RESEARCH COUNCIL OF ALBERTA

Preliminary Report 56-5

AIR PHOTOGRAPHS OF THE PLAINS REGION OF ALBERTA

by

C. P. Gravenor

Research Council of Alberta
Edmonton, Alberta
1956

TABLE OF CONTENTS

AIR PHOTOGRAPHS OF THE PLAINS REGION OF ALBERTA

by

C. P. Gravenor

INTRODUCTION

Over the past 20 years air photographs have been used extensively by the geologist, soil scientist, forester, geographer, topographer and engineer. While air photographs have been used by the different professions for a wide variety of purposes, broadly speaking they have two main uses: (a) to provide accurate topographic and planimetric maps, and (b) to provide information on landforms, structure, and materials on the surface and subsurface of the earth. The main purpose of the present report is to describe, by means of a few selected photographs, some of the main glacial landforms on the plains region of Alberta. It is anticipated that a knowledge of the morphology and origin of these glacial landforms will aid the geologist and other professionals in their exploration and development of the western plains region.

Most of the photographs described are from east-central Alberta where the writer has had field experience in glacial geology. An examination of photographs from other parts of Alberta and Saskatchewan, however, shows that the features herein described are not confined to east-central Alberta but are widespread throughout the plains region. Undoubtedly as the writer's experience widens new features will be observed and added to this basic unit.

In order to make this report useful to professionals other than geologists, and to the layman, a glossary of terms has been included. In some cases the terms are those which describe "type" features in other areas and the classical definitions do not always describe accurately the features found on the plains of western Canada. The photographs used are those printed on a scale of approximately 1:40,000 by the Department of Lands and Forests, Government of Alberta. These photographs have been used for two reasons: (a) the photographs are used widely within the Province by industry and government groups, and (b) the features herein described are large enough to show up clearly on a scale of 1:40,000. Photographic prints from negatives have been used to avoid loss of definition through reproduction. The photograph numbers appear in the southeast corner of each photograph. For those interested in stereoscopic coverage the adjacent photographs may be obtained from the Department of Lands and Forests, Government of Alberta, Edmonton.

GLOSSARY

Alluvium: Sorted gravel, sand, silt and clay deposited through the action of flowing water. In many geological reports the term alluvium is used only for modern river-sorted material. In this report, however, the term refers to any river-sorted deposit regardless of geologic age.

Alluvial fan: Fan-shaped deposits of gravel, sand, silt and clay deposited by streams (usually braided) issuing from a high land region.

Colluvium: General term for material which has moved downslope through gravity.

Crevasse-filling: A short, relatively straight, ridge of material which resulted from debris slumping into or being washed into an ice fracture or crevasse during the stagnation or waning stages of glaciation. According to classical definition the material in crevasse-fillings is stream-sorted gravel, sand and silt, but in east-central Alberta crevasse-fillings are commonly formed of till which had slumped into the crevasses or fractures. Lenses of stratified materials are often found incorporated in the till of the crevasse-fillings of east-central Alberta, and in some cases the stratified gravel, sand and silt may make up more than 50 percent of the total.

Drumlin: An oval-shaped hill usually composed of till. Most drumlins have a streamlined shape, with the steep side pointing in the upstream ice-direction. Their long dimension records the direction of the ice movement. Drumlins are formed during the advancing stages of glaciation.

Esker: A sinuous ridge composed of stratified gravel, sand and silt which was deposited from glacial meltwaters flowing through a tunnel in the ice or through an ice-walled valley. Ridges tributary to the main ridge are common, and from the air an esker system resembles an inverted stream course.

Fluting: Shallow, parallel grooves formed on ground moraine. Origin is not thoroughly understood but probably similar to drumlin formation, and undoubtedly formed during the advancing stages of glaciation.

Ground moraine (till plain): Gently undulating plain which, from the air, has a pock-marked appearance caused by the many shallow undrained depressions (kettles). The pock-marked appearance, while typical of much of the ground moraine of Alberta, is not extensively found on the ground moraine of eastern North America. Ground moraine is formed primarily of till which may contain local lenses of stratified sand and gravel.

Kame: Genetically the kame is similar to an esker in that they are both formed in contact with the ice, and from meltwater action. Topographically they are quite different: an esker is a sinuous ridge and a kame is a jumble of knolls and hollows. A kame is formed of stratified gravel, sand and silt which may contain local pockets of till. The formation of a kame can be visualized as an alluvial fan or pothole filling formed in contact with the ice. When the ice melts from under the alluvial fan the stratified materials are let down, giving rise to the hummocky topography, and faulting and folding of the stratified materials.

Kettle: A kettle is an undrained depression or pit which was formed by the melting out of a stagnant ice block which was enclosed in the glacial drift. Kettles are found in areas of ground moraine, "dead-ice" moraine, end moraine and in glacial meltwater deposits. In some cases the depressions may have a low rim around the outside and then are called "rimmed kettles".

Lacustrine plain: A relatively flat plain underlain by horizontally stratified deposits of sand, silt and clay. In some instances well developed shore cliffs may be found marking the edge of the lakes. In many instances in western Canada, however, shore cliffs are not found.

Moraines: Moraines of western Canada can be divided into three groups: (a) ground moraine, (b) end moraine, and (c) "dead-ice" or ablation moraine. Of these, ground moraine has been discussed already under its own heading.

End moraine: A ridge of till that may include stratified material, usually lobate in plain view, which was dumped at or near the terminus of a glacier. The theory of formation is that melting along the front surface of the ice approximately equals the rate of forward advance of the glacier. Hence the ice front is more or less static, and debris which has been brought forward in the ice is exposed by this melting and subsequently slumps off to form a ridge. End moraines are not common in central Alberta except on a very local scale.

"Dead-ice" moraine: The "dead-ice" moraines of central Alberta (i.e. the Viking and Buffalo Lake moraines) are broad, roughly north-south zones of rugged topography -- commonly called knob and kettle topography -- which are made up primarily of till. Interspersed with the till knobs are cones and small hillocks of gravel. Frequently a thin layer of poorly sorted, angular gravel overlies the till. The "dead-ice" moraines were formed by the stagnation of debris-choked ice. The formation of "dead-ice" moraine is similar, in many respects, to the formation of prairie mounds.

Outwash plain: An outwash plain is a relatively flat plain underlain by horizontally stratified sand and gravel, and formed by deposition from braided streams issuing from the ice. The outwash plain differs genetically from a kame in that the outwash plain is built in front of the ice and not in contact with the ice. It differs from a spillway in that the spillway is bounded by valley walls. In some instances an outwash plain may contain kettles, and in such instances it is called a pitted outwash plain.

Prairie mound: Prairie mounds are essentially mounds of till which from the air resemble giant doughnuts. The mounds average about 300 feet in diameter and from 10 to 15 feet in height and, in most cases, have a slight central depression which lies 3 to 4 feet lower than the outer rim of the mound. It is believed that the mounds originated as debris-filled pits on a stagnant ice surface, and that the melting of the ice left behind the pit-fillings as mounds. These mounds, as well as till crevasse-fillings, "dead-ice" moraine and infilled stream-trenches, all point to large-scale stagnation of the last ice to cover Alberta.

Spillway: Spillways are valleys which were cut by glacial meltwaters issuing directly from the ice or from glacial lakes. In Alberta, the term coulee is frequently given to these spillways. The spillways or coulees often have present-day streams in them which are obviously too small for the size of the valleys; such present-day streams may be called "misfits". Spillways may be floored with sand and gravel, or bedrock, or pre-existing glacial materials, depending upon the characteristics of the glacial waters which flowed through them.

Till: Till is by far the most common of glacial deposit and consists of an unsorted mixture of boulders, pebbles, sand, silt and clay. The pebbles and boulders consist of a wide variety of rock types, and are often quite angular. Farmers frequently speak of till as clay, since clay is the most obvious constituent of till when the till is wet or when boulders and pebbles are relatively scarce. Till is the main material of ground moraine, end moraine and "dead-ice" moraine. It is deposited in two ways: (a) by "plastering-on" during the advance of a glacier, and (b) by deposition from the debris-laden melting ice during the retreat of a glacier. The latter till is frequently more sandy than the former and is found directly at the surface of the ground overlying the more clayey basal till.

Valleys: There are four main types of valleys found in central Alberta: (a) preglacial, (b) stream-trenches, (c) postglacial, and (d) spillways. Of these, spillways have been discussed already under a separate heading.

(a) Preglacial valleys are those which were cut prior to the first Pleistocene glaciation to cover Alberta and are frequently underlain by "Saskatchewan sands and gravels" of late Tertiary (?) age. The preglacial valleys were quite broad as compared to the "V" shaped postglacial ones. The preglacial valleys were partially infilled by glacial materials during the advances and retreats of the glacier. In some areas the preglacial valleys have been partially exhumed by glacial and present-day drainage.

(b) Stream-trenches are similar to spillways in that they carried glacial meltwaters. They differ from spillways in that one or both sides of the valley walls were supported by ice. They are visualized as glacial meltwaters spilling through ice-walled fractures, forming a complex, interconnected series of channels. They are frequently infilled by till caused by the debris-choked stagnant ice walls slumping into the meltwater channels.

(c) Postglacial valleys are those which have been cut by present-day streams, and are not related to glacial meltwaters.

TILL CREVASSE FILLINGS

Photograph No. 160-5303
1333-36

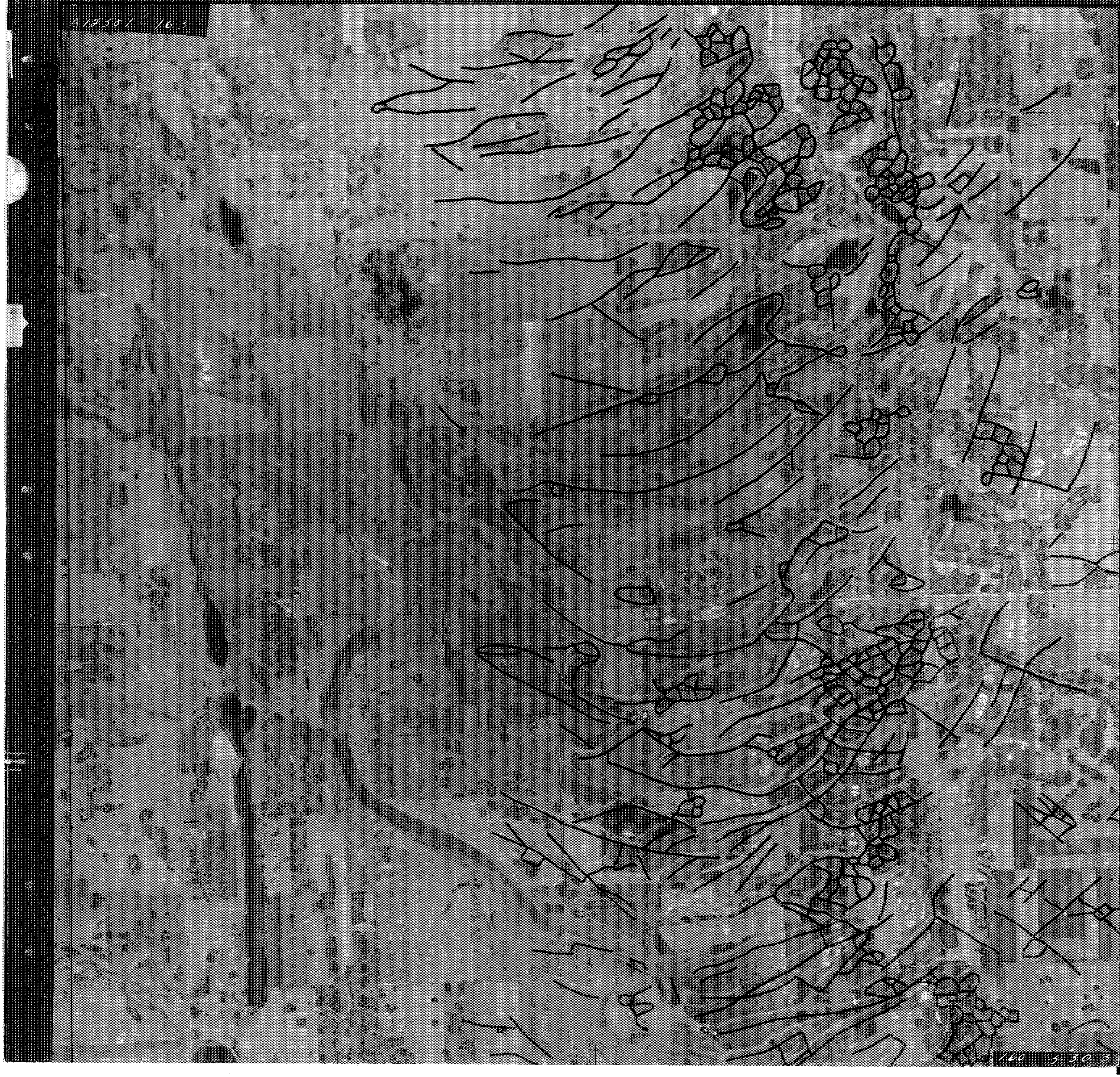
Location: Tp. 48, R. 1, W. 4th.

This photograph is characterized by a series of ridges which average 10 to 25 feet in height, 50 to 150 feet in width, and a mile or more in length. Although most of the ridges trend in a northeast-southwest direction, a smaller number trend in a northwest-southeast direction. The intersection of these ridges forms a box or waffle-type pattern. Towards the southern part of the photograph the ridge forms a lobate pattern not unlike that of a lobe of a glacier. Whether or not this lobate pattern has significance with regard to the shape of the glacier when these ridges were deposited is unknown, but certainly suggestive. In the eastern part of this photograph and in the area north of the one under discussion, the ridges grade into polygonal shapes with central depressions. This group of polygonal ridges forms a small area of subdued "dead-ice" moraine, and it is quite evident that an explanation of one must fit the other.

The origin of the ridges of this area was first discussed by Bayrock (1955), who called them ice-block ridges after somewhat similar ridges found in the Lake Simcoe district of Ontario. It is believed that these ridges and enclosed depressions are stagnant ice features and developed from debris which slumped into ice fractures and from the edges of stagnant ice blocks during the waning stages of glaciation. The pattern of the ridges shown on the overlay suggests a crushed or badly fractured stagnant ice lobe which was moving in a southerly direction prior to stagnation. South of this locality in the Alliance-Killam district similar, although less well defined, crevasse fillings have been found which consist of till and mixtures of till and stratified materials. The stratified materials show evidence of ice-contact deposition (i.e., faults and folds). Rarely is the stratified sand and gravel suitable for construction purposes. It has been suggested that certain similar ridges have been formed as pressure ridges under an ice load. This explanation might be accepted for more isolated ridges, but where they clearly grade into areas of "dead-ice" moraine a fracture filling origin seems more acceptable.

Reference:

Bayrock, L. A. (1955): Glacial geology of an area in east-central Alberta; Research Council of Alberta Prelim. Report 55-2, 46 pages.


A12581 163
160 5 30 3

"U"-SHAPED DUNES

Photograph No. A9109-78 162 A 5505
2406 52 40

Location: Grande Prairie.

This photograph was chosen as one of the best to illustrate "U"-shaped dunes in Alberta. Similar dunes are found at many locations in the province -- for example, in the Pembina, Rocky Mountain House, Redwater, and Stony Plain areas, and in the northeastern part of the province.

The "U"-shaped dune differs from the barchan in two respects: (a) the horns of the "U"-shaped dune point upwind whereas those of the barchan point downwind, and (b) the steep side of the "U"-shaped dune lies on the outside of the "U" whereas the steep side of the barchan lies on the inside. The two types are similar in that the steep side always faces the downwind direction. Applying this principle to the Grande Prairie dunes indicates that the winds which formed the dunes came from the west. Longitudinal ridge dunes and transverse dunes are commonly associated with the "U"-shapes dunes of Alberta.

The origin of "U"-shaped dunes is under some dispute, but it is generally agreed that they are the product of wind-blown sand in a semi-arid to humid region and that vegetation plays a large role in their formation. On the other hand,barchans are found in true desert areas of bare, free-blowing sand.

"U"-shaped dunes have been called parabolic dunes, humid dunes, blowout dunes, "V"-shaped dunes, bow-shaped dunes, etc. Essentially, they are all the same in origin but differ slightly in shape. In Alberta the sand was derived mainly from outwash plains, flood plains and lake deposits, all of glacial age. To the writer's knowledge these dunes were first called the "U"-shaped type in 1951 in a booklet entitled "Outstanding Aerial Photographs in North America", published by the American Geological Institute.


162A - 5505

PROGLACIAL LAKE AND DRAINAGE PATTERNS

Photograph No. 160-5205
1501-22

Location: Tp. 38, R. 11 and 12, W. 4th.

The accompanying photograph shows a number of features of both glacial and postglacial age.

The last glacier apparently moved across this area in a southeasterly direction as is indicated by the rather poorly defined flutings in the southwestern part of the photograph. During the advancing and retreating stages, a layer of ground moraine was deposited over much of the area.

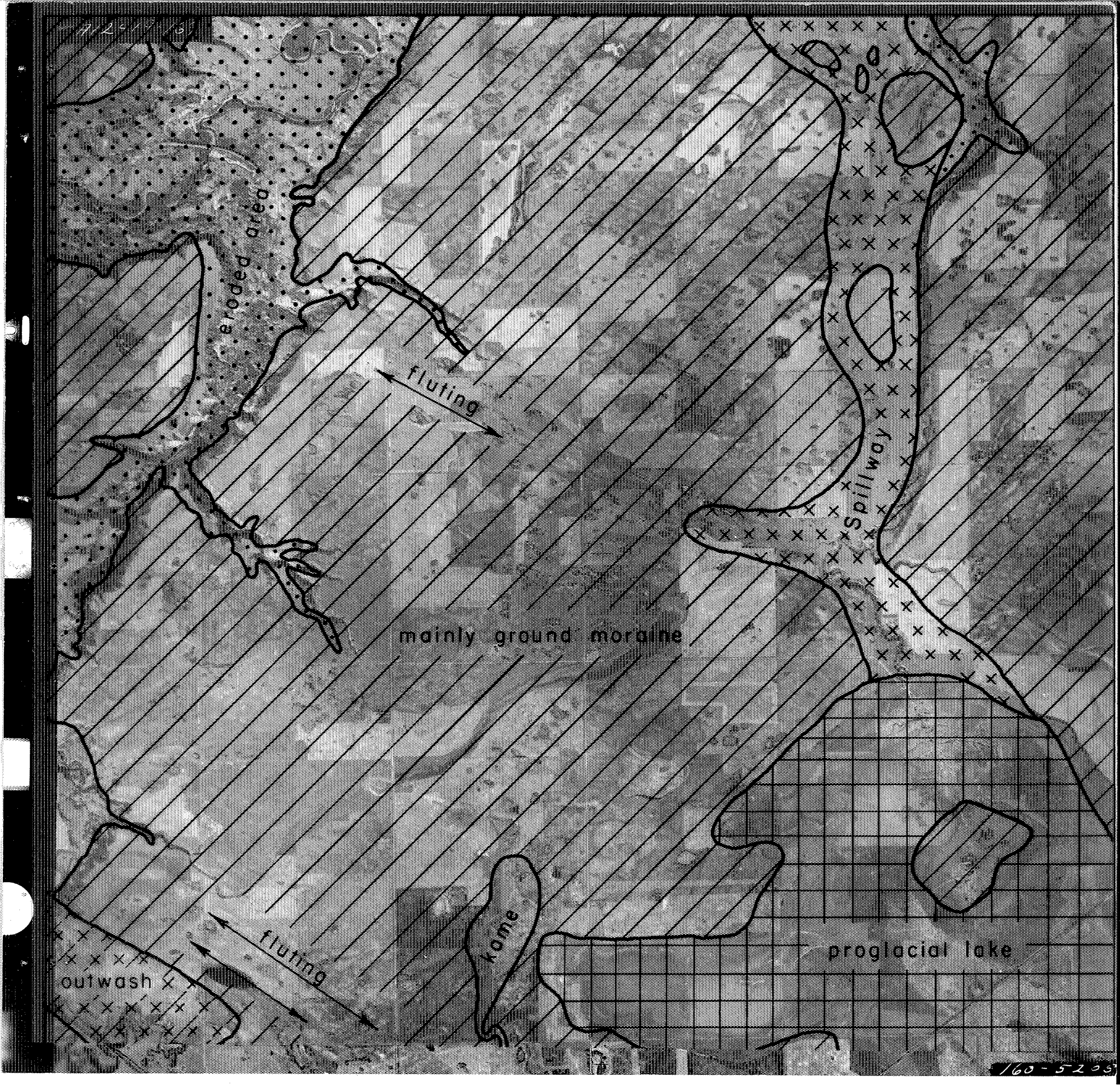
In the south-central part of the photograph, just to the west of the proglacial lake, the retreating ice left a kame deposit. Most of the kame is made up of rather subdued knobby topography, except at its southern limits where it forms a very definite sinuous ridge -- much like a crevasse filling or esker. Just south of the photograph the material in this ridge is used as a source of construction materials. The kame was probably formed by meltwaters spilling into a fracture or re-entrant in front of the glacier.

The proglacial lake deposit found in the southeast corner of the area is a natural depression which was partially filled with clay, sand and silt from glacial meltwaters coming down the spillway. After glacial times clay has been washed into the basin from the surrounding ground moraine and layers of organic muck have accumulated. In other words, during a wet season this proglacial lake area would be considered a slough. One very interesting feature of this proglacial lake is the nature of the drainage in the northern part of the lake. The lace-like pattern is indicative of poorly-drained impermeable material, which in this case signifies that the lake is filled with clay and silt. The proglacial lake extends for several miles south of the photograph.

To the north of the proglacial lake a spillway occurs. This spillway carried glacial meltwaters which scoured off the till, in some places exposing bedrock, and deposited a thin layer of sand and gravel along the spillway courses. These sands and gravels are too thin to be of any economic importance.

The small area of outwash sand in the southwest part of the photograph is marked by light tone and wavy appearance caused by windblown sand overlying the outwash.

Postglacial drainage has cut through the ground moraine cover exposing bedrock along most of the creeks.



eroded area
fluting
Spillway
mainly ground moraine
fluting
kame
outwash
proglacial lake
160-5205

SLUMP

Photograph No. 160-5206
1551-30

Location: Tp. 39, R. 10 and 11, W. 4th.

The type of earth movement described here as slump is sometimes given the term landslide, or rock slide. The term slump is used in this particular instance since the movement is in part activated by water saturation and frost action. On the other hand, most definitions of slides of various types do not include lubrication by water, but are mainly gravity movement.

In this area the Battle river lies some 200 to 300 feet below the level of the upland till plain. The walls of the Battle valley are formed primarily of soft bentonitic shales of the Bearpaw formation. When these shales are saturated with water they become very plastic and movement by rotational slippage (and possibly lateral expansion and creep) takes place on a very low angle of slope. This movement (slump) takes the form of a series of steps leading from the upland down to the valley bottom. Evidence of very recent slump is found in some of the white lines which separate the slump area from the upland ground moraine. Many of the fine white lines are probably snow.

Slump is quite common along many rivers in Alberta where the valley walls consist of poorly consolidated clay and silt, and clearly demonstrates the advisability of examining air photographs prior to planning bridge crossings or other construction.


ground moraine
slump
alluvium
slump
ground moraine

CONTORTED BEDROCK, ALLUVIAL FAN, GROUND MORAINE, AND "DEAD-ICE" MORAINE

Photograph No. 160-5203
1501-38

Location: Tp. 37, R. 9, W. 4th.

The most prominent feature on the photograph is a bedrock high -- Nose Hill -- which forms a part of an extensive series of bedrock erosion remnants in east-central Alberta collectively known as the Neutral Hills. These bedrock erosion remnants rise from 100 to 300 feet above the surrounding plain and are underlain mainly by bentonite shales and sands of the Bearpaw formation.

When the ice advanced over these hills, the underlying soft Cretaceous bedrock was severely folded and faulted by ice pressure. Excellent sections of such contorted hills are exposed south of Monitor, Alberta, and have been fully described by Slater (1927). Shallow drilling carried out by the Research Council of Alberta (Gravenor and Bayrock, 1955) shows that the bedrock making up Nose Hill is also badly deformed.

The northwest-trending ridge pattern seen on the photograph is the result of faulting and folding by ice pressure, and is not due to tectonic forces. There is a thin layer of till -- 5 to 10 feet thick -- above the bedrock; this till thickens towards the northeast into the Viking "dead-ice" moraine. South of Nose Hill the till is from 10 to 20 feet thick and bedrock is exposed in the stream valleys.

Erosion on the southwestern side of Nose Hill has produced a thin mantle of fine gravel, sand, silt and clay over the ground moraine. This stream-deposited debris (alluvial fan) is about 1 mile in width and 7 miles in length, circling the southern portion of Nose Hill. The fan slopes gently away from the foot of the hill. Drilling operations on the fan show that the alluvium is about 5 feet thick and is underlain by till. Similar alluvial fans are found around the hills to the north and east of Nose Hill. The variable nature of the material underlying the alluvial fan is shown by the drainage on the fan. For the most part, the drainage displays a fine dendritic pattern with clay-type broadly "U"-shaped gullies. This pattern indicates that the alluvial fan deposits are fairly homogeneous and developed in fine-grained materials. On the other hand, at some locations on the fan, the drainage issuing from Nose Hill disappears into the fan; this indicates more permeable and hence coarser materials at these locations.

References:

Gravenor, C. P. and Bayrock, L. A. (1955): Glacial geology of the Coronation district, Alberta; Research Council of Alberta Prelim. Report 55-1, 38 pages.

Slater, G. (1927): Structure of the Mud Buttes and Tit Hills in Alberta; Geol. Soc. America Bull., Vol. 38, pp. 721-730.


eroded area
dead ice moraine
thin ground moraine over bedrock
alluvial fan
ground moraine
160-5203

STREAM-TRENCHES

Photograph No. 160-5215
1368-13B

Location: Tp. 45, R. 10, W. 4th.

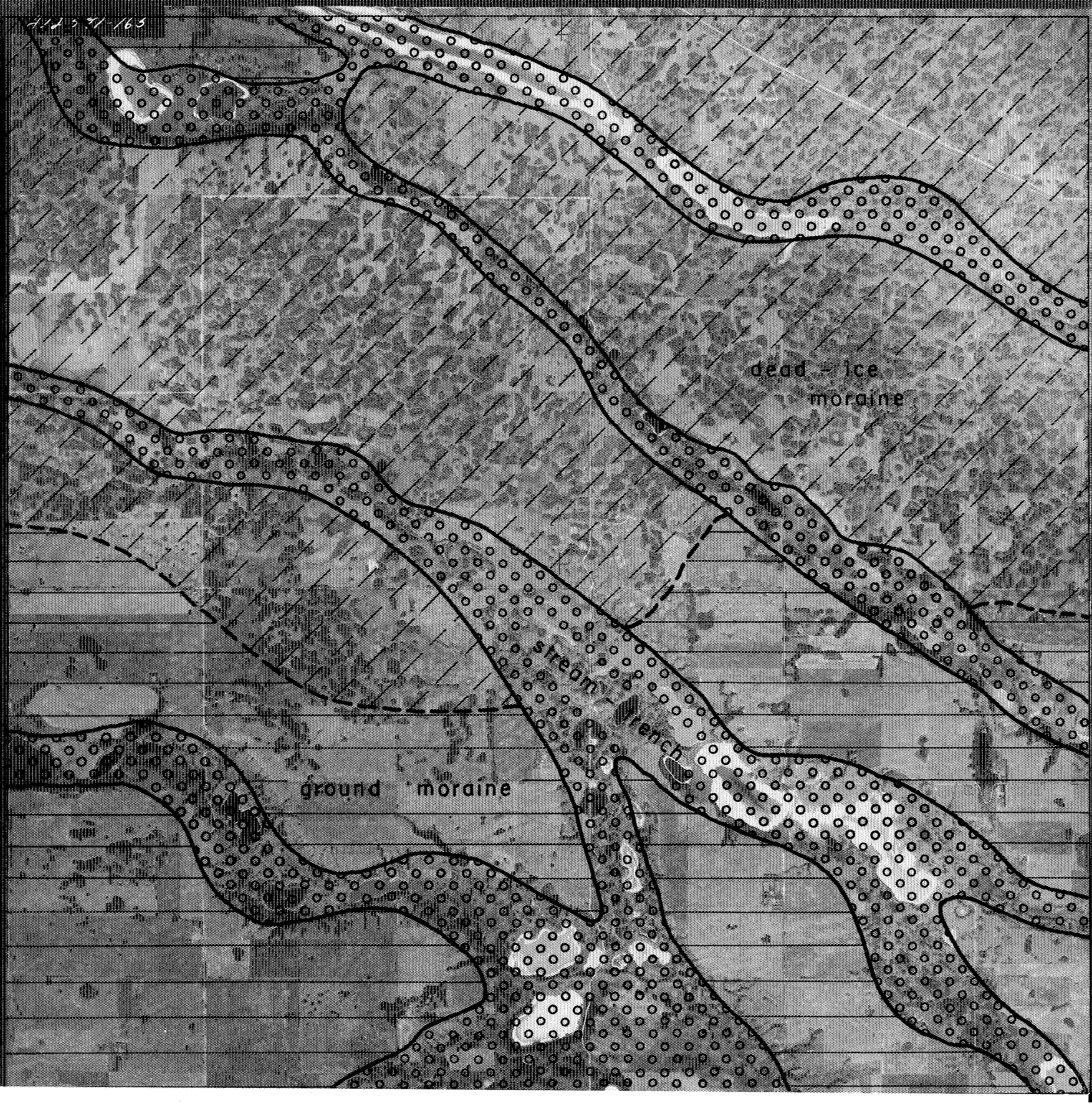
Stream-trenches consist of a confused system of interconnected, debris-filled channels. The stream-trenches of east-central Alberta can be divided into two types which are genetically similar: (a) those which are filled with moraine and sorted materials and are recognized on air photographs by the alignment of kettle lakes in the base of the valleys, and (b) broad, open troughs which contain little or no present-day drainage. The latter type is most common in areas of thin ground moraine and bedrock is frequently exposed in the valley walls. The former type is most common in areas of "dead-ice" moraine and bedrock is found at a considerable depth (up to 100 feet) below the base of the valleys. There are all degrees of gradation between these two types. In some instances the filled type of trench may broaden to widths of a mile or more and may contain thick deposits of sorted materials in the form of crevasse fillings, kames and eskers.

The trenches were formed during the waning stages of glaciation when the ice had thinned to the point where it was no longer active. At this stage in the deglaciation meltwaters flowing through fractures in the rotten ice cut down through the ice and into the underlying materials, giving rise to the trenches. The trenches were later infilled through the slumping into the trenches of the debris-choked ice walls.

The stream-trench systems of east-central Alberta have considerable importance economically. The open type of trench supplies gravel and the moraine-filled trench supplies groundwater. In many moraine-filled trenches the relatively impermeable moraine is underlain by sand and gravel, which in turn is underlain by impermeable bedrock. Thus conditions for artesian systems are satisfied, and wells in these trenches have been found to be artesian.

Reference:

Gravenor, C. P. and Bayrock, L. A. (1956): Stream-trench systems in east-central Alberta; Research Council of Alberta, Prelim. Report 56-4, 11 pages.



dead - ice
moraine
stream trench
ground moraine

ESKER

Photograph No. 160-5205
1501-32

Location: Tp. 38, R. 8, W. 4th.

The main features shown on this photograph are an esker, a kame, an outwash plain and a proglacial lake. These features all lie in a broad lowland which is bordered on the north and south by a till and bedrock upland. This broad lowland has been cut in bedrock and possibly marks the position of a preglacial river.

As the last glacier retreated towards the north and northeast in this region, meltwaters running off and through the ice deposited sand and gravel in the form of outwash plains, kames and eskers. The outwash plain which lies in the southeastern part of the lowland area was probably deposited by streams issuing from the ice. The formation of the outwash plain was probably quite similar to the formation of recent alluvial fans, one of which is shown on this photograph. In the case of the alluvial fan the debris is being washed out from the bedrock high north of the fan. If the bedrock high is replaced by ice, then debris washed out of the ice forms the outwash plain. The fact that the outwash plain is made up of coarse, permeable materials is demonstrated by the fact that streams issuing from the high land areas to the south of the outwash disappear upon entering the outwash plain.

The esker and associated kames were probably deposited during the late stages of deglaciation when the ice was cut up by meltwater channels, tunnels and potholes (moulins). The esker is made up of gravel, sand and silt which were deposited from glacial meltwaters flowing through an ice tunnel or through an ice-walled valley. When the ice finally melted, the debris was left as a sinuous ridge. The kames were probably deposited as deltas and ice-channel fillings. This latter mode of formation is suggested by the numerous wiggly ridges found on the kame materials. Thus, in this area, the esker, kame and outwash plain are closely related in time of formation, and all are the products of meltwaters running on, in, and in front of, the ice. During the time when the ice was melting back from this location, the northeastern outlet of Ribstone creek was blocked by ice. Consequently, glacial meltwaters were ponded in the Ribstone Creek valley, and this resulted in lacustrine deposits which are slightly later in age than the esker. Thus, the clay, silt and sand which make up the lacustrine deposits overlie the esker and kame edges. Drilling operations off the sides of the esker show variable thicknesses of lacustrine deposits underlain by gravels which belong to the esker.

The topography of the upland till plain of this region is strongly affected by the underlying bedrock; the fact that the bedrock is close to the surface is shown by the outcrop which exists on the north side of the alluvial fan.

mainly ground moraine
bedrock
alluvial fan
proglacial lake
kame
kame
kame
esker
outwash
outwashsand
mainly ground moraine

SPILLWAY

Photograph No. 160-5201
1474-31

Location: Tp. 35, R. 11, W. 4th.

The spillway which is shown on the accompanying photograph is known as the Sullivan Lake spillway. Sullivan lake lies about 16 miles west of the locality shown on the photograph. When the last glacier had retreated north of this district, meltwaters from the ice collected in the Sullivan Lake basin, then spilled over the eastern edges of the basin and flowed in an easterly and southeasterly direction.

In the locality under discussion the meltwaters flowed very rapidly and eroded off the thin cover of till, thus exposing the underlying Cretaceous sandstones. The photograph shows only a portion of the Sullivan Lake spillway; nevertheless, it illustrates the braided pattern of the channels, the till islands which withstood erosion, and shows a major channel which has been scoured down to bedrock.

South of this locality the spillway fans out, and material which had been eroded from the north and east was deposited to form large gravel and sand flats. A good example of one of the deposition zones can be seen on the road between Coronation and Scotfield where about 12 miles of coarse gravel is exposed in the ditches.

Localities which are marked outwash on the accompanying overlay are mainly thin sand with some gravel overlying till. The localities marked spillway are primarily very thin alluvial deposits overlying bedrock. In the northwestern part of the photograph the spillway is floored with fairly thick quantities of gravel which is being used for road construction.

outwash
thin
ground
moraine
spillway
ground moraine
ground moraine
spillway

VARIATIONS IN THE TILL THICKNESS OVER BEDROCK, AND ASSOCIATED EROSION FEATURES

The two photographs under discussion are from adjacent localities and have a small overlap which may be used for stereoscopic coverage.

Photograph No. 160-5204
1501-14

Location: Tp. 37, R. 14, W. 4th (town shown is Castor, Alberta).

This photograph illustrates the varying thickness of till over bedrock and the erosion of bedrock in east-central Alberta. The erosional features will be described separately in the next photograph.

The series of shallow holes drilled at this locality demonstrate that the till is thickest in the southwestern part of the locality and is quite thin in the central and northeastern part (the locations of the drill holes are shown on the accompanying overlay, and the logs are given at the end of this description).

The area of thin till over bedrock is a flat featureless plain with bedrock exposed in ditches and in stream valleys. The till is too thin to support shallow kettles and hence lacks the pock-marked appearance of the ground moraine in the southwestern part of this locality. Although the flat area of thin till over bedrock might be confused with a lacustrine plain, it is differentiated by the type of erosion and valley development which is typical of bedrock erosion in this district.

Photograph No. 160-5204
1501-16

Location: Tp. 37, R. 13, W. 4th.

This photograph illustrates the postglacial erosion of a bedrock escarpment.

The escarpment trends in a northwesterly direction and is being exhumed by present-day erosion of streams which head on the escarpment and discharge towards the northeast. The escarpment marks, approximately, the contact between the Bearpaw formation in the northeastern part of the locality and the Edmonton formation in the southwest.

It will be noted that in the headwater regions of the streams, the valleys fan out to form large erosion pits. The valley walls of the erosion pits are from 15 to 30 feet high, steep-sided, and composed of bedrock. A thin layer of till -- about 5 feet thick -- overlies the bedrock in the upland areas. The floors of the erosion pits are covered by a thin layer of alluvium over bedrock. Erosion remnants in the form of small buttes are found within the erosion pits. The bedrock is made up of bentonitic shales, sandstones, and clay-ironstone layers. Erosion on the sides of the pits is greatly facilitated by the alternate swelling and shrinking of the bentonitic bedrock which causes fragments of the bedrock to spall off; otherwise, erosion in the pits is caused mainly by rill action on the pit walls. The whole process of erosion is akin to badland development and resembles minor pediment formation (i.e., the parallel retreat of valley sides leaving a gently sloping floor of bedrock thinly covered by alluvium).

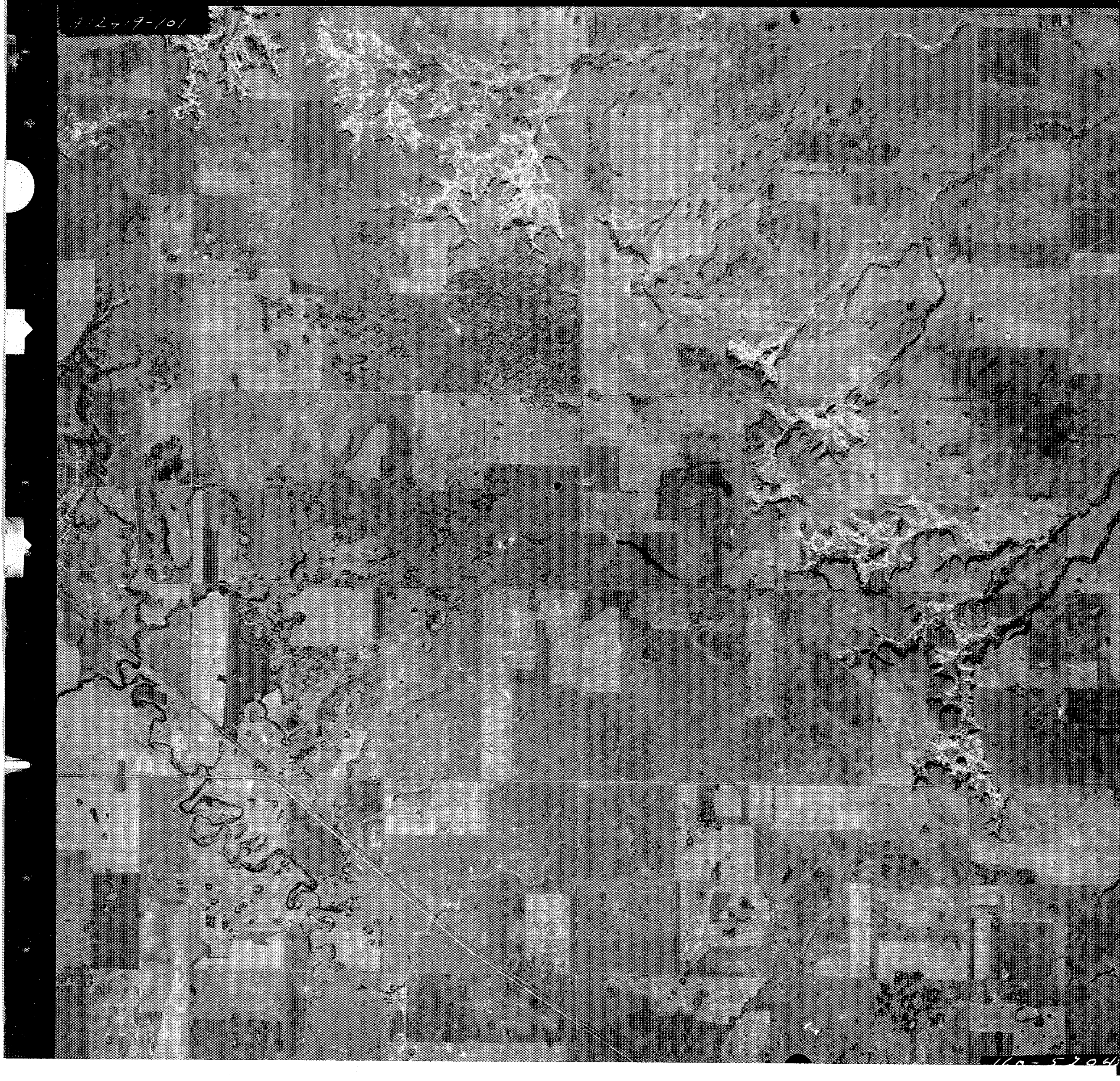
Drill Holes

(Drill hole number corresponds to number on overlay)

Drill hole No.	Depth, feet	Description of material
1	0 - 14	Brown stony till.
	14 - 21	Grey clayey till; few stones.
	21 - 25	Bedrock, Edmonton formation; grey-green medium-grained sandstone.
2	0 - 20	Brown sandy till; contains a few thin sand lenses; water table at 19 feet.
	20 - 25	Bedrock, Edmonton formation; grey-green medium-grained sandstone.
3	0 - 7	Light-brown silty till; contains a few lenses of inter-stratified silt.
	7 - 18	Brown clayey till.
	18 - 22	Bedrock, Edmonton formation; dark-grey sandy siltstone.
4	0 - 6	Light-brown silty till.
	6 - 9	Bedrock, Edmonton formation; grey sandstone containing shale layer and organic matter.
5	0 - 3	Light-brown silty clay.
	3 - 6	Brown sandy till.
	6 - 8	Bedrock, Edmonton formation; grey shale.
	8 - 8.5	Ironstone nodules.
	8.5 - 9	Coal.
6	0 - 9	Brown sandy till.
	9 - 12	Bedrock, Edmonton formation; coal.
	12 - 14	Grey-green medium-grained sandstone.
7	0 - 8	Dark-brown clayey till.
	8 - 8.5	Bedrock, Edmonton formation; bentonite seam.
	8.5 - 13	Red shale.
8	0 - 5	Light-brown silty till.
	5 - 13	Brown sandy till.
	13 - 18	Bedrock, Edmonton formation; coal.
9	0 - 3	Brown sandy till.
	3 - 5	Bedrock, Edmonton formation; grey-green sandstone.

Drill hole No.	Depth, feet	Description of material
10	0 - 12	Brown clayey till; high salt content.
	12 - 15	Bedrock, Edmonton formation; dary-grey shale with interlayered sandstone.
11	0 - 16	Brown sandy till.
	16 - 22	Grey sandy till; water table at 20 feet.
	22 - 25	Bedrock, Edmonton formation; grey sandstone with shale partings.
12	0 - 5	Bedrock, Edmonton formation; bentonitic sandstone.
13	0 - 3	Bedrock, Edmonton formation; bentonitic sandstone.
14	0 - 2.5	Brown sandy till.
	2.5 - 5	Bedrock, Edmonton formation; coal.

bedrock
strip mines
thin ground moraine over bedrock
ground moraine
13
12
11
10
9
8
7
6
5
4
3
2
1
160-520



GROUND MORAINE

Photograph No. 160-5214
1368-6

Location: Tp. 44, R. 14, W. 4th (Town of Killam in southeast corner of photograph).

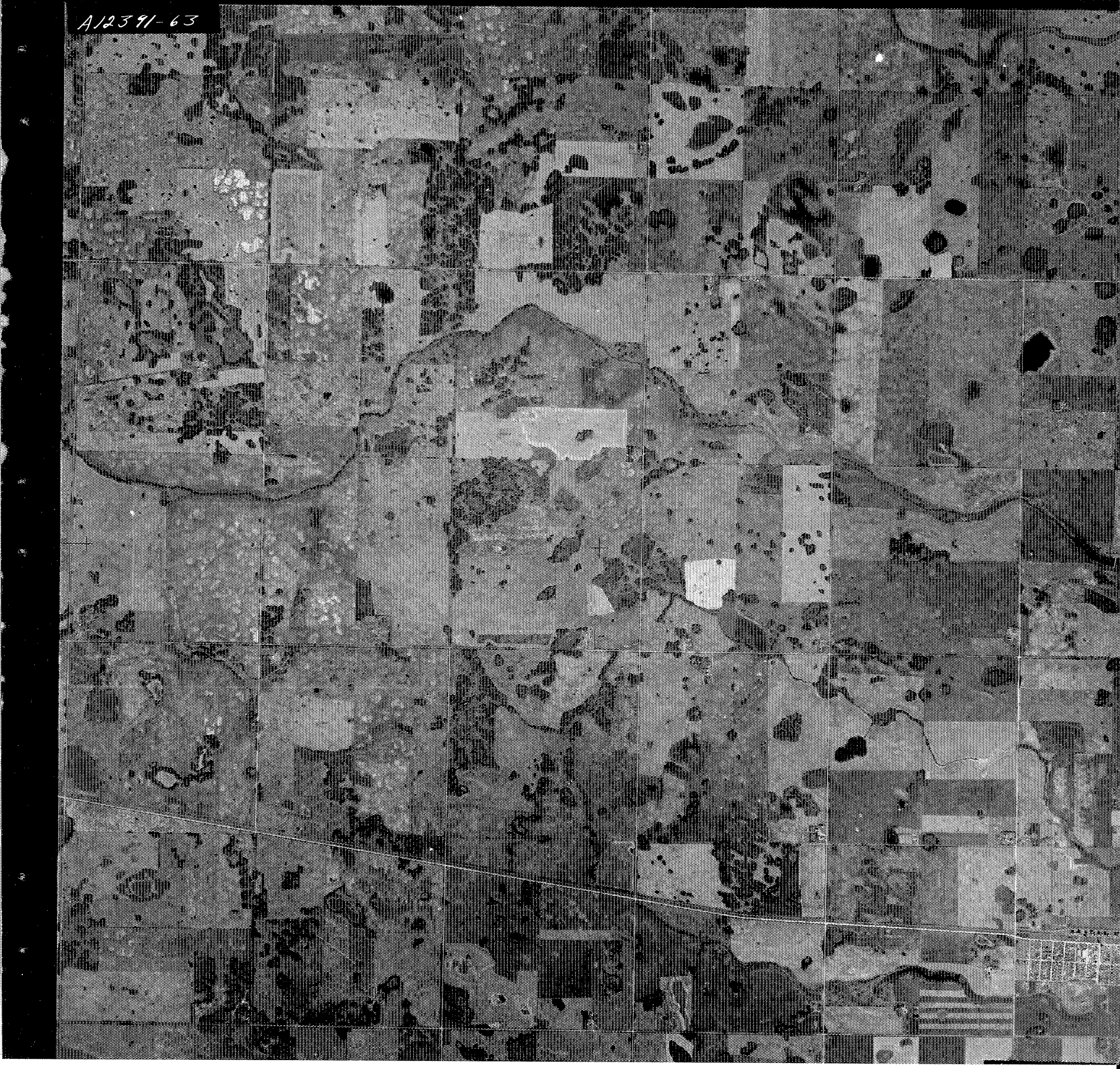
Ground moraine is undoubtedly the most common of the glacial deposits, and the photograph under discussion is typical of much of central Alberta.

The topography is flat to gently rolling and is broken only by shallow post-glacial streams and a few small crevasse fillings. One such crevasse filling is found about 2 miles northwest of the Town of Killam. In this case the crevasse filling is composed of stratified materials, and might be called a kame except for its linearity which probably places it into the crevasse-filling class.

It is generally thought that ground moraine is deposited by two distinct processes (a) during the advance of the ice a layer of till is plastered or smeared on the underlying material in much the same way as putty is spread on with a putty knife, and (b) during the retreat of the ice, till is deposited on top of the basal till from the stagnant ice. This latter till is called ablation till; where the retreating ice is heavily loaded with debris, "dead-ice" moraine results. In areas of ground moraine there was not too much debris in the stagnant ice and hence a relatively flat area results. The presence of shallow kettles with steep sides on much of the ground moraine of central Alberta indicates that there was enough debris in the ice to partly cover stagnant ice blocks left behind by the retreating ice. Where meltwaters were active, the debris in the retreating or stagnant ice was sorted and resulted in kames, eskers and outwash deposits.

It is of special interest to note that the gullies developed on till are of considerable length and are broadly "U"-shaped in cross-section. This type of gully is often found on relatively impermeable clayey materials, such as till. One other feature which is common to till plains in western Canada is the pebble-grained appearance of the till on the western side of the photograph. The pebble-grained appearance is due to very low-lying hummocks which appear as lighter spots on the photograph.

Drilling operations at this locality show that there is from 40 to 70 feet of glacial material over bedrock.


A12391-63

PREGLACIAL AND POSTGLACIAL VALLEYS

The two photographs under discussion show the Red Deer river following a preglacial valley in the City of Red Deer district and a postglacial channel southeast of the City of Red Deer. These two photographs will be discussed separately, but it should be kept in mind that the same present-day river is shown in both photographs.

Photograph No. 110-5205
1555-22

Location: Tp. 38, R. 27, W. 4th.

This photograph shows two prominent features: (a) flutings on the northwest portion of the photograph, and (b) the Red Deer river flowing in a broad valley which displays floodplain development.

The flutings indicate that in this locality the ice was flowing in a southwesterly direction. The direction of the ice in this district may have been influenced by the preglacial Red Deer valley.

Prior to glaciation a river flowed through this district and continued on a north-northeastward route north of the City of Red Deer. The present-day Red Deer river was probably developed during and shortly after glaciation, and in this particular district occupies the old preglacial channel. The sediments filling the preglacial channel are apparently easily eroded, and the present-day Red Deer river has had little difficulty in developing a floodplain by lateral erosion. Oxbow lakes, meander scars and slip-off slopes, etc., are all readily seen on this portion of the Red Deer valley. The meandering pattern is evidence of low gradient in this part of the valley, and the appearance of the valley suggests late youth in geomorphic development.

Photograph No. 160-5115
1565-105

Location: Tp. 33, R. 22, W. 4th (approximately 15 miles southeast of the City of Red Deer).

This photograph shows a portion of the Red Deer river where the glacial and postglacial river cuts through a rock gorge. Note the "V"-shaped valley, bedrock slump (especially in some of the tributaries)which produces an amphitheatre effect in the tributary valleys, and lack of floodplain development. Another noteworthy feature on this photograph is the well-developed high-level terrace adjacent to the main valley in the southeastern part of the locality.

The different appearance of the Red Deer river in this photograph versus the appearance of the river in the previous photograph is due mainly to a variation in gradient and the fact that in the previous photograph the river is following a preglacial channel.


2459 22


A12708-90

DRUMLINS AND ASSOCIATED FLUTINGS

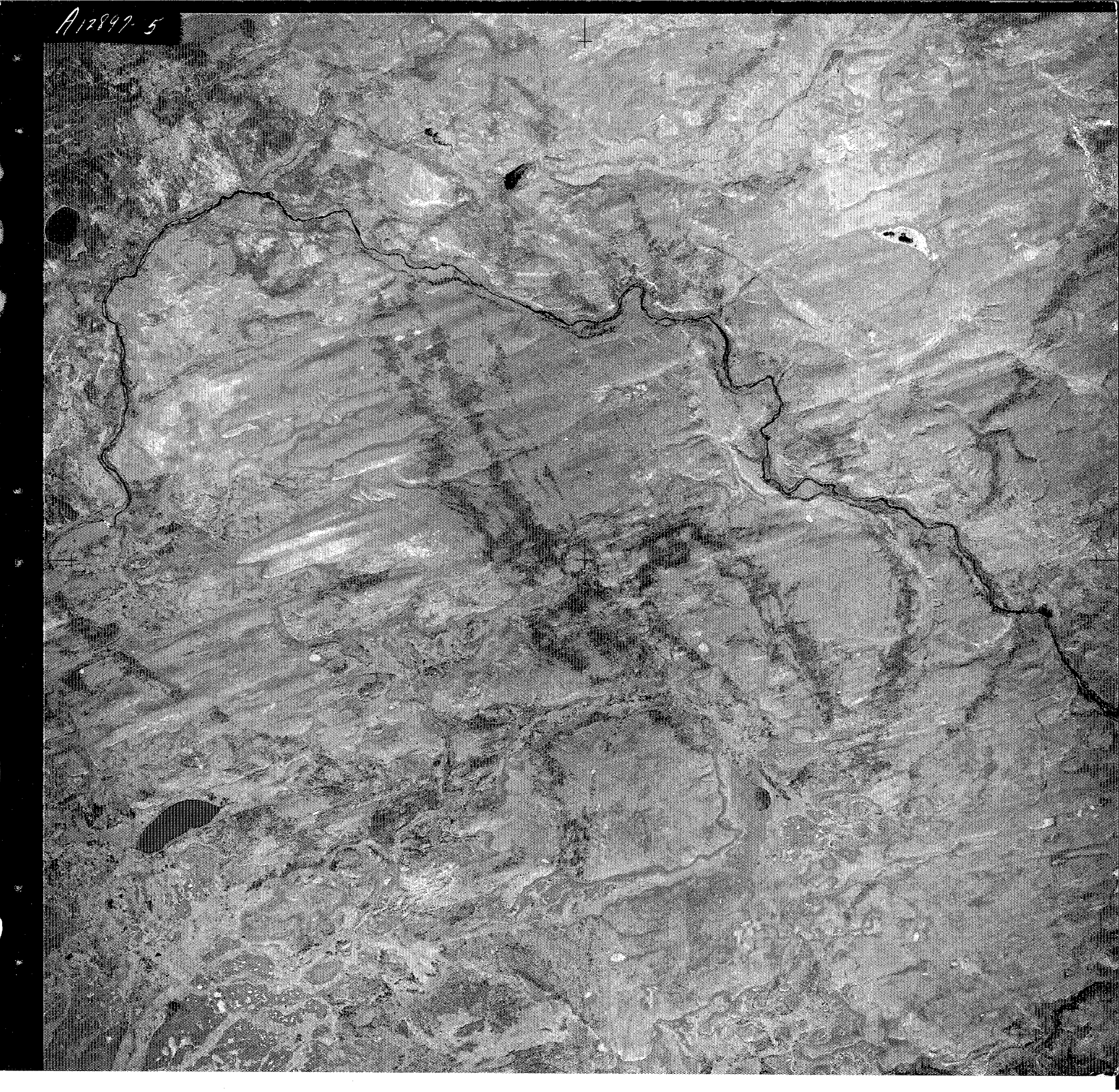
Photograph No. 160-5706
1787-72

Location: Tp. 96, R. 1, W. 4th.

This photograph shows a part of northeastern Alberta where glacial flutings and drumlins are well developed. The general ice-direction in this area was southwesterly and swung to a more southerly direction west of this location in the Athabasca River area.

The drumlins are from one-half to 1 mile in length and average about 300 feet in width. In most cases their steep end faces the northeast -- the direction from which the ice came. This photograph shows the close relationship between flutings and drumlins, and in most instances the drumlins are only swellings of the flutings. While these two features are undoubtedly related to ice advance, their origin is rather obscure. Opinions differ as to whether they were deposited under the advancing ice by "plastering-on" of debris from the base of the ice, or whether they represent erosion and reshaping of debris and rock knobs which were there prior to the ice advance. Both suggestions have merit, and the correct answer on origin may include both of the above ideas.

Both flutings and drumlins are generally developed on areas of ground moraine, but instances have been found where both features have been developed on bedrock.


A12897-5

"DEAD-ICE" MORAINE

Photograph No. 160-5216
1368-16

Location: Tp. 45 and 46, R. 9 and 10, W. 4th.

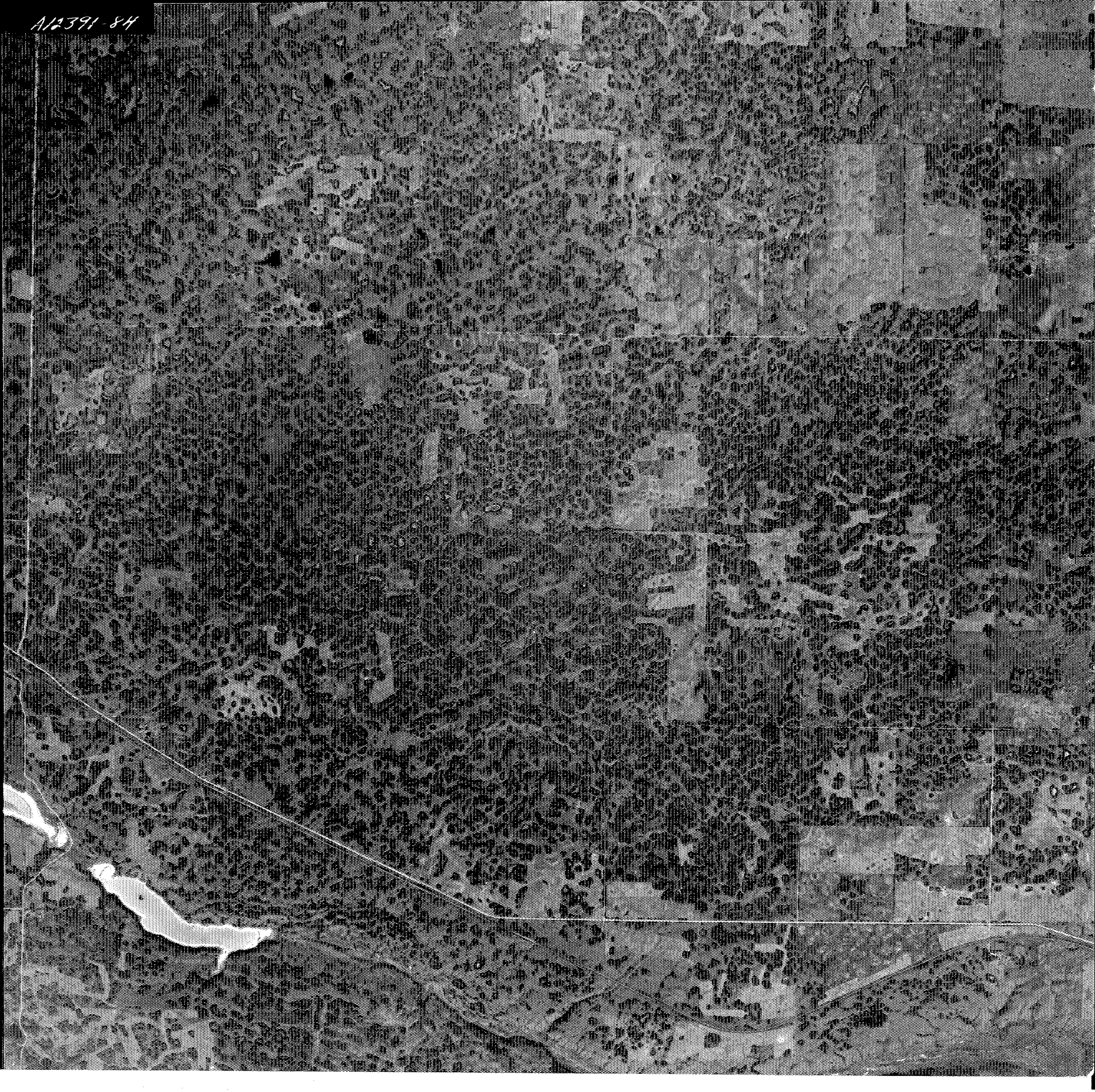
This photograph shows a portion of the Viking "dead-ice" moraine which is, roughly, a north-south belt of rugged moraine found in east-central Alberta. In appearance the Viking "dead-ice" moraine is quite similar to the Buffalo Lake moraine which lies to the west of the Viking moraine.

The moraine is characterized by a jumble of knobs and kettles. A close examination of the photograph shows three features: (a) the pattern is not unlike that of prairie mounds, (b) there is a strong similarity between this pattern and the complex till crevasse-filling pattern described elsewhere in this paper, and (c) a stream-trench system (partly moraine covered) in the southern part of the photograph.

It is believed that this type of moraine is developed from the melting of stagnant debris-choked ice. The borders of the "dead-ice" moraines are quite indefinite and grade into the surrounding ground moraine.

The material in "dead-ice" moraines is mainly till with a few interspersed knobs of sand and gravel. It is common to find a thin layer of angular poorly-sorted gravel on top of the till knobs.

In general, the till is thicker in areas of "dead-ice" moraine than it is in the surrounding ground moraine areas. In some cases, however, bedrock highs may come quite close to the surface in the "dead-ice" moraine areas.


A12391-84

PRAIRIE MOUNDS

Photograph No. 160-5113
1565-22

Location: Tp. 32, R. 6, W. 4th.

Locally the ground moraine of east-central Alberta is covered with till mounds. These mounds average 300 feet in diameter, 15 feet in height, and in many cases have a central depression which lies 3 to 4 feet lower than the outer rim of the mounds. Similar mounds found elsewhere in western Canada and the north-central United States have been called "doughnuts" and "rimmed-kettles". In the Peace River area of Alberta and British Columbia these mounds are called "humpies". Soil scientists and geologists working in the Peace River area have described the "humpies" to the author; while many of them are similar in all respects to the prairie mounds, others -- especially in British Columbia -- have variations in composition which may place them in a different category. The term "doughnut" does not seem applicable since many of the mounds do not have a central depression. The author's interpretation of the term "rimmed-kettle" is that the debris forming the rim came from the ice-block which created the depression, and the depression itself lies below the general ground level. In contrast it is believed that prairie mounds originated as debris-filled pits on a stagnant ice surface, and that the melting of the ice left the pit-fillings as mounds (Gravenor, 1955). The slight depression found in the top of many of the mounds is probably due to the melting out of an ice core in the mounds and hence is, in effect, a small kettle developed in the top of a mound. The central depression is frequently infilled by recent materials washed in from the rim of the mound. In some instances stratified sand, silt and clay are found within the mounds.

The stagnant-ice origin of the mounds is quite similar to the proposed origin of "dead-ice" moraine (Christiansen, 1956).

References:

Gravenor, C. P. (1955): The origin and significance of prairie mounds; American Jour. Sci., Vol. 253, pp. 475-481.

Christiansen, E. A. (1956): Glacial geology of the Moose Mountain area, Saskatchewan; Dept. of Mineral Resources, Saskatchewan, Report No. 21.


A 12708 -22
160 - 5113