

SASKATCHEWAN HIGHWAYS AND TRANSPORTATION

GEOLOGY ALONG HIGHWAY 16 FROM FIELDING
TO THE BORDEN BRIDGE AREA

Report 0155-002

JUNE 4, 1995

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June 26, 1995

Saskatchewan Highways and Transportation
3130 - 8th Street East
Saskatoon, Saskatchewan
S7K 2H6

Attention: Mr. N.W. Richardson P. Eng.

Dear Mr. Richardson:

Enclosed are five copies of Report 0155-002 on the "Geology along Highway 16 from Fielding to the Borden bridge area". Four copies are for your office and one is for Karl Sauer as we agreed.

If you have any queries about the report, please contact me.

Sincerely yours,

E.A. Christiansen P. Eng., P.GeoL.



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SUMMARY

The flowing artesian borrow pit immediately east of borehole 1A was discharging groundwater from the upper sand and gravel in the Fielding aquifer of the Floral Formation. The Fielding aquifer was removed by glacial erosion between boreholes 1A and 3 after deposition of the upper sand and gravel in the Fielding aquifer but before the deposition of the upper till of the Floral Formation. This erosion and deposition of the upper till took place during the same glaciation. The Fielding aquifer was not encountered east of borehole 1A.

Lacustrine silts and clays underlie prograding and regressive offlapping, deltaic sands and gravels east of Radisson. These stratified deposits become finer grained with depth.

TABLE OF CONTENTS

<u>Text</u>	Page
1. INTRODUCTION -----	1
1.1 Objective -----	1
1.2 Location -----	1
1.3 Previous work -----	1
1.4 Present study -----	1
2. STRATIGRAPHY -----	4
2.1 Introduction -----	4
2.2 Bedrock sediments -----	4
2.2.1 Lea Park Formation -----	4
2.2.2 Judith River Formation -----	4
2.2.3 Tertiary sediments -----	7
2.3 Glacial sediments -----	7
2.3.1 Sutherland Group -----	7
2.3.2 Saskatoon Group -----	7
3. ORIGIN AND GEOLOGIC HISTORY -----	9
4. LITERATURE CITED -----	16

Illustrations

Figures

1. Map showing the location of the Radisson-Borden area -----	2
2. Stratigraphic chart -----	6
3. Geologic history of glacial deposits -----	10
4. Phase 6 of the history of deglaciation by Christiansen (1979b) --	11
5. Phase 1 of the history of deglaciation of the Saskatoon region ---	12
6. Phase 2 of the history of deglaciation of the Saskatoon region ---	13
7. Phase 7 of the history of deglaciation by Christiansen (1979b) --	14

Illustrations

Tables	Page
1. Index of borehole logs in longitudinal section A-A'	3
2. Atterberg limits on Lea Park Formation and Tertiary sediments	5
3. Carbonate content of tills in boreholes 1A-6	8

Drawings	
0155-002-01. Topographic map showing the location of A-A'	in back
0155-002-02. Longitudinal section A-A'	in back

Appendices	
A Geologic logs compiled in this study	17
B Carbonate content of tills in boreholes 1A-6	27

1. INTRODUCTION

1.1 Objective

The objective is to draw a longitudinal section from near Fielding to the Borden bridge to determine the extent of the flowing artesian Fielding aquifer along this part of Highway 16.

1.2 Location

Longitudinal section A-A' extends along Highway 16 from 2 km east of Fielding to the upland east of the Borden bridge (Fig. 1, Drawing 0155-002-01) or from boreholes 2 to 15 (Drawing 0155-002-02).

1.3 Previous work

Previous work includes a map and cross sections of the Saskatoon area (Christiansen 1967), maps and cross sections of the Saskatoon region (Christiansen 1979a), a history of deglaciation of southern Saskatchewan including the Radisson-Borden area (Christiansen 1979b), and a map and cross sections showing the extent of the Fielding aquifer (Christiansen 1986). The soils were investigated by Acton and Ellis (1978).

1.4 Present study

The present study includes the examination of cutting samples from boreholes 1A, 2, 3, 4, 5, and 6 (Table 1, Appendix A) and cores from boreholes 1A and 3. Samples were selected from the above boreholes for carbonate analysis (Appendix B) and from bedrock in boreholes 1A

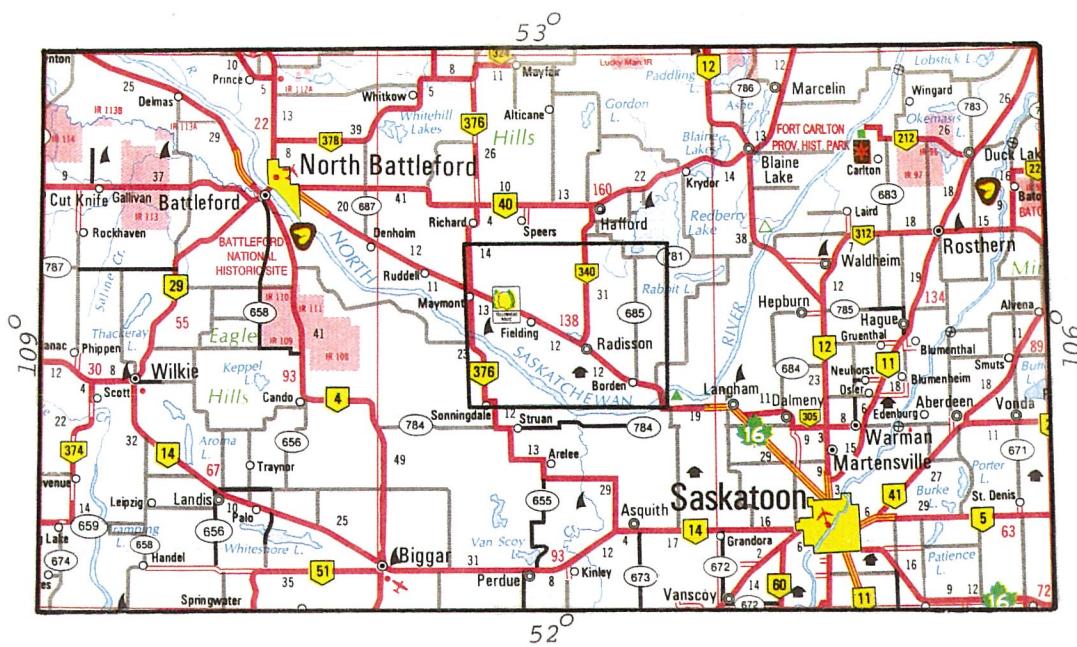


Figure 1. Map showing the location of the Radisson-Borden area.

Table 1. Index of borehole logs in longitudinal section A-A'.

No.	Name	Location	Station	Offset*	C.S.
1A	SHT Radisson No. 1A	NW-12-02-41-11-W3	8+350m	49.6m Rt.	16-25
2	SHT Radisson No. 2	NW-04-10-41-11-W3	10+181m	55m Rt.	16-25
3	SHT Radisson No. 3	NW-01-02-41-11-W3	6+694.6m	12.4m Rt.	16-25
4	SHT Radisson No. 4	NW-03-31-40-10-W3	3+668.2m	7.1m Rt.	16-25
5	SHT Radisson No. 5	SW-12-12-40-10-W3	13+272.4m	13.8m Rt.	16-24
6	SHT Radisson No. 6	NW-01-05-40-09-W3	8+313.14m	18.1m Rt.	16-24
7	SHT Radisson No. 7	SW-10-29-40-10-W3	1+563.9m	38.6m Rt.	16-25
8	SHT Radisson No. 8	SW-05-28-40-10-W3	0+751.3m	92.3m Rt.	16-25
9	SHT Radisson No. 9	NE-13-21-40-10-W3	0+077.6m	71m Rt.	16-25
10	FFIB Kindt, G.	SW-15-21-40-10-W3			
11	SWC Loessin, A.	NW-04-22-40-10-W3			
12	SRC Borden	NE-09-26-39-09-W3			
13	UofS Eagle No. 23	SW-01-25-39-09-W3			
14	UofS Eagle No. 11	SE-13-19-39-08-W3			
15	UofS Eagle No. 14	NE-03-19-39-08-W3			

* From centerline of north lane

and 2 for Atterberg limits (Table 2). Logs from these boreholes were compiled (Appendix A) and used in longitudinal section A-A' (Drawing 0155-002-02) along with 4 augerhole logs (7,8,9,12), 2 electric and driller's logs (10,11); and 3 logs from the Eagle series (13,14,15).

2. STRATIGRAPHY

2.1 Introduction

Bedrock sediments in longitudinal section A-A' include the Lea Park and Judith River formations and Tertiary sediments. The glacial sediments include the Sutherland and Saskatoon groups (Fig. 2)

2.2 Bedrock sediments

2.2.1 Lea Park Formation

The Lea Park Formation was penetrated to an elevation of 404m or a depth of 40m (Drawing 0155-002-02, log 6; Appendix A, log 6). The sediment is composed of marine, noncalcareous, gray silt and clay which becomes siltier and sandier as the Judith River Formation is approached. In boreholes 1A and 2, The Lea Park Formation has a mean liquid limit (W_l) of 70.1 ± 8.0 (Table 2).

2.2.2 Judith River Formation

The Judith River Formation is composed of less than 1 to 16m of deltaic, fine- to medium grained sand and sandstone with calcite cement (Drawing 0155-002-02, log 6). The Judith River Formation

Table 2. Atterberg limits on Lea Park Formation and Tertiary sediments from boreholes 1A and 2.

Unit	Borehole	Sample	Depth(m)	Wp	W1-1	W1-2	Avg W1	Ip
Tertiary sediments	1A	LS5-378	66.3	13.4	42.1	40.5	41.3	27.9
	1A	LS5-380	69.4	14.7	54.8	54.2	54.5	39.8
	1A	LS5-382	72.4	16.8	63.2	63.7	63.4	46.6
	1A	LS5-384	75.5	17.1	74.9	74.9	74.9	57.8
	2	LS5-448	75.5	14.7	54.7	54.7	54.7	40.0
	2	LS5-450	78.5	16.3	56.5	56.7	56.6	40.3
	2	LS5-452	81.6	15.2	58.2	58.8	58.5	43.3
Lea Park Formation	1A	LS5-386	78.5	16.4	74.1	73.5	73.8	57.4
	1A	LS5-388	81.6	19.9	74.3	75.2	74.8	54.9
	1A	LS5-390	84.6	19.1	89.8	89.6	89.7	70.6
	1A	LS5-392	87.7	15.1	69.2	68.6	68.9	53.8
	1A	LS5-394	90.7	16.6	68.2	68.1	68.2	51.6
	1A	LS5-396	93.7	15.8	68.8	68.5	68.7	52.9
	1A	LS5-398	96.8	17.0	74.3	74.7	74.5	57.5
	2	LS5-454	84.6	16.0	76.4	76.1	76.2	60.2
	2	LS5-456	87.7	17.5	73.4	72.8	73.1	55.6
	2	LS5-458	90.7	14.8	60.6	60.8	60.7	45.9
	2	LS5-460	93.7	15.5	61.9	61.3	61.6	46.1
	2	LS5-462	96.8	14.5	58.2	58.8	58.5	44.0
	2	LS5-464	99.8	17.1	69.6	68.6	69.1	52.0
	2	LS5-466	102.9	16.6	63.7	63.8	63.8	47.2
Stratigraphic unit		Number of samples		Wp	W1		Ip	
Tertiary sediments		7		15.5 ± 1.3	57.7 ± 10.2		42.2 ± 9.0	
Lea Park Formation		14		16.6 ± 1.5	70.1 ± 8.0		53.6 ± 6.9	

TIME UNIT		STRATIGRAPHIC UNIT			
		GROUP	FORMATION	DEPOSIT	
QUATERNARY	HOLOCENE	SASKATOON		12 Alluvium-sand and silt	
				11 Sand + gravel	
	PLEISTOCENE		9 Battleford	Till	
			Floral	8 Upper till	
				7 Upper sand and gravel	
				6 Lower till	
				5 Lower sand and gravel	
	4 SUTHERLAND		Till		
	TERTIARY?	3		Silt and clay	
	CRETACEOUS	MONTANA	2 Judith River	Sand and silt	
			1 Lea Park	Silt and clay	

Figure 2. Stratigraphic chart. Pleistocene nomenclature from Christiansen 1992.

is restricted to a structural depression as shown by the marker in the Lea Park Formation. The contact between the Lea Park and Judith River formations is conformable.

2.2.3 Tertiary sediments

The sandy, slightly calcareous, carbonaceous sediment between the Lea Park Formation and the bedrock surface (Drawing 0155-002-02, logs 1A,2,3) is thought to be Tertiary in age. The Tertiary sediments have a mean liquid limit of 57.7 ± 10.2 (Table 2), whereas the Lea Park Formation has a mean liquid limit of 70.1 ± 8.0 . The contact between the Cretaceous and Tertiary sediments is nonconformable.

2.3 Glacial sediments

2.3.1 Sutherland Group

The Sutherland Group is composed of less than 1 to 30m of till which has a mean carbonate content of 21.1 ± 4.0 mL CO₂/g (Table 3). The contact between the Sutherland Group and the underlying bedrock is an erosional unconformity.

2.3.2 Saskatoon Group

The Saskatoon Group is up to 76m thick in borehole 4 (Drawing 0155-002-02, Appendix A). In ascending order, the Saskatoon Group is composed of lower sand and gravel, lower till, upper sand and gravel, and upper till of the Floral Formation; till of the Battleford Formation; lacustrine silt and clay; deltaic sand and silt;

Table 3. Carbonate content of tills in boreholes 1A-6, longitudinal section A-A'.

Stratigraphic unit	Number of samples	Mean CO ₂ mL/g	Standard deviation
Battleford Fm.	51	20.6	4.4
Floral Formation	43	29.8	6.1
Sutherland Group	27	21.1	4.0

and alluvial sand and silt in the North Saskatchewan River valley. The lower and upper sands and gravels of the Floral Formation constitute the Fielding aquifer. The lower and upper tills of the Floral Formation have a mean carbonate content of 29.8 ± 6.1 mL CO₂/g. Till of the Battleford Formation has a mean carbonate of 20.6 ± 4.4 mL CO₂/g (Table 3). The contact between the Floral and Battleford formations is nonconformable.

Lacustrine silts and clays underlie prograding and regressive off-tapping, deltaic sands and gravels east of Radisson (Drawing 0155-002-02). The lacustrine unit is up to 16m thick, and the overlying deltaic unit is up to 9m thick. Up to 34m of alluvial sand and silt have been deposited in the North Saskatchewan River valley. The contacts between the lacustrine silts and clays and the underlying Battleford Formation and the overlying deltaic sands and silts are conformable.

3. ORIGIN AND GEOLOGIC HISTORY

The origin and geologic history of the glacial and proglacial deposits are depicted in five phases (Fig. 3) showing the reconstruction of longitudinal section A-A' between logs 2 and 11. Four additional sketches (Figs. 4-7) are added to show the origin and history of the surficial lacustrine and deltaic deposits.

Till of the Sutherland Group was deposited on Cretaceous and Tertiary bedrock during phase 1 (Fig. 3). It is inferred that the till was uniformly thick throughout the section. During phase 2, the lower sand

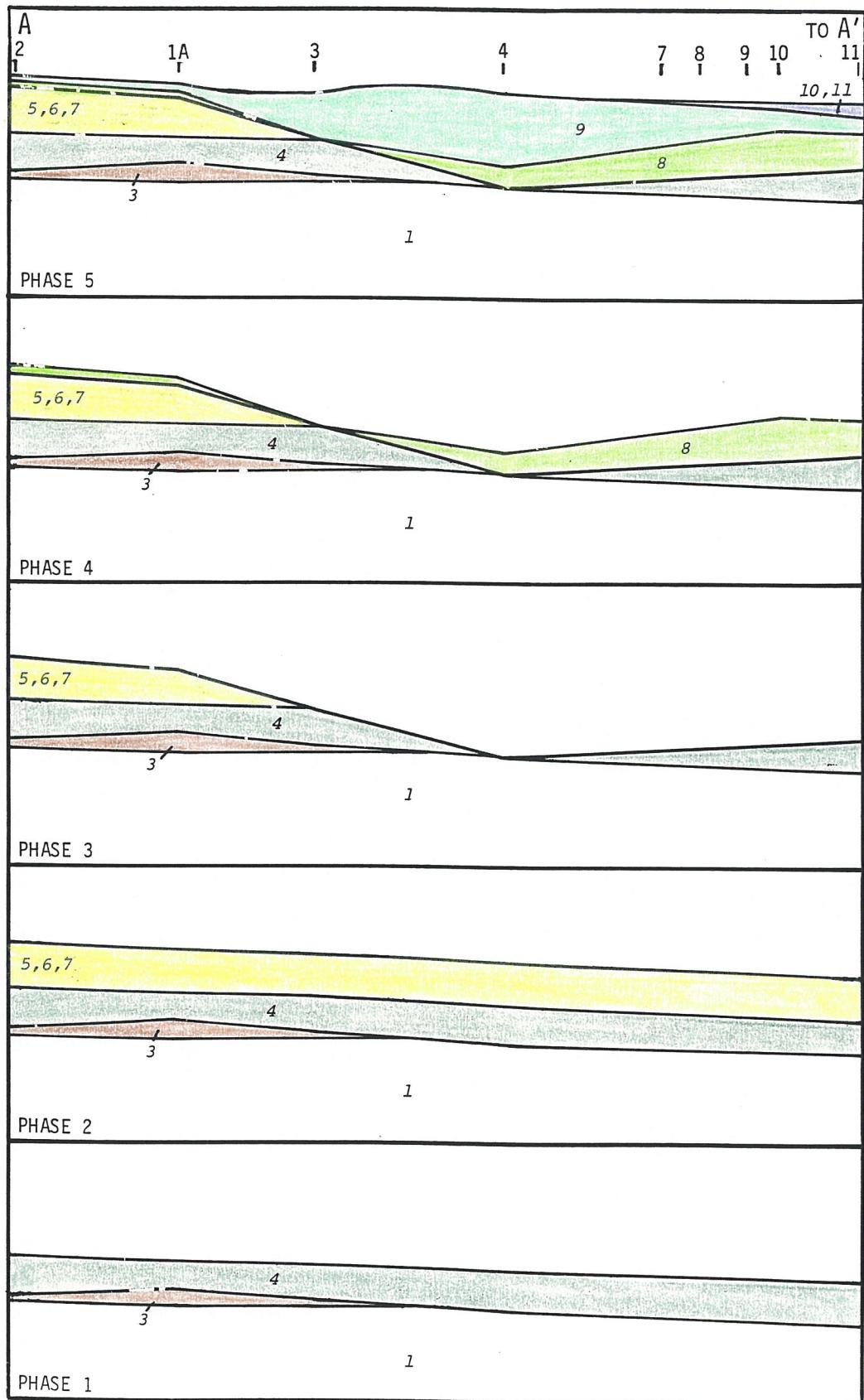


Figure 3. Geologic history of glacial deposits.

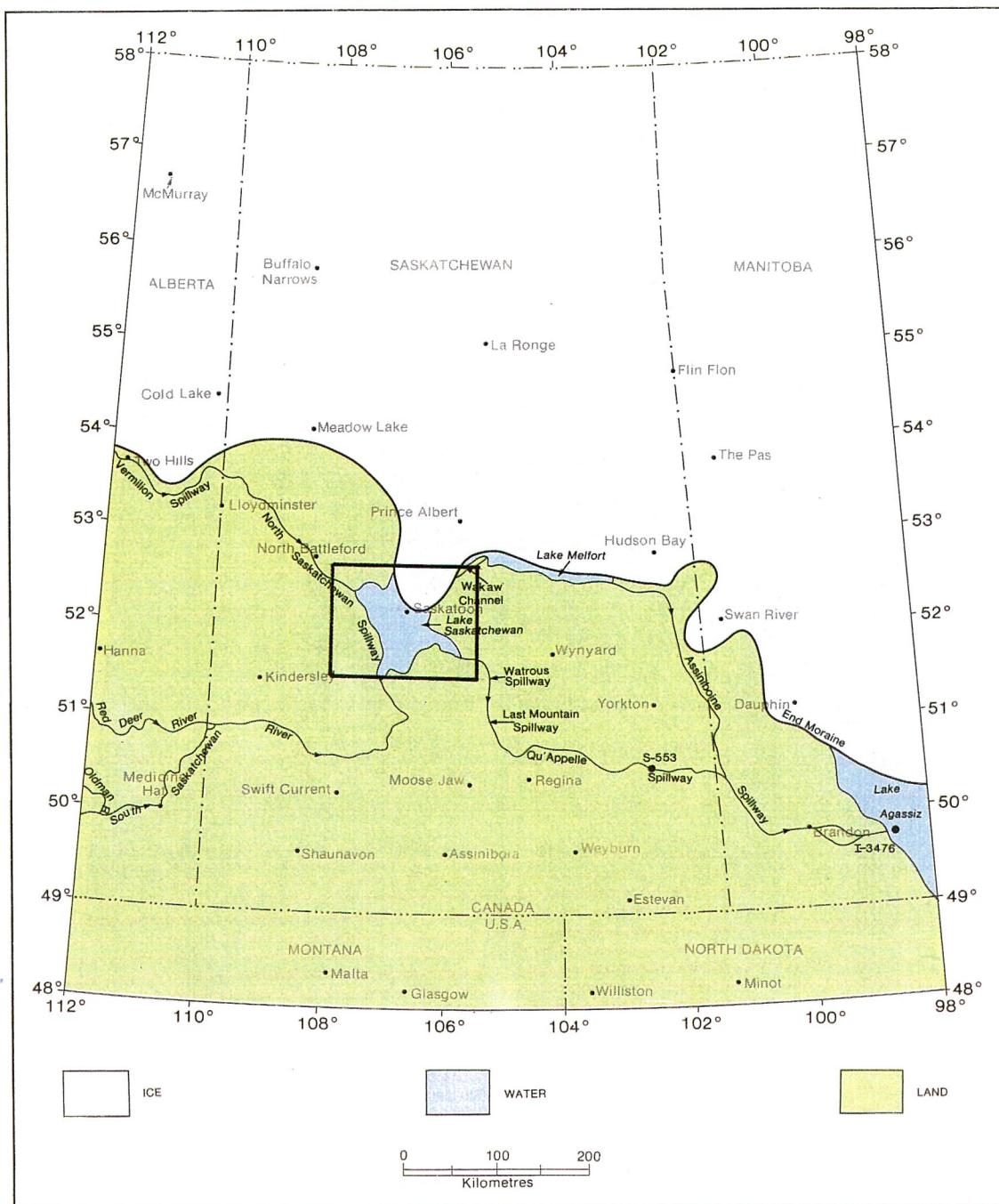


Figure 4. Phase 6 of the history of deglaciation by Christiansen (1979b) showing the location of the Saskatoon region (Figs. 5, 6).

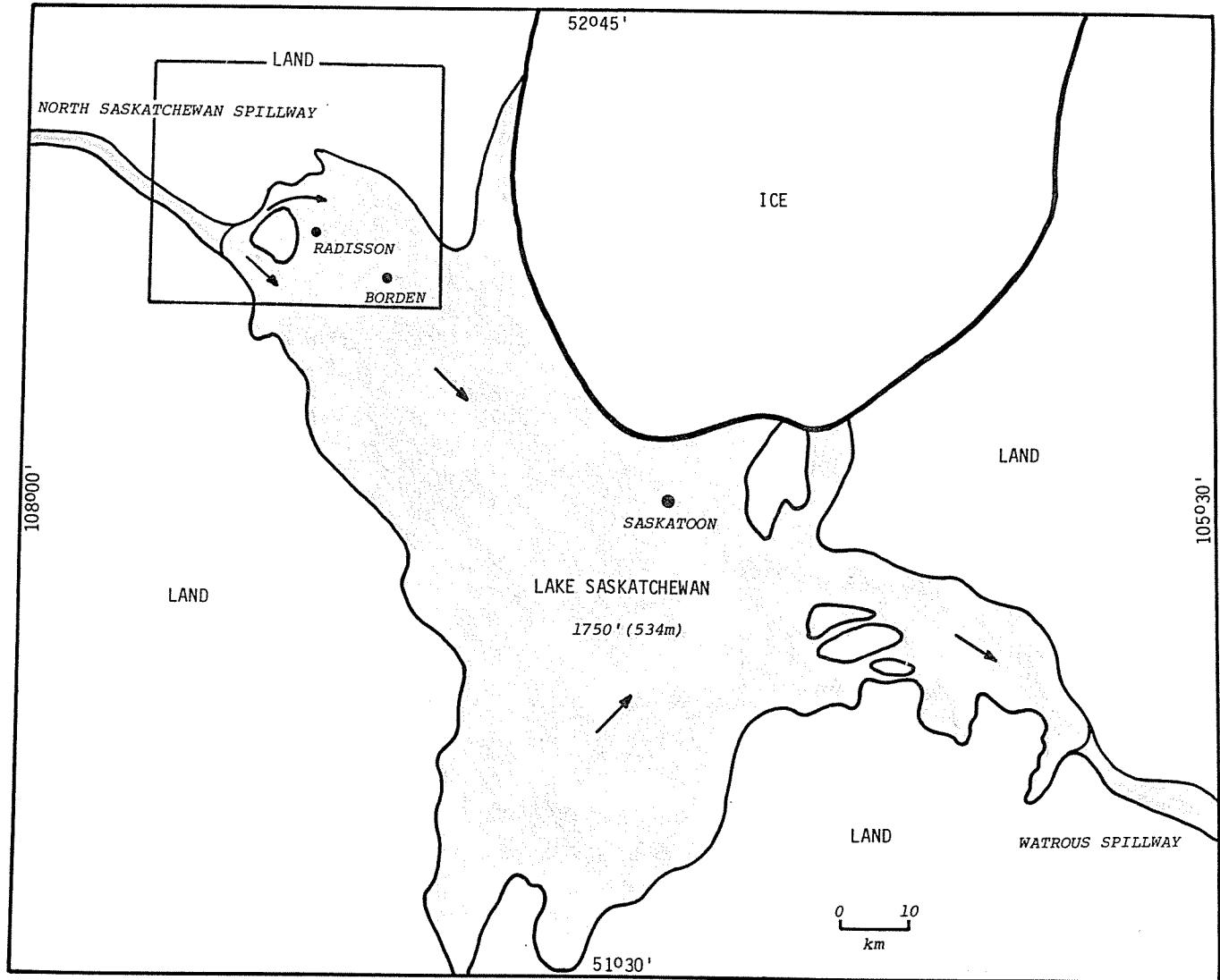


Figure 5. Phase 1 of the history of deglaciation of the Saskatoon region from Christiansen (1979a) showing the location of the Radisson-Borden area.

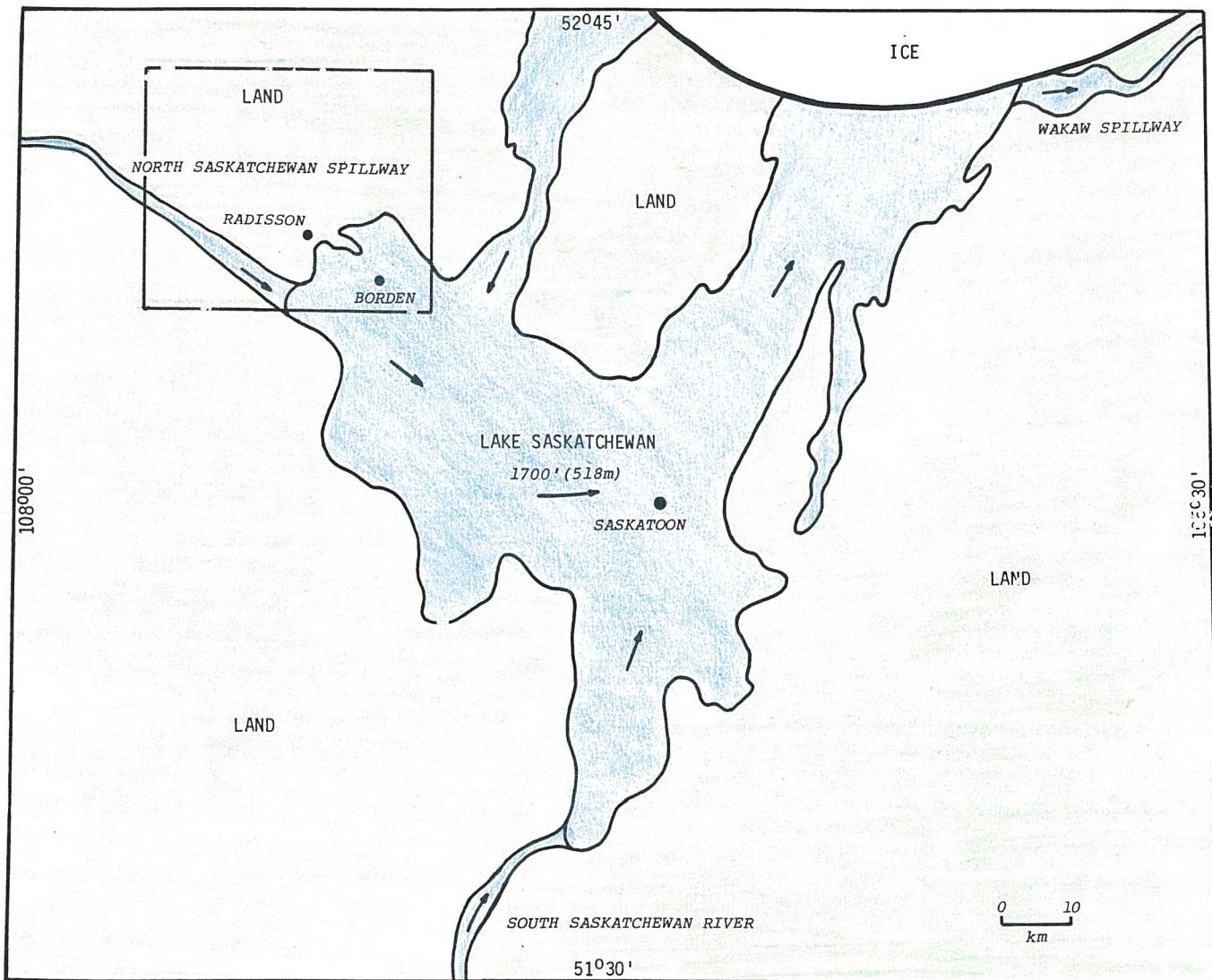


Figure 6. Phase 2 of the history of deglaciation of the Saskatoon region from Christiansen (1979a) showing the location of the Radisson-Borden area.

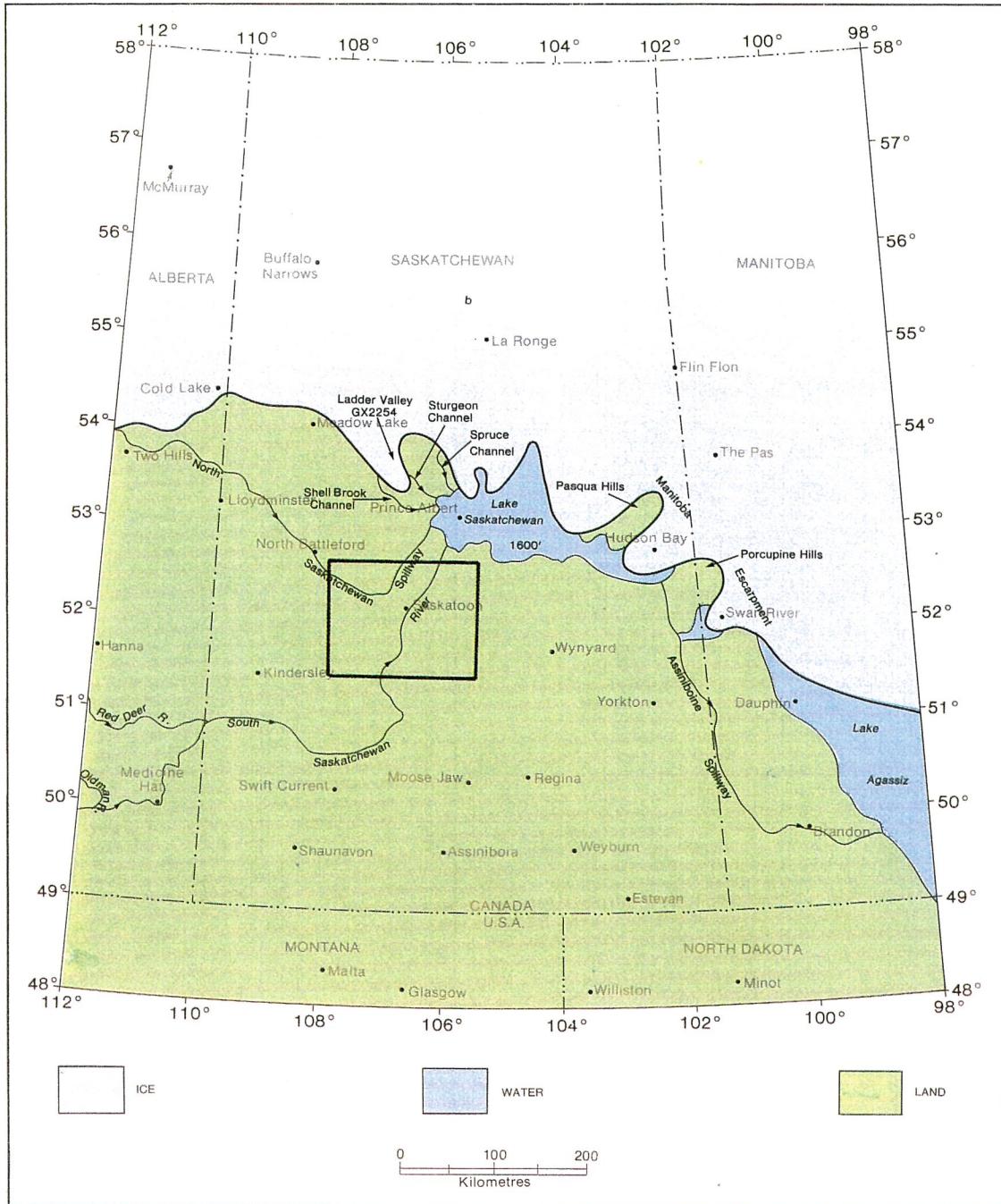


Figure 7. Phase 7 of the history of deglaciation by Christiansen (1979b) showing the location of the Saskatoon region (Figs. 5, 6).

and gravel, lower till, and upper sand and gravel of the Floral Formation were deposited. Again, it is inferred that the deposits were uniformly thick throughout the section. During phase 3, all of the glacial deposits at borehole 4 and much of the glacial deposits at boreholes 3 and 10 (Fig. 3) were removed by glacial erosion.

After the erosion was completed, the upper till of the Floral Formation was deposited during phase 4. Phase 3 and 4 occurred during the same glaciation. During phase 5, the depression created during phase 3 was filled with till of the Battleford Formation.

During the history of the last deglaciation, deltaic sands and gravels were deposited at the mouth of the North Saskatchewan spillway in the Radisson-Borden area (Figs. 4,5). The deltaic sands and gravels were deposited on lacustrine silts and clays laid down in glacial Lake Saskatchewan during a higher level of the lake when the shoreline was farther west. The sands and gravels northwest of Radisson came through the northeast flowing distributary of the North Saskatchewan spillway (Fig. 5). Lake Saskatchewan stood at 1750 feet (534m) at this time and drained through the Watrous spillway (Fig. 5).

Later, Lake Saskatchewan fell to 1700 feet (518m), and the shoreline retreated to a line between Radisson and Borden (Fig. 6). The North Saskatchewan spillway deposited a delta in the Borden area on lacustrine silts and clays deposited earlier. Lake Saskatchewan drained through the Wakaw spillway during this time (Fig. 6). Finally, Lake Saskatchewan fell to 1600 feet (488m), and extensive deltas

developed at the mouths of the South Saskatchewan River and the North Saskatchewan spillway (Fig. 7) marking the end of lacustrine and deltaic sedimentation in the Radisson-Borden area. The South Saskatchewan River and the North Saskatchewan spillway continued to erode their valleys which reached a maximum depth of 34m 11000 years ago in the North Saskatchewan River valley (Christiansen 1983) at the Borden bridge.

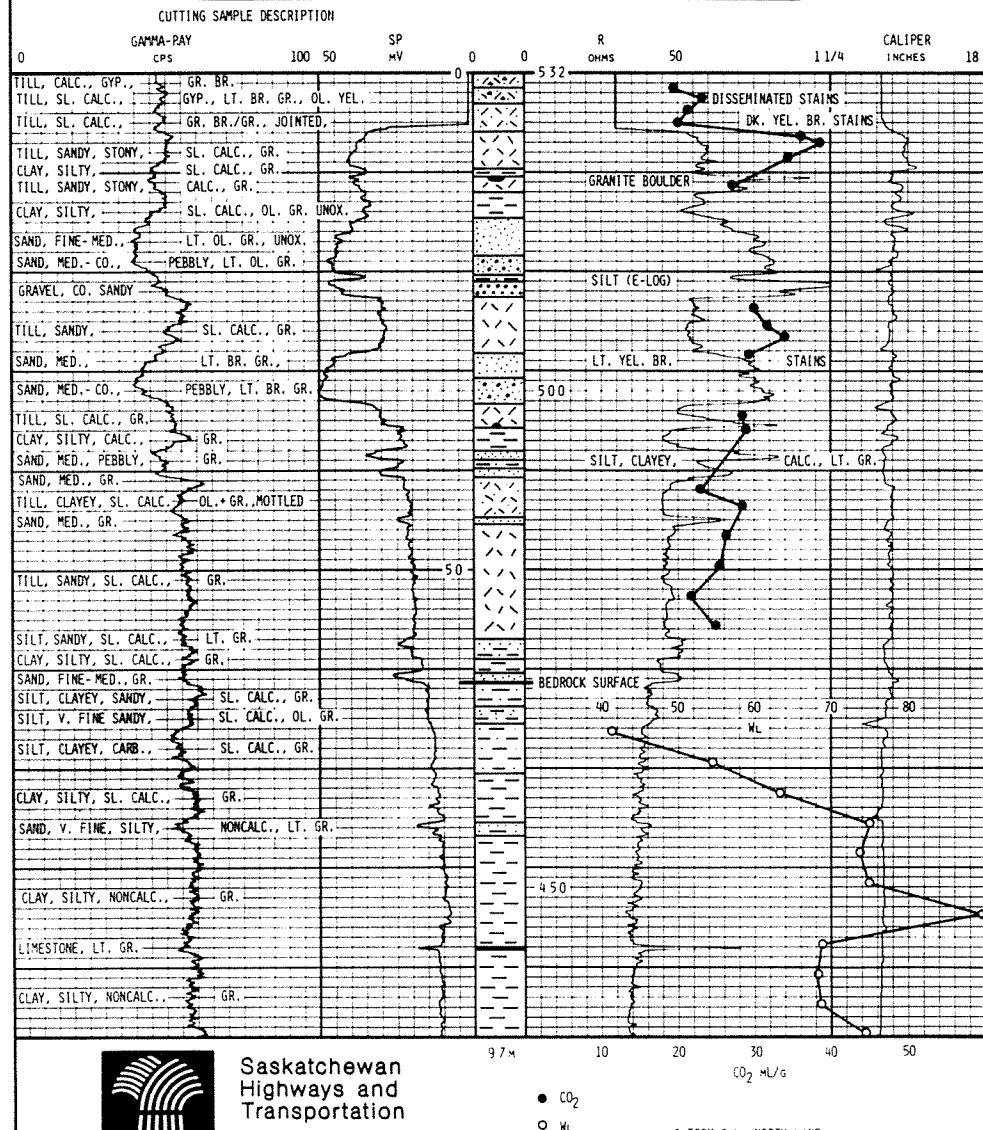
4. LITERATURE CITED

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Appendix A. Geologic logs compiled in this study.

SHT 73B/11 1995
RADISSON NO. 1A
NW-12-02-41-11-W3
13:330950E/5819600N
COREHOLE

BOREHOLE NO	1A	MTS. 23-8/11
LAND LOCATION	NM-12-02-41-11-Y3	
UTM COORD	13,330950E/5819600N	
GRO. ELEV	532.05 M	DEPTH 37.55 M
DATE DRILLED	FER. 23	TO MARCH 21, 1995
COND. WATER	700	MICROSIEMENS/CM AT 25°C
COND. MUQ	1050	MICROSIEMENS/CM AT 25°C
SPECIFIC GRAVITY MUQ		
SUPERVISOR	L. SINCLAIR	
ASST. SUPERVISOR		
LOGGED BY	L. SINCLAIR	
LOGGED TIME	1100 1500	
PROBE ELECTRIC		
PROBE GAMMA		
PROBE CALIPER		
DATE LOGGED	MARCH 21	1995
TIME OF LOGGING	1000 HRS.	TO 1130 HRS
DRILL OPERATOR	M. MILLER	
CONTRACTOR		
REMARKS	ASS'T OPEPATOR: M. MINCHUK	
PROJECT	16-25	
CONTROL SECTION	8 + 350 M	OFFSET 49.6 M RT. *
CUTTING SAMPLE INTERVAL	1.5 M	
CORE SAMPLE INTERVAL	1.8-6.1 M	
FROM		
CASING DEPTH	5.8 M	
CASING WALL THICKNESS		
WATER OR MUQ LEVEL		
ABANDONMENT	GROUTED	
BIT SIZE 4 3/4"	WALMAC	INTERVAL 0-6.4 M
BIT SIZE 4 3/4"	WALMAC	INTERVAL 6.4-12.2 M
BIT SIZE 4 3/4"	WALMAC	INTERVAL 12.2-19.75 M
TYPE OF DRILL RIG	1250 FAILING	
DEPTH	SCALE	SPEED
SP	97 M	50 M/Y
BES	97 M	50 CM/HRS
GAMMA	97 M	0-100 CPS
CAL	97 M	1 1/4 - 18 "
GAMMA TIME CONSTANT (T.C.)		5 SECONDS
GEOLOGY BY		E.A. CHRISTIANSEN
		20/04/95



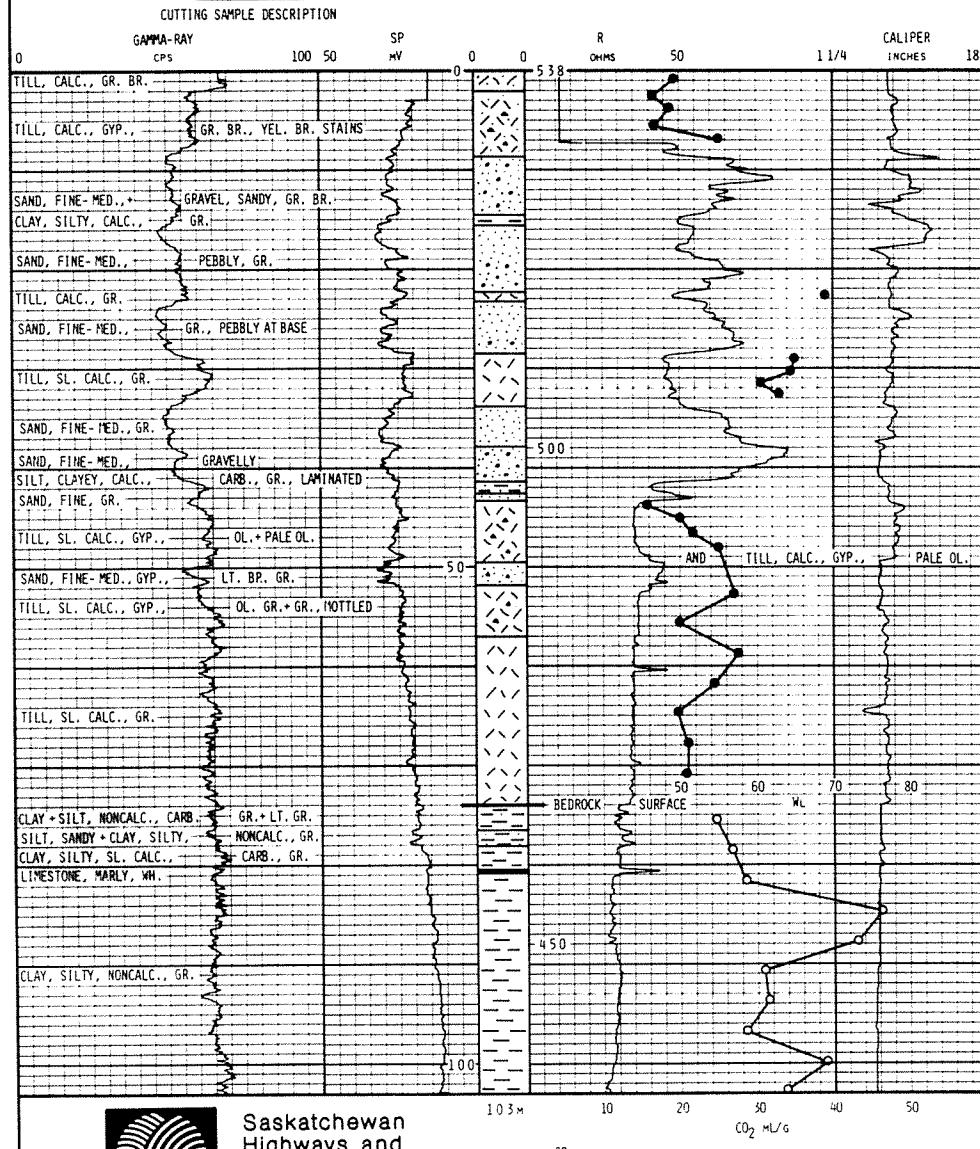
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SHT 73B/12 1995
RADISSON NO.2
NW-04-10-41-11-W3
13:329400E/5820550N
TESTHOLE

BOREHOLE NO.	2	MTS 73-B/12	
LAND LOCATION	TM-04-10-41-11-W3		
UTM COORD	13-329400E/582050N		
GRO ELEV	537.67 m	DEPTH 103.65 m	
DATE DRILLED	MAR. 22 TO MARCH 23	1995	
COND WATER	700	MICROSIEMENS/CM AT 25°C	
COND MUO	1000	MICROSIEMENS/CM AT 25°C	
SPECIFIC GRAVITY MUO			
SUPERVISOR	L. SINCLAIR		
ASST. SUPERVISOR	L. SINCLAIR		
LOGGED BY	WIDCO 1500		
INSTRUMENT			
PROBE ELECTRIC			
PROBE GAMMA			
PROBE CALIPER			
DATE LOGGED	MARCH 23 1995		
TIME OF LOGGING	1100 HRS. TO 1230 HRS		
DRILL OPERATOR	M. MILLER		
CONTRACTOR			
REMARKS	ASST. OPERATOR: M. MINCHUK		
PROJECT			
CONTROL SECTION	16-25		
STATION	10 + 181.3 M. OFFSET 55.4 RT. *		
CUTTING SAMPLE INTERVAL	1.5 M		
CORE SAMPLE INTERVAL			
FROM			
CASING DEPTH			
CASING WALL THICKNESS			
WATER OR MUO LEVEL			
ABANDONMENT	GROUTED		
BIT SIZE	4 3/4" WAL-MAC INTERVAL 0-5.1 M		
BIT SIZE	4 3/4" TRICOME INTERVAL 6.1-18.3 M		
BIT SIZE	4 3/4" WAL-MAC INTERVAL 18.3-103.6 M		
TYPE OF DRILL RIG	1250 FALLING		
DEPTH	SCALE	SPEED	
SP.	103 M	50 m/V	15 M/MIN
RES.	103 M	50 OHMS	15 M/MIN
GAMMA	103 M	0-100 CPS	8 M/MIN
CAL.	103 M	1.14 - 18"	15 M/MIN
GAMMA TIME CONSTANT (Tc)	5	SECONDS	
GEOLGY	BY F.A. CHRISTIANSEN 20/04/95		



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• CO₂

○ 4

* FROM C.L. NORTH LANE

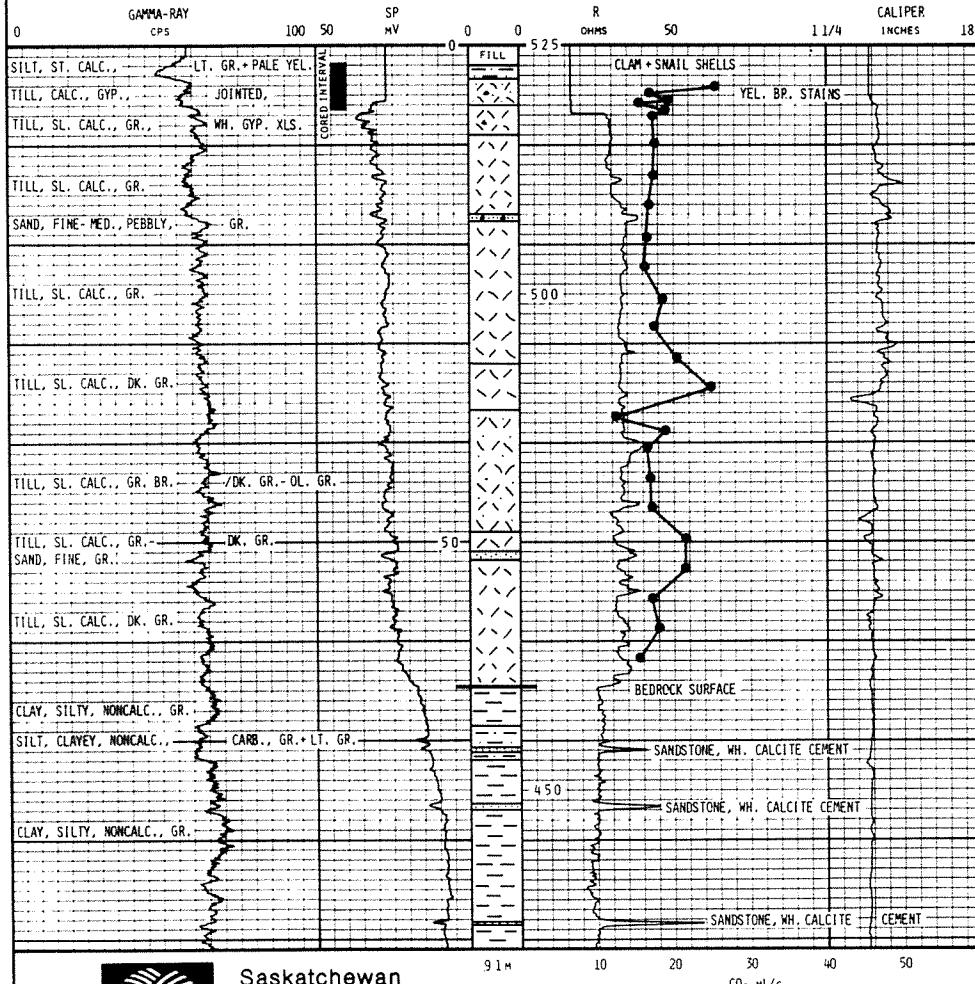
E. A. Christiansen Consulting Ltd.

SHT 73B/06 1995
RADISSON NO.3
NW-01-02-41-11-W3
13:332300E/5818800N
COREHOLE

BOREHOLE NO	3	NTS 73-B/06
LAND LOCATION	NW-01-02-41-11-W3	
UTM COORD	13:332300E/5818800N	
GRD ELEV	525.41 m	DEPTH 91.45 m
DATE DRILLED	MARCH 28 TO MARCH 29 1995	
COND WATER	0.00	MICROSIEMENS/CM AT 25°C
COND MUD	1150	MICROSIEMENS/CM AT 25°C
SPECIFIC GRAVITY MUD		
SUPERVISOR	L. SINCLAIR	
ASST SUPERVISOR		
LOGGED BY	L. SINCLAIR	
INSTRUMENT	WIDCO 1500	
PROBE ELECTRIC		
PROBE GAMMA		
PROBE CALIPER		
DATE LOGGED	MARCH 29 1995	
TIME OF LOGGING	1100 HRS TO 1230 HRS	
DRILL OPERATOR	M. MILLER	
CONTRACTOR	ASS'T OPERATOR: M. MINCHUK	
REMARKS		

PROJECT	16-25		
CONTROL SECTION			
STATION 6+694.6 m	OFFSET 12.4 m RT.		
CUTTING SAMPLE INTERVAL	1.5 m		
CORE SAMPLE INTERVAL	1.8-6.4 m		
FROM			
CASING DEPTH			
CASING WALL THICKNESS			
WATER OR MUD LEVEL	GROUTED		
ABANDONMENT			
BIT SIZE 4 3/4" WALMAC	INTERVAL 0-91.45 m		
BIT SIZE	INTERVAL		
BIT SIZE	INTERVAL		
TYPE OF DRILL RIG	1250 FALLING		
DEPTH	SCALE	SPEED	
SP	91 m	50 m	15 m/min
RES.	91 m	50 ohms	15 m/min
GAMMA	91 m	0-100 cps	8 m/min
CAL	91 m	1 1/4-18"	15 m/min
GAMMA TIME CONSTANT (TC)	5	SECONDS	
GEOLOGY BY	E.A. CHRISTIANSEN	20/04/95	

CUTTING SAMPLE DESCRIPTION

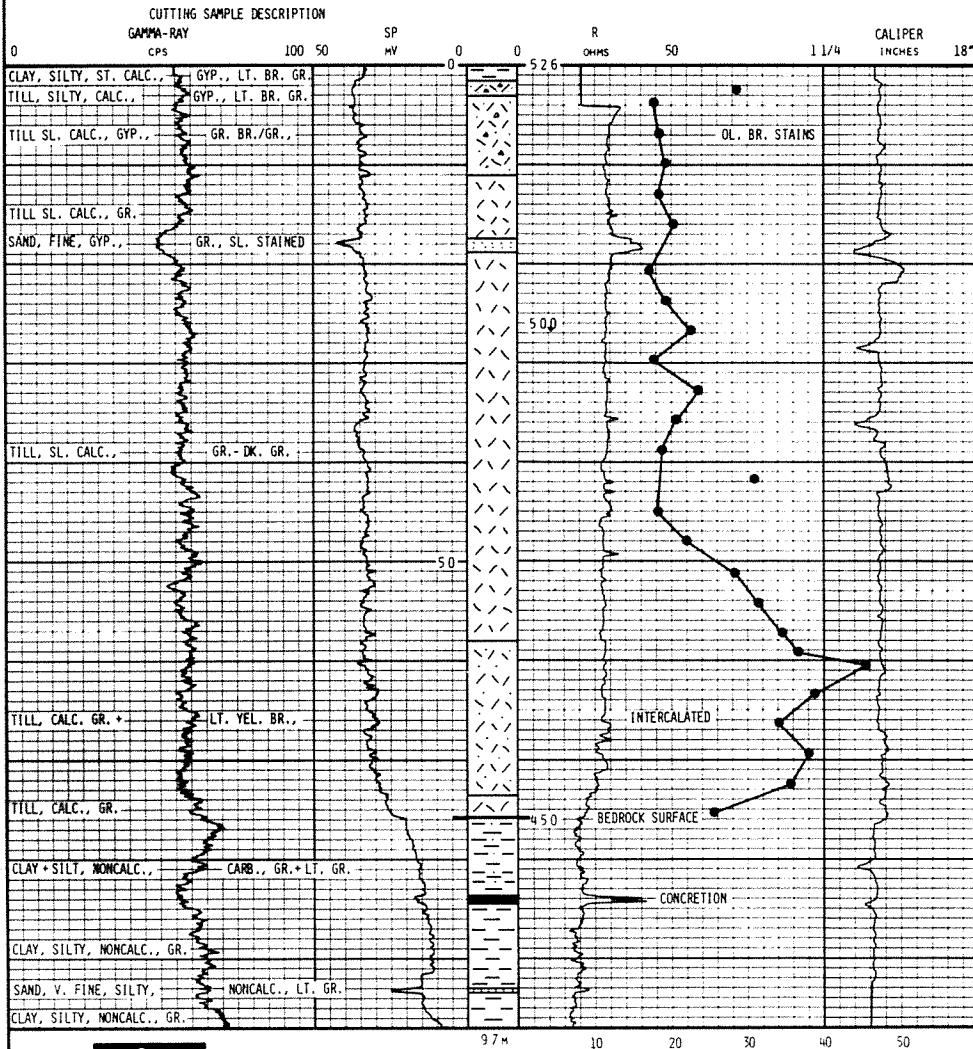


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SHT 73B/06 1995
RADISSON NO.4
NW-03-31-40-10-W3
13:334700E/5817100N
TESTHOLE

BOREHOLE NO		4	MTS 73-B/06
LAND LOCATION	NW-03-31-40-10-W3		
UTM COORD	13:334700E/5817100N		
GRO ELEV	526.43 M	DEPTH	97.55 M
DATE DRILLED	MARCH 29 TO MARCH 30	1995	
COND WATER	700	MICROSIEMENS/CM AT 25°C	
COND MUD	1100	MICROSIEMENS/CM AT 25°C	
SPECIFIC GRAVITY MUD			
SUPERVISOR	L. SINCLAIR		
ASST SUPERVISOR			
LOGGED BY	L. SINCLAIR		
INSTRUMENT	WIDCO 1500		
PROBE ELECTRIC			
PROBE GAMMA			
PROBE CALIPER			
DATE LOGGED	MARCH 30	1995	
TIME OF LOGGING	0900 HRS	TO 1030 HRS	
DRILL OPERATOR	M. MILLER		
CONTRACTOR			
REMARKS	ASST OPERATOR: M. MINCHUK		
PROJECT	16-25		
CONTROL SECTION			
STATION	3+568.2 M	OFFSET	7.1 M RT.
CUTTING SAMPLE INTERVAL	1.5 M		
CORE SAMPLE INTERVAL			
FROM			
CASING DEPTH			
CASING WALL THICKNESS			
WATER OR MUD LEVEL			
ABANDONMENT	GROUTED		
BIT SIZE	4 3/4" WALMAC	INTERVAL	0-97.55 M
BIT SIZE		INTERVAL	
BIT SIZE		INTERVAL	
TYPE OF DRILL RIG	1250 FAILING		
DEPTH	SCALE	SPEED	
SP	47 M	50 MV	15 M/MIN
RES.	97 M	50 OHMS	15 M/MIN
GAMMA	97 M	0-100 CPS	8 M/MIN
CAL	97 M	1 1/4"-18"	15 M/MIN
GAMMA TIME CONSTANT (T.C.)	5	SECONDS	
GEOLGY BY	E.A. CHRISTIANSEN	20/04/95	



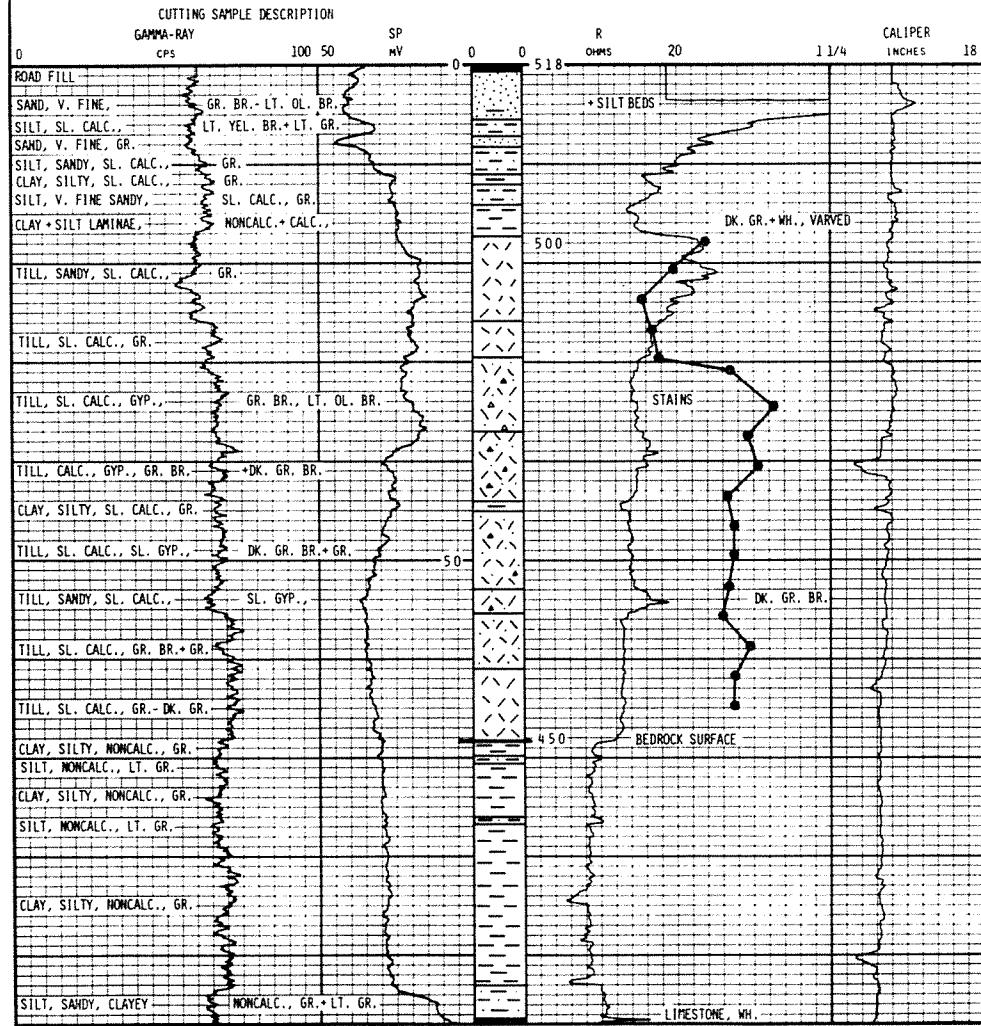
Saskatchewan
Highways and
Transportation

* FROM C.L. NORTH LANE

E.A. Christiansen Consulting Ltd.

SHT 73B/06 1995
 RADISSON NO.5
 SW-12-12-40-10-W3
 13:342050E/5811500N
 TESTHOLE

BOREHOLE NO	5	MIS	73-B/06
LAND LOCATION	SW-12-12-40-10-W3		
UTM COORD	13:342050E/5811500N		
GRD ELEV	517.74 m	DEPTH	97.55 m
DATE DRILLED	APRIL 3 TO APRIL 4 1995		
COND WATER	1500	MICROSIEMENS/CM AT 25°C	
COND MUD	2200	MICROSIEMENS/CM AT 25°C	
SPECIFIC GRAVITY MUD			
SUPERVISOR	L. SINCLAIR		
ASST SUPERVISOR			
LOGGED BY	L. SINCLAIR		
INSTRUMENT	WIDCO 1500		
PROBE ELECTRIC			
PROBE GAMMA			
PROBE CALIPER			
DATE LOGGED	APRIL 4 1995		
TIME OF LOGGING	1100 HRS TO 1230 HRS		
DRILL OPERATOR	K. MILLER		
CONTRACTOR			
REMARKS	ASST OPERATOR: M. MINCHUK		
PROJECT	16-24		
CONTROL SECTION	16-24		
STATION 13+272.4 M	OFFSET 13.8 M RT.		
CUTTING SAMPLE INTERVAL	1.5 M		
CORE SAMPLE INTERVAL			
FROM			
CASING DEPTH			
CASING WALL THICKNESS			
WATER OR MUD LEVEL			
ABANDONMENT	GROUTED		
BIT SIZE 4 3/4" WALMAC	INTERVAL 0-44.2 m		
BIT SIZE 4 3/4" TRICONE	INTERVAL 44.2-67.05 m		
BIT SIZE 4 3/4" WALMAC	INTERVAL 67.05-97.55 m		
TYPE OF DRILL RIG	1250 FAILING		
DEPTH	SCALE	SPEED	
SP	97 m	50 mV	15 m/min
RES	97 m	20 mV	15 m/min
GAMMA	97 m	0-100 CPS	8 m/min
CAL	97 m	1174-18°	15 m/min
GAMMA TIME CONSTANT (T.C.)	5	SECONDS	
GEOLGY BY L.A. CHRISTIANSEN	20/04/95		

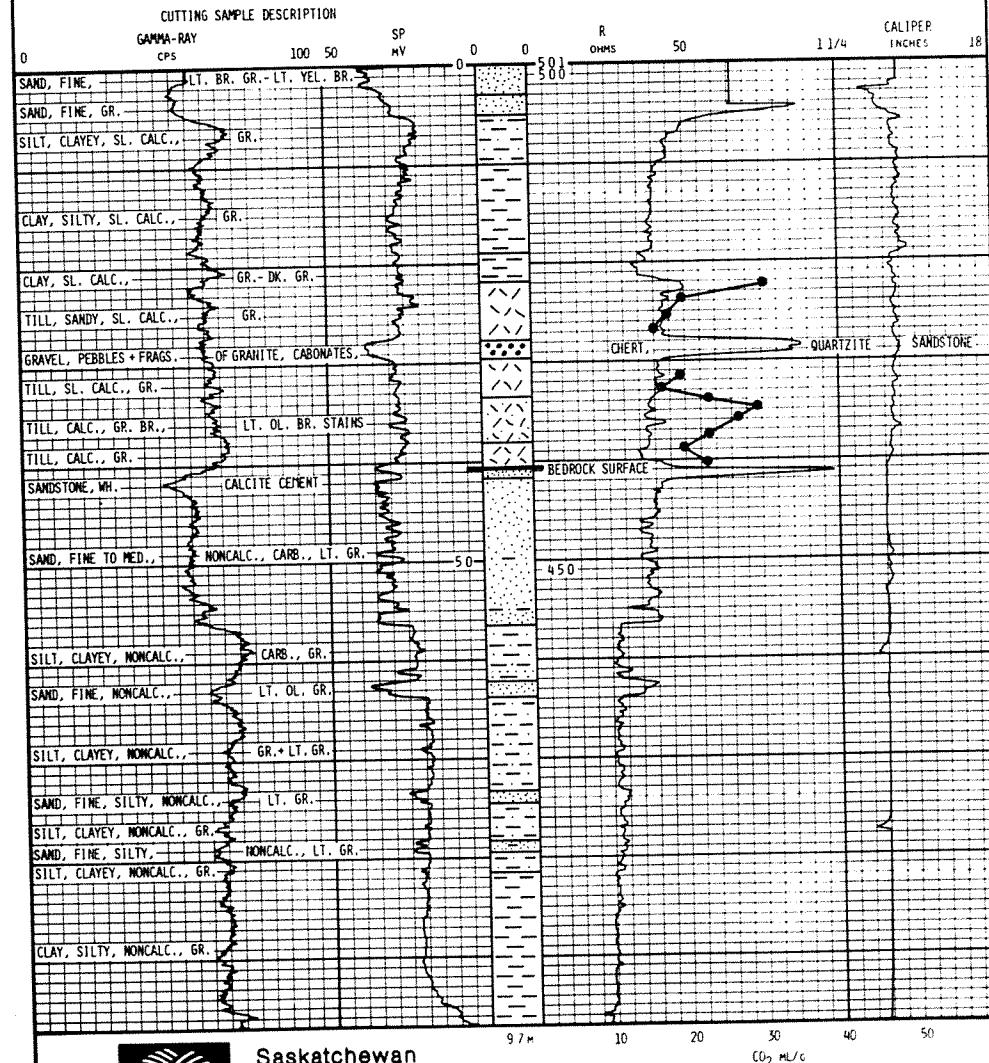


Saskatchewan
 Highways and
 Transportation

* FROM C.L. NORTH LANE

SHT 73B/06 1995
RADISSON NO.6
NW-01-05-40-09-W3
13:346500E/5808700N
TESTHOLE

BOREHOLE NO	6	MTS
LAND LOCATION	1N-01-05-40-09-W3	
UTM COORD	13-346500E/5808700N	
GRO ELEV	500.99 M	DEPTH 97.55 M
DATE DRILLED	APRIL 5	TO APRIL 5 1995
COND WATER	800	MICROSIEMENS/CM AT 25°C
COND MUD	1250	MICROSIEMENS/CM AT 25°C
SPECIFIC GRAVITY MUD		
SUPERVISOR	L. SINCLAIR	
ASST SUPERVISOR		
LOGGED BY	L. SINCLAIR	
INSTRUMENT	WIDCO 1500	
PROBE ELECTRIC		
PROBE GAMMA		
PROBE CALIPER		
DATE LOGGED	APRIL 5 1995	
TIME OF LOGGING	1250 HRS	TO 1400 HRS
DRILL OPERATOR	M. MILLER	
CONTRACTOR		
REMARKS	ASS'T OPERATOR: M. MINCHUK	
PROJECT		
CONTROL SECTION	16-24	
STATION	8-313.14 m	OFFSET 18.1 M RT.
CUTTING SAMPLE INTERVAL	1.5 M	
CORE SAMPLE INTERVAL		
FROM		
CASING DEPTH		
CASING WALL THICKNESS		
WATER OR MUD LEVEL		
ABANDONMENT	GRouted	
BIT SIZE	4 3/4" WALMAC	INTERVAL 0-97.55 M
BIT SIZE		INTERVAL
BIT SIZE		INTERVAL
TYPE OF DRILL RIG	1250 FAILING	
DEPTH	SCALE	SPEED
SP	97 M	50 m/V
RES	97 M	50 OHMS
GYM	97 M	0-100 CPS
CAL	97 M	1/14-18"
GAMMA TIME CONSTANT (TC)	5 SECONDS	
GEOLOGY BY	E.A. CHRISTIANSEN	
20/04/95		



**Saskatchewan
Highways and
Transportation**

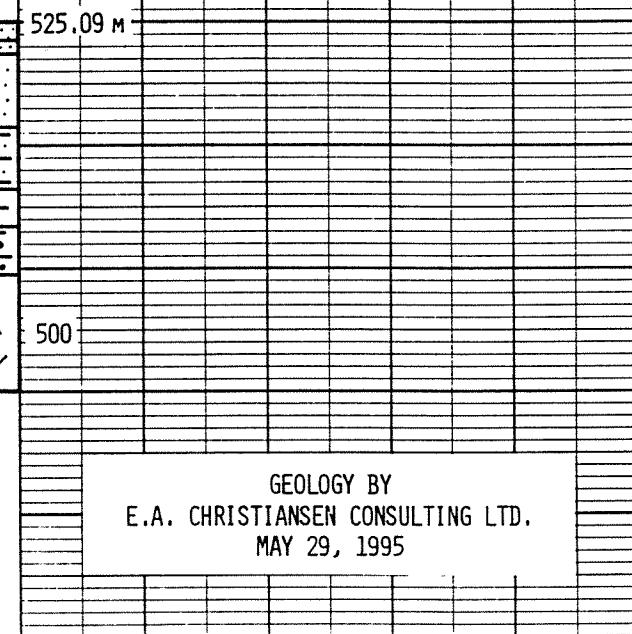
• FROM C.L. NORTH LANE

E. A. Christiansen Consulting Ltd.

SHT 73B/06 1995
RADISSON NO.7
SW-10-29-40-10-W3
13:336600E/5816000N
AUGERHOLE

SAND, SILTY, NONCALC., BK., (A-HORIZON)	0
SAND, SILTY, NONCALC., DK. BR., (B-HORIZON)	
SAND, MED.-CO., PALE BR./LT. BR. GR.	
SILT, CALC., OL., OL. GR., LT. OL. GR.	10
CLAY, SILTY, CALC., GR.	5 M
CLAY, SILTY, PEBBLY, GR., SOFT	20
TILL, SL. CALC., DK. GR., FIRM	30

AUGERING BY
SASKATCHEWAN HIGHWAYS AND TRANSPORTATION
MAY 23, 1995



SHT 73B/06 1995
RADISSON NO.8
SW-05-28-40-10-W3
13:337400E/5815700N
AUGERHOLE

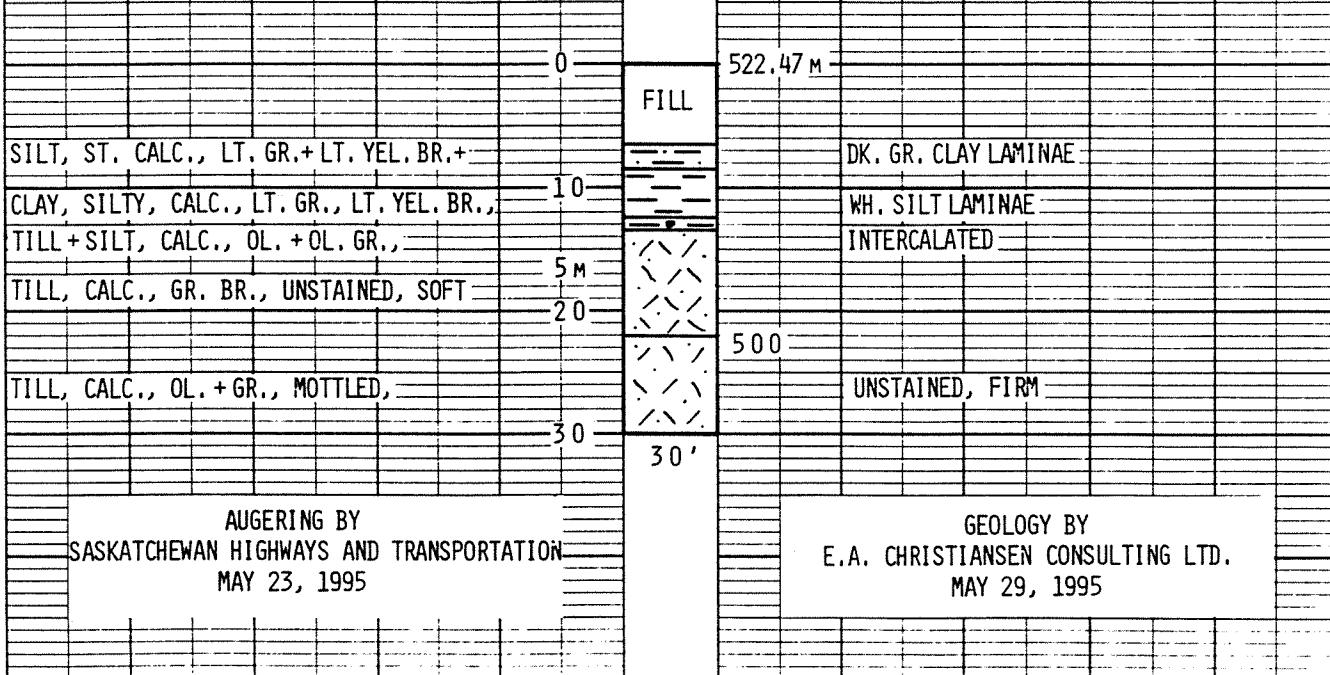
0
SAND, SILTY, ST. CALC., BK.
GRAVEL, CO. SANDY, ST. CALC., LT. YEL. BR.
SILT + CLAY, CALC.+SL. CALC., LT. GR.,
10
SILT, CLAYEY, ST. CALC., LT. GR.+
5 M
TILL, SL. CALC.- CALC., GR.

522.13 M FILL
LT. BR. GR., V.DK. GR. BR.
ST. CALC., WH. SILT LAMINAE
500
25'

AUGERING BY
SASKATCHEWAN HIGHWAYS AND TRANSPORTATION
MAY 23, 1995

GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
MAY 29, 1995

SHT 73B/06 1995
RADISSON NO.9
NE-13-21-40-10-W3
13:337700E/5815100N
AUGERHOLE



Appendix B. Carbonate content of tills in boreholes 1A-6, longitudinal section A-A'.

SASKATCHEWAN RESEARCH COUNCIL GEOCHEMICAL LAB

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SHT RADISSON 1A

M42 CHRISTIANSEN E.A. CONSULTING MAR. 14/95 (22) PG. 550 [0.5 GM BR DIG.]
 1 %Ca BY AA OT95:09

2 %Mg BY AA

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO3 (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO2 FROM CALCITE=COL.4*2.238

8 CO2 FROM DOLOMITE=COL.3*2.429

9 TOTAL CO2=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
BR2	5.08	1.53	11.61	6.39	17.99	1.82	14.29	28.19	42.48
LS5 135 1.5	2.03	0.89	6.75	1.41	8.16	4.80	3.15	16.40	19.54
LS5 137 2.4	2.43	1.06	8.04	1.70	9.74	4.72	3.81	19.53	23.34
LS5 139 3.7	2.13	1.04	7.89	1.04	8.93	7.60	2.32	19.16	21.48
LS5 141 5.0	1.98	0.97	7.36	0.95	8.31	7.74	2.13	17.87	20.00
LS5 143 6.1	4.15	1.40	10.62	4.60	15.22	2.31	10.29	25.79	36.09
LS5 144 7.0	4.33	1.55	11.76	4.43	16.19	2.65	9.92	28.56	38.48
LS5 145 8.4	3.82	1.40	10.62	3.78	14.40	2.81	8.45	25.79	34.24
LS5 147 11.3	3.06	1.09	8.27	3.15	11.42	2.62	7.06	20.08	27.14
LS5 155 23.6	3.60	1.07	8.12	4.59	12.70	1.77	10.26	19.71	29.98
LS5 156 25.2	3.77	1.17	8.87	4.60	13.47	1.93	10.29	21.56	31.85
LS5 157 26.7	4.01	1.26	9.56	4.83	14.38	1.98	10.80	23.21	34.02
LS5 158 28.2	3.65	0.97	7.36	5.12	12.48	1.44	11.46	17.87	29.33
LS5 162 34.4	3.35	1.03	7.81	4.13	11.94	1.89	9.23	18.98	28.21
LS5 163 35.8	3.43	1.05	7.96	4.24	12.21	1.88	9.50	19.35	28.84
LS5 167 41.9	2.69	0.84	6.37	3.26	9.63	1.95	7.29	15.48	22.77
LS5 168 43.5	3.68	0.84	6.37	5.73	12.10	1.11	12.83	15.48	28.30
LS5 170 46.5	3.25	0.87	6.60	4.53	11.13	1.46	10.15	16.03	26.18
LS5 172 49.6	3.03	0.93	7.05	3.74	10.79	1.89	8.37	17.13	25.50
LS5 174 52.6	2.68	0.75	5.69	3.60	9.29	1.58	8.07	13.82	21.89
BR2	5.20	1.52	11.53	6.73	18.26	1.71	15.06	28.01	43.06
LS5 176 55.6	2.97	0.91	6.90	3.67	10.57	1.88	8.21	16.77	24.98

SASKATCHEWAN RESEARCH COUNCIL GEOCHEMICAL LAB

SHT RADISSON 2

M96 CHRISTIANSEN APRIL 28/95 (23) [0.500 GM BILL ROSS DIGESTION]

1 %Ca BY AA OT95.16

2 %Mg BY AA

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
--	-----	-----	-------	--------	--------	--------	--------	--------	--------

BR	5.18	1.51	11.45	6.72	18.17	1.70	15.04	27.82	42.86
LS5 399 0.8m	1.99	0.90	6.83	1.26	8.09	5.40	2.83	16.58	19.41
LS5 400 2.3m	1.52	0.85	6.45	0.30	6.74	21.75	0.66	15.66	16.32
LS5 401 3.8m	1.85	0.88	6.67	1.00	7.67	6.70	2.23	16.21	18.44
LS5 402 5.3m	1.76	0.75	5.69	1.31	7.00	4.35	2.93	13.82	16.74
LS5 403 6.9m	2.76	1.02	7.74	2.69	10.43	2.87	6.03	18.79	24.82
LS5 414 22.5m	4.01	1.81	13.73	2.56	16.29	5.36	5.73	33.35	39.08
LS5 417 29.0m	3.99	1.35	10.24	4.41	14.65	2.32	9.86	24.87	34.73
LS5 418 29.7m	4.07	1.26	9.56	4.98	14.53	1.92	11.14	23.21	34.35
LS5 419 31.3m	3.58	1.13	8.57	4.29	12.86	2.00	9.60	20.82	30.42
LS5 420 32.5m	3.90	1.21	9.18	4.76	13.94	1.93	10.65	22.29	32.94
LS5 427 43.5m	1.69	0.70	5.31	1.34	6.65	3.97	3.00	12.90	15.89
LS5 428 45.0m	2.25	0.81	6.14	2.28	8.43	2.69	5.11	14.92	20.04
LS5 429 46.5m	2.53	0.83	6.30	2.90	9.20	2.17	6.49	15.29	21.78
LS5 430 48.0m	3.00	0.87	6.60	3.91	10.51	1.69	8.75	16.03	24.78
LS5 433 52.6m	3.34	0.89	6.75	4.68	11.43	1.44	10.47	16.40	26.86
LS5 435 55.6m	2.42	0.71	5.39	3.12	8.51	1.73	6.98	13.08	20.06
LS5 437 58.7m	3.35	0.96	7.28	4.41	11.70	1.65	9.88	17.69	27.57
LS5 439 61.8m	3.03	0.80	6.07	4.27	10.34	1.42	9.56	14.74	24.30
LS5 441 64.8m	2.28	0.78	5.92	2.48	8.40	2.38	5.56	14.37	19.93
BR	4.95	1.49	11.30	6.23	17.53	1.81	13.94	27.45	41.39
LS5 443 67.8m	2.56	0.71	5.39	3.47	8.86	1.55	7.77	13.08	20.85
LS5 445 70.9m	2.52	0.73	5.54	3.29	8.82	1.68	7.36	13.45	20.81

SASKATCHEWAN RESEARCH COUNCIL GEOCHEMICAL LAB

SHT RADISSON 3

M98 CHRISTIANSEN APRIL 28/95 (27) [0.500 GM BILL ROSS DIGESTION]

1 %Ca BY AA OT95.18

2 %Mg BY AA

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
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BR	5.09	1.51	11.45	6.49	17.95	1.76	14.53	27.82	42.36
LS5 471 4.0m	2.51	1.25	9.48	1.12	10.60	8.45	2.51	23.03	25.54
LS5 472 4.7m	1.57	0.89	6.75	0.26	7.01	26.31	0.57	16.40	16.97
LS5 473 5.3m	1.84	0.99	7.51	0.52	8.03	14.46	1.16	18.24	19.40
LS5 474 5.7m	1.46	0.82	6.22	0.27	6.49	23.03	0.60	15.11	15.71
LS5 475 6.4m	1.77	1.00	7.59	0.30	7.89	25.02	0.68	18.42	19.10
LS5 476 7.0m	1.68	0.87	6.60	0.61	7.21	10.75	1.37	16.03	17.40
LS5 478 9.9m	1.82	0.82	6.22	1.17	7.39	5.32	2.62	15.11	17.72
LS5 480 13.0m	1.86	0.78	5.92	1.43	7.35	4.13	3.21	14.37	17.58
LS5 482 16.0m	1.85	0.69	5.23	1.78	7.01	2.94	3.98	12.71	16.69
LS5 484 19.1m	1.91	0.63	4.78	2.18	6.95	2.20	4.87	11.61	16.48
LS5 486 22.1m	1.78	0.68	5.16	1.65	6.80	3.13	3.68	12.53	16.21
LS5 488 25.2m	2.03	0.77	5.84	1.90	7.74	3.07	4.25	14.19	18.44
LS5 490 28.2m	1.86	0.76	5.76	1.52	7.28	3.80	3.39	14.00	17.40
LS5 492 31.3m	2.17	0.89	6.75	1.75	8.51	3.85	3.93	16.40	20.33
LS5 494 34.3m	2.58	1.14	8.65	1.75	10.40	4.94	3.92	21.00	24.92
LS5 496 37.4m	1.34	0.52	3.94	1.21	5.15	3.27	2.70	9.58	12.28
LS5 497 38.9m	2.032	0.82	6.22	1.69	7.91	3.67	3.79	15.11	18.90
LS5 498 40.4m	1.86	0.67	5.08	1.89	6.97	2.69	4.22	12.34	16.57
LS5 500 43.5m	1.80	0.74	5.61	1.45	7.06	3.88	3.24	13.63	16.88
BR	5.18	1.52	11.53	6.68	18.21	1.73	14.95	28.01	42.95
LS5 502 46.5m	1.86	0.74	5.61	1.60	7.21	3.51	3.58	13.63	17.21
LS5 504 49.6m	2.36	0.91	6.90	2.15	9.05	3.21	4.81	16.77	21.57
LS5 506 52.6m	2.44	0.85	6.45	2.59	9.04	2.49	5.81	15.66	21.47
LS5 508 55.6m	1.82	0.77	5.84	1.37	7.22	4.25	3.08	14.19	17.26
LS5 510 58.7m	1.89	0.81	6.14	1.39	7.53	4.44	3.10	14.92	18.02
LS5 512 61.8m	1.76	0.66	5.01	1.68	6.68	2.98	3.76	12.16	15.92

SASKATCHEWAN RESEARCH COUNCIL GEOCHEMICAL LAB

SHT RADISSON 4

M97 CHRISTIANSEN APRIL 28/95 (28) [0.500 GM BILL ROSS DIGESTION]

1 %Ca BY AA OT95.17

2 %Mg BY AA

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
--	-----	-----	-------	--------	--------	--------	--------	--------	--------

BR	5.19	1.50	11.38	6.79	18.16	1.68	15.19	27.64	42.82
LS5 533 2.3m	3.09	1.23	9.33	2.65	11.98	3.52	5.94	22.66	28.60
LS5 534 3.8m	1.88	0.79	5.99	1.44	7.43	4.15	3.23	14.56	17.78
LS5 536 6.9m	1.98	0.78	5.92	1.73	7.65	3.41	3.88	14.37	18.25
LS5 538 9.9m	2.12	0.81	6.14	1.96	8.10	3.14	4.39	14.92	19.31
LS5 540 13.0m	1.96	0.79	5.99	1.64	7.63	3.65	3.68	14.56	18.23
LS5 542 16.0m	2.14	0.89	6.75	1.68	8.43	4.02	3.76	16.40	20.16
LS5 545 20.6m	1.85	0.74	5.61	1.57	7.19	3.57	3.52	13.63	17.16
LS5 547 23.6m	2.07	0.83	6.30	1.75	8.05	3.59	3.92	15.29	19.21
LS5 549 26.7m	2.50	0.91	6.90	2.50	9.40	2.76	5.59	16.77	22.35
LS5 551 29.7m	1.94	0.77	5.84	1.67	7.52	3.49	3.75	14.19	17.93
LS5 553 32.8m	2.75	0.91	6.90	3.12	10.02	2.21	6.98	16.77	23.75
LS5 555 35.8m	2.24	0.88	6.67	1.97	8.65	3.39	4.41	16.21	20.62
LS5 557 38.9m	2.06	0.79	5.99	1.89	7.88	3.17	4.23	14.56	18.79
LS5 559 41.9m	3.49	1.26	9.56	3.53	13.09	2.71	7.90	23.21	31.11
LS5 561 45.0m	1.97	0.78	5.92	1.71	7.62	3.46	3.82	14.37	18.19
LS5 563 48.0m	2.43	0.91	6.90	2.32	9.22	2.97	5.20	16.77	21.96
LS5 565 51.1m	3.06	1.20	9.10	2.70	11.80	3.37	6.05	22.11	28.15
LS5 567 54.1m	3.48	1.32	10.01	3.26	13.27	3.07	7.29	24.32	31.61
LS5 569 57.2m	3.70	1.50	11.38	3.06	14.44	3.71	6.86	27.64	34.49
BR	5.33	1.55	11.76	6.93	18.69	1.70	15.51	28.56	44.07
LS5 570 59.1m	4.06	1.52	11.53	3.88	15.41	2.97	8.69	28.01	36.69
LS5 571 60.2m	4.91	1.97	14.94	4.15	19.09	3.60	9.29	36.30	45.59
LS5 573 63.3m	4.32	1.58	11.98	4.28	16.27	2.80	9.59	29.11	38.70
LS5 575 66.3m	3.90	1.34	10.16	4.22	14.39	2.41	9.45	24.69	34.14
LS5 577 69.4m	4.25	1.55	11.76	4.23	15.99	2.78	9.47	28.56	38.03
LS5 579 72.4m	3.92	1.51	11.45	3.57	15.03	3.21	8.00	27.82	35.82
LS5 581 75.2m	2.74	1.11	8.42	2.27	10.69	3.70	5.09	20.45	25.54

SASKATCHEWAN RESEARCH COUNCIL GEOCHEMICAL LAB

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SHT RADISSON 5

M99 CHRISTIANSEN APRIL 28/95 (18) [0.500 GM BILL ROSS DIGESTION]
1 %Ca BY AA OT95.19

2 %Mg BY AA

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
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BR		5.12	1.53	11.61	6.49	18.09	1.79	14.52	28.19	42.71	
LS5	607	17.9m	2.62	1.00	7.59	2.43	10.01	3.13	5.43	18.42	23.85
LS5	609	20.6m	2.20	0.78	5.92	2.28	8.20	2.59	5.11	14.37	19.48
LS5	611	23.6m	1.73	0.64	4.85	1.69	6.54	2.88	3.77	11.79	15.56
LS5	613	26.7m	1.85	0.70	5.31	1.74	7.05	3.05	3.89	12.90	16.79
LS5	615	29.7m	1.95	0.75	5.69	1.78	7.47	3.19	3.99	13.82	17.81
LS5	616	30.8m	3.42	0.85	6.45	5.04	11.49	1.28	11.28	15.66	26.94
LS5	618	34.3m	3.91	1.16	8.80	4.99	13.79	1.76	11.16	21.37	32.54
LS5	620	37.4m	3.71	0.94	7.13	5.39	12.53	1.32	12.07	17.32	29.39
LS5	622	40.4m	3.88	0.96	7.28	5.74	13.02	1.27	12.84	17.69	30.53
LS5	624	43.5m	3.27	0.91	6.90	4.42	11.32	1.56	9.89	16.77	26.66
LS5	626	46.5m	3.56	0.82	6.22	5.51	11.73	1.13	12.34	15.11	27.45
LS5	628	49.6m	3.51	0.85	6.45	5.27	11.71	1.22	11.79	15.66	27.45
LS5	630	52.6m	3.39	0.84	6.37	5.01	11.38	1.27	11.21	15.48	26.68
LS5	632	55.6m	3.21	0.87	6.60	4.43	11.03	1.49	9.92	16.03	25.95
LS5	634	58.7m	3.60	1.03	7.81	4.75	12.56	1.64	10.63	18.98	29.61
LS5	636	61.8m	3.44	0.90	6.83	4.89	11.71	1.40	10.93	16.58	27.52
LS5	638	64.8m	3.35	0.94	7.13	4.50	11.63	1.59	10.06	17.32	27.38

SASKATCHEWAN RESEARCH COUNCIL GEOCHEMICAL LAB

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SHT RADISSON 6

M100 CHRISTIANSEN MAY 3/95 (13) PG. 913 [0.5 GM BR DIG.]

1 %Ca BY AA OT95.20

2 %Mg BY AA

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
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BR		5.09	1.58	11.98	6.21	18.19	1.93	13.89	29.11	43.00	
LS5	674	22.1m	3.30	1.28	9.71	2.97	12.68	3.27	6.65	23.58	30.23
LS5	675	23.6m	2.13	0.86	6.52	1.78	8.30	3.67	3.98	15.85	19.83
LS5	676	25.2m	1.87	0.79	5.99	1.42	7.41	4.23	3.17	14.56	17.73
LS5	677	26.7m	1.69	0.72	5.46	1.26	6.72	4.35	2.81	13.27	16.08
LS5	680	31.3m	2.33	0.70	5.31	2.94	8.25	1.81	6.57	12.90	19.47
LS5	681	32.8m	1.80	0.72	5.46	1.53	6.99	3.57	3.43	13.27	16.69
LS5	682	UNOX 33.9m									
		2.49	1.00	7.59	2.10	9.69	3.61	4.70	18.42	23.13	
LS5	682	OX 34.7m	3.66	0.99	7.51	5.06	12.57	1.48	11.33	18.24	29.57
LS5	683	35.8m	3.27	0.92	6.98	4.38	11.36	1.59	9.80	16.95	26.75
LS5	684	37.4m	2.80	0.82	6.22	3.62	9.84	1.72	8.09	15.11	23.20
LS5	685	38.9m	2.33	0.74	5.61	2.77	8.39	2.02	6.20	13.63	19.84
LS5	686	40.2m	2.73	0.81	6.14	3.48	9.63	1.76	7.79	14.92	22.72

