GEOLOGY OF THE PRINCE ALBERT NATIONAL PARK

BY

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Report No. 0006-002

For

SASKATCHEWAN INSTITUTE OF PEDOLOGY

CONTENTS

INTRODUCTION

Objective

The objective of the "Geology of the Prince Albert National Park" is threefold:

1. To prepare a cross section across the Prince Albert National Park from Montreal Lake to Big River. The cross section included in this report actually extends from Lac La Ronge to Leoville.
2. To compile a series of sketches showing the history of the last deglaciation for 73G, H, I, and J.
3. To writé a brief report describing the stratigraphy, surficial geology, and origin of the Waskesiu Hills and Waskesiu Lake.

Previous Work

Whitaker and Pearson (1972) compiled a geological map of Saskatchewan which shows the bedrock of the Prince Albert National Park (referred to below as simply "Park") to be silt and clay of the Upper Colorado Group. Christiansen (1973) published a map showing the bedrock geology and drift thickness of the southern part of the Park. Lang (1974) prepared a guide to the geology of the Park for lay people.

During the summers of 1975 and 76, a biophysical study of the Park was undertaken by the Saskatchewan Institute of Pedology. During this investigation, the soils and surficial deposits were also investigated.

Present Study

The discussion on the geology of the Park is based on the published information cited above and on original unpublished material gathered by the author during studies of Quaternary geology of Saskatchewan.

This report is based on an office study only. The history of deglaciation is partly from a paper being prepared on the "History of deglaciation of southern Saskatchewan and adjacent areas" which should be published before the Saskatchewan Institute of Pedology report on the Park is printed.

Because the author hasn't conducted a field study of the Park, the discussion on the surficial deposits will be left for the Saskatchewan Institute of Pedology who conducted the biophysical study. The ice-thrust ridges and depressions, however, which are part of the basis for the conceptual model, will be discussed.

It is the authors understanding that this report will be a part on the larger biophysical study of the Park; consequently, location maps and other items, which will be discussed in the larger report, are not included herein.

STRATIGRAPHY

Bedrock Sediments

The Lower Colorado Group, composed of gray, nocalcareous silt, and clay, forms the bedrock of the Park (Fig. 1; Christiansen, 1973; Whitaker and Pearson, 1972). This bedrock in turn is underlain by sand and silt of the Swan River Group, Devonian and Silurian-Ordovician limestones and dolomites, Cambrian sand and sandstone, and Precambrian igneous and metamorphic rocks.

The Swan River Group rests on an angular unconformity with the older rocks dipping more steeply to the south.

Bedrock Topography

The bedrock topography of the Park and surrounding area is dominated by a topographically high area under the Park (Christiansen, 1973) and by the Hatfield Valley which trends NW-SE along the southwestern side of the Park (Fig. 1; Christiansen, 1973). The bedrock surface was fashioned by fluvial erosion prior to glaciation and by glacial erosion. The absence of a weathered profile on the bedrock surface suggests that glacial erosion took place prior to deposition of the overlying drift.

Glacial Deposits

Introduction The glacial deposits of the Park and adjacent areas have been divided into the Empress, Sutherland, and Saskatoon Groups (Fig. 1). The Saskatoon Group is subdivided further into the Floral and Battleford Formations (Fig. 2). Although surficial stratified drift is known to occur in the Park from studies done by the Saskatchewan Institute of Pedology, these sediments are too thin to be shown in the cross sections (Figs. 1,2) and are not considered further herein.

Empress Group The sands and gravels in the Hatfield Valley belong to the Empress Group (Fig. 1) which was named by Whitaker and Christiansen (1972). The Hatfield Valley extends in a northwest-southeast direction across Saskatchewan (Fig. 3) and is believed to represent an ice marginal channel which drained meltwater to the Artic Ocean during the first continental glaciation. The Hatfield Valley and the Swan River Group are the largest aquifers in the Park and surrounding area and are among the largest in the Prairie Provinces.

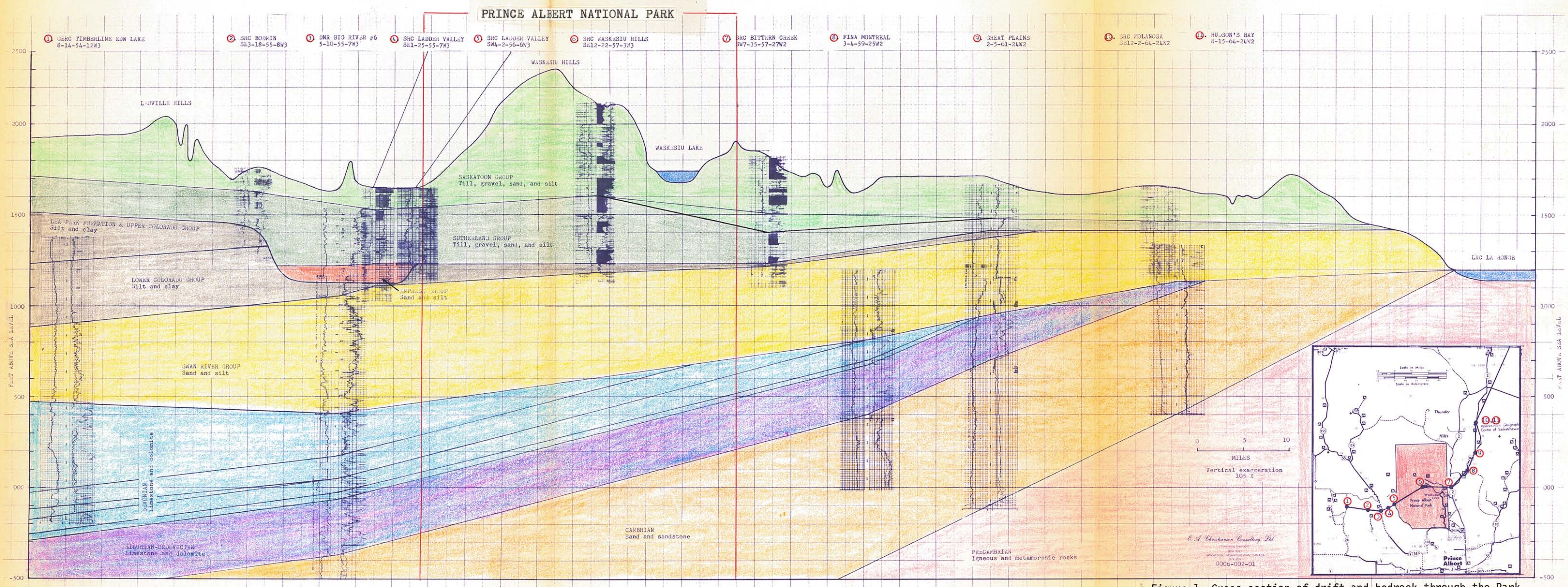

Figure 1. Cross section of drift and bedrock through the Park.

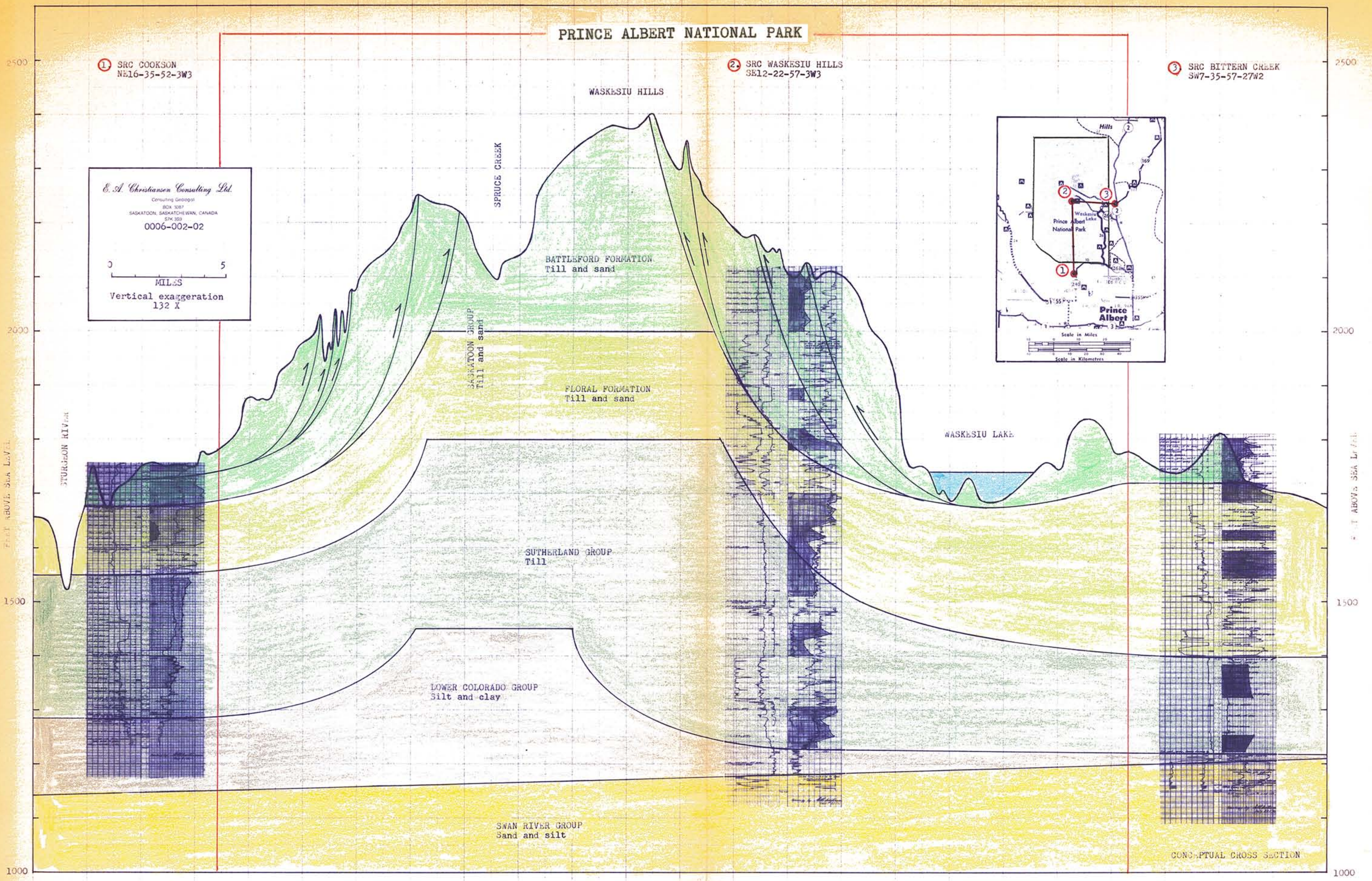

Figure 2. Cross section of drift and bedrock through the Park between Cookson and Bittern Creek.

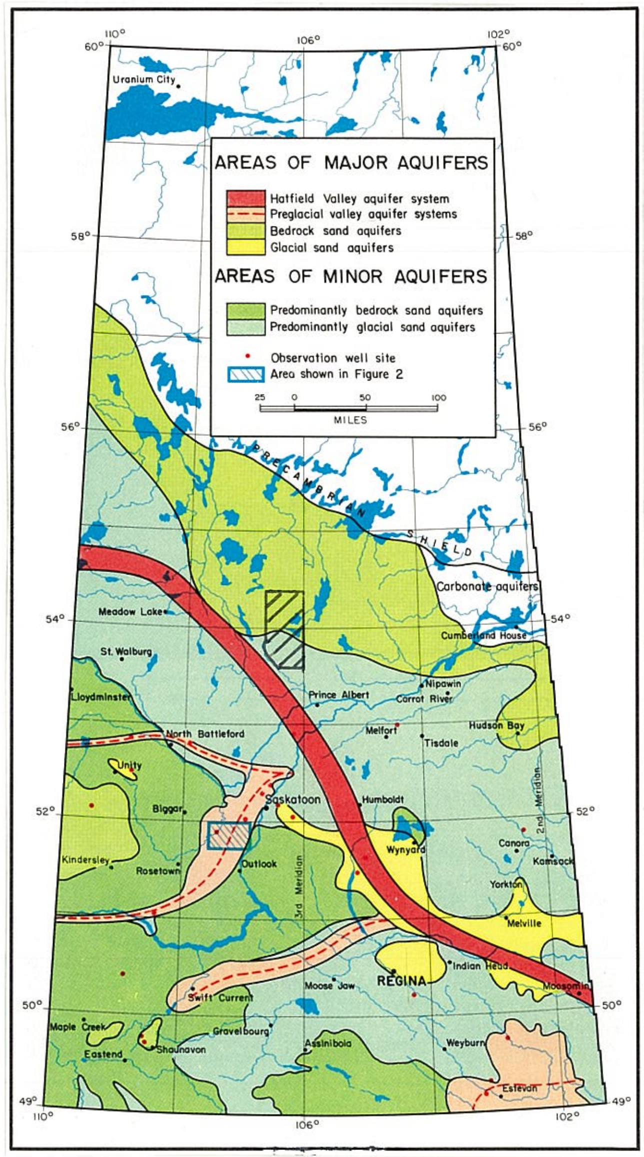

Figure 3. Location of the Hatfield Valley in Saskatchewan.

Sutherland Group In the Park, the Sutherland Group is composed of at least 370 feet of till and stratified drift (Figs. 1,2) the latter of which is believed to occur locally within the till. The Sutherland Group is differentiated on the basis of carbonate content and the presence of a weathered zone in the upper part of the unit. The tills of the Sutherland Group have a lower carbonate content than the tills of the overlying Floral Formation of the Saskatoon Group (Fig. 2). Where the weathered zone on top of the Sutherland Group was not removed by glacial erosion, it is represented by an olive gray, yellowish brown stained till. Because of the unique color of this weathered zone, it forms a means of separating the Sutherland and Saskatoon Groups.

Saskatoon Group The Saskatoon Group was divided into the Floral and Battleford Formation (Christiansen, 1968). Most of the Waskesiu Hills is composed of this Group. In the Park, the Floral Formation is composed of 200 feet of till and interbedded stratified drift (Fig. 2). The carbonate content of the tills is higher than for either the Sutherland Group or Battleford Formation.

The Battleford Formation is composed of at least 300 feet of till and stratified drift. This till is commonly soft, unjointed, and unstained, whereas the till in the weathered zone of the underlying Floral Formation is harder, jointed, and stained with yellowish-brown iron oxides.

The surficial stratified drift was studied by the Saskatchewan Institute of Pedology who will report on this subject.

Glacial Landforms

Introduction Although the Saskatchewan Institute of Pedology investigated the glacial landforms during their biophysical study of the Park and will report on these features, the author will deal with ice-thrust moraine and depressions because of the significance of these features to the origin of the Waskesiu Hills and Waskesiu Lake.

Ice-thrust Moraine Ice-thrust moraine is used herein to describe major, subparallel, generally arcuate ice-thrust ridges and intervening swales (Fig. 4). These ridges were formed near the margin of the ice by glacial over-thrusting (Figs. 5, 6).

The ridges at Hunters Lake (Fig. 7) are similar in form and pattern to those in the Matador area (Fig. 4) and are interpreted as ice-thrust ridges. It might be argued that these ridges were formed by slumping which is the only other known possibility. The gentle slope on which these ridges occur and

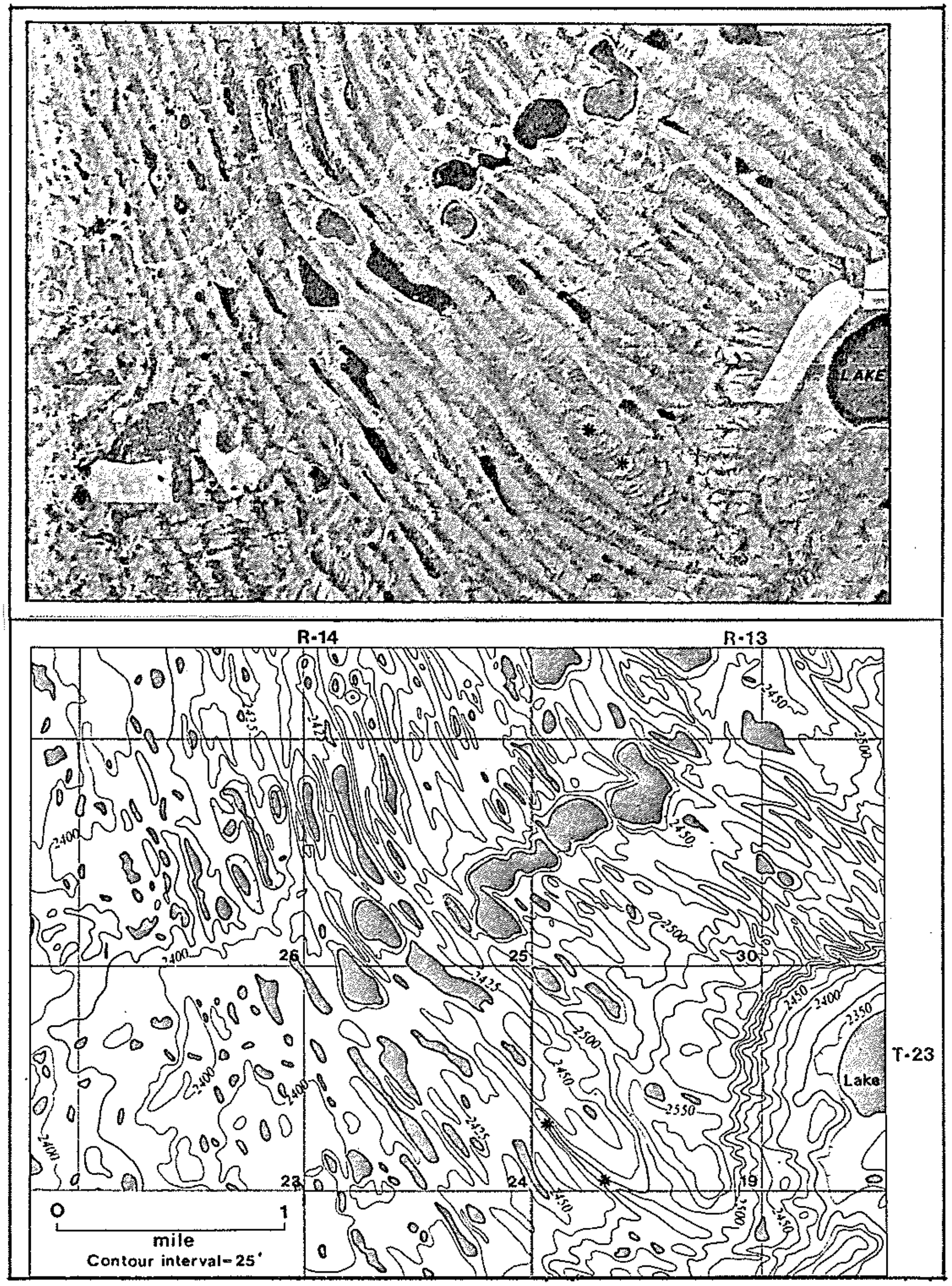

Figure 4. Aerial photograph and topographic map of ice-thrust moraine in the Matador area, Saskatchewan. From Christiansen and Whitaker (1976).

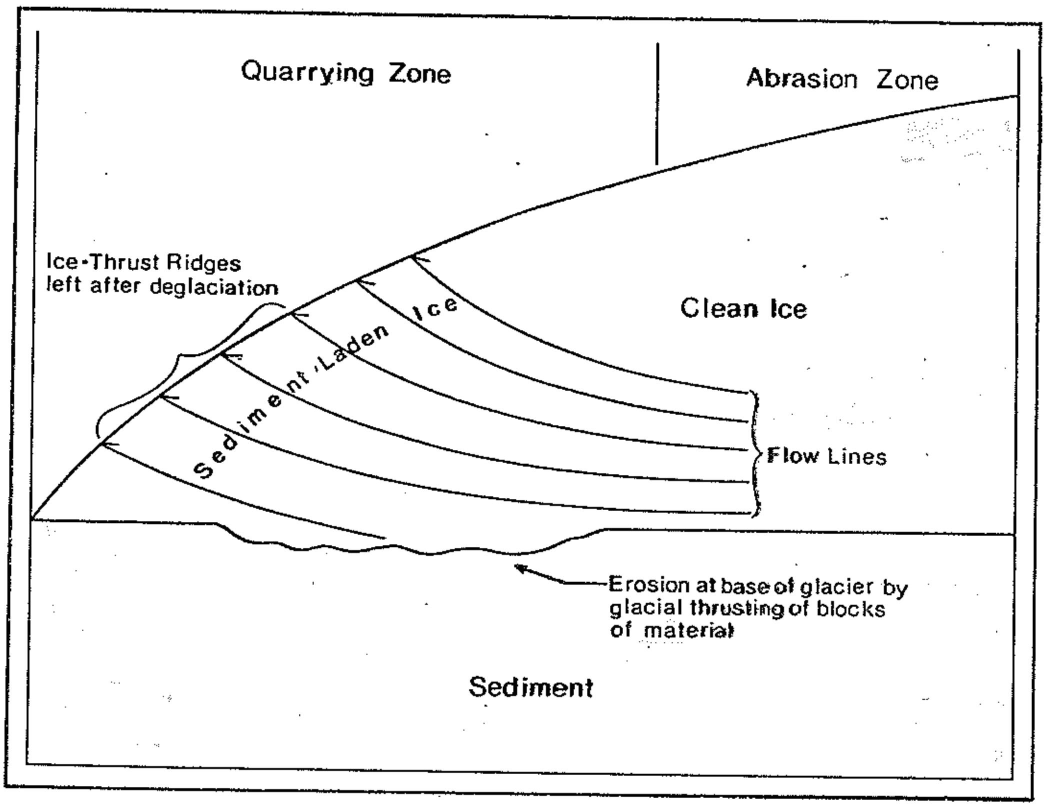

Figure 5. Schematic diagram showing quarring zone where glacial over-thrusting is concentrated and ice-thrust ridges are formed. From Christiansen and Whitaker (1976).

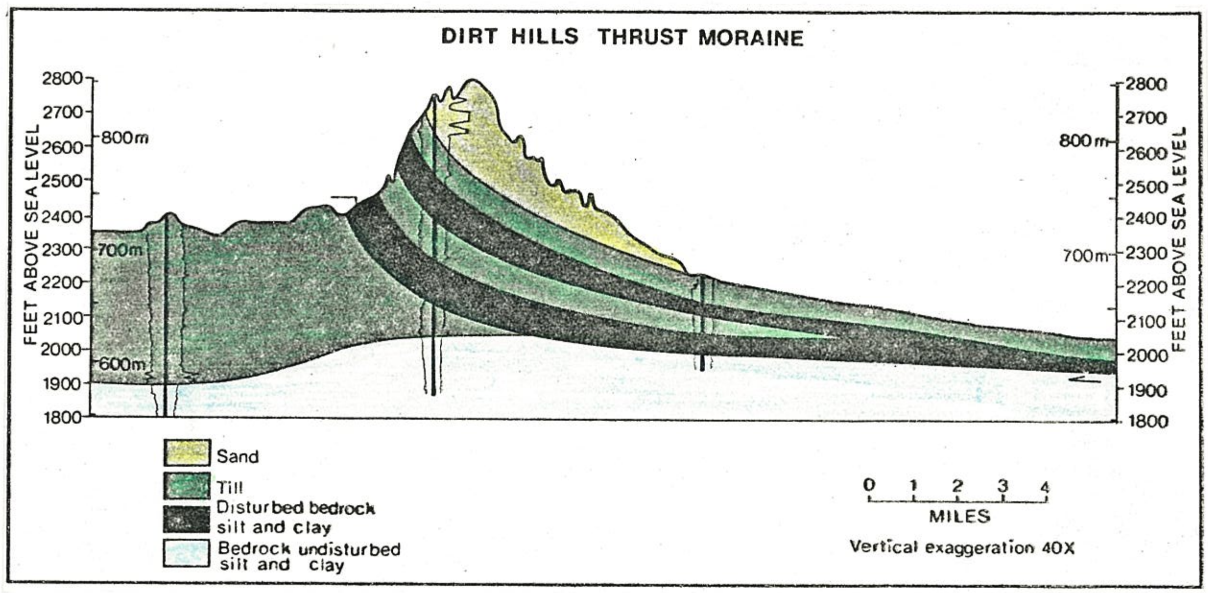

Figure 6. Repetition of beds by glacial over-thrusting in the Dirt Hills. From Christiansen and Whitaker (1976).

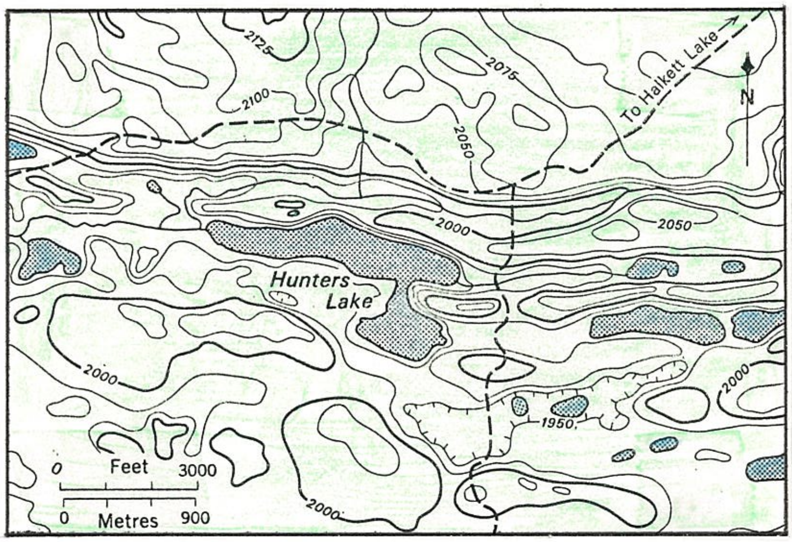

Figure 7. Ice-thrust ridges in the Hunter Lake area. From Lang (1974).

the symmetrical nature of the ridges and swales precludes this hypothesis.

Ice-thrust Depressions In the Dirt Hills (Fig. 6), drift-bedrock slabs were stacked to form the Hills. Where this material was derived, ice-thrust depressions formed. Figure 8 shows an ice-thrust depression in drift and bedrock in front of ice-thrust ridges suggesting the material in the ridges was derived from the depression.

Waskesiu Lake is a trough-like feature that flanks the northeast part of the Waskesiu Hills at right angle to the main direction of glacial flow. As the glacier moved upslope on the Hills it is believed the Waskesiu Lake basin was eroded to form an ice-thrust depression such as the one shown in Figure 8.

HISTORY OF DEGLACIATION

Introduction

Four significant phases dominate the history of deglaciation of the Prince Albert National Park (Figs. 9-12). In each phase the ice, water, and land at a particular time is shown. The ice margins are reconstructed to explain the origin of prominent glacial deposits, landforms, and drainage.

Phase 1 of the History of Deglaciation

During Phase 1 (Fig. 9), the uppermost part of the Waskesiu Hills was uncovered by the glacier to form a nunatak. This part of the Hills was inundated with water to form a glacial lake in which the lacustrine silts and clays were deposited. This lake spilled over the glacier to the south.

Phase 2 of the History of Deglaciation

During Phase 2 (Fig. 10), the glacier split into two lobes and drainage of meltwater was facilitated by the Sturgeon River and Spruce Creek Channels which are in ice marginal and sidehill positions. These channels drained into glacial Lake Melfort where sand and gravel deltas were formed. As the ice front retreated between Phases 1 and 2, the ice continued to flow to its retreating margin and thus continued to thrust material up on the Waskesiu Hills. A radiocarbon date from material under till near Ladder Valley east of Big River suggests the glacier stood at the position shown in Phase 2 above 11,500 years ago.

Phase 3 of the History of Deglaciation

Between phases 2 (Fig. 10) and 3 (Fig. 11) the glacier retreated from the Park. The lobe of ice west of the Park was melting and the meltwater was collecting in an ice-dammed lake which spilled along the southwestern boundary

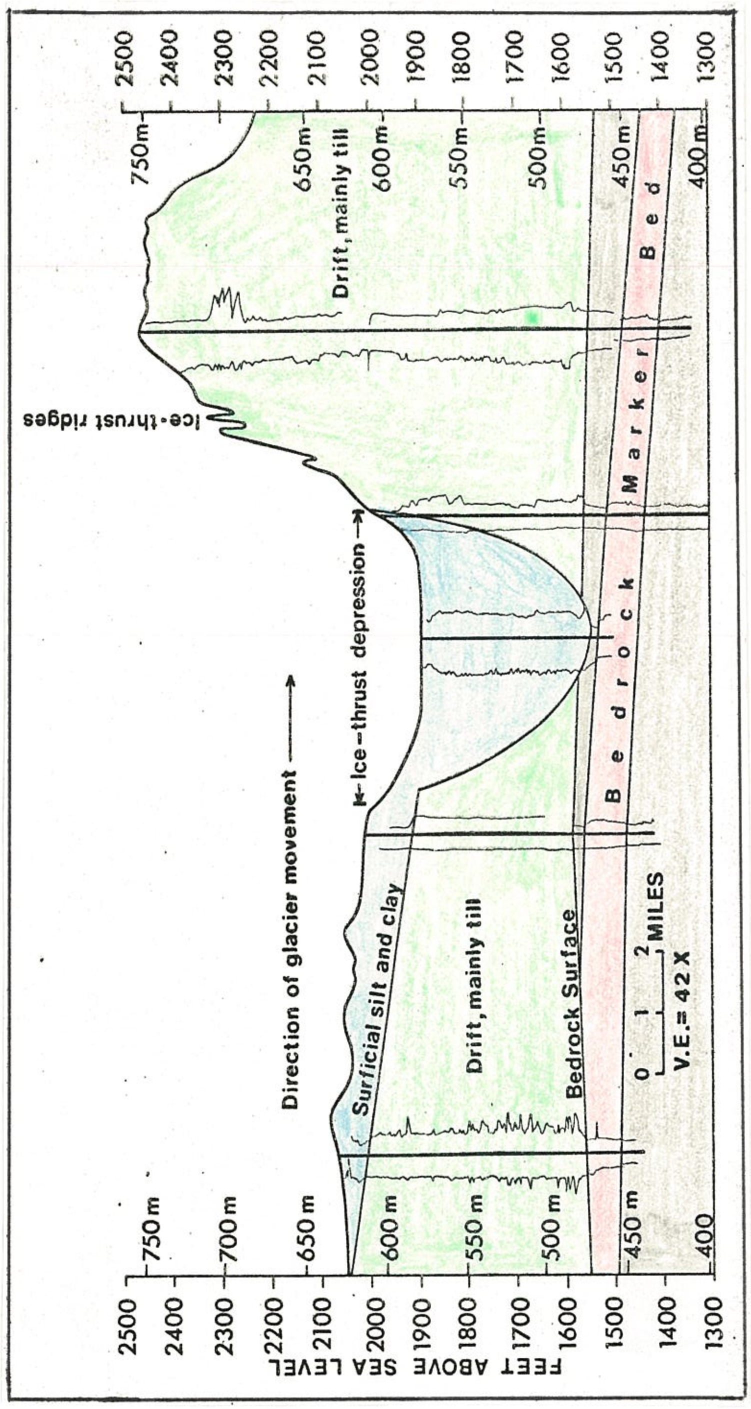

Figure 8. Ice-thrust depression near Tyner, Saskatchewan. From Christiansen and Whitaker (1976).

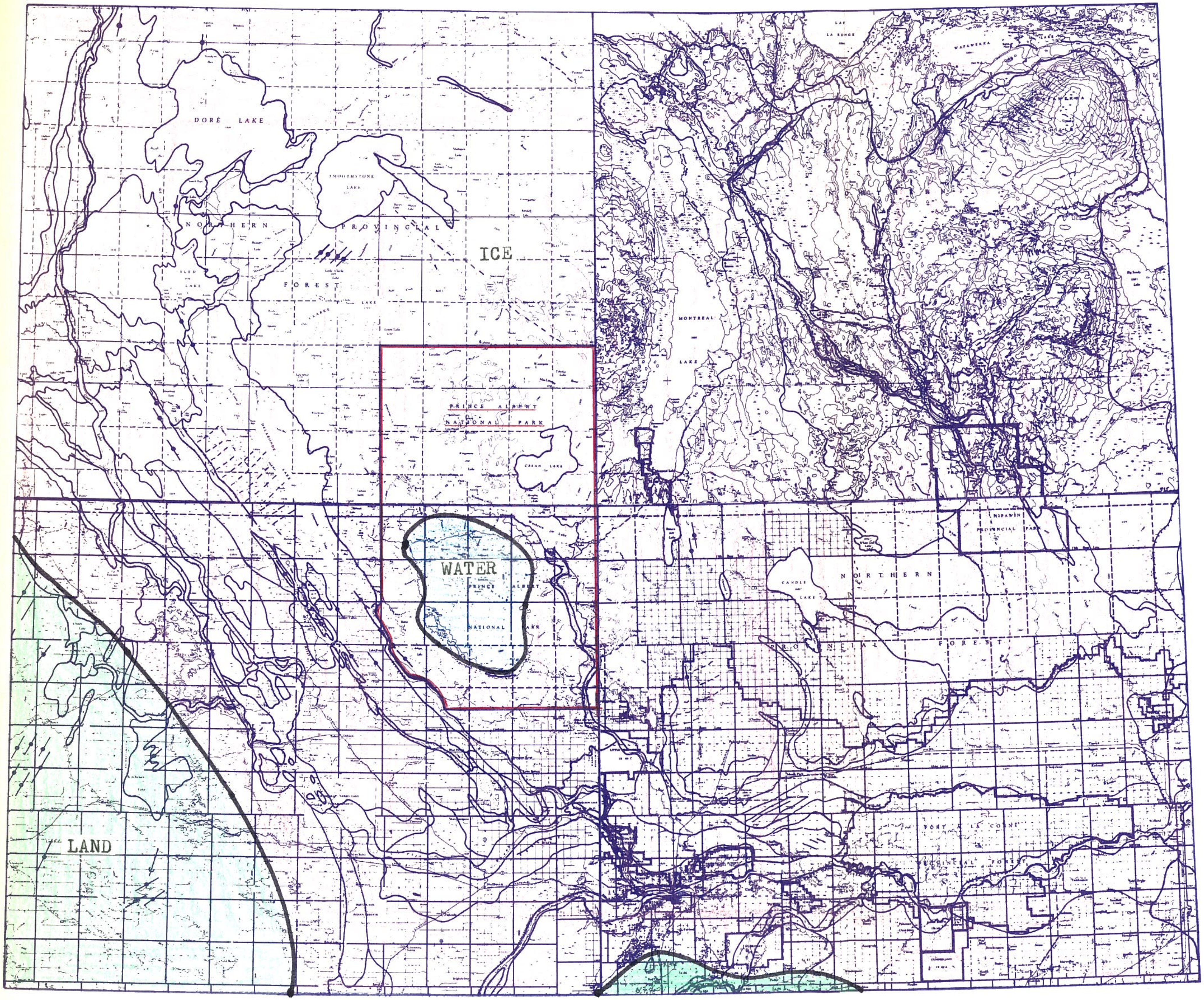

Figure 9. Phase 1 of the history of deglaciation of 73G, H, I, and J. Scale, one inch equals about 15 miles.

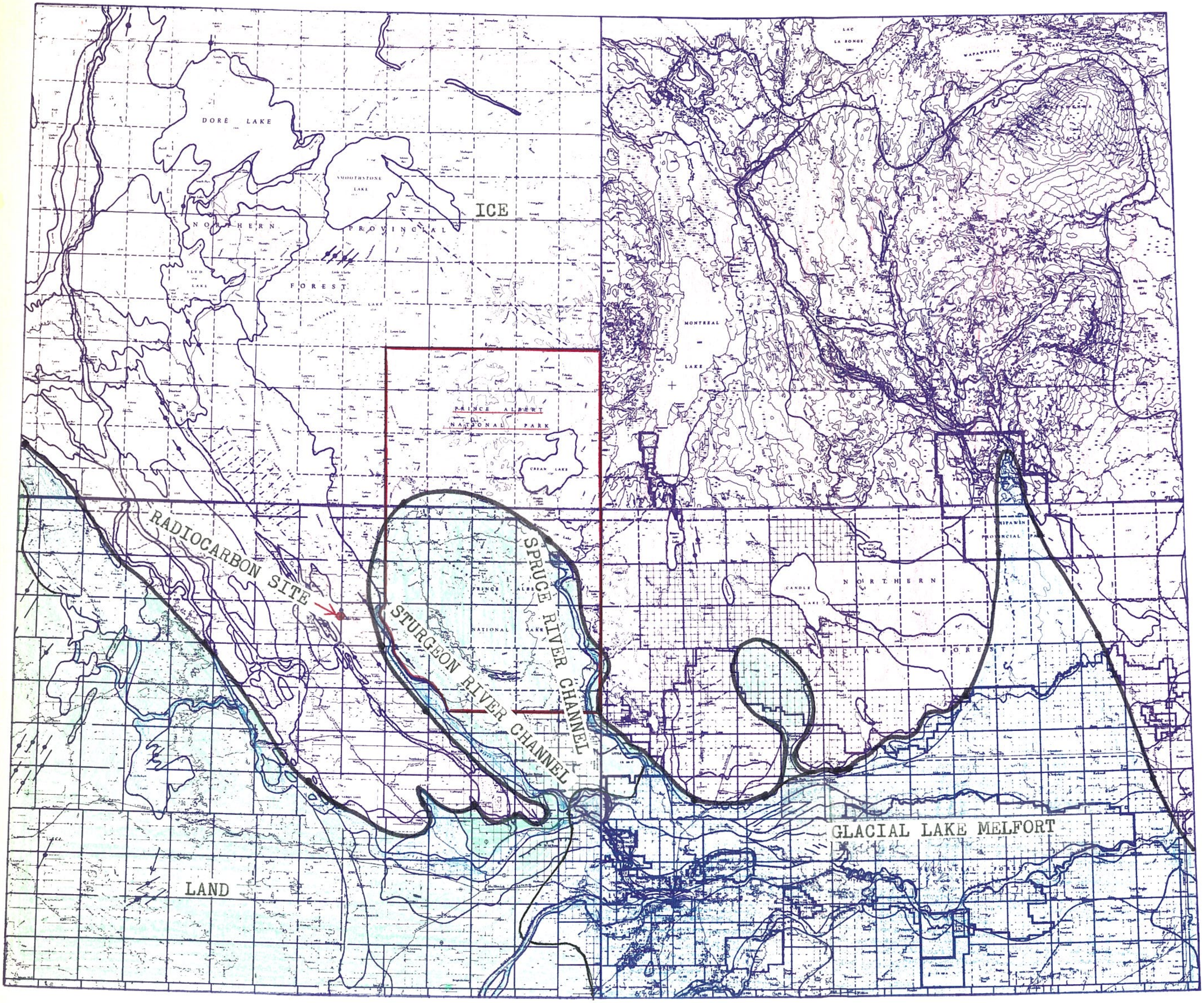

Figure 10. Phase 2 of the history of deglaciation of 73G. H. I, and J. Scale, one inch equals 15 miles.

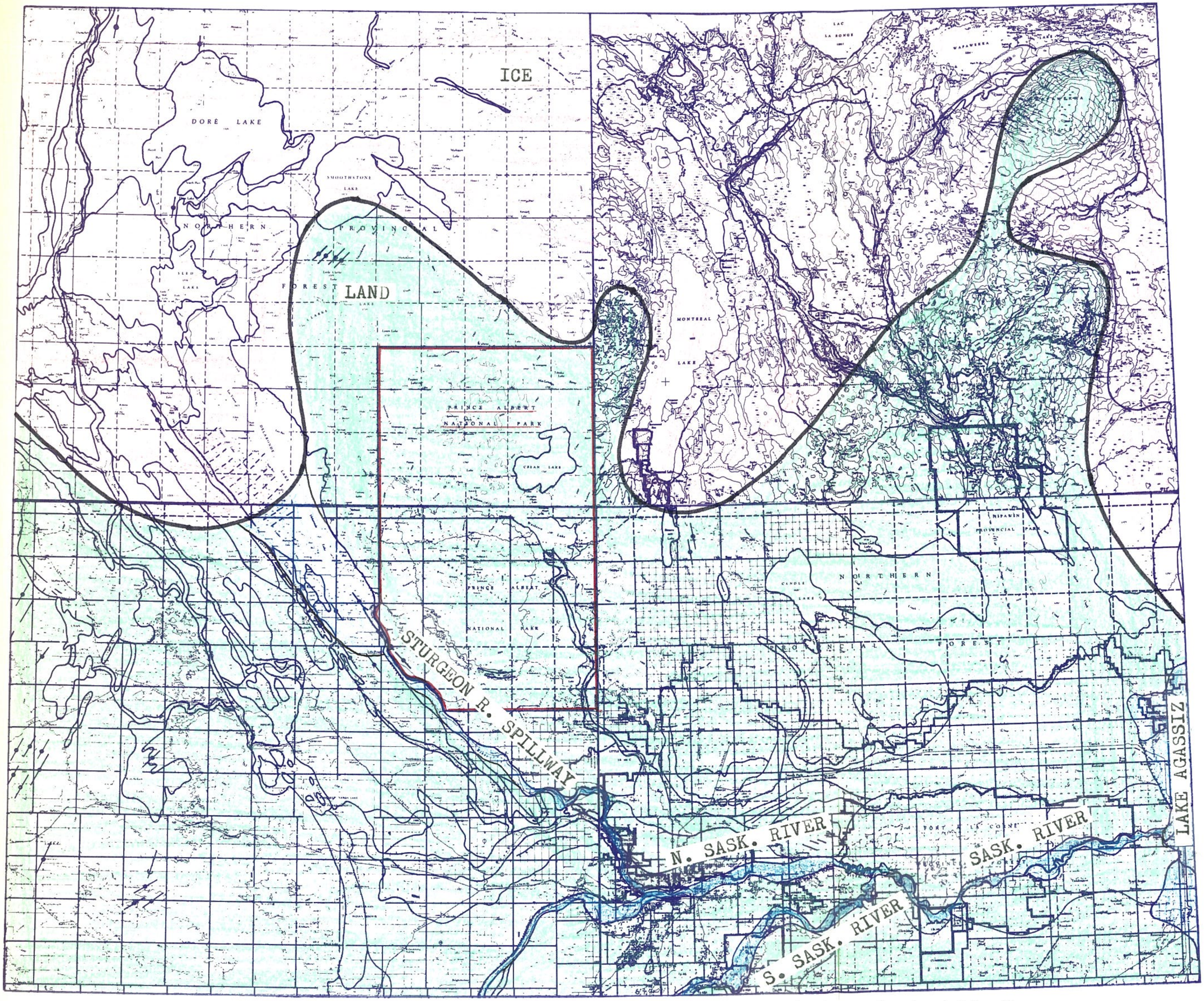

Figure 11. Phase 3 of the history of deglaciation of 73G, H, I, and J. Scale, one inch equals about 15 miles.

of the Park through the Sturgeon River Spillway. From this spillway the meltwater flowed through the North Saskatchewan and Saskatchewan Rivers into Lake Agassiz.

Phase 4 of the History of Deglaciation

During Phase 4 (Fig. 12) the Park was unaffected by both ice and meltwater. Glacial Meadow Lake formed along the west edge of the lobe of ice northwest of the Park, and Lake Agassiz was expanding northward. The Saskatchewan River was building the delta at Nipawin from sediment derived from the North and South Saskatchewan Rivers.

ORIGIN OF THE WASKESIU HILLS AND WASKESIU LAKE

As the glaciers advance toward an upland, the ice goes into compressive flow causing the flowlines in the margin of the glacier to diverge (Fig. 5). Such compressive flow results in the "Slabbing-off" of material beneath the glacier and the stacking of these slabs near the ice margin to from ice-thrust moraines (Fig. 6) which exhibit ice-thrust ridges on their surfaces (Fig. 4). Where the slabbing-off took place, a depression was formed beneath the glacier to form an ice-thrust depression (Fig. 8).

The Waskesiu Hills formed an obstacle to each glacial advance (Fig. 2). During each glaciation, the glacier went into compressive flow as it climbed over the Waskesiu Hills and over-thrusting resulted. The large accumulation of glacial deposits (at least 894 feet, SRC Waskesiu Hills, Fig. 2) in the Waskesiu Hills is a result of these glacial processes of erosion by slabbing-off (Fig. 8), transport along diverging thrust planes (Fig. 5), and deposition by stacking (Fig. 6).

The ice-thrust ridges at Hunters Lake (Fig. 7) attest to these glacial processes having been operative in the Waskesiu Hills, and the Waskesiu Lake Basin can best be explained as an ice-thrust depression formed where the slabbing-off took place as the glacier advanced up the north slope of the Waskesiu Hills.

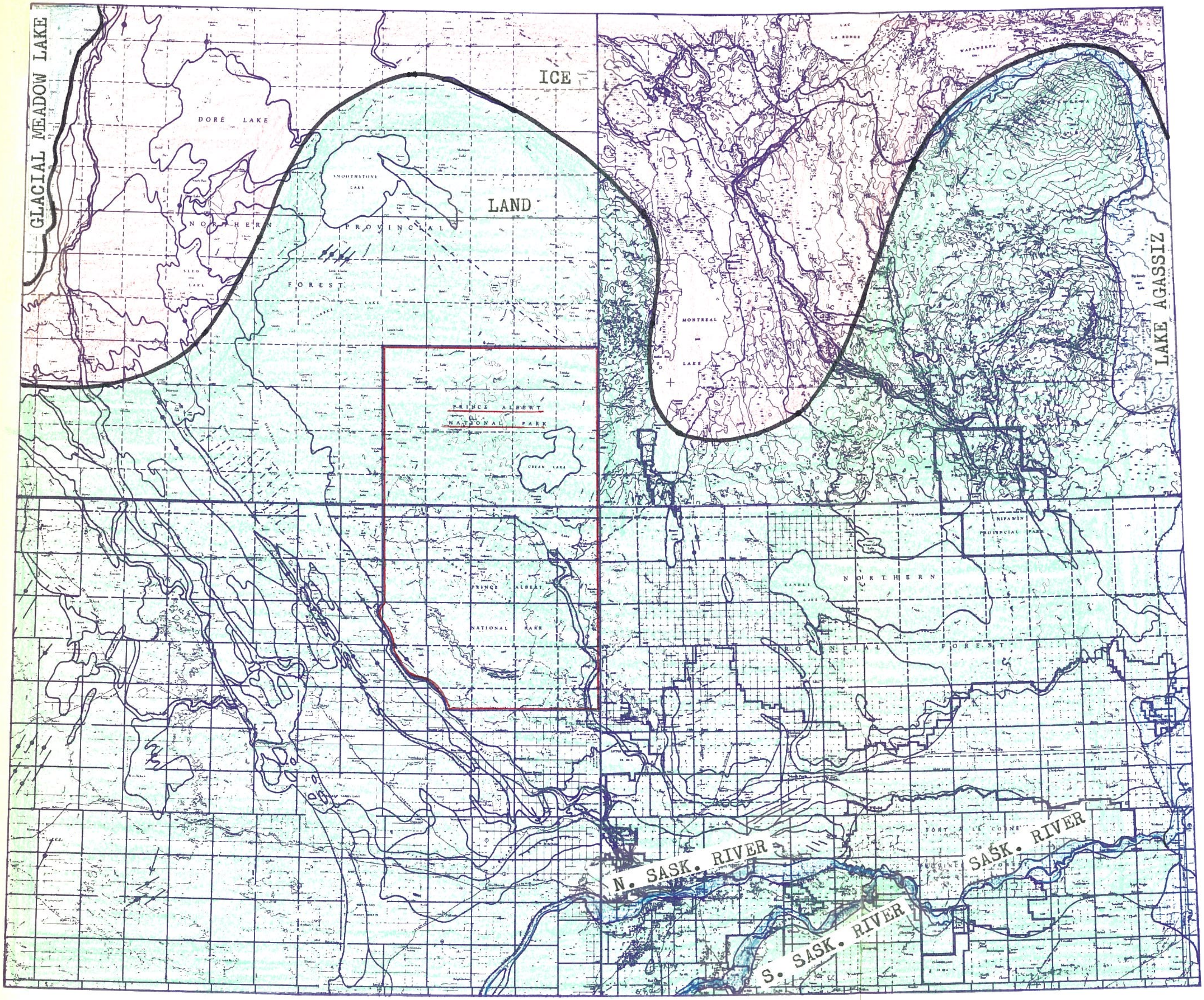

Figure 12. Phase 4 of the history of deglaciation of 73G, H, I, and J. Scale,one inch equals about 15 miles.

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