EAC

SASKATCHEWAN INSTITUTE OF PEDOLOGY

GEOLOGY OF THE BATTLEFORD AREA SASKATCHEWAN

Report 0062-002 April 21, 1981

E. A. Christiansen Consulting Ltd.

E. A. Christiansen Consulting Ltd.

CONSULTING GEOLOGIST

BOX 3087
SASKATOON, SASKATCHEWAN, CANADA
S7K 3S9

PHONE 374-6700

April 21, 1981

Saskatchewan Institute of Pedology
Department of Soil Science
University of Saskatchewan
Saskatoon, Saskatchewan

Attention: Dr. D.F. Acton

Dear Dr. Acton:

Enclosed are two copies of Report 0062-002 on the "Geology of the Battleford area, Saskatchewan". In addition, the original drawings and an unbound xerox copy of the text are enclosed.

To comply with Mr. Rostad's request for additional information, one copy of the SRC geologic logs and chemical analyses of groundwater are also enclosed.

Mr. Rostad brought up a number of queries regarding the history of deglaciation of the Wilkie block which can best be dealt with during our field investigation as most of these queries revolve around the origin of the high level silts.

Sincerely yours,

E.A. Christiansen

TABLE OF CONTENTS

Text

Text

Text

Illustrations

Illustrations

Page

Drawings

Appendices

1. INTRODUCTION

1.1 Objective

The objective of this investigation on the "Geology of the Battleford area" is as follows:

1. Prepare a regional landform map at 1:1,000,000 from existing compilations to serve as a basis for the history of deglaciation for the Battleford area and surrounding region.
2. Reconstruct the glacial history of the Battleford area by reviewing:
   a) Glacial Lake Deposits -
      (i) sand deposits south of Artland, Winter, and Vera;
      (ii) glacial Lake Unity and thin silty deposits on northeast perimeter, i.e. Cutknife, Cloan, and Scott;
      (iii) lacustrine deposits south of Unity, Denzil, Salvador, and Luseland, i.e. why are there heavy clays among silty deposits?
      (iv) source area for various lacustrine deposits.

   b) Glacial till deposits and their associated landforms-
      (i) hummocky plain in Baldwinton-Freemont area;
      (ii) ridged plain near Cloan and Revenue;
      (iii) level plain northeast of Unity;
      (iv) mixed silt and till on very large hills from Fire Lake to Senlac.

   c) Geological history of Muddy Lake, Fire Lake, Battleford Valley, Battle River, and Eagle Hills escarpment.
3. Prepare about five (5) sketches showing the history of deglaciation for the Battleford area and surrounding region based on "Wisconsinan deglaciation of southern Saskatchewan and adjacent areas" by E.A. Christiansen.

4. Summarize existing information on geomorphology, stratigraphy of

parent materials, and glacial history of the Wilkie area.

5. Prepare a map of bedrock geology and topography of the Wilkie area at 1:100,000.
6. Prepare a geomorphologic map showing the glacial, preglacial and postglacial landforms of the Wilkie area based on soil maps, aerial photographs, and mozaics.
7. Prepare eleven (11) cross sections of the Wilkie area (vertical scale 1:2400, horizontal scale 1:50,000).
8. Prepare sketches showing history of deglaciation of the Wilkie area.
9. Discuss such processes as glacial erosion and sedimentation, eolian sedimentation, and lacustrine sedimentation of the Battleford area.
10. Write a report of the results of the above work under the following chapters: introduction, geomorphology, stratigraphy of drift and bedrock, geologic processes, geologic history.

1.2 Location

The location of the Wilkie block, the Battleford area, and the Battleford region are shown in Figure 1.

1.3 Previous Work

The soils of the Battleford area were mapped by Mitchell *et al.* (1947) and reprinted in 1962. Soils of the Red Pheasant Indian Reserve No. 108 and the Mosquito Indian Reserve No. 109 were mapped by Button and Stonehouse (1968) and Padbury and Stonehouse (1968).

The surficial geology of the east half of the Battleford area was mapped by Craig (1959). The geology and groundwater resources map of the Battleford area was published by Christiansen (1967, in back) in which the bedrock geology and topography are shown in a map and the drift, bedrock,

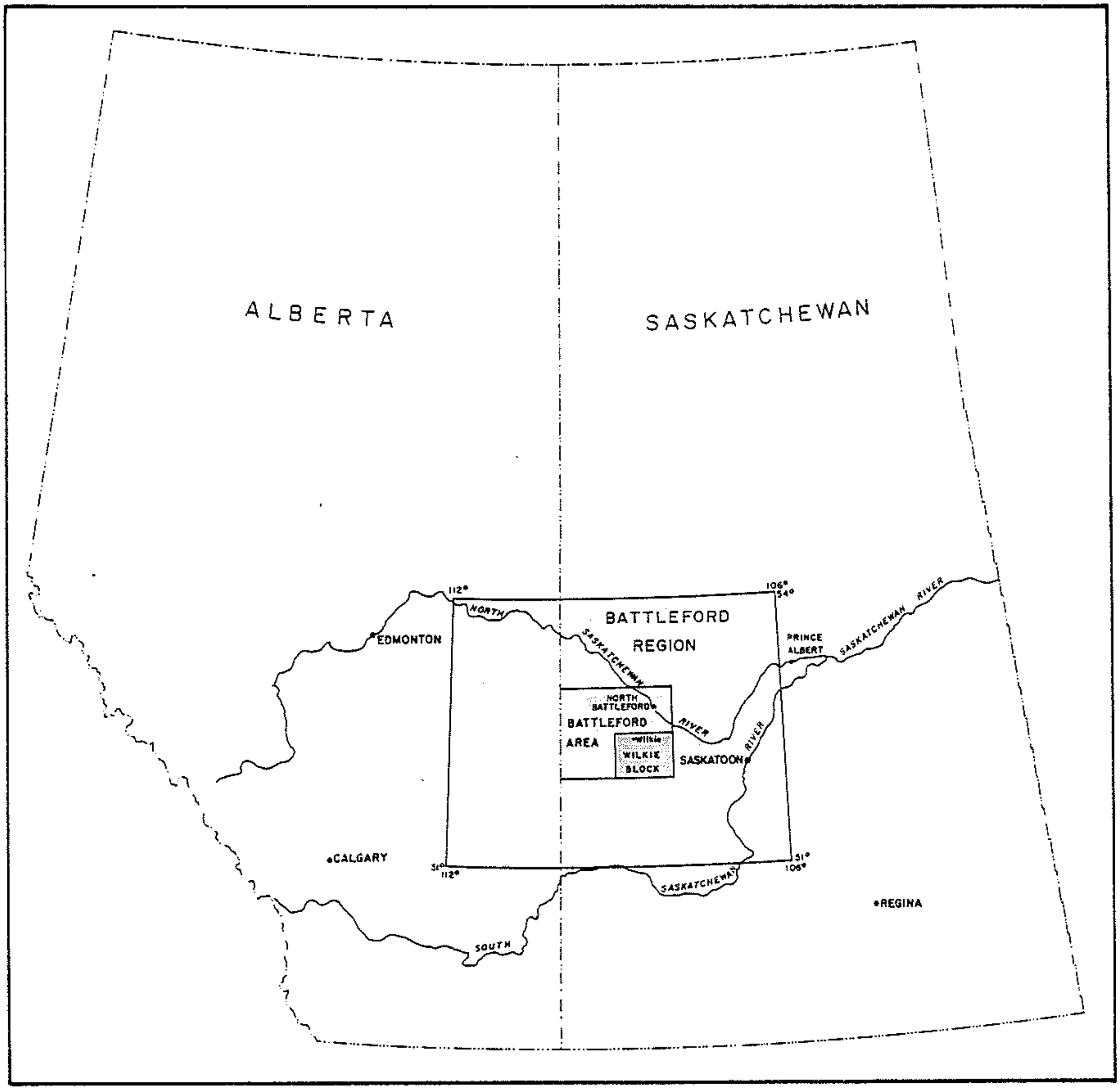


Figure 1. Location of the Wilkie block, the Battleford area, and the Battleford region.

and base of groundwater exploration are shown in cross sections.

The history of the last deglaciation in southern Saskatchewan and adjacent areas was published by Christiansen (1979). The landform map and the history of deglaciation sketches, shown herein, were taken from the manuscript of this publication.

1.4 Present Study

The present study represents a compilation of the geology of the drift and bedrock of the Wilkie block and a compilation of a landform map and history of deglaciation of the Battleford region. This report is based entirely on existing information and represents an office compilation only.

The geology of the Wilkie area will constitute the main body of this report with the geologic processes and history referring as well to the larger Battleford area and, in some cases, the Battleford region. The final Chapter will deal specifically with Item 2 of the objective.

2. BEDROCK GEOLOGY

2.1 Introduction

The bedrock deposits in the Wilkie block include the Lea Park Formation and Upper Colorado Group, the Judith River and Bearpaw Formations (Drawings 0062-002-01-12), and isolated deposits of Tertiary - Quaternary sediments. The heavy oil - bearing Manville Group and the Lower Colorado Group are also included in the cross sections and provide deeper marker beds. Further comment will not be made about these deeper groups of sediments.

2.2 Lea Park Formation and Upper Colorado Group

Because the Lea Park Formation cannot be differentiated from the Upper Colorado Group in electric logs, they were combined into one unit (Drawings 0062-002-01-12). The Lea Park Formation and Upper Colorado Group is composed of 900 to 1200 feet (270-366 m) of gray, marine silt and clay and bentonite beds. Locally, the upper part of the Lea Park Formation contains sand beds. The upper part is noncalcareous, whereas the lower part is composed of calcareous, white, speckled shales.

2.3 Judith River Formation

The Judith River Formation (McLean, 1971) is composed of 0 to 315 feet (0-96 m) of nonmarine, interbedded, very fine - to medium - grained sand, silt, and clay with carbonaceous and concretionary zones (Drawing 0062-002-01-12). The Judith River Formation is a deltaic sediment which grades eastward into marine deposits (Fig. 2).

The lower contact of the Judith River Formation is taken at the change from a silt and clay aspect of the Lea Park Formation to a sandy aspect of the Judith River Formation. Locally, thin sandy beds are placed in the upper part of the Lea Park Formation, however, rather than in the lower part of the Judith River Formation. For the most part, the upper part of the formation was glacially eroded; consequently, the Judith River Formation is the most extensive bedrock in the Wilkie block (Drawing 0062-002-01).

2.4 Bearpaw Formation

The Bearpaw Formation is composed of 0 to 140 feet (0-43 m) of gray, marine, noncalcareous silt and clay with a sand interbeds (Drawing 0062-002-07, Borehole 111). For the most part, the Bearpaw

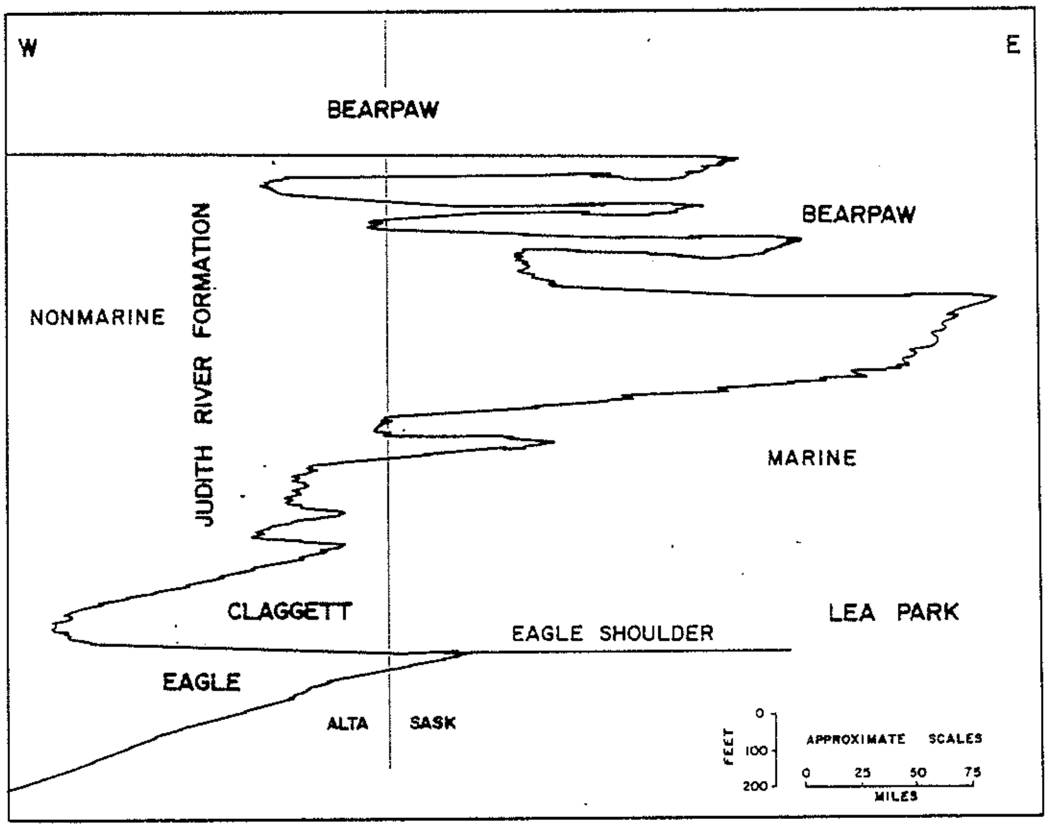


Figure 2. Schematic cross section of intertongued nonmarine Judith River sands and silts and marine Lea Park and Bearpaw silts and clays. From McLean (1971).

Formation was removed by glacial erosion. Only the larger remnants of the Bearpaw Formation are shown in Drawing 0062-002-01 .

2.5 Tertiary - Quaternary Sediments

Chert and quartzite gravels interbedded with sands, 25 feet (7.6 m) thick, occur between drift and bedrock in isolated boreholes in the Wilkie block (Drawings 0062-002-06,07; Boreholes 92,112 - too thin to be shown in cross sections). These sediments were deposited presumably in preglacial valleys which were subsequently modified by glacial erosion leaving these preglacial sediments as remnants.

3. GLACIAL GEOLOGY

3.1 Stratigraphy

3.1.1 Introduction

The glacial deposits of the Wilkie block include the Empress, Sutherland, and Saskatoon Groups. Except for part of Drawing 0062-002-07, the drift could not be divided into these groups because of paucity of lithologic information.

3.1.2 Empress Group

The Empress Group, named by Whitaker and Christiansen (1972), is composed of stratified deposits lying between till and bedrock. Although stratified deposits occur in individual boreholes at this stratigraphic position, they are not extensive enough to be shown in the cross sections.

3.1.3 Sutherland Group

The Sutherland Group, named by Christiansen (1968a), is composed of a lower till and an upper till (Fig. 3). These tills have a lower electrical resistance, a lower carbonate content, and a higher clay content than the Saskatoon Group. In the Salter borehole (Fig. 3), the upper parts of both the lower till and upper till are weathered to an olive color. Both till units have silt and sand interbeds (Fig. 3).

3.1.4 Saskatoon Group

The Saskatoon Group, named by Christiansen (1968a), is composed of the Floral and Battleford Formations and surficial stratifed drift, the latter two of which are the parent materials for most of the soils of the Battleford area.

The Floral Formation is composed of till which has a higher electrical resistance and carbonate content than the tills of the Sutherland Group (Fig. 3). The upper part of the Floral Formation is commonly oxidized to a grayish brown color and is well jointed with coatings of iron and manganese oxides on the joint surfaces.

The Battleford Formation, named by Christiansen 1968b, has its reference section in the Battleford area (Drawing 0062-002-01, NW4-17-37-19-W3). The Battleford Formation is commonly composed of 1 to 10 feet (0.3-3 m) of soft, unjointed, unstained till resting disconformably on the Floral Formation.. Over most of the flat plains of the central part of the Battleford area, the contact is marked by a boulder pavement whose boulders

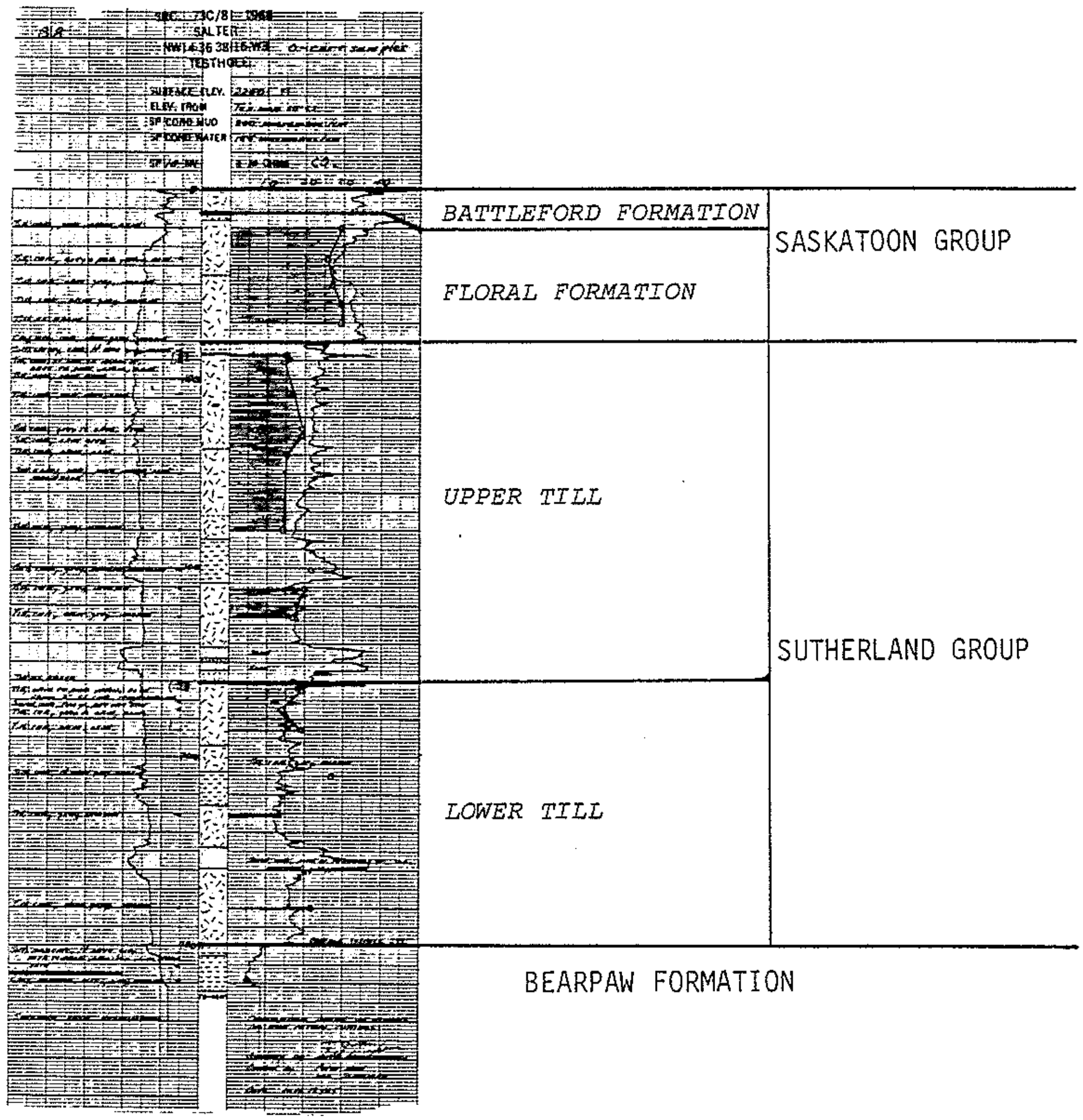


Figure 3. Drift stratigraphy in SRC Salter borehole.

are flat-topped and striated.

Surficial stratified drift of lacustrine origin overlies the Battleford Formation conformably in the southern part of the Battleford area (Fig. 4). The lacustrine deposits are composed of sand, silt, and clay which are too thin to be shown in the cross sections. The surficial stratified drift deposits and the Battleford Formation form the parent materials for most of the soils in the Battleford area.

3.2 Landforms

3.2.1 Introduction

The description of the following landforms is based on a brief study of aerial-photographs and 1:100,000 mosaics and on soil and topographic maps. The purpose of this study was to identify the landforms and to document their origin to provide a geologic framework for soil mapping. The major landforms in the Wilkie block are shown in Drawing 0062-002-13.

3.2.2 Ground Moraine

Ground moraine is composed of till areas of low relief, commonly less than 10 feet (3 m). The relief of the ground moraine is thought to be related to the thickness of the Battleford Formation. In the fluted till plain northeast of Unity, the till in the ground moraine is less than a metre thick. It is further thought that most of this thin, soft till of the Battleford Formation is ablation material resting on the glacially eroded Floral Formation.

IN BACK

Figure 4. Landform map of the Battleford region.

3.2.3 Hummocky Moraine

Hummocky moraine is composed mainly of till and has a local relief of 10 to 30 feet (3-10 m). The landscape is characterized by till knobs, kettles, and moraine plateaus. The higher relief suggests the Battleford Formation is thicker in the hummocky moraine. The local relief of 10 to 30 feet (3-10 m) also suggests the ablation material is at least that thick.

3.2.4 End Moraine

The east-west trending ridge, which rises more than 50 feet (15 m) above Handel (Drawing 0062-002-13, T.36, R.19), is considered to be an end moraine. According to Craig (1959), the moraine is composed of ice-contact silt, sand, and gravel.

3.2.5 Ridged Moraine

Ridged moraine is used herein to describe the till ridges that form a strip of intersecting ridges between Phippen and Tramping Lake (Drawing 0062-002-13). The main trend of the ridges is perpendicular to the ice-flow features. An exposure in a till ridge between Phippen and Scott (Drawing 0062-002-13, NW12-6-40-20-W3) showed that the ridge was composed entirely of till. An auger-hole at the base of this ridge showed that the ridge rests on another 12 feet (3.7 m) of till similar to the till in the ridge.

The intersecting pattern of the ridged moraine and the perpendicular trend of the main ridges to the ice-direction indicators (flutings) led Craig (1959) to conclude that the ridges are crevasse fillings. Gravenor and Kupsch (1959) concluded crevasses fillings are formed by material falling into crevasses from the melting stagnant ice, whereas Stalker (1960) argued that the till in the ridges was pressed into the crevasses from beneath stagnant ice. If the ridges in the ridged moraine in the Battleford area (Fig. 4) are all composed of till as the one between Phippen and Scott mentioned above, then the ice-pressed explanation of Stalker (1960) would seem preferable.

3.2.6 Flutings

Flutings consist of fields of narrow, straight,parallel ridges and grooves. Locally, they can be discerned only in photo-mosaics where the pattern can be seen on a regional basis. In the Katepwa Fluting Field (Christiansen *et al.* 1977), the grooves were eroded into the Floral Formation and less than a metre of Battleford Formation was let down on to this eroded surface as the ice melted. Brief examinations by the writer suggest the stratigraphic setting of the flutings in the Battleford area is the same. Further work, however, is required to determine the origin of these flutings.

3.2.7 Ice - walled Channels

The term"ice - walled channel"was used by Gravenor and Kupsch (1959) for meltwater channels formed either in tunnels or in open trenches in stagnant ice. Ice - walled channels are characterized by irregular longitudinal profiles, ridges along the top of the valleys, eskers, and valley fills which become coarser downward (Christiansen, in preparation).

Near the terminus of glaciers, meltwater sooner or later finds its way through fractures and crevasses to the base of the glacier where it has great erosive power because of the head provided by the glacier. Initally,a subglacial tunnel is formed, and subglacial material is eroded. As the tunnel expands, the roof becomes unstable and collapses to form an ice-walled channel in which erosion or sedimentation can occur. As the glacier retreats so does the channel in a time-transgressive manner (see Phases 4 and 5 of the history of deglaciation of the Wilkie block). Thus the channel becomes younger up-ice. (Christiansen, in preparation).

3.2.8 Eskers

Eskers are sinuous or broad ridges of sand and gravel formed in subglacial tunnels and ice-walled channels. The smaller, sinuous ridges are believed to have formed in subglacial tunnels,whereas the broader ridges formed in ice-walled channels. The esker in the Wilkie area (Drawing 0062-002-13, T.38, R16) is believed to have formed in a tunnel under stagnant ice. The broadening of the esker in Section 31, Township 38, Range 16 (Drawing 0062-002-13) is called a "bead" which is interpreted as a still - stand in the retreat of the ice margin.

3.2.9 Outwash Plains

Outwash plains are composed of fans or coalesced fans of sand and gravel deposited by meltwater streams. These streams either obtain their sediments from the melting glacier directly (not common in the Battleford area because the outwash was deposited in glacial lakes to become lasustrine deposits such as the Winter area, Fig. 4) or indirectly by erosion of till by glacial meltwater (Drawing 0062-002-13; S.36, T.38, R.16). Past experience in Saskatchewan suggests most outwash is derived from previously deposited material by the erosion of subglacial or proglacial meltwater.

3.2.10 Glacial Lake Basins

The extent of the glacial lakes in the Battleford area and Wilkie block are shown in Figure 4 and Drawing 0062-002-13, and their location with respect to time will be shown in the history of deglaciation sketches.

The glacial lake sediments are composed of sand, silt, and clay which is up to 117 feet (36 m) thick in the Fire Lake depression.

3.2.11 Spillways

Spillways carried meltwater from glacial lakes, commonly from one glacial lake to another. The Tramping Spillway (Drawing 0062-002-13), for example, carried meltwater from Lake Unity to Lake Saskatchewan. Spillways formed the largest valleys present in the prairies because they not only carried water from the melting glacier but also extraglacial water from proglacial runoff and melting mountain glaciers.

4. GEOLOGIC PROCESSES

4.1 Introduction

Glacial erosion and glacial, eolian, and lacustrine sedimentation are important processes in the formation of the landscape in the Battleford area.

4.2 Glacial Erosion

Glacial erosion is accomplished by either plucking or abrasion (Fig. 5), and plucking provides the rock tools for abrasion. Although the flat-topped boulders in the boulder pavements

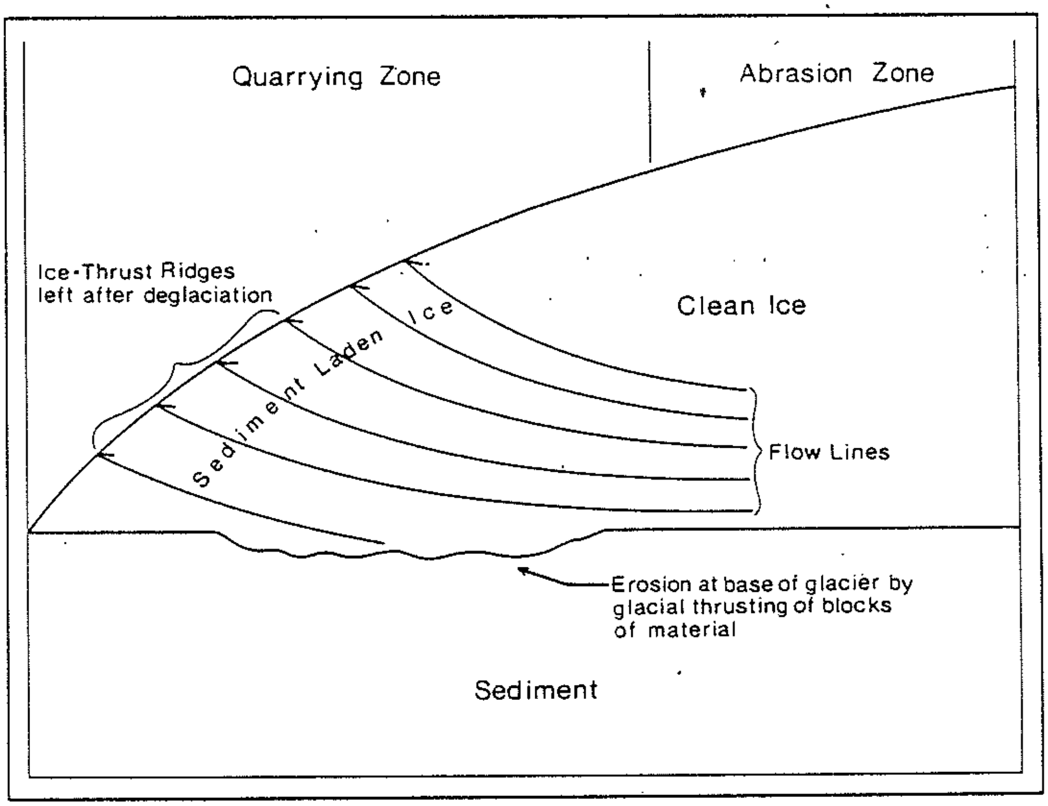


Figure 5. Schematic diagram showing the process of glacial thrusting. From Christiansen and Whitaker (1976).

between the Floral and Battleford Formation and the fluted surfaces on the Floral Formation were formed by glacial abrasion, glacial plucking is more effective as an agent of erosion.

Glacial plucking or over thrusting occurred near the margin of the glacier where drift and, in some places, bedrock was eroded from ice-thrust depressions and carried upward along diverging flowlines (Fig. 5) to form a repetition of beds by overthrusting. Christiansen (in preparation) concluded the Fire Lake depression (Figs. 6,7) is an ice-thrust depression. Such plucking would be expected to take place as the ice margin passes during glacial advances and again as the glacier re-advances during retreats. If plucking takes place during glacial advances, the plucked material would be expected to be incorporated in the glacier to be let down as a till deposit farther down-ice. If the plucking takes place during a re-advance, on the other hand, ice-thrust moraines and ridges would be expected (Fig. 4).

The glacial thrusting model (Fig. 5) was used to explain the upward - facing concave surfaces on the bedrock surface in the cross sections of the Wilkie block (Drawing 0062-002-02-12). Most of the closed depressions on the bedrock surface are also attributed to glacial erosion (Drawing 0062-002-01).

4.3 Glacial Sedimentation

Deposition of glacially transported material can take place either at the base of the glacier as lodgment till or as a result of surface melting of the glacier (ablation till). Boulton (1971) proposed a three-till classification; flow till, melt-out till, and lodgment till.

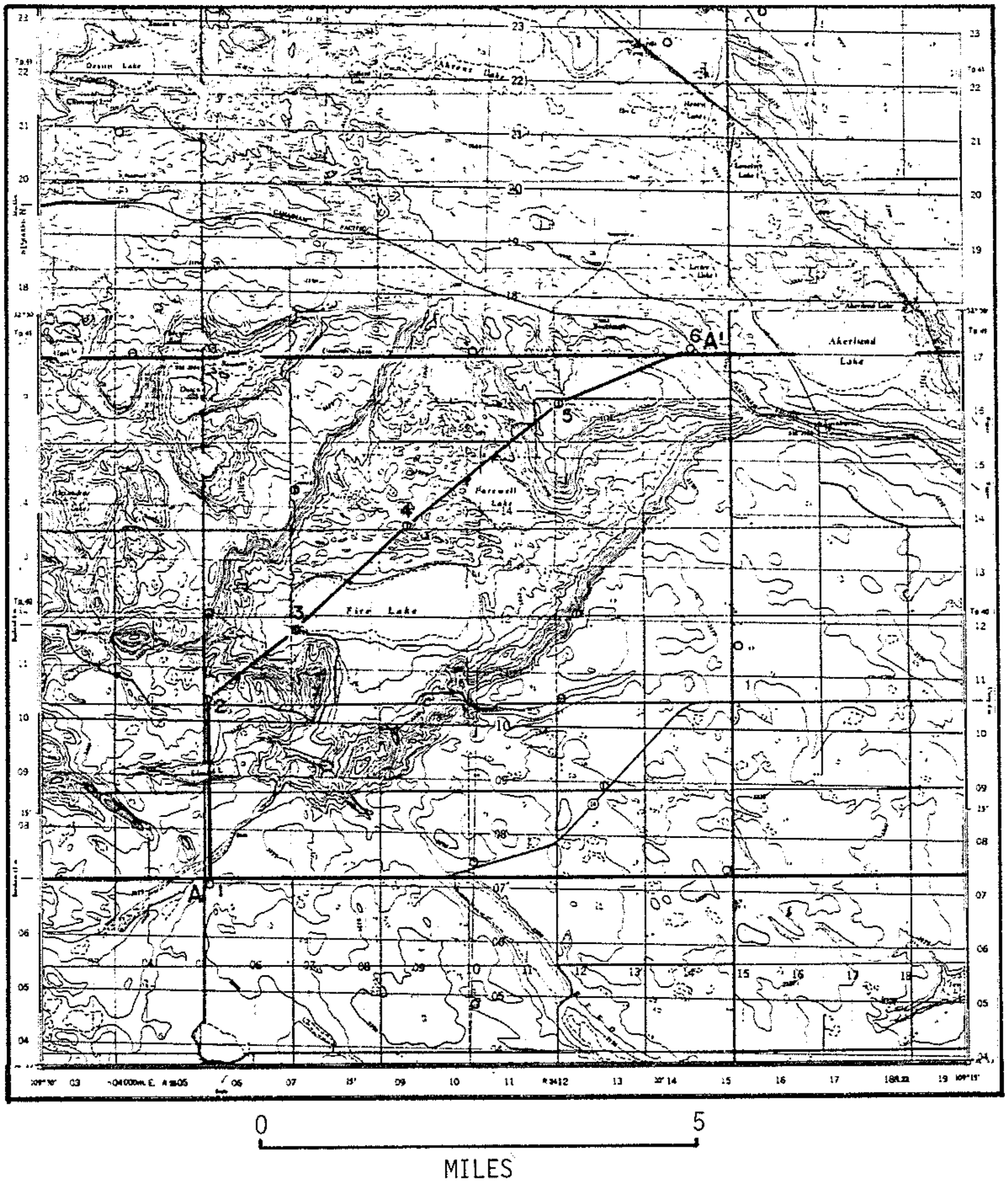


Figure 6. Fire Lake depression.

IN BACK

Figure 7. Cross section across the Fire Lake depression. See Figure 6 for location of cross section.

Flow till is released as a fluid mass from englacial debris exposed by downmelting of the glacier surface. Melt-out tills are tills which melt-out slowly from either the bottom or surface of buried stagnant ice and which retains much of its original englacial structure. Lodgment till is material released from the basal part of an active glacier either by pressure melting or by debris-rich masses which have become stagnant beneath the moving glacier.

Flow till may include lacustrine silts and clays and fluvial sands and gravels and may exhibit deformation caused by mass movement. Melt-out till is subjected only to collapse and, consequently, is not sorted. Most of the ice-thrust moraine and hummocky moraine is formed from melt-out till. Lodgment tills, on the other hand, have not been disturbed since they were deposited at the base of moving glaciers.

4.4 Eolian Sedimentation

Dune activity in the Battleford area has occurred northwest of Battleford, southwest of Biggar and in the Winter area (Fig. 4). According to David (1977), a special style of dune occurs in the Battleford area which he has named the "North Battleford type dune". This type of dune is characterized by a well-developed, symmetrical blowout dune with activity on the south-facing inner slope of its northern wing. The outer north-facing slope of the same inner wing is covered by trees and shrubs. The rest of the dune is stabilized by grass. The principle direction of dune migration is to the southeast. Eolian activity is restricted almost entirely to the southern exposed sides of these dunes.

With so much dune activity in the Battleford area, deposition of loess in the vicinity of these dune areas is expected . Such wind -blown silty deposits are suspected between Phippen (T.40, R.20) and Cutknife (T.43, R.21) where 30 to 80 cm of silt loam material overlies till (Rostad, personal communication, 1981). These silts are believed to be too high in elevation to have been deposited in a glacial lake. Further field studies are required to determine the origin of these silt loams.

4.5 Lacustrine Sedimentation

As the glacier retreated downslope to the northeast, glacial lakes were dammed by the retreating ice. As the ice down-melted, glacial lake waters inundated the stagnant ice which extended along the margin of the glacier. From these waters, silts and clays were deposited on the stagnant ice. As the stagnant ice melted, englacial material was released to the surface of the glacier to mix with the lake sediments. This resulted in a mixed zone of till of the Battleford Formation and glacial lake silt and clay to form a conformable contact between these two deposits. Such a contact was encountered in an augerhole near Denzil (Fig. 4; SW4-27-37-24-W3).

5. GEOLOGIC HISTORY

5.1 Cretaceous Period

During the Cretaceous Period, the Battleford area was covered by shallow seas into which rivers from the Cordillera emptied forming retrograding and prograding deltas as the sea levels rose and fell (Fig. 2). The sandy Judith River Formation and Mannville Group represent such deltaic deposits of nonmarine origin, whereas the clayier Lower Colorado Group, Lea Park

Formation and Upper Colorado Group, and Bearpaw Formation were deposited in shallow seas eastward from these deltas. The late Cretaceous, during which the Lower Colorado Group to the Bearpaw Formation were deposited, extended from 94 to 64 million years ago (Obradovich and Cubban, 1975).

5.2 Tertiary Period

During the Tertiary Period 64 million to about 3 million years ago, the Battleford area received nonmarine sands and chert and quartzite gravels. Remnants of these deposits occur only in the preglacial Battleford Valley (Christiansen, 1967) and in the bedrock valley west of Biggar (Drawing 0062-002-01) but were undoubtedly more extensive prior to glaciation. Because the age of these sands and gravels is uncertain, they are referred to as Tertiary - Quaternary, but, presumably, these sediments are Tertiary.

5.3 Quaternary Period

5.3.1 Introduction

The Quaternary Period covers about the last three million years of the earth's history and includes the Pleistocene and Recent Epochs.

5.3.2 Pleistocene Epoch

As the glaciers advanced across the Battleford area, they eroded the Cretaceous and Tertiary bedrock deposits and modified the valley west of Biggar (Drawing 0062-002-01).

At least four glaciations are recorded in the SRC Salter borehole (Fig. 3). The lower till of the Sutherland Group was deposited by the oldest glaciation recorded at this site. The surface of this till was weathered prior to the deposition of the upper till of the Sutherland Group. The surface of this upper till was also weathered prior to deposition of the Floral Formation which was deposited during the third glaciation recorded at this site. Although Skwara-Woolf (1979) indicated the Floral Formation at Saskatoon was deposited by two separate glaciations with an intervening interglacial interval which had a climate similar to today's climate in southwestern Saskatchewan, only one of these two glaciations, is recorded in the Floral Formation of the Battleford area.

The top of the Floral Formation was also weathered before the last glacier advanced across the Battleford area about 20,000 years ago (Christiansen, 1968b). This weathering interval commenced more than 38,000 years ago and ended during the final advance of the glacier about 20,000 years ago. The Battleford Formation was deposited during this last glaciation. This glacier started its retreat about 17,000 years ago and retreated across the Battleford area from before 14,000 years ago to about 12,000 years ago (Christiansen, 1979, in back).

5.3.3 Recent Epoch

Since the cessation of glacial influence in the Battleford area, alluvium has been deposited in the Battle and North Saskatchewan River Valleys. As soon as the lacustrine sand areas were drained, the sandy deposits were reworked into dunes by the wind which undoubtedly carried some finer-grained silts to adjacent areas where thin loessial deposits were laid down. Except for wind erosion, alluvial and eolian sedimentation, a few landslides, and some gully erosion, few changes have taken place in the Battleford area during the Recent Epoch.

6. HISTORY OF DEGLACIATION

6.1 Introduction

Most features in the landscape and most soil parent materials in the Battleford area owe their origin to the last deglaciation. To determine the history of deglaciation of the Battleford area, it was necessary to deal with a larger Battleford region. In addition to this region, the history of deglaciation was determined in more detail for the Wilkie block. The history of deglaciation for the Battleford region is taken from the manuscript map of Christiansen (1979) which is shown in Figure 4. The criteria for determing this history of deglaciation is discussed by Christiansen (1979, in back).

6.2 History of Deglaciation of the Battleford Region

6.2.1 Introduction

The history of deglaciation of the Battleford region is shown in 5 phases (Figs. 8-12).

6.2.2 Phase 1

During Phase 1 (Fig. 8), water flowed through the Sounding Channel, through a lake crossing the Alberta - Saskatchewan boundary, and through the Denzil Spillway into Lake Stewart Valley. The lakes, channel, and spillway were bordered by either active or stagnant ice. The heavy clay in the Denzil - Salvador area were deposited at this time. The lack of deltaic deposits at the lower end of the Denzil Spillway, however, requires further investigation.

IN BACK

Figure 8. Phase 1 of the history of deglaciation of the Battleford region.

6.2.3 Phase 2

During Phase 2 (Fig. 9), water flowed through the Sounding Channel, Lake Unity, and Tramping Spillway into Lake Saskatchewan. Prior to this phase, the Sunnyglen Spillway came into existence and probably carried some water during Phase 2.

During this phase, a well-defined lobe of ice advanced into the Lake Unity basin as an ice stream or glacial surge. This lobe of ice eroded and fluted the Floral Formation and laid down a pavement of boulders which the ice subsequently eroded and striated. During downmelting, the englacial material was deposited on the truncated Floral Formation and boulder pavement to form the Battleford Formation.

6.2.4 Phase 3

Water continued to flow through the Sounding Channel, Lake Unity, and the Tramping Spillway into Lake Saskatchewan during Phase 3 (Fig. 10). Water spilled from Lake Saskatchewan into Lake Regina by way of the Anerley Spillway. This phase corresponds approximately with Phase 4 of Christiansen (1979, p.926, in back). The glacier stood at this position about 14,000 years ago.

The lobe of ice which surged into the Lake Unity basin has now decreased in size, and the previously active ice to the east and west has stagnated (Fig. 10). As this lobe melted, crevasse fillings in the ridged moraine were deposited on the fluted surface of the Floral Formation.

IN BACK

Figure 9. Phase 2 of the history of deglaciation of the Battleford region.

IN BACK

Figure 10. Phase 3 of the history of deglaciation of the Battleford region.

6.2.5 Phase 4

During Phase 4 (Fig. 11), water still flowed through the Sounding Channel, Lake Unity, and Tramping Spillway into Lake Saskatchewan. The Cooper Channel and the Blackstrap Spillway came into existence during this phase. Most of the lacustrine sand of the Artland-Winter-Vera area was deposited during Phase 4.

6.2.6 Phase 5

During Phase 5 (Fig. 12), water flowed through the Battle Spillway from Lake Edmonton into glacial Lake Saskatchewan which drained through the South Saskatchewan and Qu'Appelle Spillways into Lake Agassiz. This phase corresponds approximately with Phase 5 of Christiansen (1979, p. 927, in back).

6.3 History of Deglaciation of the Wilkie Block

6.3.1 Introduction

The history of deglaciation of the Wilkie block is shown in 5 phases (Figs. 13-17). In addition to the criteria used by Christiansen (1979, in back) the presentation of the history of deglaciation of the Wilkie block is based on the interpretation of ice-walled channels and their suggested time-transgressive formation.

6.3.2 Phase 1

During Phase 1 (Fig. 13), the glacier stood at a well-developed end moraine south of Handel. The Tramping Channel was forming as a subglacial channel in a tunnel under the glacier and as an ice-walled channel in stagnant ice beyond the active glacier margin.

IN BACK

Figure 11. Phase 4 of the history of deglaciation of the Battleford region.

IN BACK

Figure 12. Phase 5 of the history of deglaciation of the Battleford region.

IN BACK

Figure 13. Phase 1 of the history of deglaciation of the Wilkie block.

IN BACK

Figure 14. Phase 2 of the history of deglaciation of the Wilkie block.

IN BACK

Figure 15. Phase 3 of the history of deglaciation of the Wilkie block.

IN BACK

Figure 16. Phase 4 of the history of deglaciation of the Wilkie block.

IN BACK

Figure 17. Phase 5 of the history of deglaciation of the Wilkie block.

6.3.3 Phase 2

During Phase 2 (Fig. 14), a well - developed system of ice - walled channels were developed in the stagnant ice south of the actively flowing glacier. The Tramping channel became the Tramping Spillway draining Lake Unity into glacial Lake Saskatchewan.

6.3.4 Phase 3

Between Phases 2 and 3 (Figs. 14,15), the glacier retreated northward before re-advancing to the position shown in Figure 15. During this interval the stagnant ice shown in Figure 14 melted. Lake Unity was at is maximum extent and drained through the Tramping Spillway into Lake Saskatchewan (Fig. 9; Christiansen, 1979, p.926, in back). The ice stood at this position about 14,000 years ago.

6.3.5 Phase 4

During Phase 4 (Fig. 16), Lake Unity fell to 2150 feet (655 m), and the Tramping Spillway, through which it drained, continued to empty into Lake Saskatchewan (Fig. 10). An ice - walled channel, herein named the "Crane Channel", was developing during this phase. The channel started in a subglacial tunnel, continued through ice walls in the stagnant ice, and opened up into an outwash plain south of the belt of stagnant ice. The active glacier and its marginal belt of stagnant ice and their associated subglacial and ice - walled channels are retreating and developing northward in a time - transgressive manner as the ice melts.

6.3.6 Phase 5

During Phase 5 (Fig. 17), Lake Unity continued to drain through the Tramping Spillway which emptied into Lake Saskatchewan (Fig. 11).

The active glacier and stagnant - ice belt continued to retreat northward. As the ice retreated the subglacial and ice-walled Crane Channel extended northward time - transgressively.

7. REVIEW OF ITEM 2 a,b,c OF OBJECTIVE

7.1 Introduction

The purpose of this chapter is to deal specifically with the questions posed in Item 2 of the objective.

7.2 Sand Deposits South of Artland, Winter,and Vera

The sand deposits south of Artland, Winter, and Vera (Fig. 4) were deposited in Lake Unity (Figs. 9-11). The source of these sandy sediments were the Sounding Channel and glacial meltwater from the adjacent stagnant and active ice.

7.3 Glacial Lake Unity and Thin Silt Deposits to the Northeast

The deposits in glacial Lake Unity grade from sand in the west to silt and clay to the east (Figs. 4,9-11). The lake sediments are composed of 74 feet (23 m) of sand with a few silt interbeds at Winter (Fig. 18) and of 117 feet (36 m) of silt with sand interbeds in the Fire Lake depression (Fig. 7).

To the northeast above the Lake Unity basin are 0 to 80 cm beds of silt loam (Rostad, personal communication, 1981) which may be loessial in origin. Further study of the sediments is required.

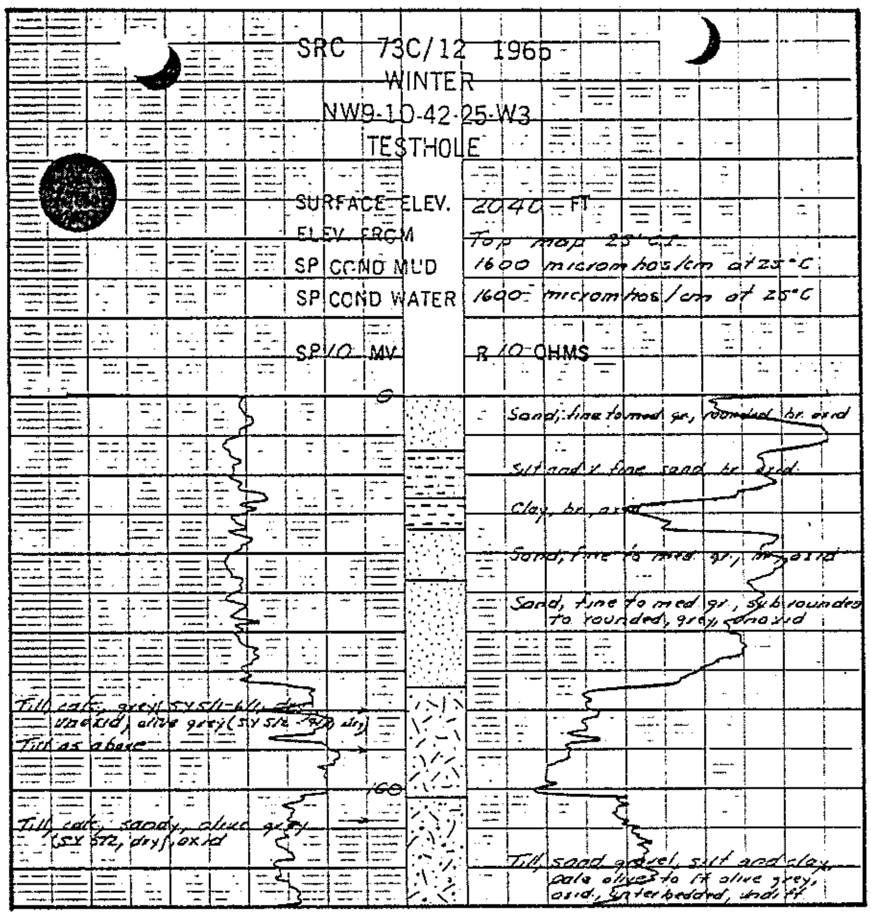


Figure 18. Sands and interbedded silts deposited in Lake Unity in SRC Winter borehole.

7.4 Lacustrine Deposits South of Unity

These deposits were laid down in glacial Lake Stewart Valley during Phase 1 of the history of deglaciation of the Battleford region (Fig. 8) and during the retreat of the glacier between Phases 1 and 2 (Figs. 8,9). Near Denzil (Fig. 4), the lacustrine silt and clay is 40 feet (12 m) thick and becomes finer grained with depth. These sediments are more clayey because of the remoteness of the South Saskatchewan and Red Deer Rivers which are believed to be the main source of the lake sediments. The relationship of the Denzil Spillway to these sediments is not clear. If it had functioned as a regular spillway, a sand and gravel delta should have formed where the spillway emptied into the lake (Fig.8). It is possible that the Denzil Spillway did not function as a spillway and that the Sounding Channel drained through the Cactus Lake area instead. Further work, including field work,is required to solve this problem.

7.5 Hummocky Moraine in Baldwinton - Freemont Areas

Hummocky Moraine is thought to have formed from melt - out till which was thrust into the glacier. Such moraines tend to form on uplands where glacially thrust material derived from the slopes tend to accumulate. The Hummocky Moraine in the Baldwinton - Freemont area was probably derived from the lower lands to the northeast and northwest. Evidence of glacial thrust can be seen in the ice - thrust ridges west of Freemont (Fig. 4).

7.6 Ridged Plain Near Cloan and Revenue

Two types of ridges occur in these area, Flutings and ridged moraines (crevasse fillings). The nature and origin of these deposits are discussed under headings 3.2.5 and 3.2.6.

7.7 Level Plain Northeast of Unity

The level plain northeast of Unity is part of a level plain which extends from Township 36 to 43 and from Range 18 to 22 (Fig. 4). In this area, a thin deposit of Battleford Formation, commonly less than one metre thick, overlies an eroded and fluted Floral Formation. The flutings and ridged moraine suggest this area was glaciated by a surging lobe of ice which had its source north of the Eagle Hills Escarpment (Fig. 9). The flatness of this plain is thought to have been the result of the erosion of the Floral Formation by this surging lobe of ice.

7.8 Mixed Silt and Till between Fire Lake and Senlac

Ice - thrust ridges west of Senlac (Fig.4) and the ice-thrust depressions at Fire Lake (Figs. 6,7) and Muddy Lake indicate glacial thrusting has occurred in these areas. The mixing of till and silt was probably accomplished by glacial thrusting of till and lacustrine or bedrock silt. Such a problem requires field work for a more detailed appraisal.

7.9 Geologic History of Muddy Lake, Fire Lake, Battleford Valley, Battle River, and Eagle Hills Escarpment

The Muddy Lake, End Lake, Fire Lake and the Artland - Winter - Vera depressions (Christiansen, 1967, in back; Figs. 6,7), are interpreted as ice - thrust depressions. Boreholes in the Muddy Lake and Fire Lake depressions encountered lacustrine sediments resting directly on bedrock indicating the older glacial deposits were removed by erosion. Since the shape of these depressions are not characteristic of fluvial erosion in this area, the process of glacial erosion has been invoked to explain their formation.

The Battleford Valley (Christiansen, 1967, in back) is a bedrock valley. The chert and quartzite gravels in the valley south of Neilberg indicate the valley is preglacial in age.

The Battle River flows in a spillway valley which carried water from Lake Edmonton to Lake Saskatchewan (Fig. 12). Near Battleford the valley is partly filled with 60 feet (18 m) of alluvium (SRC Battleford SE10-19-43-16-W3).

7.10 Eagle Hills Escarpment

The Eagle Hills escarpment is a bedrock feature which has been excentuated by glaciations (Christiansen, 1967, cross section CC', in back). As the glaciers encountered the escarpment, they went into compressive flow and eroded material from the lowland. This material was carried upward in the glacier along diverging flowlines (Fig. 5) to be deposited in the Eagle Hills by extending flow.

8. LITERATURE CITED

Boulton, G.S. 1971. Till genesis and fabric in Svalbard, Spitzbergen. *In* Till. *Edited by* R.P. Goldthwait, Ohio State University Press, p. 41-72.

Button, R.G. and Stonehouse, H.B. 1968. Soil survey of The Red Pheasant Indian Reserve No. 108. Saskatchewan Institute of Pedology, Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Publication S 142.

Christiansen, E.A. 1967. Geology and groundwater resources of the Battleford area (73-C), Saskatchewan Research Council, Geology Division, Map 4.

Christiansen, E.A. 1968a. Pleistocene stratigraphy of the Saskatoon area, Saskatchewan, Canada. Canadian Journal of Earth Sciences, v. 5, p. 1167-1173.

Christiansen, E.A. 1968b. A thin till in west-central Saskatchewan, Canada. Canadian Journal of Earth Sciences, v. 5, p. 329-336.

Christiansen, E.A. 1979. The Wisconsinan deglaciation of southern Saskatchewan and adjacent areas. Canadian Journal of Earth Sciences, v. 16, p. 913-938.

Christiansen, E.A., Acton, D.F., Long, R.J., Meneley, W.A., and Sauer, E.K. 1977. Fort Qu'Appelle Geolog. Saskatchewan Culture and Youth. Saskatchewan Museum of Natural History, Interpretive Report 2.

Christiansen, E.A. and Whitaker, S.H. 1976. Glacial thrusting of drift and bedrock. *In* Glacial Till. *Edited by* R.F. Legget. Royal Society of Canada, Special Publication 12, p. 121-130.

Craig, B.G. 1959. Surficial geology, Battleford, West of Third Meridian, Saskatchewan. Geological Survey of Canada, Map 15 - 1959.

David, P.P. 1977. Sand dune occurrences of Canada. Indian and Northern Affairs, National Parks Branch, Contract No. 74 - 230.

Gravenor, C.P. and Kupsch, W.O. 1959. Ice disintegration features in western Canada. Journal of Geology, v. 67, p. 48-64.

McLean, J.R. 1971. Stratigraphy of the Upper Cretaceous Judith River Formation in the Canadian Great Plains: Saskatchewan Research Council, Geology Division, Report 11.

Mitchell J., Moss, H.C. and Clayton J.S. 1962. Soil survey of southern Saskatchewan from Township 1 to 48 inclusive. University of Saskatchewan, Soil Survey Report 12.

Obradovich, J.D. and Cobban, W.A. 1975. A time-scale for the late Cretaceous of the Western Interior of North America. *In* The Cretaceous System in the Western Interior of North America. *Edited by* W.G.E. Caldwell. The Geological Association of Canada Special Paper 13, p. 36.

Padbury, G.A. and Stonehouse, H.B. 1968. Soil survey of the Mosquito Indian Reserve No. 109. Saskatchewan Institute of Pedology, Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Publication S 134.

Skwara-Woolf, T. 1980. Mammals of the Riddell Local Fauna (Floral Formation, Pleistocene, Late Rancholabrean), Saskatoon, Canada. Natural History Contributions No. 2, Saskatchewan Culture and Youth, Museum of Natural History.

Stalker, A.M. 1960. Ice pressed drift forms and associated deposits in Alberta. Geological Survey of Canada, Bulletin 57, p. 1-38.

Whitaker, S.H. and Christiansen, E.A. 1972. The Empress Group in southern Saskatchewan. Canadian Journal of Earth Sciences, v. 9, p. 353-360.

APPENDIX 1. NAME AND LOCATION OF LOGS

Log No.	Name	Location
1	SRC Phippen	SW2-20-40-21-W3
2	SRC Unity	SE1-28-40-21-W3
3	SRC Phippen	SE3-26-40-21-W3
4	Murphy Phippen R/A	1-29-40-20-W3
5	Murphy Wilkie	10-36-40-20-W3
6	FFIB Wes Bousguet	SE9-27-40-19-W3
7	FFIB Robert Fenrich	NE7-30-40-18-W3
8	Murphy Wilkie R/A	13-20-40-18-W3
9	EPD Wilkie	3-26-40-18-W3
10	Murphy Wilkie	1-25-40-18-W3
11	McColl Red Pheasant	1-25-40-17-W3
12	SRC Red Pheasant	SW1-29-40-16-W3
13	EPD Fred Moosomin Well	10-33-40-16-W3
14	McColl Red Pheasant No.4	9-33-40-16-W3
15	McColl Mosquito	6-34-40-16-W3
16	McColl Red Pheasant No.11	14-25-40-16-W3
17	McColl Red Pheasant No.1	11-32-40-15-W3
18	FFIB Philemen Peyachew	NE32-40-15-W3
19	McColl Red Pheasant No.12	13-27-40-15-W3
20	McColl Red Pheasant No. 3	5-26-40-15-W3
21	FFIB Bill Risling	16-29-39-21-W3
22	FFIB Ella Heather	NE14-27-39-21-W3
23	FFIB Jim Loadman	NW12-26-39-21-W3
24	FFIB Tom Hyland	NW5-30-39-20-W3
25	FFIB Roald Worrall	SE9-30-39-20-W3
26	FFIB Ray Gerein	NW13-28-39-20-W3
27	Wilkie Wilkie #2	11-6-40-19-W3
28	EPD Wilkie	NW13-32-39-19-W3
29	Albercan STH 8	NW13-33-39-18-W3
30	FFIB Joe Sander	13-33-39-18-W3
31	Albercan STH 7	NW13-35-39-18-W3

Log No.	Name	Location
32	Albercan STH 6	NW13-31-39-17-W3
33	Albercan STH 5	SW2-5-40-17-W3
34	Albercan STH 4	NW1-3-40-17-W3
35	Albercan STH 3	SE1-1-40-17-W3
36	Albercan STH 1	SE4-4-40-16-W3
37	Albercan STH 2	NW13-35-39-16-W3
38	Albercan STH 3	SW4-6-40-15-W3
39	Consolidated Eagle Hills #4	1-5-40-15-W3
40	Consolidated Eagle Hills #2	8-4-40-15-W3
41	EPD Tako	9-5-39-21-W3
42	FFIB Doug Gerein	14-34-38-21-W3
43	FFIB R.J. Schille	NW15-35-38-21-W3
44	EPD Scott	NE16-36-38-21-W3
45	FFIB Pat Volk	NE16-31-38-20-W3
46	SRC Redford	SE8-6-39-19-W3
47	Albercan STH 18	NW14-32-38-18-W3
48	Albercan STH 17	SW1-3-39-18-W3
49	Albercan STH 16	SW1-1-39-18-W3
50	Albercan STH 24	NW13-31-38-17-W3
51	Albercan STH 23	NW13-33-38-17-W3
52	Albercan STH 22	NW13-35-38-17-W3
53	Albercan STH 21	SW4-5-39-16-W3
54	Albercan STH 7	SE1-5-39-16-W3
55	Albercan STH 8	SW4-2-39-16-W3
56	SRC Salter	NW14-36-38-16-W3
57	FFIB Sam Mitzel	NE6-6-38-21-W3
58	FFIB Phil Gerein	11-4-38-21-W3
59	FFIB Jordan Elder	NW35-37-21-W3
60	FFIB Dan Miller	1-34-37-20-W3
61	FFIB Bruce Watt	2-2-38-19-W3
62	Albercan STH 51	SW4-6-38-18-W3
63	Albercan STH 25	NE16-32-37-18-W3

Log No.	Name	Location
64	SPC Landis No. 10	SW4-4-38-18-W3
65	SPC Landis No. 9	SW2-4-38-18-W3
66	SPC Landis No. 7	NE16-33-37-18-W3
67	Albercan STH 5	SE1-3-38-18-W3
68	SPC Landis No. 1	NE10-36-37-18-W3
69	Albercan STH 16	SW4-6-38-17-W3
70	SPC Landis No.5	NE16-31-37-17-W3
71	Albercan STH 4	SE1-5-38-17-W3
72	SPC Landis No 15	SW4-4-38-17-W3
73	Albercan STH 15	NW13-35-37-17-W3
74	Albercan STH 14	SW13-31-37-16-W3
75	Albercan STH 34	SE1-4-38-16-W3
76	Albercan STH 33	NE16-36-37-16-W3
77	Albercan STH 38	SE1-5-38-15-W3
78	Albercan STH 39	NW13-35-37-15-W3
79	EPD Tramping Lake	NE5-33-36-21-W3
80	EPD Tramping Lake	NE14-34-36-21-W3
81	FFIB Joe Scherr	SE3-2-37-21-W3
82	FFIB Marvin Rechelhoff	NE7-36-36-21-W3
83	FFIB Lambert Tuchscherer	15-31-36-20-W3
84	FFIB Adam Tuchscherer	2-5-37-20-W3
85	FFIB John Cey	13-2-37-20-W3
86	FFIB Frank Gruber	NE16-6-37-19-W3
87	Albercan STH 49	NW13-31-36-18-W3
88	Albercan STH 1	SE1-5-37-18-W3
89	Albercan STH 7	SW4-2-37-18-W3
90	Albercan STH 8	NE16-36-36-18-W3
91	Albercan STH 3	NW15-32-36-17-W3
92	SRC Palo	SE1-34-36-17-W3
93	Midwest Palo #1	NE12-36-36-17-W3
94	Albercan STH 13	SE1-1-37-17-W3
95	Albercan STH 26	NE13-34-36-16-W3

Log No.	Name	Location
96	SRC Naseby	SW2-3-37-16-W3
97	EPD Oban	3-2-37-16-W3
98	Albercan STH 31	SW4-6-37-15-W3
99	Albercan STH 36	SE1-5-37-15-W3
100	Albercan STH 41	SW4-2-37-15-W3
101	FFIB Ed Borschneck	5-3-36-21-W3
102	FFIB Bill Hango	1-5-36-20-W3
103	FFIB Carl Roth	SE8-34-35-20-W3
104	FFIB Steve Fruhstuk	SE16-6-36-19-W3
105	FFIB Howard Schoeler	SE4-2-36-19-W3
106	FFIB Charles Germsheid	NE1-12-36-19-W3
107	SRC Eins Lake	NE16-4-36-18-W3
108	IOE Springwater	13-30-35-17-W3
109	FFIB Morley Reis	12-22-35-17-W3
110	SRC Duperow	NW13-34-35-16-W3
111	Albercan STH 29	NW13-31-35-15-W3
112	SRC Biggar	NE16-36-35-15-W3
113	FFIB Alois Walter	13-22-35-21-W3
114	FFIB Mike Jehner	NW20-36-21-W3
115	FFIB Paul Reiter	13-28-36-21-W3
116	FFIB Dennis Brandle	NE16-5-37-21-W3
117	FFIB John Brandle	SE8-8-37-21-W3
118	FFIB Don Cey	1-17-37-21-W3
119	FFIB Kenneth Cey	SW4-24-39-21-W3
120	SRC Phippen	SW4-11-40-21-W3
121	SRC Phippen	NE16-15-40-21-W3
122	SRC Phippen	NW13-22-40-21-W3
123	SRC Phippen	NW13-34-40-21-W3
124	FFIB Fred Roth	NE8-26-35-20-W3
125	Atlantic Handle	6-22-36-20-W3
126	FFIB Norman Glessing	NE14-22-36-20-W3
127	FFIB Fred Bittner	SE2-26-37-20-W3

Log No.	Name	Location
128	FFIB Murray Jensen	SE1-14-38-20-W3
129	FFIB Keith McConnell	NW15-8-39-19-W3
130	Hunter Campana Wilkie	16-18-40-19-W3
131	FFIB Dennis Gutting	SW12-20-40-19-W3
132	Murphy Wilkie	10-30-40-19-W3
133	FFIB Harold McMillan	SE1-23-35-18-W3
134	HB Whiteshore Lake #1	16-22-35-18-W3
135	IOE Spring Water	13-27-35-18-W3
136	FFIB Ed Adrian	NW1-24-36-19-W3
137	EPD Landis	2-18-37-18-W3
138	Albercan STH 6	NW13-16-37-18-W3
139	FFIB Charles Roth	SW13-28-37-18-W3
140	Albercan STH 20	NW13-16-38-18-W3
141	Albercan STH 10	SW4-21-39-18-W3
142	Consolidated Moose Park #1	2-29-39-18-W3
143	Murphy Wilkie R/A	13-11-40-18-W3
144	FFIB Ray Hawkins	NW16-33-40-18-W3
145	FFIB Hutterian Brethren Goldview	SE13-36-17-W3
146	Albercan STH 10	NW8-3-37-17-W3
147	FFIB Marie Scott	SW13-13-37-17-W3
148	Albercan STH 11	SE1-22-37-17-W3
149	Albercan STH 19	NW13-14-38-17-W3
150	Murphy Wilkie R/A	16-10-39-17-W3
151	Albercan STH 14	SE1-22-39-17-W3
152	Albercan STH 28	SW4-3-36-16-W3
153	Albercan STH 27	NW 13-15-36-16-W3
154	Albercan STH 46	NE16-11-37-16-W3
155	Albercan STH 32	NW13-18-37-15-W3
156	Albercan STH 45	NW13-25-37-16-W3
157	Albercan STH 14	NW13-18-38-15-W3
158	Albercan STH 9	SW4-6-39-15-W3

Log No.	Name	Location
159	Albercan STH 6	NE16-13-39-16-W3
160	Liberty Cando	3-8-40-15-W3
161	Consolidated Eagle Hills #3	9-8-40-15-W3
162	Lloyd Red Pheasant #2	11-17-40-15-W3
163	FFIB Julie Buglar	SE20-40-15-W3
164	Lloyd Eagle Hills #2	3-6-36-14-W3
165	IOD Spring Water R/A	4-24-35-18-W3

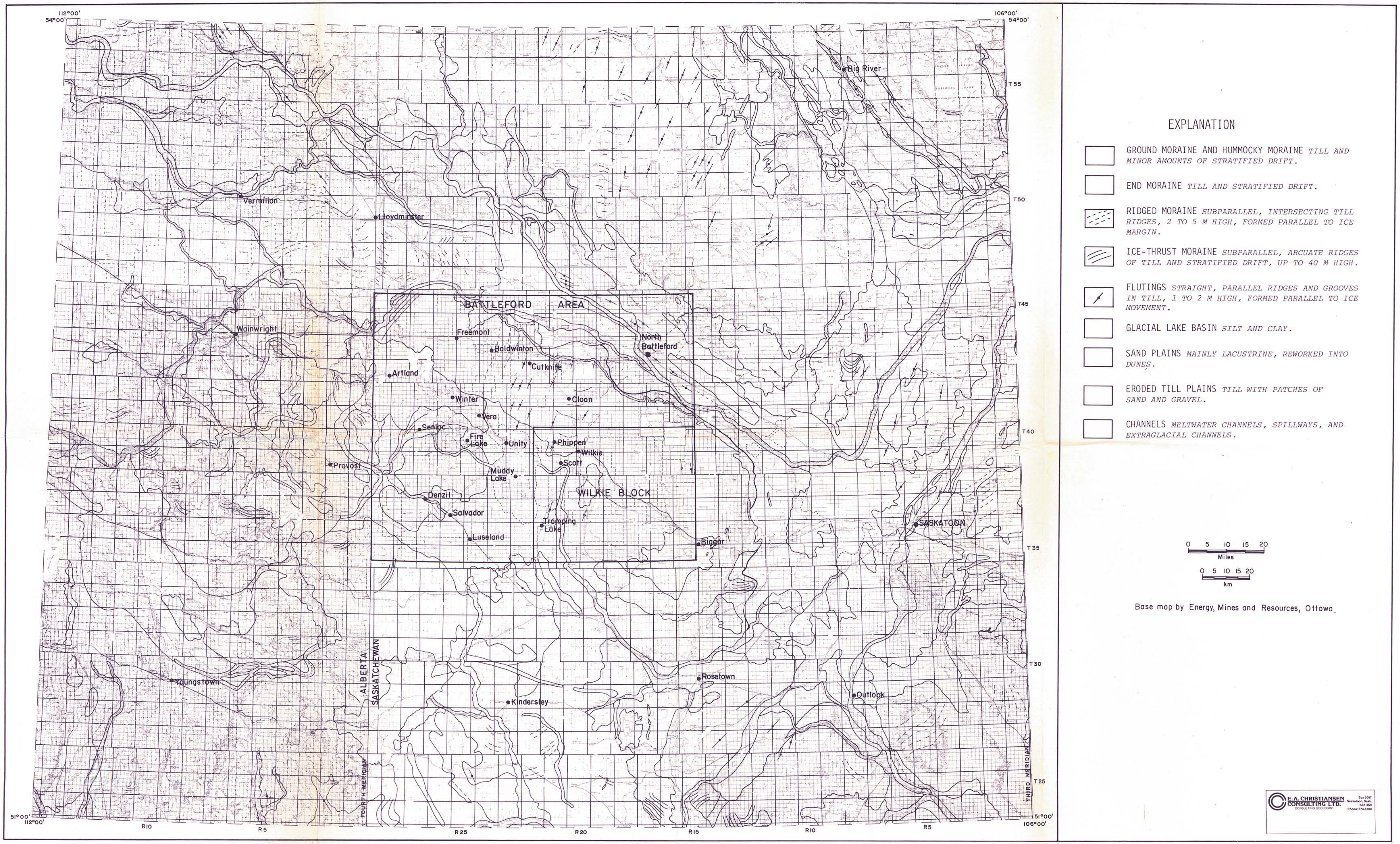
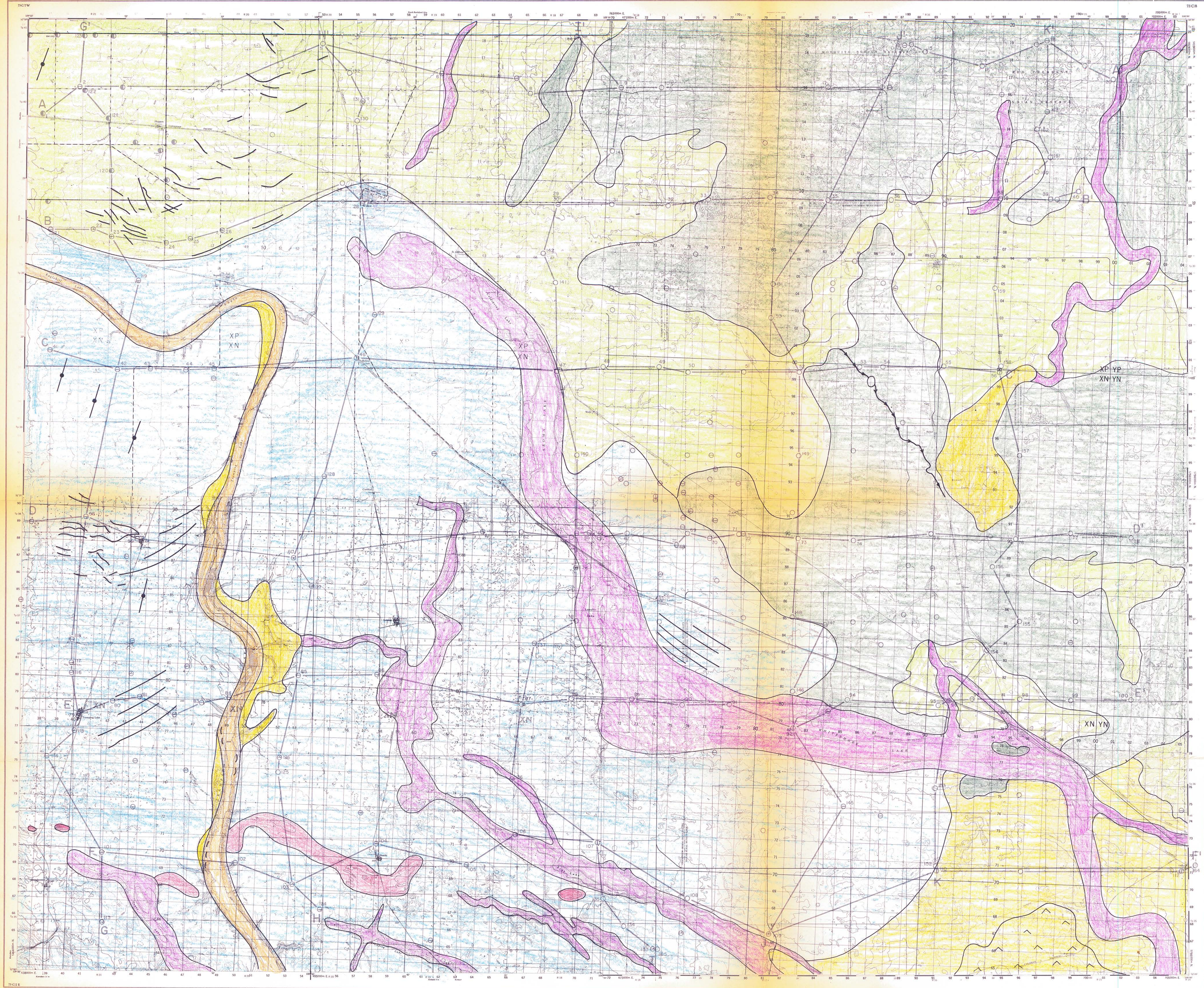


Figure 4. Landform map of the Battleford region.



LANDFORM MAP OF THE WILKIE BLOCK, SASKATCHEWAN

CATEGORIES OF SUBSURFACE INFORMATION

- Electric logs, cutting samples, and cores
- Electric logs and cutting samples
- Electric logs only
- Augerhole logs
- A—A' Location of cross section
- Cross section log number

- **GROUND MORAINE** TILL AREAS OF LOW RELIEF, COMMONLY LESS THAN 3 METRES.
- **HUMMOCKY MORAINE** TILL AREAS WITH RELIEF RANGING FROM 3 TO 10 M, INCLUDES KNOBS, KETTLES, AND MORAINE PLATEAUS.
- **END MORAINE** RIDGES AND ISOLATED HILLS OF SILT, SAND, AND GRAVEL, UP TO 15 M HIGH.
- **RIDGED MORAINE** SUBPARALLEL AND INTERSECTING RIDGES OF TILL, 1 TO 5 METRES HIGH.
- **FLUTINGS** NARROW, STRAIGHT RIDGES AND GROOVES IN TILL, 1 TO 2 METRES HIGH.
- **ICE-WALLED CHANNELS** FORMED SUBGLACIALLY AND BETWEEN ICE WALLS IN STAGNANT ICE, UP TO 40 M DEEP, IRREGULAR LONGITUDINAL PROFILE.
- **ESKER** SINUOUS RIDGE OF SAND AND GRAVEL, 5 M HIGH, 13 KM LONG, BEADED.
- **OUTWASH PLAINS** SAND AND GRAVEL.
- **GLACIAL LAKE BASINS** SILT AND CLAY
- **GLACIAL LAKE BASINS** SAND AND SILT
- **TRAMPING SPILLWAY** 1 KM WIDE, 40 KM DEEP
- **SAND DUNES** BLOWOUTS
- **SLUMPED AREAS** LANDSLIDES FORMING RIDGES ALONG VALLEY SIDES

Contour interval on present surface, 25 feet

Base map by Energy, Mines and Resources, Ottawa

0 1 2 3 4 MILES

0 1 2 3 4 KILOMETRES

E.A. CHRISTIANSEN CONSULTING LTD.
CONSULTING GEOLOGIST
Box 3087
Saskatoon, Sask.
S7K 3S9
Phone: 374-6700

Drawing No. 0062-002-13

Drawn By E A C

Date March 30, 1981

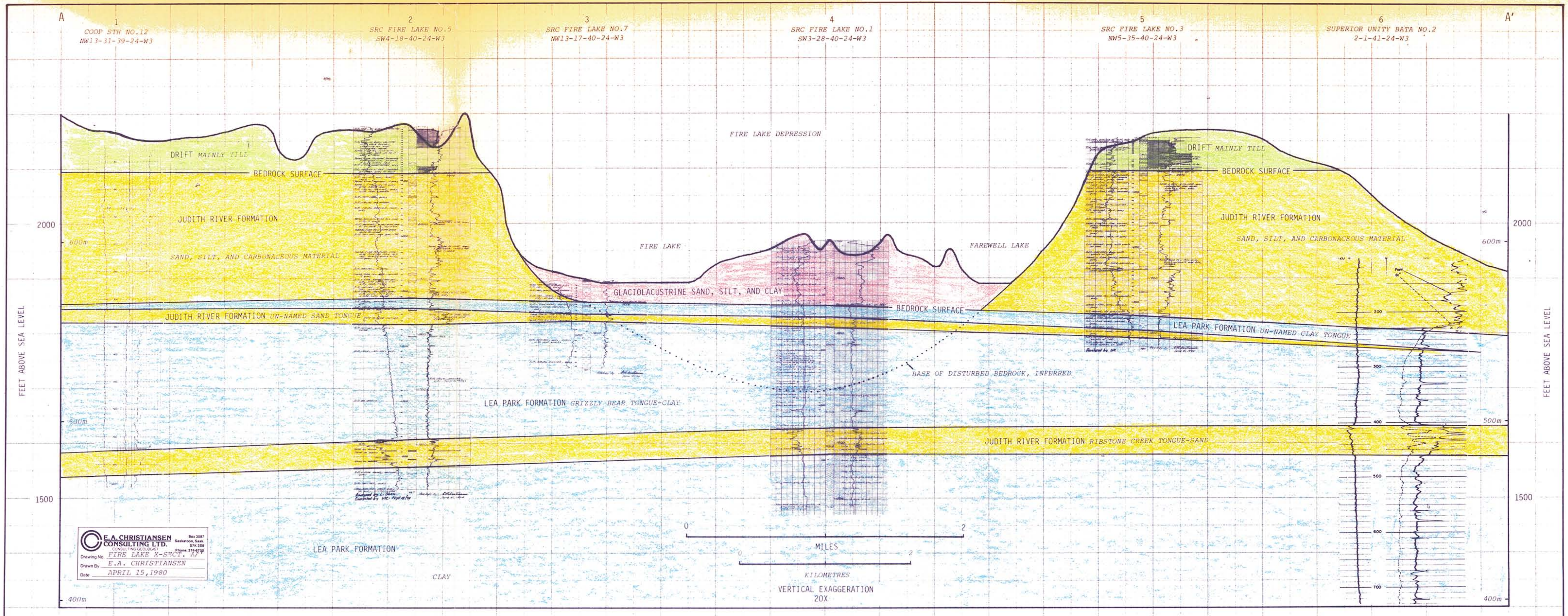


FIGURE 7. CROSS SECTION ACROSS THE FIRE LAKE DEPRESSION.
SEE FIGURE 6 FOR LOCATION OF CROSS SECTION.

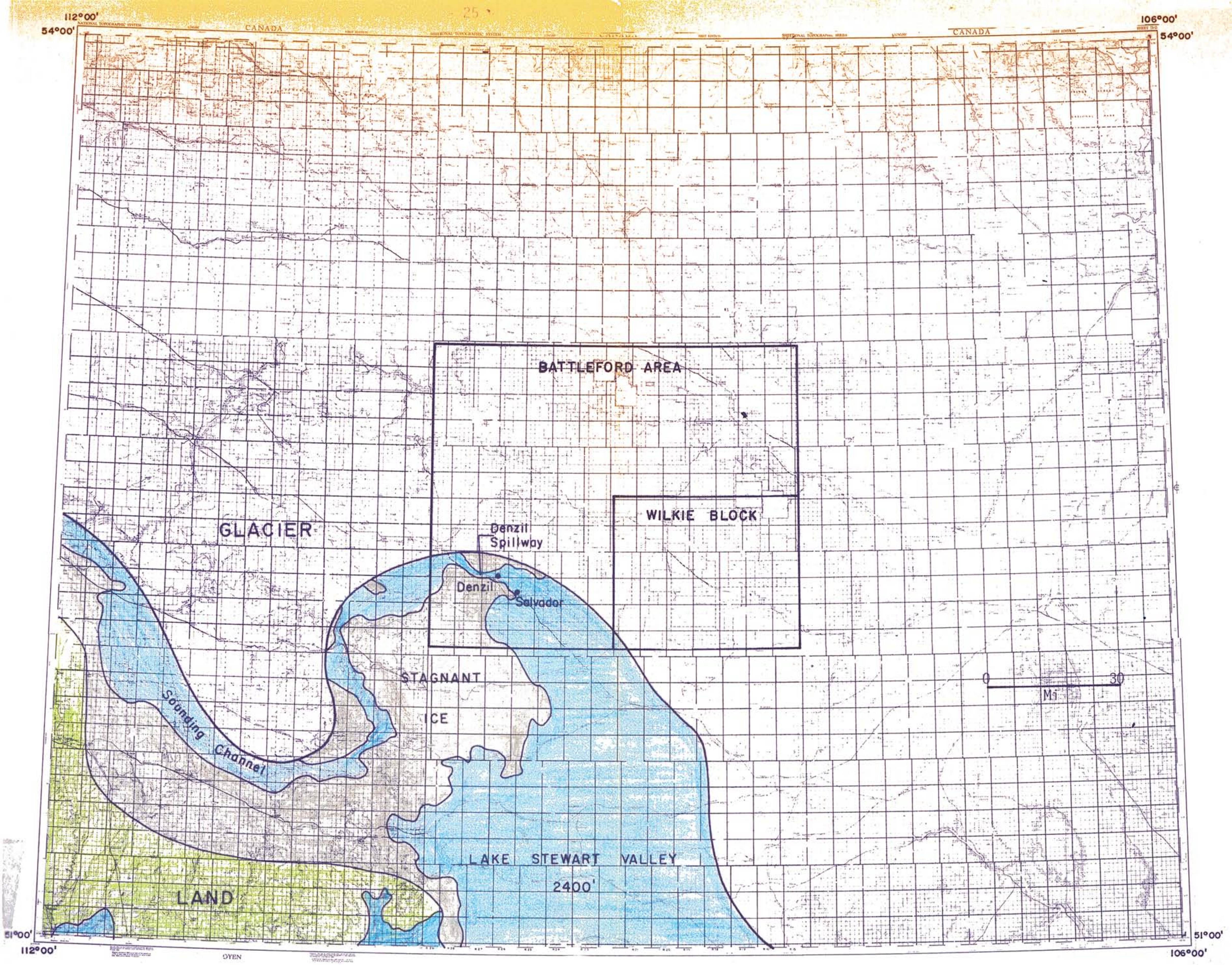


Figure 8. Phase I of the history of deglaciation of the Battleford region.

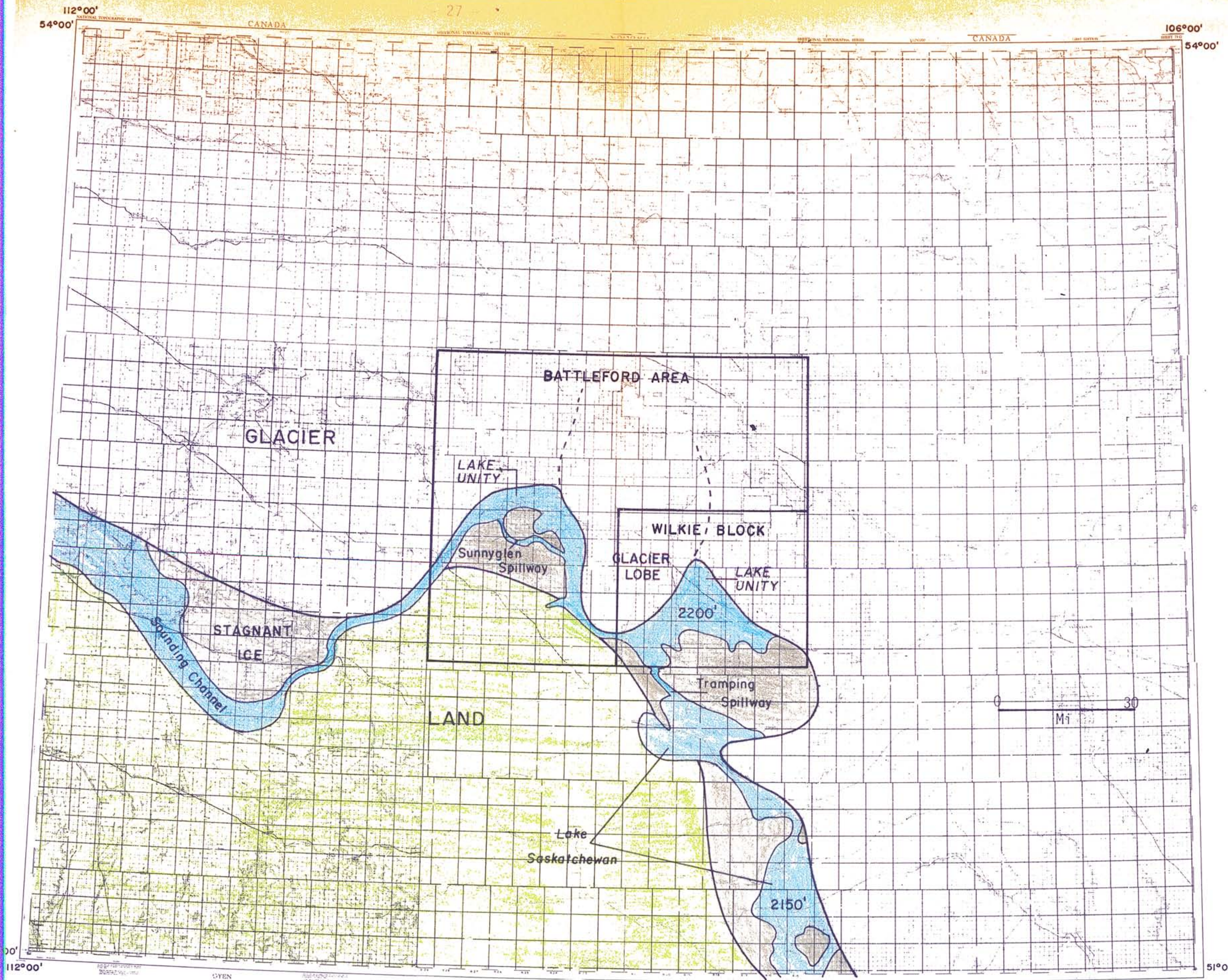


Figure 9. Phase 2 of the history of deglaciation of the Battleford region.

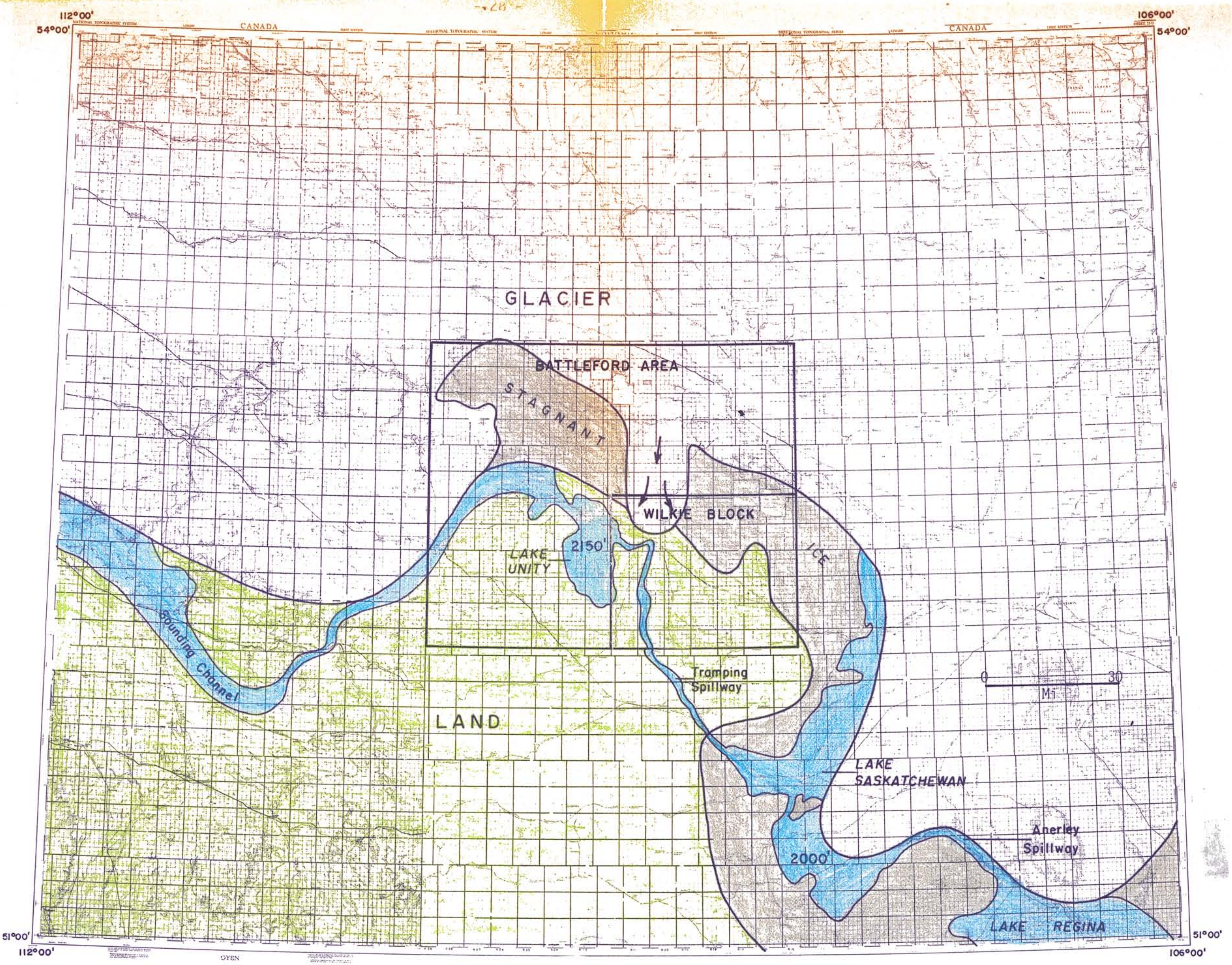


Figure 10. Phase 3 of the history of deglaciation of the Battleford region.

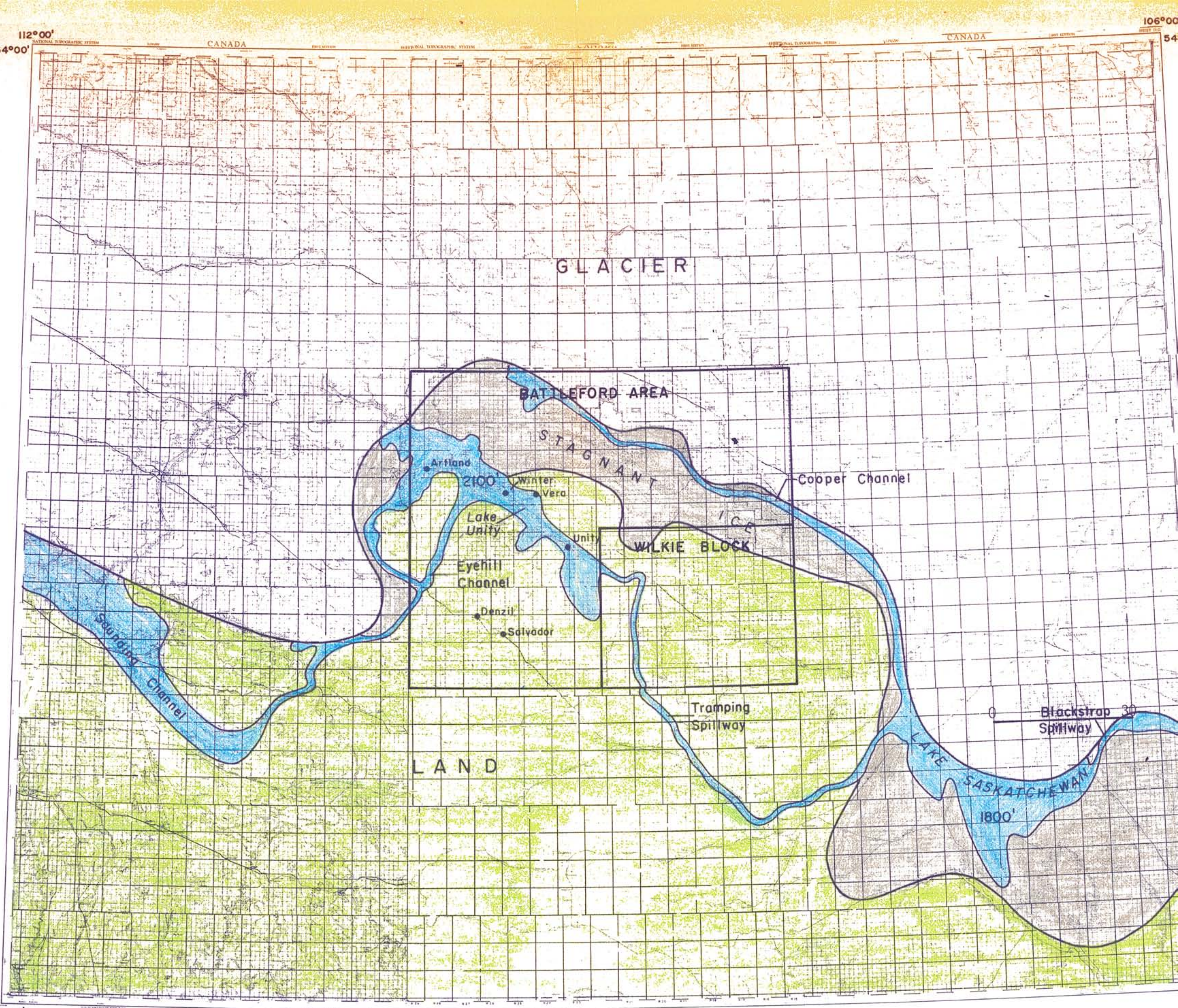


Figure 11. Phase 4 of the history of deglaciation of the Battleford Region.

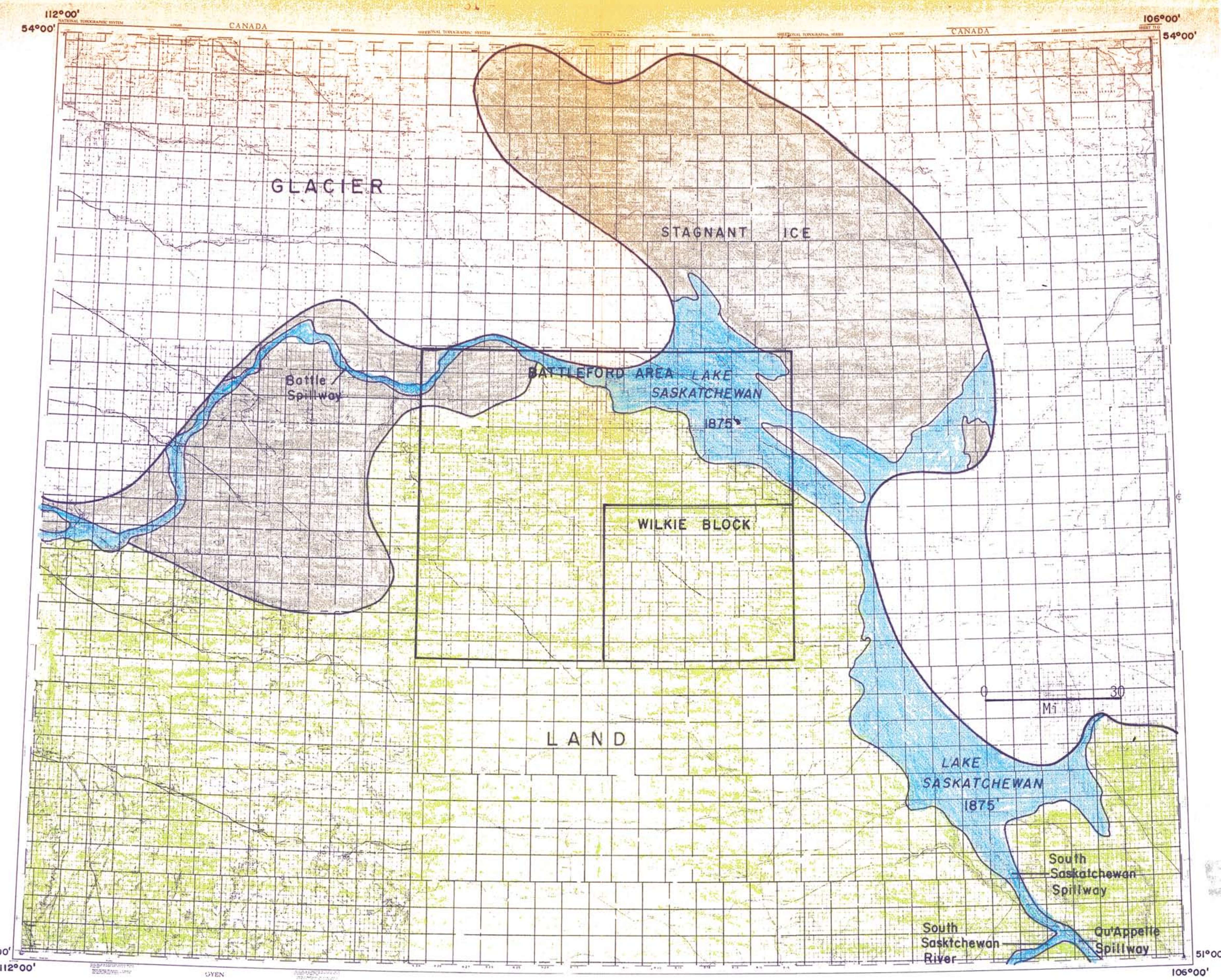


Figure 12. Phase 5 of the history of deglaciation of the Battleford region.

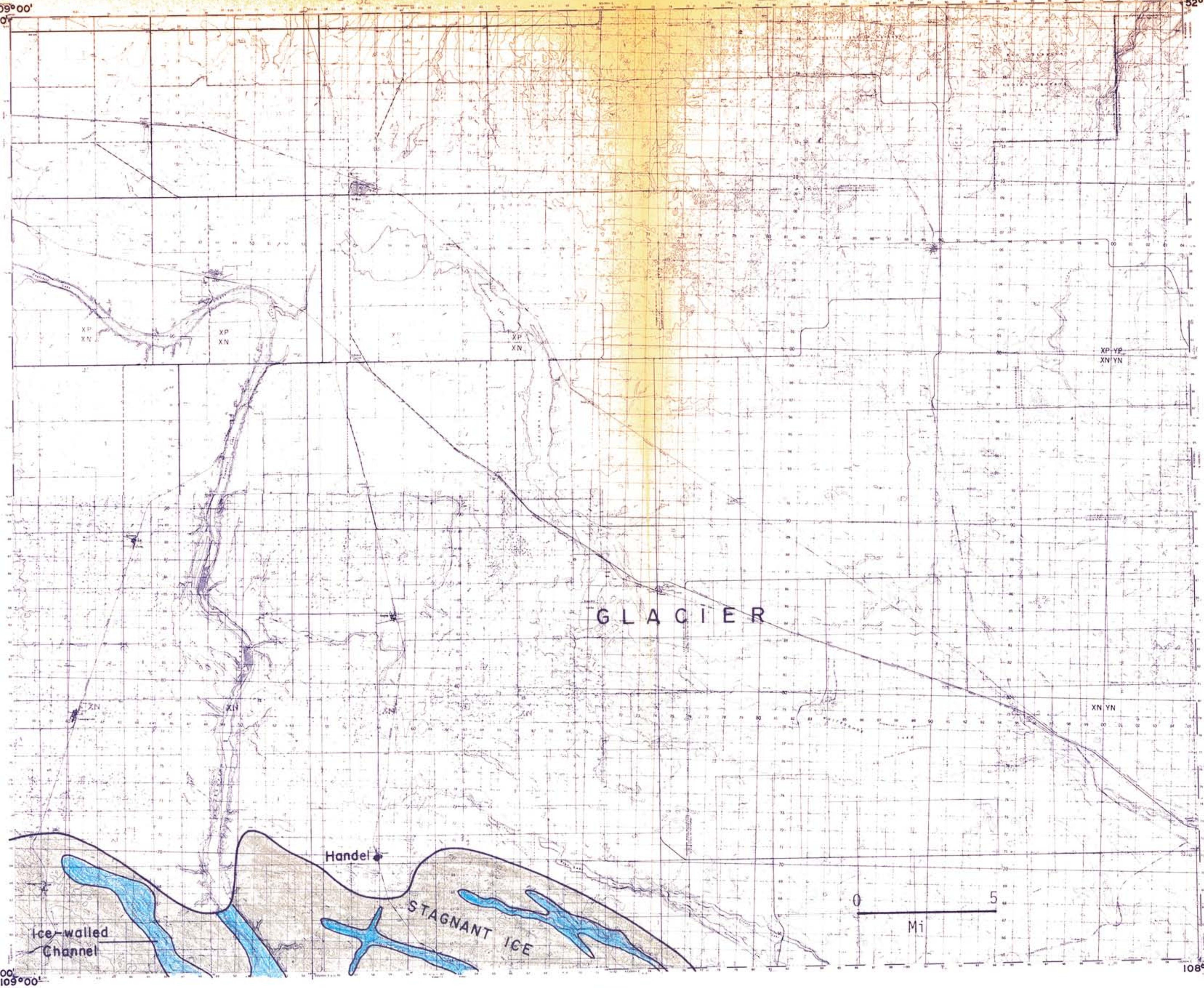


Figure 13. Phase I of the history of deglaciation of the Wilkie block.

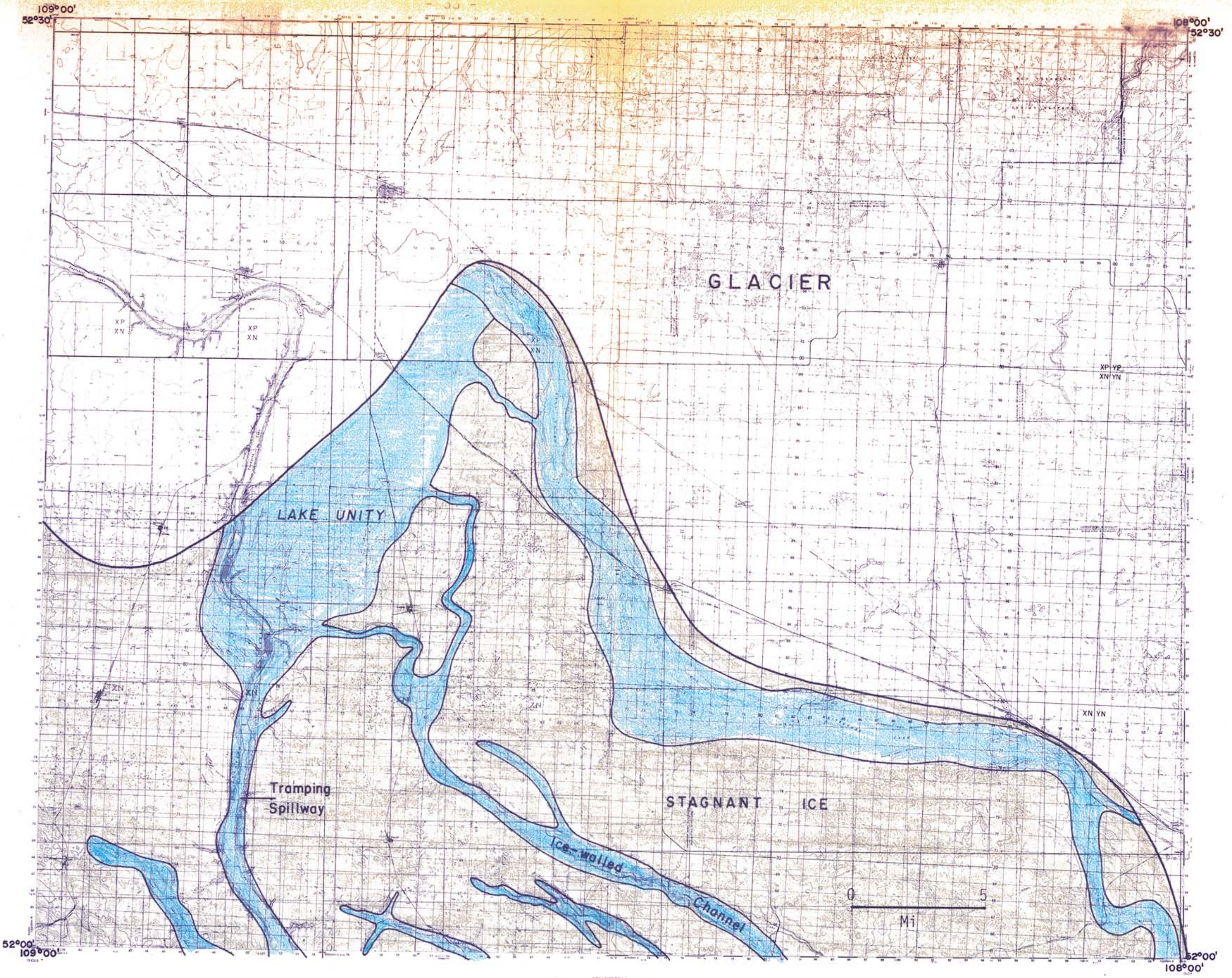


Figure 14. Phase 2 of the history of deglaciation of the Wilkie block.

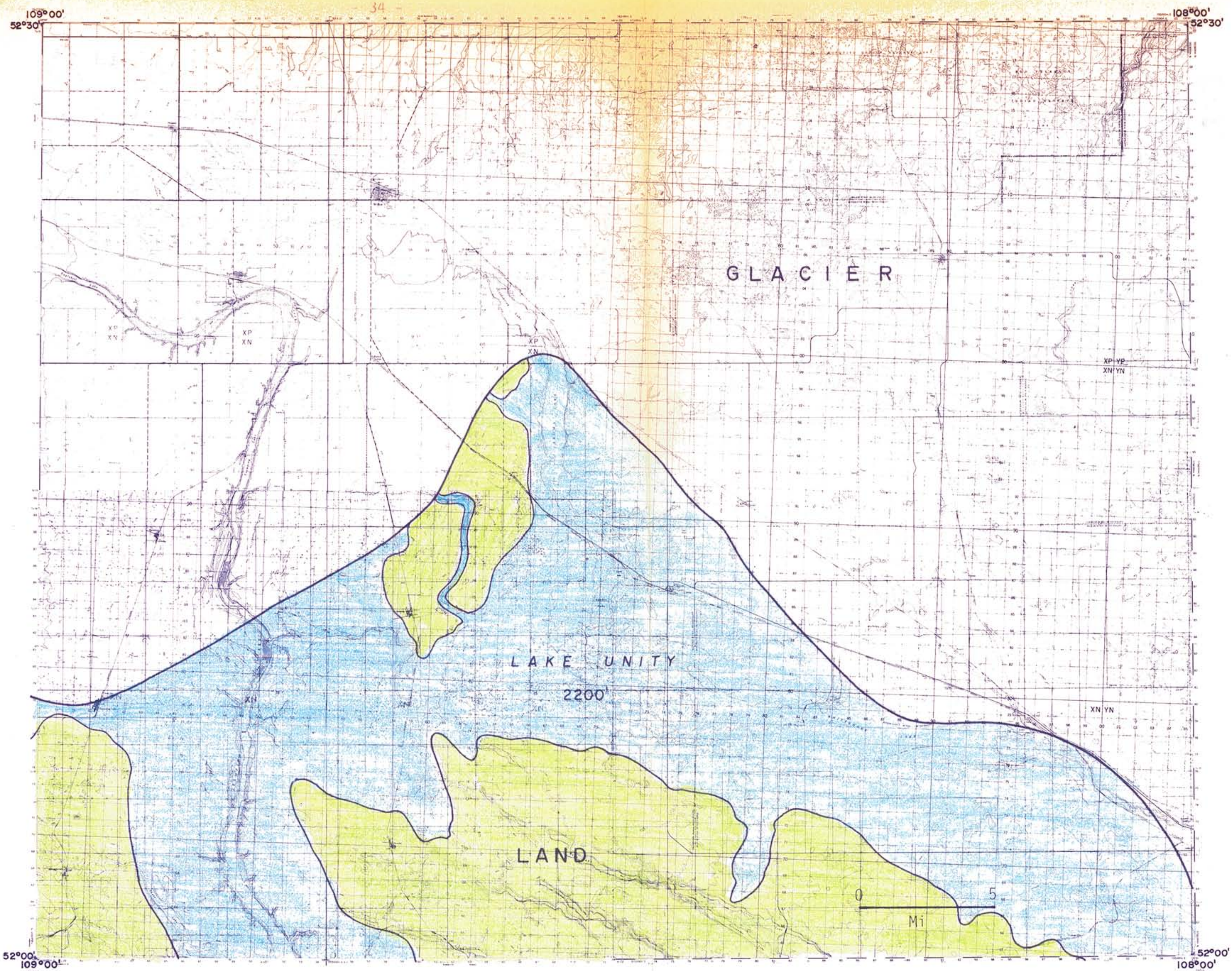


Figure 15. Phase 3 of the history of deglaciation of the Wilkie block.

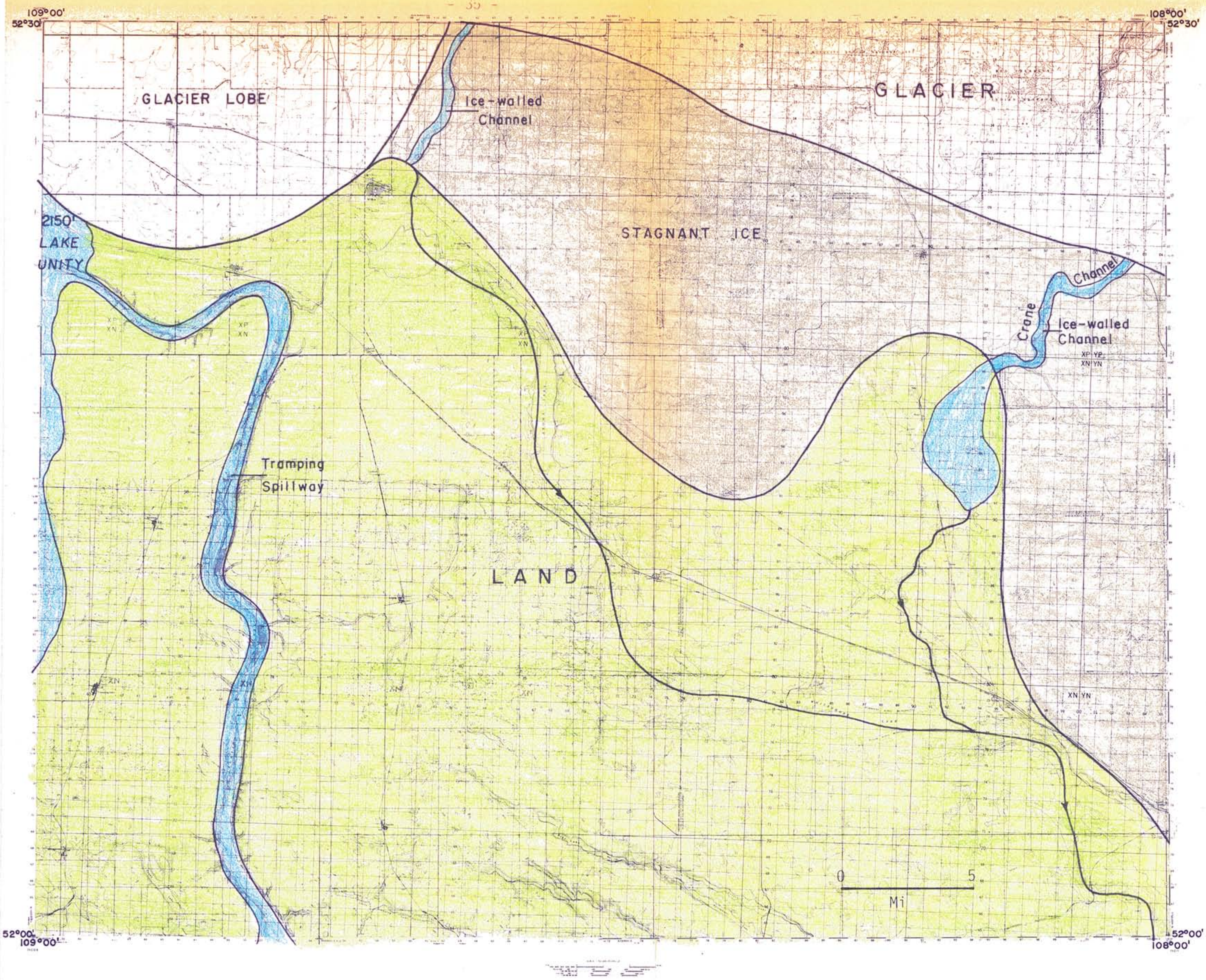


Figure 16. Phase 4 of the history of deglaciation of the Wilkie block.

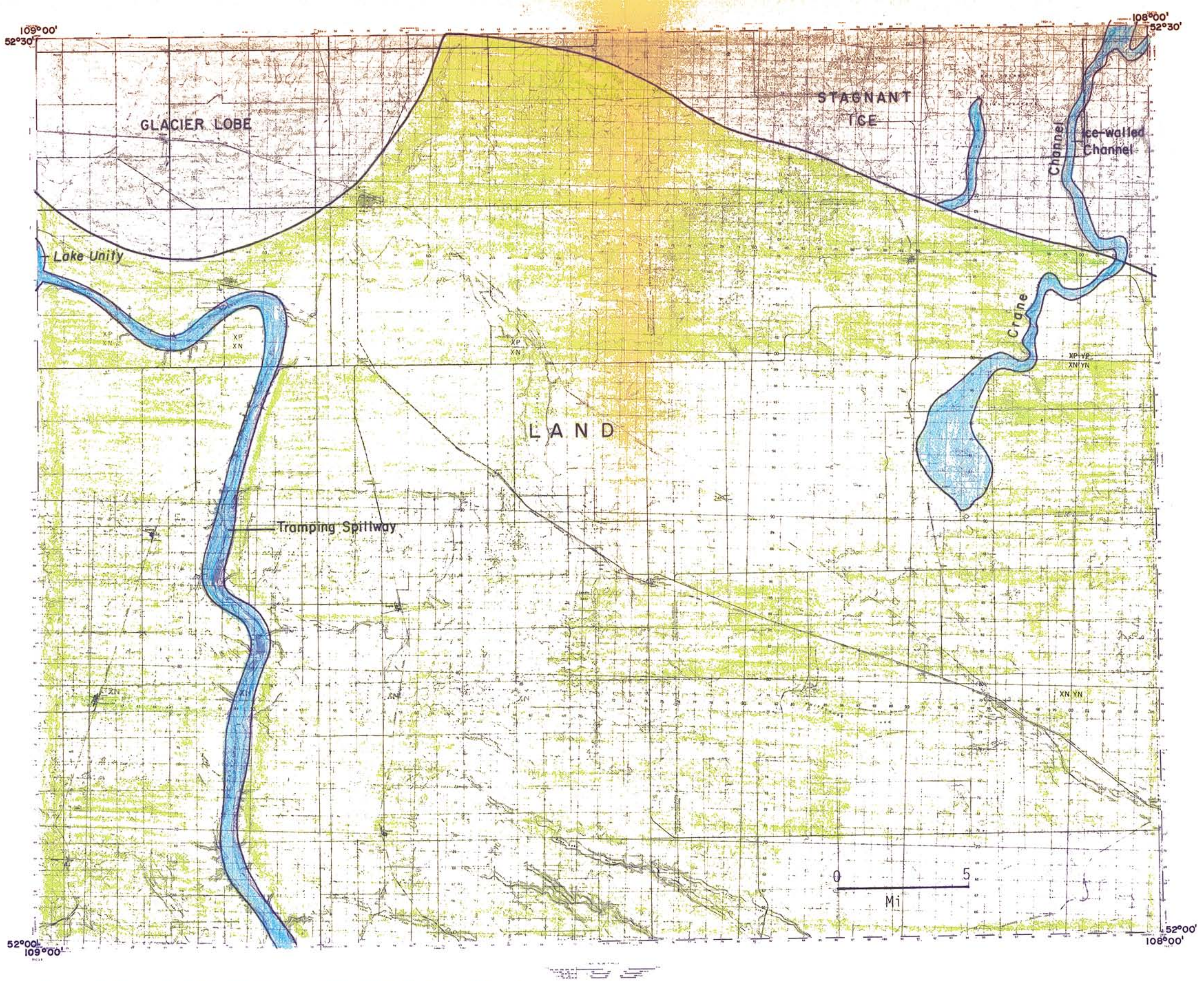
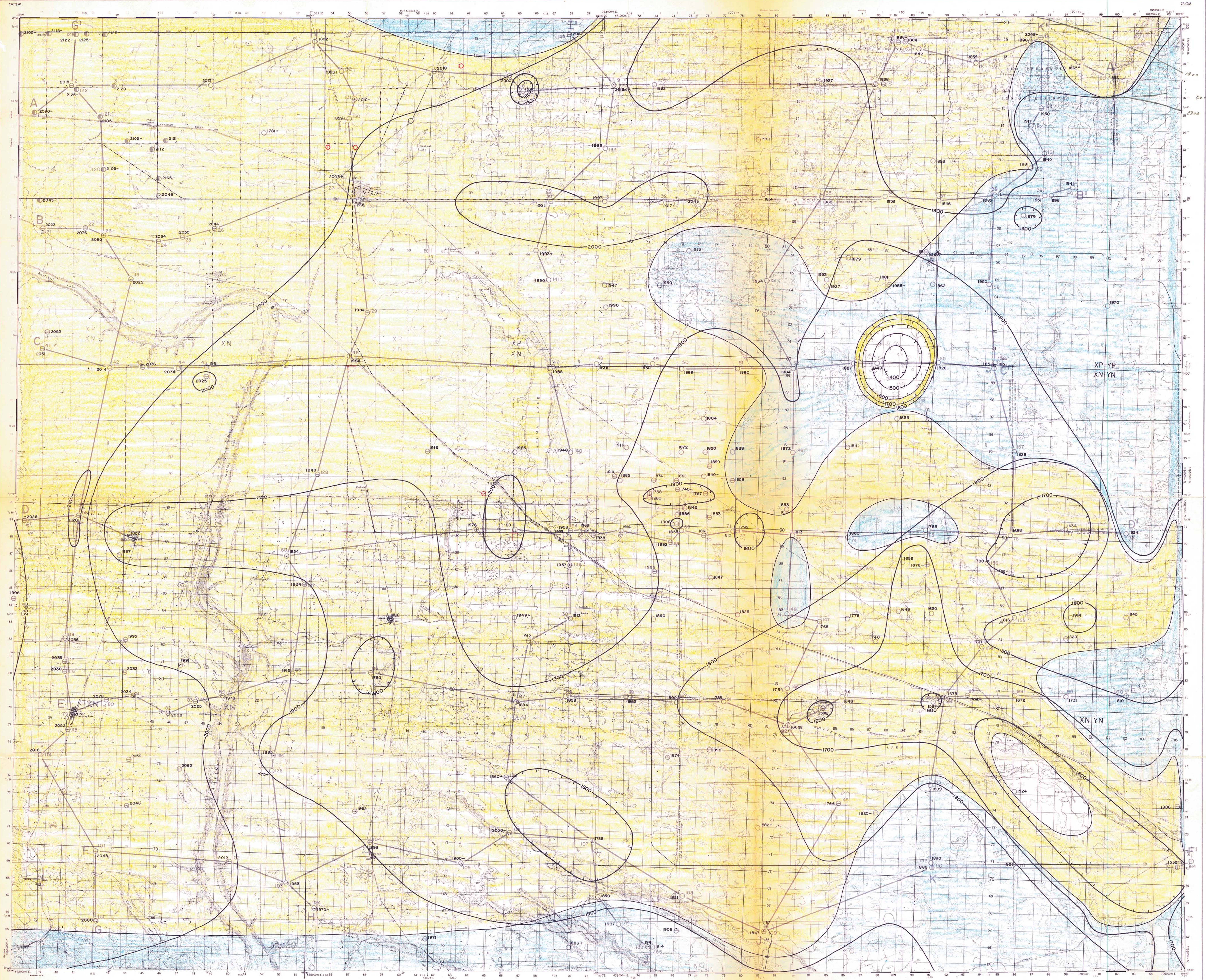


Figure 17. Phase 5 of the history of deglaciation of the Wilkie block.

BEDROCK GEOLOGY AND TOPOGRAPHY OF THE WILKIE BLOCK, SASKATCHEWAN (73-C/1,2,7,8)



CATEGORIES OF SUBSURFACE INFORMATION

- Electric logs, cutting samples, and cores
- Electric logs and cutting samples
- Electric logs only
- Augerhole logs
- A—A' Location of cross section
- 40 Cross section log number
- 1941 Point elevation in feet above sea level

BEARPAW FORMATION: 0 – 140 feet (0 – 43 metres) gray, marine, noncalcareous sand, silt, and clay.

JUDITH RIVER FORMATION: 0 – 315 feet (0 – 96 metres) gray, nonmarine, sand and silt with carbonaceous and concretionary zones and sandstones.

LEA PARK FORMATION AND UPPER COLORADO GROUP: 900 – 1200 feet (270 – 366 metres) gray, marine, noncalcareous silt and clay with calcareous white specks in basal part.

Contour interval on bedrock surface, 100 feet

Contour interval on present surface, 25 feet

Base map by Energy, Mines and Resources, Ottawa

0 1 2 3 4
MILES

0 1 2 3 4
KILOMETRES

E.A. CHRISTIANSEN CONSULTING LTD.
CONSULTING GEOLOGIST
Box 3087
Saskatoon, Sask.
S7K 3S9
Phone: 374-6700

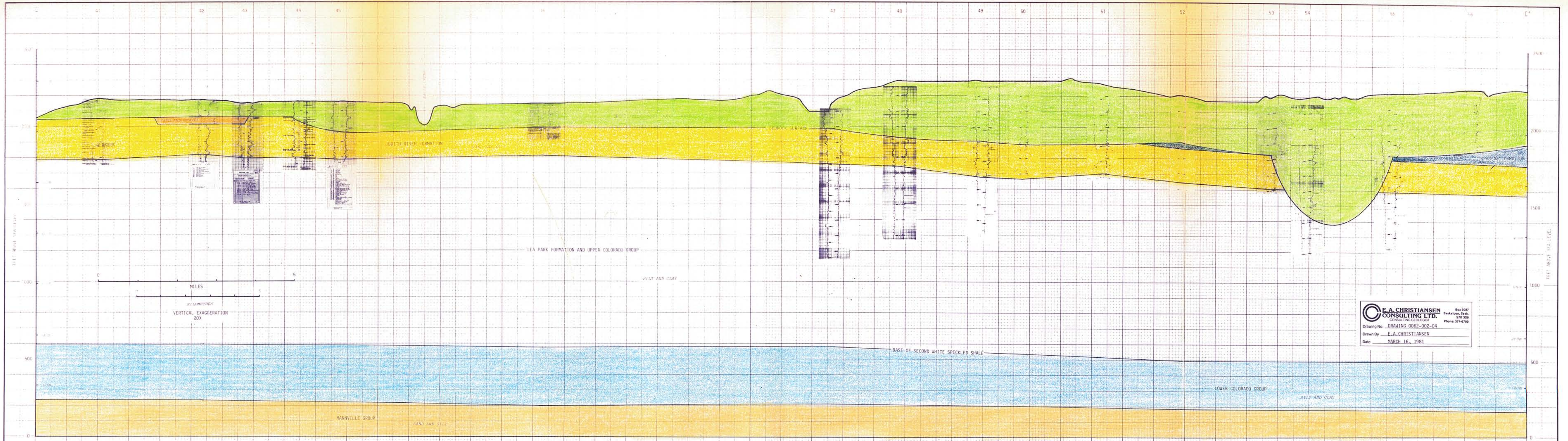
Drawing No. 0062–002–01

Drawn By E A C

Date March 30, 1981

DRAWING 0062-002-02. CROSS SECTION A-A'.
SEE DRAWING 0062-002-01 FOR LOCATION.

DRAWING 0062-002-03. CROSS SECTION B-B'.
SEE DRAWING 0062-002-01 FOR LOCATION.



DRAWING 0062-002-04. CROSS SECTION C-C'.

SEE DRAWING 0062-002-01 FOR LOCATION.

E. A. CHRISTIANSEN CONSULTING LTD.
CONSULTING GEOLOGIST
Box 3087
Saskatoon, Sask.
S7K 3S9
Phone: 374-6700

Drawing No. DRAWING 0062-002-05
Drawn By E.A.CHRISTIANSEN
Date MARCH 16, 1981

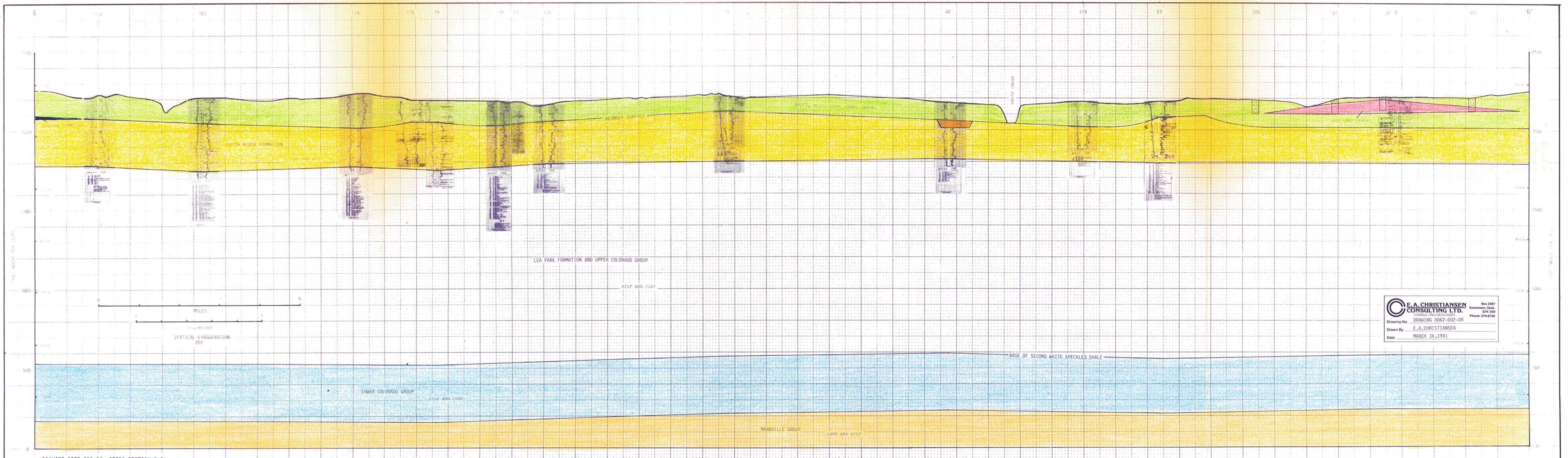
DRAWING 0062-002-05. CROSS SECTION D-D'.

SEE DRAWING 0062-002-01 FOR LOCATION.

DRAWING 0062-002-06. CROSS SECTION E-E'.

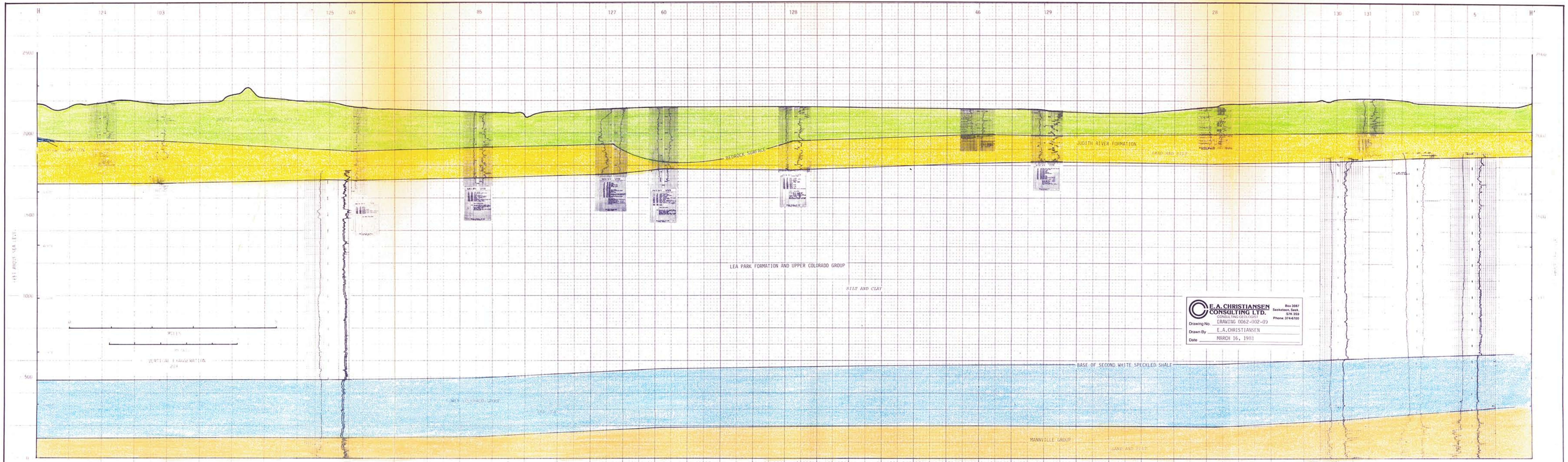
SEE DRAWING 0062-002-01 FOR LOCATION.

DRAWING 0062-002-07. CROSS SECTION F-F'.
SEE DRAWING 0062-002-01 FOR LOCATION.



DRAWING 0062-002-08. CROSS SECTION G-G'.

SEE DRAWING 0062-002-01 FOR LOCATION.



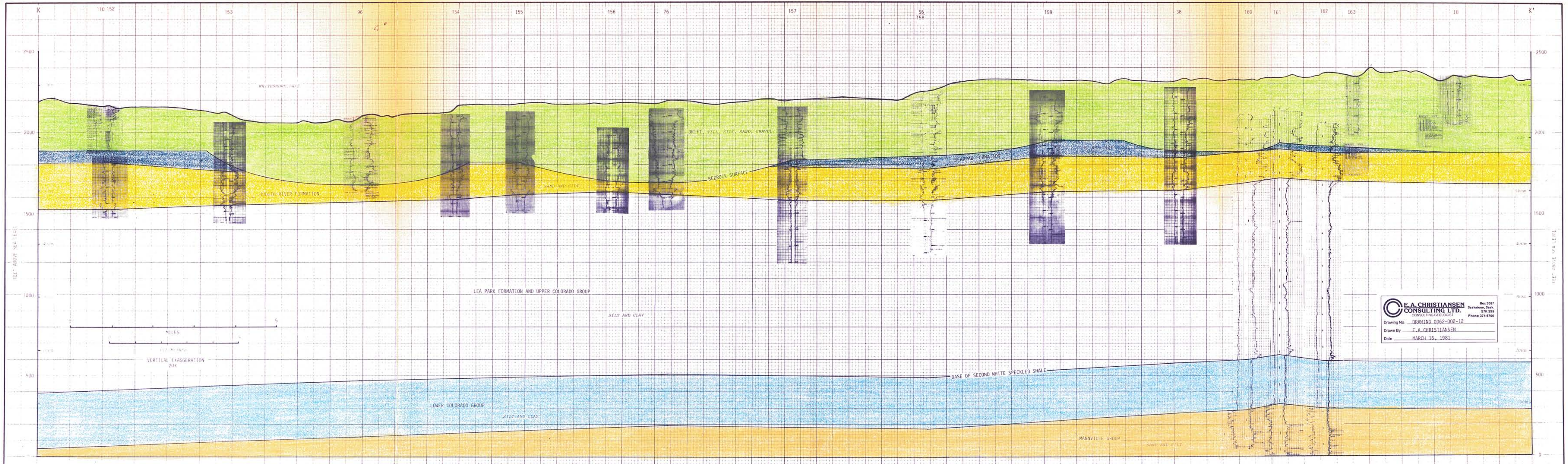
DRAWING 0062-002-09. CROSS SECTION H-H'.
SEE DRAWING 0062-002-01 FOR LOCATION.

DRAWING 0062-002-10. CROSS SECTION I-I'.

SEE DRAWING 0062-002-01 FOR LOCATION.

DRAWING 0062-002-11. CROSS SECTION J-J'.

SEE DRAWING 0062-002-01 FOR LOCATION.



DRAWING 0062-002-12. CROSS SECTION K-K'

SEE DRAWING 0062-002-01 FOR LOCATION.