SASKATCHEWAN RESEARCH COUNCIL

GEOLOGY DIVISION

REPORT NO. 1

GEOLOGY and GROUND-WATER RESOURCES

of the

QU'APPELLE AREA SASKATCHEWAN

by

E. A. Christiansen

1960

ERRATA

Page 13, line 1, under Soils

—The Brown and Dark Brown Soils should read—

—The Black and Dark Brown Soils—

Page 15, line 1, second paragraph under End Moraines

—2 miles north of Grenfell should read—

—2 miles south of Grenfell—

ERRATUM

Substitute for legend in Figure 1, page 9

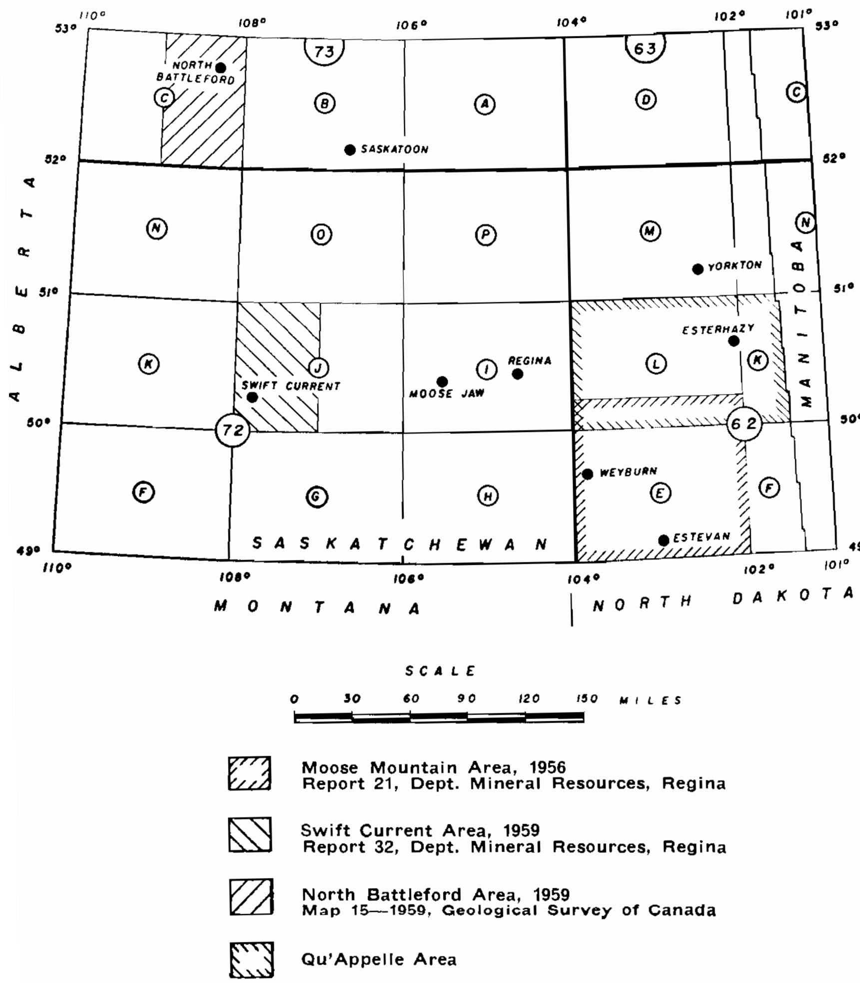

Figure 1.—Location of the Qu'Appelle Area

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E. A. Christiansen

ABSTRACT

The Qu'Appelle area, which comprises about 6500 square miles, lies between the Manitoba-Saskatchewan Boundary and 104° 00′ West Longitude and between 50° 00′ and 51° 00′ North Latitude in south-eastern Saskatchewan. The climate is semiarid. The average precipitation is about 17 inches, and the mean annual temperature is about 35°F. The soils closely resemble the parent material upon which they are developed which enables the geologist to interpret the surficial sediments directly from the soil map. Most of the soils in the Qu'Appelle area are within the Black Soil Zone.

The surficial sediment is mainly till and lacustrine silt and clay. Sands and gravels in the form of outwash plains are scattered throughout the area. The drift ranges in thickness from a few feet in the east-central portion of the area to about 700 feet near Fort Qu'Appelle. The paucity of exposures and subsurface data necessitate that the stratigraphic study be preliminary. Present data suggest, however, that there are at least three tills in the Qu'Appelle area. Geological evidence indicates that the Qu'Appelle area contains a till margin which represents a re-advance of the ice sheet to a position north of the Qu'Appelle Valley. The drift is underlain by Upper Cretaceous Marine Shales or Riding Mountain Formation equivalent to the Bearpaw, Belly River, and older formations farther west. The bedrock is exposed in the Qu'Appelle Valley and its tributaries east of Round Lake where meltwaters have cut deeply into the shale. Locally the hard, siliceous, Odanah Member occurs within the Riding Mountain Formation.

The exposed tills are calcareous, oxidized, locally unoxidized, and plastic. The texture of the tills range from loam to clay loam. The fact that the clay mineral content of both the tills and the Riding Mountain Formation is essentially montmorillonite and minor amounts of illite and kaolinite suggests that this formation is the source of most of the clay in the tills. Echo Lake Gravel, believed to be Sangamonian, lies within the drift section.

Slightly to highly mineralized water occurs in the following: Qu'-Appelle Valley fill where induced infiltration from the Qu'Appelle Valley Lakes and River may be possible; meltwater channel deposits; surficial sand and gravel; Odanah Member of the Riding Mountain Formation; intertill sand and gravel; and sand and gravel lenses in till. Large quantities of gravel occur in interlobate areas, terraces, outwash plains, and eskers. Interlobate areas are defined by v-shaped re-entrants in the washboard moraines. Large deposits of gravel were formed in close proximity to the glacier which was the source and which provided the necessary gradients for the transportation of the coarse sediment.

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INTRODUCTION

Location

The Qu'Appelle area, which comprises the Qu'Appelle Quadrangle (62 L) and the west quarter of the Riding Mountain Quadrangle (62 K), lies between the Manitoba-Saskatchewan Boundary and 104° West Longitude and between 50° and 51° North Latitude (Fig. 1). Regina is about 25 miles west and Yorkton about 15 miles north of the area. The southern boundary is 70 miles north of the International Boundary between Saskatchewan and North Dakota. Most of the ranges within the area are west of the Second Meridian which is at 102° West Longitude. The area comprises about 6500 square miles.

Previous Work

Fraser *et al.* (1935), in their study of the geology of southern Saskatchewan, mapped the bedrock geology of the area west of the Second Meridian on a scale of 1 inch to 8 miles. Wickenden (1945) included the area between the Second Meridian and the Saskatchewan-Manitoba Boundary in his report on the Mesozoic stratigraphy of the eastern plains. His map is also on a scale of 1 inch to 8 miles.

Stansfield (1918 and 1919), in his study of the surficial deposits of southeastern Saskatchewan, briefly described the soils and the groundwater resources of a portion of the Qu'Appelle area. Johnston and Wickenden (1930 and 1931) described the major land forms of the southwestern portion of the Qu'Appelle area. Johnston (1934) published a map of the surficial deposits of the area east of the Second Meridian on a scale of 1 inch to 8 miles. He also reported on the ground-water resources of this area. Johnston *et al.* (1948) published a preliminary map of the surficial deposits in southern Saskatchewan west of the Second Meridian. Christiansen (1956) included the area 62-L-1, 2, 3 and 4 in his study of the glacial geology of the Moose Mountain area.

Mitchell *et al.* (1947) published a soil map of southern Saskatchewan on a scale of 1 inch to 6 miles. Because the surficial sediments can be interpreted, to a large degree, directly from the soil map, Mitchell's map has greatly facilitated the study of surficial deposits in the Qu'Appelle area.

Present Studies

The present report is based on field and laboratory work conducted in 1958 and 1959. Before beginning the field work, contacts of the surficial sediments, as interpreted from the soil map, were plotted on topographic sheets. With the aid of this map and aerial photographs and mosaics, the land forms were classified. The preliminary interpretation was then checked and amplified in the field at which time the stratigraphy was studied. The surficial geology is shown in Plate 1.

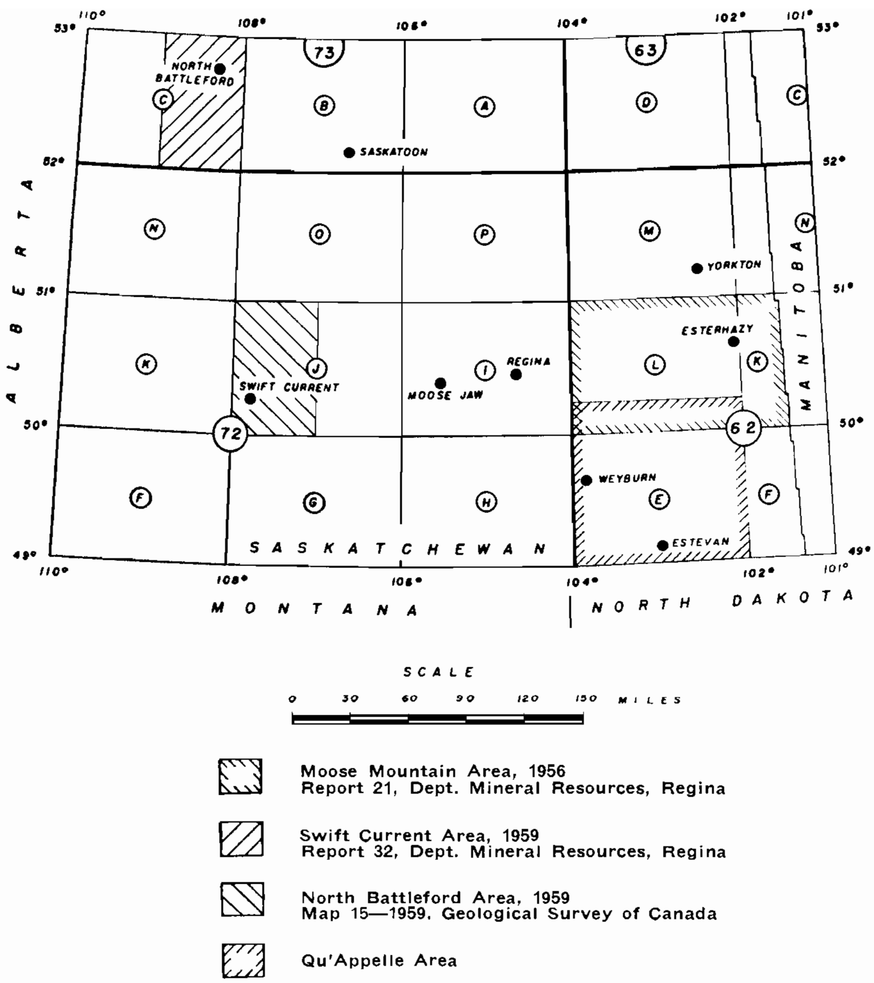


Figure 1. —**Location of the Qu'Appelle Area**

The preliminary studies on ground water are based on Geological Survey of Canada Water Supply Papers (Table 1), seismic test-hole logs, structural-hole logs, and field geology. These data are interpreted and presented as a ground-water probability map (Plate 2).

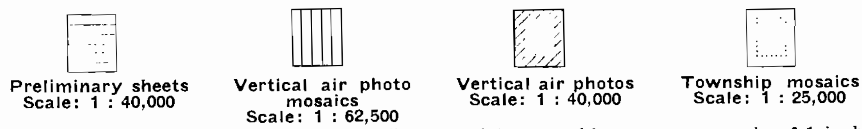
Mapping was done on a base map prepared by the Department of Mineral Resources, Regina, on a scale of 1 inch to 2 miles. The geology of area 62-L-1,2,3 and 4 is based on Christiansen (1956). The maps and photographs available for the area are shown in Figure 2.

Acknowledgments

Field trips and discussions with Professors G. W. White and P. R. Shaffer, University of Illinois; Messrs. J. S. Scott, E. Hall, and A. M. Toth, Geological Survey of Canada, contributed much to the study.

The writer is particularly indebted to Professor W. O. Kupsch, University of Saskatchewan, for critically reading the section on geology and to Professor F. H. Edmunds, University of Saskatchewan, for critically reading the section on ground water.

The author is grateful to Mr. J. R. Foster, Superintendent, Dominion



NOTE: Vertical air photos (scale: 1 : 15,300) and topographic maps on a scale of 1 inch to 3 miles are available for entire area. Topographic map (scale: 1 : 250,000) is available for 62 K.

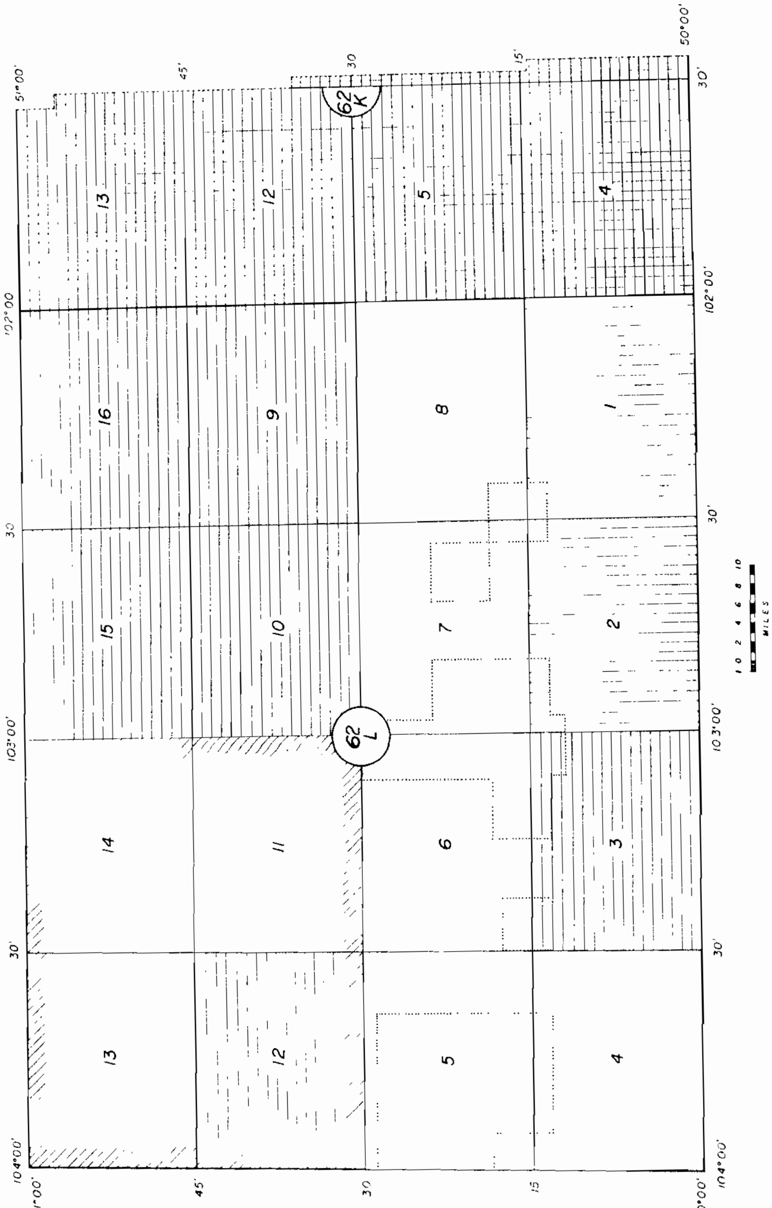


Figure 2.—Index to maps of the Qu'Appelle area

Experimental Farm, Indian Head, who provided excellent office facilities and who was willing to co-operate in every way. The writer is also grateful to Mr. J. K. Wiens for the loan of aerial photographs.

The drafting was done by the Department of Mineral Resources, Regina, for which the author wishes to record his thanks. The writer also wishes to thank Mr. Henry Sawatsky of this department for determining the drift-bedrock contact on electric logs from structural holes and for making the shot-hole data available.

The writer was ably assisted in the field by Messrs. R. E. Borstmayer, D. L. Delorme, G. J. Greer, and W. C. Ross. Mr. Ross also studied the tills in the laboratory.

Sample logs were provided by International Water Supply, Saskatoon, and the Glacier Drilling Company, Qu'Appelle, for which the author is grateful.

PHYSIOGRAPHY

Climate

Precipitation

The precipitation recorded at the Experimental Farm, Indian Head, is shown graphically in Figure 3. The annual precipitation ranges from 9.14 to 26.92 inches or a total variation of 17.78 inches which is greater than the mean. The monthly precipitation ranges from 0 to 11.20 inches, the highest precipitation being in June and July. The monthly distribution of precipitation is not conducive to recharge of aquifers because the highest transpiration rates occur during the months of high precipitation. The annual precipitation varies as much as 12 inches between successive years. The standard deviation of 4.1 inches attests to this variability.

Temperature

The mean annual temperature at Indian Head is 35°F. The recorded extremes of temperature are 109°F and -50°F (Fig. 4). The coldest month is January when the mean temperature is 0.5°F, and the warmest month is July when the average temperature is 65°F. The average temperature is below freezing from November to March inclusive. The maximum variation in monthly temperature ranges from 80°F in summer to 110°F in winter.

Wind and Evaporation

The prevailing wind at Qu'Appelle is from the northwest during all months of the year. Evaporation data from open tanks for May to September inclusive, for 1936 to 1958, are available at the Dominion Experimental Farm, Indian Head. They show that the average evaporation in May is 3.8 inches, in June 4.0, in July 4.9, in August 4.4, and in September 2.9 inches. The average evaporation is about twice the average precipitation for these months.

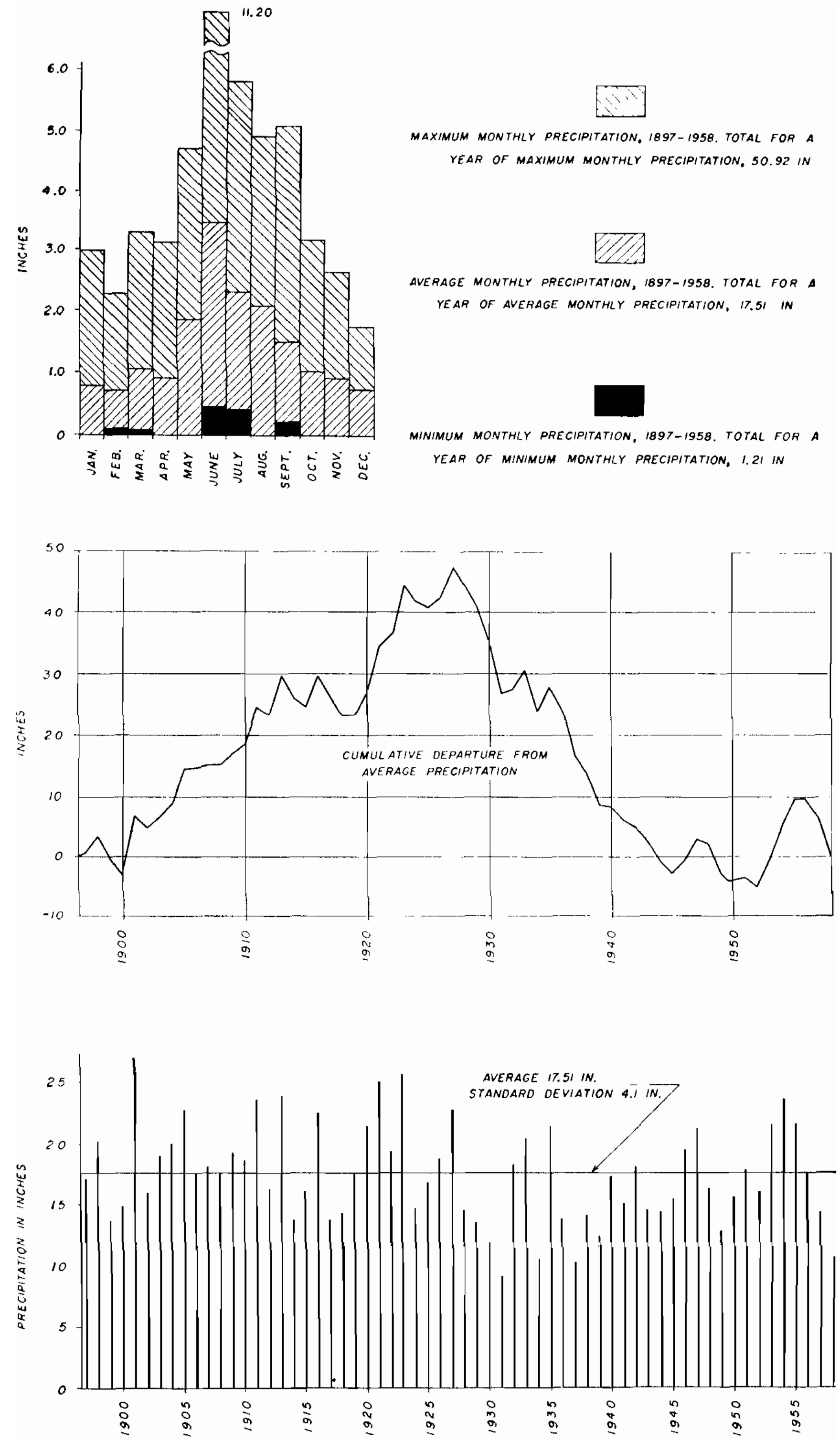


Figure 3.—Precipitation records from the Dominion Experimental Farm, Indian Head (1897-1958)

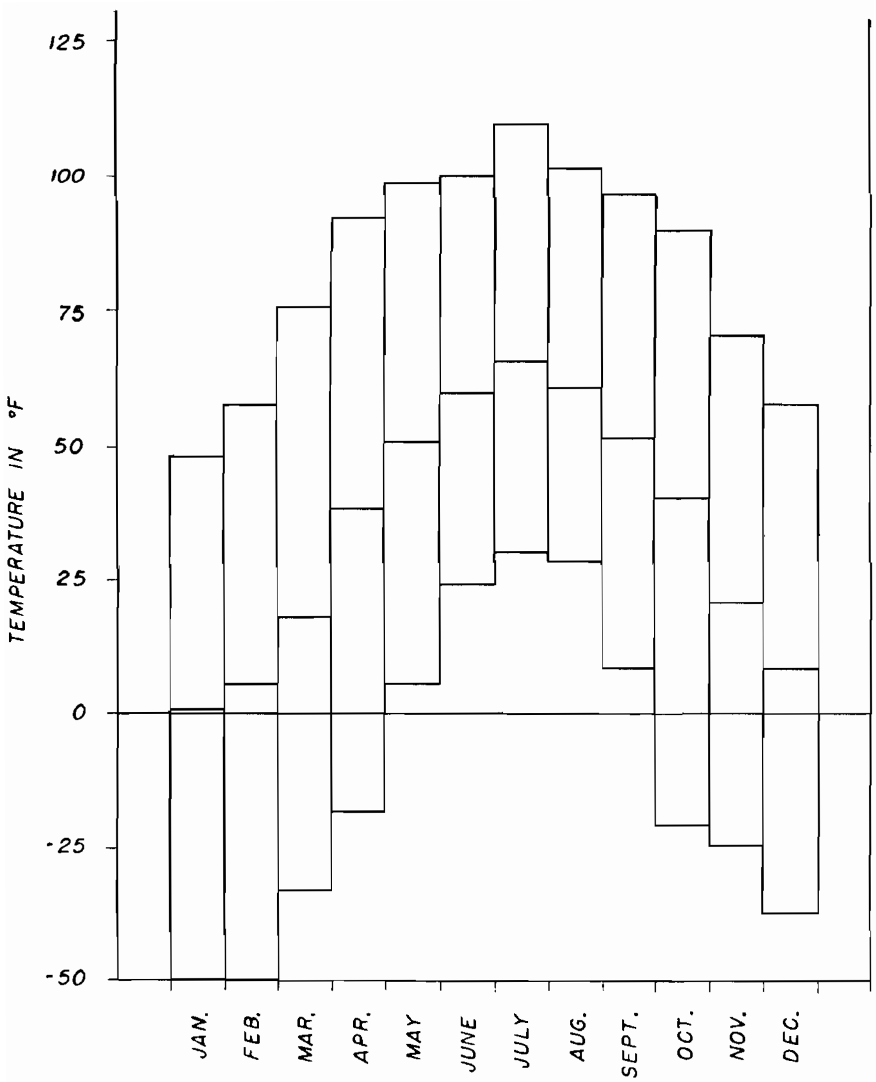


Figure 4.—Temperature records. Maximum, minimum, and mean monthly averages for temperatures, Dominion Experimental Farm, Indian Head (1897-1958)

Soils

The Brown and Dark Brown Soils constitute the zonal soils of the Qu'Appelle area. With the exception of a few of the valley bluffs in the east-central part of the area, all soils are developed on glacial drift, dominantly till.

The Soil Association is the fundamental mapping unit in the classification of Saskatchewan soils. Soils that develop on similar parent material within the same Soil Zone constitute a Soil Association. The Weyburn, Oxbow, Ryerson, Yorkton, and Naicam Associations are developed on till; the Biggar, Asquith, Whitesand, and Meota Associations on stratified deposits, mainly fluvial; and the Regina, Elstow, Indian Head, and Canora Associations on lacustrine clay. Since Soil Associations are based on parent material, it is possible for the geologist to interpret the surficial sediments directly from the soil map. This is particularly true in Saskatchewan where the parent materials are relatively young, and consequently, the soils closely resemble the sediment upon which they are developed.

Topographic Features

The major topographic features are controlled by structure and erosion which antedate glaciation. Upon these basic elements the glacial deposits are superposed. The Qu'Appelle area may be divided into four physiographic divisions: Souris River Plain, Moose Mountain Upland, Assiniboine River Plain, and the Pheasant Hills Upland.

The Souris River Plain, called Weyburn Lowland, was described by Christiansen (1956). Since only a small part of this division lies in the Qu'Appelle area, the reader is referred to this reference for further detail. The Moose Mountain Upland lies between the Souris River Plain to the south and the Assiniboine River Plain to the north. The upland trends in a northwest-southeast direction and rises about 500 feet above the Souris River Plain. The Assiniboine River Plain lies to the north and east of the Moose Mountain Upland. The broad, relatively flat Assiniboine River Plain lies on either side of the Qu'Appelle Valley which forms the most striking topographic feature in the lowland. The Pheasant Hills Upland is in the north-central portion of the area. It forms a broad, dome-like feature which rises 50 to 100 feet above the surrounding Assiniboine River Plain. A portion of the Touchwood Hills Upland lies within the northern boundary of the Qu'Appelle area.

Drainage

The northern portion of the Qu'Appelle area drains into the Qu'Appelle River which in turn drains into Lake Winnipeg by way of the Assiniboine and Red Rivers. The southern sector of the area drains by way of Moose Mountain and Pipestone Creeks into the Souris River which in turn drains into Lake Winnipeg by way of the Assiniboine and Red Rivers.

GEOMORPHOLOGY

Glacial Land Forms

Ground Moraine

The topography of the ground moraine is undulating to gently rolling and has a relief of 5 to 30 feet, commonly less than 10 feet. The landscape is comprised of smooth hills, flat till plains, kettle areas, washboard moraines, and flutings. A large portion of the ground moraine is traversed by numerous small, shallow, meltwater channels which, in places, show a lobate pattern. The sediment is composed essentially of till but includes minor amounts of sand and gravel in the form of lenses, small outwash plains, and ice-contact deposits. Locally, the upper 5 feet of the sediment contains small lenses (up to 200 feet long) of lacustrine silt and clay which are commonly varved (N.W. 1/4 S. 17, T. 17, R. 2, W.2).

End Moraine

Three end moraines were deposited in the area: Qu'Appelle Moraine, Grenfell Moraine, and Stoughton Moraine. The Qu'Appelle Moraine is 15 miles long and 4 miles wide and trends in a northerly direction. The moraine is bordered by the Lake Indian Head Basin on the east and the Lake Muscow Basin on the west. A second order relief of 10 to 20 feet is superposed upon a broad ridge which rises about 50 feet above the surrounding lake basins. The landscape on the moraine is characterized by numerous kettles and rimmed kettles. The sediment is essentially till but includes minor amounts of sand and gravel.

The Grenfell Moraine is about 2 miles north of Grenfell (T. 17, R. 7, W.2) and trends in a northwest-southeast direction. The moraine is about 25 miles long and 5 miles wide and lies between the Grenfell and Hillesden Channels. The moraine, which has a second order relief of 10 to 40 feet, forms a broad, low ridge on the northeast slope of the Moose Mountain Upland. The landscape comprises undulating to hummocky terrain and contains numerous knobs, kettles, and rimmed kettles. The sediment is essentially till but includes minor amounts of sand and gravel in the form of kames and small outwash plains. The Qu'Appelle and Grenfell Moraines are believed to be formed, at least in part, by dead ice deposition as indicated by the nature of the landscape.

The Stoughton Moraine was named and described by Christiansen (1956). The morainal belt between Kendal (T. 15, R. 12, W.2) and McLean (T. 18, R. 15, W.2) is herein considered part of the Stoughton Moraine.

Washboard Moraine

Washboard moraine, also called washboard ridges, (Gravenor and Kupsch, 1959, p. 54), minor recessional ridges (Christiansen, 1956, p. 13), and swell and swale pattern (Gwynne, 1942), is common in the Qu'Appelle area. Although the areal pattern of washboard moraine is not, in most places, apparent in the field, it is quite apparent in aerial photographs and very apparent in photo mosaics. In some places the pattern is formed by a sequence of sub-parallel, generally arcuate swells and swales. In other places, the pattern is indicated by the alignment of sloughs, streams, and irregularities of shorelines which are best shown in mosaics. The ridges range from 5 to 40 feet in height and are commonly 10 to 20 feet high. Although there is a lack of agreement on the origin of washboard moraine, there appears to be complete agreement on the significance of this form—that washboard moraines are generally parallel to the position occupied by the ice margin. It is herein recommended that these features be called washboard moraine whether they are deposited in water or on ground.

In an area between Dubuc (T. 20, R. 4, W.2) and Pearl Creek (T. 20, R. 7, W.2), the ridges rise 30 to 40 feet above the swale bottoms. Locally, short, discontinuous eskers 30 to 40 feet high trend about normal to the washboard moraine. These ridges are composed of ice-contact stratified sand and gravel. Washboard moraine is composed mainly of till but includes minor amounts of sand and gravel.

Since washboard moraines were deposited parallel to the ice front, their importance for the interpretation of the glacial history cannot be overstressed. Because of their wide areal extent and their ease of interpretation, they are the most important criterion for determining the direction of ice retreat.

Crevasse Fillings

The crevasse fillings in the Qu'Appelle area occur northwest of Indian Head (T. 18, R. 13, W.2) and southwest of Francis (T. 13, R. 14, W.2). The land form pattern of these ridges is characterized by two sets of ridges which intersect at acute angles. The ridges are 5 to 10 feet high and about 200 feet wide at the base. They are composed mainly of till.

Flutings

The term flutings is used here to describe a field of narrow, straight to gently curved, parallel ridges and grooves. Flutings are very apparent in aerial photographs (Fig. 5) but are difficult to discern in the field in most places. The ridges, which rise 3 to 20 feet above the adjacent grooves, are up to 4 miles long and 200 to 300 feet wide at the base. In the flutings near Katepwa Lake (Fig. 5) the pattern is best developed where the blanket of lacustrine clay is absent. This observation supports the conclusion that flutings occur in lodgement till where the superglacial sediment is thin or absent owing to water erosion (Christiansen, 1956, p. 16). Shallow exposures suggest that the sediment is essentially till, but it also includes lenses of sand and gravel (S. 19, T. 19, R. 11, W.2).

Lemke (1958) concluded that flutings are formed at the base of actively flowing glaciers, and that they trend in the direction of ice movement. Gravenor and Meneley (1958) support this conclusion and propose that the till has been moved from the groove to the adjacent ridge by the component of ice flow perpendicular to its long axis.

Kames and Kame Complexes

Ice-contact stratified drift occurs in the form of kames and in broader areas as kame-eskerine complexes. These land forms are particularly well developed along Deerhorn Creek (T. 19, R. 31, W. 1) and in the Kendal area (T. 15, R. 12, W. 2). In the latter area the kame complex forms part of the Stoughton Moraine. Shallow exposures show the sedi-

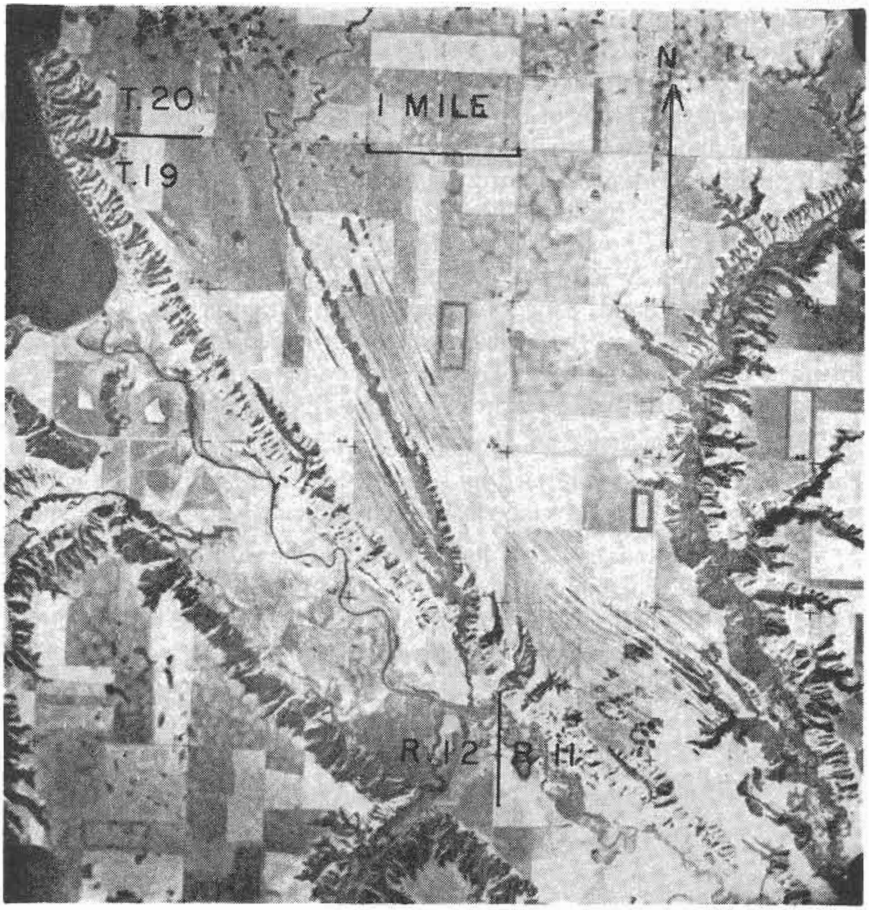


Figure 5.—Flutings above northeast bluff of Qu'Appelle Valley southeast of Katepwa Lake. Note drainage control caused by pattern. Air Photo A15961-72, courtesy R.C.A.F.

ment to be mainly stratified. Locally, however, the hummocks are composed of till. The deposits are typically contorted and heterogeneous in composition.

PROGLACIAL LAND FORMS

Glacial Lake Basins

Glacial lakes were formed where the glaciers provided the necessary closure to the north and east. Since glacial lake shorelines are absent in the Qu'Appelle area and since lacustrine sediments are not deposited on the shores of these lakes, glacial lake boundaries were determined largely from the altitude of drainage outlets. Lake Indian Head Basin, Lake Regina Basin, and Lake Saltcoats Basin are the three major glacial lake basins in the Qu'Appelle area.

Evidence of glacial lake shorelines are not present around Glacial Lake Indian Head, hence, the boundary of the basin was determined by the elevation of the drainage outlet (2000 feet). The topography is flat to undulating and has a local relief of about 10 feet. The basin slopes gently toward the Qu'Appelle Valley which bisects it. The sediment ranges in texture from a lag deposit of pebbles and cobbles near the shoreline to clay in the center of the basin. The sediment attains a maximum thickness of about 20 feet which can be seen where the Qu'Appelle Valley and its tributaries have cut through the lacustrine deposit. Most of the sediment is varved as shown in cuts along Highway 1 and in a road cut along Highway 56, north of Indian Head (south bluff of tributary along east side of Highway 56 in S. 23, T. 19, R. 13, W.2). In the latter locality the light colored bands range in texture from silt to gravel. The coarse texture suggests that the glacier, which provided the sediment, was only a short distance away. The variability of texture and the cyclic arrangement of the strata further suggest a fluctuating ice front.

The Lake Regina Basin was described by Christiansen (1956, p. 20). The lake basin is characterized by smooth, level topography and is composed essentially of lacustrine clay which becomes silty near the shore.

The Lake Saltcoats Basin lies in the northeastern portion of the Qu'Appelle area. The boundary of the basin is determined by the altitude of the outlet channel (Cutarm Creek, at 1700 feet). The topography is flat to gently undulating and has a local relief of less than 10 feet. The eastern arm of the basin contains predominantly silty deposits which are at least 5 feet thick (1/4 mile north of S.W. corner S. 16, T. 23, R. 2, W. 2) whereas the western arm of the basin contains predominantly sands which are less than 10 feet thick.

Outwash Plains

Outwash plains occur as alluvial fans at the mouths of meltwater channels, in a broad collecting channel which formed an outlet for Lake Indian Head, and as sand and gravel plains formed along the ice front.

The Welby Sand Plain (T. 18, R. 30, W. 1), the outwash plain near Tyvan (T. 12, R. 13, W. 2), and the outwash plains in Township 15, Range 4 and Township 16, Range 5, West of the Second Meridian were formed at the mouths of meltwater channels. The sediment in the outwash plains is essentially sand and gravel which becomes thicker and coarser as the apex of the fan is approached from the periphery. The sediment ranges in thickness from a thin veneer up to a maximum of about 50 feet, but it is commonly less than 15 feet thick.

Outwash plains also occur on terraces along meltwater channels and spillways, particularly the Qu'Appelle Spillway. The sediments are mainly sands and gravels which become thicker and coarser as the valley is approached from the upland. The thickness of the sediment ranges from a thin veneer to about 20 feet.

The Summerberry Spillway contains an extensive outwash plain. The sediments are essentially sands and gravels in the form of bars between the smaller channelways. Exposures along Highway 47 north of Grenfell indicate that the sediment is less than 5 feet thick. That the sediment is so thin is understandable because the Summerberry Spillway drained relatively clear water from Lake Indian Head, and therefore, the only source available for gravel was the till into which the spillway eroded. This thin veneer, therefore, represents a lag deposit which was formed by erosion of the till.

The outwash plains near Lipton (T. 22, R. 14, W. 2), Duff (T. 22, R. 8, W. 2), Melville (T. 22, R. 6, W. 2), Waldron (T. 21, R. 4, W. 2), Lebret (T. 20, R. 13, W. 2), and Kendal (T. 16, R. 12, W. 2) were deposited in close proximity to the glaciers. The sediments are essentially sands and gravels which are generally 10 to 15 feet thick. The outwash plain south of Lebret and the plain north of Kendal are excellent examples of outwash plains formed close to the glacier.

North of Kendal the outwash deposits show a gradational change in texture from sand (S. 32, T. 15, R. 12, W. 2) to cobbles (S. 29, T. 16, R. 12, W. 2). The thickness of the sediment and the number of kettles also increase from south to north. These observations indicate that the ice stood immediately north of the outwash plain when it was deposited.

The sediment in the outwash plain south of Lebret shows a gradual change in texture from gravel near the Qu'Appelle Moraine to sand 2 miles east of the moraine. Lithological counts and a shape analysis of the pebbles indicate that the gravel was transported only a few miles. The extreme angularity of the carbonate pebbles, the high percentage of carbonate pebbles, and the presence of schist pebbles attest to the immaturity of these gravels.

Meltwater Channels

The term meltwater channel is here used to describe any channel that carried meltwater from a glacier. These channels may have carried meltwater under the ice, on top of the ice, parallel to, or away from the ice. Meltwater channels range in size from broad, shallow runways 10 feet deep and about 1000 feet wide to deep trenches about 150 feet deep and 3000 feet wide. The larger ones are outlined on the map whereas the smaller ones are indicated by a line. A large number of meltwater-channel bottoms are cut into by postglacial gullies, and the old channel bottoms are either completely removed or appear as poorly developed paired terraces along the valley walls. This type of rejuvenation is common where meltwater channels empty into spillways or larger meltwater channels.

Outwash sand and gravel in meltwater channels occur in terraces and in slip-off slopes on meanders. Other sediments in meltwater channels are till, colluvium-alluvium in the form of fans along valley walls, and exposed bedrock shales.

A large number of the meltwater channels in the Qu'Appelle area are parallel to the washboard moraines, and like these moraines, the channels outline successive positions of the retreating ice front. Proglacial channels, subglacial channels, and superglacial channels are also believed to be present in the Qu'Appelle area.

The Deerhorn Channel contains kames and kame-eskerine complexes interspersed with outwash plains. These forms are composed of sand and gravel which is locally absent. The sediments in most places lie in a shallow trench which was formed prior to the deposition of these sediments. The ice-contact sediments commonly rise above the surrounding ground moraine (Spy Hill, which is a kame).

Spillways

Channels which were formed as drainage outlets of glacial lakes are here called spillways. There are four spillways in the Qu'Appelle area: the Pipestone Spillway which is now occupied by Pipestone Creek, the Summerberry Spillway, the Qu'Appelle Spillway which is now occupied by the Qu'Appelle River, and the Cutarm Spillway which is now occupied by Cutarm Creek.

The Pipestone Spillway was the highest outlet of Lake Indian Head. The valley is up to 4000 feet wide and 150 feet deep and is occupied by the underfit Pipestone Creek. The sediment consists of gravel and sand in the form of terraces and slip-off slopes, eroded till on the steep valley bluffs, alluvium and colluvium in the form of alluvial fans along the valley walls, and flood plain deposits in the center of the valley. Except for the large outwash areas, these sediments are not differentiated on the map.

The Summerberry Spillway is a broad, shallow "collecting channel" which formed the second outlet for Lake Indian Head. It is somewhat lower in altitude than the Pipestone Spillway. The Summerberry Spillway, which is up to 4 miles wide and 10 to 20 feet deep, contains a complex of tributaries and distributaries which form a braided pattern. The sediment consists of sand and gravel less than 5 feet thick in the form of bars between the tributaries and distributaries and till with a thin cover of alluvium in the channelled areas.

The Qu'Appelle Spillway was the lowest outlet of Lake Indian Head and Lake Regina. The valley is up to 450 feet deep, and the valley bottom is up to 1 mile wide. The Qu'Appelle Spillway includes the deeply eroded Qu'Appelle Valley and the outwash plains that flank the valley discontinuously on both sides, eroded till bluffs, three sets of terraces along the valley walls (Fig. 6), and an alluvial valley bottom.

The Cutarm Spillway was the outlet for Glacial Lake Saltcoats. The valley is up to 1 mile wide and up to 200 feet deep at its confluence with the Qu'Appelle Valley. In the upper reaches of the spillway a trench 50 feet deep and 1500 feet wide is flanked by two outwash plains.

Terraces

Three sets of terraces are present in the bluffs along the Qu'Appelle Valley (Fig. 6). Although these terraces occur only in fortuitous positions on the inside of meanders, the fact that they are at least 50 feet apart

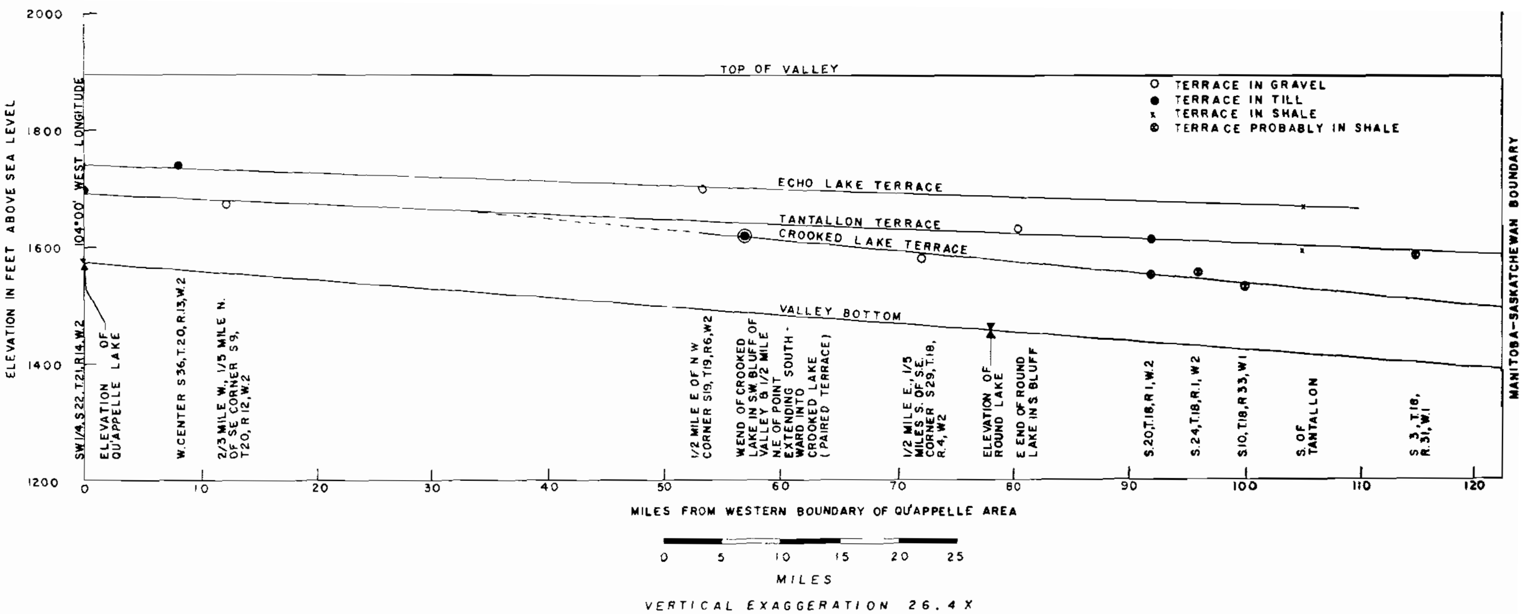


Figure 6.—**Long profile of Qu'Appelle Valley. Elevations recorded with an Air Force altimeter**

vertically, and that the upper two of them show gradients comparable to the present valley, suggest that the correlation shown in Figure 6 is a valid one.

The terrace surfaces are underlain by a 10 to 20 feet thick blanket of sand and gravel which in turn is underlain by either till, shale, or more sand and gravel (Fig. 7). The Echo Lake and Tantallon Terraces are slightly divergent whereas the Tantallon and Crooked Lake Terraces are strongly divergent down valley, and apparently the latter two converge above Crooked Lake (Fig. 6). Thornbury (1958, p. 157-162) attributes divergent terraces to either increased rate of uplift inland as compared with that nearer to the base level or to a shortening of the intervals between successive rejuvenations. This would give the streams successively less opportunity to develop graded floors before uplift started a new cycle. As a consequence of this the gradients would increase from the uppermost to the lowermost terrace. Since there is no evidence for an increased rate of uplift in the inland region, it is suggested that the interval between successive rejuvenations after the development of the Tantallon Terrace became shorter and that a rejuvenation took place before the stream that flowed upon the Crooked Lake Terrace became a graded stream.

The fact that thick gravel and sand underlie terrace remnants at all levels shows that all terraces were formed after the gravel-fill was deposited in the valley.

Postglacial Land Forms

Qu'Appelle Valley Bottom

The Qu'Appelle Valley is being filled by sediments which take the form of alluvial fans. In places these fans coalesce. Alluvial fans have their apex in re-entrants along the valley bluff and extend toward the center of the valley where they control the course of the Qu'Appelle River. Alluvial fans form the closure for lakes which lie in the valley; Fort Qu'Appelle is built on a fan which forms the closure for Echo Lake. These fans are also responsible for the "points" which extend into the lakes from the valley sides. The sediment in the fans ranges from gravel in the apex to clay in the periphery. Because the apex migrates in the direction of the valley walls and because the streams frequently change course upon the fan, the sediments are extremely heterogeneous. Fine silt and clay are being deposited upon the flood plain parallel to the Qu'Appelle River whose course is determined largely by the development of the alluvial fans.

Slump Areas

Landslides are common in the Qu'Appelle Valley and its tributaries. This is particularly true in valleys where the streams have penetrated the drift-shale contact. Landslides also occur, however, where the valley is wholly developed in drift. Slump areas are very common in the Qu'-

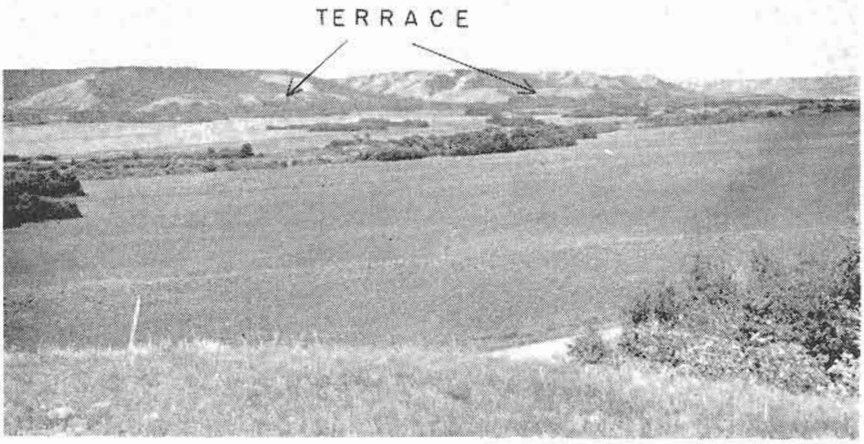


Figure 7. —Terrace on gravel fill near east end of Round Lake

Appelle Valley and its tributaries below Round Lake. The occurrence of slumping in this area is stratigraphically controlled in that slumping occurs only where the streams have penetrated the drift-shale contact. This stratigraphic control of slumping is also well illustrated in the Swift Current area (Christiansen, 1959, p. 21-23). V-shaped valleys (S. 14, T. 18, R. 2, W. 2) have developed where slumping is severe. It is believed that slumping in the v-shaped Qu'Appelle Valley has formed a temporary base level for the valley up stream from this area.

Landslides also occur in drift sections along the Qu'Appelle Valley. The Fort Qu'Appelle and Lebret Lake Landslides are the two most spectacular slides in this type.

A peculiar land form occurs in Section 33, Township 20, Range 13, West of the Second Meridian. The land form has an amphitheater-like shape ($1\frac{1}{2}$ x $1\frac{1}{2}$ miles) which opens towards Lebret Lake. Superimposed upon the surface of the amphitheater are arcuate ridges which in turn have rimmed kettles superposed upon them (Fig. 8). Postglacial erosion has modified only the lower portion of the amphitheater. Since this land form south of Lebret Lake is similar to landslide areas in other parts of Saskatchewan and the arcuate ridges have a very restricted areal extent being restricted to the amphitheater, it is believed that the land form is an expression of a landslide and not of a washboard moraine. This feature is herein called the Lebret Lake Landslide.

The fact that dead-ice features are superposed upon the amphitheater and that there is no evidence of a bulge at the toe of the slide indicates that the slide occurred in early-Postglacial time. The following explanation is offered foı the origin of the Lebret Lake Landslide. After Phase No. 4 (Fig. 19) of the glacial history, the dead-ice dam in the Qu'Appelle Moraine was breached by meltwater from Lake Muscow. The meltwater cut through this stagnant ice and into the water-soaked drift until the Qu'Appelle Valley bluff above Lebret Lake became unstable and the Lebret Lake Landslide occurred. Meltwater continued to sweep through the valley and thus removed the toe of the slide. Finally, the stagnant ice melted leaving dead-ice features superposed upon the arcuate ridges and amphitheater formed by the slide.

The Fort Qu'Appelle Landslide is in a ravine in the south bluff of a tributary (N.E. 1/4, S. 1, T. 21, R. 14, W. 2) which has its confluence with the Qu'Appelle Valley at the town of Fort Qu'Appelle (Fig. 9). The scar of the slide is about 1000 feet long, 100 feet wide, and 10 to 15 feet deep. It is estimated that about 50,000 cubic yards of earth moved through the narıow gap at the base of the scar.

The Fort Qu'Appelle Landslide occurred on May 13 and 14, 1956. According to an eye witness, Mr. M. W. Brown, Foreman, Department of Highways, Fort Qu'Appelle, the slide started at 8:00 p.m. May 13 at which time the movement was restricted to an area below a point 100 feet above Highway 35. The main movement, however, occurred at

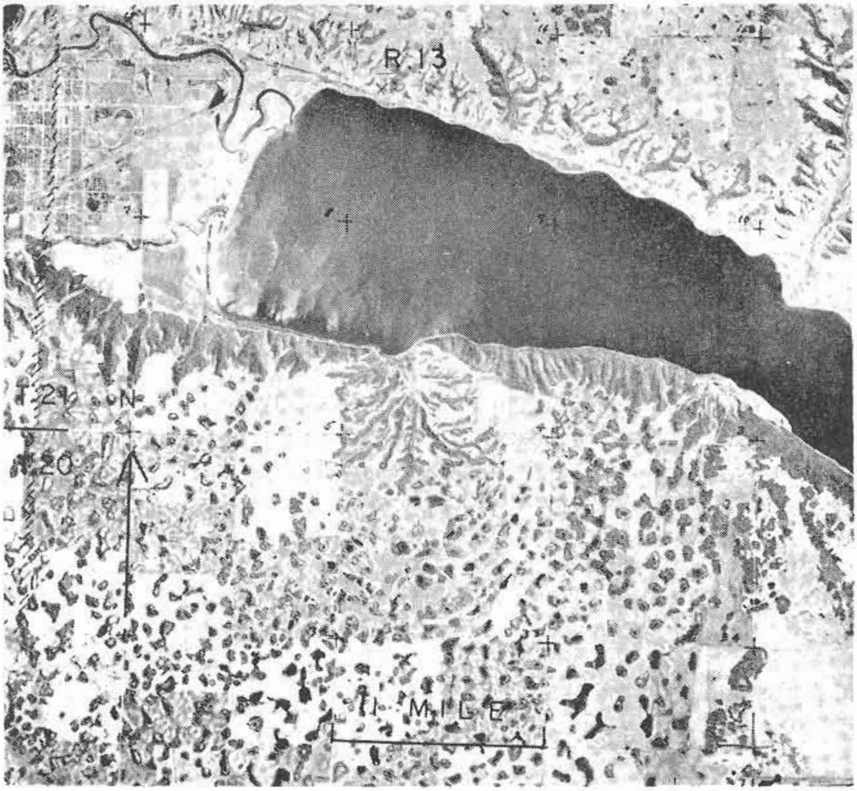


Figure 8.—Lebret Lake Landslide. Note superposition of kettles upon arcuate ridges. Air photo A15975-71, courtesy R.C.A.F.

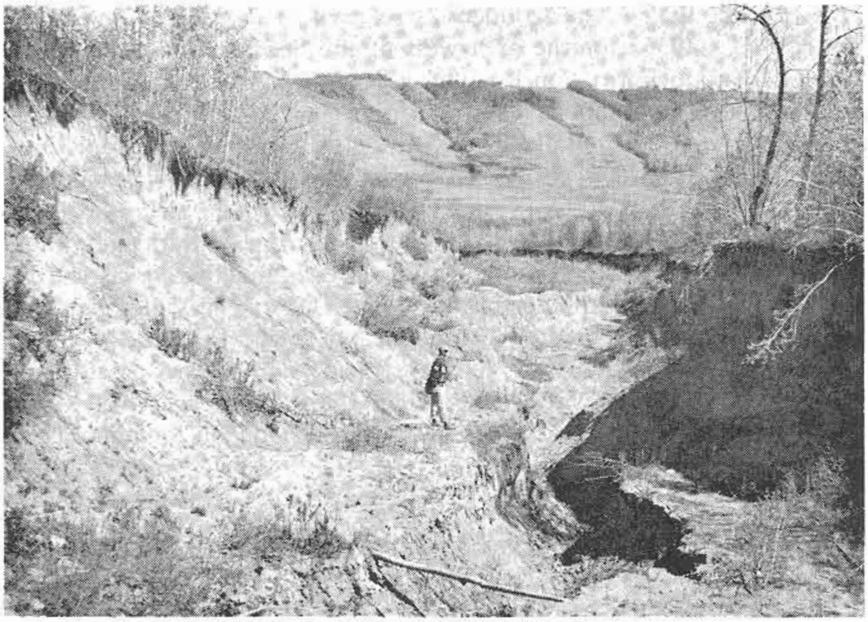


Figure 9.—Fort Qu'Appelle Landslide

10:00 a.m. the following day and lasted for about three hours. He indicated that the material in transport resembled a viscous fluid, and that a portion of Highway 35 was removed by the slide.

Inspection of the exposures in the landslide scar shows that the slide occurred in colluvial sediments which are comprised of interbedded gravel, sand, silts, and organic layers. Since precipitation was unusually heavy in 1956, it is believed that water entered the gravel beds in the colluvium which caused the pore pressure to increase sufficiently to render the sediment a viscous fluid. The Qu'Appelle Landslide is described in greater detail by Mollard (1957).

Bedrock Topography and Drift Thickness

With the exception of the eastern part of the area where the drift is sufficiently thin to expose the bedrock in valleys, little is known about the bedrock surface. The drift ranges in thickness from a thin veneer in the Rocanville area to about 700 feet near Fort Qu'Appelle. With the exception of bedrock valleys which are filled with drift, the present surface closely reflects the bedrock surface in the Rocanville-Welby-Esterhazy area. In general, the major topographic features (Moose Mountain Upland, Assiniboine River Plain, etc.) are controlled by the bedrock topography.

STRATIGRAPHY

Upper Cretaceous Series

The drift in the Qu'Appelle area is underlain by Marine Shales equivalent to the Bearpaw, Belly River, and older formations farther west

(Fraser *et al.*, 1935). The sediment is referred to as Marine Shales by Fraser *et al.* (1935) for the area west of the Second Meridian and as Riding Mountain Formation by Wickenden (1945) for the area east of this meridian. The sediment is exposed in the Qu'Appelle Valley and its tributaries east of Round Lake where the meltwaters have cut deeply into the bedrock. According to Wickenden (1945) the Riding Mountain Formation is at least 1100 feet thick, 300 to 400 feet of which is exposed in the Qu'Appelle Valley. The sediment is composed of dark grey, non-calcareous, soft, massive shale which in places is fossiliferous as can be seen in the road cut in the north bluff of the Qu'Appelle Valley north of Tantallon. In a well north of Tantallon and in the Qu'Appelle Valley (S. 18 and 19, T. 18, R. 1, W. 2) light grey, hard, non-calcareous, siliceous shales are exposed at elevations of 1850 and 1650 feet respectively. This hard, indurated shale is believed to belong to the Odanah Member of the Riding Mountain Formation.

Pleistocene Series

General Statement

Neither valleys occupied by underfit streams nor shallow road cuts afford good exposures. This is particularly true in the Qu'Appelle area where shallow road cuts along the valley bluff form the only exposures available for stratigraphic study. Because only the upper portion of the drift is exposed and subsurface data are lacking, the stratigraphic study is necessarily preliminary. The location and generalized lithology are shown in Figure 10 and a more detailed description of a few of the sections is given in the appendix. Measured exposures of the upper portion of the drift show two and possibly three tills separated by intertill sand, gravel, and boulder pavement. All of the exposed drift is calcareous and no marker beds have been observed.

Till Studies

Textural and plasticity studies were made on the tills of the Qu'-Appelle area. These studies were conducted in order to find some physical criterion by which the tills may be differentiated and correlated. It is assumed that the uppermost till is the same till throughout the area sampled. This seems to be a valid assumption because end moraines which marks the margin of till sheets, are not present in the area sampled.

The tills were analysed by the hydrometer method following the procedure described by Bouyoucos (1951). The sands were divided into five separates by sieving (Table 1). A typical cumulative curve from which the medium size and sorting coefficient were determined for each sample is shown in Figure 11. The texture of the tills is clay loam, sandy clay loam, and loam (Fig. 12). Atterberg limits of the tills in the Qu'Appelle area were determined (Table 1). These values were plotted on a plasticity chart (Fig. 13). Atterberg limits are the most suitable physical characteristic for the description of the gross aspect of till. The limits are

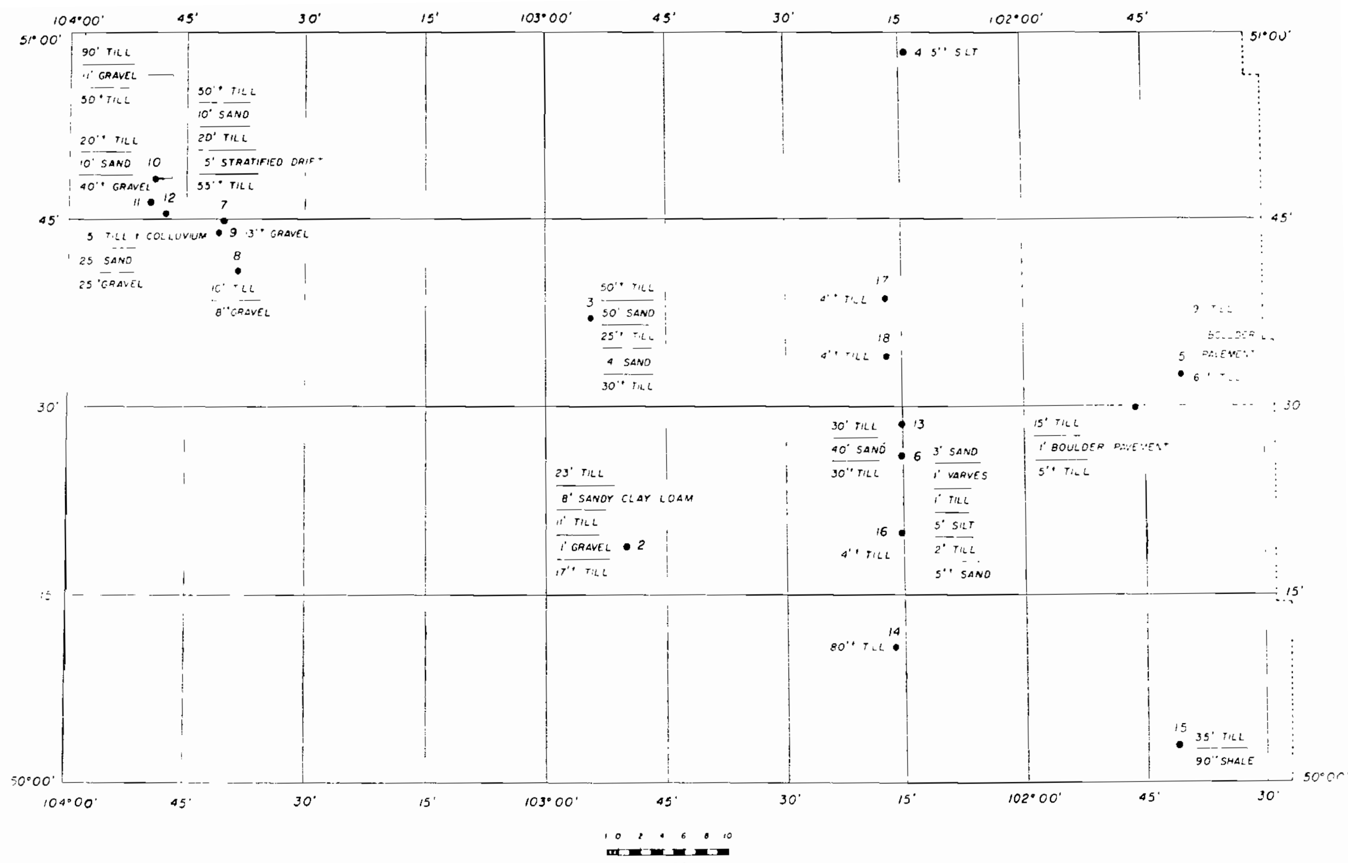


Figure 10.—Map showing location of sections and generalized lithology

Table 1.—Texture, median size, Atterberg limits, and sorting coefficients of tills in the Qu'Appelle area

Section No.**	Location	Till†	% clay <0.002 mm	% silt 0.05-0.002 mm	% sand Total sand 2.0-.05 mm	% sand 2.0-1.0 mm	1.0-0.5 mm	0.5-0.25 mm	0.25-0.1 mm	0.1-0.05 mm	cumulative curve data Md	So	Atterberg Limits Lw	Pw	Iw
1	S.1, T.18, R.32, W.1	1	27.5	30.7	41.8	2.7	4.6	8.1	13.0	13.4	0.030	11.1*	35.5	20.5	15.0
		2	25.2	27.0	47.8	3.4	5.4	10.0	15.8	13.2	0.035	9.7	25.0	14.2	10.8
2	S.1, T.16, R.7, W.2	1	25.0	33.2	41.7	2.4	5.0	8.0	12.8	13.6	0.032	7.9	32.7	17.5	15.2
		2	21.6	29.1	49.3	3.0	5.9	9.6	14.8	16.0	0.050	7.5	23.3	13.4	9.9
		3	32.5	35.5	32.0	2.0	3.8	6.6	10.1	9.5	0.014	11.4*	33.0	14.7	18.3
3	S.10+15, T.19, R.7, W.2	1	24.5	30.1	45.4	2.4	4.7	8.2	14.0	16.1	0.041	8.6	24.5	13.8	10.7
		2	26.8	30.1	43.1	3.1	4.9	7.6	12.4	14.9	0.058	11.0	25.0	14.6	10.4
		3	32.9	27.1	40.0	2.2	3.6	6.6	12.3	15.3	0.026	12.9*	33.8	15.0	18.8
		3	28.7	26.8	44.5	2.0	4.1	7.6	14.0	16.8	0.040	10.7*	29.0	15.2	13.8
7	S.1, T.21, R.13, W.2	1	26.3	21.9	51.8	2.6	4.2	8.0	16.4	20.6	0.052	10.0	24.2	12.6	11.6
		2	26.0	24.5	49.5	3.0	5.1	8.5	14.0	18.9	0.050	9.3	26.8	14.7	12.1
		3	28.1	26.1	45.8	2.6	5.5	9.7	14.4	13.6	0.043*	12.6*	25.8	13.1	12.7
13	South Bluff Qu'Appelle Valley along Highway 9	1	24.3	26.4	49.3	3.7	6.7	9.7	14.9	15.0	0.048	8.5	25.3	13.6	11.7
		1	24.6	23.8	51.6	3.3	5.5	9.3	15.4	18.1	0.054	8.0	27.0	15.2	11.8
		2	25.8	23.0	51.2	2.5	5.3	9.9	17.5	16.0	0.052	9.5	26.8	14.3	12.5
		2	24.5	28.5	47.0	2.3	5.5	9.0	15.0	15.2	0.043	8.1	25.5	14.4	11.1
14	S. Bluff Pipestone Cr. along old Highway 9	1	26.1	26.2	47.7	2.8	5.5	9.3	14.9	15.1	0.045	9.3	27.0	12.5	14.5
16	S.8, T.16, R.2, W.2	1	25.1	20.6	54.3	3.6	6.4	10.3	16.6	17.4	0.048	10.7	20.3	12.8	7.5

†No. 1 is the surficial till, Nos. 2 and 3 are successively older tills

*75% Quartile estimated

**Refer to Figure 10 for index of section numbers and to the Appendix for more complete description of some of the above sections influenced primarily by texture and mineralogy; consequently, any change in aspect of the tills would be shown by a corresponding change in the plastic limits. In the tills of the Qu'Appelle area the variation in the Atterberg limits is caused by the variation in texture and clay mineral content.

Montmorillonite is the commonest clay mineral of the till and Marine Shales, but minor amounts of illite and kaolinite also occur. The similarity of clay mineral content in the till and Marine Shales (Fig. 14) suggests that the shales are the major source of the clay minerals in the till.

If the assumption is valid that the same top till occurs over the entire area sampled, then it must be concluded that the variation in texture and plasticity is as great within till sheets as between till sheets. Although these studies can therefore not be used to differentiate till sheets, they can still serve to characterize the sediments.

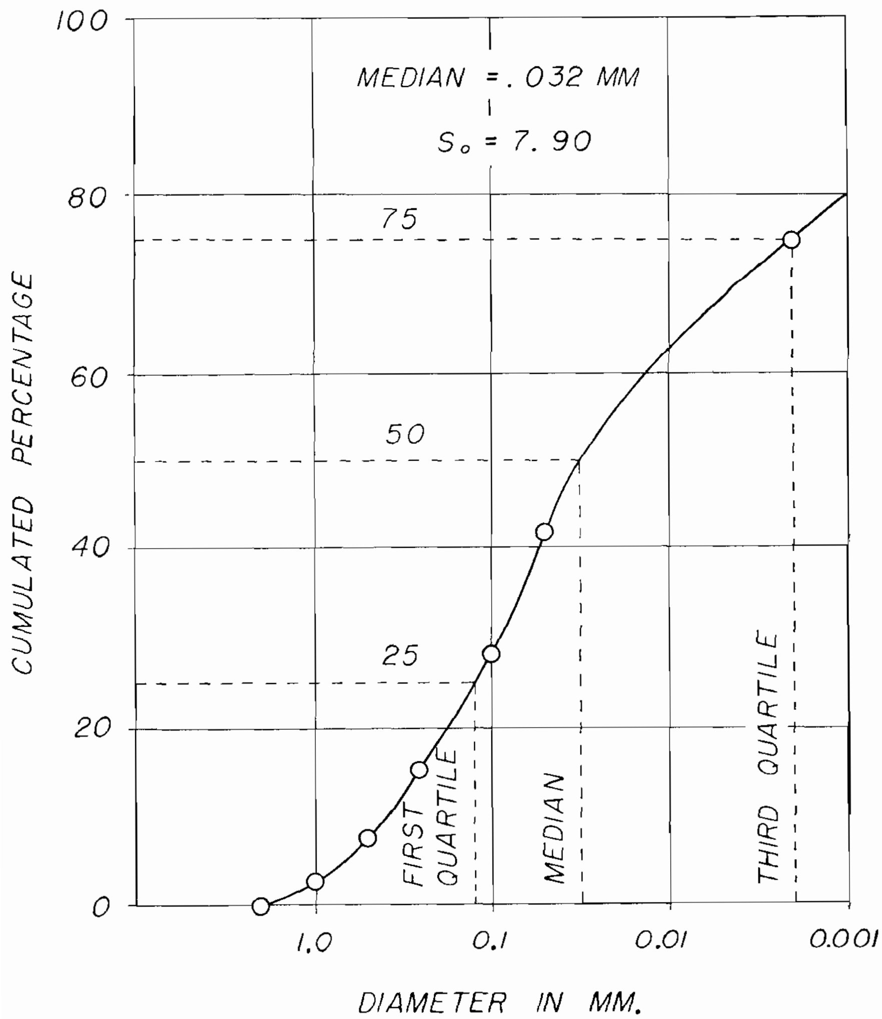


Figure 11.—Typical cumulative curve of till in the Qu'Appelle area

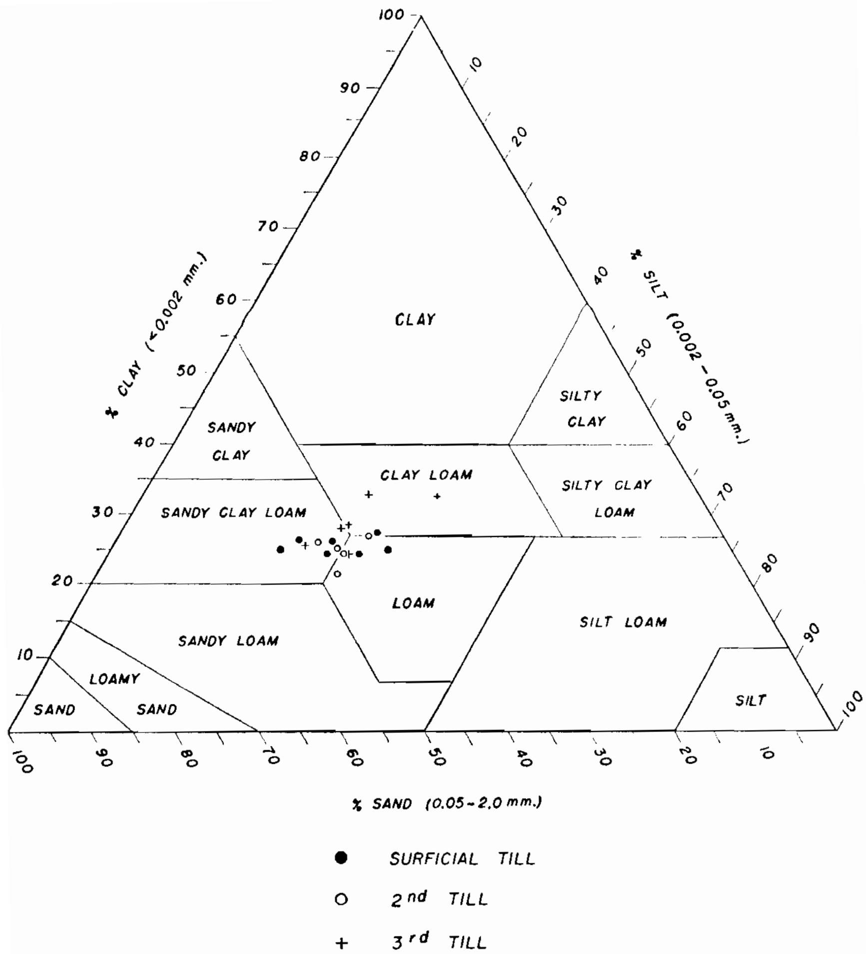


Figure 12.—Texture of tills in the Qu'Appelle area

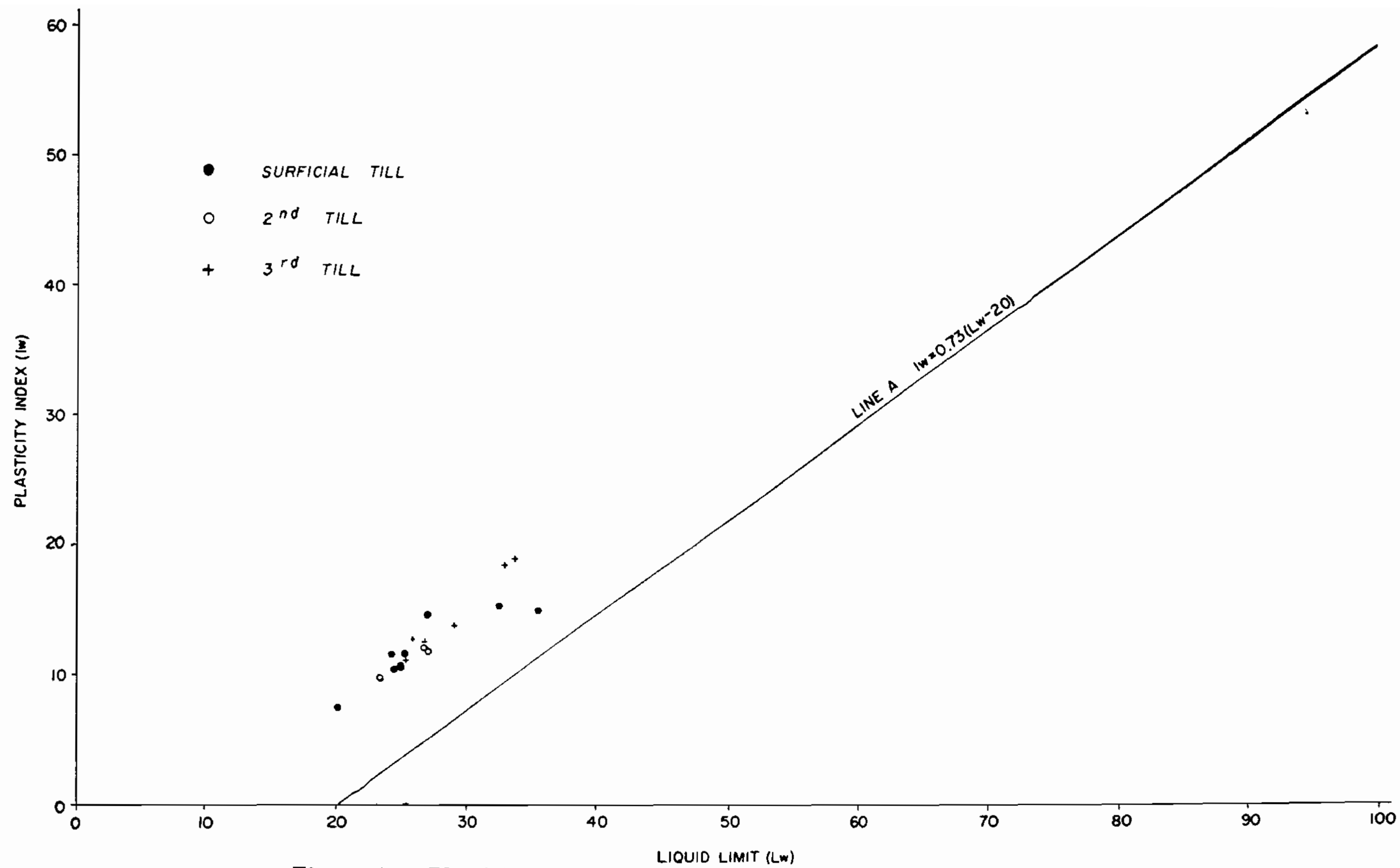


Figure 13.—Plasticity characteristics of tills in the Qu'Appelle area

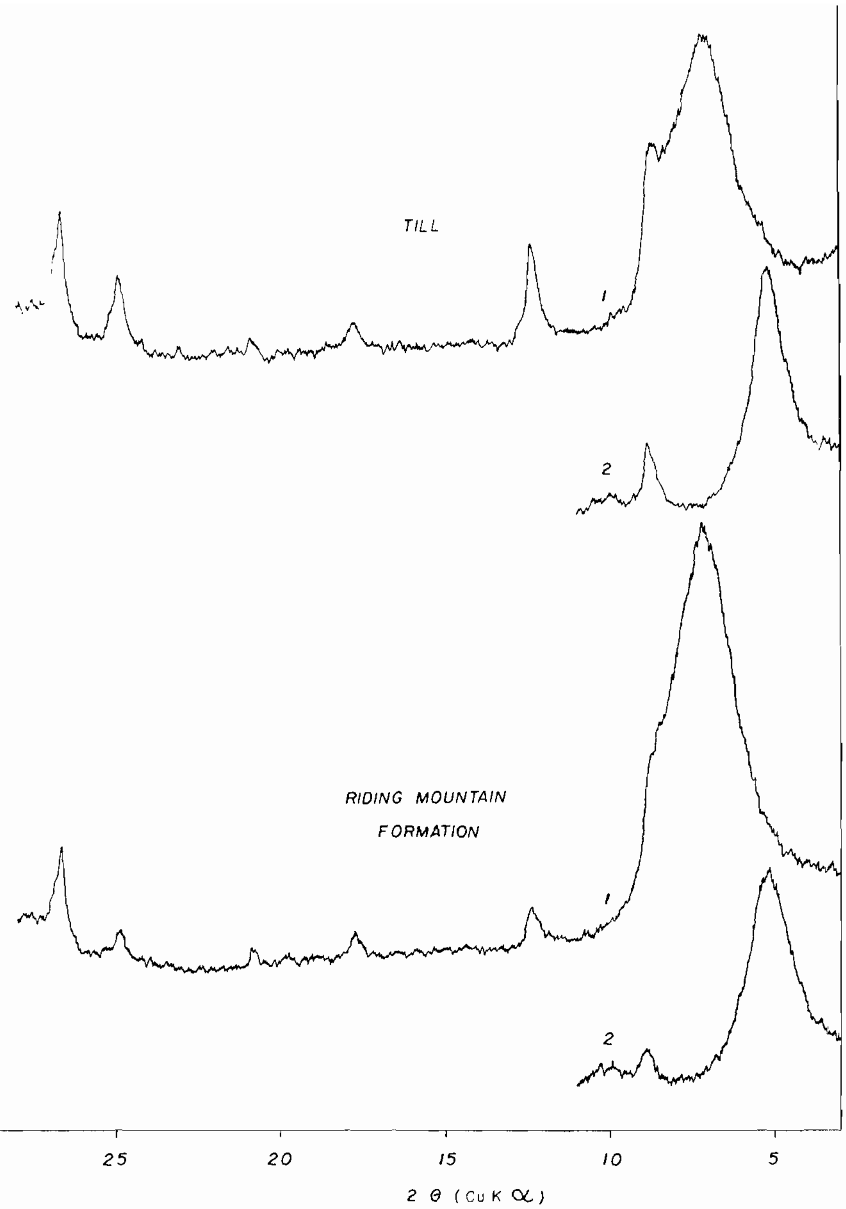


Figure 14.—X-ray diffraction patterns of clay fraction (< 0.002 mm.) of till and Riding Mountain Formation: (1) Sample treated with sodiumhexametaphosphate and (2) sample treated with sodiumhexametaphosphate and ethylene glycol

Gravel Studies

Gravels occur in a number of stratigraphic positions in and parallel to the Qu'Appelle Valley: intertill gravels at the foot of the south bluff of the valley above the south shore of Echo Lake; lenses of gravel in till sheets; gravel in an outwash plain south of Lebret; gravel partially filling the valley below Fort Qu'Appelle; and gravel in terraces. A more complete study of these gravels will appear at a later time.

Echo Lake Gravel.—The name Echo Lake Gravel is proposed for the unit which is exposed along the foot of the south bluff of the Qu'Appelle Valley between B-Say Tah and Fort Qu'Appelle and which lies presumably between two till sheets, the underlying one of which is not exposed. The name is taken from Echo Lake which occupies the Qu'Appelle Valley bottom below the gravel. The reference section is in an excavation at the foot of the Qu'Appelle Valley ¼ mile north and ¼ mile west of the southeast corner of Section 14, Township 21, Range 14, West of Second Meridian (Fig. 15, Appendix, Section 11). Since these sections may become covered, the area between B-Say Tah and Fort Qu'Appelle is proposed as a reference locality.

The Echo Lake Gravel comprises a basal gravel which ranges in thickness from 20 to 40 feet in measured sections and an overlying sand which ranges from 10 to 25 feet in thickness. The contact between these

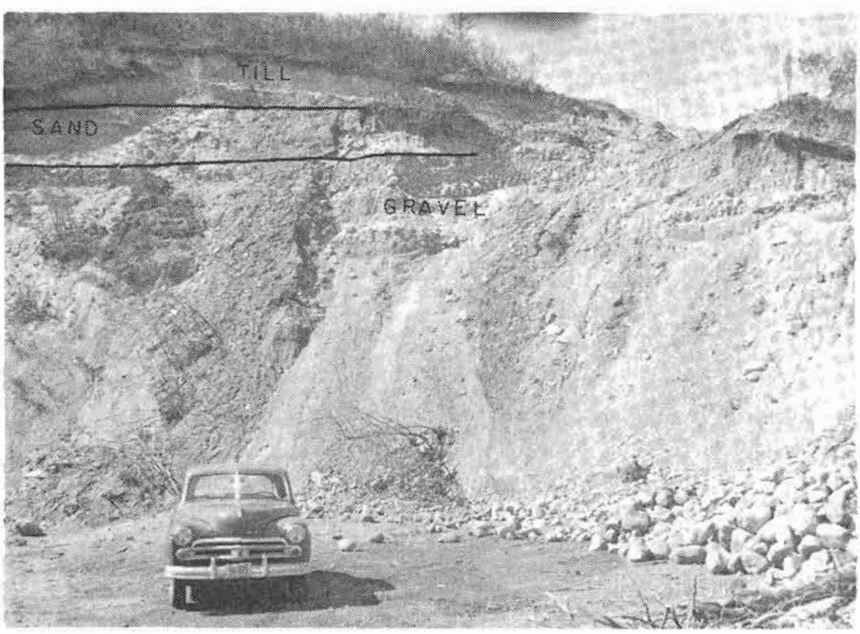


Figure 15.—Reference Section of Echo Lake Gravel

two units dips about 7 feet per mile downvalley. The cross beds also dip downvalley indicating that the current was in this direction.

A paleontological study of the vertebrate fauna in these gravels has been conducted by L. S. Russell who tentatively believes that the sediment is Sangamonian (Personal communication, 1959). If this age is correct, then the gravels must have been deposited during the retreat of the Illinoian glacier because the steep gradient of the sand-gravel contact and the coarse, well-sorted nature of the gravel strongly suggest that the ice was nearby when these sediments were deposited. Present gradients are not sufficiently large to transport such a coarse sediment.

Gravel Fill in Qu'Appelle Valley.—The Qu'Appelle Valley is partially filled with gravel below Fort Qu'Appelle where most of the gravel is present in terraces which are favorably located on the inside and down-valley side of meander bends. The location of these terraces is shown in Figure 6.

The gravel fills are composed of fine to coarse gravel, the texture of which is not related to its position in the valley. The sediment is at least 120 feet thick in the terrace near the east end of Round Lake in the south bluff of the valley (Fig. 7). The gravel fill can be traced from the Qu'Appelle Valley northward into the tributary north of Katepwa Beach (T. 20, R. 12, W. 2) indicating that the source lies in this direction. The top of the gravel fill is higher than the terraces. In the terrace above the point that extends southeast into Crooked Lake, the top of the fill is at about 1720 feet whereas the terrace surface is about 100 feet lower. If the base level of the stream that excavated the gravel fill was higher than the bottom of the valley on which the gravel was deposited, then one would expect to encounter gravel belonging to this fill in the valley bottom below the younger, finer sediments. A drilling program is being planned to test this hypothesis.

The fact that the gravel fill can be traced northward into tributaries and that the texture of the sediment does not change uniformly down-valley indicates that the source of the valley fill lies to the north and that the gravel was deposited in a pre-existing valley in the form of large fans. These fans were then truncated by subsequent meltwater to form terraces.

Age and Correlation

Based on a paleontological study of the vertebrate fauna in the Echo Lake Gravel, L. S. Russell (Personal communication, 1959) has tentatively assigned Sangamonian to these gravels. The calcareous, oxidized tills which overlie the Echo Lake Gravel are, therefore, Wisconsinan. If drift occurs beneath this gravel, and an E-log study indicates that it does, then this drift is pre-Sangamonian.

GLACIAL HISTORY

General Statement

Five significant phases dominate the glacial history of the Qu'Appelle area. Each of these phases is shown in a map (Figs. 16-20) in which the ice front at a particular time is drawn. The ice margins were reconstructed to explain the origin of the prominent glacial features. The stratigraphy, particularly in the Qu'Appelle Valley, together with morphological features such as meltwater channels and washboard moraines are the most important criteria for determining the glacial history. The glacial history is based in part upon evidence obtained in the Regina area (72 I) No attempt has been made to estimate the time occupied by these phases. The phases have not been named because it is considered premature to do so.

Phase No. 1

Phase No. 1 of the glacial history of the Qu'Appelle area is correlative with Phase No. 3 of the Moose Mountain glacial history as described by Christiansen (1956). During this phase the ice front stood at Marguerite Lake, at the Stoughton Moraine near Kendal, and at the moraine north of Montmartre (Fig. 16); thus it formed a major re-entrant into which large quantities of gravel were deposited. The progressive sorting of the sediment, which ranges from a coarse gravel immediately south of Marguerite Lake to a sand farther south, indicates that the source was to the north. The increase in number of kettles as Marguerite Lake is approached from the south attests to the close proximity of the ice at this time. This re-entrant is comparable to the one that existed in the Lost Horse Hills during Phase No. 2 of the glacial history of the Moose Mountain area. The meltwater drained southward from the re-entrant area by way of Moose Mountain Creek.

Phase No. 2

Phase No. 2 of the glacial history in the Qu'Appelle area is correlative with the Weyburn Lobe in Phase No. 4 and the Moose Mountain Lobe in Phase No. 5 of the glacial history of the Moose Mountain area as described by Christiansen (1956). During this phase the Weyburn Lobe stood at the Stoughton and Qu'Appelle Moraines whereas the Moose Mountain Lobe stood immediately northeast of the Pipestone Spillway (Fig. 17). The Weyburn and Moose Mountain Lobes formed the closure for Lake Indian Head which drained through the Pipestone Spillway. During the interval between Phases No. 1 and No. 2 the Weyburn and Moose Mountain Lobes competed for space in the Lake Marguerite area. The valley containing Deep Lake and the valley in Township 17, Range 12 were plugged off at both ends during this time.

Phase No. 3

Phase No. 3 of the glacial history is correlative with the Weyburn Lobe in Phase No. 5 of the glacial history of the Moose Mountain area as described by Christiansen (1956). The Weyburn Lobe stood immediately southwest and parallel to Manybone Creek (Fig. 18) and thus accounts for the side hill position of that stream. The re-entrant between the two lobes had now become located beyond the northern boundary of the area. The Moose Mountain Lobe blocked off the Qu'Appelle Valley and thus compelled Lake Indian Head to drain through the Pipestone Spillway. At this time the spillway was occupied by a graded stream. The elevation

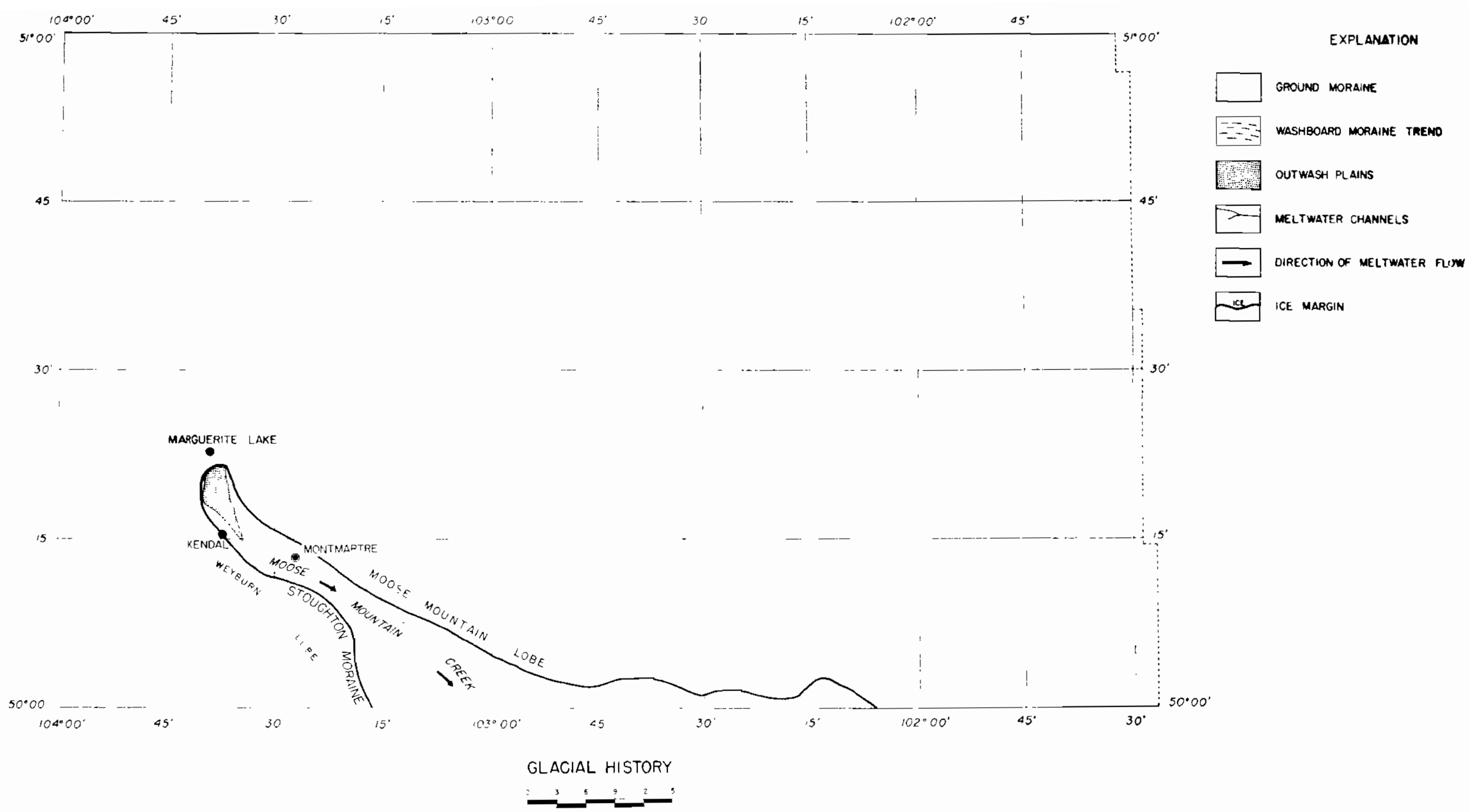


Figure 16.—Phase No. 1 of Glacial History

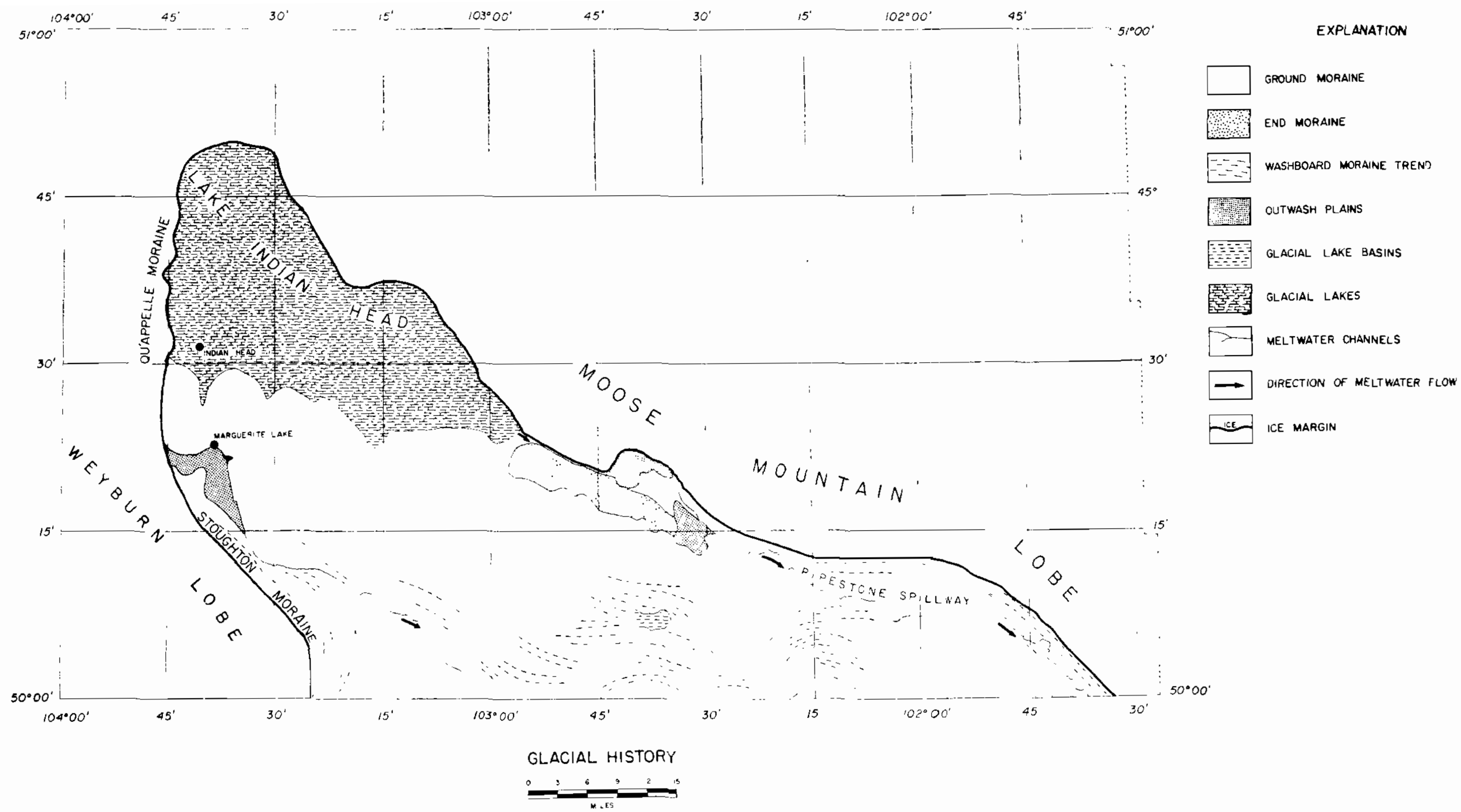


Figure 17.—Phase No. 2 of Glacial History

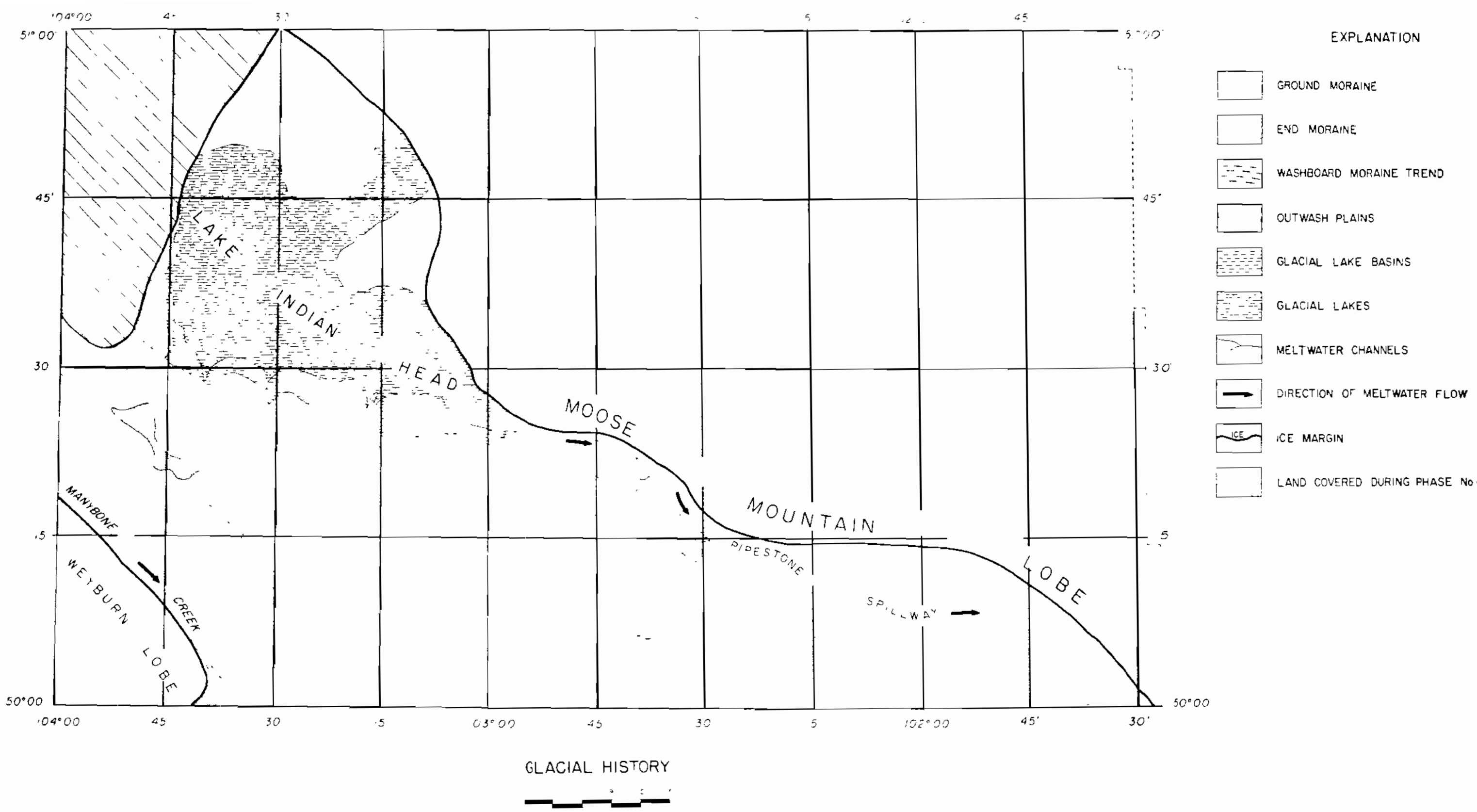


Figure 18.—Phase No. 3 of Glacial History

of the Pipestone Spillway was lowered from about 2000 feet in the previous phase to 1950 feet in Phase No. 3, and consequently, during the second phase of Lake Indian Head the shoreline was at 1950 feet.

Phase No. 4

During the interval between Phases No. 3 and No. 4 the ice retreated to a position north of the Qu'Appelle Valley. Although the exact position of retreat is not known, it is believed to have been north of the present map area. During this interval Lake Indian Head drained through the Summerberry Spillway and finally through the Qu'Appelle Spillway north of Grenfell. This portion of the Qu'Appelle Valley was occupied by dead ice while the Summerberry Spillway was being used. The dead ice moraine in this portion of the valley is the basis for this hypothesis. During Phase No. 4 the ice front stood north of the Qu'Appelle Valley and at the Qu'Appelle Moraine (Fig. 19). The meltwater from the ice front to the north of the valley deposited sand and gravel in the Qu'Appelle Valley in the form of alluvial fans, accounting for the variability in texture of the valley fill. The Welby Sand Plain was formed at this time. The meltwaters which flowed down the valley redistributed the sand and gravel to some degree. These deposits were able to accumulate in the Qu'Appelle Valley because most of the meltwater was diverted through the Souris Spillway by the ice dam west of Fort Qu'Appelle. During the retreat of the ice front from the Qu'Appelle Moraine Lake Muscow was formed. This lake drained over dead ice in the Qu'Appelle Moraine near Fort Qu'Appelle. The presence of dead ice features in this area is the basis for this hypothesis. The Lebret Lake Landslide is believed to have formed at this time.

Phase No. 5

During the interval between Phases No. 4 and No. 5 the ice retreated north of the Qu'Appelle Valley west of Fort Qu'Appelle. This permitted vast quantities of water from Lake Regina and the proglacial areas to drain through the Qu'Appelle Valley. It was at this time that the terraces were formed in the Qu'Appelle Valley. During Phase No. 5 the ice front stood immediately north of the Qu'Appelle area. Glacial Lake Saltcoats was formed at this time in front of the retreating glacier (Fig. 20). The lake drained by way of the Cutarm Spillway into the Qu'Appelle Valley.

ECONOMIC GEOLOGY

Ground Water

General Statement

The large areal extent of the surficial sedimentary units and the scantiness of subsurface data necessitate that the geological investigation be preliminary. The paucity of hydrological data further necessitates that the ground-water study be concerned primarily with the occurrence of permeable zones within the drift and bedrock. Because the bedrock is

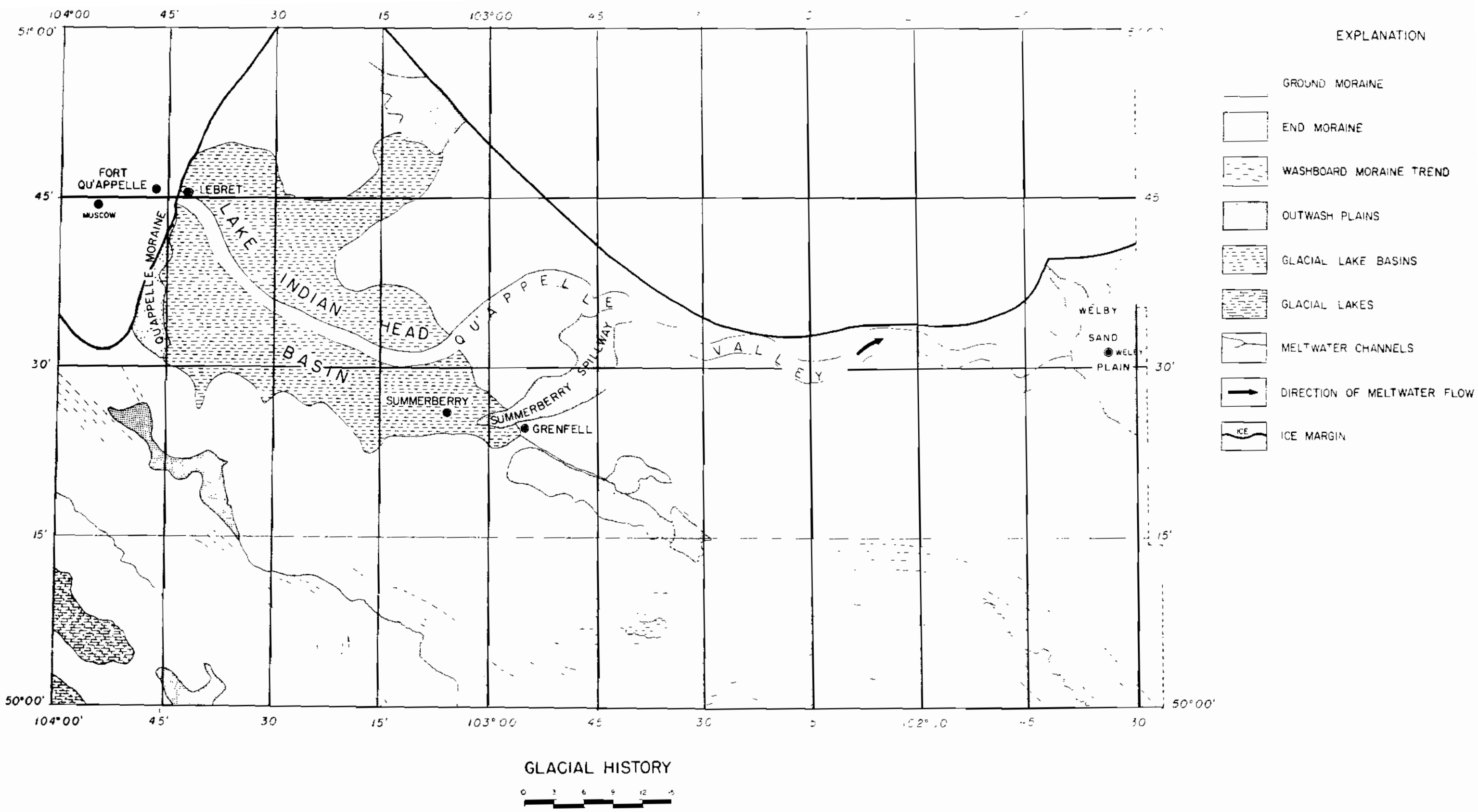


Figure 19.—Phase No. 4 of Glacial History

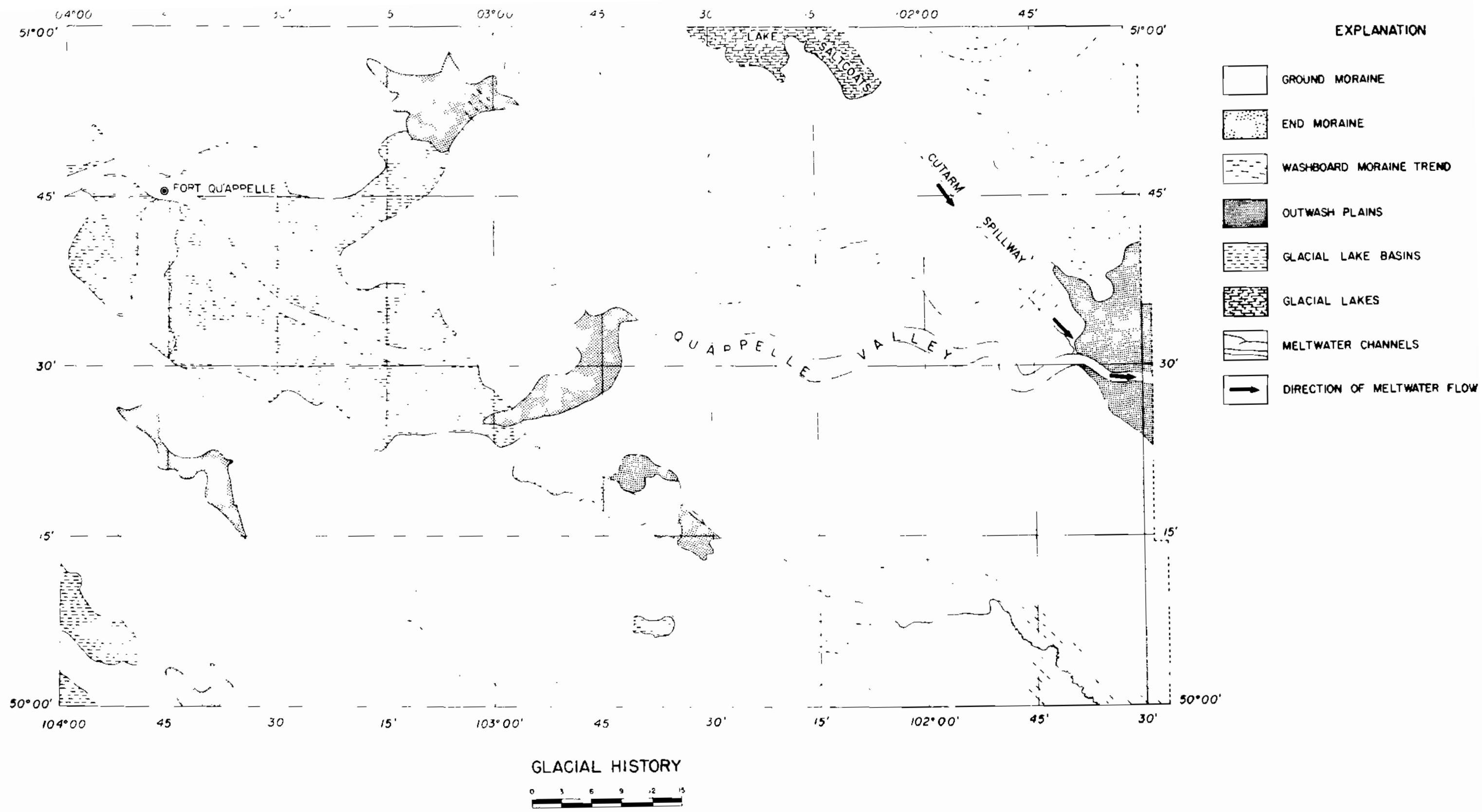


Figure 20.—Phase No. 5 of Glacial History

impermeable for the most part, the younger, Pleistocene sediments are emphasized. The surface data were obtained from geological field work and from Soil Report No. 12 (Mitchell *et al.*, 1947). The subsurface data were obtained from exposures along streams, Geological Survey of Canada Water Supply Papers (Table 2), and seismic shot-hole and structural test-hole data. The ground-water probability map has been compiled from these sources of information (Plate 2).

Table 2.– Water Supply Papers of the Qu'Appelle Area

Rural Municipality	Name	Water Supply Paper
91	Maryfield	18
92	Walpole	23
93	Wawken	36
94	Hazelwood	46
95	Golden West	64
96	Fillmore	51
97	Wellington	40
121	Moosomin	80
122	Martin	78
123	Silverwood	66
124	Kingsley	58
125	Chester	71
126	Montmartre	76
127	Francis	83
181	Langenburg	107
183	Fertile Belt	149
184	Grayson	150
185	McLeod	151
186	Abernethy	152
187	North Qu'Appelle	153
211	Churchbridge	157
213	Saltcoats	158
214	Cana	159
215	Stanley	160
216	Tullymet	161
217	Lipton	162

Occurrence

Qu'Appelle Valley Fill.— Preliminary studies show that the Qu'Appelle Valley was partially filled with sand and gravel which were partially or wholly removed during the second phase of valley development. The flowing artesian well in the center of the Qu'Appelle Valley north of Whitewood (Fig. 21), which is 60 feet deep, supports the view that these sands and gravels were not entirely removed during the second phase of down-cutting. If, on the other hand, the second phase of down-cutting exceeded the first, then remnants of this fill, which take the form of terraces, must be relied upon as the only source of saturated sand and gravel fill. If these sands and gravels occur at the base of the valley, then they will be saturated by recharge from lakes and the Qu'Appelle River which occupy the present surface of the valley. A drilling and pump testing program is being planned to test this area.

Meltwater Channels.—Sand and gravel is associated with meltwater channels in: alluvial fans; slip-off slopes on meander bends; high-level terraces; channel bottoms under recent alluvium; and ice-contact deposits in trenches on the till surface (Deerhorn Creek).

The most important occurrence of water in sand and gravel of the above deposits is in alluvial fans along the deeper meltwater and spillway trenches where sand and gravel is intercalated with silt and clay. This

Figure 21.—Flowing artesian well near bridge where Highway 9 crosses Qu'Appelle River north of Whitewood. It is believed that the water is discharging from the sand and gravel fill. The rate of flow is estimated at 200 g.p.m

occurrence of sand and gravel is described under the land form Qu'Appelle Valley bottom. Water, commonly artesian (Fig. 22), occurs at depths of 5 to 50 feet and is slightly to highly mineralized*.

Sands and gravels occur in slip-off slopes on meander bends and in high-level terraces along meltwater channels. These sediments are commonly less than 10 feet thick. Where the sediments are saturated they may produce small to large supplies of slightly mineralized water. The amount of water that can be produced from these sediments depends upon the thickness of the deposit, the amount of closure on the underlying till surface, and the size of the catchment area. In most cases, however, these sediments are drained by contact springs and, consequently, are of little value for ground water.

Sands and gravels also occur under postglacial alluvium in the floor of meltwater channels. In most places, however, these sediments are less than 5 feet thick and are of interest to only small water users.

* <500 p.p.m. hardness =slightly mineralized
500-1000 p.p.m. hardness =mineralized
>1000 p.p.m. hardness =highly mineralized

Sand and gravel in the form of proglacial and ice-contact deposits occur in the Deerhorn and associated channels. This occurrence is particularly significant because the stratified sediments lie in a trench on the till surface; as a consequence, there is closure in three directions. In deposits such as these, it may be economical to place an impermeable dike across the channel to prevent ground-water discharge downstream. Preliminary studies indicate that the portion of the Deerhorn Channel

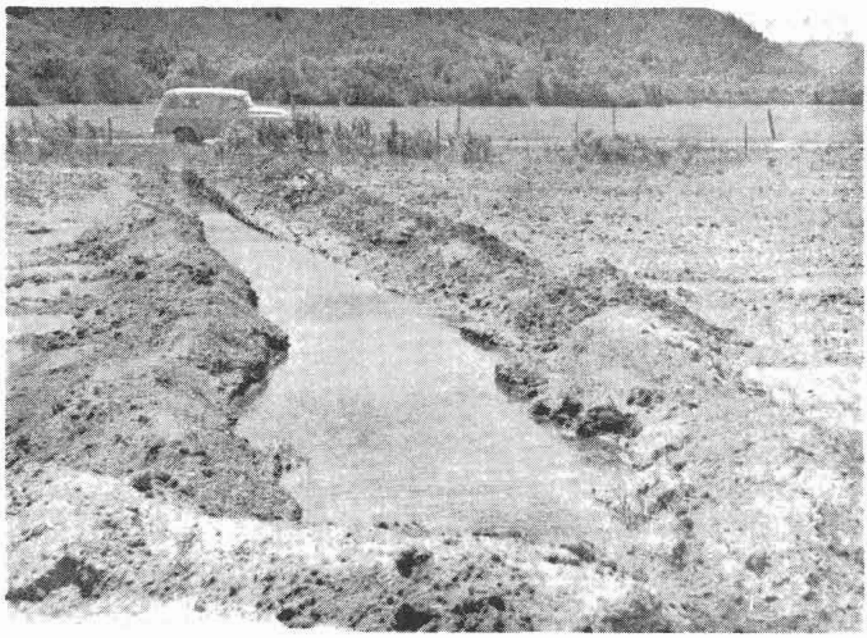


Figure 22.—Flowing artesian well in an alluvial fan in the Qu'Appelle Valley near Ellisboro. Water is discharging at a rate of about 200 g.p.m. Note apex of fan in upper right corner

near Spy Hill (T. 19, R. 31, W. 1) would be an excellent source of water for large towns and probably small industry. The stratified sediment ranges from a few feet to 60 feet thick. The thickness of the zone of saturation, however, is not known.

Surficial Sand and Gravel.—Sand and gravel also occur outside of channel boundaries in fans at the mouths of meltwater channels, in outwash plains, and in re-entrant areas. The sediment ranges in thickness from a few feet to 50 feet in the Welby Sand Plain. The following factors are important in evaluating this deposit for a ground-water supply: (1) texture and sorting of sediment; (2) thickness of sediment; (3) amount of closure upon underlying till surface; and (4) size of recharge area. The coarser the texture, the better the sorting, the thicker the sediment, the greater the closure upon the underlying till surface beneath the sand and gravel, the larger the supply of water that will be available.

Water commonly occurs at depths of 5 to 30 feet and is slightly mineralized. Although, in places, these sediments may not contain water, they serve to recharge the underlying sediment because of their reduced evaporation rate. During wet years surficial sands and gravels are excellent sources of ground water; in dry years, however, only the thicker ones contain a zone of saturation.

Odanah Member of the Riding Mountain Formation.—Where the siliceous Odanah Shale has a cover of less than 50 feet of drift slightly mineralized to mineralized water is obtained from fractures in the shale. The remainder of the Riding Mountain Formation is not suitable for ground water because of its low permeability and poor quality water.

Intertill Sand and Gravel.—Sand and gravel occur between till sheets as channel fills and buried outwash deposits. If the present surface were covered by a till sheet, then the buried surficial sands and gravels would constitute intertill deposits. The paucity of subsurface information has made it difficult to detect this occurrence of sand and gravel. In the south bank of the Qu'Appelle Valley along Highway 9 (Fig. 23), however, an intertill sand is discharging water at a rate of about 300 g.p.m. Where these sediments have limited areal extent, they will be interpreted as lenses from subsurface data.

Sand and Gravel Lenses in Till.—Water occurs in sand and gravel lenses throughout the till (Fig. 24). These lenses range in shape from shoestrings to blankets both of which range in thickness from 5 to about 40 feet. It is not possible to predict the location of subsurface lenses from

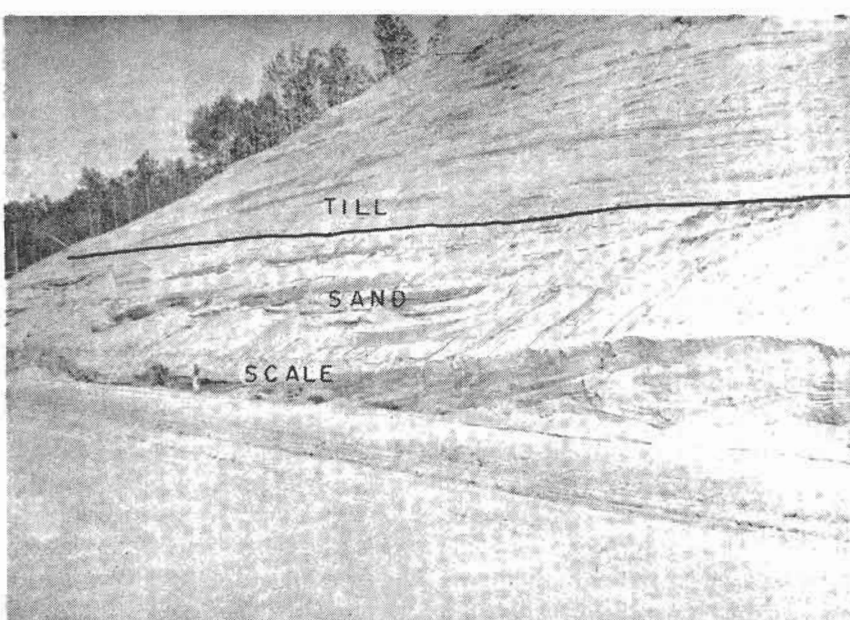


Figure 23.—Intertill sand. Sand unit between two till sheets where Highway 9 crosses south bluff of Qu'Appelle Valley. Water is being discharged from this unit at a rate of about 300 g.p.m.

studies of surficial sediments. Their position can be determined only by subsurface methods such as drilling. The water is commonly mineralized and becomes more so with depth.

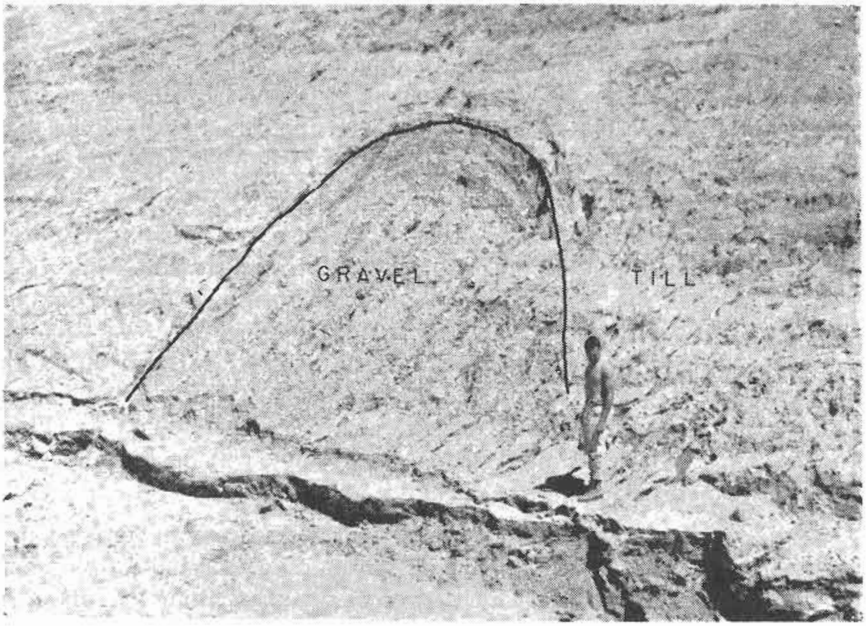


Figure 24.—Gravel lens in till, south bluff Qu'Appelle Valley along Highway 9 north of Whitewood

Buried Valleys.—Sand and gravel probably occur at the base of buried valleys in the east-central portion of the Qu'Appelle area; however, little is known about them. Many ancient valleys undoubtedly occur in the Qu'Appelle area, but the thick drift sections and the paucity of subsurface data make it impossible to map them at this time.

Quality

The hardness, iron, pH, and chloride content were determined on water from 99 wells in the Qu'Appelle area (Table 3) with the aid of a Hach Water Test Kit. The results represent a general preliminary inventory of ground-water quality in the area. The median hardness is about 1000 p.p.m., and the total range of hardness is from about 200 p.p.m. to 4000 p.p.m. In general, the ground water becomes harder as the depths of wells increase. The content of iron ranges from 0 to more than 10 p.p.m., the median of which is about 1.0 p.p.m. The amount of iron in ground water increases with depth. The pH of the ground water ranges from 6.5 to 8.5 around a median of 7.0. Chlorides range from 0 to 350 p.p.m., the median of which is about 60 p.p.m. There does not appear to be a correlation between chloride content and depth to water.

Table 3.—Quality of Ground Water in the Qu'Appelle area

Location S-T-R-M-	Iron in ppm	pH	Hard-ness in ppm	Chlor-ides in ppm	Depth in Feet	Source
SE ¼ 13-18-30-1	0.0	7.2	290	37	—	Gl. Outwash
SW ¼ 21-18-32-1	0.5	7.1	872	87	14	Marine Shales
SE ¼ 28-15-9-2	0.4	7.2	393	37	0	Spring
NW ¼ 31-16-4-2	0.1	7.2	427	62	12	Surficial Sand
NE ¼ 1-16-5-2	0.1	7.0	1863	137	40	Till*
NW ¼ 2-16-5-2	2.0	7.2	598	50	34	Till
NW ¼ 3-16-5-2	2.0	7.0	837	100	40	Till
SW ¼ 4-16-5-2	0.2	7.2	1214	100	26	Till
NE ¼ 7-16-5-2	0.1	7.0	427	37	30	Surficial Sand
SE ¼ 10-16-5-2	1.0	7.0	769	37	30	Till
SE ¼ 10-16-5-2	0.4	7.0	1949	175	60	Till
SE ¼ 12-16-5-2	2.0	7.0	1026	37	34	Till
NW ¼ 13-16-5-2	2.0	7.1	820	37	40	Till
SW ¼ 15-16-5-2	0.5	7.0	1470	100	28	Till
NW ¼ 15-16-5-2	3.0	7.2	427	37	35	Till
SE ¼ 16-16-5-2	dry				40	Till
NE ¼ 16-16-5-2	0.1	7.0	649	75	35	Till
SW ¼ 18-16-5-2	1.0	7.5	684	125	17	Till
SE ¼ 20-16-5-2	0.4	7.0	1162	62	—	Till
NW ¼ 21-16-5-2	2.0	7.0	1060	37	-	Till
SE ¼ 24-16-5-2	0.1	7.5	1692	425	60	Till
SE ¼ 24-16-5-2	0.1	7.2	769	150	15	Till
NE ¼ 24-16-5-2	5.0	7.0	1265	37	60	Till
NE ¼ 25-16-5-2	0.4	7.0	581	75	30	Till
NE ¼ 25-16-5-2	0.1	7.2	649	37	26	Till
NE ¼ 26-16-5-2	0.1	7.7	1537	325	135	Till
SE ¼ 27-16-5-2	3.0	7.0	632	50	30	Till
SW ¼ 28-16-5-2	2.0	7.0	1504	200	60	Till
SW ¼ 31-16-5-2	7.5	7.0	649	362	53	Till
SE ¼ 32-16-5-2	1.0	7.0	769	87	28	Till
SW ¼ 32-16-5-2	2.0	7.0	1026	212	18	Till
SE ¼ 34-16-5-2	1.0	7.2	769	87		Till
SE ¼ 1-16-6-2	3.0	7.0	957	37	-	Till
S ½ 31-17-7-2	0.5	7.5	393	50	0	Dam
S ½ 31-16-7-2	0.0	7.9	675	50	0	Dam
SE ¼ 1-16-8-2	1.0	6.9	1172	50	0	Spring
SE ¼ 1-16-8-2	0.4	7.1	1343	62	40	Till
SE ¼ 19-16-9-2	5.0	7.2	376	25	—	Till
SW ¼ 29-16-17-2	0.1	8.0	188	37	- -	Till
SW ¼ 20-17-13-2	2.0	7.2	317	37	0	Spring
NW ¼ 32-17-14-2	0.5	7.2	598	62	30	Till
SE ¼ 17-17-14-2	10.0	7.7	2137	37	314	Till
NW ¼ 34-17-14-2	7.5	7.1	1795	62	297	Till
SW ¼ 17-18-2-2	3.0	7.0	752	50	60	Gravel
SW ¼ 17-18-2-2	0.0	7.1	564	25	0	Till
SW ¼ 17-18-2-2	0.0	7.2	684	25	0	Till
SW ¼ 17-18-2-2	0.0	7.2	632	37	0	Till
SW ¼ 23-18-10-2	3.0	7.2	632	137	0	Spring
SW ¼ 23-18-10-2	3.0	7.2	615	125	0	Spring
SW ¼ 2-18-14-2	2.0	7.3	359	37	14	Till
NW ¼ 2-18-14-2	0.5	7.2	1402	150	30	Till
NW ¼ 2-18-14-2	2.0	7.2	444	37	28	Till
SE ¼ 5-18-14-2	3.0	7.2	513	37	30	Till
SE ¼ 6-18-14-2	0.5	7.0	1744	75	84	Till
SW ¼ 9-18-14-2	0.3	7.0	547	62	22	Till
NE ¼ 9-18-14-2	0.0	7.2	666	37	15	Till
NE ¼ 12-18-14-2	5.0	6.8	1881	87	85	Till
SE ¼ 14-18-14-2	5.0	7.1	461	25	16	Till
SW ¼ 15-18-14-2	2.0	7.2	324	37	—	Till
SW ¼ 16-18-14-2	0.4	7.2	222	25	9	Surficial Sand
SE ¼ 16-18-14-2	10.0	7.2	427	25	14	Till
NE ¼ 16-18-14-2	0.5	7.0	1026	37	16	Till
NE ¼ 16-18-14-2	7.5	7.1	1402	50	408	Till

*Water derived from sand and gravel in till

Table 3—*Continued*

Location S-T-R-M-	Iron in ppm	pH	Hard-ness in ppm	Chlor-ides in ppm	Depth in Feet	Source
NW ¼ 17-18-14-2	7.5	7.2	1470	50	360	Till
NE ¼ 19-18-14-2	5.0	7.1	1419	50	197	Till
SE ¼ 20-18-14-2	0.4	7.0	2086	112	25	Till
NW ¼ 21-18-14-2	0.0	7.0	564	50	—	Till
NW ¼ 21-18-14-2	0.5	7.2	906	125	14	Till
NW ¼ 21-18-14-2	2.0	7.0	238	37	—	Till
NW ¼ 21-18-14-2	3.0	7.0	1077	37	333	Till
NE ¼ 22-18-14-2	0.3	7.1	767	125	22	Till
NW ¼ 24-18-14-2	8.5	7.1	1231	37	230	Till
NW ¼ 25-18-14-2	3.0	7.0	1162	37	250	Till
SW ¼ 28-18-14-2	0.1	7.0	1111	100	22	Till
SW ¼ 28-18-14-2	0.2	7.2	1128	150	16	Till
SE ¼ 29-18-14-2	0.0	6.8	2770	112	405	Till
SE ¼ 30-18-14-2	3.0	7.0	1692	62	168	Till
SE ¼ 31-18-14-2	10.0	7.2	1851	37	210	Till
SW ¼ 35-18-14-2	0.5	7.0	1111	37	12	Surficial Sand
SW ¼ 1-19-1-2	0.2	6.5	889	50	15	Marine Shales
NW ¼ 21-20-11-2	2.0	7.0	940	112	30	Till
NW ¼ 22-20-11-2	0.3	7.0	478	50	22	Dam Seepage
NE ¼ 28-20-11-2	1.0	7.0	1231	62	42	Till
NE ¼ 28-20-11-2	0.5	7.0	1710	125	42	Till
NW ¼ 33-20-11-2	2.0	7.0	513	37	20	Till
NE ¼ 3-20-12-2	10.0	7.5	4155	150	36	Till
NE ¼ 23-20-12-2	10.0	7.2	940	75	280	Till
NE ¼ 25-20-12-2	1.0	7.5	427	62	13	Till
SW ¼ 27-20-12-2	2.0	7.0	1077	87	315	Till
SW ¼ 33-20-12-2	not used				250	Till
NE ¼ 35-20-12-2	1.0	7.0	1162	62	14	Till
SW ¼ 8-21-11-2	5.0	7.2	1060	50	130	Till
NW ¼ 1-21-12-2	2.0	7.0	410	87	12	Till
SE ¼ 5-21-12-2	0.4	7.7	1094	62	0	Spring
SE ¼ 12-21-12-2	0.5	6.8	95	50	12	Till
SE ¼ 13-21-12-2	1.0	7.2	342	37	15	Dam Seepage
SW ¼ 14-21-12-2	10.0	8.5	290	87	260	Till
NW ¼ 14-21-14-2	0.1	7.5	701	450	0	Spring
SE ¼ 29-22-6-2	2.0	6.8	1370	50	100	Till

GRAVEL

General Statement

Since the Department of Highways is conducting extensive studies on the location, quantity, and quality of gravel, it will suffice here to classify the gravel deposits and to give a few prospecting controls. In general the deposition of gravel requires high velocity streams. Since the area is relatively flat, the gradient necessary for the transportation of these deposits must have been supplied by the glacier. The fact that there is a good correlation between the degree of angularity and the percentage of carbonate pebbles suggests that the variation in lithology is related to distance of transport. Where the carbonate pebbles are extremely angular, the percentage of carbonate pebbles is high and the gravels commonly contain schist pebbles, all of which attest to their immaturity and short distance of transport. A more complete investigation of these gravels will appear at a later date.

Occurrence

Preliminary studies indicate that extensive deposits of gravel are restricted to the following occurrences: interlobate areas; low-level terraces; outwash plains; high-level terraces; and eskers.

Interlobate areas.—Gravel occurs almost without exception in interlobate areas where accumulated meltwaters left the glacier. These areas range in size from major re-entrants (Marguerite Lake area and Spy Hill area) to small areas indicated only by a v-shaped re-entrant in the washboard moraines which points in the direction from which the ice came. The sediments range from ice-contact sand and gravel in the upstream portion to proglacial sand and gravel in the downstream portion. In general, interlobate or re-entrant areas are apparent in air photographs but more apparent in mosaics. The areas are defined by the v-shaped pattern formed by the washboard moraine.

Low-level Terraces.—Gravel occurs on low-level terraces which were cut in gravel (Fig. 7), till, and bedrock within the Qu'Appelle Valley (Fig. 6). Where the terraces are cut in till and bedrock, the gravel, which caps them, is less than 20 feet thick. Where the terraces are cut in the valley fill, however, the gravel is up to at least 120 feet thick (east end of Round Lake in the south bluff of the Qu'Appelle Valley).

Outwash Plains.—Gravel occurs in large quantities in alluvial fans at the mouth of side-hill channels (Hillesden, Manybone, and Grenfell Channels) and in outwash sediments which were deposited in front of the ice (T. 20, R. 13, W. 2; T. 22, R. 9, W. 2; T. 17, R. 14, W. 2). The sediment becomes coarser and thicker as the apex of the fan and the moraine are approached from the downstream portion of the deposit. The sediment is commonly less than 15 feet thick, well sorted, and cross-bedded, the foresets of which dip downstream.

High-level Terraces.—Gravel occurs in high-level terraces along meltwater channels and spillways, the areal extent and thickness of which depend on the size of the channel and the proximity of the ice when the sediment was deposited. Spillways, which were cut entirely by meltwater from glacial lakes, contain only a few feet of lag concentrate which was left behind when the finer sediments were removed from the till (Summerberry Spillway). Meltwater channels formed in close proximity to the ice, however, commonly contain deposits of gravel up to 15 feet thick. These high-level gravels were deposited prior to the main valley development.

Eskers.—Between Dubuc (T. 20, R. 4, W. 2) and Pearl Creek (T. 20, R. 7, W. 2) short, discontinuous ridges of sand and gravel 30 to 40 feet high trend about normal to the washboard moraine. These features are readily recognized in air photographs by their trend. These deposits are for the most part small and contain a great deal of sand and clay. They are of interest to small users.

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APPENDIX

*Pleistocene Sections**

Section 3.—Road cut in upper portion of south bluff of Qu'Appelle Valley along Highway 47 in N.W. ¼ S. 10, and S.W. ¼ S. 15, T. 19, R. 7, W. 2

Deposit	Thickness (feet)
Till, calcareous, clay loam, upper part of unit is dark-greyish brown, (2.5 Y 4/2** wet) to light grey (2.5 Y 7/2 dry), oxidized; the lower part of unit is calcareous, very dark-greyish brown (2.5 Y 3/2 wet) to light-greyish brown (2.5 Y 6/2 dry). Contact with underlying unit is sharp.	50+
Sand, very calcareous, fine grained, locally medium to coarse grained, pale brown to olive yellow, oxidized, cross-bedded. Unit contains ¼ to 1 inch grey clay partings; this unit is interpreted as an intertill deposit.	50+
Till, calcareous, loam, light-olive brown (2.5 Y 3/4 dry), oxidized and massive. Cover interval between this unit and overlying sand.	25+
Sand, calcareous, silty, light olive brown (2.5 Y 5/4 wet) to light-brownish grey (2.5 Y 6/2 wet), oxidized, lensy, containing boulders and pebbles. Upper 1-1½ feet contains brown, well stratified, calcareous, lensy gravel.	4
Till, calcareous, loam, light-brownish grey (2.5 Y 6/2 wet) to light grey (2.5 Y 7/2 dry), unoxidized, well jointed, manganese staining common.	30+

Section 7.—Road cut near center of S. 1, T. 21, R. 13, W. 2 along east side of Highway 10 at mouth of tributary of Qu'Appelle Valley

Deposit	Thickness (feet)
Till, calcareous, sandy clay loam, pale yellow (2.5 Y 7/4 dry), oxidized.	50+
Sand, medium to coarse grained, gravelly.	10
Till, calcareous, sandy clay loam, pale yellow (2.5 Y 8/4 dry), oxidized, locally unoxidized, contains shale pebbles.	20

*The location and general description of sections is shown in Figure 10
**From Munsell soil color chart

Stratified drift, shows extreme variation in texture and thickness.	5
Till, calcareous, sandy clay loam, light-brownish grey (2.5 Y 6/2 dry), unoxidized, locally oxidized.	55+

Section 11.—In an excavation at the foot of the Qu'Appelle Valley ¼ mile north and ¼ mile west of S.E. corner S. 14, T. 21, R. 14, W. 2

Deposit	Thickness (feet)
Till, calcareous, oxidized, containing silt and clay partings. Upper two feet is comprised of colluvial material.	20+
Echo Lake Gravel	
Sand, calcareous, medium grained, oxidized, well stratified, well sorted. Base of unit sharp and regular.	10
Gravel, predominately pebbles and cobbles but contains a few boulders up to 1′ in diameter. Pebbles 1 to 2 inches in diameter are composed of 33% granite, 24% gneiss, 20% carbonate, 12% quartz and quartzite, and 11% dark igneous rocks. The carbonate pebbles are well rounded. The gravel is cross-bedded and show forset beds which dip downvalley. The base of the gravel is not exposed. Vertebrate fossils are present in this unit, many of which have been collected and identified.	40+

Section 13.—Road cut in south bluff of Qu'Appelle Valley along Highway 9

1. Lowermost exposure 6354 feet north of N.E. corner S. 30, T. 17, R. 2, W. 2

Deposit	Thickness (feet)
Till, calcareous, loam, very dark grey (2.5 Y 3/0 wet), unoxidized, oxidation along joint surfaces. Locally till contains highly contorted sand and gravel.	15+
Sand, medium grained, locally fine and coarse grained, oxidized, locally laminated. Base of unit is sharp and regular.	40
Till, calcareous, sandy clay loam, light-brownish grey (2.5 Y 6/2 dry), oxidized, locally unoxidized near base. Upper part of unit contains a few lenses of silt up to 3 feet thick.	30+

2. Uppermost portion of exposure 1554 to 2054 feet north of N.E. corner S. 30, T. 17, R. 2, W. 2

Deposit	Thickness (feet)
Till, calcareous, loam, light-olive brown (2.5 Y 5/4 wet), oxidized, to olive brown (2.5 Y 4/4 wet), unoxidized. Basal 15 feet is essentially unoxidized whereas the upper 15 feet is essentially oxidized. The contact is graditional. This unit is separated from the underlying contorted silt by a cobble pavement.	30
Sand and silt, calcareous, yellowish brown, well stratified (Fig. 25). Strata range from 1 to 2 inches in thickness, friable. The sediment is highly folded, the amplitude of which ranges from 2 to 10 feet. Crenulations, which have an amplitude of about 1 to 2 inches, are superposed upon the larger folds. The fine silt and clay bands are highly slickensided. This structure is believed to have been formed by ice shove. It is further believed that this friable sediment was deformed in a frozen state.	8

Note: Exposure 1 and 2 can not be correlated at this time.

Figure 25.—Contorted silt and clay under the surficial till in Section 13

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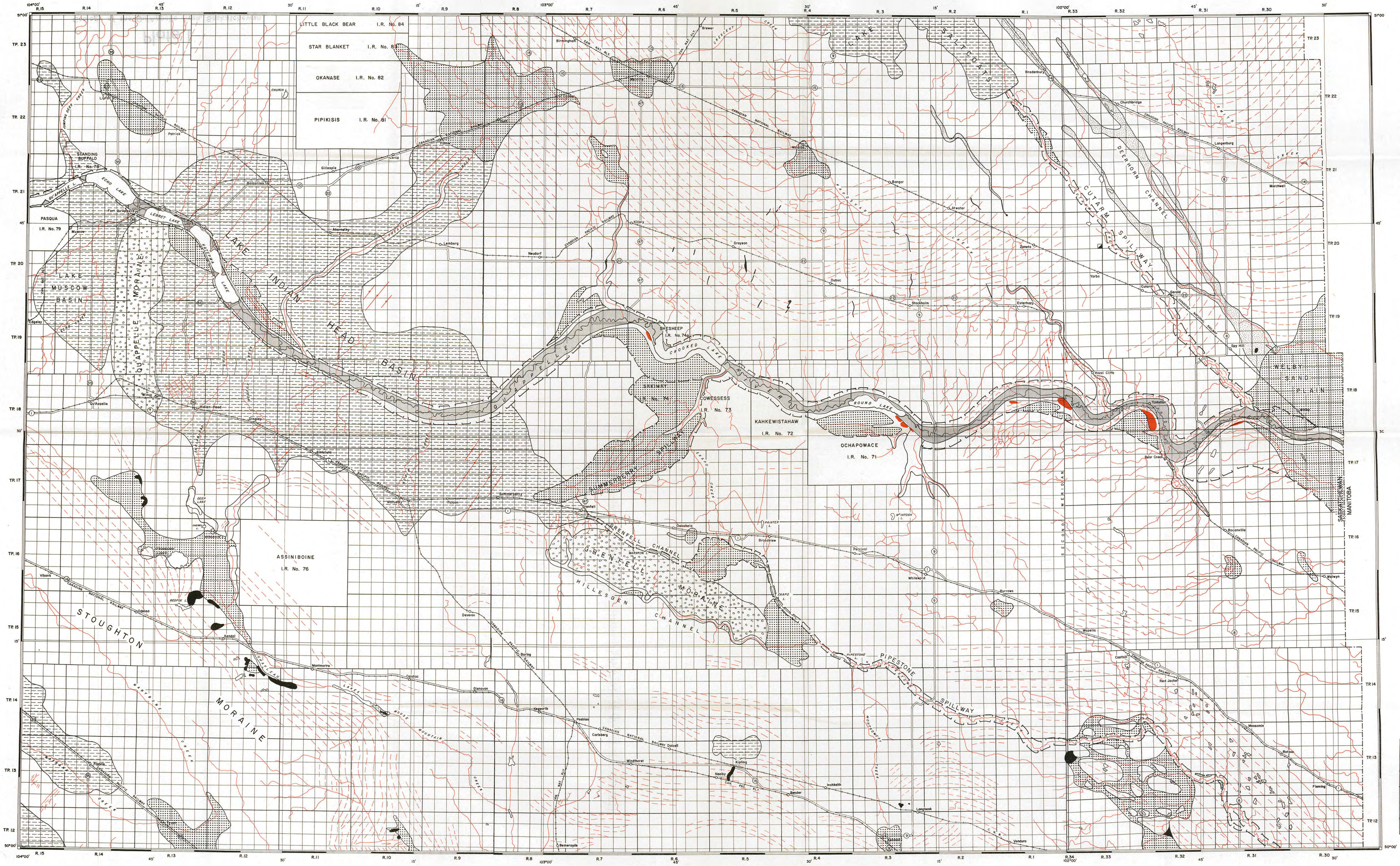
Plate I



EXPLANATION

GLACIAL LAND FORMS

Ground moraine
Undulating to gently rolling; till and minor amounts of sand and gravel.

End moraine
Gently rolling to rolling; till and minor amounts of sand and gravel.

Washboard moraine
Sub-parallel, generally arcuate ridges 5-30 feet high, composed of till; trend indicated by pattern.

Crevasse fillings
Two systems of ridges 5-30 feet high, composed of till.

Flutings
Straight to gently arcuate, parallel ridges and grooves in till and bedrock; relief 5-30 feet.

Kames, eskers, and kame-eskerine complex
Conical hills and sinuous ridges of sand and gravel.

PROGLACIAL LAND FORMS

Glacial lake basins
Flat to undulating; sand, silt, and clay up to 20 feet thick.

Outwash plains
Flat to undulating; sand and gravel up to 20 feet thick.

Meltwater channels
20-300 feet deep, up to 1 mile wide; till, colluvium and alluvium undifferentiated.

¼-2 miles wide; sand and gravel in shallow trenches below the general surface or rising above it in the form of ice-contact deposits.

Trend of small meltwater channels about 1000 feet wide and 10 feet deep; till and sand and gravel in positions favorable for deposition.

Spillway
Valleys 50-400 feet deep with flat bottoms ¼-1 mile wide; sand, silt, clay, eroded till, colluvium, and bedrock undifferentiated.

Terrace remnants
Benches in till, gravel and sand, and bedrock covered with about 20 feet of spillway gravel.

POSTGLACIAL LAND FORMS

Qu'Appelle Valley bottom
Piedmont alluvial fans along valley bluffs separated by flood plains; gravel, sand, and silt in fans, alluvial clay in flood plains.

Slump areas
Slides along valley bluffs of Qu'Appelle Valley and its tributaries where streams have cut into shale of the Riding Mountain Formation.

GEOLOGY BY E. A. CHRISTIANSEN
1958-59

Approximate magnetic declination, 15°E

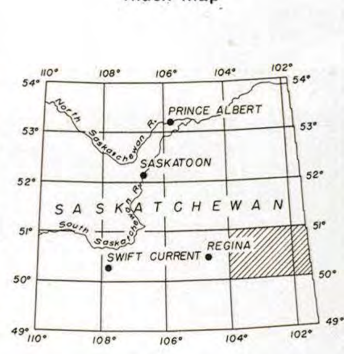
Base Map adapted from Qu'Appelle and Moose Mountain sheets and 1:250,000 map of 62K issued by Surveys and Mapping Branch, Department of Mines and Technical Surveys, Ottawa.

Cartography by Saskatchewan Department of Mineral Resources.

DIAGRAM OF TOWNSHIP SHOWING NUMBERING OF SECTIONS

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

Index map



Geology of the Qu'Appelle Area, Saskatchewan

SCALE

2 1 0 10 20

MILES

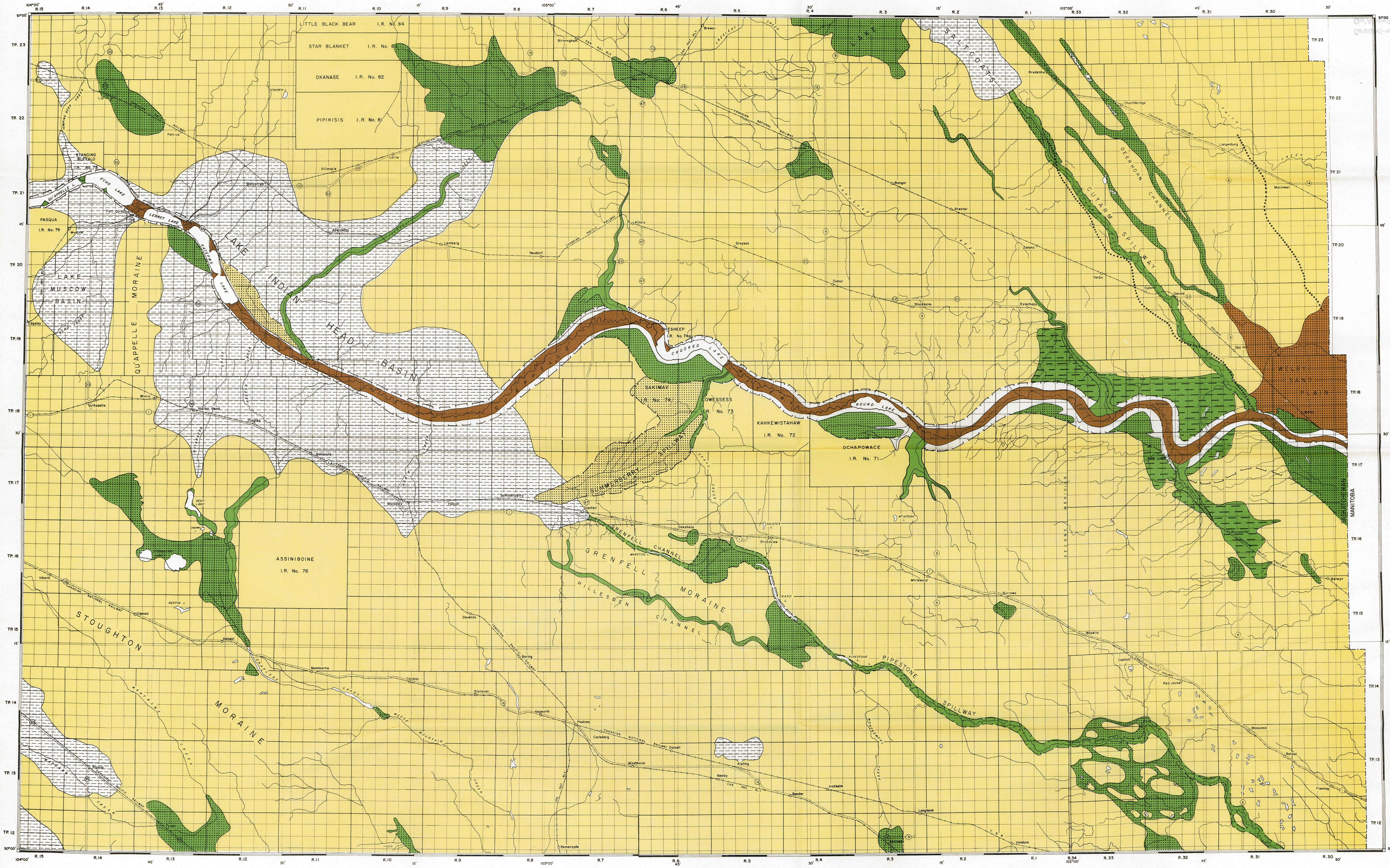
Scale 1:250,000

SCALE VARIES SOMEWHAT THROUGHOUT MAP

Saskatchewan Research Council

GEOLOGY DIVISION

Plate II



EXPLANATION

QU'APPELLE VALLEY BOTTOM

Sand and gravel occur as terrace remnants in the inside of meander turns and possibly on the floor of the old valley bottom. Where this gravel forms the shore of Katepwa Lake infiltration galleries may be used to extract large volumes of water.

Recent alluvial sediments occur as piedmont alluvial fans along valley bluffs and as flood plain deposits. Although these sediments occur in small valleys, they are not differentiated on the map. Sand and gravel are intercalcated with silt and clay throughout the fans. Water, commonly artesian, occurs at depths of 10 to 40 feet, commonly 20 feet. The water is slightly to highly mineralized. Springs are common in this area.

SURFICIAL SAND AND GRAVEL

Sand and gravel occur as fans at the mouth of meltwater channels, as high and low-level terraces along meltwater channels, and in re-entrant areas along the ice front. The sediment, which is up to 40 feet thick, is commonly less than 15 feet thick. The sand in most places is discontinuous. The water table normally lies 10 to 15 feet below the surface. Even though the sand and gravel may not be sufficiently thick to be saturated, it serves to recharge the underlying sediment. The water is slightly mineralized. The thicker sands and gravels are excellent aquifers.

MELTWATER CHANNELS

Sands and gravel occur in high-level terraces, in slip-off slopes on meander bends, under recent alluvium upon the valley floor, and in alluvial fans in the large valleys. The sediment is commonly less than 15 feet thick. The ground water drains readily as contact springs from the first two occurrences. The water is commonly slightly mineralized. This occurrence of water is important for small users in till areas.

Sand and gravel occur as ice-contact and outwash deposits in shallow trenches in the till surface which form a closure in three directions. The ground water is slightly mineralized and occurs at depths of 10 to 20 feet. Where these sediments are thick large supplies of water are found.

RIDING MOUNTAIN FORMATION

Where the siliceous Odanah shale has a cover of less than 50 feet of drift, slightly mineralized to mineralized water is obtained from fractures. It is not recommended to drill into the Riding Mountain Formation where the Odanah Member does not occur in the upper part of the formation because of the low permeability of the shale.

TILL

Water occurs in sand and gravel lenses, intertill sand and gravel, and small outwash plains, undifferentiated. Water also occurs in buried valleys on the bedrock surface; a few of the valleys have been differentiated. Areas of no visible drainage are believed to be more favorable because of their higher recharge potential. Water is obtained throughout the till, commonly 40 to 100 feet below the surface. The water is commonly highly mineralized and becomes more so with depth.

LACUSTRINE SILT AND CLAY

Water does not occur in these sediments and the deposits permit little recharge of water into the underlying aquifers.

TREND OF BURIED VALLEYS

It is not known whether ground water is readily available in these buried valleys. If sand and gravel are present in these valleys, they should form good aquifers.

PROBABILITY OF FINDING WATER

Good for cities and industry

Good for farm and town supplies

Fair for farm and town supplies

Poor for all water users

Ground-water map by E. A. Christiansen and D. L. Delorme, 1958-59

Approximate magnetic declination, 15°E

Base map adapted from Qu'Appelle and Moose Mountain sheets and 1:250,000 map of 62 K issued by Surveys and Mapping Branch, Department of Mines and Technical Surveys, Ottawa.

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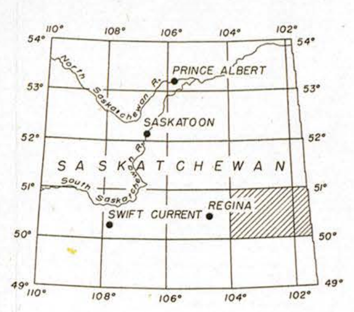
Index map



Ground-Water Resources of the Qu'Appelle Area, Saskatchewan

SCALE

2 1 0 10 20

MILES

Scale 1:250,000

SCALE VARIES SOMEWHAT THROUGHOUT MAP