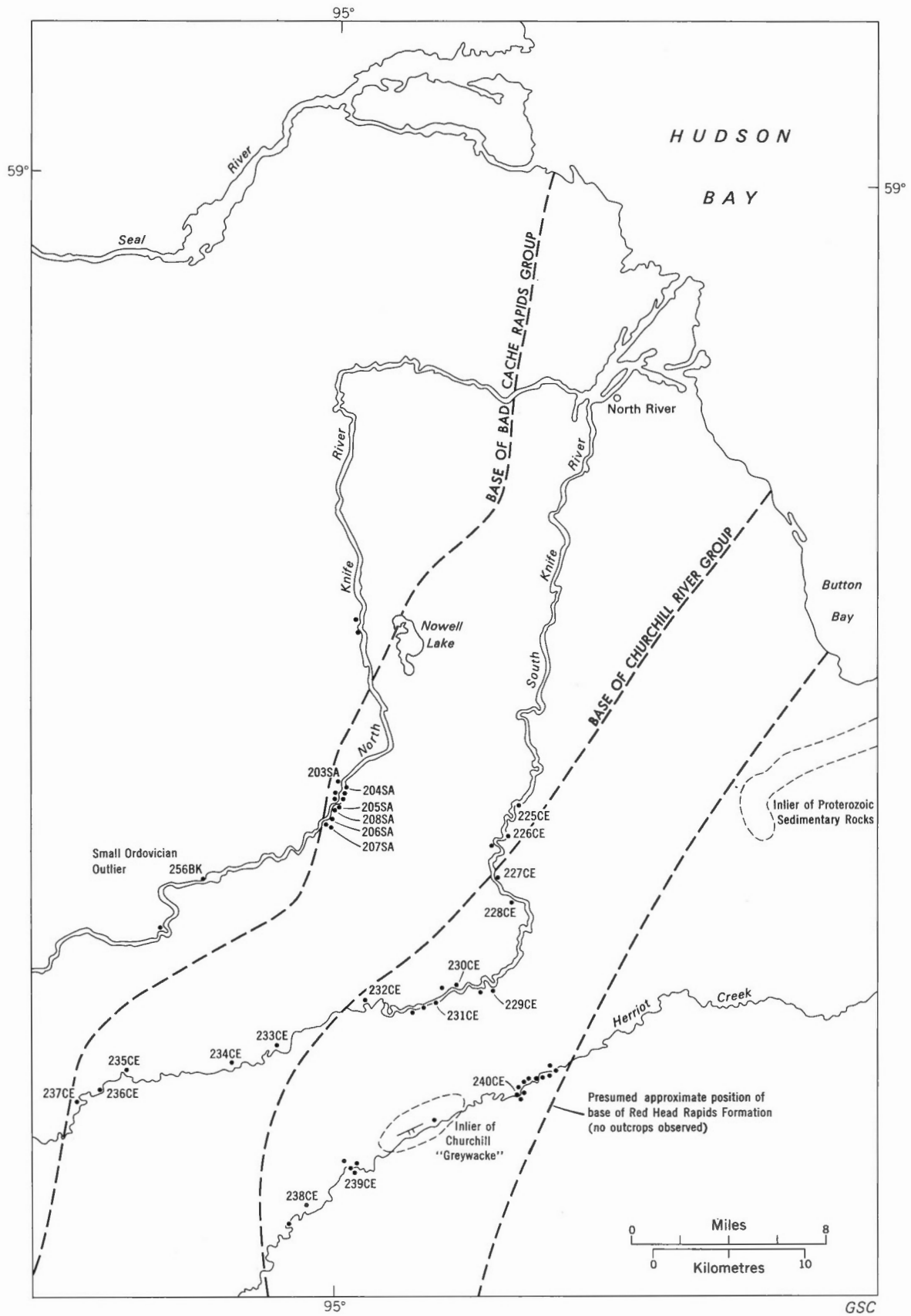


Figure 3. Geological sketch map of part of Churchill (54 L) map-area, showing Ordovician outcrops, stations and fossils localities.

North Knife River Stations

Station 208SA: north bank of North Knife River at 58°38'20" N (description by B.V. Sanford).

Unit	Portage Chute Formation, member 1	Thickness (feet)
2	Siltstone, shaly, red and light grey mottled, weathers brick red with light grey mottling, beds nodular and rubbly, less than one inch thick.	5.8
1	Sandstone, black, containing abundant quartz pebbles up to 1 inch in diameter, beds up to 3 inches thick with pyrite cement or are entirely replaced by pyrite. These flat-lying basal beds of Ordovician age weather white and dark grey mottled and rest unconformably on Precambrian siltstone and shale which have a vertical dip and strike at 105°. These Precambrian strata are bright red with olive green mottling and are exposed for 3.1 feet above river level.	1.1

Station 206SA: east bank of North Knife River at 58°38'15"N

Unit	Portage Chute Formation, member 2	Thickness (feet)
8	Limestone, dolomitic, light grey and orange tan mottled, weathers grey and orange mottled, beds 1 inch to 3 inches thick, crystalline texture, contains a few cephalopods and <i>Maclurites</i> sp.	5.5
7	Limestone, dolomitic, sandy, grades into calcareous sandstone patches, sucrosic texture, light orange tan, weathers light orange, massive, beds 10 to 13 inches thick (see Pl. I A), macrofossils include <i>Maclurites</i> sp. and <i>Fusispira</i> sp.	2.5
member 1		
6	Sandstone, greenish tan with a slight reddish cast, beds varying from 1 inch to 4 inches thick, moderately fossiliferous with favositid corals, pyrite cement occurs in a few lenses less than ¼ inch thick, weathers white to tan with small orange rusty patches, some orange rusty weathering and red coloration along bedding planes. Upper contact is a 1-inch clay seam, above which is a possible disconformity.	4.0
5	Sandstone, calcareous, well cemented and resistant, good vuggy porosity, a few stringers of pyrite cement.	0.2
4	Sandstone, very fine grained, dark greyish brown, argillaceous with thinly laminated beds one inch or less thick.	1.5
3	Sandstone, in one massive bed, medium grey, weathers grey tan with orange cast, some reddish oxidized laminae, pebbles of average diameter of 1/8 inch fairly abundant.	0.8
2	Sandstone, light grey, very fine grained, weathers rusty orange and dark grey mottled.	1.1
1	Sandstone, argillaceous throughout, fine-grained, red and light grey mottled, beds laminated and generally less than 1 inch thick, but varying up to 4 inches.	4.7

Station 205SA: North Knife River at 58°38'30"N; 95°01'00"W.

Unit	Portage Chute Formation, member 2	Thickness (feet)
2	Limestone, dolomitic, light grey and orange tan, weathers medium grey and orange mottled, beds vary from 10 inches thick at base gradually decreasing to 3 inches at top.	7.4

Unit	member 1	Thickness (feet)
1	Sandstone, quartzose, conglomeratic, light grey, coarse grained, friable except for basal foot which is strongly cemented with silica and very hard and brittle; abundant quartz pebbles up to ½ inch in diameter; most of this unit is highly porous and would make an excellent petroleum reservoir. Abundantly fossiliferous, mega-fossils include: - <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <i>Maclurites sp.</i> <i>Trochonema sp.</i> <i>Favosites sp.</i> <i>Catenipora sp.</i> </div> <div style="width: 45%;"> <i>Nartheoceras Hyatt-1895</i> <i>Actmoceras sp.</i> <i>Endoceras sp.</i> </div> </div> Underlain by 12 feet of rubble to water level. This covered interval probably underlain by porous sandstone.	6.5

Station 204SA: North Knife River at 58°39'05"N. Well exposed section and terraced from river level, easily accessible. Bedding undulating but essentially flat lying (Pl. 1B). Prominent vertical joint sets are at 112° and 050°.

Unit	Portage Chute Formation, member 1	Thickness (feet)
4	Sandstone, slightly argillaceous, light grey tan, weathers rusty orange, beds 14 inches thick at base gradually decreasing to 6 inches at top; many beds are pebble conglomerates, most pebbles less than an inch in diameter, some elongated pebbles 2 inches long. Abundantly fossiliferous with: - <div style="margin-left: 40px;"> <i>Maclurites sp.</i> <i>Receptaculites sp.</i> bryozoa cephalopods corals including <i>Favosites sp.</i> </div>	5.5
3	Sandstone, conglomeratic in part, light grey tan, massive, weathering rusty orange; pebbles of quartz with some fragments 2 to 4 inches long, pebbles forming about two per cent of bed. Numerous fragmentary bryozoa and cephalopods present.	2.9
2	Sandstone, conglomeratic, light grey tan, with rusty orange streaks, fine- to medium-grained, granules and pebbles common throughout, fragments varying from 2 mm to 6 mm, bedding pinches and swells up to 1.1 feet thick and averaging 1.5 inches thick. A few cephalopods present.	6.3
1	Sandstone, slightly argillaceous, light grey, very fine grained, beds 1 to 2 inches thick, weathers orange.	0.9

Station 203SA: North Knife River at 58°39'30"N.

Unit	Portage Chute Formation, member 1	Thickness (feet)
2	Sandstone, quartzose, conglomeratic, coarse-grained, larger fragments varying from 2 mm to 6 mm in diameter, bedding 0.3 foot to 1.2 feet thick, weather grey tan with orange cast, numerous rusty brown streaks along bedding planes. Beds are highly friable and contain minor carbonate cement in the upper parts; worm trails present on some bedding surfaces. Bedding attitude is nearly horizontal with a possible slight dip upstream.	14.6

- 1 Sandstone, quartzose, fine-grained, light grey, bedding uniform, varying from 1 inch to 3 inches thick; weathers tan with an orange cast, contains a few cephalopods. Samples of sandstone later tested with a scintillometer gave a reading 20% above background; suggesting a minor amount of allanite. 1.6

The unit is underlain by 7.6 feet of alluvium and rubble to river level.

Station 256BK: a small Ordovician outlier on the North Knife River approximately 9 miles southwest of the main exposure of the Precambrian-Ordovician contact (see Fig. 3 and Bostock, 1969, p. 29).

- Unit 1 Sandstone, quartzose, matrix of kaolinite-rich material, friable, creamy white medium-grained.
Unit is exposed in the middle of a 300-foot section of Precambrian slaty siltstone, and may represent a remnant preserved in a downfaulted block or deposition in a fissure in the Precambrian surface.

South Knife River (Fig. 3)

The South Knife River probably originated as a post-glacial consequent stream. It is a small, relatively ungraded, meandering river, along which are exposed extensive outcrops of Ordovician strata (see Pl. IC, IB, IIA).

Only one outcrop of member 1 of the Portage Chute Formation is exposed near the western end of the outcrop belt. This sandstone has an exposed thickness of only 1.5 feet (see station 237CE, Fig. 3). Limestone of member 2 occupies most of the 10-mile distance across the regional strike of the strata. The exposed maximum thickness in a single outcrop (station 233CE) is 13.5 feet.

A gap in outcrop of 2.25 miles occurs between the exposures of the Bad Cache Rapids Group and the Churchill River Group. This interval may be underlain partly by the Surprise Creek Formation.

The Caution Creek Formation is exposed for about 9 miles. The best exposures occur upstream from the sharp, northward bend of the river (see Fig. 3).

On the basis of the limited exposures of the Caution Creek Formation along the South Knife River, the formation has been divided into a lower and upper member (Nelson, 1964, p. 24).

The lower member is at least 6 feet thick and is exposed in the centre of a low arch between stations 230CE and 231CE. The lower member is a light grey sublithographic limestone, containing: -

- Desmograptus canadensis* (Whiteaves)
- Strophomena planocorrugata* Twenhofel
- Lepidocyclus capax* (Conrad)

Desmograptus canadensis is known elsewhere only from the Cat Head Member of the Red River Formation in southern Manitoba. *Strophomena planocorrugata* occurs in both the Surprise Creek and Caution Creek formations, whereas *Lepidocyclus capax* is characteristic of the Churchill River Group. Thus, faunal elements of both the Bad Cache Rapids and Churchill

River groups are present in the lower member. The lower member is tentatively correlated with Caution Creek Formation.

The upper member along the South Knife River has a minimum thickness of 16 feet and a calculated maximum of between 20 and 30 feet. It consists of fossiliferous, mottled orange and grey weathering, crypto crystalline to microcrystalline, light yellowish grey, slightly dolomitic limestone occurring in rubbly weathering beds 1 inch to 3 inches thick. The best exposures are in the half-mile-long outcrop belt east of the arch. Within this restricted area the member can be divided into two zones, the lower, which is 5 feet thick, contains numerous pelmatozoan columnals. This zone is separated from the upper zone by an easily recognizable 1- to 2-inch thick bed of dark grey weathering, dark grey pelmatozoan limestone. The upper zone is at least 10 feet thick and is similar to member 1 of the Caution Creek on Churchill River. Up and down river from these outcrops, however, the two zones cannot be distinguished with certainty.

Fossils identified from the lower zone in the area to the west of the bend in the river include (Nelson, 1963, p. 16):

- Lobocorallium trilobatum* var *major* Nelson
- Deiracorallium manitobense* Nelson
- Bighornia patella* (Wilson)
- Lyopora manitobensis* Nelson
- Calapoecia anticostiensis* Billings
- C. canadensis* var. *ungava* Cox
- Protrochiscolithus kiaeri* Troedsson
- Palaeofavosites alveolaris* (Lonsdale) (?)
- P. capax* (Billings)
- Favosites wilsonae* Nelson
- Catenipora robusta* (Wilson)

C. foerstei Nelson
Manipora amicarum Sinclair
Plaesimys occidentalis (Okulitch)
Megamyonia unicostata (Meek and Worthen)
M. nitens (Billings)
M. ceres (Billings)
Strophomena planocorrugata Twenhofel
S. hecuba Billings
S. fluctuosa Billings
Lepidocyclus perlamellosus (Whitfield)
Hypsiptycha anticostiensis (Billings)
Trochonema coxi Wilson
Liospira parva Wilson
Cyclendoceras belli Nelson
Parksoceras lepidodendroides (Parks)
Lambeoceras nudum Troedsson
Billingsites borealis (Parks)

Plaesimys occidentalis, *Strophomena planocorrugata*, *S. fluctuosa*, and *Billingsites borealis* all occur on Churchill River some 32 miles south. A few are known to range either above or below this formation, but their association is distinctly different.

In numerous but scattered outcrops approximately 5 miles to the northeast of the arch, two members, each very similar lithologically to those in the arch area, are present. The lower member consists of smooth conchoidally weathering, cryptocrystalline, light grey limestone containing chert nodules. Except for the chert, the member is almost identical with that of the lower member exposed near the arch. The maximum thickness measured is 5.5 feet. The only fossils found were some poorly preserved trilobites belonging to the genus *Ceraurus* (s.l.). The upper member consists of relatively unfossiliferous 3- to 6-inch beds of brown and grey limestone with abundant organic detritus. Among the few fossils found in this member are *Aulacera undulata* (Billings) and *Nartheoceras crassisiphonatum* (Whiteaves).

This meagre fauna gives conflicting information as to the age of these beds. *Aulacera undulata* is most characteristic of the Chasm Creek Formation whereas *Nartheoceras crassisiphonatum* is known chiefly from the Bad Cache Rapids Group.

This fauna is similar to that of the Caution Creek Formation of the type locality. Such species as *Lyopora manitobensis*, *Deiracorrallium manitobense*, *Bighornia patella*, *Favosites wilsonae*, *Catenipora foerstei*,

Stations 225CE and 210SA: west bank of South Knife River at 58°39'N. This is GSC loc. 25311 of Nelson (1964).

Unit	Surprise Creek Formation	Thickness (feet)
1	Limestone, slightly dolomitic, light grey tan, weathers yellowish tan, finely granular or microsugrosic, contains siliceous limestone nodules up to 3 inches in diameter that grade to chert; chert also occurs as small irregular black blebs, beds vary from 1 inch to 3 inches thick, bedding approximately horizontal, prominent joint system at 280° t.	3.3

Stations 226CE and 211SA: east bank of the South Knife River at 58°37'N. This is GSC loc. 25310 of Nelson (1964).

Unit	Surprise Creek Formation	Thickness (feet)
1	Limestone, dolomitic, light brown and orange mottled; orange limestone is dolomitic and granular in texture, weathers light greyish brown with yellowish orange mottling. Beds up to 4 inches thick, abundant tripolitic chert in nodules 2 to 3 inches in diameter, and lenses up to 8 inches long. Beds are horizontal with dominant vertical joint sets at 065° and 135°. At 3 feet from the base of the section are giant orthocerids 6 feet long and a halysitid colony 3 feet across. A sample for conodont analysis yielded (GSC loc. 80393): <i>Belodina compressa</i> (Branson and Mehl) <i>Panderodus</i> spp. Lowermost 3 feet of section are slightly more dolomitic than the upper part.	7.9

Station 227CE: south bank of the South Knife River at 58°35'30"N.

Unit	Caution Creek Formation, member 2 and/or 3	Thickness (feet)
1	<p>Limestone, light grey tan and yellowish orange, mottled, finely crystalline, grades here and there into light brown aphanitic limestone, thin bioclastic zones also occur. Bedding irregular and nodular varying from 1 inch to 3 inches thick, averages 1.5 inches thick; bedding attitude 150/1NE; cut by strong fracture system at 090°. Weathers yellowish orange and grey tan mottled.</p> <p>Megafossils include:</p> <p><i>Lobocorallum</i> sp. <i>Favosites</i> sp. trilobites gomphocerid or <i>Gomphoceras</i> sp. gastropod</p> <p>Sample for conodont analysis yielded (GSC loc. 80394): <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Cyrtoniodus flexuosus</i> (Branson and Mehl) <i>Panderodus</i> spp. <i>Ozarkodina</i> sp. ?</p>	4.3

Stations 228CE and 213SA: southwest bank of South Knife River, at 58°34'35"N; 94°49'30"W.

Unit	Caution Creek Formation	Thickness (feet)
1	<p>Limestone, mottled, light brown yellowish tan, beds even and slightly nodular varying in thickness from 1 inch to 3 inches, weathers grey tan with some rusty orange. Beds contain abundant <i>Rhynchotrema capax</i> (Conrad) and other brachiopods. Graptolites abundant in upper part of unit (see Pl. ID). These have been identified as <i>Glyptograptus</i> n. sp. by D.E. Jackson (pers. comm., 1970). Beds strongly jointed at 045° and less so at 120°. Bedding 330°/3°NE. The specimens of <i>Glyptograptus</i> n. sp. are associated with a shelly fauna including <i>Paleofavosites</i> sp., ? <i>Bighornia</i> sp. <i>Ceraurinus</i> sp. <i>Isotelus</i> sp. and <i>Pionorthis</i> (GSC loc. 79806) which indicate a Stony Mountain equivalent and thus represents the lower part of the Churchill River Group at an horizon correlative with the <i>Pleurograptus linearis</i> Zone. <i>Glyptograptus</i> n. sp. is slightly smaller than <i>G. hudsoni</i> Jackson which occurs in the Edenian Oil Shale Horizon on Southampton Island (Sanford, 1970).</p>	3.7

Station 229CE (= 214SA): southeast bank of South Knife River at 58°32'30"N; 95°50'00"W. This is GSC loc. 25307 of Nelson (1964).

Unit	Caution Creek Formation	Thickness (feet)
1	<p>Limestone, light brownish grey, aphanitic, but contains abundant bioclastic material, beds platy and irregular, between 1 inch and 2 inches thick, weathers light yellowish tan with some rusty orange staining. Overall bedding attitude 025°/2° to 3°NW. Small scale doming (10 feet in diameter and 4 feet high) evident, which may be due to biohermal development in underlying beds. Dips on flank of dome are up to 4 degrees.</p>	1.0

Station 230CE (= 215SA): north bank of the South Knife River at 58°32'30"N; 95°54'00"W.

Unit	Caution Creek Formation	Thickness (feet)
1	<p>Limestone, light brownish grey with some yellowish orange mottling, finely crystalline, beds thin and platy, 1 inch to 2 inches thick, weathers medium brown with grey mottling.</p> <p>Contains strap-like algal fucoids, and <i>Halysites</i>, <i>Favosites</i> and <i>Calopoecia</i> colonies which are spaced 30 to 40 feet apart. One large cephalopod, 3 feet long and 4 inches wide is oriented 210°. Joint sets oriented at 250° and 325°. Bedding 090°/1° to 2° S.</p> <p>Conodonts present include (GSC loc. 80397): <i>Cyrtoniodus</i> sp. ? Megafossils present include (GSC loc. 81760):</p> <p><i>Lobocorallium</i> sp.</p> <p><i>Catenipora</i> sp.</p> <p>favositid coral</p> <p><i>Protrochiscolithus</i> sp.</p> <p><i>Endoceras</i> sp.</p>	2.7

Station 231CE (= 216SA): north bank of South Knife River, 58°31'00"N; 94°55'00"W. This is GSC loc. 25304 of Nelson (1964).

Unit	Caution Creek Formation, member 2	Thickness (feet)
2	<p>Limestone, light grey tan and yellowish orange mottled. The yellowish orange carbonate consists of finely granular dolomite. The grey tan material is a dolomitic limestone. Beds nodular and average one inch thick. Weathers light grey and orange mottled.</p> <p>Bedding 85°/1° to 2° S (see Pl. IIA). Jointing 325°; also minor joints at 350° and 030°. The fauna includes:</p> <p><i>Diestoceras</i> sp.</p> <p><i>Cyrtogomphoceras</i> sp. Foerste, 1924</p> <p><i>Endoceras</i> sp.</p> <p><i>Paleofavosites?</i> sp.</p> <p>small streptalasmid coral</p> <p><i>Catenipora</i> sp.</p> <p>a favositid coral</p> <p><i>Dinorthis</i> sp.</p> <p><i>Isotelus?</i> sp.</p> <p>Age: Stony Mountain age is indicated.</p> <p>Conodonts from the lower 4.4 feet include (GSC loc. 80398): <i>Panderodus</i> sp.</p> <p>Conodonts from the upper 4.6 feet include (GSC loc. 80400): <i>Drepanodus suberectus</i> (Branson and Mehl), <i>Panderodus</i> spp.</p>	9.6
	member 1	
1	<p>Limestone, light grey, aphanitic to sublithographic. Bedding uniform, 1 inch to 2 inches thick with scattered nodules. Weathers light grey tan to yellowish orange. Fossils include: <i>Favosites</i> sp., <i>Zaphrentis</i> sp., and <i>Plaesiomys</i> sp.</p> <p>Equivalent to upper part of member 1 of the Caution Creek Formation and separated from member 2 by a pronounced bedding plane.</p>	4.4

Station 232CE (= 217SA): north bank of South Knife River at 58°31'N; 94°69'W. This is GSC loc. 25302 of Nelson (1964).

Unit	Caution Creek Formation	Thickness (feet)
1	<p>Limestone, light brownish grey with yellowish orange mottling, finely crystalline to aphanitic. Yellowish orange mottled patches represent areas of secondary dolomitization. The uppermost 2 feet becomes increasingly dolomitic. Beds 8 to 10 inches thick. Weathers medium grey with much rusty orange mottling.</p> <p>Bedding flat lying with joint sets at 095° and 170°</p> <p>Megafossils include (GSC loc. 81763):</p> <ul style="list-style-type: none"><i>Armenoceras</i> sp.<i>Lobocorallium</i> sp.<i>Halysites</i> sp.a small streptelasmid coral<i>Leptaena</i> sp.cf. <i>Isotelus</i> sp.echinoderm fragments <p>Microfossils include (GSC loc. 80401):</p> <ul style="list-style-type: none"><i>Drepanodus suberectus</i> (Branson and Mehl)<i>Panderodus</i> spp.Indet. fragment	5.5

Station 233CE (= 218SA): north bank of South Knife River at 58°29'30"N; 95°06'00"W. This is GSC loc. 25300 of Nelson (1964).

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	<p>Limestone, light grey tan, finely crystalline, slightly yellowish orange mottling. Beds uneven and nodular, 1 inch to 2 inches thick, the latter being more dominant. Weathers light grey tan.</p> <p>Beds horizontal or nearly so, with joint sets at 345° and 295°.</p> <p>Fossils include the Red River assemblage (GSC loc. 81764):</p> <ul style="list-style-type: none"><i>Maclurites manitobensis</i> (Whiteaves)<i>Receptaculites</i> sp.<i>Diestoceras</i> sp.<i>Endoceras</i> sp.<i>Winnipegoceras</i><i>Streptelasma</i> sp.<i>Cataenipora</i> sp.<i>Halysites</i> sp. <p>Conodonts include (GSC loc. 80402 A & B):</p> <ul style="list-style-type: none"><i>Drepanodus suberectus</i> (Branson and Mehl)<i>Cyrtoniodus flexuosus</i> (Branson and Mehl)<i>Panderodus</i> spp.	13.5

Station 234CE (= 219SA): north bank of South Knife River at 95°06'40"W.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	<p>Limestone, light grey, finely crystalline. Weathers medium brown and orange brown mottled. Beds are nodular, 2 to 3 inches thick. The upper 1.5 feet of section is mottled algal limestone.</p> <p>Bedding horizontal, with joint sets at 230°, 045°, 080° and 350°.</p> <p>Fossils include (GSC loc. 81778):</p> <p><i>Cameroceeras?</i> sp.</p> <p><i>Lambeoceras</i> sp.</p> <p><i>Diestoceras</i> sp. Foerste, 1924</p> <p><i>Cataenipora</i> sp. growing on a cephalopod</p> <p><i>Halysites</i> sp.</p> <p><i>Maclurites</i> sp.</p> <p><i>Grewingkia</i> sp.</p> <p>Conodonts include (GSC loc. 10c. 80406):</p> <p><i>Panderodus</i> spp.</p>	3.2

Station 235CE (= 220SA): north bank of South Knife River at 95°13'40"W.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	<p>Limestone, light brownish grey, aphanitic containing calcite 'eyes', bioclastic beds average 1 inch thick. Bedding irregular, up to 2 inches thick, Bedding horizontal, joints at 175°; weathers brownish tan and yellowish orange mottled. Sideritic or iron oxide staining has accented the mottling of the algal parts of this limestone. The yellowish orange mottled carbonate is highly dolomitic.</p> <p>Macrofossils rare and include (GSC loc. 81779):</p> <p><i>Rhynchotrema</i> sp.</p> <p>echinoderm fragments</p> <p>Condonts include (GSC loc. 80407):</p> <p><i>Drepanodus suberectus</i> (Branson and Mehl)</p> <p><i>Dichognathus</i> sp. ?</p> <p><i>Panderodus</i> spp.</p>	5.3

An additional 2 feet of section occurs as pavement in the river bottom

Station 236CE (= 221SA): south bank of South Knife River at 95°15'30"W.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	<p>Limestone, light brownish grey, mottled with dolomitic stringers and aphanitic to finely crystalline patches, containing an abundance of bioclastic material</p> <p>Upwards in section, beds gradually become light greyish brown with yellowish orange dolomitic mottling. Beds are fairly uneven and nodular and for the most part 1 inch or less thick, but here and there approach 2 inches thick.</p> <p>Beds are nearly horizontal with joints at 060°, 110° and 165°. These are cut by curved joints, thus tending to break the strata into small blocks of varying shapes and sizes.</p> <p>An additional 1 foot of section occurs as pavement below river level.</p>	7.4

Beds 1.5 feet from base of section contain many trilobite fragments. Other fossils include (GSC loc. 81780):

Paleofavosites sp.

Grewingia sp.
echinoderm fragments

Receptaculites sp.
large cephalopod (several feet long, indet.)

cf. *Narthococeras* sp. Hyatt, 1895.

Age: Probably Red River.

Conodonts include (GSC loc. 80408):

Drepanodus suberectus (Branson and Mehl)

Trichonodella sp.

Panderodus spp.

Station 237CE (= 222SA): north bank of South Knife River at 95° 17' 10" W

Unit	Portage Chute Formation, member 1	Thickness (feet)
1	Sandstone, dark grey, fine-grained, contains abundant lenses of quartz grains interbedded in numerous shale partings. Weathers greyish green with much iron oxide coloration. Beds horizontal, average 2 inches thick and are up to 3 inches thick, carbonate nodules 3 inches in diameter (probably detrital) are abundant. No macrofossils observed, a sample prepared for conodont analysis yielded negative results.	1.5

Herriot Creek (Fig. 3)

Herriot Creek is a small northeast-flowing tributary of the Churchill River. Helicopter traverses during Operation Winisk led to the discovery of Ordovician outcrops on this stream. Also, a small Precambrian inlier composed of arkosic sandstone and feldspathic quartzite was found to protrude through the Ordovician out-

crop belt approximately 18 miles from the Button Bay coast (see Fig. 3). No Ordovician outcrops were observed near the Precambrian inlier, but exposures of the Caution Creek Formation occur 5 miles to the northwest along the South Knife River. Ordovician outcrops on Herriot Creek represent limestones of the Churchill River Group.

Station 238CE: north bank of Herriot Creek at 95° 03' 30" W.

Unit	Caution Creek Formation, member 1	Thickness (feet)
1	Limestone, light brown and yellowish orange mottled, sublithographic; yellowish orange mottling is dolomitic; beds average 1 inch to 2 inches thick. Bedding 000/1°E. Prominent fracture system at 080°. Megafossils abundant and include (GSC loc. 81782): <i>Streptelasma angulatum</i> (Billings) <i>Favosites</i> sp. <i>Catenipora</i> sp. <i>Lobocorallium trilobatum</i> var. <i>major</i> Nelson <i>Charactoceras</i> sp. Foerste, 1924 <i>Aulacopella</i> sp. <i>Bastostoma</i> sp. <i>Pleisorhynchia</i> sp.	2.6

Diplograptus sp.

trilobite fragments

Age: Upper Ordovician (Richmond-Stony Mountain)

Conodonts include (GSC loc. 80401):

Panderodus sp.

Station 239CE: south bank of Herriot Creek at 94°58'50"W. Small rapids at this locality.

Unit	Churchill River Group	Thickness (feet)
1	<p>Limestone, dolomitic, light greyish brown, aphanitic, contains scattered skeletal material. Bedding regular up to 4 to 5 inches thick; bedding attitude 355°/1°E; dominant jointing at 120°, secondary at 035°. Occasional geodes occur, 1 inch to 2 inches in diameter, lined with calcite crystals. Weathers light grey, with much iron oxide staining along fractures.</p> <p>The distinctive yellowish orange mottling observed elsewhere to be characteristic of Ordovician rocks is absent at this locality; this may be due to the influence of a local basement high, a few miles to the east. Fossils are abundant and well preserved and include:</p> <p><i>Protochiscolithus kiaeri</i> Troedsson</p> <p><i>Lobocorallium</i> sp.</p> <p><i>Plaesiomys</i> sp.</p> <p>trilobite indet.</p> <p>Conodonts include (GSC loc. 80411):</p> <p><i>Drepanodus suberectus</i> (Branson and Mehl)</p> <p><i>Panderodus</i> spp.</p>	7.8

Station 240CE: north bank of Herriot Creek at 94°47'W.

Unit	Churchill River Group	Thickness (feet)
2	<p>Limestone, light brown, aphanitic, tan, thin-bedded, beds average 1.5 inches thick, weathers light grey tan.</p> <p><i>Orthoceras</i> sp., <i>Bighornia patella</i> (Wilson) and <i>Streptelasma</i> sp. are abundant.</p>	5.0
1	<p>Limestone, light brown, beds 4 to 6 inches thick, weathers light grey tan. Corals are abundant and fossils include:</p> <p><i>Palaeophyllum</i> sp.</p> <p><i>Lobophyllum</i> sp.</p> <p><i>Bighornian patella</i> (Wilson)</p> <p><i>Maclurites?</i> sp.</p> <p>bryozoa</p> <p><i>Hebertella</i> sp. cf. <i>H. sinuata</i> (Hall)</p> <p>Vertical joint sets at 110° and 035°. Bedding at west end of the outcrop has a pronounced dip of 4° east. An additional 3.8 feet of strata similar to unit 1 occur upstream and diagonally across the river.</p>	7.8

Churchill River (Fig. 4)

The thickest development and best exposures of Ordovician strata in the Hudson Bay Lowlands are found along the Churchill River. These are the type sections for the Ordovician of the Hudson Bay Basins (see Pl. II B to V A).

Detailed descriptions of the Ordovician stratigraphy along Churchill River have been provided by Nelson (1963, 1964) whose accurate distribution map (1963, Fig. 3) and sections (1964, Fig. 2) augment the Operation Winisk observations shown on Figure 4.

Precambrian granitic rocks floor the Churchill River for about 12 miles downstream from the Precambrian-Ordovician contact above Portage Chute. The contact follows the canyon edge of the river throughout this distance. A view of this contact (station 202CE) from a helicopter is shown by Norris and Sanford (1968, Pl. 4). A ground view of this locality (Pl. II B) shows Aphebian granite flooring the river and overlain by cliff-forming Upper Ordovician strata. Since the Ordovician contact coincides with the river bank, the contact is difficult to depict, from a cartographic standpoint, on large scale maps. King (1969) accentuated the Precambrian "indentation" in the Churchill River area; whereas Douglas (1969) accentuated the regional Ordovician contact in the same area.

Alcock (1915) described the section as follows: "On the lower portion of the river, Ordovician limestone is exposed, through which the river has cut a canyon. For the greater part of the distance, the river flows over the granite floor, exposing a complete section of the horizontal limestone. At one point a flat-lying sandstone, 15 feet in thickness, forms the basal member. The limestone reaches a thickness of at least 60 feet, is fossiliferous, and is apparently of the same horizon throughout. The uneven surface of the ancient floor upon which the limestone was deposited is well displayed in the limestone canyon, islands of red granite projecting in the middle of the river, at places, where on the

adjacent banks the limestone descends beneath the surface of the river; but at no point were the irregularities more than 10 to 20 feet."

At the mouth of the Churchill River on the east bank at Merry Point (Battery Point) fossils from Ordovician float have been described and illustrated by Miller and Youngquist (1947).

Fossils collected from these transported boulders of cream coloured dolomite from "Battery Point", just northwest of Churchill, Manitoba, contain a typical Upper Ordovician fauna, which include:

- Armenoceras* sp. [S. U. I.] No. 6968.
- Armenoceras* sp. [S. U. I.] No. 6967, 6969
- Dowlingoceras?* sp. [S. U. I.] No. 3662
- Endoceras* sp. [S. U. I.] No. 6952, No. 6956
- Floweroceras boreale* Miller and Youngquist
State Univ. of Iowa No. 6953, 6957, 6958
- Gorbyoceras* cf. *G. geronticum* Foerste and Savage
State Univ. of Iowa No. 6961
- Manitoboceras hudsonense* Miller and Youngquist
State Univ. of Iowa No. 6959, 6960
- Oxygonioceras?* sp. [S. U. I.] No. 6966
- Winnipegoceras laticurvatum* (Whiteaves)
= *Winnipegoceras youngquisti* Flower n. sp.
State Univ. of Iowa No. 6963
- Hormotoma* cf. *H. salteri* Ulrich [S. U. I.] No. 6949
- Maclurina* cf. *M. manitobensis* (Whiteaves) [S. U. I.]
No. 6950
- Calapoecia canadensis* Billings [S. U. I.] No. 6948

Station 202CE: north bank of Churchill River at 95° 16' 30" W. Vertical cliff composed of the Bad Cache Rapids Group is 30 to 40 feet high. The floor of the river is a smooth, water-worn red granite surface (see Pl. IIB).

Unit	Portage Chute Formation, member 2	Thickness (feet)
2	Limestone, slightly dolomitic, beds 14 to 16 inches thick; highly resistant, cliff-forming. The top 2 feet of beds 2 to 3 inches thick are limonite-stained, light brown to greyish brown, fine-grained crinoidal limestone containing patches of finely disseminated pyrite. Remainder of unit is light grey. A vuggy bed, 4 inches thick, with brachiopod fragments 15 mm in maximum length and subangular milky quartz grains up to 4 mm, occurs 3 feet above the base. <i>Halysites</i> sp. noted 6 inches above base.	30.0
	member 1	
1	Sandstone, light grey, subangular sand grains ½ to 1.0 mm in a limestone matrix. This basal sandstone is separated from unit 2 by a recessive bed of clay, 1 inch thick. Megafossils include <i>Maclurites</i> sp.; lowermost bed displays prominent worm markings.	4.5

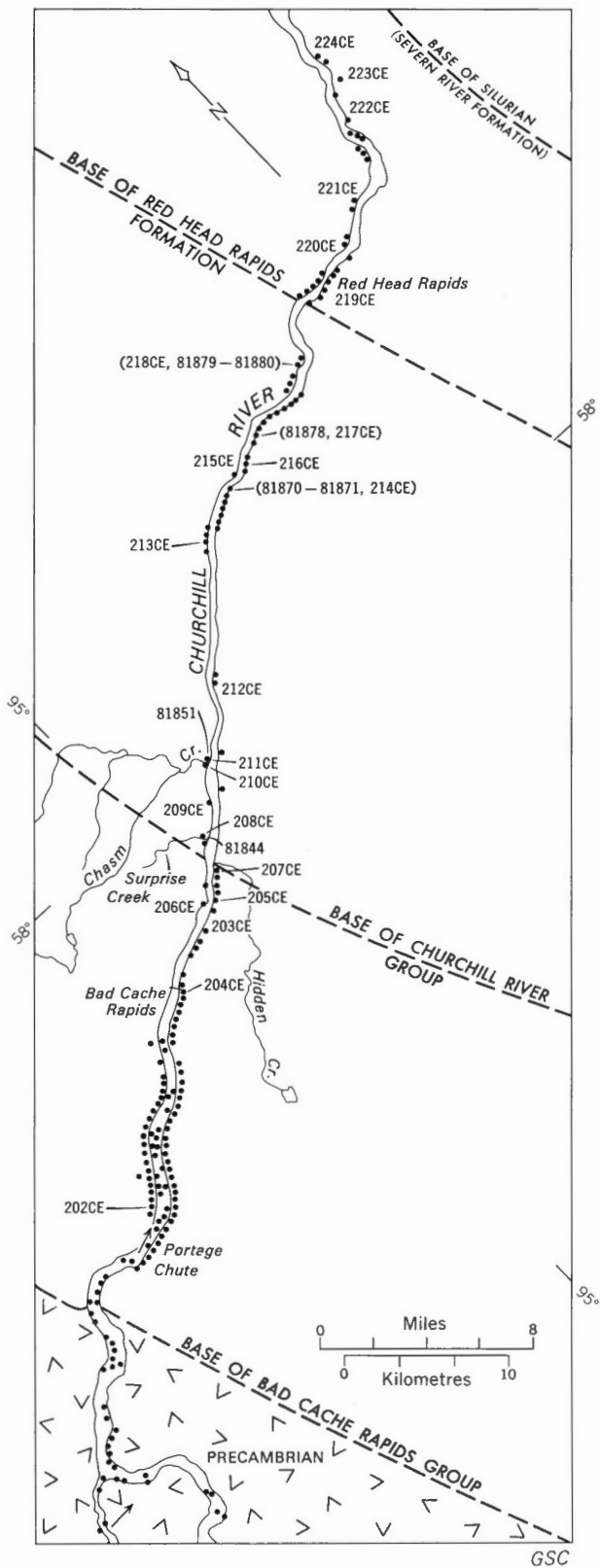


Figure 4. Geological sketch map of parts of Herchmer (54 E) and Churchill (54 L) map-areas, showing Ordovician outcrops, stations and fossil localities.

Station 203CE: south bank of the Churchill River at 95°04'W. This locality is the same as GSC loc. 2574 of Nelson (1964).

Unit	Portage Chute Formation, member 2	Thickness (feet)
2	Limestone, yellowish grey beds wavy and irregular, averaging 1.5 inches thick; separated from underlying unit by a bed of clay 1 inch thick. Fossils present include: <i>Receptaculites</i> sp., <i>Favosites</i> sp., trilobite fragments, horn corals, gastropods and cephalopods.	23.0
1	Limestone, light grey, in beds averaging 2 inches thick, slightly more resistant than unit 2 above. Macerated fossil fragments averaging 2 mm in diameter scattered throughout; an occasional cephalopod fragment up to 10 cm long.	7.0

Station 204CE: south bank of the Churchill River at 95°06'30"W. A Precambrian granitic outcrop can be seen in midstream slightly upstream from this locality, which is near the northeastern extremity of Precambrian rocks along the bed of the river (see Fig. 4). Ordovician rocks at this locality reflect the reworking of a pre-Upper Ordovician regolith.

Unit	Portage Chute Formation, member 2	Thickness (feet)
2	Limestone, strongly sandy, light grey, contains subangular quartz and granitic fragments averaging ¼ mm in diameter forming 5 per cent of rock. Weathering dark yellowish orange, some crinoidal and brachiopod fragments up to 5 mm in diameter.	3.0
	member 1	
1	Sandstone, quartzose, with limestone matrix, very light grey, weathering light yellowish grey. Quartz and rock grains average 1 mm in diameter and make up 15 per cent of the rock; quartz particles, subangular averaging ¼ mm in diameter make up 30-40 per cent of the rock; particles of mafic minerals ¼ mm in size, subangular, form 2 per cent of rock. A few echinoderm ossicles also present.	6.5

Station 205CE: south bank of the Churchill River at 95°01'00"W.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	Limestone, yellowish grey, beds uneven, ½ - 1 inch thick, fossil fragments averaging ½ mm in diameter make up 25 per cent of rock, weathers greyish orange to dark yellowish orange.	2.0
	Fossils include (GSC loc. 81834): <i>Receptaculites</i> sp. <i>Grewingkia robusta</i> (Whiteaves) <i>Catenipora agglomeratiformis</i> (Whitfield) <i>Cyrtogomphoceras</i> sp. <i>Lambeoceras</i> sp. <i>Hormotoma</i> sp. algal heads (30 mm in diameter) dichotomous branching fucoidal filaments (1 cm wide and 10 cm long).	

Station 206CE: north bank of Churchill River at 95°01'05"W.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	Limestone, yellowish grey, in beds averaging 1 inch thick, same fossil fragmental features and macrofauna as 205CE; occasional geodes, 3 cm in diameter lined with calcite crystals. Bedding surfaces knobby, contains well preserved <i>Cyrtogomphoceras alcocki</i> Nelson, 1963 and <i>Grewingkia</i> sp.	5.0

Station 207CE: south bank of the Churchill River at 95°00'W, section begins on Hidden Creek, 100 yards from its junction with the Churchill River.

Unit	Caution Creek Formation (Churchill River Group)	Thickness (feet)
2	Limestone, dolomitic, yellowish grey, in massive beds up to 7 feet thick (see Pl. II D). Weathers yellowish grey with light brown limonitic stains along fractures. Richly fossiliferous with bryozoa, crinoidal fragments (see Pl. IIIA) brachiopods, corals, cephalopods and <i>Ceraurimus</i> sp. cf. <i>C. daedalus</i> Cox of Richmondian age. Many fossil shells are in a crushed condition because support is shell upon shell with little intervening matrix.	25

Surprise Creek Formation (Bad Cache Rapids Group)

1	Limestone dolomitic, very pale brown, beds 1 inch - 2 inches thick which consist of thin laminations 1 mm thick. Pale brown chert occurs as bedding plane blebs and stringers and make up as much as 15-20 per cent of the rock. The weathered surface of the chert is chalky white. These are the uppermost beds of the formation and are exposed at creek level (see Pl. IID).	6
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Station 208CE: north bank of Churchill River at 95°00'W at Surprise Creek. There are no outcrops at the junction of Churchill River and Surprise Creek, as the bedrock is covered by a recent mudflow.

The section at this station is the Surprise Creek Formation type locality, concisely described by Nelson (1963, p. 12). The writer accepts his subdivision of the formation into 7 members. Plate III B illustrates some features of the lithology of this formation.

Chert characterizes the Surprise Creek Formation and 7 feet above the base of cliff section yellowish grey to white chert is bedded in layers up to 3 inches thick. Interbedded are yellowish grey slightly dolomitic limestone. One bed 4 inches thick shows calcite-filled shrinkage cracks, 1 inch long, normal to the bedding.

Member 1 of the Surprise Creek Formation contains abundant fossils.

A trilobite and a graptolite aid in correlation with beds of southern Manitoba.

Megafossils include:

Ceraurinus sp. cf. *C. daedalus* Cox (1933)

Desmograptus sp.

Leptaena sp.

Rafinesquina sp.

Rhynchotrema sp.

Sowerbyella sp.

echinoderm fragments

Hormotoma sp.

Age: Richmondian, equivalent to Cat Head (but slight faunal differences).

Station 209CE: north bank of the Churchill River and at the cliff on the northeast side of Caution Creek at approximately 94°58'W.

Unit	Caution Creek Formation	Thickness (feet)	
		Unit	From base
3	Limestone, slightly dolomitic, light grey, with very light brown mottling, beds uneven, platy, 1 inch to 2 inches thick, highly resistant to top of cliff.	13.0	25.0
2	Limestone, light grey to pale brown, rubbly beds up to 2 inches thick, composed of macerated fossil fragments up to 1 mm in diameter.	7.0	12.0

Unit		Thickness (feet)	
		Unit	From base
1	Limestone, light grey, fine-grained, composed of fragmental fossils, weathers light yellowish brown, beds $\frac{1}{2}$ inch to 2 inches thick, sparse geodes.	5.0	

Station 210CE: north bank of Churchill River at head of Chasm Creek.

Unit	Chasm Creek Formation	Thickness (feet)	
		Unit	From base
3	Limestone, dolomitic, fine-grained, light grey and brown, forms massive beds (<u>see</u> Pl. IIID), weathers orange tan.	12.0 ⁺	36.0 ⁺
	Caution Creek Formation, member 3		
2	Limestone, dolomitic, finely crystalline, light grey, beds 1 inch to 2 inches thick. The contact with the overlying Chasm Creek Formation is conformable (<u>see</u> Pl. III D).	6.0	24.0
	Caution Creek Formation, member 2		
1	Limestone, dolomitic, petroliferous odour, light grey, microcrystalline, beds average 2 inches thick, irregularly bedded (<u>see</u> Pl. IIIC).	18.0	

Station 211CE: on northwest bank of the Churchill River at 94°54'W, at head of canyon at mouth of Chasm Creek. Minor normal faulting (see Pl. XD).

Unit	Chasm Creek Formation	Thickness (feet)	
		Unit	From base
6	Limestone, light grey, fine-grained, contains about 5 per cent cavities, weathers orange tan with limonitic stains along fractures. Corals abundant, some are silicified and include: <i>Favosites</i> sp., <i>Streptolasma</i> sp., <i>Protochiscolithus kiaeri</i> Troedsson, and <i>Bighornia</i> sp.,	5.0	30
5	Limestone, light grey, bioclastic lenses contain broken fragments of trilobites, weathers orange tan.	5.0	25
4	Limestone, light grey, microfossils include (GSC loc. 80367); <i>Drepanodus suberectus</i> (Branson and Mehl).	5.0	20
3	Limestone, bioclastic, mottled light grey and brown, contains numerous small specimens of <i>Bighornia</i> sp. and also the conodont <i>Panderodus</i> sp. (GSC loc. 80365).	5.0	15
2	Limestone, dolomitic, light grey, sublithographic, weathers bright orange yellow. Microfossils include (GSC loc. 80363): <i>Panderodus</i> sp.	5.0	10
1	Limestone, dolomitic, fine-grained, contains echinoderm fragments. Microfossils include (GSC loc. 80361): <i>Belodina compressa</i> (Branson and Mehl) <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Panderodus</i> spp.	5.0	

Station 212CE: south bank of Churchill River at 94°53'W. This locality shows a broad undulation of the bedding of a sequence of orange weathering Caution Creek Formation overlain by cliff-forming beds of the Chasm Creek Formation. A line of trees at the base of the cliff marks the upper contact of member 3 of the Caution Creek Formation as illustrated by Nelson (1964, Pl. VI and Fig. 2).

Station 213CE: on north bank of Churchill River at 94°48'W.

Unit	Chasm Creek Formation, member 2	Thickness (feet)	
		Unit	From base
5	Limestone, light grey, beds 1 inch to 2 inches thick; contains abundant detrital halysitid colonies averaging 7 inches in diameter. Other megafossils include (GSC loc. 81866): <i>Favosites</i> sp. <i>Bighornia</i> sp. <i>Lobocorallium trilobatum</i> var <i>major</i> Nelson <i>Strophomena</i> sp. Microfossils include (GSC loc. 80370): <i>Panderodus</i> spp. <i>Plectodina</i> sp. cf. <i>P. furcata</i> (Hinde)	4.5	14.5
4	Limestone, light grey, in massive beds up to 2 feet thick (see Pl. IV A). Microfossils include (GSC loc. 80368): <i>Belodina compressa</i> (Branson and Mehl) <i>B. profunda</i> (Branson and Mehl) <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Plectodina</i> sp. cf. <i>P. furcata</i> (Hinde) <i>Ozarkodina</i> sp. cf. <i>O. tenuis</i> Branson and Mehl <i>Panderodus</i> spp.	7.0	10.0
3	Covered	0.5	3.0
2	Limestone, light grey, in beds 2 to 3 inches thick.	2.0	2.5
1	Covered to river level	0.5	

Station 214CE: on south bank of Churchill River at 94°45'W.

Unit	Chasm Creek Formation, member 2	Thickness (feet)	
		Unit	From base
2	Limestone, dolomitic, light tan grey, mottled; dominant vertical joint sets at 065° and 275°. Contains <i>Panderodus</i> sp. (GSC loc. 80373).	21.0	29.0
1	Limestone, light grey, highly fossiliferous and contains (GSC loc. 81870): <i>Armenoceras</i> sp. (see Pl. IV B) <i>Bighornia</i> sp., <i>Lobocorallium trilobatum</i> var. <i>major</i> Nelson, <i>Halysites</i> sp. and <i>Lepidocyclus perlamellosus</i> (Whitfield) and (GSC loc. 80372) <i>Panderodus</i> sp.	8.0	

Station 217CE: on south bank of Churchill River at 94°40'W, 5.4 miles upstream from Red Head Rapids. This is GSC loc. 25289 of Nelson (1964).

Unit	Chasm Creek Formation, member 2	Thickness feet
1	Limestone, light grey, sparsely fossiliferous but contains (GSC loc. 81878): <i>Bighornia</i> sp., <i>Lobocorallium trilobatum</i> var. <i>major</i> Nelson, <i>Halysites</i> sp., <i>Armenoceras</i> sp. and trilobite fragments as well as (GSC loc. 80378) <i>Panderodus</i> sp. Represents part of member 2 of the Chasm Creek Formation.	12.0

Station 218CE: on north bank of Churchill River at 94°37'W., 2.4 miles above Red Head Rapids.

Unit	Chasm Creek Formation, member 3	Thickness (feet)	
1	Limestone, light grey, bioclastic beds 1.5 inches to 2 inches thick. Fossils include (GSC loc. 81879): <i>Endoceras</i> (<i>Cyclendoceras</i> sp.), <i>Bighornia</i> sp., <i>Favosites</i> sp., <i>Strophomena</i> sp. and <i>Lepidocyclus perlamellosus</i> (Whitfield)		15.0

Station 219CE: on south bank of Churchill River in cliffs immediately above Red Head Rapids.

Unit	Red Head Rapids Formation	Thickness (feet)	
		Unit	From base
2	Dolomite, thin-bedded, platy cream coloured, contains (GSC loc. 80384) <i>Rhipidognathus</i> sp. ? and indet. fragments of conodonts (GSC loc. 80385).	12.0	21.0
	Chasm Creek Formation, member 4		
1	Limestone, dolomitic, thin irregular beds (Pl. IV C) algal mottling; megafossils include: <i>Plaesiomys</i> sp., <i>Lepidocyclus</i> sp. and bryozoa (GSC loc. 81884).		9.0

Station 220CE: north bank of Churchill River at 58°09'50"N; 94°22'15"W, 2.8 miles downstream from Red Head Rapids.

Unit	Red Head Rapids Formation, member 1	Thickness (feet)	
1	Dolomite, cream coloured, platy, beds 1 inch to 3 inches thick, some bedding surfaces contain worm-like markings; bedding laminations up to 1/8 inch thick show concentrations of black organic flakes and specks containing (GSC loc. 80387): <i>Drepanodus</i> sp. cf. <i>D. suberectus</i> (Branson and Mehl) of possible Upper Ordovician age. Similar beds at 58°09½'N, 94°30'W (Station 528NE; GSC loc. 80142) contain: <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Ozarkodina</i> cf. <i>O. robusta</i> Stauffer ? <i>Oulodus casteri</i> Pulse and Sweet <i>Panderodus</i> spp. of Middle and/or Upper Ordovician age identified by T. T. Uyeno.		5.0

Station 221CE: on north bank of Churchill River, at 58°10'45"N; 94°25'10"W, 4.2 miles below Red Head Rapids.

Unit	Red Head Rapids Formation, member 1	Thickness (feet)	
1	Dolomite, cream coloured, platy, beds 1 inch to 3 inches thick, fine-grained, weathers pale yellow.		8.0

Station 222CE: on east bank of Churchill River 58°13'N; 94°21'W, 7 miles below Red Head Rapids.

Unit	Red Head Rapids Formation, member 1	Thickness (feet)	
		Unit	From base
2	Dolomite, cream coloured, platy; basal 2 inches is recessive, cream coloured clay overlain by an 8-inch dolomite bed (Pl. V A).	2.5	7.5

Unit	Chasm Creek Formation, member 4	Thickness (feet)
1	Limestone, dolomitic, algal rods conspicuous (Pl. IV D). Megafossils include (GSC loc. 81893): <i>Murchisonia</i> sp., <i>Plaesiomys</i> sp. and <i>Bighornia</i> sp. Microfossils include (GSC loc. 80389): <i>Panderodus</i> spp. <i>Drepanodus suberectus</i> (Branson and Mehl) and indicate an Upper Ordovician age.	5.0

Station 223CE: on east bank of Churchill River at 58° 14' N. This exposure is on the river bank of an abandoned channel in back of a small pond several hundred feet from the present river.

Unit	Chasm Creek Formation, member 4	Thickness (feet)
1	Dolomite light grey mottled, contains casts of salt crystals ½ inch in diameter; beds sparsely fossiliferous and contain (GSC loc. 80391): <i>Plaesiomys</i> sp. or <i>Dinorthis</i> sp., and <i>Panderodus</i> sp.	6.0

Station 224CE: on east bank of Churchill River at 58° 14' 30" N, 6.5 miles south of south tip of Long Islands. This is the most easterly outcrop along this stretch of the Churchill River and the lack of outcrops downstream probably reflects a post-Pleistocene change in the river channel.

Unit	Red Head Rapids Formation	Thickness (feet)
1	Limestone, dolomitic, light grey, algal mottling, weathers pale buff yellow. The upper 8 feet is dolomitized algal limestone in beds averaging 3 inches thick. The basal 9 feet is dolomitized algal limestone in beds 1.5 feet thick. The outcrop shows a general dip of a few degrees upstream. Sparse fossils include (GSC loc. 81894): <i>Favosites</i> sp. and fasciculate corals.	17.0

The tidal estuary of the mouth of the Churchill River was traversed during abnormally low tides in August 1971 by B. S. Norford. Large blocks of fossiliferous dolomite occur on the beach, 1.5 miles southwest of Fort Prince of Wales. Similar dolomite blocks are scattered in the mud at Sloops Cove immediately to the south. These blocks contain large cephalopods and tabulate corals and an occasional cobble of Precambrian rocks.

Source of these dolomite blocks appears to be from intertidal outcrops at 58° 47' N, 94° 14' W at the northern side of the entrance to Sloops Cove. There, about a 3-foot section of well-bedded dolomite occurs. Fossils from these outcrops are of Ordovician age (Norford, 1971, p. 206) and include (GSC loc. C-10504):

Maclurites sp.

Catenipora sp.

Panderodus gracilis (Branson & Mehl)

P. compressus (Branson & Mehl)

Near Seahorse Gully (at 58° 45' 25" N, 94° 14' 30" W) white sandstone, possibly also belonging to the Bad Cache Rapids Group, was reported by Nelson and Johnson (1966, p. 544).

Another intertidal outcrop of Ordovician strata was also discovered by B. S. Norford just east of the mouth of the Churchill River at 58° 46½' N, 94° 08½' W. Fossils from this locality are Maysvillian - Richmondian age

and include (GSC loc. 80621):

Calapoecia sp.

Catenipora sp.

? *Mesofavosites* sp.

? *Palaeofavosites* sp.

Palaeophyllum sp.

Favistina sp.

? *Megamyonia* sp.

? *Monomerella* sp.

? *Aphelognathus* sp.

Cordylodus cf. *C. robustus* Ethington & Furnish

Drepanodus homocurvatus Lindström

Ecoligonodina sp.

Panderodus compressus (Branson & Mehl)

P. gracilis (Branson & Mehl)

P. panderi (Stauffer)

Plegagnathus dartoni (Stone & Furnish)

P. nelsoni Ethington & Furnish

Trichonodella sp.

Zygognathus sp.

Nelson River (Fig. 5)

Robert Bell (1880) ascended the Nelson River and made fossil collections at and near Limestone Rapids. These fossils were identified by Whiteaves (in Bell 1880, Appendix I) and provided the first evidence for the occurrence of Ordovician rocks in the area, which were correlated with rocks along the Red River in southern Manitoba.

Nelson (1952) renamed the Nelson River Limestone of Savage and Van Tuyl (1919) the Portage Chute Formation and recognized that their horizons 1, 2, 3, and 4 of the Nelson River Limestone were actually all the same horizon. That is, the dip of beds at all four horizons coincided with the river gradient.

Quinn and Currie (1961) noted an outcrop of arenaceous dolomite on Limestone River, 8 miles above Nelson River. This locality represents an exposure of member 2 of the Portage Chute Formation. They also noted small Ordovician limestone outliers as far west as Kettle Rapids but these were too small to plot on their 4-mile map.

Nelson (1964, Fig. 4, p. 15) provided data in the form of composite sections outcropping along Nelson River between Long Spruce Rapids and Angling River.

Station 188CE: on east bank of Nelson River at 94°17'W, 11.7 miles east of Kettle Rapids railway station.

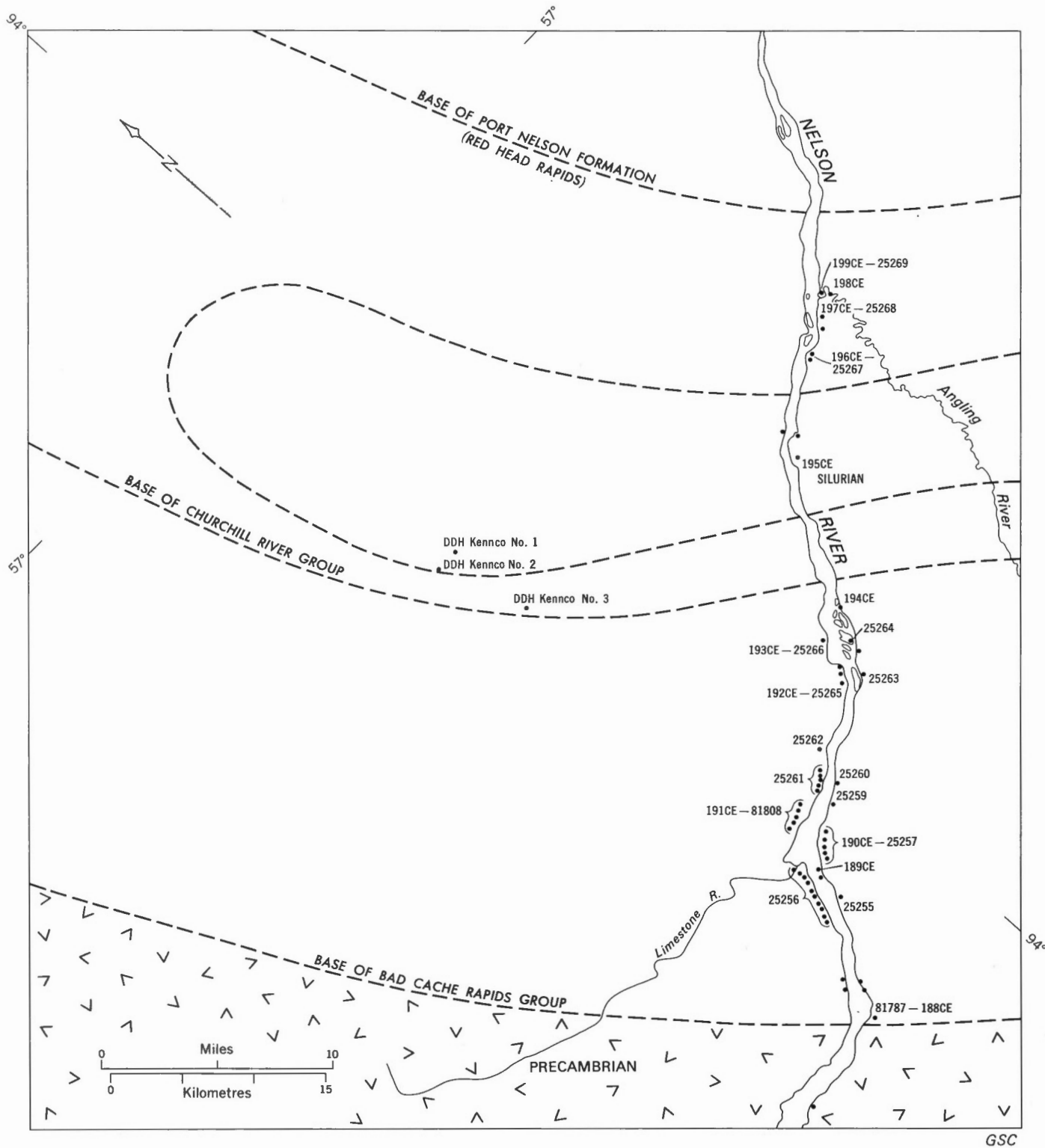
Unit	Portage Chute Formation, member 2	Thickness (feet)
1	Limestone, light grey, bioclastic, dominant vertical jointing at 165°, joint surfaces have limonite staining. Megafossils abundant and are typical of a Red River Formation assemblage (GSC loc. 81787): <i>Grewingkia</i> sp. <i>Palaeophyllum</i> sp <i>Catenipora</i> sp. <i>Endoceras</i> (<i>Cyclenoceras</i>) sp. <i>Maclurites</i> sp. cf. <i>M. manitobensis</i> (Whiteaves) <i>Hormotoma</i> sp. cf. <i>H. gigantea</i> (Billings) <i>Receptaculites</i> sp. Microfossils include (GSC loc. 80326) <i>Panderodus</i> sp.	13.0

Station 189CE: on the east bank of Nelson River at the uppermost of the Upper Limestone Rapids (94°08'W), 4.3 miles east of Bird railroad station.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	Limestone, bioclastic, light grey, beds averaging 4 inches thick, containing black chert nodules with white rims, averaging 3 to 4 inches in diameter, but up to 7 inches in maximum diameter (see Pl. V B). Sparse fragments of <i>Grewingkia</i> sp. (GSC loc. 81800).	4.0

Station 190CE: on the southeast bank of Nelson River at 94°06'W, 4.9 miles east of Bird railway station.

Unit	Portage Chute Formation, member 2	Thickness (feet)
1	Limestone, light grey, bioclastic, dominant vertical joint system at 207° parallels river bank. Megafossils include (GSC loc. 81811): <i>Receptaculites</i> sp. <i>Maclurites</i> sp. <i>Hormotoma</i> sp. <i>Endoceras</i> sp.	18.0



GSC

Figure 5. Geological sketch map of parts of Kettle Rapids (54 D), Hayes River (54 C), York Factory (54 F) and Herchmer (54 E) map-areas, showing Ordovician outcrops, stations and fossil localities along the Nelson River and the position of drill holes north of the river.

Station 191CE: on the north bank of Nelson River at 94°06'W; 56°32'N.

Unit	Portage Chute Formation, member 2	Thickness (feet)
4	Limestone, light grey, mottled, irregular bedding (see Pl. V D) with a few pyrite nodules. Megafossils include <i>Orthoceras</i> sp. up to 4 feet in length, <i>Receptaculites</i> sp. and <i>Halysites</i> sp. Microfossils include (GSC loc. 80328): <i>Panderodus</i> sp.	3.0
3	Limestone, light grey, mottled, pyrite nodules, contains wisps of sandy limestone (see Pl. V C).	4.0
	Portage Chute Formation, member 1	
2	Sandstone, light grey, fine-grained matrix is greenish grey clay; contains occasional angular black chert fragments up to ¼ inch in diameter, interbeds of white to grey clay, contains smoky quartz clasts up to 1.5 inches in diameter.	4.0
	Precambrian	
1	Granite, red, occurs under water and is exposed on a small island near the middle of the river.	

Station 192CE: on west bank of Nelson River, immediately above Lower Limestone Rapids.

Unit	Surprise Creek Formation	Thickness (feet)
1	Limestone, dolomitic, light grey, bioclastic beds 0.5 to 1 foot thick (see Pl. VI B), cliff forming (see Pl. VI A), contains occasional chert blebs averaging 0.5 inch in diameter. Sparsely fossiliferous (GSC loc. 81815), with <i>Rafinesquina</i> sp. and trilobite fragments.	20.0

Station 193CE: on north bank of Nelson River below Lower Limestone Rapids at 56°35'30"N; 93°55'00"W.

Unit	Surprise Creek Formation	Thickness (feet)
1	Limestone, bioclastic, light grey, beds up to 2.5 feet thick No fossils collected (GSC loc. 81816).	7

Station 194CE: on island in Nelson River at 56°36'N; 93°52'W.

Unit	Surprise Creek Formation	Thickness (feet)
1	Limestone, dolomitic, and dolomite, light grey, in beds 0.5 to 1 inch thick, contains flattened chert nodules up to 1 inch thick and 8 inches long. No fossils observed. Outcrop on downstream end of island, beds overlain by 60 feet of glacial drift.	1.0

Station 196CE: on south bank of Nelson River, 12.25 miles east of 94°00'W. This is GSC locality 25267 of Nelson (1964).

Unit	Chasm Creek Formation	Thickness (feet)
1	Limestone, light grey, bioclastic weathers pale yellow with white mottling; abundantly fossiliferous; the occurrence of <i>Beatricea</i> sp. indicates a Richmond age; other megafossils include: <i>Lobocorallum trilobatum</i> var. <i>major</i> Nelson <i>Catenipora</i> sp. <i>Palaeophyllum</i> sp.	6.0

Favosites sp.
Lophospira sp.
Armenoceras sp.
Carabocrinus ? sp. (isolated plates only)
Ceraurinus sp.
bryozoans

Station 197CE: on southeast bank of the Nelson River at 56°44'30"N; 93°38'20"W.

Unit	Chasm Creek Formation	Thickness (feet)	
1	Limestone, light grey, bioclastic with coral, crinoid and trilobite fragments; a conglomerate bed 1 inch thick is composed of limestone fragments averaging ¼ inch in diameter.	1.0	

Station 198CE: on south bank of Angling River, 0.3 mile from the Nelson River junction, 56°45'N; 93°32'W.

Unit	Chasm Creek Formation	Thickness (feet)	
		Unit	From base
4	Limestone, slightly dolomitic, light grey mottling (see Pl. VI D), bedding irregular averaging 1 inch thick (see Pl. VII A), weathers pale yellowish brown; microfossils include (GSC loc. 80334): <i>Amorphognathus ordovicicus</i> Branson and Mehl <i>Panderodus</i> spp.	7.5	26.0
3	Limestone, light grey, bioclastic, beds ½ inch to 6 inches thick (see Pl. VI C) weathers greyish orange, petroliferous odour from freshly broken surface; megafossils abundant (see Nelson 1963, p. 19 for faunal list): Macrofossils include (GSC loc. 80332). <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Panderodus</i> spp.	8.5	18.5
2	Covered	2.0	10.0
1	Limestone, light grey, beds average 3 inches thick, bedding surface uneven and with sinuous vertical joints at 160°; megafossils include (GSC loc. 81821): <i>Bighornia</i> sp. <i>Halysites</i> sp. <i>Catenipora</i> sp. stromatoporids gastropods trilobite fragments Conodonts include (GSC loc. 80335): <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Amorphognathus ordovicicus</i> Branson and Mehl <i>Panderodus</i> spp.	8.0	

Gods River (Fig. 6)

The Gods River was formerly referred to as the Shamattawa (meeting-of-the-waters) River (Cumming, 1969a). The term "Shamattawa limestone" proposed by Savage and Van Tuyl (1919, p. 344-352) is discarded because it is now recognized that the exposures along the Gods River are a part of the Churchill River Group.

Regarding the correlation of the "Shamattawa limestone" (i. e. Chasm Creek Formation of the Churchill River Group) Foerste and Savage (1927, p. 12) concluded that "The Shamattawa limestone evidently is related closely to the Stony Mountain member of the Richmond in southern Manitoba. In common with the latter it contains such characteristic species as *Streptelasma trilobatum* (Whiteaves), the coarsely striated form of *Dinorthis* which resembles *Dinorthis subquadrata*, and the large and coarse form of *Rhynchotrema* which resembles *Rhynchotrema capax*. It includes also a considerable variety of cephalopods, in contrast with the single species listed so far from the Stony Mountain limestone, namely *Apsidoceras insigne* Whiteaves."

Nelson and Johnson (1967, p. 550-551) summarized the correlation of the "Shamattawa Formation" as follows:

"Savage and Van Tuyl's (1919) Shamattawa Formation clearly correlates with the Churchill River Group and has closest faunal affinities with the Chasm Creek Formation. The type section along Gods River (then called Shamattawa River), for about 20 miles commencing below the trading post of Shamattawa, was described as two limestone members about 38 feet thick. The fauna of the lower member is suggestive of Caution Creek although it does carry the diagnostic Chasm Creek species *Huronion septata* and *Antipteroceras shamattawaense*. That of the upper member is more suggestive of the Chasm Creek Formation. Since the Shamattawa Formation was not visited by the present writers these correlations, based on faunal lists in the literature, should be suspect. The unit may contain correlatives of both the Caution Creek and Chasm Creek Formations, or be equivalent only to Chasm Creek."

R.R. Potter (1962) mapped a belt of flat-lying Upper Ordovician limestone and shale (map-unit 10 of Map 17-1962) in the northeast corner of the Gods River map-area. Ordovician fossil collections from this belt was identified by G. Winston Sinclair as follows:

From Shamattawa (Limestone Rapids)
GSC Loc. 46549:

Stromatocentrum sp.

Streptelasma sp.

Favistina sp.

Rhynchotrema sp. cf. *R. capax* (Conrad)

Sowerbyella sp.

From Pishu Rapids (24 miles south of Shamattawa)
GSC loc. 46550:

Maclurites sp. cf. *M. manitobensis* (Whiteaves)

Alumettoceras sp.

Illaenus sp. cf. *I. americanus* Billings

Twenhofel (1954, p. 284) noted that the "Shamattawa formation" contained "many species of Richmond affinity together with some species of Trenton aspect. The formation belongs to the upper Richmond."

Flower (1957, p. 11) also correctly recognized the actinocerooid cephalopod fauna of the "Shamattawa limestone" to be of Richmond age. He summarized the cephalopod occurrences as follows: - "*Kochoceras shamattawaense* is clearly an *Actinoceras*, strikingly similar to *A. carletonense* of the *Anticosti* section. *Actinoceras parksi* is of the *A. anticostiense* group. *Armenoceras* is represented by two species, *A. magnum* and one tentatively assigned to *A. richardsoni*. *Huronion septata* completes the list."

During Operation Winisk traverses in this area, during August 1967, high water levels had submerged all outcrops upstream from Shamattawa. However, angular carbonate float was observed upstream from Pishu Rapids at station 6-7-DCG-140. This locality provides a control point for the position of the Precambrian-Paleozoic contact as shown on Figure 6.

Station 171CE: northeast bank of Gods River; 2.65 miles northwest of the Hudson's Bay Company flagstaff at the village of Shamattawa.

Unit	Churchill River Group	Thickness (feet)
1	Limestone, grey, algal or burrowed carbonate mud facies showing circular bifurcating and anastomosing cavities $\frac{1}{4}$ to $\frac{3}{8}$ inch across. Upon weathering of the cavities they characteristically become filled with clay. Contains abundant fossils (GSC loc. 81798): <i>Carabocrinus</i> sp. <i>Ceraurinus</i> sp. "Dalmanella" sp.	0.5

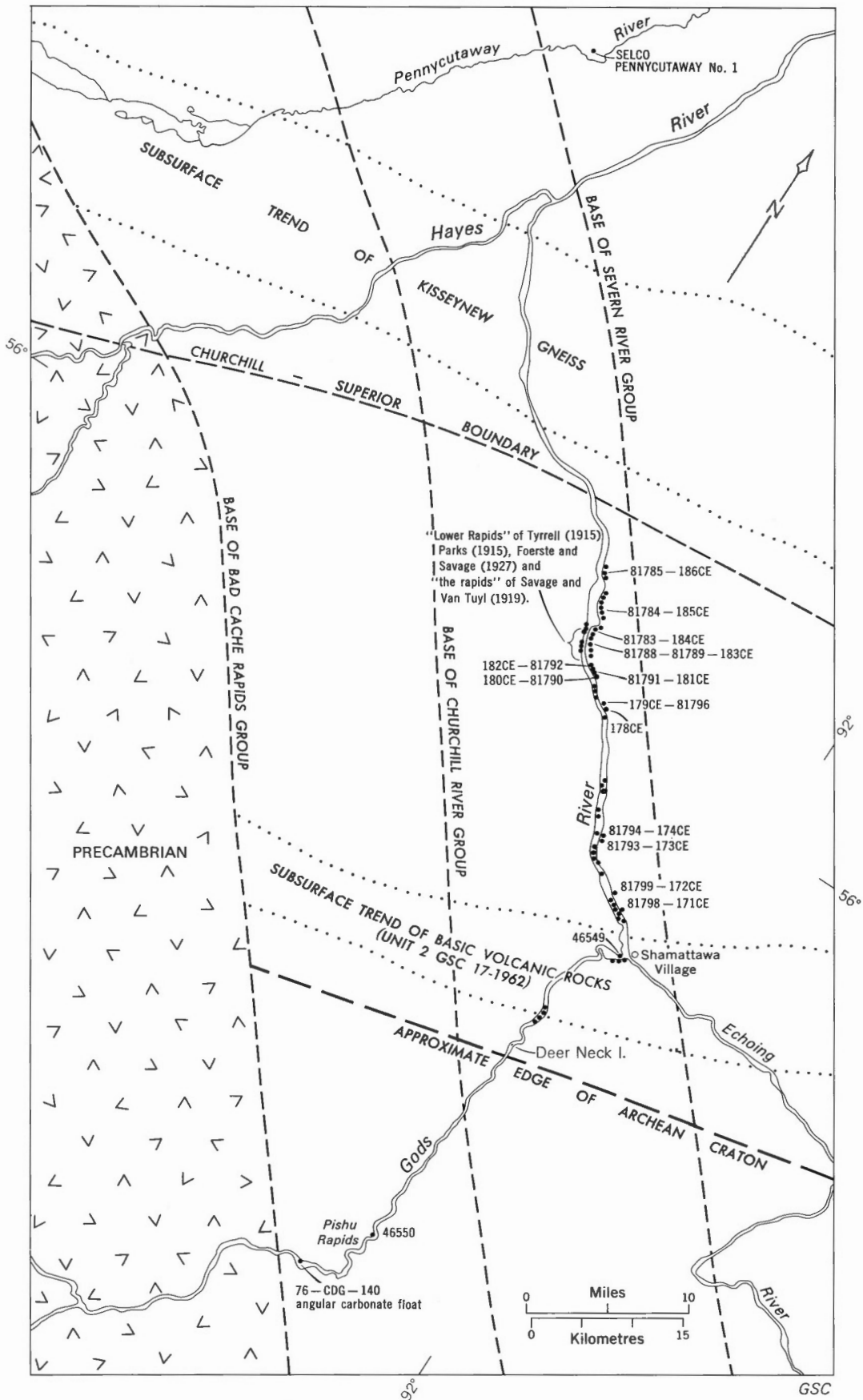


Figure 6. Geological sketch map of parts of Gods River (54 N), Hayes River (54 C) and Sturgeon Lake (53 O) map-areas, showing Ordovician outcrops, stations and fossil localities along Gods River.

Isotelus sp.
Armenoceras sp.
Liospira sp.
Cycloceras sp.
 ? "*Leptaena*" sp.
Hormatoma sp.
Orthoceras sp.
Maclurites sp. (small specimen)
Eotamaria sp.
 ? *Vanuxemia* sp.
Trochonema sp.

Age: Upper Ordovician possibly Richmond (on basis of *Armenoceras*).

Outcrop pavement extends across the entire river bottom at depth of 3 to 6 feet below the surface of the water.

Station 172CE: northeast bank of Gods River; 3.8 miles northwest of Hudson's Bay Company flagstaff at the village of Shamattawa, at 55° 53'N.

Unit	Churchill River Group	Thickness (feet)
3	Limestone, grey in beds 2-3 inches thick which contain abundant <i>Rhynchotrema capax</i> (Conrad).	2.0
2	Limestone, light grey, contains abundant trilobite fragments.	0.5
1	Limestone, grey, algal, mottled in beds 2-3 inches thick.	1.0

Megafossils (GSC loc. 81799) include:

Catenipora sp.
Streptelasma sp.
Grewingkia (sp.)
 bryozoans indet.
Dinorthis sp.
Rafinesquina? sp.
Rhynchotrema sp.
Sowerbyella sp.
Lepidocyclus sp.
Trochonema sp.
Ceraurinus sp.
Pholidops sp.
Encrinurus sp.
Isotelus sp.
Chasmops sp. (pygidium only)
Kraussella sp.
 crinoid fragments

Age: Richmond

A composite sample for conodont analysis (GSC loc. 80321) yielded:

Drepanodus suberectus (Branson and Mehl)

Panderodus spp.

According to Uyeno these conodonts are of Middle and/or Upper Ordovician age.

Station 173CE: Gods River, east bank at 55°56'N; 7.3 miles below Shamattawa flagstaff.

Unit	Caution Creek Formation	Thickness (feet)
1	Limestone, light grey, in beds averaging 1.5 inches thick. An additional few feet of section occur as an underwater pavement. Fossils include (GSC loc. 81793): <i>Dalmanella</i> sp. <i>Pachydictya</i> sp. "Leptaena uniplicate" echinoderm fragments trilobite cephalon indet. This locality is probably "Fossil Horizon I" of Foerste and Savage (1927 map, opposite p. 1).	1.0

Station 174CE: northeast bank of Gods River at 55°56'N; 7.5 miles northwest of the Hudson's Bay Company flagstaff at Shamattawa.

Unit	Churchill River Group	Thickness (feet)
1	Limestone, light grey, in beds 1.5 inches thick; rusty staining from bog iron. Megafossils identified by G. W. Sinclair include (GSC loc. 81794): <i>Chasmops</i> ? sp. (pygidium only) 'Leptaena' sp. <i>Sowerbyella</i> sp. <i>Rhynchotrema</i> sp. <i>Dalmanella</i> sp. <i>Lepidocyclus</i> sp. bryozoan indet. crinoid fragments Age: Stony Mountain equivalent-Richmondian (based on <i>Lepidocyclus</i>). Conodonts (GSC loc. 80325) include: <i>Amorphognathus ordovicicus</i> (Branson and Mehl) <i>Drepanodus suberectus</i> (Branson and Mehl) <i>Panderodus</i> spp. <i>Trichonodella</i> sp.	2.5

According to Uyeno these are of Middle and/or Upper Ordovician age.

Between this locality and Station 178CE, 8 miles downstream, two Pleistocene tills are exposed and no outcrop was observed, but the river bed is paved with Ordovician strata (see Fig. 6).

Station 178CE: northeast bank of Gods River; at 56°01'10"N; 92°20'00"W.

Limestone, dolomitic, fine-grained, 'ropy' bedding surfaces, weathers buff. Present as abundant frost-heaved rubble; bedrock is presumed to be near surface. Fossils fragmentary and undeterminable.

Station 179CE: northeast bank of Gods River; at 56°01'15"N; 92°20'10"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
2	Limestone, dolomitic, mottled, light grey, beds 2 to 3 inches thick and highly irregular, weathers white.	1.0	1.5
1	Limestone, platy beds 1 inch to 3 inches thick, weathers mottled grey. Sparsely fossiliferous (GSC loc. 81796): <i>Trochonema</i> sp. Composite sample for conodonts was barren.	0.5	

Station 180CE: east bank of Gods River; at 56°02'25"N; 92°17'20"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, slightly calcareous, pale yellow in beds 1 inch to 1½ inches thick. Weathers white when dry and pale yellow when wet; fossils rare but include (GSC loc. 81790): <i>Cyclocrinites</i> sp. = <i>Pasceolus</i> Billings 1857 or <i>Nidulites</i> Salter 1851 A composite sample collected for conodont analysis was barren. <i>Cyclocrinites</i> occurs in the Jupiter Formation of Anticosti Island, suggesting an Upper Ordovician age.	2.0	

Station 181CE: east bank of Gods River; 56°02'30"N; 92°17'25"W.

Unit	Churchill River Group	Thickness (feet)	
1	Limestone, mottled light and dark grey, numerous fragmental fossils, bedding flat, 2 to 3 inches thick, prominent vertical jointing at 175°. Fossils abundant (GSC loc. 81791) with: <i>Spyroceras</i> sp. <i>Grewingkia</i> sp. strophomenid indet. small cephalopod indet.	3.0	

Station 182CE: east bank of Gods river, at 56°02'35"N; 92°18'20"W.

Unit	Chasm Creek Formation	Thickness (feet)	
1	Limestone, light grey, mottled. The bedding is flat and the jointing dips upstream (see Pl. VII B). Abundantly fossiliferous and contains (GSC loc. 81792): <i>Grewingkia</i> sp. <i>Tyrrelloceras</i> sp. cf. <i>T. striatum</i> Foerste and Savage <i>Armenoceras</i> sp. <i>Maclurites</i> sp.	7.0	

Loxonema sp.
Trochonema sp.
Hormatoma sp. cf. *H. acuminata*
Bumastus sp.
 crinoid fragments

Station 183CE: east bank of Gods River, at 56°03'50"N; 92°25'00"W.

Unit	Chasm Creek Formation	Thickness (feet)
1	<p>Limestone, light grey, mottled in beds 6 to 10 inches thick, highly resistant, cliff-forming; the gastropod <i>Holopea media</i> Parks (GSC loc. 81788) is abundant in fragmental beds in the lower five feet.</p> <p>Section is exposed in cliffs on both banks of the river between two rapids. Abundant corals and other fossils are present at 15 feet up in the section (GSC loc. 81789):</p> <p style="padding-left: 40px;"><i>Grewingkia</i> sp. cf. <i>G. robusta</i> (Whiteaves) <i>Grewingkia</i> sp. (with budding) cephalopod indet.</p>	22.0

These fossils are suggestive of an Upper Ordovician age (Newman, 1969, p. 36)

Station 184CE: east bank of Gods River, at 56°04'25"N; 92°25'10"W.

Unit	Churchill River Group	Thickness (feet)
1	<p>Limestone, light grey, mottled, fossil fragments in beds 6 to 10 inches thick (see Pl. VII C). At base of the section is a burrowed carbonate bed 3 feet thick (see Pl. VII D). Identifiable fossils rare but strophomenid fragments are present (GSC loc. 81783).</p> <p>The cliffs on the opposite bank display strong jointing. This local joint system dips 26° upstream and may be related to the occurrence of the Precambrian basement rocks at shallow depth (see Fig. 7).</p>	20.0

Station 185CE: east bank of Gods River at 56°05'30"N; 92°26'00"W.

Unit	Churchill River Group	Thickness (feet)
1	<p>Limestone, white to light grey, mottled, bioclastic beds averaging 4 inches thick; contains the following Upper Ordovician fossils (GSC loc. 81784):</p> <p style="padding-left: 40px;"><i>Grewingkia</i> sp. a favositid coral indet. <i>Cyclocrinites</i> ? sp. <i>Hormatoma</i> sp. trilobite fragment - not identifiable <i>Rafinesquina</i> sp. bryozoan indet.</p>	20.0

Station 185CE: east bank of Gods River at 56°07'20"N; 96°27'30"W.

Unit	Red Head Rapids Formation	Thickness (feet)
2	<p>Dolomite, buff to cream coloured, fine-grained, in beds averaging 1 inch thick. No fossils observed.</p>	6.0

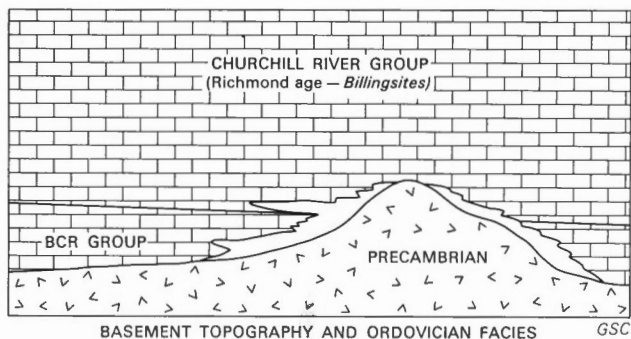


Figure 7. Conjectural north-south cross-section of the Gods River area: Beds of burrowed carbonate mud immediately overlying the Precambrian are shown by blank areas.

Unit	Red Head Rapids Formation	Thickness (feet)
1	Limestone, light grey, mottled bioclastic; contains the following fossils (GSC loc. 81785): <i>Maclurites</i> sp. cf. <i>Palaeophyllum</i> sp. brevicone (with marginal siphuncle) - indet. a bumastid ostracodes strophomenid brachiopod - indet.	7.0

Thorne River area (Fig. 8)

In the Thorne River area evidence for the presence of Ordovician strata is limited to small isolated outcrops and abundant frost-heaved angular blocks, confined to a narrow belt 10 miles wide and 120 miles long. This type of evidence makes it possible to delineate only approximately the contact between the Precambrian and the overlying Ordovician rocks. Ordovician strata within the belt are flat lying, relatively thin and wedge to a feather edge southwestwards. Ordovician rubble along streams becomes progressively more abundant southeastwards in the belt.

Two small inliers of Precambrian rocks are present within the area (Fig. 8): (1) on the Sachigo River, 0.5 mile downstream and east of the Precambrian edge; and (2) on a tributary of Sachigo River, 25.5 miles southeast of the first inlier and 2.5 miles north of the Precambrian edge.

Ordovician outliers occur 3 miles upstream from the latter locality. Another outlier occurs 17 miles to the northwest on an unnamed stream 8 miles southeast of the Sachigo River. The approximate positions of the base of the Churchill River Group and the Severn River Formation are indicated on Figure 8. These are reasonable estimates based on the position of the base of the Bad Cache Rapids Group and the regional thicknesses of the Bad Cache Rapids and Churchill River groups.

Fossils found at the stations indicated below, provide evidence of the regional distribution of the Bad Cache Rapids Group. The occurrence of *Receptaculites* and *Maclurites* indicates that these are Ordovician beds and post-Chazy in age.

Station 60NBG: west bank of Thorne River at $54^{\circ}52\frac{1}{2}'N$; $91^{\circ}07'W$. Light grey, fine-grained, sandstone with calcite cement with an "Arctic Ordovician" (Red River) fauna GSC loc. 81350:

- Maclurites* sp.
- Actinoceras* ?
- Cycloceras* sp.
- Receptaculites* sp.

Station 60NBb: west bank of Thorne River at $54^{\circ}52\frac{1}{2}'N$; $90^{\circ}07'W$. Limestone, light grey, bioclastic. Fossils include: (GSC loc. 81351):

- Catenopora* sp.
- Maclurites* sp. (large inflated species with strong growth lines - i. e. not like *M. manitobensis*)

Station 60NB₁: west bank of Thorne River at 54° 52½'N; 91° 07'W. Limestone, bioclastic, mottled light grey and buff. Fossils include (GSC loc. 81352):

Streptelasma sp.
echinoderm fragments

Station 60NB₂: west bank of the Thorne River 54° 52½'N; 90° 07'W. Lithological specimen only of light grey mottled bioclastic limestone (GSC loc. 81353). Light grey mottled dolomitic limestone, bioclastic, with no identifiable fossil material (GSC loc. 81349).

Station 187CE: Sachigo River, lat. 55° 04'N. Steep banks of the river at this locality are composed of glacial till and fluvioglacial gravels. Ordovician rocks in the form of cobbles of silicified light grey limestone contain coral and echinoderm fragments (GSC loc. 81786) and were presumably derived from the Ordovician belt to the west.

Station 170BK: island in Severn River at 54° 28'45"N; 89° 28'00"W. Overlying Precambrian mixed amphibolite rocks is 5 feet of light grey platy carbonate exposed on the west bank and on the small islands above the rapids. These carbonate rocks are presumably of Ordovician age.

Station 183BK: on unnamed tributary of the Sachigo River at approximately 54° 32'45"N; 90° 17'00"W. On the north-west bank of the river, underwater, north of the island, is 1.5 feet of light grey, fine-grained limestone. The strata are nearly horizontal and break into slabs 2 to 10 inches thick. This limestone has ovoid to lenticular patches, commonly 1 inch by 3 inches in section, of slightly lighter coloured but darker weathering dolomitic limestone. The matrix surrounding these patches contains clear brownish grains of crystalline calcite forming 3 to 4 per cent of the rock.

Station 195BK: on Pasquatchai River at 54° 54'00"N; 91° 11'00"W. Abundant Ordovician debris in the creek bottom; 150 yards upstream 90 per cent of the debris is sandy, light grey mottled limestone which occurs as blocks up to 2.5 feet square. These rocks are composed of 20 per cent quartz sand and probably represent the Portage Chute Formation. The abundance of this debris suggests that it represents near outcrop or a frost shattered outcrop.

Station 505NE: on north bank of Severn River immediately below eastern end of rapids over Precambrian crystalline rocks at 54° 28'45"N; 89° 28'00"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
2	Limestone, yellowish brown, irregularly mottled, aphanitic, beds 2 to 3 inches thick, weathers pale yellowish brown.	3.0
1	Limestone, sandy, yellowish brown, with 40 per cent quartz sand grains, beds 3 to 8 inches thick, weathers yellowish grey. Megafossils include: <i>Maclurites</i> sp. (GSC loc. 80610). Microfossils include the conodonts (GSC loc. 80113): <i>Drepanodus homocurvatus</i> Lindström <i>Belodina compressa</i> (Branson and Mehl) cf. <i>Sagittodontus</i> sp. <i>Panderodus</i> sp.	1.5

Conodont identifications by T. T. Uyeno are indicative of a Middle and/or Upper Ordovician age.

Clendenning River and Winiskisis Channel areas (Fig. 9)

Exposures of Ordovician strata are sparse within the area covered by Figure 9. Careful searches for Paleozoic outcrops near the edge of the Precambrian Shield were made along Tabosokwia Channel, Winisk

and Fawn rivers. Paleozoic rubble is present along stretches of Fawn River. Ordovician rocks in the area are presumably relatively thin and nearly flat lying. Two areas of Ordovician rocks are present along the

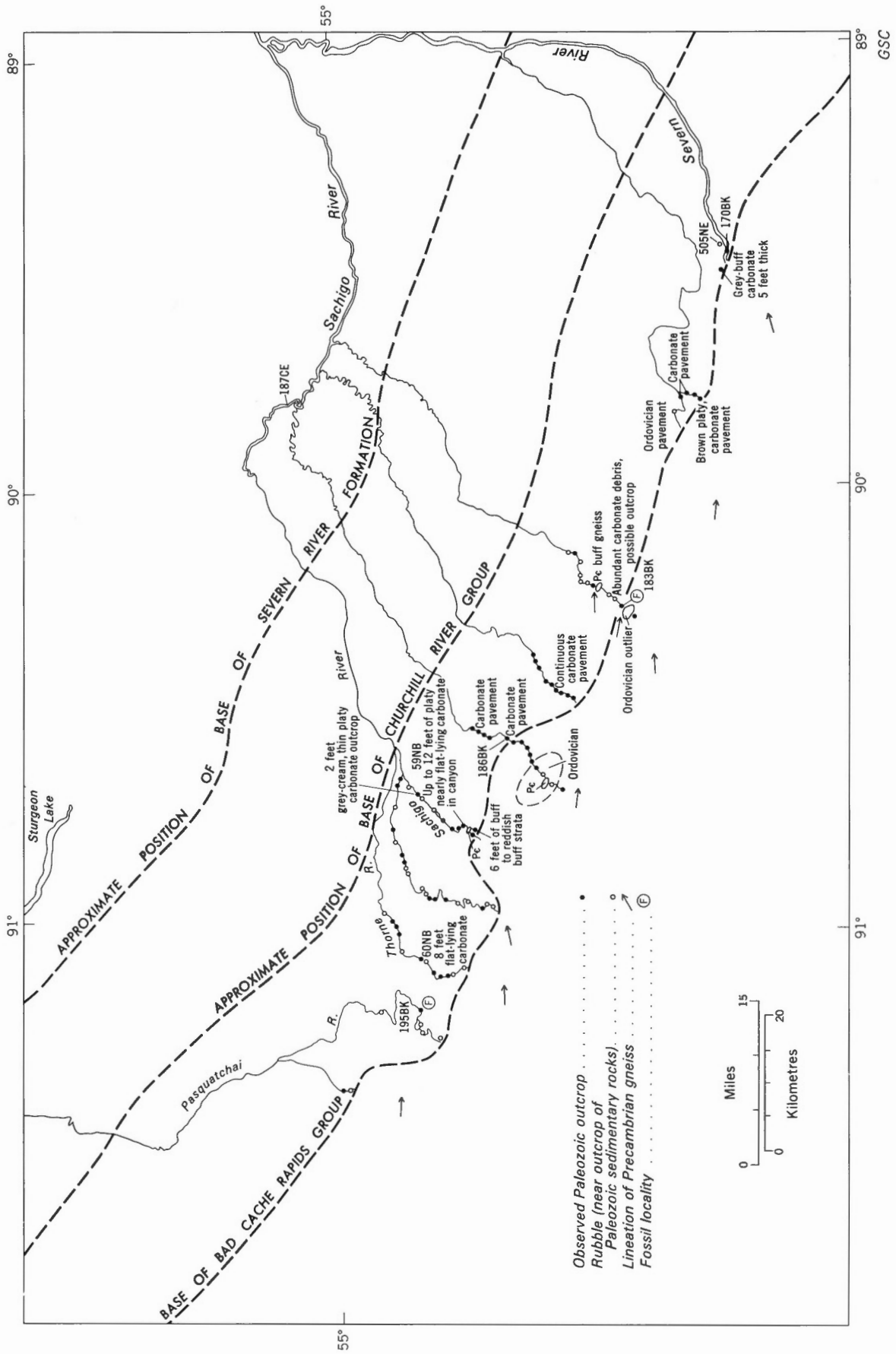


Figure 8. Geological sketch map of parts of Thorne River (53 J) and Fawn River (53 I), Sturgeon Lake (53 P) map-area, showing Ordovician localities.

Asheweig River, along a stretch of the river 10 miles below Precambrian granites at Greenstone Rapids.

The position of the Precambrian-Paleozoic contact has received an alternative interpretation by Hobson (1969, p. 239-240) who suggested a northeast-trending basement high in the area, based on a regional seismic refraction survey. The northwest portion of this suggested contact is shown on Figure 9; the southeast portion lies outside the figure. It is now known that Ordovician outcrops are present in the middle portion of the Precambrian prong indicated on Figure 11 of

Hobson (1969). These outcrops on the Asheweig River reaffirm the mapped position of the edge of the Ordovician strata (Geol. Surv. Can., map 17-1967). However, the thickness of the Ordovician strata throughout the area shown on Figure 9 is relatively thin (perhaps in the order of several hundred feet) and the beds are nearly flat lying and outcrop information in general lacking. As suggested by Hobson (1969, p. 239), perhaps velocity contrasts in the area do not permit a relatively thin Ordovician section to be detected by the seismic technique.

Station 1NE: southwest bank of island in Asheweig River at 54°01'30"N; 87°28'00"W.

Unit	Portage Chute Formation	Thickness (feet)
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1	Limestone, aphanitic, olive grey, grey and light brownish grey, weathers yellowish grey, bedding 2 to 6 inches thick, weathers platy and very light grey. Some beds somewhat argillaceous, rare stromatoporoids, straight cephalopods, and gastropods (<i>Maclurites</i>); sparse grains of well rounded, medium to coarse quartz sand, are present in the limestone.	4.0
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Fossils from this outcrop include (GSC loc. 80599):

Isotelus sp.

fragment of *Lingula* ? sp.

indet. black fragments (scolecodonts?)

Fossils from talus of adjacent outcrops include (GSC loc. 80600):

? *Plectoceras* sp. Hyatt, 1884

small smooth ostracodes

Cycloceras ? sp.

indet. black fragments (scolecodonts?)

Fossils from both collections are of Ordovician age and the general facies and fauna is similar to that of the Blue Mountain Formation of southern Ontario.

Station 2NE: on north bank of Asheweig River opposite downstream end of small island at 54°58'30"N; 87°37'00"W.

Portage Chute Formation

Limestone, silt size to aphanitic with biogenic fragments, very pale yellowish brown; weathering colour not seen; beds about 2 inches thick; some impure chert; strophomenid brachiopods, gastropods, and cephalopods present.

Bedding attitude nearly flat lying. These form extensive submerged outcrops, some of which are only 2 feet below water level and thus could be sampled.

Large blocks of similar limestone are present on the banks of the river. This float material (GSC loc. 80602) appears similar to the submerged outcrop and contains:

small coral indet.

Platystrophia sp.

Rafinesquina sp. (very convex species)

Maclurites sp.

Endoceras sp.

Diestoceras (*Gomphoceras*) sp.

Fossils collected from the submerged outcrop (GSC loc. 80601) are:

Rafinesquina? sp.

Rhychotrema sp.

Strophomena sp.

cf. *Isotelus* sp.

echinoderm fragments

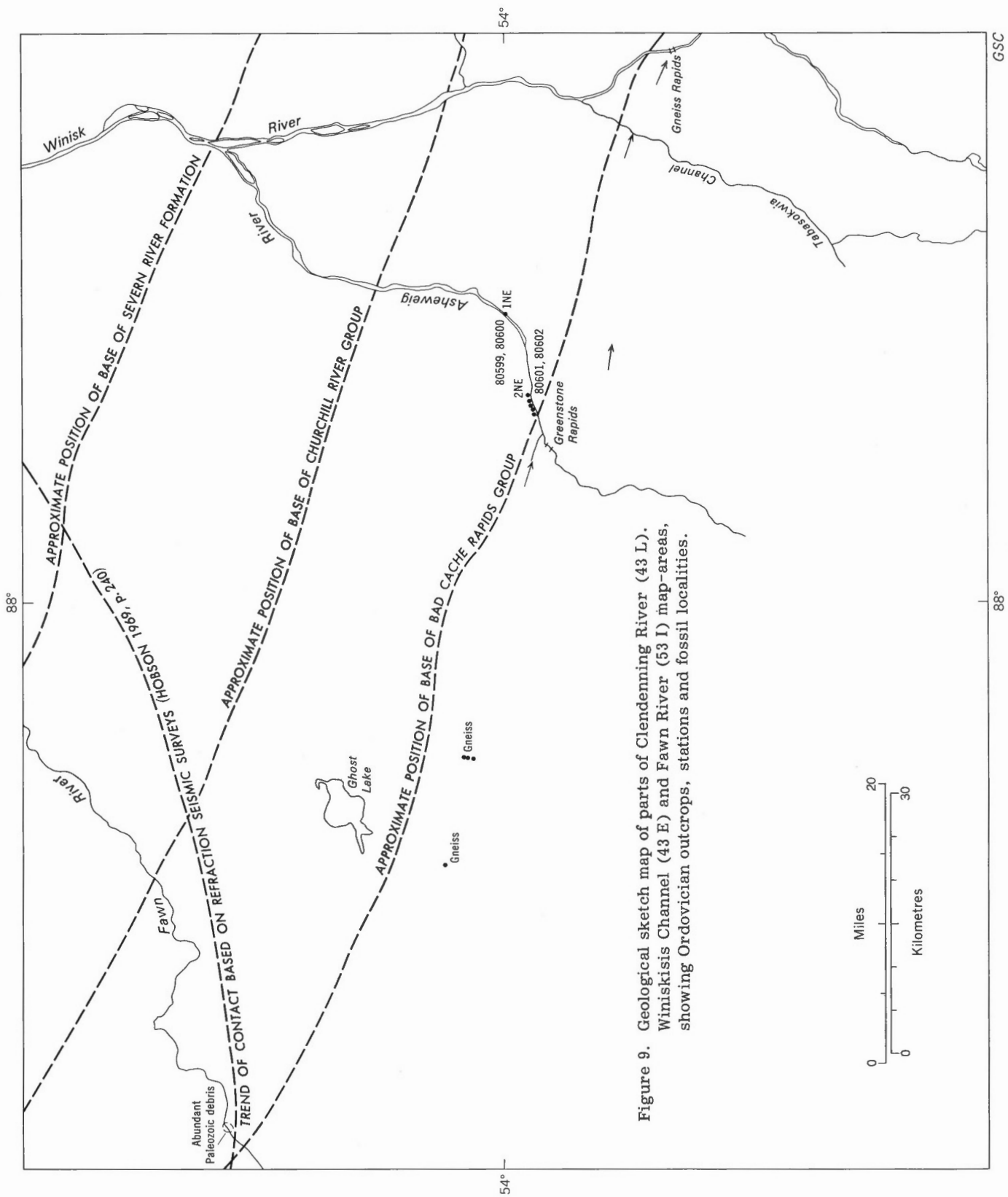


Figure 9. Geological sketch map of parts of Clendenning River (43 L), Winiskisis Channel (43 E) and Fawn River (53 I) map-areas, showing Ordovician outcrops, stations and fossil localities.

These fossils indicate an Upper Ordovician age and a Red River faunal equivalent. Above station 2NE, a limestone pavement forms much of the river bed, up

to within 50 yards of the Precambrian outcrop upstream. A limestone pavement is present also below station 2NE.

Ekwan River to Attawapiskat River (Fig. 10)

During Operation Winisk, traverses in the relatively inaccessible region of the axial portion of the Cape Henrietta Maria Arch located numerous previously unsuspected outcrops of Ordovician strata, on the Ekwan, Muketei and Attawapiskat rivers and along Winiskisis Channel. Exposures on the Attawapiskat River, northwest of Missisa Lake were previously assigned to the Silurian Severn River Formation (Geol. Surv. Can., map 17-1967) but are now known to con-

tain Ordovician conodonts.

Typically the outcrops, in the area covered by Figure 10, display only a few feet of outcropping section at any one locality. The river bottoms near these outcrops may be paved with carbonate rocks. The Precambrian inlier, shown in the southeast corner, presumably was a basement knob during Ordovician time and in the subsurface the Ordovician strata are presumably overlapped by Silurian beds.

Station 125CE: Ekwan River at 53°26'45"N; 86°06'45"W, south of a comma-shaped island. No outcrop, but large blocks and slabs, up to 4 feet long, at rapids of light grey sandy limestone (4 per cent sand). This sandy limestone shows desiccation cracks, occasional smoky quartz pebbles ¼ inch in diameter and *Iliaenus* trilobite fragments.

Station 126CE: on east bank of the Ekwan River at 53°25'N; 86°09'W. No outcrop, but slabs 4 square feet and 8 inches thick of light grey mottled limestone, weathering light yellowish brown and containing echinoderm fragments and *Maclurites* sp.

Station 127CE: on east bank of the Ekwan River at 53°25'30"N; 86°08'00"W, 4.4 miles south of 53°30'N. Exposed section 3 feet thick with an additional 1 foot underwater of light grey bioclastic limestone in beds averaging 4 inches thick. Vertical joint sets at 220° and 140°. Corals and brachiopods are relatively abundant; fossils include:

- Streptelasma* sp.
- Sowerbyella* sp.
- Hormotoma* sp.
- scolecodont indet.

Station 128CE: on west bank of Ekwan River, at 53°26'15"N; 86°07'10"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light grey, bioclastic, in beds up to 18 inches thick, contains a few horn corals, echinoderm fragments, " <i>Dalmanella</i> " sp., trilobite fragment. Jointing 113°/80S and 190°/80E. (see Pl. VII A).	3.0

Station 129CE: on east bank of Ekwan River at 53°25'45"N; 86°08'00"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, algal, light grey, thin-bedded, bioclastic, mottled, weathers brownish yellow with limonitic staining. Contains crinoidal fragments.	1.5

Station 130CE: on east bank of the Ekwan River at 53°26'N; 86°07'W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limetstone, light grey, bioclastic, mottled, in beds 1 inch to 2 inches thick. Jointing 035°/90 which is the river direction at this point. Bedding surface shows brownish yellow weathering with limonitic stain. Fossils abundant (GSC loc. 81765):	2.5

- Streptelasma* sp.
- Sowerbyella* sp.
- Liospira* ? sp.
- Armenoceras* sp.
- echinoderm fragments

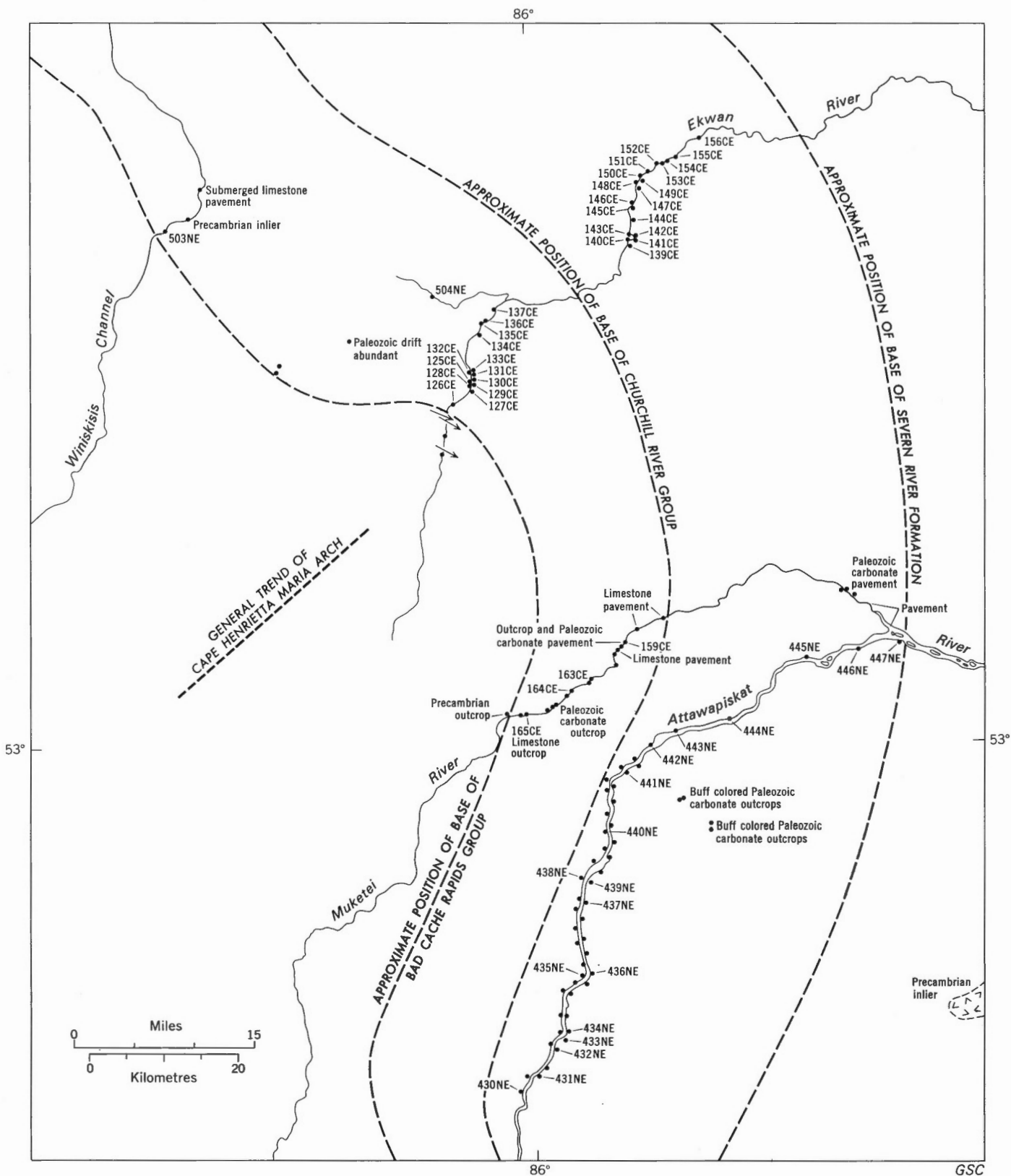


Figure 10. Geological sketch map of parts of Matateto (43 F), Winiskisis Channel (43 E), Missisa Lake (43 C) and Lansdowne House (43 O) map-areas, showing Ordovician outcrops, stations and fossil localities.

Station 131CE: on east bank of Ekwan River at 53°26'30"N; 86°07'00"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light grey, mottled, beds average 2 inches thick (see Pl. VII B). Contains vertical sandstone dykes up to ½ inch wide which strike 135° and 145°; jointing at 127°/30N. The sandstone dykes have a carbonate matrix and 80 per cent of the vein material is well rounded milky quartz grains. These dykes were presumably injected into this horizon from underlying beds of the Portage Chute Formation. The limestones are fossiliferous and contain <i>Lepidocyclus</i> sp.; and T. T. Uyeno has identified <i>Drepanodus suberectus</i> (Branson and Mehl) and <i>Panderodus</i> sp. (GSC loc. 80312).	2.0

Station 132CE: on west bank of Ekwan River at 53°27'20"N; 86°07'00"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, grey bioclastic, contains <i>Lepidocyclus</i> ? sp. brachiopod indet. bryozoan indet. echinoderms Sandstone dykes up to ½ inch wide, oriented 295°/60N	5.0

Station 133CE: on east bank of the Ekwan River at 53°27'30"N; 86°07'00"W; [3.0 miles south of 53°30'N].

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light grey, mottled, with dichotomously branching fucoidal markings, <i>Isotelus</i> sp., gastropods and large endocerid cephalopods (see Pl. VIII C). Vertical joints at 355° are parallel to the river bank.	2.0

Station 134CE: on east bank of Ekwan River at 53°29'45"N; 86°07'00"W; [0.2 mile north of 53°30'N].

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light grey, bioclastic with uneven beds ½ inch to 2 inches thick. A pavement occurs in the river for 100 yards downstream.	3.0

Station 135CE: on west bank of the Ekwan River at 53°31'30"N; 86°06'00"W; [1.1 miles north of 53°30'N].

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light grey, bioclastic with uneven and wavy beds 1 inch to 3 inches thick, contains crinoidal fragments and <i>Sowerbyella</i> sp. A pavement occurs for 150 yards upstream.	3.5

Station 136CE: on west bank of Ekwan River at 53°32'00"N; 86°05'00"W; [1.1 miles north of 53°30'N].

Unit	Bad Cache Rapids Groups	Thickness (feet)
1	Limestone, light grey, mottled, bioclastic with <i>Palaeophyllum</i> sp. (GSC loc. 81766).	1.5

Station 137CE: west bank of the Ekwan River at 53°32'00"N; 86°04'00"W; [2.1 miles north of 53°30'N].

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light grey, bioclastic in beds 1 inch to 3 inches thick; overlying the limestone are Pleistocene shells in sand, 18 feet above river level at an elevation of about 400 feet.	3.5

Station 139CE: on east bank of the Ekwan River at 53°36'25"N; 85°47'30"W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, argillaceous, white to pale greenish grey, in beds 4 to 6 inches thick and averaging 2 to 3 inches thick; displays worm casts, mudcracks (see Pl. VIII D), and rip-off argillaceous chips up to an inch long. No fossils were observed.	3.5

Station 140CE: on west bank of Ekwan River at 53°36'45"N; 85°47'40"W; [2 miles north of 53°35'N].

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, argillaceous, pale greenish grey, beds platy, up to 3 inches thick and with blue clay partings, with ripple-marks oriented 350°; breaks into irregular blocks up to 18 inches square. Bedding undulates gently; no fossils observed.	2.5

Station 141CE: on east bank of the Ekwan River at 53°36'45"N; 85°46'40"W; [1.9 miles north of 53°35'N].

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, argillaceous, pale greenish grey, in beds 1 inch to 3 inches thick (see Pl. IX A). No fossils observed.	2.5

Station 142CE: on east bank of the Ekwan River at 53°37'15"N; 85°38'00"W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, argillaceous, a light greenish grey, with a few small vugs lined with drusy calcite.	4.0

Station 143CE: on west bank of the Ekwan River at 53°37'15"N; 85°38'00"W; [2.5 miles north of 53°36'N].

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, argillaceous, light greenish grey, some shale chip, conglomerate with fragments up to 5 inches in diameter mudcracks, ripple-marks striking at 250°.	4.0

Station 144CE: on east bank of the Ekwan River at 53°38'00"N; 85°47'00"W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, light green grey, silty, mudcracked and in platy beds averaging 2 inches thick, bedding flatlying.	1.0

Station 145CE: on east bank of the Ekwan River at 53°39'10"N; 85°47'00"W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, pale green grey, silty with shale chip conglomerate beds and mudcracks.	1.0

Station 146CE: on west bank of the Ekwan River at 53°39'30"N; 84°46'50"W; [5.1 miles north o 53°35'N].

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, silty, light greenish grey, beds platy, 2 to 4 inches thick (see Pl. IX B), sparse vugs lined with drusy calcite up to 5 inches in diameter. Bedding gently undulating with some surface showing dessication cracks.	5.0

Station 147CE: on east bank of Ekwan River at 53°40'30"N; 85°46'20"W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, light greenish grey and creamy white, interbedded in beds 1½ to 2 inches thick. Fossils include (GSC loc. 80320) <i>Strophomena</i> sp. and the conodonts: <i>Drepomodus suberectus</i> (Branson and Mehl) <i>Ozarkodina tenuis</i> (Branson and Mehl) <i>Panderodus</i> sp.	5.0

Station 148CE: on west bank of the Ekwan River at 53°40'50"N; 85°46'30"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
5	Limestone, dolomitic, algal, yellowish brown to yellowish grey, with vugs lined with calcite and tiny blade-like cavities representing dissolved anhydrite crystals.	3.0	8.5
4	Limestone, dolomitic, weathering light grey, with <i>Isotelus</i> sp. (GSC loc. 18772).	1.0	5.5
3	Shale, light grey, barren of conodonts.	1.0	4.5
2	Dolomite, light yellowish grey weathers white.	1.5	3.5
1	Dolomite, silty, light grey, platy beds with fucoid markings.	2.0	

Station 149CE: on the east bank of the Ekwan River at 53°41'05"N; 85°45'50"W. Contains the same succession as station 148CE, with the exception that unit 4 contains a more varied fauna (GSC loc. 81775) as follows:

- brachiopod indet.
- small smooth ostracodes
- bryozoans - cf. *Arthroclema* sp.
- echinoderm fragments
- small snails
- trilobite fragments
- Rhinodictya* sp.

These fossils are badly macerated and are not sufficiently well preserved to allow an age determination.

Station 150CE: on west bank of the Ekwan River at 53°41'15"N; 85°46'00"W. An exposure of the same section as at 148CE with the exception that a few inches of fine-grained, light grey, sandstone occurs at the base of shale unit (unit 3).

Station 151CE: west bank of the Ekwan River at 53°41'40"N; 85°15'00"W;

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, pale yellow, white weathering, with occasional <i>Favosites</i> sp.	2.5

Station 152CE: on west bank of the Ekwan River at 53°42'00"N; 85°44'00"W.

Unit	Churchill River Group	Thickness (feet)
	Dolomite, pale yellow in beds 1 inch to 2 inches thick, containing blebs of dark grey chert up to 2 inches in diameter making up to 5 per cent of the rock.	2.0

Station 153CE: on west bank of the Ekwan River at 53°42'10"N; 85°43'30"W. This locality is near the Hudson Bay-James Bay watershed (see Cumming, 1969a; Fig. 4, p. 156) and there is little active erosion on the Ekwan River. There is no outcrop on the banks but a carbonate pavement can be seen underwater.

Station 154CE: on east bank of Ekwan River at 53°42'20"N; 85°42'50"W;

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, slightly calcareous, pale yellow in platy beds 2 to 3 inches thick, white weathering.	0.5

Station 156CE: on the east bank of the Ekwan River at 53°43'55"N; 85°38'30"W. No outcrop, but entire river bed is paved with carbonate. Specimens from gravel bar in midstream are of light yellowish brown silty dolomite in platy beds averaging 3 inches thick. These show desiccation cracks and shale-chip beds.

Station 504NE: on a tributary of the Ekwan River about 6 miles above junction with the Ekwan River at approximately 53°33'N; 86°12'W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, finely crystalline to silt size, abundant biogenic debris, light olive grey, weathers yellowish orange and greyish orange, bedding 1 inch to 3 inches thick, blocky weathering, resistant. Large <i>Maclurites</i> sp. in float probably derived from these rocks. Some beds are coarsely crystalline in places. A sample for conodont analysis (GSC loc. 80112) yielded: <i>Drepanodus homocurvatus</i> Lindström <i>Cordylodus flexuosus</i> (Branson and Mehl) <i>Panderodus</i> spp.	2.0

This assemblage according to T. T. Uyeno indicates a Middle and/or Upper Ordovician age.

Station 159CE: on north bank of Muketei River at 53°07'30"N; 85°48'50"W.

Unit	Surprise Creek Formation	Thickness (feet)
1	Dolomite, pale yellowish orange, beds 3 to 8 inches thick, vertical joints oriented 185° and 275°. One slab of dolomite contains abundant specimens of a brachiopod similar to <i>Brachyprion</i> sp. and <i>Dalmanella</i> sp. and trilobite and bryozoan fragments.	1.5

Station 163CE: on the northwest bank of the Muketei River at 53°05'00"N; 85°53'10"W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, pale yellow, sugary textured, vugs up to 3 inches long lined with coarse calcite crystals, fossils include trilobite fragments and <i>Favosites</i> ? sp. Strong jointing at 090° and 185°; weathers yellowish brown with irregular limonite stains. On the opposite bank of the river 6 feet of strata are exposed but are inaccessible.	2.0

Station 164CE: on southeast bank of Muketei River at 53°04'10"N; 85°54'50"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
3	Limestone, light grey, bioclastic beds ½ to 1 inch thick.	2.0
2	Dolomite, light to dark grey, original textures of a bioclastic limestone is preserved.	3.5
1	Limestone, dark grey, fucoidal (see Pl. IX C) and fossiliferous (see Pl. IX D) (GSC loc. 81776): <i>Streptolasma</i> ? sp. <i>Rhynchotrema</i> ? sp. endocerid cephalopod trilobite fragments Rubble, presumably from a nearby outcrop, contains a "Red River" Ordovician fauna (GSC loc. 81777) with: <i>Maclurites</i> sp. <i>Receptaculites</i> sp. actinocerid cephalopod	5.0

Station 165CE: on northwest bank of Muketei River at 53°02'30"N, 86°00'50"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, dolomitic, light grey, bioclastic, beds up to 3 inches thick (see Pl. X A), bedding surfaces show limonite staining. Fossils include (GSC loc. 81797): <i>Leiospira</i> sp. <i>Sowerbyella</i> sp. <i>Isotelus</i> sp. trilobite fragments indet. crinoid fragments This is the first outcrop downstream from Precambrian outcrops.	3.0

Station 430NE: on the west bank of Attawapiskat River at 52°36'N; 96°02'W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
5	Dolomite, silt size to finely crystalline, siliceous, greyish yellow, bedding ¼ inch to 6 inches thick, conodonts include (GSC loc. 80036):	3.0	22.0

Unit		Thickness (feet)	
		Unit	From base
	<i>Belodina</i> sp.		
	<i>Panderodus</i> sp.		
	<i>Trichonodella</i> sp.		
4	Covered	8.5	19.0
3	Dolomite, calcareous, yellowish orange, 15 per cent rounded quartz grains, moulds of fossil pelecypods and ostracodes in biogenic layers. Conodonts include (GSC loc. 80035):	0.5	10.5
	<i>Belodina</i> sp.		
	<i>Ozarkodina</i> sp.		
	<i>Panderodus</i> sp.		
2	Covered	4.0	10.0
1	Sandstone, fine to coarse subrounded grains, calcareous cement, brownish grey, beds 3 to 15 inches thick. Microfossils include (GSC loc. 80034):	6.0	
	<i>Drepanodus homocurvatus</i> Lindström		
	<i>Eoligonodina</i> ? sp.		
	<i>Ozarkodina</i> sp.		
	T. T. Uyeno regards these as Middle and/or Upper Ordovician in age.		

Station 431NE: on the east bank of Attawapiskat River at 52°36'N; 86°01'W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
3	Dolomite, silt size to finely crystalline, some drusy cavities, some interbedded quartz sandstone, beds 2 to 6 inches thick, weathers dull greenish grey.	5.5	22.5
2	Covered	11.0	17.0
1	Sandstone, fine to coarse subrounded quartz grains, calcareous cement.	6.0	

Station 432NE: on the east bank of the Attawapiskat River at 52°37'30"N; 85°58'00"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
3	Dolomite arenaceous, siliceous, olive grey, beds ¼ inch to 5 inches thick, contains clasts of dolomite in lower part, weathers greyish orange.	8.0	14.0
2	Covered	5.0	6.0
1	Dolomite, fine to medium crystalline greyish orange, contains 5 per cent rounded quartz sand, beds 1 inch to 8 inches thick; contains ostracodes, pelecypods and gastropods.	1.0	

Station 433NE: on the east bank of the Attawapiskat River at 52°38'N; 85°57'W.

Unit	Churchill River, Group	Thickness (feet)
1	Dolomite, greyish orange, beds 1 inch to 3 inches thick, weathers pale greyish orange.	2.0

Station 434NE: on the east bank of Attawapiskat River at 52°39½'N; 85°57'W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, argillaceous, greyish orange, bedding 2 to 8 inches thick, some quartz sandstone and greenish grey mudstone. Microfossils include (GSC loc. 80038): <i>Panderodus</i> spp.	11.5

Station 435NE: on the west bank of Attawapiskat River at 52°43'N; 85°54½'W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, finely crystalline, greyish orange to pale yellowish brown, beds ¼ to ½ inch thick, rare argillaceous dolomite layers, sparse layers with echinoderm debris, rare bryozoans, brachiopod and trilobite fragments. Microfossils (GSC loc. 80039) include: <i>Drepanodus homocurvatus</i> Lindström <i>Ozarkodina robusta</i> Stauffer <i>Panderodus</i> spp. <i>Oistodus excelsus</i> Stauffer <i>Zygognathus deformis</i> (Stauffer) <i>Belodina</i> ? sp. <i>Ecligonodina</i> sp. <i>Cordylodus</i> sp. <i>Prioniodina robusta</i> (Stauffer) T. T. Uyeno regards these as Middle and/or Upper Ordovician in age.	3.0

Station 436NE: on the east bank of Attawapiskat River at 52°45½'N; 85°54'W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, resistant, finely crystalline, greyish orange and pale yellowish brown, beds 1½ to 3 inches thick, weathers yellowish orange and pale greyish orange. Microfossils include (GSC loc. 80040): <i>Drepanodus homocurvatus</i> Lindström indeterminate fragments	1.0

Station 437NE: on the east bank of Attawapiskat River 52°50'N; 85°54'W.

Unit	Churchill River Group	Thickness (feet)
1	Dolomite, finely crystalline greyish orange, beds 1 inch to 4 inches thick, abundant nodules, weathers pale yellowish brown, rare solitary corals.	6.0

Station 438NE: on the northwest bank of Attawapiskat River near head of rapids at 52°51'30"N; 85°53'30"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
6	Dolomite, greyish orange and yellowish orange, mottled, nodular, beds 1 inch thick, recessive, weathers yellowish orange.	5.5	25.0
5	Dolomite, pale greyish orange, beds 3 to 18 inches thick, resistant, weathers yellowish grey.	2.5	19.5
4	Dolomite, greyish orange with dark yellowish orange layers and nodules, somewhat recessive, beds 1 inch to 3 inches thick, weathers pale orange.	2.5	17.0
3	Dolomite, silt size to finely crystalline, mottled, greyish yellow and yellowish orange, beds 1 inch to 8 inches thick, flaggy, weathers pale orange, indeterminate brachiopods present.	12.0	14.5
2	Covered	1.0	2.5
1	Dolomite, calcareous, finely crystalline, yellowish orange, beds 1 inch to 3 inches thick, contains <i>Favosites</i> sp., solitary corals and indeterminate brachiopods.	1.5	

Station 439NE: on the east bank of Attawapiskat River at 52°51'30"N; 85°53'00"W, at west end of an island $\frac{1}{2}$ of a mile downstream from 438NE. Dolomite, similar to that at station 438NE, fossils include solitary corals, strophomenid brachiopods, straight cephalopods and echinoderm debris.

Station 440NE: on the northwest bank of Attawapiskat River at head of canyon at 52°55'30"N; 85°51'00"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
3	Dolomite, light grey, fine to medium crystalline, in beds up to 6 feet thick, weathers pale yellowish orange.	19.0	42.0
2	Dolomite, light brownish grey, fine to medium crystalline, bedding 2 inches to 2 feet thick, some fragmental and siliceous dolomite, rare solitary corals, brachiopods and cephalopods, weathers greyish orange and yellowish orange.	17.0	23.0
1	Dolomite, greyish orange, siliceous, finely crystalline, beds 1 inch to 3 inches thick, weathers yellowish brown.	6.0	

Station 441NE: on the east bank of Attawapiskat River at 52°58'00"N, 85°49'30"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
1	Dolomite, light grey, siliceous, finely crystalline with fine to medium crystalline fragmental laminae, yellowish brown with dark yellow brown laminae, beds 1 inch to 4 inches thick, rare solitary corals, brachiopods and gastropods. Weathers greyish orange.		22.5

Sample 441NEaF from 0 to 15 feet up; strophomenid brachiopods and solitary corals.

Station 442NE: on the west bank of Attawapiskat River at 53°00'15"N, 85°45'30"W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
2	Dolomite, light greyish orange, resistant, beds 3 inches to 3 feet thick, contains brachiopods, cephalopods and echinoderm debris.	21.5	24.5
1	Dolomite, slightly argillaceous, dark yellowish orange, finely crystalline, beds 1 inch to 6 inches thick, weathers yellowish orange.	3.0	

Station 443NE: on the west bank of Attawapiskat River at 53°01'30"N; 85°40'30"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, greyish orange, finely crystalline with pebble-sized clasts of dolomite, beds 1 inch to 2 inches thick, strophomenid brachiopods; weathers pale orange.		5.0

Station 444NE: on the north bank of Attawapiskat River at 53°02'N; 85°37'W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, yellowish orange, finely crystalline, beds 2 to 4 inches thick, biogenic fragments, weathers pale yellowish brown.		1.0

Station 445NE: on the north bank of Attawapiskat River at 53°06'30"N; 85°27'00"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, greyish yellow, argillaceous and interbedded siliceous siltstone ripple-marks and mudcracks present, beds ¼ inch to 2 inches thick, weathers dark yellowish orange.		4.0

Station 446NE: on the east bank of Attawapiskat River just above Black Fence River at 53°07'00"N; 85°13'30"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, yellowish brown, finely crystalline, 20 per cent biogenic debris with corals, brachiopods, ostracodes and gastropods. Microfossils include (GSC loc. 80048): <i>Scyphiodus</i> sp. <i>Panderodus</i> spp. indeterminate fragments		3.0

Station 447NE: on the east bank of Attawapiskat River at 53°07'30"N; 85°16'00"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, brownish grey, finely crystalline, mottled, beds 1 inch to 2 inches thick; contains (GSC loc. 80049) <i>Favosites</i> sp. and <i>Panderodus</i> sp.		2.0

Station 503NE: on the east bank of Winiskisis Channel at 53°38'00"N; 86°43'30"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Limestone, light brown, bioclastic, beds 1 inch to 4 inches thick, weathers yellowish brown.	5.0

Megafossils (GSC loc. 80603) include:

"Dalmanella" sp.
Sowerbyella sp.
Rhynchotrema sp.
Rafinesquina sp.
cf. *Strophomena* sp.
Plaesiomys sp.
Bythocyperys sp.
Solenopora sp.
Glyptocystides ? or *Carocrinites* ?

Megafossils collected from loose blocks (GSC loc. 80604) include:

Sowerbyella sp.
"Dalmanella" sp.
Rafinesquina sp.
Rhynchotrema sp.
cf. *Strophomena trilobatum* ?
Oncoceroid cephalopod
conularia fragment
large trilobite fragment

Conodonts from these beds include (GSC loc. 80111):

Drepanodus homocurvatus Lindström
Eobelodian fornicala (Stauffer)
Salodina grandis (Stauffer)
Cordylodus sp.
Drepanodus suberectus (Branson and Mehl)
Ozarkodina robusta Stauffer
Amorphognathus sp.
? *Culodus casteri* Pulse and Sweet
Trichonodella sp.
Panderodus spp.

About 1 mile upstream from Station 503NE a 5-foot section of similar limestone is exposed. The base of this section is probably within a few feet of the Precambrian rocks beneath, but the Precambrian-

Ordovician contact itself is not exposed. The limestone is flat lying and the Precambrian contact at this locality trends roughly east northeast across the river where two small islands are present and then due north.

Ogoki, Fort Hope, Missisa Lake and Lansdowne House areas (Fig. 11)

The Ordovician belt averages only 5 miles in width, and outcrops are confined to limited exposures on Albany River and Wabassi River. Additional information has been obtained from borings at the proposed Pym and Buffalo Skin dam sites.

In 1968, test borings at Pym (52° 18'N; 86° 16'W) on the Attawapiskat River and at Buffalo Skin (51° 45'N; 86° 11'W) on the Albany River were drilled.

Four holes were drilled at the Pym dam site where up to 24.5 feet of lower Paleozoic sedimentary rocks overlie Precambrian granitic rocks. Holes Py-1 and Py-4 encountered the greatest thickness of lower Paleozoic sediments. The siltstone, shale, sandstone and conglomerate beds are all of Ordovician age. The uppermost dolomites are tentatively assigned to the Severn River Formation of Silurian age (see Fig. 12 and descriptive log).

At the Buffalo Skin dam site three holes were drilled and Hole No. BU-1 provided the best core

recovery and the thickest lower Paleozoic section. Precambrian granitic rocks were cored for 21.4 feet and these were overlain by 105.8 feet of lower Paleozoic bedrock, consisting almost entirely of sandstone with a few interbeds of shale. These detrital rocks were overlain by 2.8 feet of dolomite (see Fig. 13 and descriptive log).

The mudstone, shale, sandstone and conglomerate in this succession are presumably entirely of Late Ordovician age. The uppermost dolomite, 2.8 feet thick, is tentatively assigned to the Silurian Severn River Formation. These cores are stored at the Geological Survey of Canada, Atlantic Geoscience Centre, Bedford Institute, Dartmouth, N. S.

Two Precambrian inliers or basement knobs are shown on Figure 11. Ordovician strata in the subsurface presumably pinch out against these basement knobs and the surface exposures are entirely the Silurian Severn River Formation.

Pym Dam Site

Hole No. PY-1

Elevation ground surface: 603.2 a. s. l.
 Elevation bedrock surface: 501.2 a. s. l.
 Elevation bottom of hole: 432.2 a. s. l.

Depth (feet)

Description by E. B. Owen

0.0 - 102.0	Overburden.
102.0 - 107.0	Dolomite, fine-grained, buff-coloured, sandy.
107.0 - 112.7	Sandstone, argillaceous, fine-grained, grey, slightly dolomitic, scattered shaly partings.
112.7 - 114.2	Shale, sandy, grey.
114.2 - 117.5	Shale, green, slightly sandy and silty.
117.5 - 119.1	Siltstone, green.
119.1 - 123.5	Sandstone, argillaceous, fine-grained, green, considerable secondary marcasite.
123.5 - 125.6	Conglomerate, quartz-pebble, green, sandstone and siltstone matrix.
125.6 - 126.5	Boulder (?): granitic, less weathered than granitic rocks below.
at 126.5	Precambrian surface.

Hole No. PY-4

Elevation ground surface: 610.8 a. s. l.
 Elevation bedrock surface: 497.0 a. s. l.
 Elevation bottom of hole: 449.8 a. s. l.

0.0 - 113.8	Overburden.
113.8 - 115.0	Lost core.
115.0 - 115.3	Dolomite, sandy, fine-grained, buff-coloured, porous.
115.3 - 121.9	Sandstone, dolomitic, argillaceous, fine-grained, grey to buff-mottled, porous, a few minor scattered shaly partings.

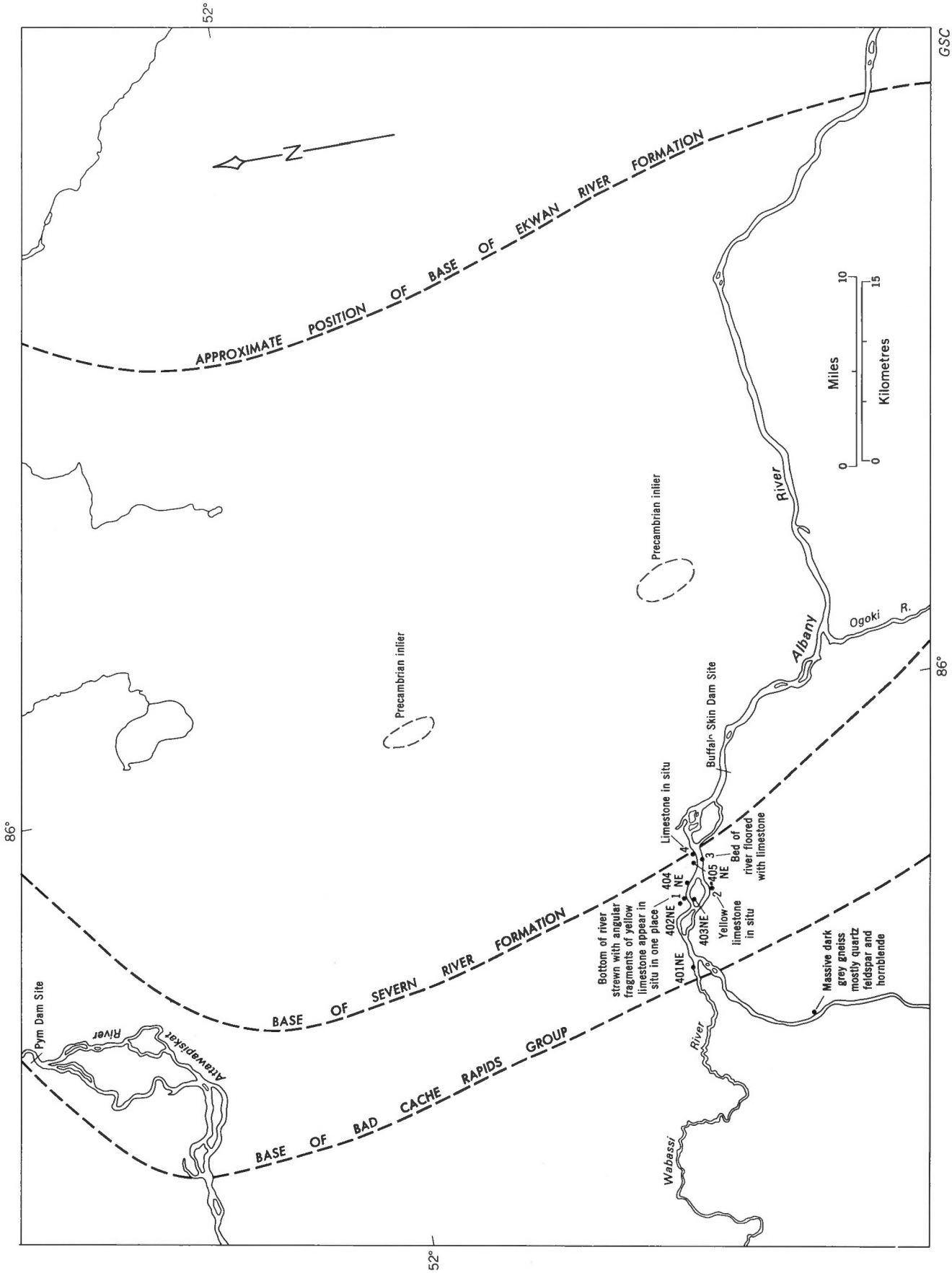


Figure 11. Geological sketch map of parts of Ogoki (42 N), Fort Hope (42 M), Missisa Lake (43 C) and Lansdowne House (43 D) map-areas, showing Ordovician outcrops and location of Pym and Buffalo Skin dam sites and stations 1 to 4 by Robert Bell, 1871.

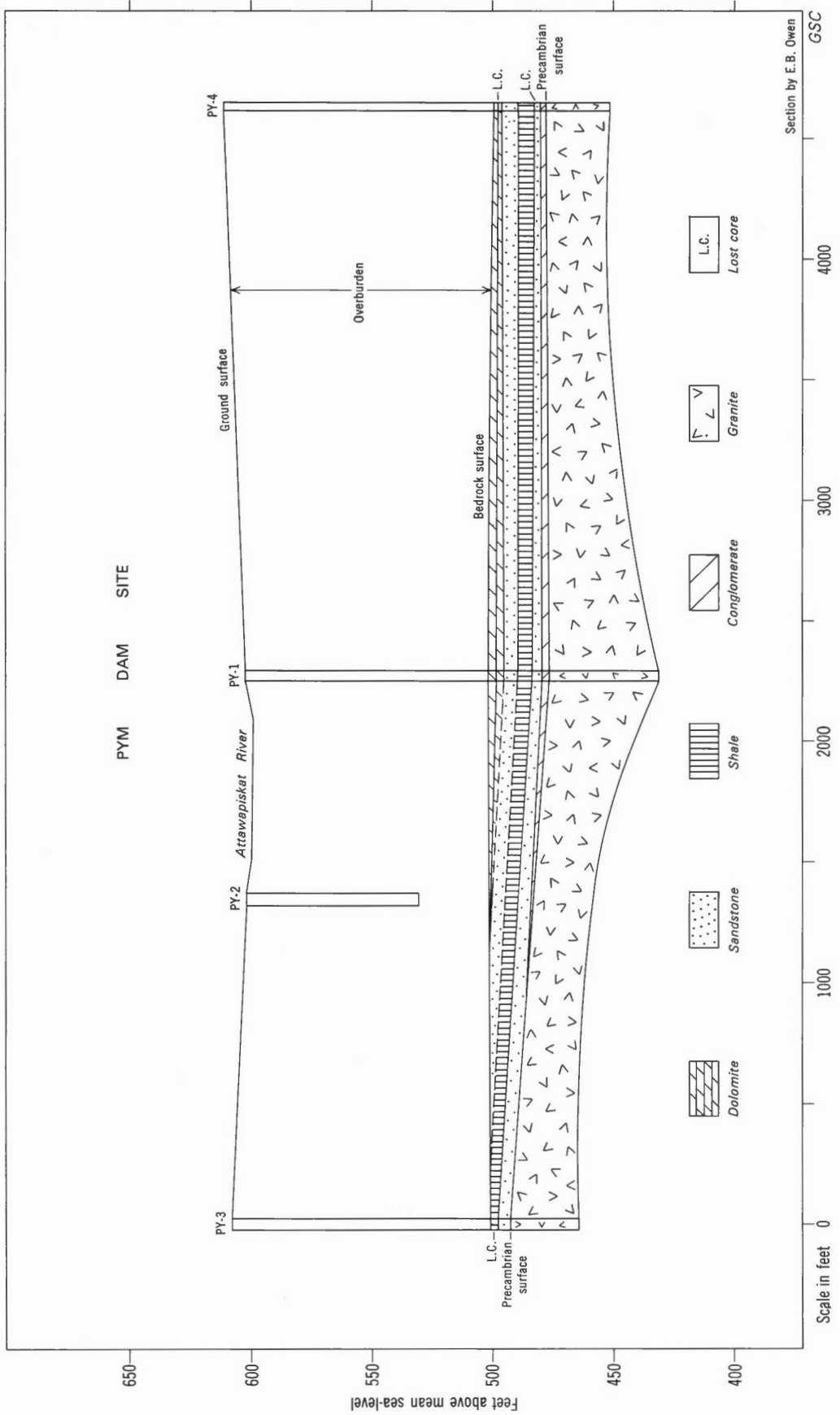


Figure 12. Pym dam site cross-section.

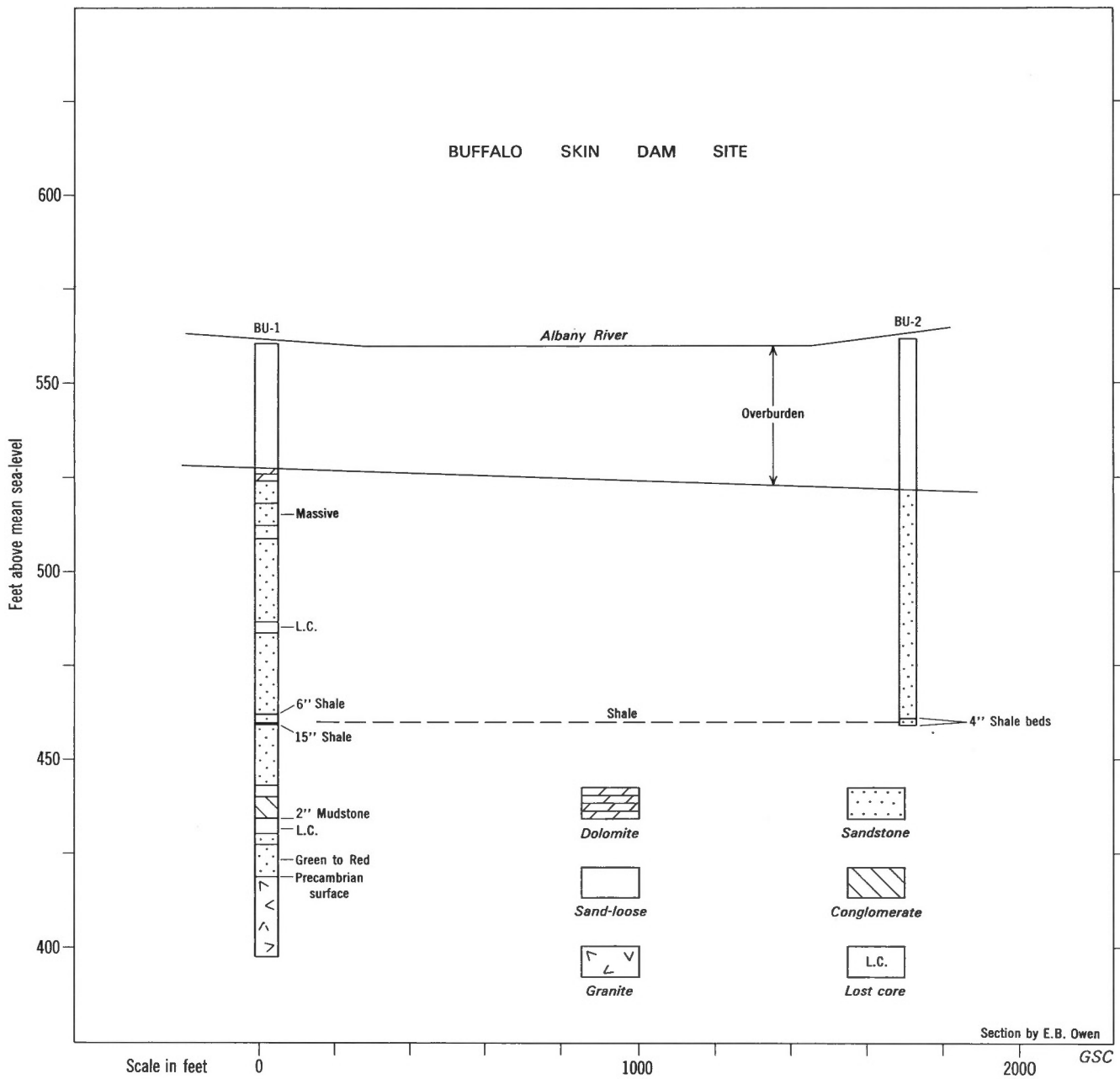


Figure 13. Buffalo Skin dam site cross-section.

Hole No. PY-4 (cont'd)

121.9 - 125.3	Shale, sandy, grey.
125.3 - 129.0	Shale sandy, green.
129.0 - 131.0	Lost core.
131.0 - 131.2	Shale, sandy, green.
131.2 - 132.4	Sandstone, argillaceous, fine-grained, green.
132.4 - 132.9	Conglomerate, quartz pebbles up to ½ inch in diameter, green silty to sandy matrix.
132.9	Precambrian surface.

Buffalo Skin Dam Site

Hole No. BU-1

Elevation ground surface: 565.7 a. s. l.
 Elevation bedrock surface: 531.4 a. s. l.
 Elevation bottom of hole: 403.1 a. s. l.

Description by E. B. Owen

Bedrock consisted almost entirely of sandstone with a few scattered shale interbeds. Precambrian rocks were encountered near the bottom of the hole. There were indications of percolating groundwater throughout most of the hole.

<u>Depth (feet)</u>	
0.0 - 34.3	Overburden.
34.3 - 37.1	Dolomite, fine-grained, buff, vuggy, weathered, core badly broken.
37.1 - 43.9	Sandstone, fine-grained, light grey, calcareous, considerable brown carbonate along vertical fractures at 40.0 - 40.4 and 42.8 - 43.4.
43.9 - 48.5	Sandstone, fine-grained, white, massive, slightly calcareous.
48.5 - 51.4	Sandstone, same as for 37.1 - 43.9.
51.4 - 56.0	Sandstone, fine-grained, buff, considerable pitting in lower part where 24 inches of core is lost.
56.0 - 71.3	Sandstone, fine-grained, buff, vuggy, core badly broken, longest core is 2 inches, 12 feet of core lost; only 16 inches of core recovered between 56.0 - 65.5.
71.3 - 75.1	Sandstone, fine-grained, grey with buff, minor pitting, core broken, 4 feet of core lost.
75.1 - 76.8	Lost core.
76.8 - 84.0	Sandstone, as for 71.3 - 75.1, scattered vugs ½ inch in diameter.
84.0 - 98.2	Sandstone, slightly calcareous, fine-grained, grey, a few scattered vugs 1/8 inch in diameter.
98.2 - 98.8	Sandstone, shaly, fine-grained, dark brown.
98.8 - 99.3	Sandstone, as for 84.0 - 98.2.
99.3 - 99.8	Shale, dark grey to black, soft, a distinct bed.

Hole No. BU-1 (cont'd)

99.8 - 100.7	Sandstone, as for 84.0 - 98.2.
100.7 - 101.3	Sandstone, fine-grained, reddish brown, a distinct bed.
101.3 - 101.6	Sandstone, as for 84.0 - 98.2
101.6 - 102.9	Shale, dark grey to black, soft.
102.9 - 112.6	Sandstone, fine- to medium-grained, grey, a few scattered irregular, shaly partings.
112.6 - 118.1	Sandstone, silty, carbonaceous, fine-grained, light grey, porous, friable, loosely cemented.
118.1 - 121.1	Sand, fine- to medium-grained, loose, unconsolidated.
121.1 - 126.4	Conglomerate, sandy matrix, carbonaceous, angular to rounded pebbles, porous, slightly friable.
126.4 - 126.6	Mudstone, sandy and silty, dark grey to slightly brownish.
126.6 - 130.8	Lost core.
130.8 - 132.7	Sandstone, fine-grained, light grey, soft, friable.
132.7 - 135.2	Sandstone, argillaceous, medium-grained, green, considerable secondary marcasite in upper 18 inches.
135.2 - 140.1	Sandstone, slightly argillaceous, medium-grained, reddish brown.
140.1	Precambrian surface.
140.1 - 162.6	Precambrian granite.
162.6	Bottom of hole.

In 1871, Robert Bell of the Geological Survey of Canada made a micrometer survey of the Albany River (Manuscript plotting sheet GSC No. 26 and GSC field notebook 1709).

The following 4 stations of Robert Bell show his observations of September 20 (1871). Locations are shown on Figure 11.

Station 1: north bank of Albany River at 51°46'00"N; 86°46'00"W. "Bottom of river strewn with angular fragments of yellow limestone appear in situ in one place; swift-fall 3 feet."

Station 2: south bank of Albany River 51°45'00"N; 86°47'00"W. "Yellow limestones, in situ."

Station 3: south bank of Albany River at 51°45'N; 86°49'W. "Bed of river floored with limestone; dip with current 10 feet per mile."

Station 4: north bank of Albany River at 51°45'15"N; 86°49'00"W. "Limestone in river."

Station 401NE: on northeast bank of Wabassi River at 51°46'30"N; 86°19'00"W.

Unit	Bad Cache Rapids Group	Thickness (feet)
1	Dolomite, yellowish brown, siliceous, fine to medium crystalline, 5 per cent quartz sand and silt, some quartz grains are subangular, beds 2 to 8 inches thick, weathers greyish orange.	2.0

Station 402NE: on north bank of Albany River; at 51°46'N, 86°14'W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, light brown, arenaceous, up to 30 per cent angular and sub-rounded quartz sand, beds 3 to 14 inches thick, weathers dark yellowish orange; megafossils include: ? <i>Favosites</i> sp., brachiopods, cephalopods and gastropods.		5.0

Station 403NE: on the Albany River at 51°46'N; 86°14'W.

Unit	Churchill River Group	Thickness (feet)	
		Unit	From base
2	Dolomite, argillaceous, yellowish brown, finely crystalline, chert nodules, beds 1/8 inch to 3 inches thick, weathers yellowish orange; brachiopods abundant.	3.0	5.0
1	Dolomite, argillaceous, light brown, up to 30 per cent quartz sand grains, beds 3 to 14 inches thick, weathers yellowish orange.	2.0	2.0

Station 404NE: north bank of Albany River at 51°45'15"N, 86°13'00"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, arenaceous, yellowish orange, with up to 30 per cent angular quartz sand grains, beds flat lying.		0.5

Station 405NE: on the north bank of Albany River at 51°45'15"N; 86°11'00"W.

Unit	Churchill River Group	Thickness (feet)	
1	Dolomite, siliceous, greyish orange, nodular, beds 1 inch to 6 inches thick, weathers yellowish orange.		4.5

Little Current River to Kenogami River (Fig. 14)

A five-mile-wide northwest-southeast trending belt of Ordovician strata is terminated south of Kenogami River by a major fault, the result of uplift of Precambrian rocks on the south side of the Moose River Basin.

Martison (1953, p. 57) described this Ordovician belt as "flat-lying to undulating in attitude, but the areal extent is small, and the observed thickness approximately 30 feet. . . ."

Ordovician outcrops are limited to the Little Current and Kenogami rivers and high water levels during June, 1967, restricted the amount of section available for observation.

Two small Precambrian inliers are shown on Figure 14, one on the Kenogami River and another on the Little Current River. Both represent small mounds on the peneplained basement surface. Adjacent Ordovician beds show radially outward initial dips. A larger inlier of Ordovician and Precambrian rocks had previously been interpreted between Kingfisher and Drowning rivers. Interpretation was based on the occurrence of strong lineaments, as seen on airphotos

(Sproule, 1962; Fig. 3). These widespread lineaments were regarded as indicative of outcrop or near-outcrop of Precambrian rocks. Thus, the occurrence of an inlier extending for 15 miles in a northeast direction was proposed (see area outlined by dots on Fig. 14).

An interpretation by P. H. McGrath, Geological Survey of Canada, from depth determinations calculated from anomalies occurring on Geological Survey of Canada regional aeromagnetic maps indicates a uniform slope of the basement surface to the eastward, deepening gradually to 1,060 feet (see Fig. 14). A basement depth of 638 feet below surface level has also been determined between Kingfisher and Drowning rivers. Thus, the strong lineaments referred to above are here interpreted as intersecting regional joint systems in Silurian strata. These may have been caused by subsurface leaching of evaporites and subsequent collapse of overlying beds of the Kenogami River Formation (Cumming, 1969, p. 160).

Also shown on Figure 14 is the approximate subsurface position of two carbonatite complexes. These

circular features (see Geol. Surv. Can. Map 7119G) occur approximately 1,000 feet below the bedrock surface. They are a part of a north-south string of a

similar carbonatite complexes which extend for about 60 miles, to the north of Albany River.

Station 421NE: on the northwest bank of Little Current River at 50°48'00"N; 85°49'30"W.

Unit	Thickness (feet)
1 Dolomite, arenaceous, light olive grey, finely crystalline, beds 1 inch to 2 inches thick, flat lying, weathers yellowish grey. Megafossils include: <i>Rafinesquina alternate</i> (Conrad) <i>Anomalodonta gigantea</i> Miller <i>Modiolopsis concentricus</i> Hall and Whitfield <i>Heterocrinus</i> ? (columnal only)	0.5

These fossils provide important evidence in establishing the Upper Ordovician (Richmond) age for the oldest Paleozoic rocks along the western margin of the Moose River Basin. The above identifications were made by E. O. Ulrich. The fossils were collected by W. J. Wilson on July 9, 1903 from "solid limestone in south bank (of the Little Current River) below station

146." Wilson noted (1903, p. 14) that the limestone "breaks up like dry Leda Clay which it resembles very much." The fossil location is plotted on the W. J. Wilson and Owen O'Sullivan manuscript map (GSC Map Sheet No. 10, I-1-35) scale 40 chains = 1 inch and noted in O'Sullivan's notebook (GSC No. 396, p. 7).

Stations 17CE (= 42NE): on the southeast bank of Little Current River at 50°49'35"N; 85°49'00"W.

Unit	Thickness (feet)
1 Dolomite, arenaceous, with 25 per cent quartz clasts, beds 6 to 8 inches thick, dark yellowish orange, weathers pale yellowish brown, beds show an initial dip of 15 degrees upstream. Precambrian grey granitic gneiss outcrops in the middle of the river and on the north bank.	10.0

Station 420NE: on the southeast bank of Little Current River at 50°46'30"N; 85°52'00"W.

Unit	Thickness (feet)
1 Dolomite, argillaceous, finely crystalline, olive grey, weathers yellowish grey and blocky. Megafossils (GSC loc. 78436) include: <i>Rafinesquina</i> sp. cf. <i>R. alternate</i> Conrad " <i>Dalmanella</i> " sp. <i>Zygospira</i> sp. <i>Hormatoma</i> sp. <i>Lophospira</i> sp. <i>Byssonchia</i> sp. ? dendroid graptolites smooth ostracodes worm markings	1.0

Age: The general taxa are similar to that of the Dundas Formation of southwest Ontario (Eden-Maysville) but no precise Ordovician age is assigned to this fauna (G. Winston Sinclair, pers. comm.).

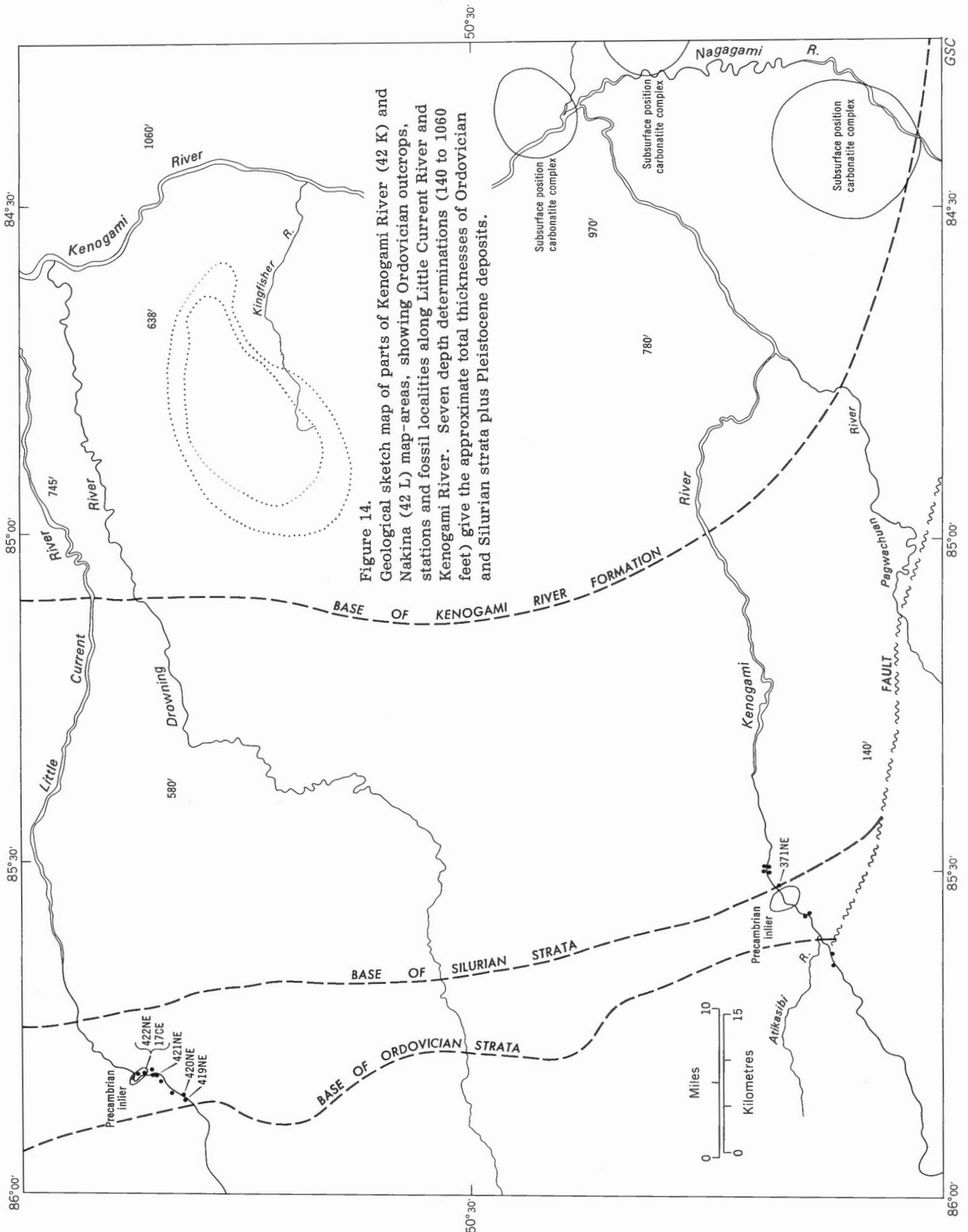


Figure 14.
 Geological sketch map of parts of Kenogami River (42 K) and Nakina (42 L) map-areas, showing Ordovician outcrops, stations and fossil localities along Little Current River and Kenogami River. Seven depth determinations (140 to 1060 feet) give the approximate total thicknesses of Ordovician and Silurian strata plus Pleistocene deposits.

Station 419NE: on the northwest bank of Little Current River at 50° 46' 30"N; 86° 52' 30"W.

Unit	Red Head Rapids Formation	Thickness (feet)
1	Limestone and dolomitic limestone, finely crystalline, yellowish grey, beds 1 inch to 2 inches thick, locally fragmental, rare mudstone partings, weathers light grey and blocky. Megafossils include: <i>Finkelbergia</i> sp. and comminuted graptolite fragments (GSC loc. 78434).	2.5

Station 371NE: on the south bank of Kenogami River at 50° 12' 15"N; 85° 32' 30"W. Precambrian gneiss, foliated. Going downstream Ordovician carbonate strata outcrop here and there on bed of river but are submerged. Martison's (1953) most westerly outcrops were not seen.

Station 373NE: on the northwest bank of Kenogami River at 50° 14'N; 85° 21'W.

Unit		Thickness (feet)
1	Limestone, conglomeratic and arenaceous, clasts of pale yellowish brown aphanitic limestone set in a finely crystalline matrix, beds 1 inch to 2 inches thick, weathers yellowish brown to light grey.	1.0

Harricanaw River (Fig. 15)

Ordovician strata of this part of Quebec are mainly clastic sediments which mark the southern margin of deposition of the Moose River Basin. These clastic sediments along the Harricanaw River contain limestone lenses in sandstones. Because of the steep gradients of rivers flowing north into James Bay, outcrops of Ordovician strata are fairly abundant and exposures relatively complete (see Pl. X B and X C for views of the Ordovician strata near the Precambrian contact on the Harricanaw River).

The western boundary of the exposed Ordovician strata is terminated along a major north-south lineament. This major crustal break, the Hudson Bay Paleolineament, extends from the Noranda mining area through James Bay and along the eastern part of Hudson Bay (Kutina, 1971). In the area south of James Bay, it has been traced by aeromagnetic anomalies and by surface lineaments suggested by the drainage patterns. Aeromagnetic coverage is not yet available for the "Quebec Embayment" part of the Hudson Bay Low-

lands, so that little evidence is available for confirming the presence of this feature in the subsurface.

Geological mapping in the area by J. H. Remick (written comm., 1968) locates the Precambrian-Paleozoic contact at only one place, the base of the Ordovician section below Seven Mile Island seen at low water in mid-summer (see prel. map 1478, Quebec Dept. Nat. Resour.). Precambrian rocks at the contact are gneisses, the feldspars in places are kaolinized. Overlying arkosic grits contain grains of feldspar and quartz up to 6 mm in diameter. These basal grit beds are one foot thick and grade upward into maroon argillites or siltstones. A study of the brachiopods collected from these basal Ordovician beds by C. J. Durden provided no information by which to date these strata (A. J. Boucot, written comm., 1968).

Ordovician strata extend for 27 miles northeast of the Harricanaw River and for 15 miles west of the Harricanaw River where exposures are particularly abundant on the Birthday (Malouin) and Again rivers.

Station 1CE: on the east bank of Harricanaw River at 50° 35' 30"N; 79° 10' 00"W, immediately north of Seven Mile Island.

Unit		Thickness (feet)	
		Unit	From base
5	Sandstone, massive light yellowish grey, coarse-grained, sand grains well rounded, bedding 1 foot to 7 feet thick (see Pl. X C) some cross-bedding and layers of siliceous pebbles, an occasional lens of limestone 6 inches thick, mudcracks, weathers light olive grey to pale orange.	36.0	57.0
4	Siltstone, olive grey, contains 20 per cent subangular fine quartz sand, slightly calcareous cement, beds 2 to 6 inches thick. Megafossils include (GSC loc. 78532): <i>Ischyodonta</i> sp. cf. <i>I. unionoidea</i> (Meek), <i>Lingula</i> sp. and <i>Caryocaris</i> sp.	13.0	21.0

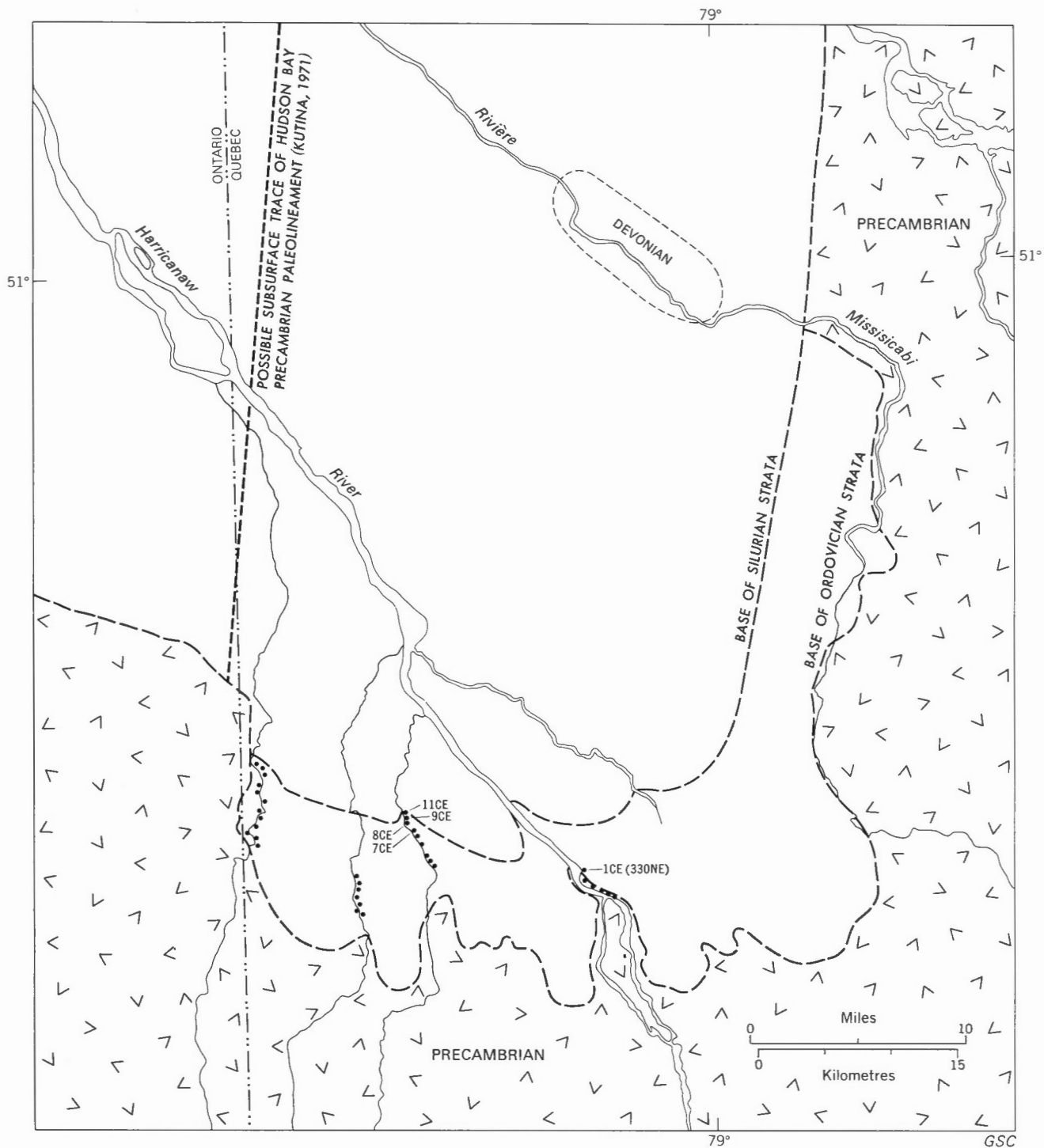


Figure 15. Geological sketch map of parts of Lower Harricanaw River (32 L) and Rupert House (32 M) map-areas, showing Ordovician outcrops, stations and fossil localities.

Unit		Thickness (feet)	
		Unit	From base
3	Clay, grey to bluish grey, grades upward into mudstone in upper half of unit, beds 1 inch to 3 inches thick, barren.	1.5	8.0
2	Siltstone, dark reddish brown to olive grey; contains 15 to 25 per cent angular to subangular sand grains, 10 per cent of section is mudstone with quartz silt particles. Megafossils include: (GSC loc. 76550) <i>Ormoceras</i> sp. identified by R. H. Flower. This is a long ranging genus (Middle Ordovician to Devonian).	5.5	6.5
1	Siltstone, argillaceous, olive grey, contains 20 per cent quartz sand, beds 1 inch to 3 inches thick.	1.0	

Station 7C: on Birthday (Malouin) River, Quebec, at 50°37'15"N; 79°21'00"W.

Unit		Thickness (feet)	
1	Sandstone, grey brown, fine-grained, quartz grains rounded and subangular, crossbedded, beds up to 10 inches thick.		3.0

Station 8CE: on Birthday River, Quebec, at 50°37'45"N; 79°21'00"W.

Unit		Thickness (feet)	
1	Sandstone, greenish grey, friable, fine-grained with rounded and subangular grains, beds average ½ inch thick.		2.0

Station 9CE: on Birthday River, Quebec, at 50°38'00"N; 79°21'00"W.

Unit		Thickness (feet)	
1	Dolomite, light grey with interbedded sandstone containing pale green shale chips up to 3 inches in diameter.		1.0

Station 11CE: on east bank of Birthday River, Quebec, at 50°38'15"N; 79°21'00"W.

Unit	Basal Silurian	Thickness (feet)	
2	Sandstone, light brown, friable at base, beds 2 to 6 inches thick, barren of fossils. Erosion surface with chemical corrosion to a depth of 2 inches, limonite staining along the surface.		5.0
	Upper Ordovician		
1	Dolomite, light grey to buff, argillaceous, some sandstone at base containing light grey dolomite and siltstone clasts up to 1 inch in length. Megafossils include indet. gastropod casts.		2.0



Plate I A

Beds of the Portage Chute Formation exposed along the North Knife River at station 206SA. (GSC 202274, by B.V. Sanford).



Plate I B

Undulating beds of basal sandstone of the Portage Chute Formation outcropping at station 204SA, North Knife River. (GSC 202273, by B.V. Sanford).



Plate I C

Limestone of member 2, Portage Chute Formation, showing prominent jointing oriented 230° exposed at station 234CE on South Knife River at $95^{\circ}06'40''$ W. GSC 142974.



Plate I D

Beds of Caution Creek Formation, at station 228CE on South Knife River at $58^{\circ}33'$. Ordovician graptolite locality marked by sample bags in the foreground. GSC 142971.



Plate II A

Limestone beds of the Caution Creek Formation at station 231CE on north bank of South Knife River at 58° 31'N. GSC 142973.



Plate II B

Nonconformable contact between Upper Aphebian granitic rocks and basal beds of the Portage Chute Formation of the Ordovician Bad Cache Rapids Group. Station 202CE on Churchill River, view in downstream direction. GSC 142939.

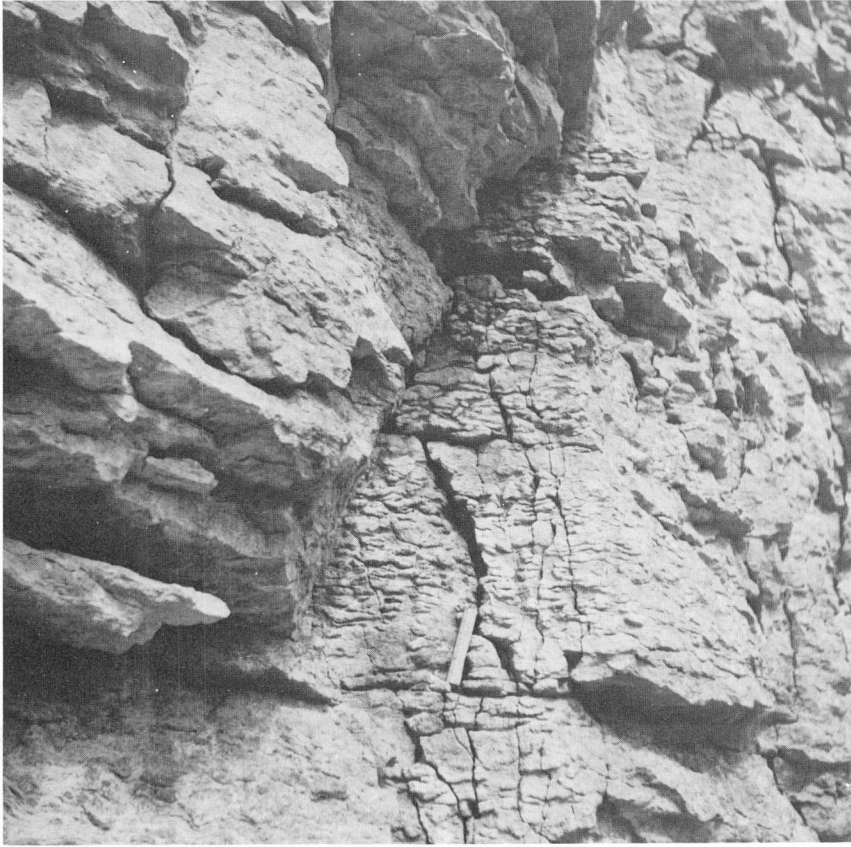


Plate II C

Beds of member 2 of the Portage Chute Formation, six-inch ruler provides scale; station 202CE on Churchill River. GSC 142944-B.



Plate II D

Conformable contact (marked by X on right side of photograph) between beds of the Surprise Creek Formation and overlying Caution Creek Formation; station 207CE on Hidden Creek. Measuring stick in middle distance is 5 feet long. GSC 142947.



Plate III A

Close-up view of bedding surface of crinoidal limestone of the Caution Creek Formation; station 207CE on Hidden Creek. GSC 142948.

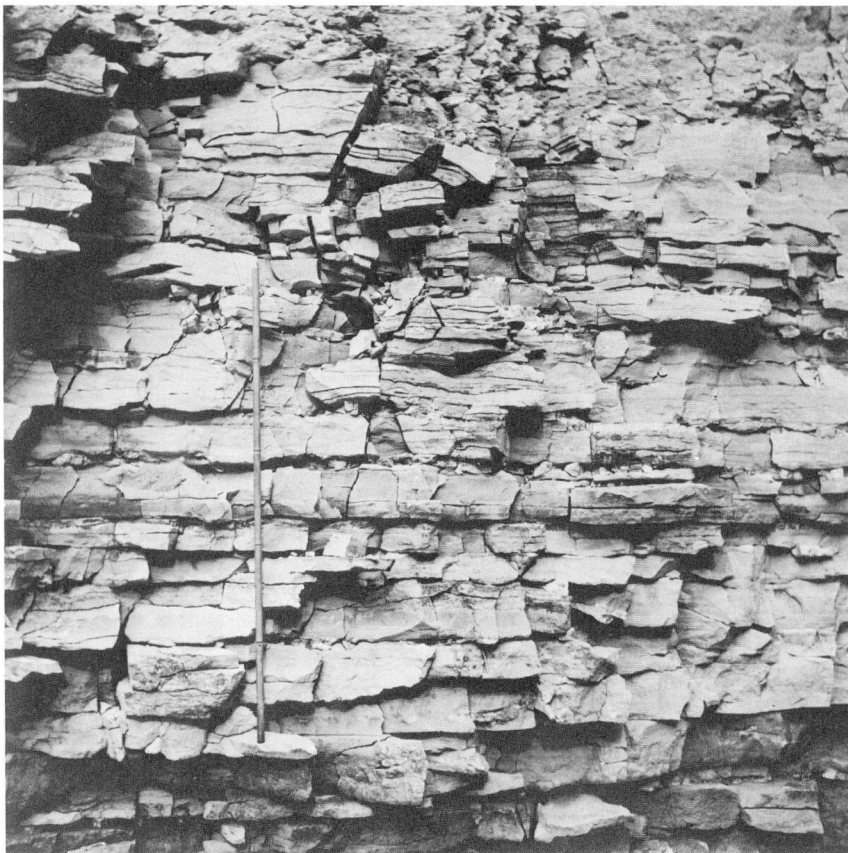


Plate III B

Cherty limestone beds of member 3 of the Surprise Creek Formation, Bad Cache Rapids Group on Surprise Creek. Measuring stick is 5 feet long. GSC 142951.

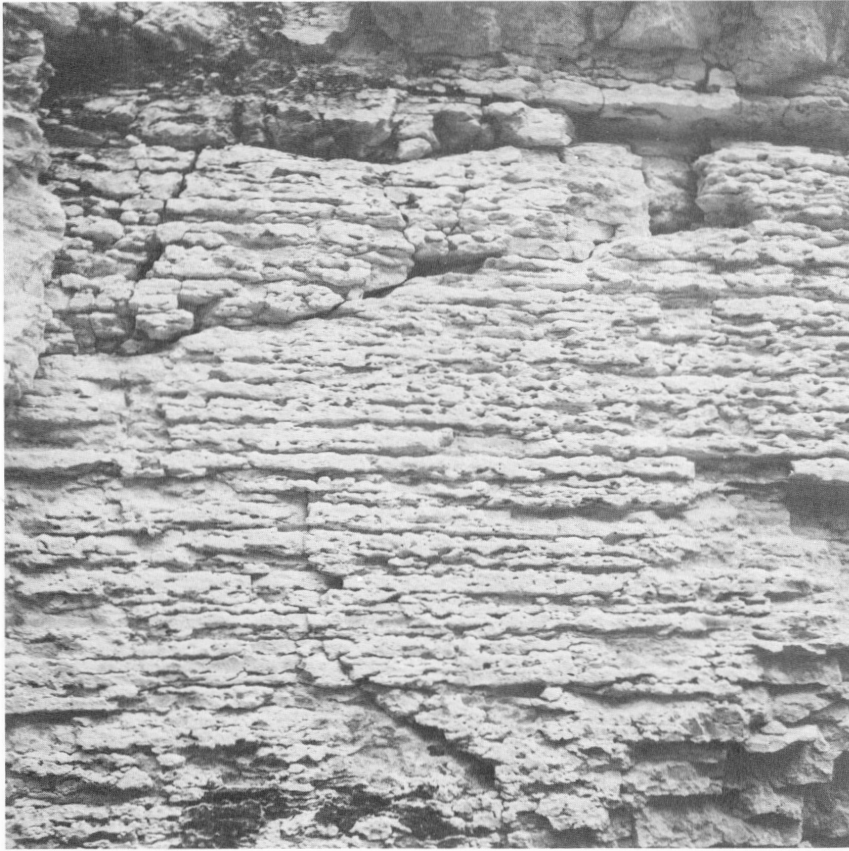


Plate III C

Close-up view of thin, irregularly bedded limestone of member 2 of the Caution Creek Formation, exposed at base of waterfall shown in Plate III B, station 210CE on Chasm Creek. GSC 142954.



Plate III D

Contact (marked by X) between resistant thick beds of the Chasm Creek Formation and thin, less resistant, beds of the Caution Creek Formation; station 210CE on Chasm Creek. Members 2 and 3 of the Caution Creek Formation marked on left side of illustration. GSC 142953.

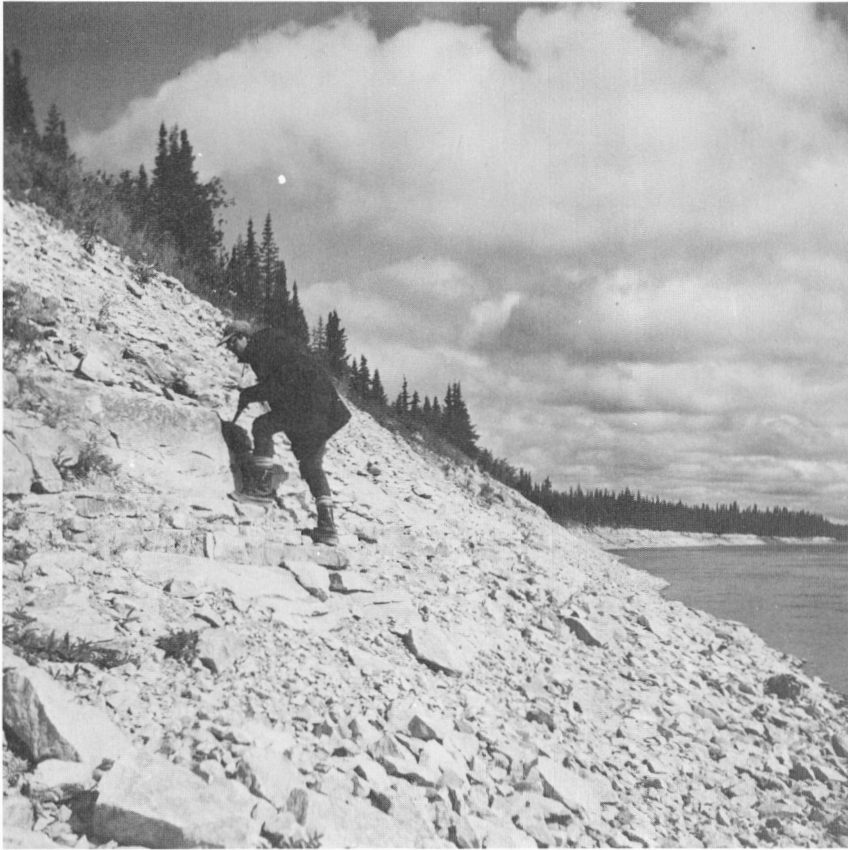


Plate IV A

Beds of member 2, Chasm Creek Formation;
station 213CE (GSC loc. 25283) on
Churchill River. GSC 142960.



Plate IV B

Armenoceras sp. in limestone of member
2 of the Chasm Creek Formation;
station 214CE on Churchill River.
GSC 142962.

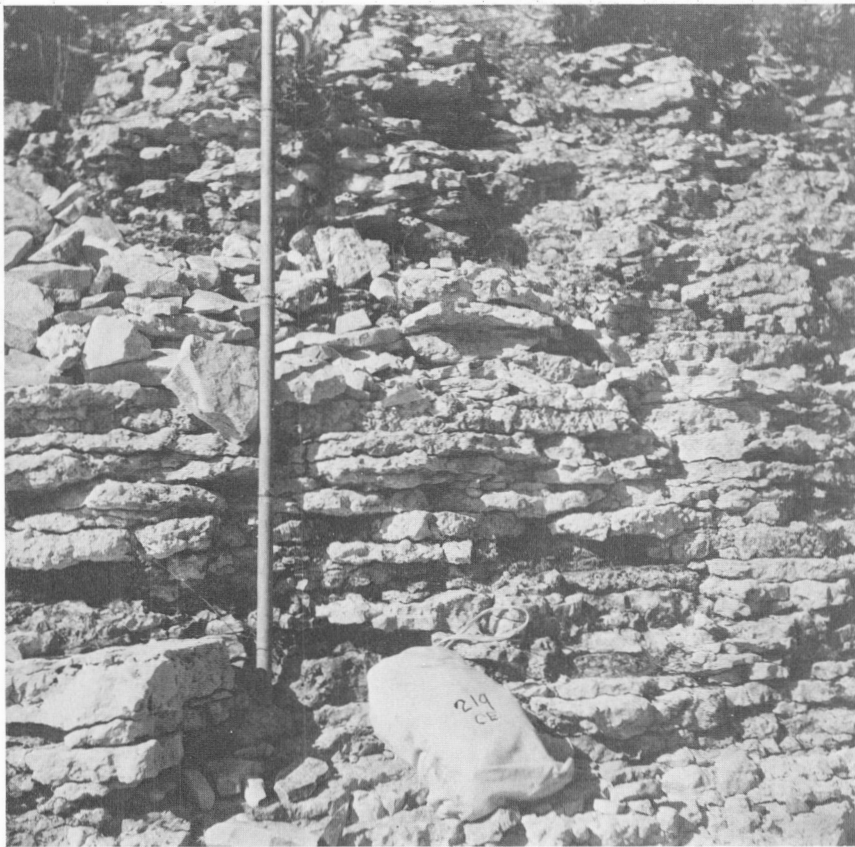


Plate IV C

Close-up view showing characteristic bedding of the limestones of member 4 of the Chasm Creek Formation; station 219CE at Red Head Rapids on the Churchill River; measuring stick is marked in feet. GSC 142965.



Plate IV D

Furoid beds of member 4 of the Chasm Creek Formation; station 222CE on Churchill River. GSC 142968.



Plate V A

Contact between upper part of Chasm Creek Formation and lowermost beds of Red Head Rapids Formation. Bedding plane of uppermost bed of member 4 of Chasm Creek Formation lies below the 5-foot measuring stick. Station 222CE on Churchill River, 7 miles below Red Head Rapids at approximately $58^{\circ} 13' N$, $94^{\circ} 21' W$. GSC 142967.



Plate V B

Chert nodules in limestone of member 2 of the Portage Chute Formation; station 189CE on Nelson River, 4.3 miles east of the Bird railroad station at $56^{\circ} 30' N$, $94^{\circ} 07' W$. GSC 142916.



Plate V C

View upstream of massive limestone overlying sandstone of the Portage Chute Formation; station 191CE on Nelson River, $56^{\circ}32'N$, $94^{\circ}06'W$. GSC 142918.

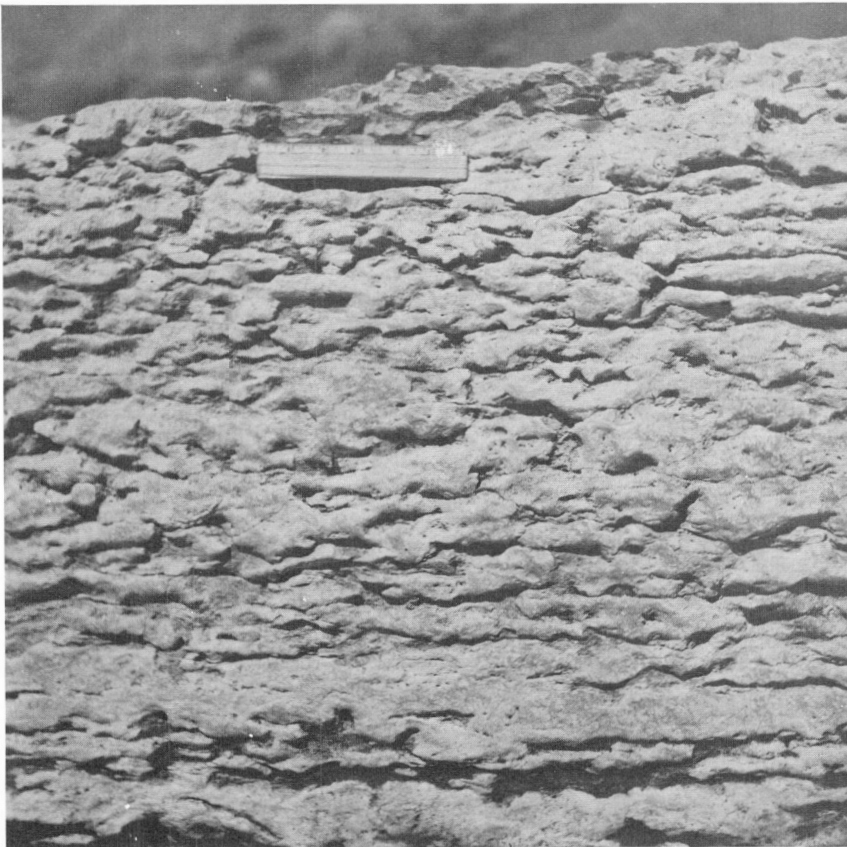


Plate V D

Close-up view showing typical bedding and mottling of limestone of member 2 of the Portage Chute Formation; station 191CE on Nelson River at $56^{\circ}32'N$, $94^{\circ}06'W$ and 8 feet above the Precambrian surface. GSC 142917.



Plate VI A

Thick-bedded limestone of Surprise Creek Formation at station 192CE at Lower Limestone Rapids on Nelson River. GSC 142931.



Plate VI B

Close-up view of irregularly bedded mottled limestone of the Surprise Creek Formation outcropping at station 192CE near Lower Limestone Rapids on Nelson River. GSC 142921.



Plate VI C

Limestones of units 3 and 4 of the Chasm Creek Formation at station 198CE on Angling River. GSC 142933.



Plate VI D

Close-up view of bedding surface of the mottled dolomitic limestone of unit 4 of the Chasm Creek Formation, at station 198CE on Angling River. GSC 142928.

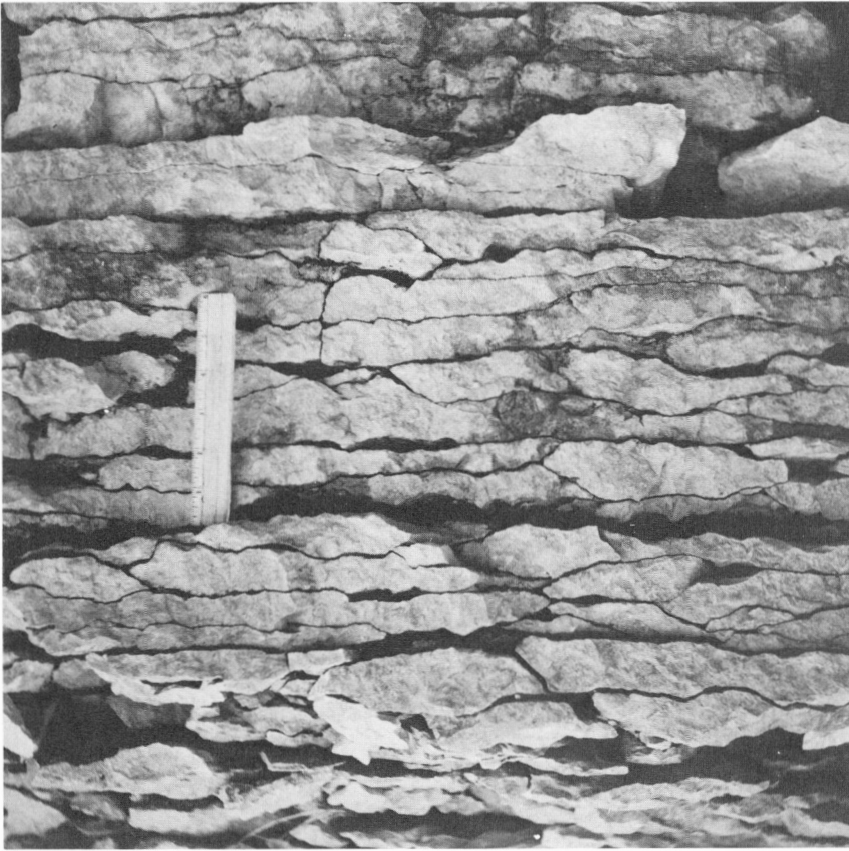


Plate VII A

Close-up view of irregular bedding of unit 4 of the Chasm Creek Formation at station 198CE on Angling River. GSC 142930.



Plate VII B

View downstream of flat-lying beds of Chasm Creek Formation of the Churchill River Group; station 182CE on Gods River, at $56^{\circ}02'35''\text{N}$, $92^{\circ}18'20''\text{W}$. GSC 142908.



Plate VII C

Limestone beds of the Chasm Creek Formation (formerly Shamattawa Formation) at station 184CE on Gods River, at $56^{\circ}04'25''\text{N}$, $92^{\circ}26'10''\text{W}$. GSC 142911.

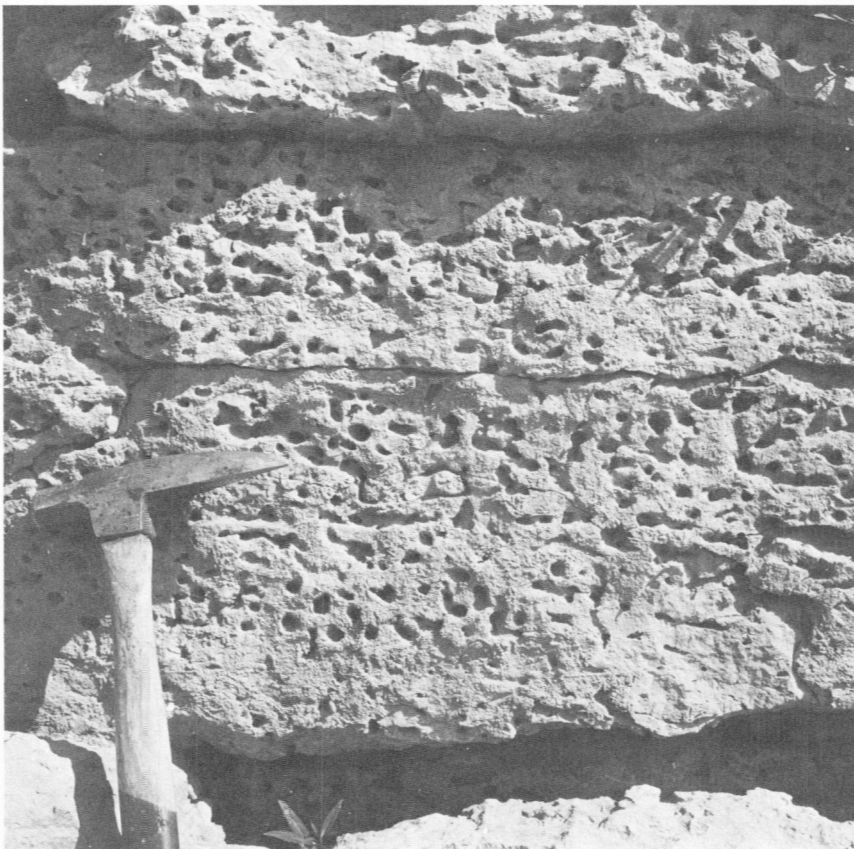


Plate VII D

Close-up view of burrowed carbonate mud facies of the Chasm Creek Formation of the Churchill River Group at station 184CE on Gods River, at $56^{\circ}04'25''\text{N}$, $92^{\circ}25'10''\text{W}$. GSC 142909.

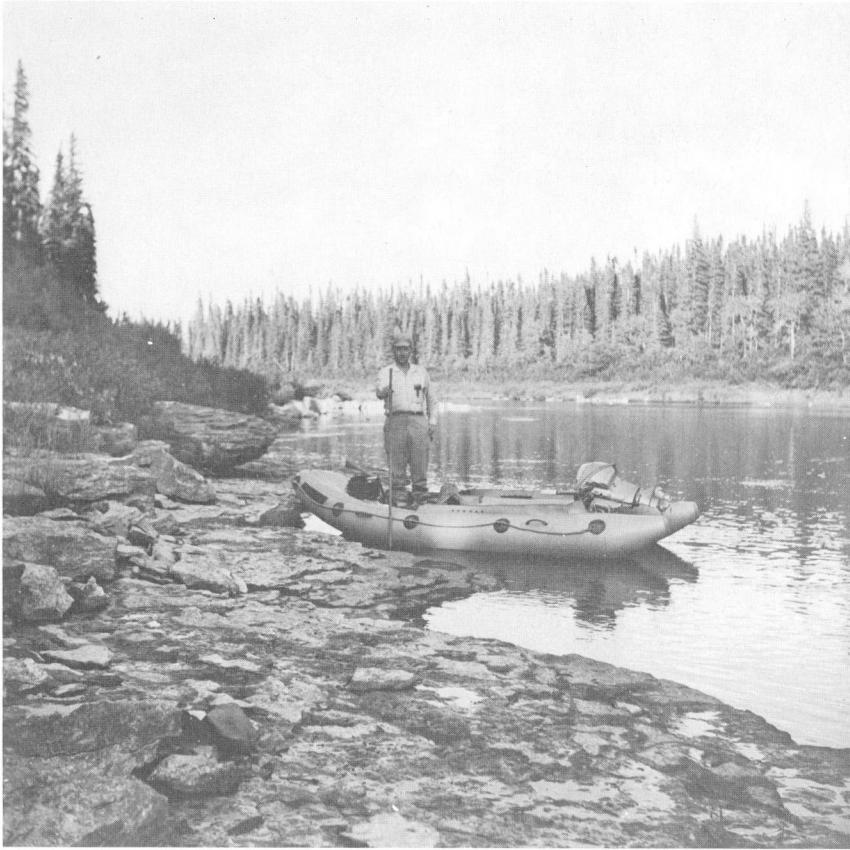


Plate VIII A

Limestone of the Bad Cache Rapids Group on the west bank of the Ekwan River at station 128CE at $53^{\circ}26'15''\text{N}$, $86^{\circ}07'10''\text{W}$. GSC 142891.



Plate VIII B

Limestone of the Bad Cache Rapids Group containing sandstone dykes; station 131CE on Ekwan River, at $53^{\circ}26'30''\text{N}$, $86^{\circ}07'00''\text{W}$. GSC 142892.

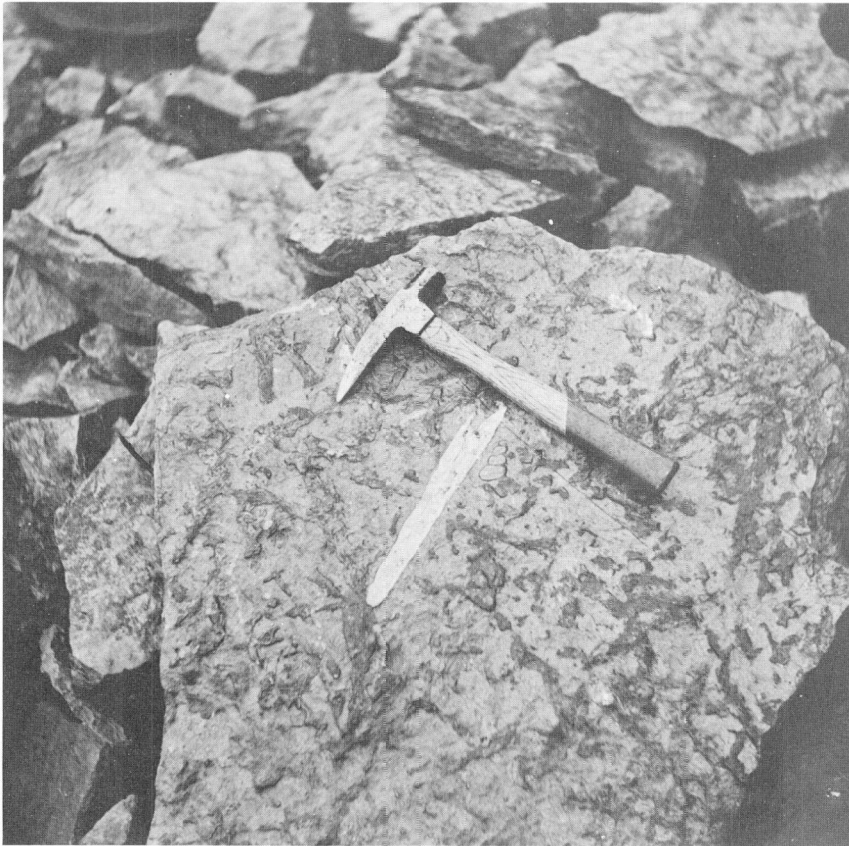


Plate VIII C

Limestone with endocerid cephalopod and fucoidal markings (Bad Cache Rapids Group) on the Ekwan River at station 133CE at $53^{\circ}27'30''\text{N}$, $86^{\circ}07'00''\text{W}$. GSC 142894.



Plate VIII D

Desiccation cracks in silty dolomite of the Churchill River Group at station 139CE on Ekwan River, at $53^{\circ}36'25''\text{N}$, $85^{\circ}47'30''\text{W}$. GSC 142895.



Plate IX A

View downstream of typical exposure of blocky-fracturing, pale green-grey, silty dolomite of the Churchill River Group or younger strata at station 141CE on the east bank of the Ekwan River at $53^{\circ}36'45''\text{N}$, $85^{\circ}46'40''\text{W}$. GSC 142896.



Plate IX B

Silty dolomite of Churchill River Group at station 146CE on west bank of Ekwan River, at $53^{\circ}39'30''\text{N}$, $85^{\circ}46'50''\text{W}$; 5.1 miles north of $53^{\circ}35'\text{N}$. GSC 142898.



Plate IX C

Mottled fucoidal dolomitic limestone of the Bad Cache Rapids Group at station 164CE on south bank of Muketei River at $53^{\circ}04'10''\text{N}$, $85^{\circ}54'50''\text{W}$. GSC 142902.



Plate IX D

An endocerid cephalopod in dolomitic limestone of the Bad Cache Rapids Group at station 164CE on south bank of the Muketei River at $53^{\circ}04'10''\text{N}$, $85^{\circ}54'50''\text{W}$. GSC 142901.



Plate X A

View downstream of dolomitic limestone of the Bad Cache Rapids Group; station 165CE on the Muketei River at $53^{\circ}02'30''\text{N}$, $86^{\circ}00'50''\text{W}$. GSC 142903.



Plate X B

View eastward, towards station 1CE below Seven Mile Island on Harricanaw River, Quebec, of cliff exposures of Upper Ordovician red siltstone and shale (snow covered) overlain by Upper Ordovician sandstone. At low water, Precambrian gneiss is exposed in mid-stream. GSC 142858.



Plate X C

Cliff section of Upper Ordovician siltstone and sandstone at station 1CE, east bank of Harricanaw River, Quebec. GSC 142860.

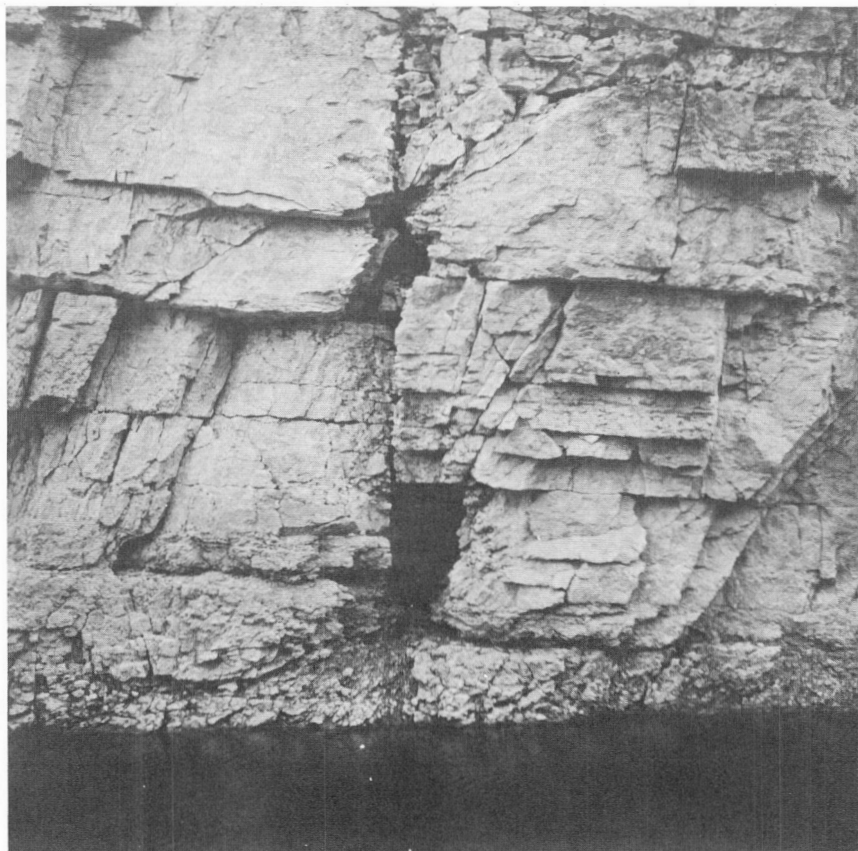


Plate X D

Normal fault in Ordovician limestone at Chasm Creek, Churchill River; station 211CE; view to the northwest, right side has been down-dropped 1.5 feet. GSC 142958.