GEOMORPHOLOGY OF THE WATERHEN RIVER AREA, SASKATCHEWAN

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The geomorphology of the Waterhen River map sheet (73K) was determined to provide basic information on the distribution of landforms (soil material and slope pattern). An attempt is made to evaluate these landforms as habitat for natural vegetation.

GLACIAL HISTORY

The surficial deposits indicate that this area was covered by continental glaciers during the Pleistocene epoch. Till sheets separated by fluvial sand and striated boulder pavements indicate that the area was affected by more than one ice movement, but it is not known whether these were oscillations of the same ice sheet or invasions by different ice masses.

All drumlinoid features indicate an ice advance from the northeast, passing beyond this area. Later the forward motion of the ice ceased and the ice sheet became stagnant, at least in the southern part of the area. Thick till covered the stagnant ice in the southwestern part of the area where the ice may have persisted for a long time beneath this insulating blanket. In places the till is thin; the kame complex in the Loon Lake area is covered by till which is often only three feet thick. The ablation till is thinner in the southeast, shown by the absence of dead ice features and the sharpness of landforms built by active ice.

A lake became established in the southeastern part of the area, which could be called early Lake Dorintosh for convenience. This lake was created by the blockage of the natural drainage to the east by thick ice or active ice extending from just south of Cold Lake through Golden Ridge to north of Meadow Lake (Fig. 1). A large river, the ancestral Beaver River flowed into the early Lake Dorintosh, depositing coarse lacustrine sediments near its mouth. A small delta was built in the Morin Creek area by rivers reaching the lake from the south. Fine textured lacustrine sediments were laid down in the lake bed. The eastern part of the lake bed was ice which became buried by sediments; the lake sediments collapsed after the melting of the ice, resulting in very irregular topography. The early Lake Dorintosh probably drained to the southeast, as no outlets were found in this area.

Later the continued melting of the ice caused the disappearance of glacier ice from the entire area. Initially the ice probably melted in the lowlands, but persisted on the Mostoos Hills highlands for a long time under an insulating blanket of till. The lowlands were inundated by the expanded Lake Dorintosh (Fig. 2). The level of this lake, as indicated by its deposits, was about the same as the earlier, smaller Lake Dorintosh. This suggests that the melting of the ice did not uncover a lower outlet and that the ice sheet to the north or east still blocked the natural drainage. The lacustrine deposits appear to be coarser than those of the early Lake Dorintosh.

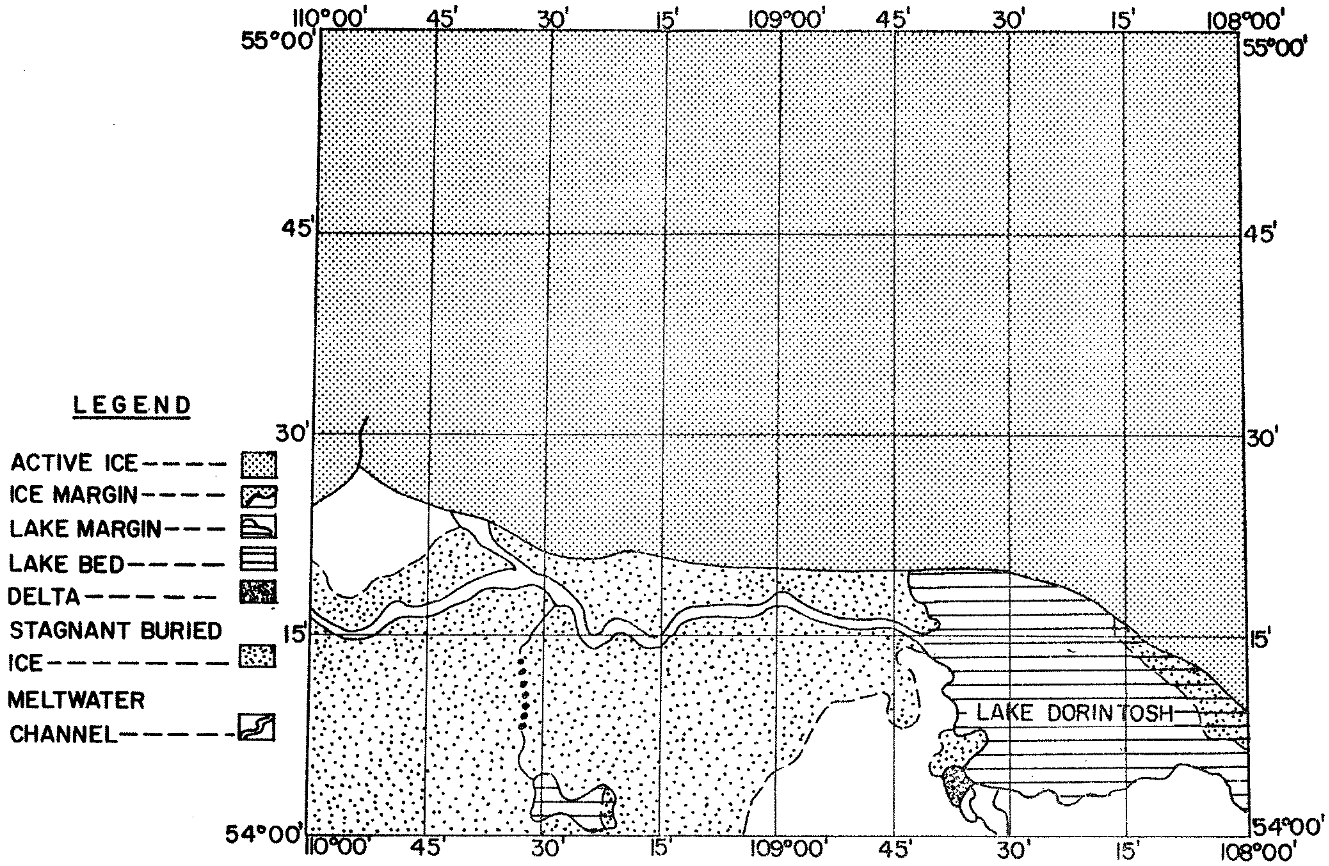

Figure 1. Ice-frontal position and early Lake Dorintosh

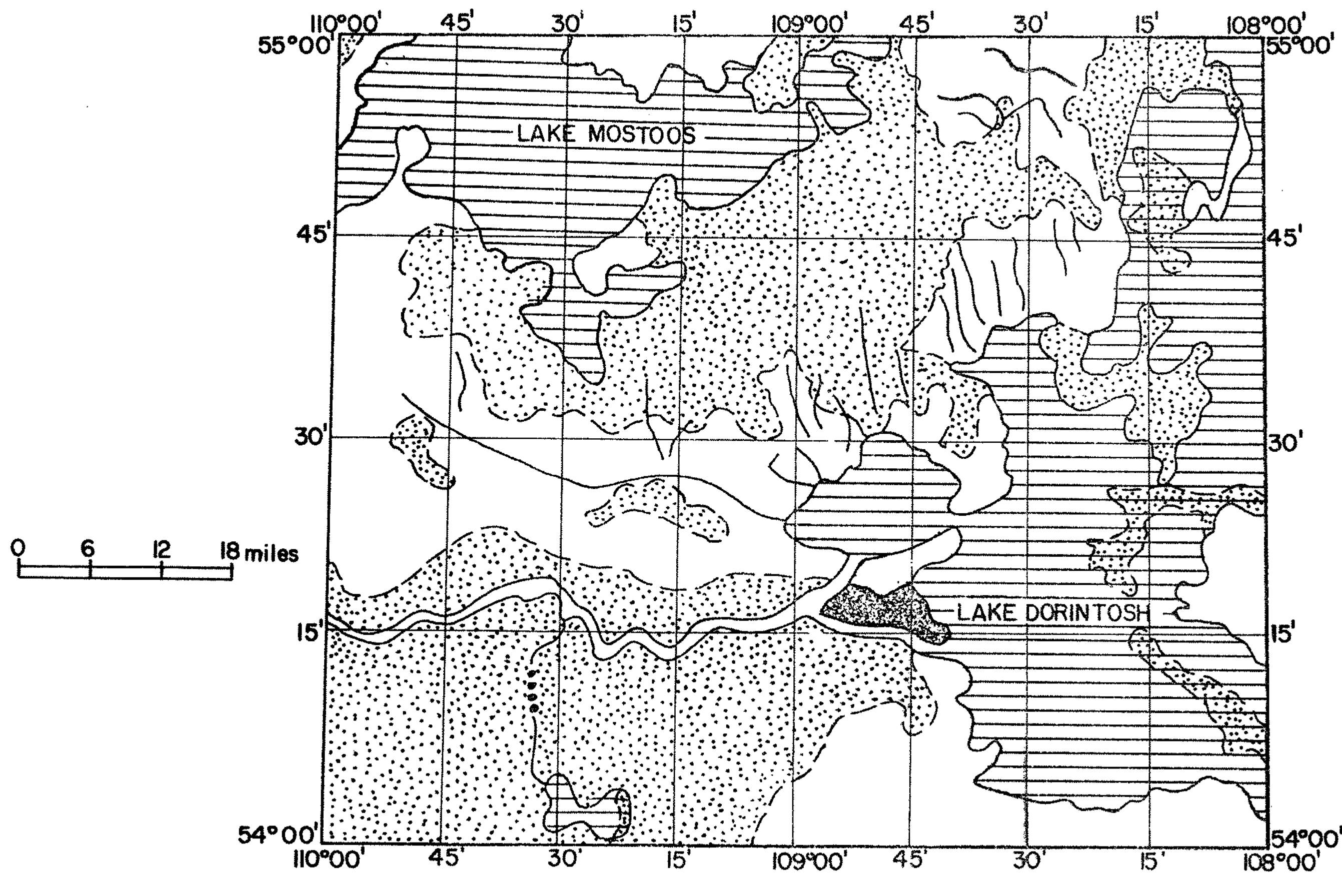

Figure 2. Approximate extent of pro-glacial lakes

The existence of another lake, here named Lake Mostoos, is indicated by lacustrine sediments in the northwestern part of the area. Both fine and medium textured sediments were deposited in this lake, although much of these are now covered by thick peaty organic matter.

Post-glacial changes in the landscape include the re-working of coarse lacustrine or fluvial sediments by wind and the building of sand dunes. Organic matter was deposited in flat depressions, especially in the northern half of the area. Alluvial sediments were spread out in the major river valleys, and the steep slopes of the Mostoos Hills were incised by creeks.

LANDFORMS

1. Geologic materials

a. Glacial deposits

Till is the most widespread glacial deposit. Three different types of till were found on the surface.

Calcareous clay loam till. This till is very widely distributed on the whole area. The analysis of a typical till sample (Table I, No. 1) shows that it has low amounts of carbonates. The material is seldom excessively stony. Grey wooded soil profile* develops on this parent material on fresh and moist sites.

Acid loamy till. This till was observed on the eastern slopes of the Mostoos Hills only, occurring as a thin (3-5 ft.) mantle overlying acid clay loam till. The till is slightly to moderately stony. The analysis of a typical sample appears in Table I (No. 2). Grey wooded profile, with a strongly bleached horizon characterizes this soil.

Acid clay loam till. This till was found on the Mostoos Hills only, generally overlain by acid loamy till in the east and by calcareous clay loam in the west. This till is clay textured (Table I, No. 3) and is somewhat stony. Grey wooded profile develops on this till when it forms the parent material. In some instances, however, a dense solonetzic B horizon was noted, especially on the fresh to dry sites.

b. Lacustrine deposits

Fine textured sediments. These materials are widely distributed within the ancient lake basins, principally in the Meadow Lake and in the Primrose Lake areas. The texture of the material ranges from very find sand to clay (Table I, Nos. 4,5). Dark grey, dark grey wooded or grey wooded profiles develop on fresh to moist sites in this parent material.

Medium textured sediments. These materials occur mainly in the ancient lacustrine basin in the east central part of the area, ranging in texture from fine sand to silt. As most of these soils are wet to moist, gleisolic profiles characterize them.

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* Soil information may be obtained from Saskatchewan Soil Survey Reports No. 13 and 14.

TABLE I. Mechanical and chemical analyses of typical parent material samples.

Geologic material	Sand %	Silt %	Clay %	Textural class	pH	Calcite %	Dolomite %
1. Calcareous clay loam till	47	22	31	Sandy clay loam	8.2	3.3	2.6
2. Acid loamy till	51	38	11	Loam	5.8	-	-
3. Acid clay loam till	54	15	31	Sandy clay loam	5.2	-	-
4. Fine textured lacustrine	27	54	19	Silt loam	8.3	2.3	6.1
5. Fine textured lacustrine	6	27	67	Clay	8.3	10.3	1.8
6. Coarse textured lacustrine	96	-	4	Sand	7.0	-	-

Coarse textured sediments. These materials occur near the mouths of ancient rivers and near the shores of the extinct Lake Dorintosh. Much of the earlier outwash deposits in the Keely Lake area have been modified by wave action and could be considered as lacustrine. The texture is usually sand (Table I, No. 6), without gravel.

c. Fluvial deposits

Glacio-fluvial deposits. The most common deposit in this class is outwash sand and gravel. Eskers and kames are composed of the same material, but these are often mantled by thin, sandy till. The texture of this material is mainly sand, often with gravel. Podsol profiles characterize the dry and fresh sites on these materials.

Deltaic deposits. These materials occur locally, consisting of sand and gravel. Grey wooded profiles are common on these materials.

Fluvial deposits. These occur near major rivers and were deposited during flooding and shifting of channels. The material is sand and gravel. Grey wooded and podsol profiles characterize these materials on dry and fresh sites.

d. Eolian deposits.

Dune sand. This material was formed by wind action on lacustrine, outwash or fluvial sand areas. The texture of the material is medium sand, without stones. Dune sand in this area occurs almost always as islands in poorly drained plains of organic matter. On some dunes little profile development is evident, but some show well developed podsol profiles. The dunes appear to be stable, except when disturbed by bulldozing or road building.

e. Organic matter

Mesic organic matter. This somewhat decomposed organic material is found mainly in the southern part of the area and in string bogs in the north. It is formed dominantly by the remains of grassy plants.

Fibric organic matter. This material is poorly decomposed, being composed of sphagnum peat and forest peat (moss and wood). Fibric organic matter is common in the northern half of the area.

f. Alluvium

Alluvial sediments. These materials were deposited in the flood plains of major rivers. They consist of a mixture of medium to fine textured mineral soil and organic humus. Gleisolic soils characterize these poorly drained materials.

2. Form of land

The landforms were identified on the basis of their genesis and were further subdivided their characteristic slope pattern. These form the mapping units of the geomorphic map (in pocket).

Knob- and kettle-complex (subscript 'k' on map) refers to a rolling, hummocky till plain. The hummocks may be strongly expressed in the high relief areas (Table II), or can be barely noticeable on the ground. In either case, high and low ground alternate with great frequency.

Linear ridges (subscript 'r' on map) modify a ground moraine where a considerable number of elongated till ridges occur. The ridges are generally low, 5-20 feet high, occasionally with steep slopes. The ridges seldom occur singly and show a general trend of orientation, although they may be cut by other ridges at right angles or at more acute angles.

Circular dimpled knobs (subscript 'c' on map) identify an area where these 'doughnut' shaped landforms occur. They are generally low, less than 10 feet high. The central depression may hold a bog. The diameter of these landforms may vary from 30 to 200 feet. These landforms are usually readily recognized on aerial photographs, but are not conspicuous on the ground. Sometimes they may occur in a knob-and-kettle hummocky moraine, further modifying the surface topography.

Flutings (subscript 'f' on map) identify areas where elongated, low, broad ridges occur parallel to one another. Some of these forms in lacustrine materials reflect the landforms of the underlying till sheet.

Morainic hills (subscript 'm' on map) identify areas where elongated till ridges are found at right angles to the apparent movement of the ice sheet. The height and extent of these hills is variable.

Dissected ground moraine (subscript 'd' on map) refers to areas which are cut by steep gullies. The depth of the gullies varies from about 20 feet to over 100 feet. Some gullies may be occupied by underfit streams.

Wave-washed ground moraine (subscript 'w' on map) identifies areas that were modified by lake erosion, or by sheet erosion through shifting streams. In former lake beds the relief tends to be low or very low, but can be moderate in stream-eroded areas.

Pitted surfaces (subscript 'p' on map) identifies essentially level areas where deep, steep-sided hollows occur. The pits are 50-200 feet in diameter and may be as much as 30 feet deep.

VEGETATION

Three broad vegetation zones were recognized in the area as shown on the vegetation zone map (in pocket). These are, from south to north: 1. Aspen-Spruce forest; 2. Boreal forest, southern section; 3. Boreal forest, northern section.

1. Aspen-Spruce forest

Areas of adequate soil moisture are covered with dense, continuous canopy of trembling aspen. When left undisturbed, white spruce will seed in and eventually form nearly pure stands. Jack pine forests occur on dry, sandy soils. White spruce, together with tamarack or balsam poplar occur on some wet sites. A shallow mat of mesic peat may accumulate in poorly drained areas under a sedge-grass cover with scattered clumps of willow.

TABLE II. Broad relief classes

Very low relief	- Essentially level area, less than 10% of the area occupied by low relief features, the magnitude of which is less than 25 ft.
Low relief	- Area of long gentle slopes, or very short steep slopes. Differences in elevation less than 75 feet.
Moderate relief	- Area of long moderate slopes or of short steep slopes. Difference in elevation less than 200 feet.
High relief	- Area of moderately steep long slopes or short very steep slopes. Difference in elevation frequently in excess of 200 feet.

2. Boreal forest, southern section

This vegetational zone is characterized by boreal tree species. Jack pine grows in dense stands on dry sandy soils or on dry to fresh loamy soils. Trembling aspen occurs on most fresh to moist sites, with white spruce as an occasional component. Black spruce and tamarack grow on poorly drained areas. Shallow fibric to mesic peat frequently accumulates in depression under open sedge-grass, or under sphagnum moss and black spruce cover.

3. Boreal forest, northern zone

The species present in this zone are the same as those in the southern section of the Boreal forest, but black spruce and jack pine are able to compete successfully on the moist and fresh sites, respectively, with aspen and white spruce. On dry sandy soils open jack pine forest grow with a dense reindeer lichen ground vegetation, characteristic of areas farther north. Deep peat accumulates in poorly drained depressions, supporting stunted black spruce or tamarack. Patterned deep peat deposits, such as string bogs are frequent.

In addition, organic soil landforms were noted in this zone that indicate the presence of scattered, discontinuous permafrost (See: Vegetation zone map, in pocket). No permafrost was actually seen in the field, but landforms, called 'palsas' (Brown 1965) were noted on aerial photographs in the area east of Primrose Lake. These palsas are irregular to subrounded peat domes that can rise eight feet or more above the surrounding organic terrain. The vegetation on the palsa is usually black spruce, or white birch, but the surrounding area is dominated by sedge-grass vegetation. An open 'lead' of water is often found at the base of the individual palsa. Brown (1967) shows the occurrence of discontinuous permafrost at Cold Lake, Alberta, just west of the map sheet, and at Canoe Lake, just north of the area.

Frequently, palsas were noted that are eroding into the surrounding organic terrain. Sedge meadows form initially at the site of an eroded palsa, as trees invade the wet meadow very slowly. This results in nearly circular, treeless patches of meadow in the stagnant spruce-tamarack bogs. These patches may be called 'palsa scars'. They are believed to indicate the relatively recent disappearance of discontinuous permafrost from organic terrain.

LANDFORMS AS PLANT ENVIRONMENT

Landforms, because of their connotation of soil texture and slope pattern, may be used as a first approximation of the quality of land for plant growth. However, it is imperative that soil textural and petrographic classes be differentiated within similar landforms. Furthermore, the ecological significance of the parent material, slope and soil moisture must be considered and evaluated in effective classes. In this outline a brief reference will be made to factors that may limit the growth on trees on different materials and in different parts of the area.

Regional climate - climate-induced vegetation succession limits the growth of black spruce in the Aspen-Spruce zone. More severe climatic conditions limit the growth of white spruce on flat to gently sloping areas in the northern section of the boreal zone.

Local climate - topography induced local climate is seldom mappable at more than local levels. Some pothole depressions and broad peat areas in the north may have a cold local climate which would limit the growth of trees.

Lack of soil moisture - a major factor limiting tree growth. Soil moisture is in shortest supply in coarse textured materials with low water tables, upper slopes of high relief loamy to clay loam materials. Less severe moisture shortage is prevalent on mid-slopes and on upper slopes of low knobs.

Excess soil moisture - a major factor limiting tree growth. All materials with high water table, and organic soils have the greatest excess of soil water. Lesser limitation is imposed on level medium textured soils.

Fertility - the lack of soil nutrients is limiting tree growth mainly on coarse textured, stone-free soils. These soils are some of the lacustrine sands and eolian deposits.

Density of soil - pedogenic processes may cause dense layers in the soil which impede the rooting of trees. This condition may occur on some acid clay loam tills, especially on upper slope positions.

Inundation - periodic flooding of low lying areas by rivers or lakes limits tree growth. This condition is found in the flood plains of larger rivers.

Erosion - actively eroding soils may limit tree growth. Such conditions are found on the slopes of deeply incised river valleys; deeply eroded slopes of creeks running off the Mostoos Hills; and on some exposed dunes.

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