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G L A C I A L   G E O L O G Y

of

S E D G E W I C K   D I S T R I C T ,   A L B E R T A

by

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GLACIAL GEOLOGY, SEDGEWICK DISTRICT

INTRODUCTION

General Statement

The western portion of the Sedgewick district of east-central Alberta lies in the Torlea flats, which is a north-south belt of relatively featureless ground moraine in east-central Alberta. A curvilinear band of outwash and ice-contact deposits is found north, northwest and northeast of Sedgewick. This outwash lies in a broad, shallow valley which probably marks the location of a preglacial or interglacial stream course. Wind action on the outwash south and east of Sedgewick has produced faint dune development. Local kames, crevasse fillings and stream-trenches are found on the till plain.

The eastern and northern part of the area is made up primarily of an area of hummocky dead-ice moraine. One of the more spectacular features found in the region is a southeasterly trending system of debris-filled stream-trenches found within the dead-ice moraine. The meltwater which issued from the stream-trenches flooded the southeastern part of the district and left broad tracts of outwash which cross the valley of the Battle river. Southeast of the Battle river wind action on the outwash has produced longitudinal and U-shaped dunes, some of which are still active.

Flutings found north and east of Sedgewick demonstrate that the ice moved in a southeasterly direction following the course of a preglacial trough. A few miles south of Jarrow, lineations suggest a southwesterly ice-movement direction.

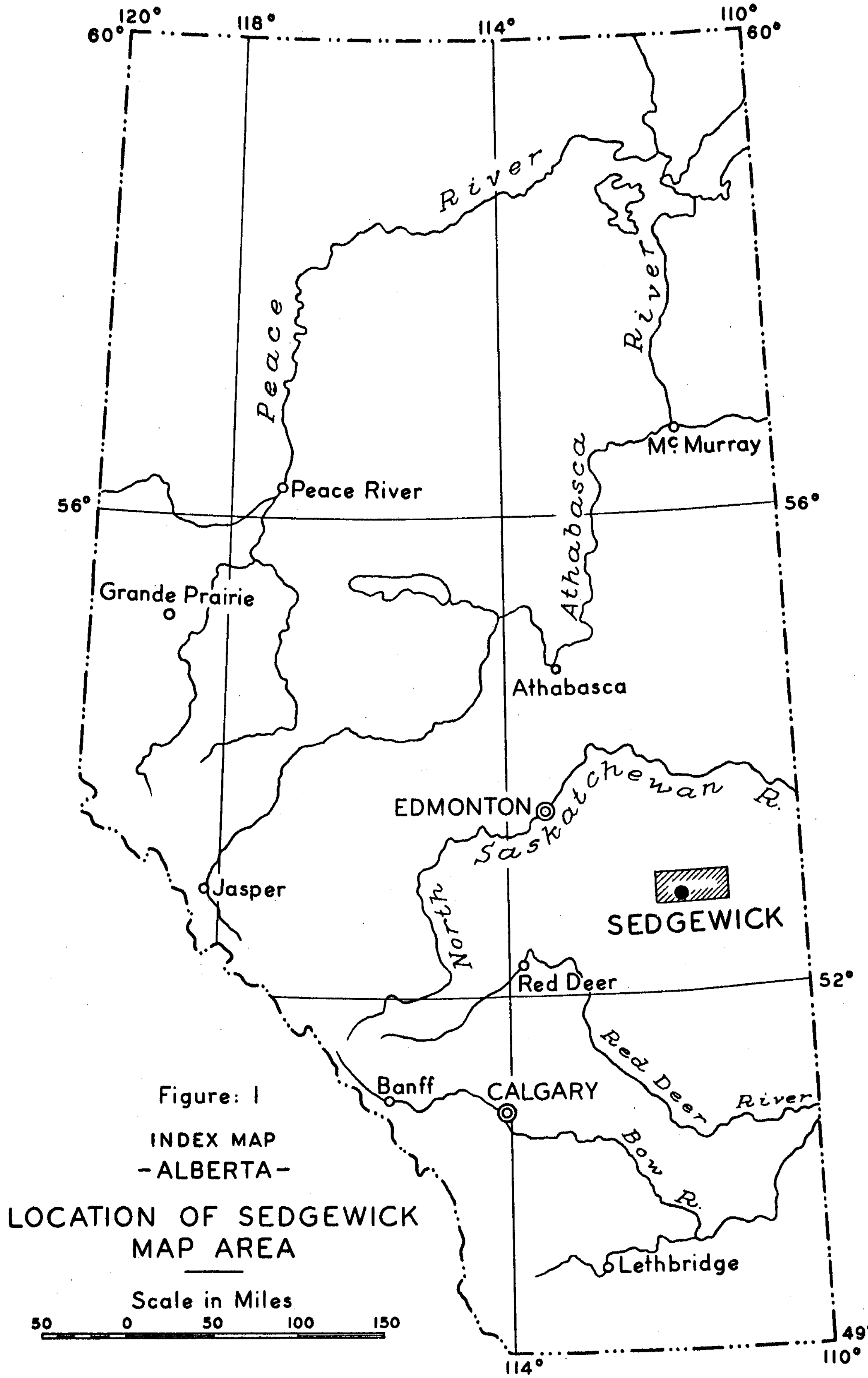

Figure: I

INDEX MAP
-ALBERTA-

LOCATION OF SEDGEWICK MAP AREA

Location of District

The district mapped is located in east-central Alberta (Fig. 1) and is bounded on the east by longitude 111°00' and on the west by 112°00'; the northern limit is marked by latitude 53°00' and the southern limit by latitude 52°45'. The total area of the district comprises about 720 square miles. As the district lies west of the 4th meridian, all locations given in this report will have that interpretation.

Previous Work

Reconnaissance studies on the glacial geology of east-central Alberta have been made by Warren (1937, 1954), Rutherford (1941), Bretz (1943), and Bayrock (1955). The parts of these reports which deal with east-central Alberta are mainly concerned with the position of moraines, and the ages of the glacial deposits. As yet there is little agreement on either the position of the moraines or their ages.

The soils of the Sedgewick district have been mapped by Wyatt, Newton, Bowser and Odynsky (1944).

Acknowledgments

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GLACIAL GEOLOGY

General Statement

The western portion of the Sedgewick district is made up of a gently rolling till plain dotted with kames and crevasse fillings. The most significant feature on this till plain is a broad, shallow curvilinear trough which is now occupied by Iron creek. During the retreat of the last ice, this trough was infilled with ice-contact deposits and outwash. The eastern and northern side of the trough is bounded by a low bedrock escarpment. East and northeast of the trough, the ground gradually rises from about 2250 feet at the base of the trough to the highest point in the area in the northeast corner of Tp. 45, R. 12, where the altitude is slightly over 2,400 feet. As the drift thickness is more or less uniform in the district, this gradual rise in ground is undoubtedly controlled by the bedrock surface.

The northern and northeastern part of the Sedgewick district is covered by a dead-ice moraine which consists of knobs, kettles, till plateaus and ridges. Although dead-ice moraine is found over the bedrock high in Tp. 45, R. 12, this type of moraine is also found on lower ground in the northeastern part of the district, north of Irma, and hence the location of dead-ice moraine is apparently not controlled by bedrock irregularities. One of the most significant features in the central and eastern portions of Sedgewick district is a series of sub-parallel debris-filled stream-trenches which carried glacial meltwaters towards the southeast. Some of these trenches have a relief of from 50 to 100 feet, and others are completely drift-filled and hence have little or no topographic expression. The meltwater which issued from the stream-trenches deposited a cover of outwash across the southeastern part of the Sedgewick district. Longitudinal and U-shaped dunes have been developed on some parts of this outwash.

The course of the Battle river was initiated as a glacial spillway which drained waters from the Edmonton district (Gravenor and Bayrock, 1956). This spillway (Gwynne outlet) probably started as an ice-marginal river which flowed around a great ice lobe that was retreating in a northerly and northeasterly direction. There is some evidence to support the idea that part of the course of this outlet in the Sedgewick and Wainwright districts was determined by channels which were cut by meltwater flowing through stagnant ice.

GLACIAL DEPOSITS

Ground Moraine

That part of the Sedgewick district which is mapped as ground moraine is a gently undulating plain underlain primarily by till. The history and definition of the terms moraine, ground moraine, ablation moraine and end moraine have been summarized by Flint (1955, p. 111), who states that, "Moraine can be defined as an accumulation of drift having a constructional topographic expression in detail that is independent of the surface of the ground underneath it, and having been built by the direct action of glacier ice." Of ground moraine Flint states, "In accordance with current general usage, ground moraine can be thought of as moraine with low relief devoid of transverse lineal elements." According to the definition of moraine, it is important to note that if the drift is thin,surface irregularities may be controlled by the topography of the surface underlying the drift, and hence such drift cannot be classified as moraine. This places a severe limitation on the utilization of the term "ground moraine" as it is not always possible to determine the influence of a pre-drift surface on the surface irregularities. In many places in the Sedgewick district and indeed over much of east-central Alberta, it is quite clear that the surface topography is controlled by the underlying bedrock topography. In the present report the term ground moraine is used to include both those areas where the drift topography is constructional in origin and also those areas where the surface topography is largely controlled by bedrock irregularities.

It is recognized by Flint (1955, pp. 111-112) that the definition of ground moraine given above does not differentiate between drift which was deposited by lodgment under the ice and drift which has been let down from the surface of stagnant ice (ablation moraine). In some cases ablation drift may be differentiated from lodgment drift on a basis of internal variations. If, for example, ablation drift has been subjected to meltwater action on the stagnant ice surface, it might show evidence of rude sorting and the clays and silts may have been removed, giving rise to a sandy or stony drift overlying the more clayey lodgment drift. It is also possible that slumping and sliding of ablation drift on top of the stagnant ice would result in a different internal fabric from the underlying lodgment drift. It is evident that the composition, the degree of sorting and the fabric of ablation drift is dependent upon the conditions existing on the top of a downwasting ice sheet. If downmelting were very slow and few irregularities existed on the stagnant ice surface, it is possible that ablation drift would show little variation in composition or fabric from the underlying lodgment drift. Another difficulty in differentiating between ablation drift and lodgment drift depends upon the definition of ablation drift. The term "ablation drift" is usually used to describe material which is resting on the top of stagnant ice. It is, however, generally assumed that there is a considerable amount of englacial drift in-transport near the base of a glacier. This in-transport material may never appear in the superglacial environment, but during the final stage of melting it is let down on the underlying lodgment drift. It is quite likely that in-transport drift would be protected from extensive meltwater action and from fabric disruption. Is this material classified as lodgment drift or ablation drift?

Flint (1955, p. 112) suggests that ablation drift (material which has been let down from a stagnant ice surface) is usually quite thin and,

> "After deposition it (ablation drift) may or may not possess local surface irregularities. If there are irregularities, the drift is usually classed as ground moraine, differing little or not at all externally, though differing internally from lodged drift."

This statement depends largely upon interpretation of surface form and the location under discussion. In Western Canada, Germany and Sweden there are large tracts of hummocky moraine which have been interpreted as ablation moraine (dead-ice moraine). If this interpretation is correct, then clearly ablation moraine plays an important role in determining surface expression.

In east-central Alberta the material which is mapped as ground moraine is dotted with a myriad of shallow depressions, some of which are steep-sided. These depressions are usually filled with water which is held up by the impermeable nature of the clayey till which floors the shallow depressions. The steep-sided nature of many of the depressions would suggest that they mark the position of stagnant ice blocks which were buried in the drift. If it is admitted that these depressions mark the sides of stagnant ice blocks, then the depressions could be interpreted either as kettles or as depressions caused by ice blocks sinking under their own weight, into a water-saturated sea of mud. According to Hoppe (1952), when a stagnant ice block sinks into a water-saturated mass of till, a rim of till should be found around the depression representing material pressed out from under the ice block. Such rims have not been found around the depressions of east-central Alberta, but it is realized that this does not rule out the possibility that the depressions have been created by sinking ice blocks. If the depressions are true kettles, then there is the possibility that much of the surface drift of east-central Alberta is ablation moraine. Other features found on the ground moraine of Western Canada, notably till mounds, "rimmed kettles", and crevasse fillings (Kupsch, 1956; Christiansen, 1956; Gravenor, 1955), have been suggested as ablation features. It is abundantly clear that the origin of the surface features on the plains of Western Canada warrants a great deal of attention before a proper classification can be introduced. In the meantime, the gently undulating surface drift of east-central Alberta is called ground moraine, but with the reservation that some of the constructional surface forms may be ablation moraine.

There is considerable variation in the thickness of the ground moraine in the Sedgewick district. In the southwestern part of the area drill holes show thicknesses ranging from 22 feet to greater than 68 feet. In the extreme northwestern part of the district the ground moraine is quite thin, ranging from zero to 14 feet in thickness. To the east in Tps. 46 and 47, R. 13, the ground moraine is slightly thicker than in the western part of the district but still shows considerable variation. In the central and southern portion of the Sedgewick district the ground moraine is, in general, thinner than in the southwest corner and bedrock either outcrops or comes close to the surface in many places. In this particular part of the district the surface topography is regulated partly by the underlying bedrock topography. A few patches of ground moraine occur within the borders of the dead-ice moraine, especially in Tp. 46, R. 12. These areas of ground moraine, which are termed moraine plateaus, will be considered under dead-ice moraine.

In general, the ground moraine of the Sedgewick district is clayey to sandy in nature. The high content of montmorillonite in the clay fraction of the till makes it quite plastic when saturated. Exposed sections and drill hole records show that the upper part of the till -- from 5 to 25 feet -- is brown in color and the lower part is blue grey in color. This color change may be either sharp or gradual, and there is no distinct physical break at the color change horizon to suggest that more than one till is involved. In rare instances sand and/or gravel lenses are found separating the brown and grey till, but it is more common to find such lenses within the brown and grey portions of the till. It is believed that the brown till represents an oxidized portion of the lower grey till.

Dead-ice Moraine

The broad tracts of rough morainic topography in central Alberta have, at different times in the past, been called terminal or end moraines and lateral moraines (Warren, 1937; Rutherford, 1941; and Bretz, 1943). More recently, similar morainic features in Western Canada have been called knob and kettle moraine (Stalker, 1956) and dead-ice moraine (Christiansen, 1956). Hoppe (1952) prefers to use the term hummocky moraine rather than dead-ice moraine, as there are some features of the moraines which would suggest that the ice was not completely stagnant during the initial phases of moraine formation. The term ablation moraine has been used extensively in North America to denote materials which have been let down from the surface of downwasting ice, but the end result is usually visualized as a thin mantle of drift over lodgment till. As the term dead-ice moraine appears to be firmly rooted in the language of European geologists, it would appear to be the best term available at the present for the moraines of central Alberta.

The dead-ice moraine of the Sedgewick district is made up of several distinct features: (1) moraine plateaus, (2) morainic ridges, (3) knobs and kettles, and (4) stream-trenches. Moraine plateaus are relatively flat patches of ground moraine found within the dead-ice moraine. The surface elevation of the plateaus lies at or above the elevation of the knobs in the surrounding moraine. Minor till ridges (rim ridges, Hoppe 1952) are sometimes found at or near the edges of the moraine plateaus. In one instance a faint till ridge was found around one of the kettles on a moraine plateau but in the majority of cases no kettle rims exist.

The very irregular plateau found in the northeast corner of Tp. 45, R. 12 forms the headwater area of a stream-trench which carried meltwater towards the southeast. An examination of the till in the moraine plateaus shows it to be clayey in nature and not unlike the till found in the ground moraine of the Sedgewick district. One drill hole in a moraine plateau in Sec. 24, Tp. 46, R. 11 shows the following sequence:

Depth in feet	
0 - 4	Light-brown silty clay
4 - 9	Light-brown sandy clay till
9 - 20	Blue clay till
20+	Gravel

Unfortunately, it was not possible to drill through the gravel at the base of the hole as the drill used was of the auger type. It is obvious that more logs are required before the true nature of the moraine plateaus can be ascertained.

Morainic ridges are sinuous ridges of till found in areas of dead-ice moraine. The ridges are usually, but not always, bounded by deep irregular or circular depressions which resemble kettles. In some instances depressions (kettles) are found in the crests of the ridges, which creates the appearance of a split in the ridge. Although many of the ridges appear to be haphazard in orientation, some of them have a rude alignment in a northeast-southwest direction. In Sec. 23, Tp. 46,

R. 12 an east-west trending ridge forms the headwater area of a stream-trench which carried meltwaters towards the east. In some cases, poorly defined ridges have been found which cross stream-trenches.

Knobs and kettles are by far the most common features found in the dead-ice moraine of the Sedgewick district. The knobs may occur as isolated mounds, in clumps, or in chains connected by ridges. Slight depressions are found in the tops of many of the knobs, which gives the knob a doughnut appearance when viewed from the air. In many respects these knobs are similar to the more isolated prairie mounds (Gravenor, 1955). It is not uncommon to find thin layers of rudely sorted bouldery gravel covering the till knobs, and kame-like sand and gravel cones are sometimes found interspersed with the till knobs. The knobs are separated by circular to irregular kettles. In many instances the kettles are closely spaced and almost fuse into what appears as a short valley separating the knobs.

The stream-trenches of the Sedgewick district have been described in a separate paper (Gravenor and Bayrock, 1956) and only a brief description will be given here. In plan view the trenches present a pattern of subparallel and intersecting valleys. Where the trenches are found in areas of dead-ice moraine, they are almost always infilled with moraine; in many cases they cannot be located topographically but are recognized from the air by the alignment of kettle lakes found along their courses. Drilling records frequently show that the moraine in the stream-trenches is underlain by sand and gravel. In areas of ground moraine the trenches are usually marked as broad open troughs which may be partially infilled by drift. In the latter type, it is quite common to find bedrock outcrops along the valley walls. The broad outwash-filled trough which exists in the northern part of Tp. 44, R. 10 and in the southern part of Tp. 45, R. 10 forms a part of the stream-trench pattern, but it is possible that this trough existed prior to the last glaciation and was connected to the curved bedrock low which exists north and northwest of the town of Sedgewick. Similarly, the trench which is found in the southwest corner of Tp. 44, R. 10 and the outwash-filled valley which is located about 3 miles southeast of the town of Killam may have been formed prior to the last glaciation and mark the location of preglacial or interglacial drainageways.

The stream-trenches carried meltwater in ice tunnels or in ice-walled channels toward the southeast. The waters carried in the stream-trenches issued from the stagnant ice front in the vicinity of the Battle river and deposited broad outwash flats. In the northwestern part of Tp. 44, R. 9 two stream-trenches can be traced into an area of dead-ice moraine, but they have been completely infilled with glacial debris making it impossible to connect them directly with the outwash which exists to the southeast of the moraine. It is interesting to note, however, that the stream-trench found in Sec. 25, Tp. 44, R. 10 is in direct line with the esker complex which is found southeast of the moraine in the southern part of Tp. 44, R. 9. It is quite likely that this stream-trench and esker system formed a continuous ice-walled channel or tunnel, and they represent degraded and aggraded portions of the tunnel respectively.

The relationships found in the north-central part of the Sedgewick district near the town of Kinsella (Gravenor and Bayrock,

1956) strongly suggest that the stream-trenches were infilled with till during the final stages of stagnation of the ice. This infilling was probably due to the slumping of debris-choked ice walls and/or tunnel roofs into the channels.

Morainic ridges, knobs and kettles, and moraine plateaus are undoubtedly all related in manner of formation. In Europe, dead-ice moraine has been intensively studied and it is generally agreed to be a product of stagnant or near stagnant ice. Most European geologists believe that dead-ice moraine originated as superglacial debris which formed during the downwasting stages of stagnation. The various irregularities such as knobs and ridges can be explained as thick accumulations of superglacial debris in crevasses and potholes in the stagnant ice. Moraine plateaus, especially those which form the headwater areas of stream-trenches, might be explained through water-saturated debris slumping and flowing into openings in the rotten ice.

Hoppe (1952) has made a study of the fabric in dead-ice moraine features and has found that in the till ridges there is a marked orientation of the stones at right angles to the crests of the ridges. From this and other observations Hoppe is of the opinion that the till under the stagnant ice was in a water-saturated state and was pressed into basal crevasses and cavities by the weight of the surrounding ice.

The fact that the stream-trenches have been infilled with moraine and this moraine frequently overlies sand and gravel in the base of the stream-trenches suggests that there was a considerable amount of debris enclosed in the stagnant ice which was let down during the final stages of stagnation. This would suggest that the dead-ice moraine features owe their origin at least in part to in-transport debris enclosed in the stagnant ice and let down from an uneven surface. The possibility, however, that certain of the dead-ice features have resulted from the "squeezing-up" of water-saturated debris from under stagnant ice-blocks and into basal openings in the ice, has a great deal of merit and should not be ignored as a major process in the formation of dead-ice moraine.

GLACIO-FLUVIAL DEPOSITS

Esker Complex

The esker complex found in Tp. 44, R. 9 is made up of a spectacular array of linear and circular gravel ridges. The linear ridges are subparallel and trend in a northwest-southeast direction -- the same direction as the stream-trenches found to the north and north-east of the esker complex. The principal ridge found in the complex extends from about the center of Sec. 17 to the southeast corner of Sec. 10. This ridge, which has a relief of from 100 to 150 feet, is flat-topped, and there are numerous kettles in the top of the ridge. Southeast of this main ridge, between the ridge and the Battle river, the esker complex is composed of a jumble of deep kettles bounded by gravel ridges. In Sec. 15, Tp. 44, R. 9, just northeast of the main gravel ridge, there is a semicircular valley which is marked by a chain of small lakes. This valley resembles the stream-trench valleys which are found northwest of this location, and quite possibly is a curved portion of a stream-trench which has been buried on its southern side by sands and gravels of the esker complex. The area surrounding this stream-trench and also the area southwest of the main ridge are covered with a number of short sinuous gravel ridges. A few of these ridges are roughly circular in plan view and resemble the till knobs which have central depressions found in areas of dead-ice moraine. However, most of the circular variety of gravel ridges are broken by gaps and consequently have a horseshoe-shape when viewed from the air.

As mentioned in the section on stream-trenches, it is believed that the main ridge of the esker complex originated as an aggraded portion of a stream-trench. The flat top found on the main ridge would suggest that the waters which deposited the gravel, flowed through an ice crevasse rather than a tunnel. If such is the case, this ridge might be referred to as a crevasse filling rather than an esker. It is believed that this whole complex of ridges and kettles is a result of meltwaters spilling through cracks in stagnant ice and around isolated stagnant ice blocks. The sorted material in the circular ridges may have been developed partly from debris within the stagnant ice blocks, and partly from material which was deposited on top of or on the sides of stagnant ice blocks, leaving a U-shaped rim when the ice melted. The immense quantity of sand and gravel in this area was in all probability derived from the scouring action of meltwater in the stream-trenches to the northeast. The esker found in Sec. 19, Tp. 45, R. 8 is a relatively normal esker system but has been mapped as an esker complex to avoid utilizing an additional map symbol for this one deposit.

Till Crevasse Filling

The crevasse fillings found in the Sedgewick district are short, relatively straight ridges of till which, in some cases, contain pockets of sand and gravel. A few of the crevasse fillings have a sinuous course and it is generally found that such ridges contain a higher proportion of sand and gravel than the straight types. It is noted that there are two sets of crevasse fillings, one aligned roughly in a northeast-southwest direction and the other in a northwest-southeast direction. The crevasse filling found in Sec. 11, Tp. 44, R. 12 is of the sinuous type and its long direction -- northeast-southwest -- lies at right angles to the direction of glaciation as marked by the underlying flutings. A similar alignment of a field of crevasse fillings has been noted northeast of the Sedgewick district (Gravenor, 1956). Crevasse fillings found in other parts of Western Canada and Montana (Kupsch, 1956) generally have two directions of alignment, and the better developed ridges lie either parallel to or perpendicular to the direction of ice movement. It would seem that the alignment of the crevasse fillings is controlled by ice fractures and that, in many cases, their long direction can be used as a rough indication of the direction of glaciation.

The more sinuous type of crevasse filling resembles, in some respects, the pattern of a small esker and it has been suggested by Stalker (1956) that the sinuous till ridges found in the Beiseker area of Alberta represent plastic material which was squeezed out into extinct esker tunnels by the weight of the surrounding ice. This explanation is somewhat the same as that given to a similar phenomenon found in Europe and called aufpressungsoser (squeezed-up esker). The straight till ridges would appear to be crevasse fillings rather than esker tunnels, and it is believed that they represent material which slumped into open crevasses in a waning ice sheet. It might be argued that they represent basal crevasses which were infilled by water-saturated plastic material which was squeezed-up from the ice. Such an hypothesis would fit in very closely with the idea of Hoppe (1952) on morainic ridges. Whichever explanation is correct, it is almost certain that till crevasse fillings represent one of the last deposits of a downwasting ice sheet and that their formation is controlled by a fracture pattern developed in the ice.

Kame

The ground moraine found in the western part of Sedgewick district is dotted with small kames. In plan view the kames are roughly circular to elongate, and frequently have indented borders. A few of the kames have little topographic expression, but in most cases they are from 15 to 30 feet in height and have a knobby surface. There are some borderline cases where it is rather difficult to differentiate between elongate kames and short crevasse fillings which contain a considerable amount of stratified material. It would appear that these two types of deposits are gradational and hence assigning them to one or the other is largely a matter of personal opinion.

Borrow pit excavations and road cuts through the kames show that they are composed of sand and gravel, and often contain inclusions of till. As is the case with most ice contact deposits, the sorting of the granular material is rather poor and rapid changes in size of material is the rule. In a number of cases the kames found in the Sedgewick district are made up almost entirely of poorly sorted sand, generally unsuitable for construction purposes.

Outwash

During the deglaciation of the Sedgewick district, glacial meltwater discharged in a southeasterly direction through the stream-trenches. Some sand and gravel was deposited in the floors and sides of the stream-trenches, but most was deposited beyond the ice front in the southeastern part of the district. The enormous amount of water which was discharged from the stream-trenches probably flowed from the ice front in a braided pattern or as turbulent sheet flow,and deposited a rather even coating of sand with some gravel over the southeastern part of the district. This water continued in its southeasterly course for many miles south and east of the Sedgewick district where great tracts of land are sand-covered.

Outwash, which was deposited directly from the retreating ice, is found in Tp. 46, R. 9 and immediately south of the town of Sedgewick. This outwash consists mainly of a clean brown sand and some fine gravel. These deposits of sand and gravel are 6 to 10 feet thick at the center and thin towards the borders. Since the sand and gravel is quite thin, the topography in these two areas of outwash is controlled largely by the underlying till, whereas the outwash plain found in the southeastern corner is sufficiently thick to mask out the underlying topography. The outwash found in the western part of the Sedgewick district, Tp. 44, R. 12 and 13, was deposited by meltwater which flowed in a southeasterly direction along a preglacial lowland.

In Sec. 8, Tp. 45, R. 8 and in Sec. 2, Tp. 45, R. 10 the ground moraine was scoured off by meltwater action and at these locations a thin layer of outwash is found overlying bedrock. A similar condition exists in Sec. 23, Tp. 44, R. 11, where 10 feet of sandy outwash is found overlying bedrock (Drill Hole No. 39).

Terrace Deposit

The present course of the Battle river in the Sedgewick district was initiated by glacial meltwater which flowed through a deep spillway from the Edmonton district, through the towns of Gwynne and Alliance, then turned abruptly to the northeast and passed through the southeast corner of the Sedgewick district. During the initial phases of the cutting of this spillway (the Gwynne outlet), the meltwater flowed at a much higher elevation than the present Battle river and scoured off the glacial deposits. Subsequently, downcutting proceeded and left a well developed terrace about 100 to 200 feet above the level of the present floor of the valley. This terrace is cut into the surrounding outwash which would mean that the cutting of the terrace was later than the development of the outwash. The terrace developed at the south of a stream-trench in Sec. 10, Tp. 45, R. 8 lies at approximately the same elevation as the terraces along the Gwynne outlet, and this would suggest that the base level for this particular stream-trench was regulated by the high water-level in the Gwynne outlet. Hence, some of the stream-trenches were probably still in operation at the same time as the Gwynne outlet was being cut.

A gravel pit on the terrace in Lsd. 15, Sec. 18, Tp. 45, R. 7 shows 6 feet of gravel over bedrock, and this exposure is fairly representative of the thickness of alluvial materials found on the terraces.

Glacio-lacustrine Deposit

Two small areas of lacustrine materials have been mapped in the northern portion of Tp. 46, R. 10. The deposits of silt and clay were laid down in meltwater ponds. It is not uncommon to find a very thin veneer of clay, 2 to 3 feet, on top of some of the moraine plateaus, but since the plateaus are formed primarily of till this veneer of clay was not mapped. This thin layer of clay on the plateaus probably formed when the plateaus were free of ice, but meltwater was held up by stagnant ice which surrounded the plateaus.

RECENT DEPOSITS

Aeolian

Recent sand dunes are found south of the town of Sedgewick, in Tp. 44, R. 11 and in the extreme southeast corner of the district. The dunes in the southeast corner are of the longitudinal type, and in some places where vegetation is sparse the dunes are still active but on a very minor scale. The rest of the dunes in the Sedgewick district are poorly developed U-shaped dunes which can only be recognized from air photographs. All dunes in the district were developed by winds blowing from the northwest and the longitudinal dunes show a wind direction 50 degrees west of north.

Apparently none of the sand making up the dunes was blown very far and most of the dunes are developed from underlying outwash.

Landslide

Landsliding and broad areas of slump are common features along the major valleys in central Alberta, due in part to the undercutting action of the rivers and in part to the clayey nature of the bedrock. When the bedrock becomes water-saturated, it tends to slide and flow down very gentle slopes (the order of 1 in 10). In many cases in Alberta, valley broadening is accomplished quite rapidly by the retreat of the valley walls through mass movement. Small alluvial fans are sometimes developed at the foot of the valley walls and one example of this type of deposit is found in Sec. 24, Tp. 44, R. 12.

Bottomland Deposit

Bottomland deposits are found along recent flood plains and in undrained channels. The flood plain deposits in the Sedgewick district are confined to the Battle River valley and are composed of gravel, sand, silt and clay. The flood plain of the Battle is quite broad and is marked by a number of ox-bow lakes. It is quite possible that the valley width is due mainly to the action of meltwater when the Gwynne outlet was in operation and hence the present Battle river is a misfit occupying an ancient spillway.

Bottomland deposits found in the western part of the Sedgewick district are composed of silt, clay and organic matter which has been wasted into undrained depressions from adjacent highlands.

GLACIAL HISTORY

Stratigraphy

Sections of the glacial drift in the Sedgewick district have indicated the presence of only one till overlying bedrock. Similar to other districts in east-central Alberta the upper part of the till is brown in color and with depth grades into a grey color. In some places drilling operations have encountered lenses of sand and gravel in the till, but the lack of continuity of these lenses would suggest that they represent local pockets of stratified drift and not a retreat and readvance of the ice. It is assumed that any drift which was deposited by an earlier glaciation was removed by the last ice to cover the district.

Direction of Ice Advance

Well developed local flutings and poorly defined elongate drumlins found along the lowland in Tp. 44, R. 12 indicate that the ice moved in a southeasterly direction. The fact that these flutings follow the trend of the lowland very closely would suggest strong topographic control on the movement of the ice, and hence these directions may not be representative of regional ice-movement direction for the district. Other lineations found south of Jarrow suggest a southwesterly ice-movement direction. It is quite possible that during different periods of the same ice-advance or retreat, local ice-movement directions varied considerably over a short distance.

In order to obtain a broad picture of the direction of ice-movement in Alberta, air photographs covering the northern and

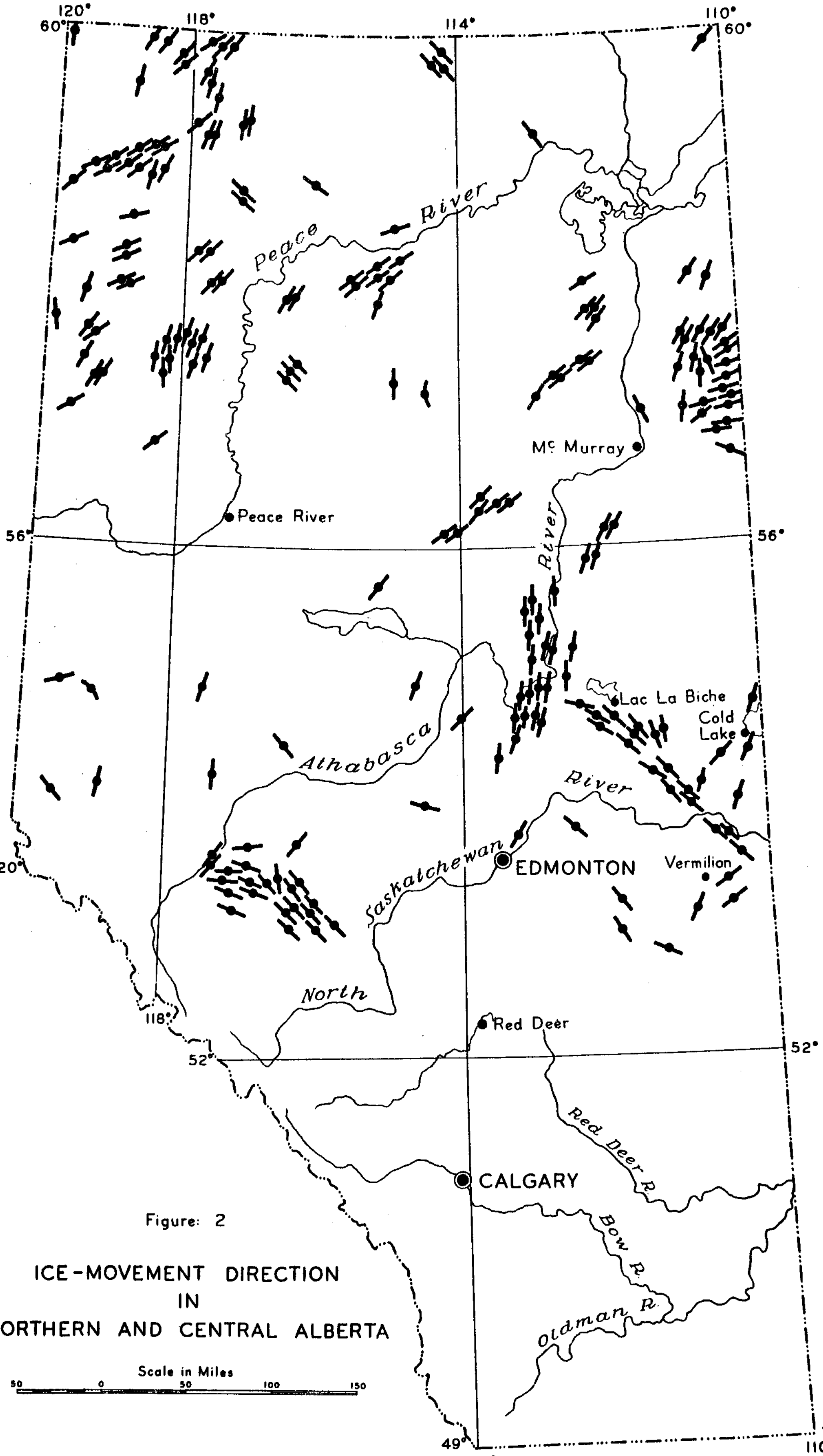

Figure: 2

ICE-MOVEMENT DIRECTION IN NORTHERN AND CENTRAL ALBERTA

Scale in Miles

50 0 50 100 150

north-central parts of the province were examined and glacial directions as indicated by flutings and drumlins recorded. The results of this work are shown on Figure 2. Except for one major ice-stream which extended from Lac La Biche to Lloydminster, most of the ice directions were toward the southwest. The southeasterly direction shown in the foothill belt west of Edmonton resulted from Cordilleran glaciation. One of the more interesting sets of ice directions occurs in east-central Alberta where there is a definite southwesterly trend across the Cold Lake district which is nearly at right angles to the south-easterly trend from Lac La Biche. South of Vermilion the southwesterly direction is again apparent. This could be interpreted in three ways, (1) the two sets of ice-movement directions represent two glaciations, (2) the Cold Lake trend may swing to a southeasterly and then southwesterly direction, forming an S-turn (although part of the southeasterly trend continues over to Saskatchewan), or (3) the two sets of directions may have been produced at slightly different periods by the same ice, either during advance or retreat. As there is no suggestion of one set of flutings intersecting another set, the writers prefer either explanation (2) or (3).

The generalized southwesterly ice-movement direction predicted from the use of indicators (Gravenor and Bayrock, 1955) would appear to be sound except that the paths of some of the indicators, particularly the Athabasca sandstone and Presqu'ile dolomite, may have followed a more curved path rather than the conventional straight lines shown for indicators.

Retreat of the Ice

As has been suggested under the heading "dead-ice moraine", the main method of ice retreat in the Sedgewick district was by down-wasting and stagnation which gave rise to most of the surface deposits in this part of Alberta.

The direction of ice-retreat in central Alberta presents a rather interesting problem in that it has been assumed from the general alignment of the dead-ice moraines that the ice retreated in an easterly or northeasterly direction. Evidence gained from a study of the Gwynne outlet would suggest that the ice retreated towards the north (Gravenor and Bayrock, 1956). A similar suggestion has been made more recently by Rennie (1957) for the Lac La Biche district.

The Gwynne outlet was originated from meltwaters ponded in front of the ice in the Edmonton district. These meltwaters apparently spilled around, and possibly in part through, an ice lobe which was retreating northward in east-central Alberta. At this time the North Saskatchewan outlet must have been closed by ice in the Edmonton district. Evidence from the Sedgewick district demonstrates that the terraces along the Gwynne outlet were cut during and slightly later than the development of outwash and stream-trenches in the Sedgewick district. Hence the ice must have stood to the east of Edmonton, blocking the North Saskatchewan outlet, at the same time as there was ice standing in the Sedgewick district. Thus, the ice probably retreated to the north or perhaps slightly east of north, and the formation of the Cooking Lake dead-ice moraine east of Edmonton was probably contemporaneous in time with the formation of the dead-ice moraines in the Sedgewick district. If the above reasoning is correct, it represents a major departure from the views currently held on the direction of ice retreat in central Alberta. It might be mentioned that in the area north of the Sedgewick district evidence of a similar type has been found which will appear in a future publication.

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APPENDIX A

GRAVEL DEPOSITS

The best gravel deposits in the district are located along stream-trenches, and in the outwash and esker complex found in the southeastern part of the district. In general, kame and crevasse fillings are local in extent and poor in quality. The outwash in the western and northeastern parts of the district tends to be quite sandy and, except for local gravel concentrations, is unusable.

Location	Extent of Gravel	Description of Gravel
Lsd. 12, Sec. 1, Tp. 44, R. 14.	Limited in extent to 10 acres. Gravel pit exposes 4 feet of gravel overlying 5 feet of sand.	Kame deposit. Poorly sorted fine gravel. Shows rapid changes in bedding, and contains ironstone nodules and coal fragments.
Lsd. 4, Sec. 13, Tp. 44, R. 14.	Limited in extent.	Kame deposit. Very poorly sorted mixture of till, sand and gravel.
Lsd. 2, Sec. 5, Tp. 46, R. 13.	Fairly extensive -- 20 acres.	Stream-trench deposit. Moderately sorted, cross-bedded, fine, sandy gravel. Contains chert, ironstone and soft coal fragments.
Lsd. 5, Sec. 34, Tp. 45, R. 13.	Limited in extent. Gravel pit exposes very poor gravel.	Kame deposit. Very poorly sorted gravel and till. Contains chert, ironstone and shale fragments.
Lsd. 2, Sec. 28, Tp. 45, R. 13.	Limited in extent.	Crevasse filling deposit. Very poorly sorted sand, gravel and stony till.
Lsd. 7, Sec. 21, Tp. 45, R. 13.	Limited in extent.	Kame deposit. Moderately sorted, medium to coarse gravel. Contains ironstone nodules.
Lsd. 3, Sec. 21, Tp. 45, R. 13.	Limited in extent.	Crevasse filling deposit. Moderately sorted gravel and coarse sand.

Location	Extent of Gravel	Description of Gravel
Lsd. 5, Sec. 22, Tp. 45, R. 13.	Limited in extent.	Crevasse filling deposit. Poorly sorted coarse gravel which contains till pockets and lumps of bedrock.
Lsd. 6, Sec. 15, Tp. 45, R. 13.	Fairly extensive -- 30 acres. Gravel pit exposes a 10-foot section. Quite large reserves.	Stream-trench deposit. Moderately sorted, horizontally bedded, sandy gravel. Tends to be bouldery in places (up to 6 inches in diameter). Sandy portions are cross-bedded.
Lsd. 4, Sec. 16, Tp. 45, R. 13.	Limited in extent and may be up to 30 feet thick. Contains a small gravel pit 10 feet deep.	Crevasse filling deposit. Poorly sorted sandy gravel, tends to be bouldery.
Lsd. 4, Sec. 30, Tp. 44, R. 14.	Limited in extent. Two small pits expose 4 feet of gravel.	Crevasse filling deposit. Poorly sorted coarse bouldery gravel. Contains ironstone nodules.
Lsd. 15, Sec. 24, Tp. 44, R. 13.	Limited in extent. Pit has been abandoned.	Crevasse filling deposit. Poorly sorted, fine sandy gravel.
Lsd. 2, Sec. 2, Tp. 45, R. 13.	Fairly extensive -- 30 acres. Pit has been abandoned.	Stream-trench deposit. Poorly sorted, fine, sandy gravel. (Kame deposit just to the east is composed of poorly sorted sand, gravel and till).
Lsd. 5, Sec. 15, Tp. 46, R. 11.	Very extensive and contains large gravel pits. Large reserves of gravel.	Major stream-trench deposit. Well sorted, cross-bedded, medium grained gravel. Becomes coarser to the west (up to 2 feet in diameter).
Lsd. 1, Sec. 6, Tp. 44, R. 14.	Limited in extent -- 30 acres. Occurs as a flat-lying deposit, 5 - 10 feet thick, overlying till.	Outwash deposit. Gravel is moderately to poorly sorted. Contains ironstone nodules, quartzite, igneous and metamorphic pebbles.
Lsd. 13, Sec. 3, Tp. 44, R. 13.	Limited in extent. Occurs on top of a small kame knob.	Kame deposit. Fine to medium grained, poorly sorted gravel. Contains ironstone nodules, igneous and metamorphic pebbles. Tends to be bouldery near the surface.

Location	Extent of Gravel	Description of Gravel
Lsd. 13, Sec. 10, Tp. 44, R. 13.	Very small deposit, overlying ground moraine.	Outwash deposit. Poorly sorted gravel with a sandy clay matrix. Contains ironstone nodules.
Lsd. 4, Sec. 27, Tp. 45, R. 11.	Small deposit overlying till in the valley wall of a stream-trench.	Stream-trench deposit. Quality of gravel is poor and is only moderately sorted; quite sandy.
Lsd. 1, Sec. 4, Tp. 46, R. 11.	Very small deposit overlying till within the dead-ice moraine.	Superglacial debris. Moderately sorted, good quality gravel.
Lsd. 14, Sec. 22, Tp. 46, R. 11.	Local deposit 3.5 feet thick; overlies till knobs in the dead-ice moraine. Thins out away from the crests.	Superglacial debris. Fairly well sorted gravel. Contains granite and quartzite pebbles.
Lsd. 16, Sec. 20, Tp. 45, R. 11.	Thin local deposit overlying till within the dead-ice moraine. Local gravel lenses are common in this type of deposit.	Superglacial debris. Fairly well sorted but has a clay matrix.
Lsd. 8, Sec. 29, Tp. 46, R. 11.	Limited in extent. Low rounded knob composed of gravel. Has the form of a kame deposit within the moraine.	Kame deposit. Moderately sorted with a coarse sand matrix; contains boulders up to 6 inches in diameter. Sand lenses are common. In places it has the appearance of a gravelly till.
Lsd. 1, Sec. 30, Tp. 46, R. 11.	In this area gravel is found on the crests of most of the till knobs.	Superglacial debris. Coarse, poorly sorted gravel; often bouldery.
Lsd. 14, Sec. 15, Tp. 46, R. 12.	Small deposit.	Morainic ridge. Poorly sorted, bouldery gravel containing much coarse sand.
Lsd. 1, Sec. 20, Tp. 46, R. 12.	Limited in extent, and up to 8 feet in depth.	Superglacial debris. Fairly well sorted gravel with a sandy matrix. Average diameter of pebbles is 2 inches.
Lsd. 9, Sec. 13, Tp. 45, R. 13.	Thin local deposit over ground moraine.	Small kame deposit. Gravel is poorly sorted.
Lsd. 6, Sec. 3, Tp. 45, R. 11.	Limited in extent and patchy in distribution.	Outwash deposit. Well sorted, fine grained gravel and coarse sand.

Location	Extent of Gravel	Description of Gravel
Lsd. 2 and 8, Sec. 17, Tp. 44, R. 10.	Fairly large deposit -- 80 acres in extent; contains two large gravel pits.	Kame deposit. Moderately sorted gravel. Contains sand and till inclusions. Tends to be bouldery in places.
Lsd. 2, Sec. 27, Tp. 44, R. 12.	Gravel is limited in extent. Gravel pit is 2 to 3 feet in depth.	Outwash deposit within a stream-trench. Poorly sorted, fine grained gravel, sand and till.
Lsd. 2, Sec. 4, Tp. 45, R. 10.	Fairly large deposit, about 60 acres in extent, but gravel content is small.	Kame deposit. Very poorly sorted. Mixture of sand, till and gravel lenses. Tends to be bouldery in places.
Lsd. 3, Sec. 2, Tp. 45, R. 10.	Thin local deposit; patchy in distribution. Fills in irregularities in the underlying till.	Outwash deposit associated with the stream-trench to the west. Moderately sorted gravel.
Lsd. 9, Sec. 14, Tp. 45, R. 11.	Thin, patchy gravel overlying till.	Stream-trench deposit. Moderately sorted gravel and coarse sand.
Lsd. 12, Sec. 10, Tp. 45, R. 10.	Limited in extent; 1 foot thick and is overlain by 1 foot of outwash sand.	Stream-trench deposit. Moderately sorted gravel.
Lsd. 15, Sec. 19, Tp. 45, R. 8.	Limited in extent to a low ridge. Gravel pit is 12 feet deep.	Esker deposit. Moderately sorted gravel and coarse sand. Tends to be bouldery.
Lsd. 8, Sec. 28, Tp. 46, R. 9.	Gravel is patchy in distribution within a large outwash area. Local gravel pits have been opened up.	Outwash deposit. Fairly well sorted, coarse sand and fine gravel. Shows horizontal stratification.
Lsd. 9, Sec. 22, Tp. 46, R. 9.	Limited in extent. Contains small gravel pit. Has a maximum thickness of 10 feet, and overlies and subdues the dead-ice moraine topography.	Outwash deposit. Moderate to well sorted, fine grained gravel and coarse sand.
Lsd. 16, Sec. 2, Tp. 46, R. 9.	Limited in extent to esker-like ridge.	Crevasse filling deposit. Poorly to moderately sorted. Gravel tends to be bouldery and has a sandy matrix.

Location	Extent of Gravel	Description of Gravel
Lsd. 4, Sec. 16, Tp. 44, R. 9.	Very extensive. Large ridges several miles long, composed of sand and gravel.	Esker complex deposit. Well sorted gravel and coarse sand. Gravel in the sharper ridges tends to be bouldery.
Lsd. 16, Sec. 19, Tp. 45, R. 9.	Quite extensive. Flat-lying deposit on an elevated plateau within a stream-trench.	Stream-trench deposit. Well sorted gravel and coarse sand overlain by 2 feet of silty clay. The surface is strewn with boulders.
Lsd. 14, Sec. 20, Tp. 45, R. 9.	Extensive deposit -- 10 acres. Gravel pit exposes a 20-foot section.	Stream-trench deposit. Well sorted gravel and coarse sand. Contains a small amount of ironstone. Deposit becomes finer grained towards the base.
Lsd. 8, Sec. 21, Tp. 45, R. 9.	Quite extensive and 20 feet thick.	Stream-trench deposit. Well sorted fine gravel and coarse sand. Contains boulders up to 6 inches in diameter.
Lsd. 14, Sec. 5, Tp. 45, R. 8.	Gravel is limited in extent and is thin.	Outwash deposit. Coarse sand containing gravel stringers.
Lsd. 10, Sec. 18, Tp. 45, R. 8.	Quite extensive -- 160 acres. Gravel pit is 12 feet deep.	Stream-trench deposit. Fairly well sorted gravel with sandy matrix. Contains lenses of well sorted coarse sand. Shows cross-bedding. Tends to become finer grained near the base.
Lsd. 5, Sec. 24, Tp. 45, R. 9.	Gravel is not extensive. Occurs on the valley slope of a stream-trench.	Stream-trench deposit. A small gravel pit shows it to be very similar to the deposit described above.
Lsd. 15, Sec. 14, Tp. 44, R. 9.	Fairly extensive thin irregular mantle overlying hummocky till.	Outwash deposit. Moderately sorted gravel and coarse sand.
Lsd. 9, Sec. 2, Tp. 45, R. 9.	Fairly extensive hummocky deposit.	Outwash deposit. Knobs consist of fine, well sorted stratified gravel with a sand matrix.
Lsd. 5, Sec. 23, Tp. 45, R. 9.	Quite extensive -- 40 acres. All the gravel pits in this area are located on the inside bends of a stream-trench.	Stream-trench deposit. Well sorted, fine gravel and coarse sand. Coarsely stratified and contains carbonaceous bands up to 4 inches in thickness.

Location	Extent of Gravel	Description of Gravel
Lsd. 13, Sec. 7, Tp. 44, R. 8.	Extensive gravel deposit which is overlain by about 20 feet of outwash sand. Road cut exposes 2 feet of gravel.	Outwash deposit. Fine to medium grained, well sorted gravel.
Lsd. 1, Sec. 1, Tp. 44, R. 9.	Extensive gravel deposit -- 40 acres; overlain by 4 feet of sand. Gravel pit exposes a 15-foot section.	Outwash deposit. Good quality, well sorted, medium grained gravel with a matrix of coarse sand.
Lsd. 2, Sec. 19, Tp. 44, R. 8.	Limited in extent. Gravel pit exposes 6 to 8 feet of gravel overlying sand.	Outwash deposit. Poorly sorted; contains many large boulders up to 3 feet in diameter.
Lsd. 15, Sec. 18, Tp. 45, R. 7.	Limited in extent. Road cut exposes 6 feet of gravel and sand overlying 34 feet of bedrock.	Terrace deposit. Poorly sorted mixture of sand and gravel with a clay matrix.
Lsd. 6, Sec. 19, Tp. 45, R. 7.	Extent, 100 acres; 6 feet of sand and gravel overlying flood plain deposits in the valley.	Postglacial alluvial deposit. Moderately sorted gravel and coarse sand, overlying silt, clay and well sorted sand.
Lsd. 1, Sec. 19, Tp. 45, R. 7.	Extent, 40 acres. Flat lying deposit on the flood plain of the Battle river, up to 15 feet thick.	Postglacial alluvial deposit. Poorly sorted sand and gravel overlain by 2 feet of sand. Gravel is poorly sorted and tends to be bouldery. Shows local imbricate structure.

APPENDIX B

DRILL HOLES

Drill Hole No.	Location	Depth, feet	Description of Material
1	N.W. corner Sec. 7, Tp. 44, R. 13	0 - 11	Light-brown clayey till.
		11 - 13	Dark brown till.
		13 - 15	Grey till.
		15 - 35	Fine grained gravel.
		35 - 42	Blue grey clayey till.
		42 - 63	Bedrock, Bearpaw formation; grey fine grained sandstone.
2	N.W. corner Sec. 9, Tp. 44, R. 14	0 - 2	Light-brown sandy till.
		2 - 20	Brown clayey till.
		20 - 42	Blue grey clayey till.
		42 - 55	Bedrock, Bearpaw formation; brown shale containing gypsum.
3	S.W. corner Sec. 4, Tp. 45, R. 14	0 - 16	Brown clayey till.
		16 - 20	Brown, fine grained, clayey sand; contains shale fragments.
		20 - 45	Grey sandy till.
		45 - 45.5	Hard blue grey clayey till.
		45.5 - 68	Grey sandy clay till; contains shale fragments and gypsum.
4	N.W. corner Sec. 31, Tp. 44, R. 13	0 - 15	Brown clayey till.
		15 - 39	Blue grey clayey till.
		39 - 42	Blue clayey till; contains brown shale fragments.
		42 - 43	Bedrock, Belly River formation; brown shale.
5	S.W. corner Sec. 30, Tp. 45, R. 13	0 - 5	Brown clayey till.
		5 - 19	Brown, medium grained pebbly sand (glacial); water table at 10 feet.
		19 - 20	Bedrock, Belly River formation; bentonitic brown sandy shale.
6	Lsd. 3, Sec. 29, Tp. 46, R. 13	0 - 5	Brown sandy till.
		5 - 7	Green brown sandy till.
		7 - 13	Green brown clayey till.
		13 - 23	Green brown sandy clayey till.
		23 - 26	Blue grey clayey till.
		26 - 29	Blue brown clayey till; contains numerous stones.

Drill Hole No.	Location	Depth, feet	Description of Material
6 (continued)		29 - 45	Blue sandy clayey till; contains shale fragments.
		45 - 68	Bedrock, Belly River formation; green bentonitic shale.
7	N.E. corner Sec. 20, Tp. 46, R. 14	0 - 9	Brown clayey till.
		9 - 14	Blue clayey till; contains numerous stones and shale fragments.
		14 - 18	Bedrock, Belly River formation; hard blue shale.
8	S.E. corner Sec. 8, Tp. 46, R. 14	0 - 11	Brown clayey till.
		11 - 12	Bedrock, Belly River formation; blue shale.
9	N.W. corner Sec. 21, Tp. 45, R. 14	0 - 15	Brown till containing coal fragments.
		15 - 18	Coarse sand.
		18 - 25	Blue clayey till.
		25 - 29	Blue sandy clayey till.
		29 - 35	Blue clayey till.
		35 - 45	Dark blue sandy clayey till.
		45 - 58	Bedrock, Bearpaw formation; blue soft shale.
10	S.W. corner Sec. 7, Tp. 46, R. 13	0 - 11	Brown clayey till.
		11 - 20	Blue clayey till.
		20 - 32	Blue brown clayey till; contains shale fragments.
		32 - 38	Bedrock, Belly River formation; blue grey silty shale.
11	S.E. corner Sec. 1, Tp. 45, R. 13	0 - 15	Brown clayey till.
		15 - 42	Brown medium grained sand (glacial); contains a few pebbles and soft coal fragments.
		42 - 45	Brown pebbly sand; contains ironstone and shale fragments.
		45 - 63	Grey clayey sand; contains lumps of brown stony clayey till.

Drill Hole No.	Location	Depth, feet	Description of Material
12	S.E. corner Sec. 2, Tp. 45, R. 13	0 - 4	Brown coarse sand.
		4 - 9	Brown clayey till; contains numerous pebbles.
		9 - 58	Blue sandy clayey till; contains green shale fragments.
13	S.W. corner Sec. 2, Tp. 45, R. 13	0 - 6	Brown coarse sand.
		6 - 12	Grey brown fine grained sand.
		12 - 23	Grey sandy clayey till; contains many pebbles and shale fragments.
		23 - 63	Bedrock, Belly River formation; green bentonitic soft shale.
14	S.W. corner Sec. 3, Tp. 45, R. 13	0 - 10	Brown clayey till.
		10 - 22	Blue clayey till.
		22 - 28	Bedrock, Belly River formation; green silty soft shale.
15	N.W. corner Sec. 33, Tp. 44, R. 13	0 - 12	Brown clayey till.
		12 - 12.5	Brown coarse sand.
		12.5 - 15	Brown clayey till.
		15 - 21	Brown coarse sand.
		21 - 23	Brown clayey till.
		23 - 38	Dark brown grey sandy clayey till.
16	S.W. corner Sec. 1, Tp. 46, R. 13	0 - 2	Brown clayey till.
		2 - 3	Brown coarse clayey sand.
		3 - 11	Brown clayey till.
		11 - 35	Blue clayey till.
		35 - 45	Blue grey sandy clayey till.
17	Lsd. 5, Sec. 2, Tp. 44, R. 13	0 - 2	Blue clay (recent).
		2 - 4	Blue grey clayey sand.
		4 - 13	Brown medium grained sand; contains shell fragments and a few pebbles.
18	Lsd. 3, Sec. 3, Tp. 44, R. 13	0 - 9	Brown medium grained clayey sand; contains small shell fragments and a few pebbles.
		9 - 13	Brown coarse sand; contains shell fragments; water table at 9 feet.

Drill Hole No.	Location	Depth, feet	Description of Material
19	Lsd. 14, Sec. 12, Tp. 44, R. 13	0 - 6	Brown coarse sand; containing a few pebbles and ironstone concretions.
		6 - 7	Grey brown coarse sand.
		7 - 18	Grey coarse sand; contains a few quartz and carbonaceous shale fragments; water table at 7 feet.
20	S.E. corner Sec. 5, Tp. 44, R. 11	0 - 2	Brown coarse sand.
		2 - 8	Brown clayey till.
21	Lsd. 3, Sec. 18, Tp. 44, R. 11	0 - 3	Brown medium grained clayey sand.
		3 - 12	Brown clayey till.
		12 - 18	Brown sandy clayey till.
		18 - 25	Dark brown clayey till.
		25 - 29	Blue grey clayey till.
		29 - 48	Dark brown sandy clayey till; contains coal fragments.
22	S.W. corner Sec. 27, Tp. 44, R. 11	0 - 8	Light-brown silty till.
		8 - 16	Dark brown stony clayey till.
		16 - 21	Grey medium grained clayey sand.
		21 - 29	Dark brown clayey till.
		29 - 33	Bedrock, Belly River formation; grey to black bentonitic shale; contains ironstone nodules.
23	N.W. corner Sec. 35, Tp. 44, R. 11	0 - 12	Brown coarse sand.
		12 - 17	Brown stony clayey till.
		17 - 53	Dark blue clayey till.
24	S.E. corner Sec. 4, Tp. 46, R. 11	0 - 22	Dark blue to brown stony clayey till.
25	Lsd. 5, Sec. 14, Tp. 44, R. 12	0 - 5	Brown pebbly fine grained sand.
		5 - 8	Brown sandy clayey till.
26	Lsd. 5, Sec. 14, Tp. 44, R. 12	0 - 6	Light-brown stony clayey till.
		6 - 9	Dark brown clayey till; contains many shale fragments.
		9 - 12	Bedrock, Belly River formation; blue grey bentonitic shale.

Drill Hole No.	Location	Depth, feet	Description of Material
27	S.E. corner Sec. 9, Tp. 46, R. 11	0 - 19	Dark brown stony clayey till.
		19 - 43	Dark blue clayey till.
28	Lsd. 5, Sec. 27, Tp. 46, R. 11	0 - 14	Dark brown clayey till.
		14 - 40	Dark blue clayey till.
		40 - 45	Bedrock, Belly River formation; grey blue sandy bentonitic shale.
29	N.E. corner Sec. 24, Tp. 46, R. 11	0 - 9	Light-brown sandy clayey till.
		9 - 20	Blue clayey till.
		20 - 21	Fine grained gravel; water table at 15 feet.
30	Lsd. 5, Sec. 34, Tp. 45, R. 10	0 - 5	Brown clayey till.
		5 - 8	Light-brown sandy clayey till.
		8 - 12	Grey brown clayey till.
		12 - 14	Dark brown clayey till.
		14 - 38	Blue clayey till.
31	Lsd. 9, Sec. 12, Tp. 46, R. 9	0 - 2	Grey silty clay.
		2 - 3	Fine grained gravel; well sorted.
		3 - 18	Brown clayey till.
32	N.E. corner Sec. 14, Tp. 45, R. 11	0 - 12	Brown clayey till.
		12 - 63	Blue clayey till.
33	S.E. corner Sec. 23, Tp. 45, R. 11	0 - 5	Brown coarse sand and fine gravel.
		5 - 7	Fine grained clayey gravel.
		7 - 8	Green brown silty clayey till.
		8 - 11	Light-brown clayey till.
		11 - 13	Grey sandy clayey till.
		13 - 17	Brown coarse sand.
		17 - 27	Brown sandy clayey till.
		27 - 31	Dark grey brown sandy clayey till.
34	S.E. corner Sec. 13, Tp. 46, R. 13	0 - 11	Brown clayey till.
		11 - 18	Grey clayey till; contains shale fragments.
		18 - 23	Blue clayey fine gravel and coarse sand; water table at 18 feet.

Drill Hole No.	Location	Depth, feet	Description of Material
35	S.W. corner Sec. 30, Tp. 46, R. 12	0 - 4	Light-brown silty clayey till.
		4 - 7	Brown clayey sand.
		7 - 11	Brown clayey till.
		11 - 53	Blue clayey till; contains shale fragments at depth.
36	S.W. corner Sec. 3, Tp. 46, R. 13	0 - 10	Dark brown clayey till.
		10 - 19	Brown clayey till.
		19 - 20	Red brown clayey till.
		20 - 22	Light-brown clayey till.
		22 - 28	Bedrock, Belly River formation; blue green bentonitic shale.
37	S.W. corner Sec. 15, Tp. 46, R. 13	0 - 3	Dark brown clayey till.
		3 - 6	Brown clayey till.
		6 - 10	Brown clayey till.
		10 - 18	Dark brown clayey till.
		18 - 22	Grey clayey till; contains ironstone pebbles, and coal and shale fragments.
		22 - 23	Bedrock, Belly River formation; blue grey bentonitic shale.
38	Lsd. 5, Sec. 24, Tp. 45, R. 11	0 - 5	Dark brown clayey till.
		5 - 7	Brown sandy clayey till.
		7 - 12	Dark brown clayey till.
		12 - 29	Blue clayey till.
		29 - 33	Bedrock, Belly River formation; blue grey bentonitic shale.
39	S.E. corner Sec. 23, Tp. 44, R. 11	0 - 5	Brown silty sand; contains a few pebbles.
		5 - 10	Brown coarse clayey sand and fine gravel.
		10 - 13	Bedrock, Belly River formation; grey brown soft shale.
		13 - 18	Bedrock, Belly River formation; blue grey soft shale.

RESEARCH COUNCIL OF ALBERTA

LEGEND

QUATERNARY

CENOZOIC

RECENT

- 12 — Bottomland deposit: silt, clay and organic matter, some gravel in floor of Battle River valley
- 11 — Slump and land slide
- 10 — Aeolian: wind-blown sand overlying glacial outwash

PLEISTOCENE

GLACIO-LACUSTRINE

- 9 — Sand, silt and clay

GLACIO-FLUVIAL

- 8 — Terrace: sand and gravel over bedrock
- 7 — Outwash: sand, sand and gravel
- 6 — Outwash: (thin over bedrock)
- 5 — Kame: silt, sand and gravel; inclusions of till
- 4 — Crevasse-filling: mainly till with local pockets of sand and gravel
- 3 — Esker complex: sand, sand and gravel

GLACIAL

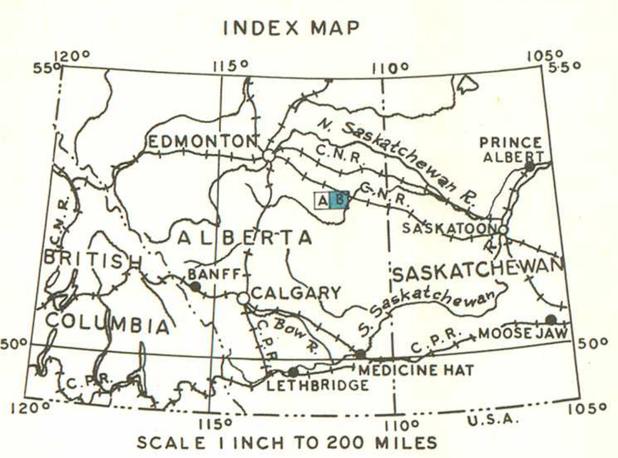
- 2 — Dead-ice moraine: mainly till, some surface cappings of sand and gravel
- 1 — Ground moraine-till: unsorted clay, silt, sand and boulders; local lenses of sand and gravel

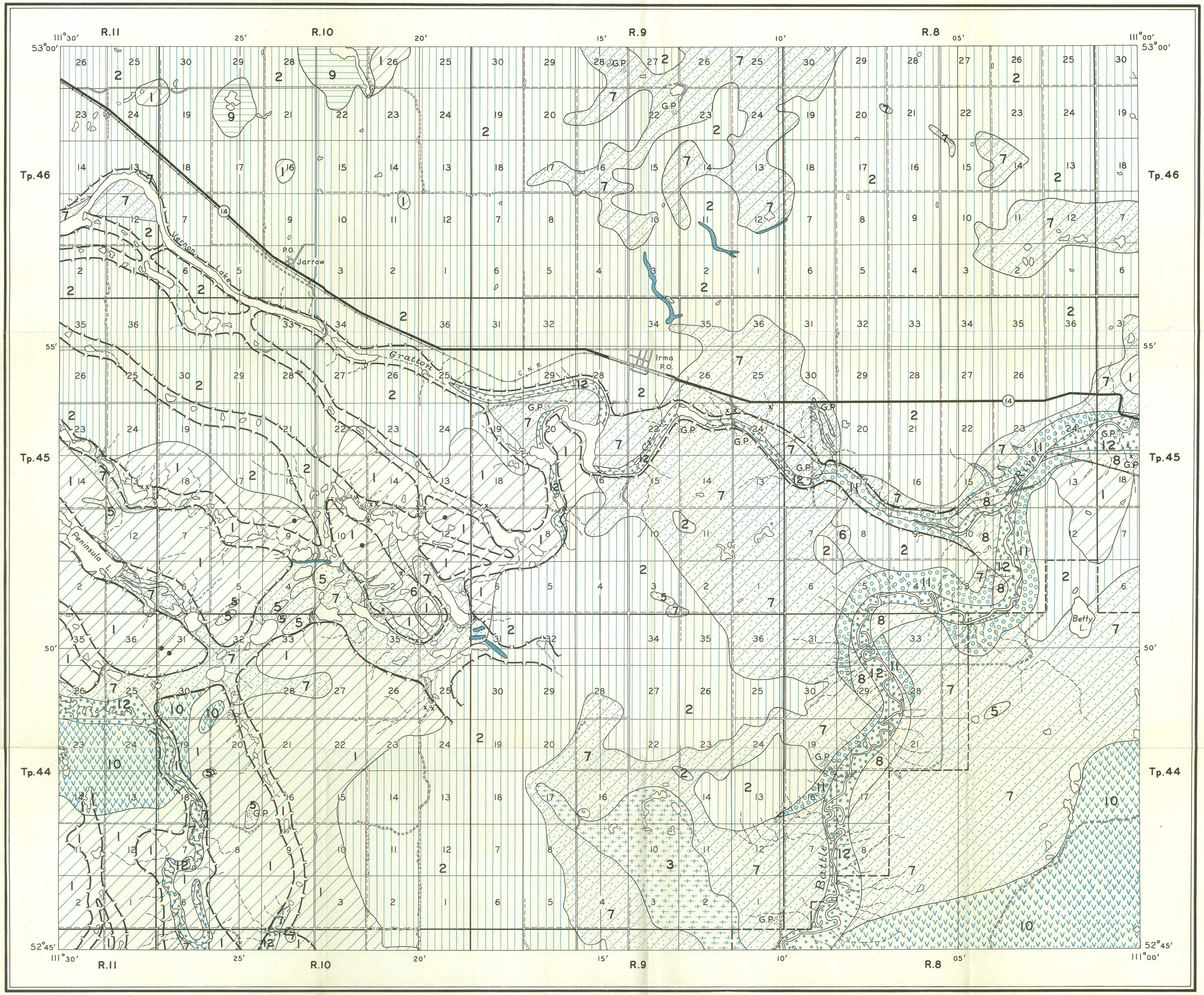
Bedrock (Upper Cretaceous) outcrop x
Fluting (denotes ice-movement direction) ....
Stream-trench ....
Gravel pit .... G.P.

Geology by C.P. Gravenor and R.B. Ellwood

Main highway .... (14)
Local road, well travelled ....
Local road, not well travelled ....
Railway ....
Township boundary ....
Section line ....
Post office .... P.O.

Cartography taken from Department of Lands and Forests, Alberta, Aerial Survey Sheet No. 73 D/14





Map to be used in conjunction with Preliminary Report No. 57-1.

Published in 1957

PRELIMINARY MAP 57-1B

GLACIAL GEOLOGY

SEDGEWICK DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

Scale: One Inch to One Mile = 1/63,360

1 3/4 1/2 1/4 0 1 2 3 MILES

RESEARCH COUNCIL OF ALBERTA

LEGEND

QUATERNARY

CENOZOIC

RECENT

8 — Bottomland deposit: silt, clay and organic matter

7 — Alluvial fan: sand, silt and clay

6 — Aeolian: wind-blown sand overlying glacial outwash

PLEISTOCENE

GLACIO-FLUVIAL

5 — Outwash: sand; sand and gravel

4 — Kame: silt, sand and gravel; inclusions of till

3 — Crevasse-filling: mainly till with local pockets of sand and gravel

GLACIAL

2 — Dead-ice moraine: mainly till; some surface cappings of sand and gravel

1 — Ground moraine-till: unsorted clay, silt, sand and boulders; local lenses of sand and gravel

Bedrock (Upper Cretaceous) outcrop x

Fluting (denotes ice-movement direction)

Stream-trench

Gravel pit .... G.P.

Geology by C.P. Gravenor and R.B. Ellwood

Main highway

Local road, well travelled

Local road, not well travelled

Railway

Oil pipe line

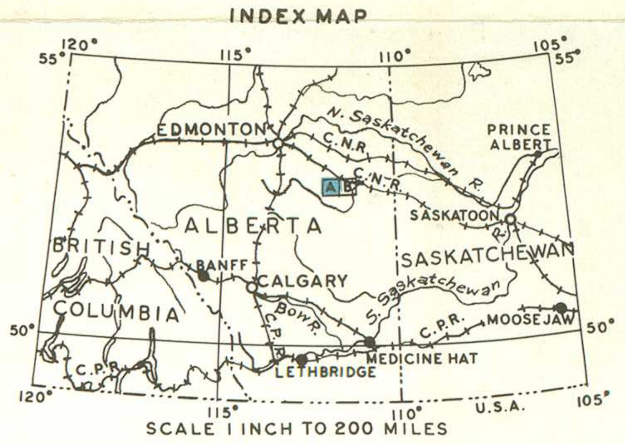
Township boundary

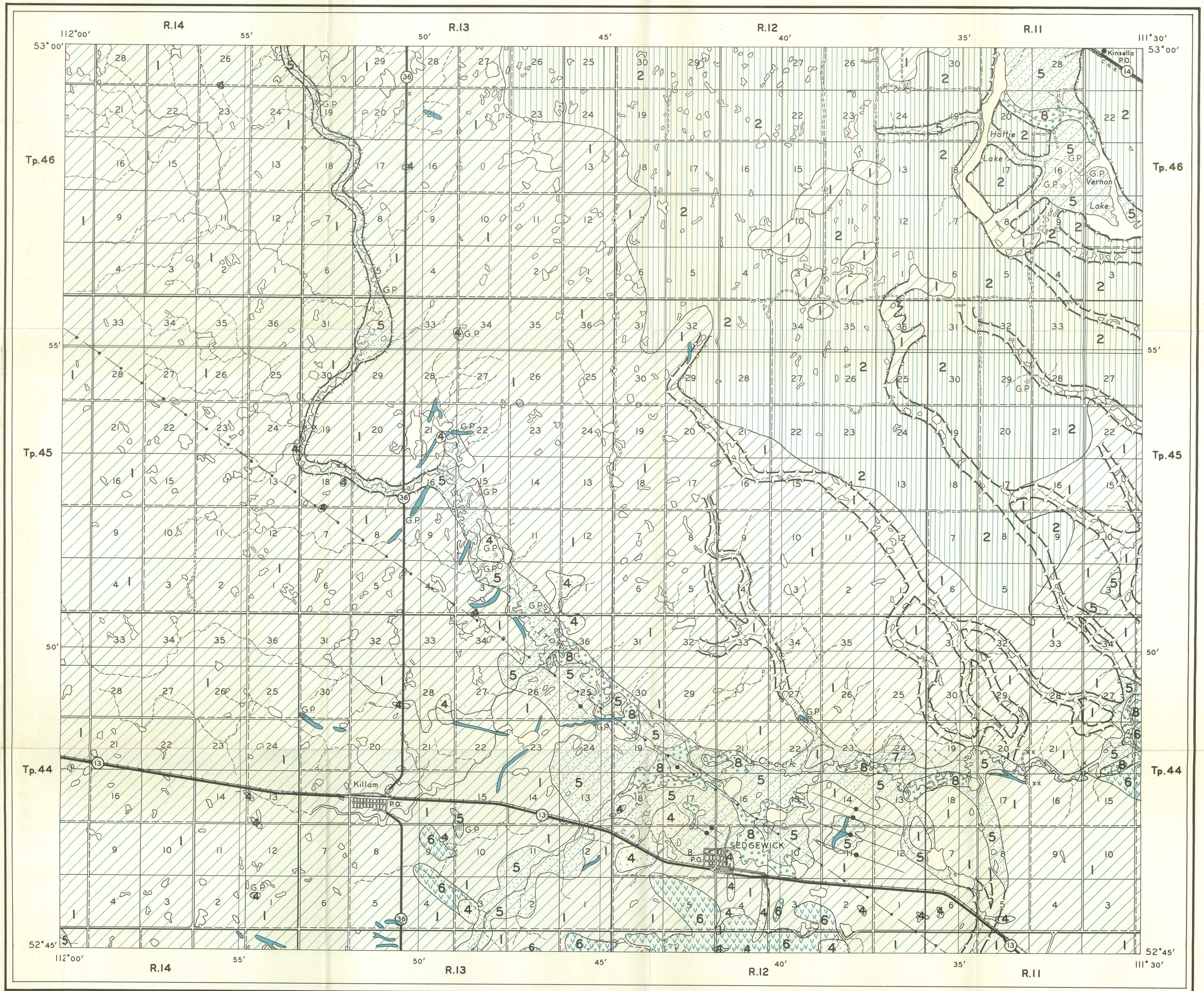
Section line

Post office .... P.O.

Cartography taken from Department of Lands and Forests, Alberta, Aerial Survey Sheet No. 73 D/13

INDEX MAP





Map to be used in conjunction with Preliminary Report No. 57-1

PRELIMINARY MAP 57-1A

GLACIAL GEOLOGY

SEDGEWICK DISTRICT, ALBERTA

WEST OF FOURTH MERIDIAN

Scale: One Inch to One Mile = $\frac{1}{63,360}$

1 ¾ ½ ¼ 0 1 2 3 MILES

Published in 1957