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Landform Features in Northwestern Ontario

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Forestry Canada, Ontario Region
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ABSTRACT

This report provides information on commonly encountered landform features in northwestern Ontario. A brief introduction is provided to the glacial history and current surficial geology of northwestern Ontario. Photographs are provided to illustrate common landform features. For 13 common landform features, the following are summarized: typical landscape pattern, topographic expression, genesis, distribution in northwestern Ontario, material composition (including comments on soil drainage and frost-heave hazard) and concerns related to forest management. Using the terminology of the Northwestern Ontario Forest Ecosystem Classification, soil and vegetation conditions related to each landform feature are noted. Forest managers in northwestern Ontario can use landform features to more effectively predict site-specific soil and vegetation characteristics, and to help improve integrated resource management of the forest landbase.

RÉSUMÉ

Ce rapport contient des données sur les formes de relief communes dans le nord-ouest de l'Ontario. Il comprend une brève introduction à l'histoire glaciaire et à la géologie des formations superficielles actuelles dans cette partie de la province. Des photographies illustrent 13 formes de relief courantes, dont les suivantes ont été résumées: modèle de relief typique, topographie, genèse, distribution dans le nord-ouest de l'Ontario, composition des matériaux (y compris des commentaires sur le drainage du sol et la sensibilité du sol au gel) et les problèmes reliés à l'aménagement des forêts. Les conditions pédologiques et les types de végétation pour chaque forme de relief sont indiqués, conformément à la terminologie utilisée dans la classification des écosystèmes forestiers du nord-ouest de l'Ontario. Les aménagistes forestiers du nord-ouest de la province peuvent utiliser les formes de relief pour évaluer plus efficacement les caractéristiques des sols et de la végétation particulières à un site et pour améliorer la gestion intégrée des ressources de la superficie forestière.

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(*middle*) A portion of a Northern Ontario Engineering Geology Terrain Study map (NOEGTS Map No. 5063).

(*bottom*) Aerial view of a bedrock-controlled landscape in northwestern Ontario (S. Walsh).

LANDFORM FEATURES IN NORTHWESTERN ONTARIO

INTRODUCTION

Landform features are shapes that have been produced in the landscape by natural processes operating on or near the earth's surface. They are created and then modified over time by weathering and erosion, glacial action, flowing or standing water, waves, wind and mass movement (Flint 1971, Mollard and Janes 1984). In northwestern Ontario, as well as in other parts of Canada, the most recent continental glaciers had a strong and pervasive influence on the development of the majority of contemporary landform features.

In northwestern Ontario, close relationships exist between landform features and sediment types, as well as with various soil and vegetation factors. By their nature (i.e., the processes related to their formation), certain landform features exhibit similar soil characteristics regardless of geographic location (Tuttle 1970, Paton 1978, Jenny 1980). In addition, the distribution of vegetational communities is often closely related to soil/site factors (Jones et al. 1983, Corns and Annas 1986, Sims et al. 1989, Baldwin et al. 1990). When relationships between landform features and other ecological parameters are understood within a specific physiographic or geographic area, it is then possible to make accurate predictions about certain soil and vegetation characteristics based on the recognition of landform features.

For forest management purposes at a broad to intermediate scale, it is important that foresters are able to recognize landform features. An appreciation of the processes involved in the formation of different landform features leads to a general understanding of their material composition and of the characteristics of associated soil deposits. A knowledge of the recurring relationships among landforms, soils and vegetation within a geographic area is needed for integrated resource planning, prime-site determination and land suitability or capability mapping. Information on landform features can be of value for a variety of specific forest management purposes, including forest road planning and engineering, timber harvesting, wildlife management and silviculture. A number of silvicultural interpretations may be directly related to landform features, including the prediction of frost-heave hazard, vegetation competition potential and site quality (Racey et al. 1989). With a general knowledge of the characteristics of landform features in northwestern Ontario, forest managers can effectively utilize a variety of surrogate information sources on the distribution of landform features, including aerial photos and mapped information (Table 1), to facilitate the management planning process.

At a more localized scale, it is generally agreed that the ecological character of a forest site is a function of the complex interaction of many biophysical conditions; climate, soil parent material, biodiversity, ecosystem function, topographic effects and elapsed developmental time are all important factors in defining the ecological uniqueness of a particular site (Jenny 1941, 1980; Paton 1978; Brady 1984). Within a relatively small geographic area, such as a local management unit, these biophysical conditions will either be relatively similar among specific sites or vary within a limited (and usually predictable) range of expression. Thus, even at a very local level, a knowledge of the characteristics of landform features can assist forest managers in projecting relationships among ecological parameters. Soil texture, soil depth, coarse-fragment content, organic matter form and thickness, vegetation cover and microtopography are properties that may be readily anticipated from a knowledge of the landform features in a local area (Baldwin et al. 1990).

Table 1. Landform features: some useful mapped information for northwestern Ontario.

Name	Source	Description
1. Surficial Geology / Physiography		
Quaternary Geology, Geological Series (e.g., Geddes and Bajc 1985)	Ontario Geological Survey (OGS)	1:50,000 scale maps showing detailed Quaternary geology; covers selected areas in northwestern Ontario
Northern Ontario Engineering Geology Terrain Study (NOEGTS) (e.g., Mollard 1979, Mollard and Mollard 1981)	OGS	1:100,000 scale maps showing terrain units with landform, mode of deposition, texture, drainage and topography; covers most forested areas in northern Ontario
Zoltai (1965), and Boissonneau (1966a,b)	Ontario Ministry of Natural Resources	1:506,880 scale maps showing terrain units with landforms and modes of deposition; covers most of northern Ontario
Sado and Carswell (1987)	OGS	1:1,200,000 scale map of regional geomorphology showing parent materials and landforms; covers all of northern Ontario
Wickware and Rubec (1989)	Environment Canada	1:2,000,000 scale map of 17 terrestrial ecoregions and 79 ecodistricts in Ontario, defined by general relief patterns, soils, geomorphology and vegetation; covers all of Ontario
2. Soil		
Soil Survey Reports (e.g., Hills and Morwick 1944, Acton et al. 1978)	Various agencies, including Agriculture Canada, Ontario Institute of Pedology (OIP)	Maps at various scales (usually 1:50,000 or larger), usually of selected small areas with agricultural potential in northwestern Ontario
Ontario Land Inventory (OLI)	Ontario Centre for Remote Sensing (OCRS)	1:50,000 scale working maps from which 1:250,000 scale CLI maps were compiled (see below); covers most forested areas in northwestern Ontario
Canada Land Inventory (CLI)	Environment Canada	1:250,000 scale maps for land classification, recreation capability, agricultural capability, wildlife capability (ungulates, waterfowl) and forestry capability; covers most of Ontario

The purpose of this report is to provide forest managers with a general overview of commonly occurring landform features in northwestern Ontario. The glacial history and formation of glacial landforms in northwestern Ontario are discussed briefly. In 13 separate sections, common landform features are described in terms of their genesis, general appearance and common properties. Some comments are included on forest management considerations and constraints. Color photographs are provided to illustrate a variety of landform characteristics. Geographically, the area dealt with in this report is the general area of Ontario north and west of Lake Superior (Fig. 1). Most landform features in this area are of glacial origin; however, the northern part of northwestern Ontario is blanketed by extensive organic deposits, and in many other areas, local non-glacial landform features are common.

GLACIAL HISTORY OF NORTHWESTERN ONTARIO

A general appreciation of the recent glacial history of northwestern Ontario is useful in understanding the natural distribution of individual landform features across the area, and in associating specific soil conditions with these features. Detailed chronologies of glaciation in northern Ontario have been provided by Zoltai (1961, 1963, 1965, 1967), Prest (1963, 1970), Boissonneau (1966a,b), Saarnisto (1974), Kor (1981), Sado and Carswell (1987), Shilts et al. (1987) and Dredge and Cowan (1989). Only a very brief synopsis of some aspects of the glacial history of northwestern Ontario is provided here.

Quaternary refers to approximately the last million years of the earth's history. During the Quaternary period, climatic changes gave rise to successive glaciations of vast continental regions, and to a general lowering of snowlines throughout the world (Saarnisto 1974). In North America, four major glaciations (the Nebraskan, Kansan, Illinoian and Wisconsinan) occurred over this period, each lasting about 100,000 years (Prest 1970, Flint 1971). Each successive glaciation effectively removed or deeply buried almost all evidence of the previous one. The most recent glaciation, the Wisconsinan, covered virtually all of Canada with glacial ice during its climax, about 20,000 years before the present (BP).

Centered north of present-day Hudson Bay, the Laurentide Ice Sheet influenced much of eastern Canada and northeastern United States during the Wisconsinan glaciation. At its maximum, it is believed to have reached thicknesses of up to 4,000 m in parts of northwestern Ontario. The weight of ice was sufficient to depress the land surface by an amount proportional to its thickness; subsequent loss of this tremendous weight during deglaciation resulted in isostatic adjustment of the land, a rebound process that continues today. The total amount of rebound is estimated at about 100 m near the northwestern Lake Superior shoreline and 250 m near the southern coast of Hudson Bay, Ontario (Sado and Carswell 1987).

At its maximum, the Laurentide Ice Sheet covered northern Ontario entirely and continued south of the Great Lakes region into the continental United States (Dyke and Prest 1987a). During its advance, subglacial till was deposited in the form of drumlins, drumlinoid ridges, crag and tail features, and undifferentiated ground moraine, producing a streamlined topographic "grain" to the landscape. Approximately 20,000 years BP, the ice began to recede. Entrained materials within the ice melted out as ablation till. Meltwaters deposited sands and gravels within eskers, moraines and outwash systems near the receding ice-front margin. Finer-textured silts and clays were deposited in the many glacial lakes that temporarily formed during the recession. Retreat of the ice was by no means uniform or continuous along the ice margins. Periodic readvances of local ice lobes frequently accompanied the general recession of ice, resulting in the overriding and reworking of many surficial deposits. As meltwaters carried glacial debris away from the ice fronts, outflow

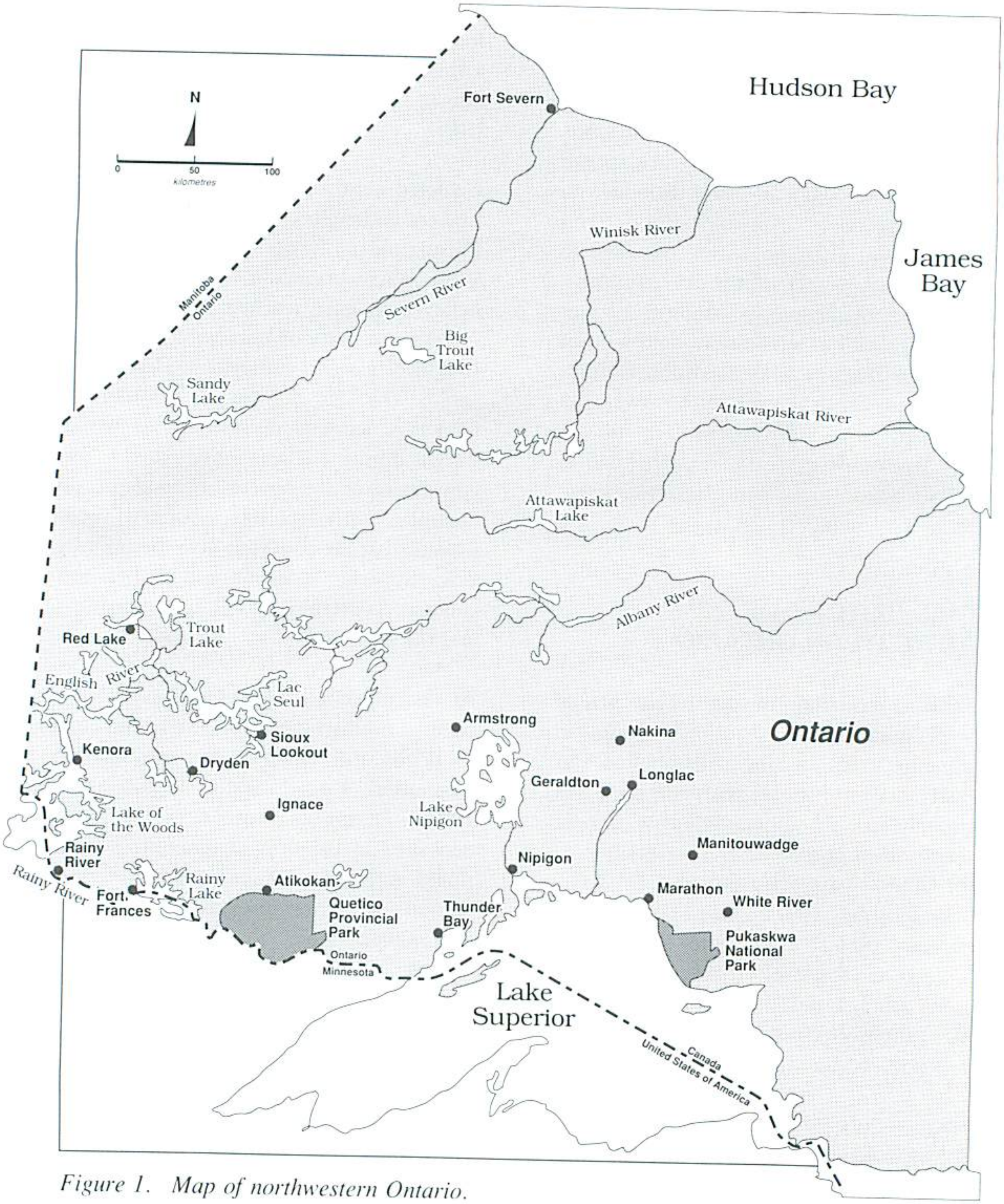


Figure 1. Map of northwestern Ontario.

channels frequently opened and closed, sometimes completely reversing the directions of water movement. Such events have served to complicate considerably the depositional character of northwestern Ontario.

Figure 2 shows the major ice-margin positions for five successive dates and illustrates the approximate time sequence associated with glacial decay and retreat. Also shown for the five dates in Figure 2 are the shapes and extents of some of the principal glacial lakes that formed over parts of northwestern Ontario during this general retreat. The major moraine systems that now exist in northern Ontario are mapped and named in Figure 3; some of the most extensive and well-developed end, interlobate and recessional moraine systems in North America are found in northwestern Ontario. The correlative relationship between Figures 2 and 3 is obvious: each major moraine system is associated with one of the prolonged halts of the ice margin ("still-stands") during the retreat of the glaciers.

At 13,000 years BP, northwestern Ontario was completely covered by glacial ice (Fig. 2a, 4). In general, northwestern Ontario was influenced by three major ice lobes that moved independently at times. Although they are not clearly separable in Fig. 2a, the three lobes were named, from west to east, the Patricia, Hudson and Superior lobes.

Over the next 2,000 years, a period of time referred to as the North Bay Interstadial, the ice continued to slowly retreat and melt. By 11,000 years BP, much of the southwestern corner of northwestern Ontario was free of glacial ice (Fig. 2b). However, a portion of an extensive glacial lake covered most of this ice-free area; glacial Lake Agassiz, unable to drain northward or eastward, began to expand in the west with much of the Patricia ice-lobe margin standing in its waters and forming its northern shoreline. A number of other glacial lakes developed elsewhere in northwestern Ontario. The position occupied by the southern edge of the Laurentide sheet in northwestern Ontario at 11,000 years BP is today marked by the Eagle-Finlayson, Steep Rock and Brule end moraines (Fig. 3; Zoltai 1965).

Between about 11,000 and 10,000 years BP, during the Algonquin Stadial, the late-Wisconsinan climate became temporarily cooler (Saarnisto 1974), slowing the rate of glacial retreat. At this point, a slight northward withdrawal of the Patricia ice lobe resulted in the formation of the Hartman moraine (Fig. 3; Nielson et al. 1982). Several large interlobate moraines (Fig. 5), such as the Kaiashk and Dog Lake–McKenzie moraines (Fig. 3), were created between smaller ice fronts during the Algonquin Stadial. In general, the three glacial lobes and their major end, interlobate and recessional moraines blocked the flow of meltwater northward. As a result of the general elevation, the irregular relief of the Precambrian landbase and the evolving landform features, westward and southward movement of meltwaters was also restricted (Clayton 1983, Teller and Thorleifson 1983). At 10,000 years BP, most of the Superior basin was still covered by the Superior ice lobe, obstructing the eastward movement of water (Fig. 2c). Glacial Lake Agassiz continued to grow and, as drainageways were blocked and meltwaters were redirected, a number of other smaller lakes developed temporarily.

The Algonquin Stadial was followed by a rapid disintegration of the Laurentide Ice Sheet during the Timiskaming Interstadial, 10,000 to 8,200 years BP. During this period, tremendous volumes of water were released by melting ice, and many modern-day drainage networks became established and well defined. A major event during this period was the sudden eastward drainage of Lake Agassiz. At about 9,500 years BP, the Patricia ice lobe had retreated northward to create the Sioux Lookout moraine (Fig. 3). At the same time, the Hudson ice lobe had withdrawn northward an undetermined distance, suddenly allowing Lake Agassiz to drain into Lake Minong, a glacial lake that was a precursor of modern Lake Superior, and which at this time

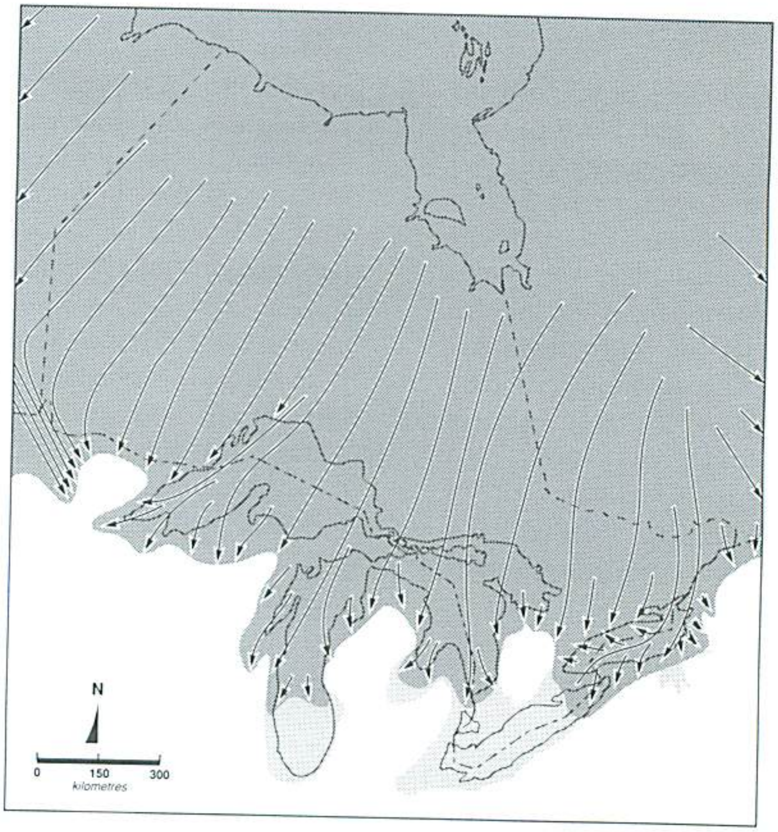


Figure 2a. 13,000 years BP.

Figure 2. *Patterns of Wisconsinan glacial retreat overlain on map of present-day northern Ontario (after Dyke and Prest 1987b). Darker shading shows the extent of glacial ice and directional arrows highlight the main paths of glacial advance; lighter shading outlines the extent of proglacial lakes. Maps show coverage by glaciers and proglacial lake waters at five successive dates: (a) 13,000 years BP (this page); (b) 11,000 years BP (page 7); (c) 10,000 years BP (page 7); (d) 9,000 years BP (page 8); and, (e) 7,000 years BP (page 8).*

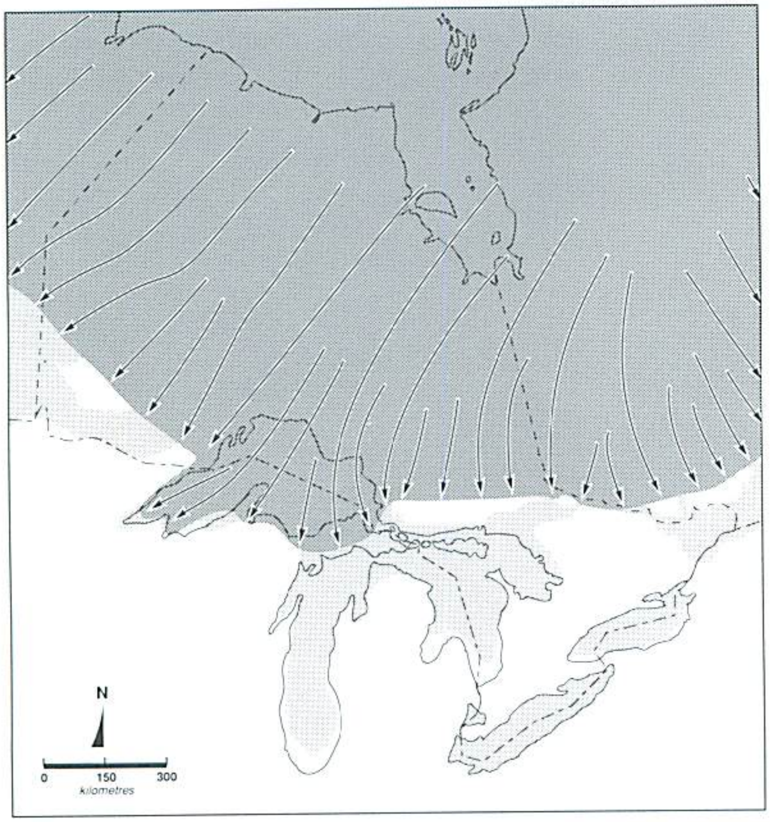


Figure 2b. 11,000 years BP.

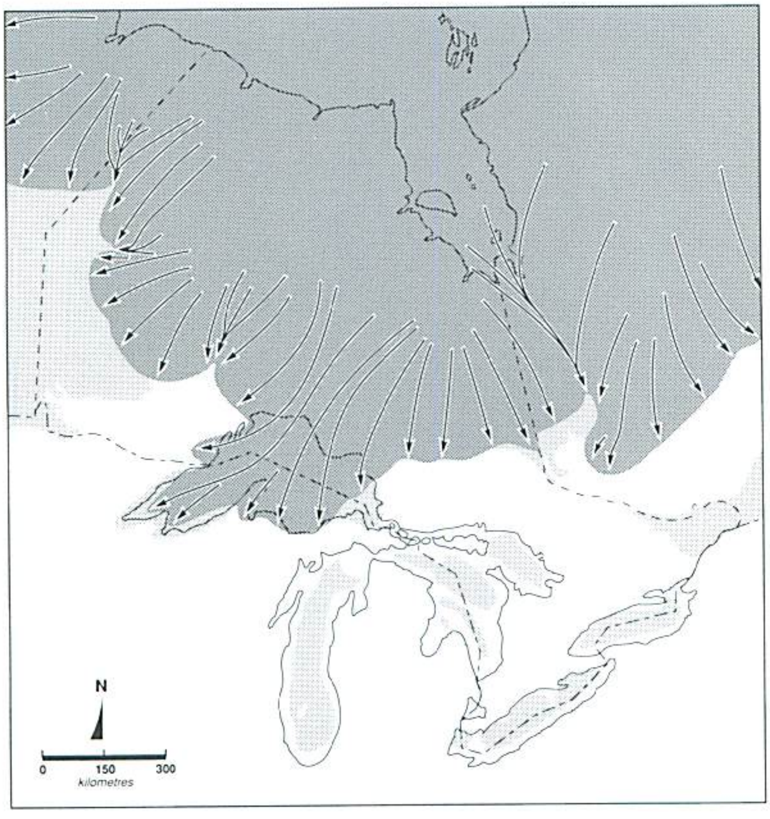


Figure 2c. 10,000 years BP.

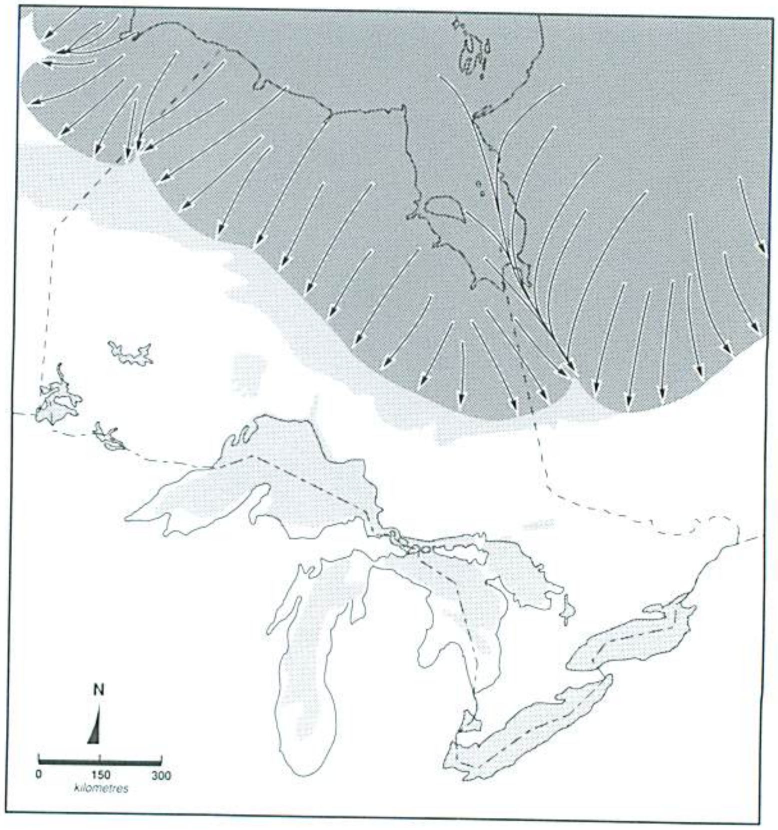


Figure 2d. 9,000 years BP.

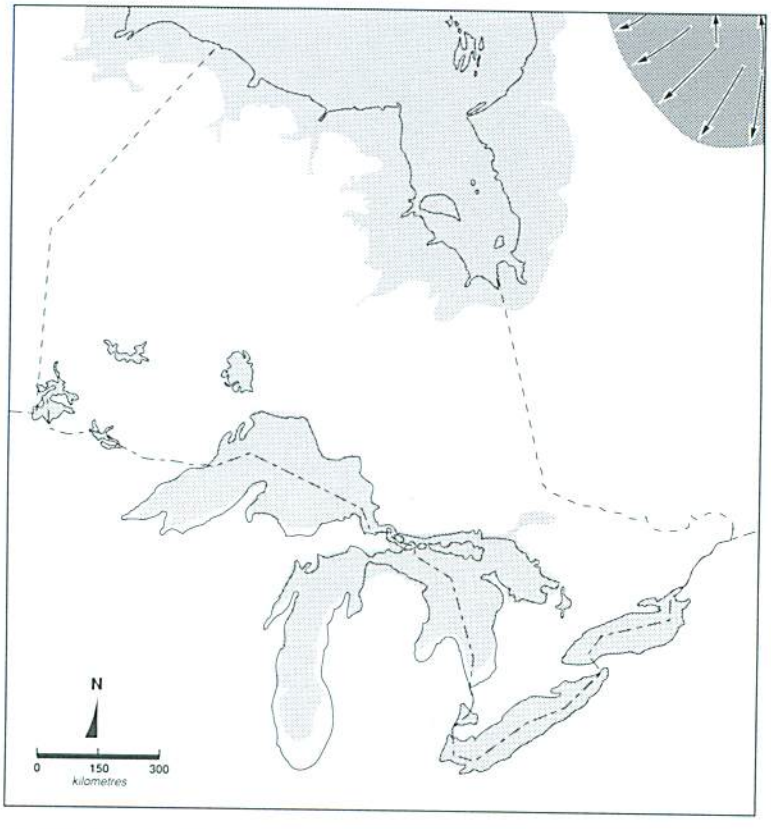


Figure 2e. 7,000 years BP.

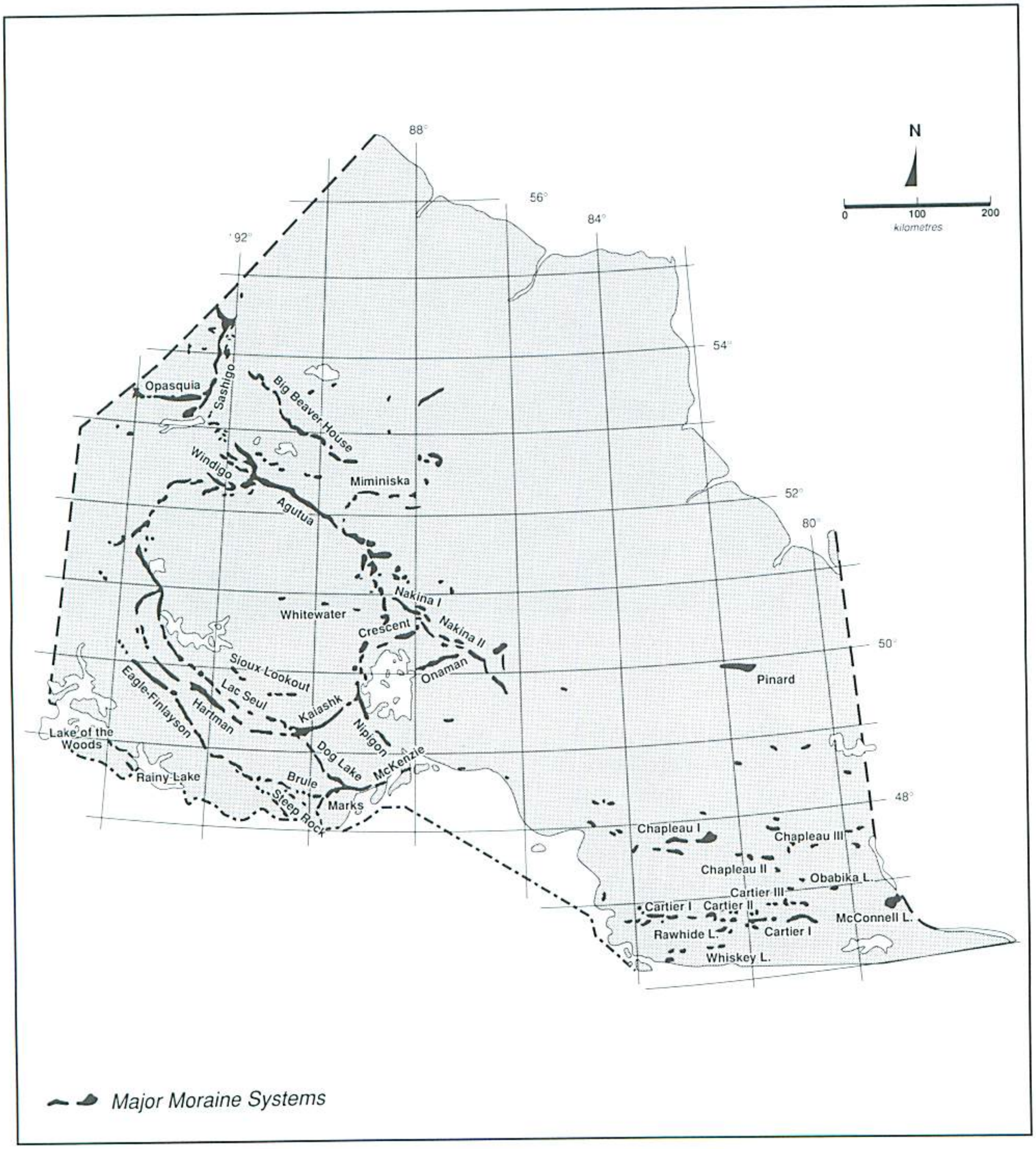


Figure 3. Major end, interlobate and recessional moraines in northern Ontario (after Sado and Carswell 1987).

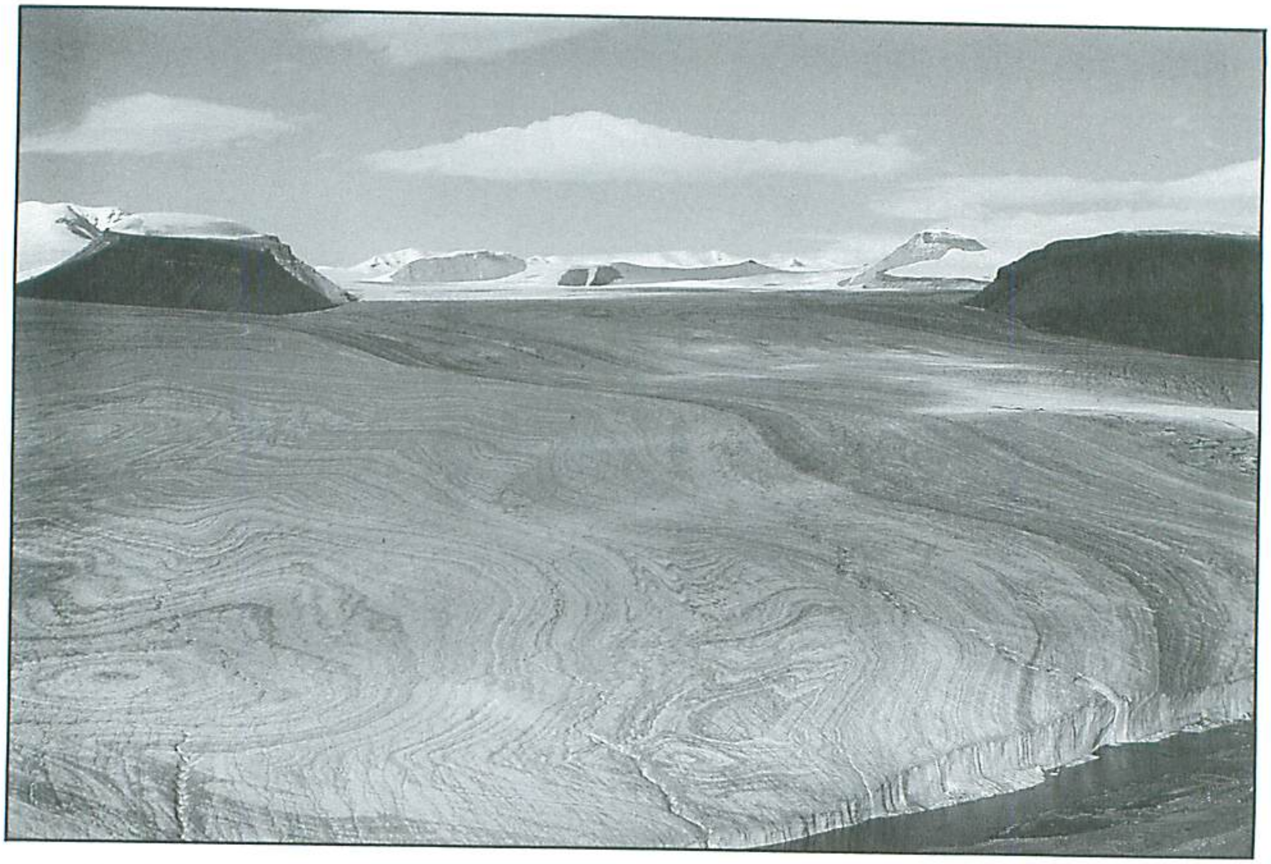


Figure 4. *A large glacier advances across the landscape, reshaping and modifying the ground surface* (G. Wickware).

bordered the retreating Superior ice lobe. More than a dozen torrential bursts of water flowed into the Superior basin, with more than 4,000 km^3 of Lake Agassiz water passing into the basin in less than 2 years (Sado and Carswell 1987). This sudden influx raised water levels in the Superior basin dramatically, resulting in clay deposits within broad bedrock channels along the northern shore of Lake Superior, and the formation of a series of distinct, raised beach lines (Farrand 1960, Nielson et al. 1982, Clayton 1983, Teller and Thorleifson 1983, Sado and Carswell 1987).

The Hudson ice lobe continued to retreat northward until a readvance to the Agutua–Nakina moraine system occurred (Fig. 3; Prest 1963). At this point, isostatic rebound following deglaciation played a major role in defining the landscape and establishing lake levels. Uplift led to the withdrawal of the remainder of Lake Agassiz from the area in the west. Several other glacial lakes drained and disappeared. By 9,000 years BP, the entire Laurentide Ice Sheet had retreated northward in Ontario so that only the areas of present-day Hudson Bay, James Bay and the Hudson Bay Lowland remained ice-covered; during this period, a series of large, shallow, proglacial lakes skirted the southern edge of the ice front (Fig. 2d).

In the millennia following 9,000 years BP, uplift at the eastern end of the Superior basin created higher water levels and the eventual development of the modern-day Lake Superior shoreline (Burwasser 1977, 1981); this process continued until the lake reached approximately its current shape and size at about 5,500 years BP. As glacial ice continued to withdraw into the Hudson Bay basin, marine waters invaded the Hudson Bay Lowland from the north, forming the Tyrrell Sea, which then slowly receded. All

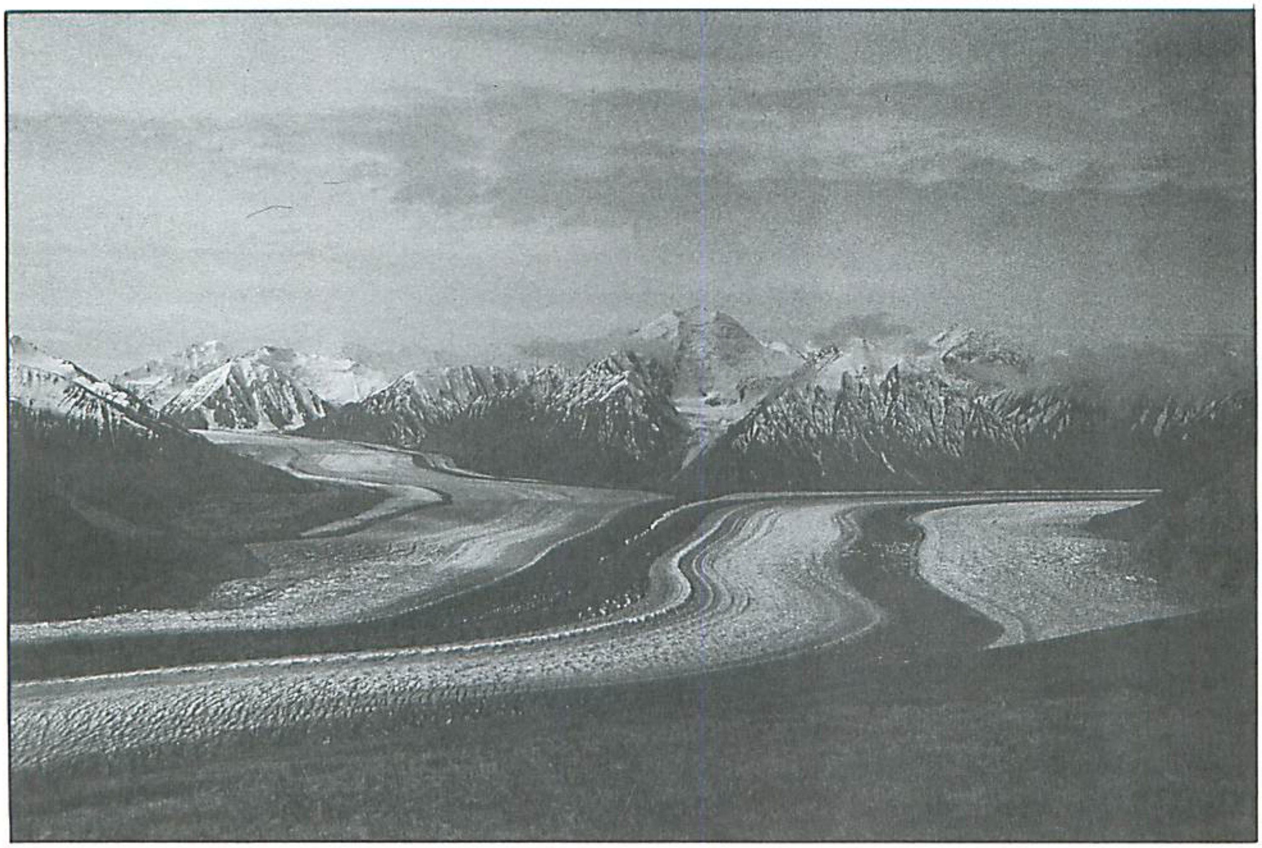


Figure 5. Two glaciers move through a mountain valley in northwestern Canada, and glacial debris accumulates as a long, dark band where the two abut; when these glaciers eventually retreat or decay, this material will be deposited as an interlobate moraine (G. Wickware).

of Ontario and most of mainland Canada was ice-free by 7,000 years BP (Fig. 2e; Dyke and Prest 1987a,b).

As the glaciers and then the glacial lakes receded, northwestern Ontario was revegetated. Immediately after deglaciation, pioneer species of vegetation became established and processes of soil development were initiated. Over a period of time, boreal forests developed on suitable sites. In some locations, northwesterly winds reworked sandy materials into dune forms, usually before vegetation became established (Sado and Carswell 1987). Organic soils developed on poorly drained lowland areas. The landscape continued to evolve as isostatic rebound proceeded. In the far north of Ontario, rapid isostatic rebound continues today; along the shoreline of Hudson Bay, the landbase currently undergoes uplift at a rate of about 1 m per century (Webber et al. 1970).

LANDFORM FEATURES IN A REGIONAL CONTEXT

Northwestern Ontario is characterized by a diverse physical setting. The southern half of northwestern Ontario is underlain by mostly Archean (Precambrian) granites, greenstones and gneisses of the Superior and Southern Provinces (Pye 1969); the northern portion, on the Hudson Bay Lowland, is underlain by mostly calcareous Paleozoic strata (Zoltai 1961, Boissonneau 1966a). In some areas, Phanerozoic sedimentary rocks overlie the Precambrian bedrock. Glacial landform patterns are distinct and widespread because of the complex events that occurred

During Glaciation

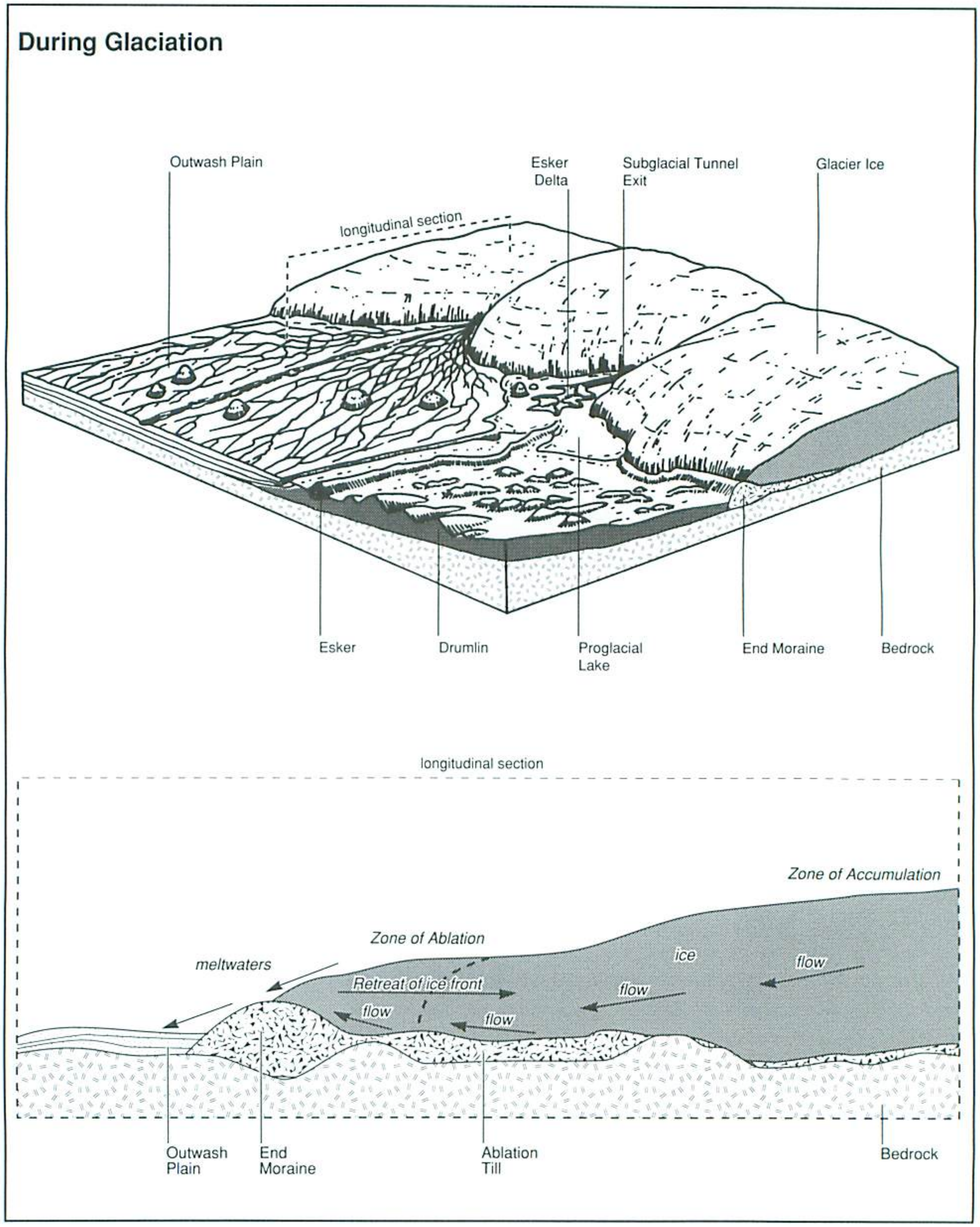
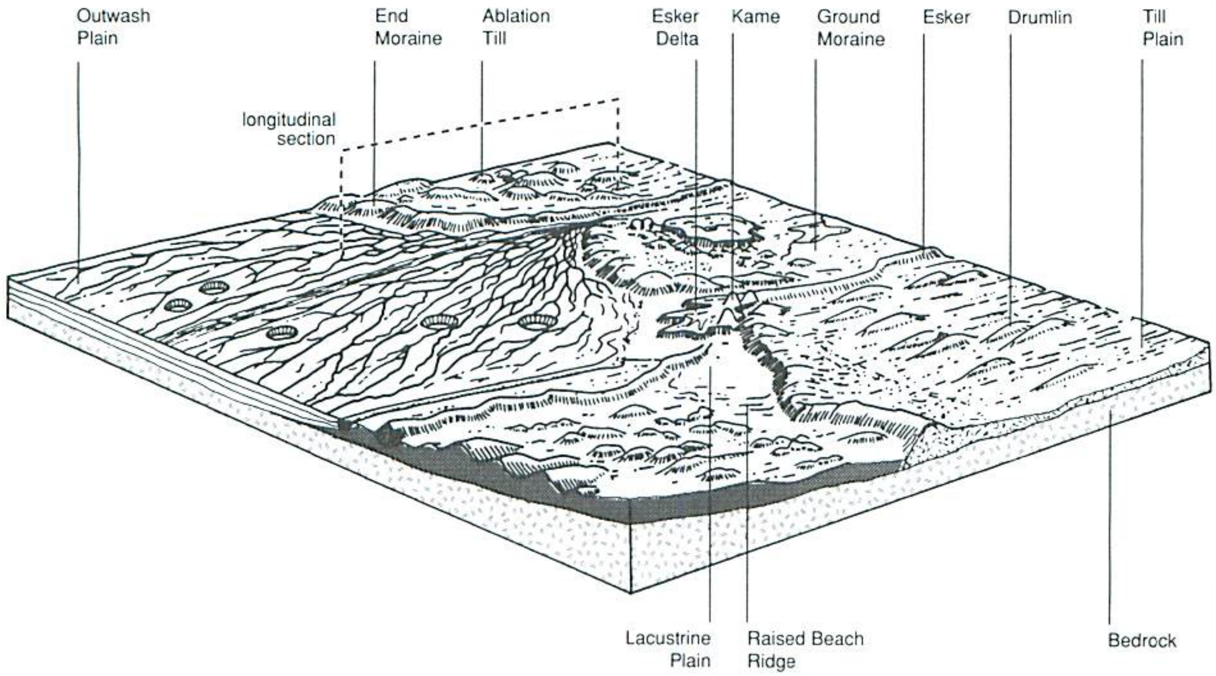
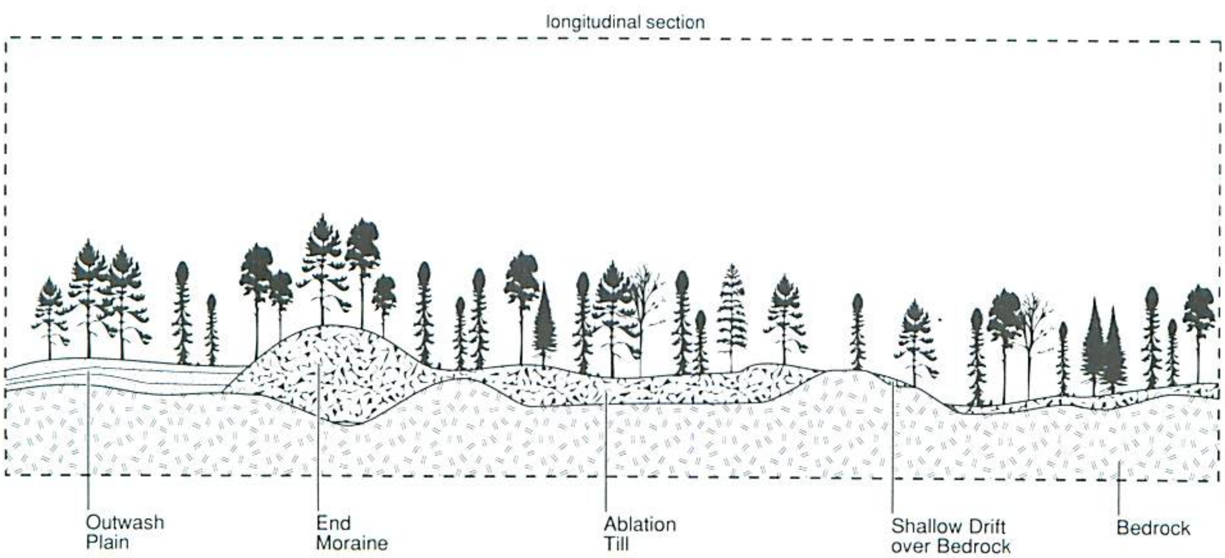


Figure 6. Three- and two-dimensional schematic views during (this page) and after (facing page) glaciation of a typical northwestern Ontario landscape, with bedrock close to the ground surface. The diagrams show the genesis of some landforms during glacial movement and their subsequent modification and development, after glacial decay and retreat, into modern-day forested landscapes (adapted from Mollard and Janes 1984).

After Deglaciation





during glacial and early post-glacial periods (Zoltai 1965, 1967; Shilts et al. 1987). With the exception of a zone of strongly broken topography along the Lake Superior coast and areas of stratified glacial deposits, the Shield landscape in northwestern Ontario is characterized by an undulating, bedrock-dominated terrain. North of the Shield lies the Hudson Bay Lowland, a flat landscape typified by an almost continuous mantle of organic terrain.

Most landform features in northwestern Ontario (Fig. 6, 7) were created or modified by glacial movements and actions. Glacial till is found throughout northwestern Ontario, occurring as unstratified ground moraines, ablation tills, end moraines and drumlins. Stratified glacial deposits, including glaciofluvial, proglacial (outwash), glaciolacustrine and glaciomarine deposits are frequently encountered. Expanses of shallow glacial drift occur over rolling to rugged bedrock. A number of other landform features that occur in northwestern Ontario are not directly associated with glacial action; these include colluvial, aeolian and alluvial deposits, as well as organic accumulations (Fig. 7).

In the Shield areas of northwestern Ontario, the most commonly occurring glacial deposit is a shallow drift deposit, usually a bouldery, sandy or coarse loamy till (Sado and Carswell 1987), which clearly reveals the topographic character of the underlying bedrock. Thicker deposits of till are also widespread. A fine-textured till, derived from the carbonate bedrock of the Hudson Bay Lowland and carried southward onto the Shield by moving ice, occurs within discrete dispersion trains and locally thin smears (Karrow and Geddes 1987).

Ice-contact and outwash glaciofluvial deposits, consisting of sorted sands and gravels, are found in local areas throughout the Shield portion of

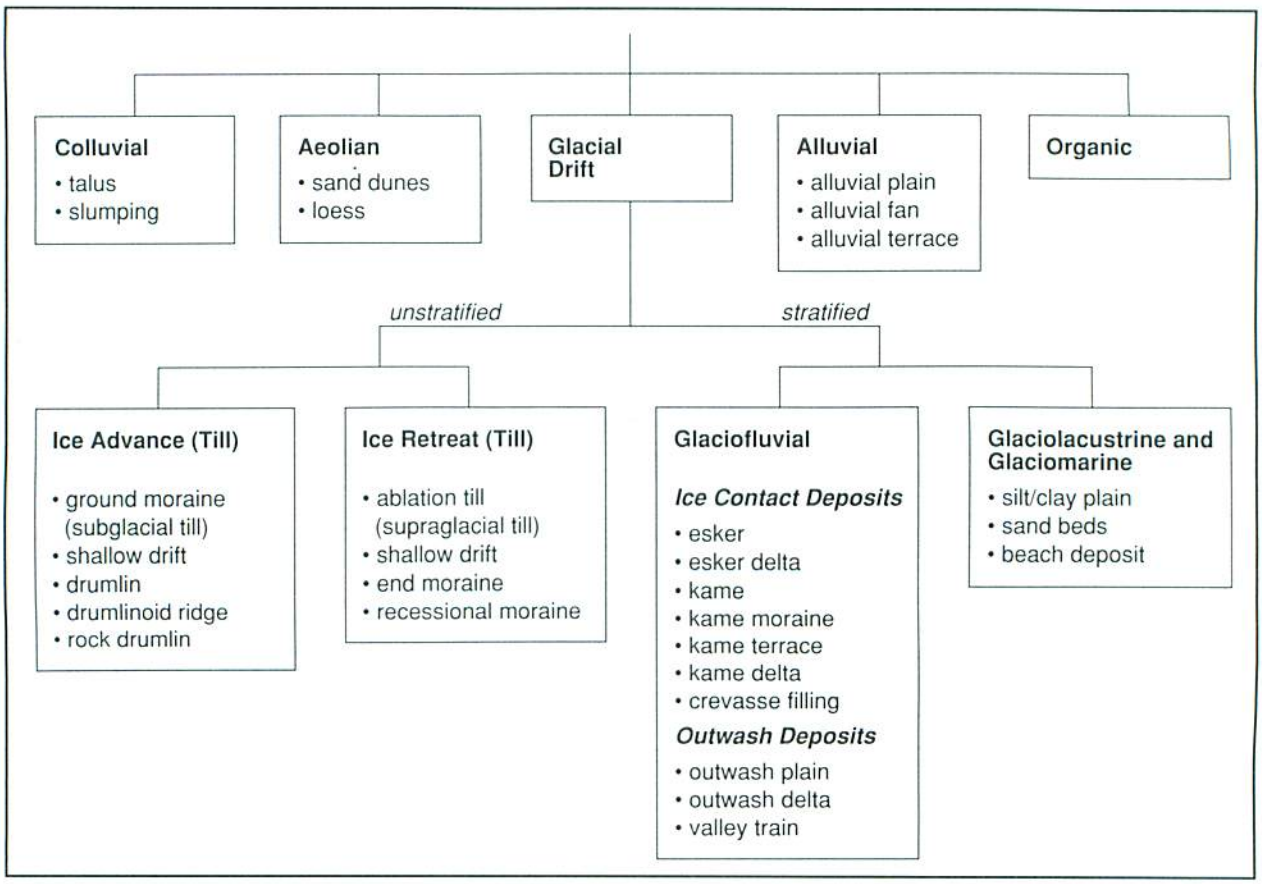


Figure 7. Common landform features in northwestern Ontario.

northwestern Ontario. These deposits, including features such as eskers, kames, kame moraines and deltas, are among the most prominent and most recognizable landform features in the area (Zoltai 1965, 1967). Numerous glacial lakes (including Lake Agassiz), which historically inundated much of northwestern Ontario, deposited a range of materials including beach and near-shore sands as well as deep-basin silts and clays; these glaciolacustrine deposits are frequently found in close proximity to glaciofluvial landforms. Glaciomarine deposits are found only in the Hudson Bay Lowland.

Aeolian deposits occur throughout northwestern Ontario, although individual deposits are local in extent. Usually coarse-textured, these materials tend to be associated with both glaciofluvial and glaciolacustrine landforms. Organic deposits are generally found only in local areas of the Shield portion of northwestern Ontario, usually occupying poorly drained bedrock depressions and lower landscape positions. Occasionally, organic materials extensively overlie fine-textured (silt and clay), low-relief glaciolacustrine basins (Graham 1979). Although peatlands on the Precambrian Shield are typically small and confined, the Hudson Bay Lowland is characterized by large and continuous expanses of organic soils (Cowell et al. 1991).

There are a number of mapped databases that provide excellent information on the distribution of landform features in northwestern Ontario (Table 1). Northern Ontario Engineering Geology Terrain Study (NOEGTS) maps are particularly valuable tools for many forestry planning purposes, providing surficial geology data at an intermediate mapping scale (1:100,000). A portion of a NOEGTS database map is shown in Figure 8 along with an example and an explanation of the NOEGTS map notation system. There are also several valuable publications that discuss guidelines and techniques for recognizing and interpreting landform features on aerial photographs (Lueder 1959, Keser 1979, Mollard and Janes 1984).

INTRODUCTION TO THE LANDFORM SUMMARIES

Several references were consulted during the compilation of the following summary sections for individual landform features: Zoltai (1961, 1963, 1965, 1967), Jeglum et al. (1974), Graham (1979), Keser (1979), Kor (1981), Mollard and Janes (1984), Sado and Carswell (1987) and several NOEGTS maps and their accompanying reports (see Table 1). Definitions of selected terms in the glossary section of this report were derived from Anon. (1976, 1978), Keser (1979) and Sims et al. (1989).

The Northwestern Ontario Forest Ecosystem Classification (NWO FEC) is an ecologically based system of site classification (Sims et al. 1989). The system permits the ecological classification of forest soils and vegetation as a framework for the organization, communication and application of forest management expertise (Racey et al. 1989). It projects relationships among soil textures, other soil features and vegetational conditions on a forested site. The NWO FEC may be used to develop land-management strategies and options, and can be readily applied in an area where a forest manager has a good understanding of landform features. In the following summary sections, commonly associated NWO FEC Vegetation and Soil Types are listed for each landform feature, based on information collected at more than 2,100 NWO FEC plots in northwestern Ontario.

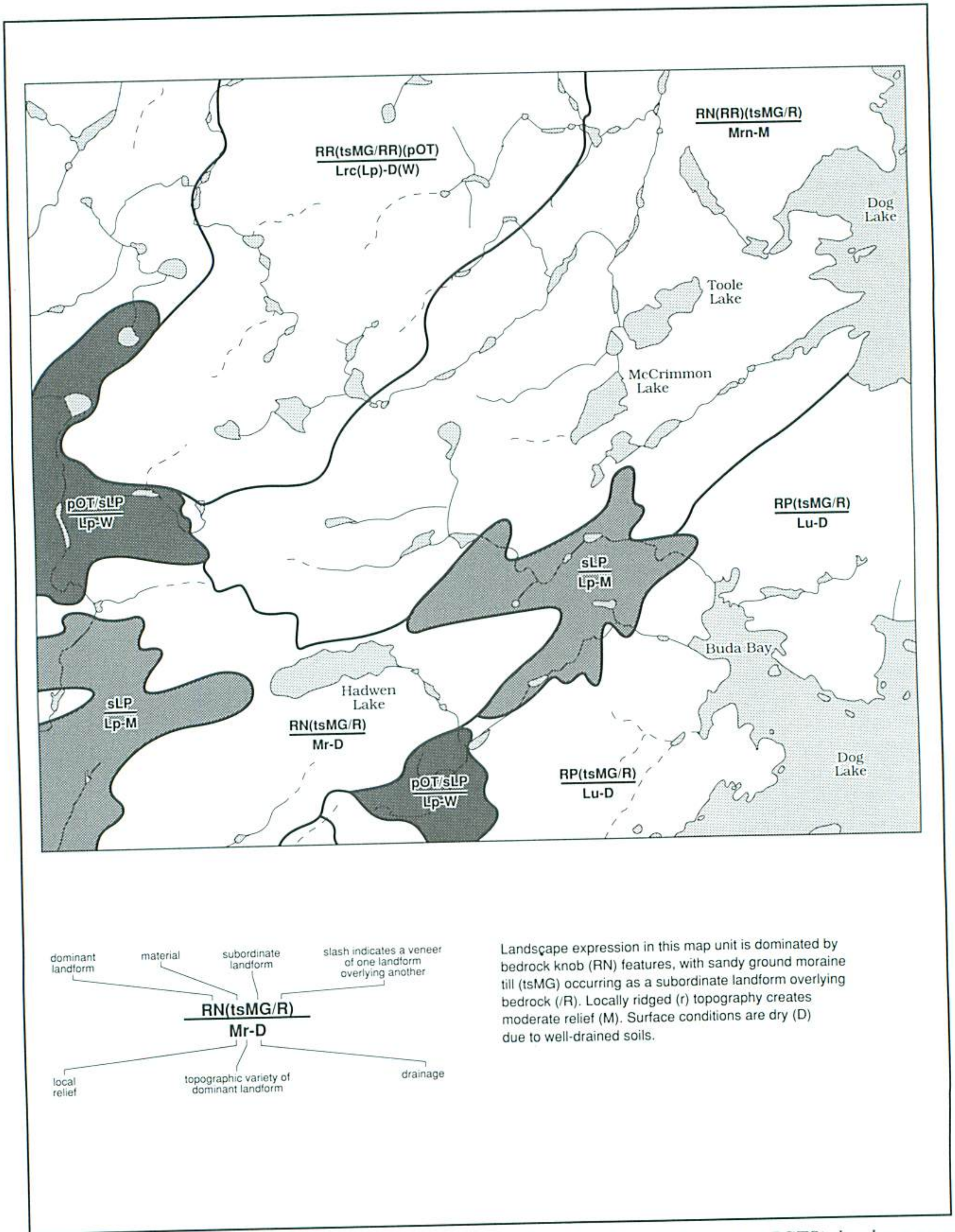


Figure 8. A portion of a Northern Ontario Engineering Geology Terrain Study (NOEGTS) database map (Map No. 5045, Kaministikwia; original scale 1:100,000), showing an explanation of the map notation system (adapted from Mollard 1979).

COMMON LANDFORM FEATURES IN NORTHWESTERN ONTARIO

Ground Moraine (Subglacial Till)

Drumlins

Ablation (Supraglacial) Till

Shallow Drift Overlying Bedrock

End Moraines

Eskers

Kames and Crevasse Fillings

Outwash Deposits

Glaciolacustrine and Glaciomarine Deposits

Alluvial Deposits

Colluvial Deposits

Aeolian Deposits

Organic Terrain

Ground Moraine (Subglacial Till)

General Description (Fig. 9, 10, 11)

During the advance of the continental ice sheets, soil and rock fragments were eroded from the land surface and incorporated into the ice. Much of this debris accumulated in the basal layer of the glaciers and, as a result of both frictional drag and melting, was deposited directly beneath the ice as *subglacial till*. The resulting landform, called *ground moraine*, is typically an undulating *till plain* that is often grooved, fluted or drumlinized parallel to the direction of ice flow. Individual fragments within the till are often aligned with the direction of ice flow. The till varies in thickness, but tends to be thinner on bedrock knolls and ridges and deeper in depressional site positions. Because of compression of the till by the weight of overriding ice, ground moraine is often compact and impervious. In contrast with ablation till, which may contain material that was transported a great distance, rock fragments in ground moraine tend to reflect the characteristics of local bedrock conditions.

Occurrence

Deposits of subglacial and supraglacial till are extremely common in northwestern Ontario. The distributional pattern of these materials, together with the configuration of underlying bedrock, is responsible for most of the landform expression associated with the landscape of northwestern Ontario. Extensive deposits of till that are sufficiently deep to mask the expression of bedrock topography are encountered primarily along the northern limit of the Precambrian Shield. Deep deposits of ground moraine, often associated with drumlin fields, also occur to the west of Geraldton, in the Red Lake–Savant Lake–Pickle Lake area and to the southwest of Lake Nipigon.

Planning Considerations

In most of the Shield areas of northwestern Ontario, ground moraine deposits contain a high sand fraction as well as large volumes of stones and boulders. These materials are unsorted and unstratified, with considerable spatial variability in thickness and composition. Their usefulness for aggregate extraction is generally minimal, although small pockets of sand and gravel may be of value. In many areas of northwestern Ontario, ground moraine is thin and intermittent, with frequent outcrops of exposed bedrock. Although foundation materials are generally suitable for engineering projects, construction on ground moraine can be difficult as a result of shallow soils and the often high boulder content.

Internal drainage is variable in ground moraine deposits, and depends upon the composition of the till, its degree of compaction and its topographic position. Depressional sites between bedrock knolls or drumlinoid features often have high water tables, with organic materials overlying the till. Upper slope positions may be excessively drained, resulting in dry moisture regimes if soils are shallow. Permeability may be reduced by compacted soils. Vegetational conditions are variable, reflecting the wide range of characteristics encompassed by ground moraine deposits. Logging operations may be influenced by site restrictions where soils are shallow or excessively bouldery.

Topography

- flat to gently undulating
- usually without abrupt or steep slopes
- the landscape is often patterned with drumlins, fluting features or small, irregular mounds
- kettle holes are uncommon
- often with stagnant or poorly developed drainage

Air Photo Tone/Pattern

- mottled appearance, with light tones associated with higher site positions and darker tones with depressions
- a range of patterns occurs, from an irregular, feathery pattern to relatively flat, uniform, featureless terrain

Common NWO FEC Vegetation Types

- V4–V21, V24–V28, V30–V34

Common NWO FEC Soil Types

- S1–S3, S7, S8, SS2, SS3, SS5–SS8

Material

- the till varies depending on the origin of the rock material; coarse fragments occur in a wide range of volumes and sizes
- tills derived from rock of the Precambrian Shield tend to be granular, often with a large component of coarse fragments
- tills derived from carbonate bedrock are usually fine-textured, stony silts

Drainage/Erosion

- disordered or random drainage patterns are most common
- there are many small, undrained, irregularly-shaped depressions
- local erosion may occur; gully shapes depend upon the texture of the parent material, but are usually smooth

Frost-heave Hazard

- coarse-textured till soils typically have low frost-heave hazards
- fine-textured till soils may be susceptible to frost heaving

Drumlins

General Description (Fig. 12, 13, 14)

Drumlins are low, elongated, smoothly rounded hills of compact glacial *till*. These features were created when debris at the base of a glacier was deposited and then overridden by the ice during its advance. Drumlins are characterized by a streamlined, teardrop shape with a steep, blunt (stoss) end and a gently sloping, tapered (lee) end. The long axis of a drumlin is oriented in the direction of ice flow, with the stoss end pointed in the direction from which the glacier approached. Long, low, cigar-shaped *drumlinoid ridges*, resulting from the same depositional processes, are often associated with drumlins. Drumlins and drumlinoid ridges are often clustered closely together in *drumlin fields*. *Rock drumlins*, also found in northwestern Ontario, were created by the reshaping of bedrock surfaces during glacial advance.

Occurrence

In northwestern Ontario, drumlins and drumlinoid ridges are most prevalent in till derived from the calcareous bedrock of the Hudson Bay Lowland. Large drumlin fields are prominent landscape features only in the northern portion of northwestern Ontario, near the boundary of the Precambrian Shield and the Hudson Bay Lowland. Extensive and well-developed drumlin fields occur to the west of Geraldton and in the vicinity of Sioux Lookout–Pickle Lake, as well as along the northern edge of the Shield between Big Trout Lake and Nakina. Across southern portions of northwestern Ontario, drumlins occur only as scattered individuals and small groups.

Planning Considerations

Soil characteristics of drumlins and drumlinoid ridges vary considerably, depending on the source of erosional debris transported by the glacier. Drumlinized till typically contains a broad size range of unsorted particles (from clay to boulders), which have been compacted by the weight of overriding ice. Till within drumlins tends to have low compressibility, low permeability and high load-bearing strengths. Depending upon the composition of the till, drumlins may have potential for aggregate extraction. Although drumlins may provide suitable foundations for buildings and roads, the irregular terrain associated with drumlin fields may require the excavation of large quantities of materials.

Although internal drainage of compacted drumlin soils is often poor, lateral water movement (seepage and runoff) from elevated drumlinoid features typically results in dry to fresh soil moisture regimes. Drumlins support a range of upland forest conditions. Within drumlin fields, the areas between drumlins may have high water tables as a result of poor or restricted drainage and the effects of downslope water flow from drumlin surfaces; lowland forest types may occur in these depressional positions. Steep slopes and broken topography in tightly clustered drumlin fields sometimes present terrain obstacles to mechanized logging operations, particularly during snow-free periods.

Topography

- low, narrow, oval to elongated hills, often occurring in irregularly patterned, oriented drumlin fields
- groups of drumlins and/or drumlinoid ridges have a characteristic streamlined appearance and are oriented in the same direction
- drumlins typically have a blunt face and a gently tapered or fluted end, but the size, length and general shape is variable

Air Photo Tone/Pattern

- drumlins are teardrop-shaped and drumlinoid ridges are cigar-shaped

Common NWO FEC Vegetation Types

- V4–V6, V8–V12, V17, V18, V20, V26, V32, V33
- V30 (rock drumlins)

Common NWO FEC Soil Types

- S1, S2, S3

Material

- the till material of drumlins varies considerably; in northwestern Ontario, most tills are bouldery and sandy, although calcareous tills are often silty and stony

Drainage/Erosion

- poor internal drainage but typically good surface runoff
- inter-drumlin areas may be poorly drained, with moist to wet soil moisture regimes
- erosion potential is generally low

Frost-heave Hazard

- susceptibility to frost heaving is variable, depending on the texture of the till material and the topographic position; frost-heave hazard is generally low to moderate

Ablation (Supraglacial) Till

General Description (Fig. 15, 16, 17)

Debris carried within and upon the upper layers of the glaciers was eventually deposited when the ice became stagnant and melted. Such deposits, resulting from glacial wasting and degradation, are known as *ablation till* or *supraglacial till*. Since the depositional environment included large quantities of meltwater, the washing and reworking of supraglacial sediments resulted in an extremely variable landform condition. In northwestern Ontario, ablation till comprises mainly coarse-textured, unsorted, bouldery till, but it also contains pockets of stratified silts, sands and gravels. Unlike till materials in ground moraine, ablation till is not compacted and has no orientation relative to the direction of ice flow. Deep ablation till deposits typically generate an irregular, hummocky, *knob-and-kettle landscape*, often associated with scattered kame features.

Occurrence

Ablation till is ubiquitous in northwestern Ontario. In the southern portions of the region, it typically forms a thin, intermittent veneer overlying bedrock. Ground moraine deposits to the north of the height of land are deeper, often masking the bedrock topography; in this area, ablation tills occur as loose, bouldery, unconsolidated caps, typically overlying drumlin fields and till plains. Thick deposits of ablation till, forming a hummocky, knob-and-kettle landscape, are commonly located on the northern sides of major end moraines.

Planning Considerations

Throughout most of the areas in northwestern Ontario underlain by the Precambrian Shield, ablation tills contain large sand fractions as well as large volumes of stones and boulders. These materials are generally unsorted and unstratified, with considerable spatial variability in both thickness and composition. Their usefulness for aggregate extraction is minimal, although small pockets of sand and gravel may be of value. In many areas, ablation till is thin and intermittent, with frequent outcrops of exposed bedrock. Although foundation materials are generally suitable for engineering projects, construction can be difficult on ablation till because of the shallow soils, the variability of soil textures and the high coarse-fragment contents associated with these deposits.

The internal drainage of ablation till is generally good as a result of the typical coarseness of the materials as well as their unconsolidated and uncompacted nature. Moisture regimes range from dry to moist, and vary with soil texture, topographic position and soil depth. Depressional sites between hummocks, knolls or ridges often have high water tables, with organic materials overlying the till. Upper slope positions may be excessively drained, resulting in dry moisture regimes, especially if soils are shallow. Vegetational conditions are variable, reflecting the wide range of characteristics encompassed by ablation till deposits. Logging operations may be influenced by site restrictions where there are steep or irregular slopes and where soils are shallow or excessively bouldery.

Topography

- irregular and variable relief, often with a knob-and-kettle appearance
- frequently associated with collapse features, such as crevasse fillings and kames, and ice-contact sediments, such as end moraines and eskers

Air Photo Tone/Pattern

- characteristic pattern of knobs and closed hollows (kettles)
- light tones are associated with higher ground; darker tones indicate lower ground

Common NWO FEC Vegetation Types

- V4–V21, V24–V28, V30–V34

Common NWO FEC Soil Types

- S1–S3, S7, S8, SS2, SS3, SS5–SS8

Material

- a mixture of ice-contact, till and fluvial materials
- there are abrupt and usually unpredictable changes in material composition

Drainage/Erosion

- disordered drainage, usually with stagnant kettle pools
- because material varies, potential for erosion is highly variable, from nil to high hazard

Frost-heave Hazard

- locally, where there are fine-textured soils, the frost-heave hazard may be high

Shallow Drift Overlying Bedrock

General Description (Fig. 18, 19, 20)

In the Precambrian Shield areas of northwestern Ontario, till was deposited directly onto the bedrock. In most places, both subglacial and supraglacial tills form a thin, discontinuous veneer of *glacial drift*, with topographic expression controlled by underlying bedrock. In general, Shield terrain consists of an irregular surface, ranging from undulating bedrock plains of low relief to rugged bedrock knob, ridge or plateau landscapes. Thickness of the overlying drift varies considerably, but is typically less than 1 m deep on the upper slope and crest positions, and up to several metres deep on the lower slope and depressional sites. Exposed bedrock is very common in the southern areas of northwestern Ontario, near the height of land. Toward the northern edge of the Shield, thicker, more continuous till deposits usually mask bedrock expression.

Occurrence

Bedrock-controlled terrain comprises the vast majority of the landscape in the southern (Shield) portions of northwestern Ontario. Depth of the overlying drift is extremely variable, even within local areas. There is a general northward trend toward deeper deposits. Bedrock relief is greatest in the Thunder Bay–Lake Nipigon area and along the northern shore of Lake Superior.

Planning Considerations

Although the Precambrian Shield offers solid foundation conditions, bedrock terrain in northwestern Ontario is generally considered poor for construction activities. Topography is often highly broken and irregular, and excavations tend to require expensive blasting. Very shallow, coarse-textured soils and areas of bedrock fracturing are unsuitable for septic fields or waste disposal. On low-relief bedrock plains, road development may be possible with a minimum of rock cuts.

Bedrock permeability varies with the degree of rock fracturing. Shallow, coarse-textured soils, such as those that typically occur on upper bedrock slope positions in northwestern Ontario, may maintain minimal reserves of moisture and nutrients for vegetation development. Toe-slope and depressional positions often develop high water tables, and may support organic soils. Vegetational characteristics are variable, reflecting the wide range of site conditions encountered in bedrock terrain. On sites with exposed bedrock, vegetation cover is typically discontinuous and stunted (V30). Logging operations are often restricted on bedrock terrain by topography and the fragility of shallow soils.

Topography

- relief is strongly controlled by the surface configuration of the bedrock, and ranges from gently rolling to rugged and broken
- exposed, non-forested bedrock patches are common; drift cover is typically <1 m thick over upland areas but may be much deeper in local pockets and low-lying depressions
- small peatlands and water pools may develop, even on uplands, where bedrock impedes drainage

Air Photo Tone/Pattern

- variable and not diagnostic, although patterns of underlying bedrock are often evident, showing signs of directional movement of glaciers (e.g., striations or lineations, *roches moutonées*, rock drumlins, etc.)
- rock outcrops often have a characteristic light tone; they are usually sparsely vegetated or unvegetated, and may support depauperate and widely spaced trees that are prone to windthrow

Common NWO FEC Vegetation Types

- V30 (especially where rock outcrops are visible on air photos)
- V4–V21, V25–V28, V31–V34

Common NWO FEC Soil Types

- S1–S3, S7, S8, SS1–SS3, SS5–SS9

Material

- variable materials, but usually composed of coarse till deposits
- organic terrain is common in depressions and where water tables are "perched" on raised bedrock features

Drainage/Erosion

- areas are often poorly or imperfectly drained because of the shallow soils
- small pools of water and peatlands are common
- drainage is strongly bedrock-controlled
- erosion potential is variable, ranging from low to high; on slopes associated with very shallow soils, site degradation is a serious threat

Frost-heave Hazard

- variable, depending upon the texture of materials and slope position; the frost-heave hazard is generally low

End Moraines

General Description (Fig. 21, 22, 23)

For periods of time during deglaciation, the rate of advance of an ice sheet balanced that of retreat, and the ice front remained semi-stationary. During these "still-stands", debris was continually transported forward by ice flow, becoming concentrated near the ice margins. Deposition of these sediments at the ice margins resulted in the creation of prominent landforms, oriented transverse to the direction of ice flow, known as *end moraines*. Major end moraine systems, such as those occurring in northwestern Ontario, form broad, linear landform complexes that extend for hundreds of kilometres. The general features of this landform type are extremely variable, depending on the characteristics of the immediate depositional environment and the local sequence of events during deglaciation. Some moraines are long, narrow, esker-like ridges, sometimes terraced and flattened by the wave action of proglacial lakes. Some moraines were modified by readvances of the ice sheet, forming an indistinct band of irregular, hummocky terrain. In other cases, a series of parallel *recessional moraines* marks successive positions of the ice front during its retreat. Since ice recession was always accompanied by large volumes of meltwater, end moraine materials are typically a combination of unsorted, bouldery till and stratified sands and gravels of *glaciofluvial* origin. End moraine complexes often include features such as kames, eskers and *ice contact deltas* as well as deposits of ablation till.

Occurrence

Several major end moraines occur in northwestern Ontario (see Fig. 3), including some of the best-developed moraine complexes in North America. From south to north, these end moraine locations reflect successive still-stand positions of the ice margins as the glaciers retreated across northwestern Ontario. The Eagle–Finlayson moraine complex is virtually continuous from Thunder Bay through the Quetico area to north of Vermillion Bay. The Hartman and Lac Seul moraines extend to the south of Lac Seul between Lake Nipigon and the Red Lake area. The Nakina–Agutua moraine system stretches from Sandy Lake to Nakina, passing to the north of Lake Nipigon.

Planning Considerations

Materials within end moraine complexes are extremely variable in both composition and structure, with coarse, unsorted tills intermixed with stratified silts, sands and gravels. In northwestern Ontario, the boulder content of these landforms is generally high. Terrain conditions range from narrow, steep-sided ridges to knob-and-kettle topography. Construction difficulties may arise due to excessive boulder content and unpredictable material composition. Moraine systems may be suitable sources of aggregate, especially where a large proportion of the materials are of glaciofluvial origin.

Internal drainage is variable within end moraine systems in northwestern Ontario, depending upon the composition of the materials. In general, materials are coarse-textured, with a high proportion of coarse fragments, so soils range from well drained to rapidly drained. Soils are typically deep in end moraine deposits, and exposed bedrock is rarely encountered. Vegetational conditions are variable, reflecting the wide range of characteristics encompassed by end moraine deposits. Logging operations may encounter site-related restrictions, such as steep slopes or excessively bouldery or compacted soils.

Topography

- variable relief, but typically hummocky to irregular; sometimes major landscape features such as large, distinctive, steep-sided ridges
- sub-parallel ridges, from 1 to 10 km wide, and from 5 to 100 km long
- abrupt elevation changes

Air Photo Tone/Pattern

- typically mottled tones
- irregular topography

Common NWO FEC Vegetation Types

- V4–V21, V24–V28, V31–V33

Common NWO FEC Soil Types

- S1, S2, S3, S7, S8

Material

- mainly composed of glacial till, with pockets of granular glaciofluvial materials
- more variable materials than ground moraine, but sometimes end moraine soils are strongly compacted
- interstratified sediments are common
- kames and kame fields are sometimes associated with large end moraines
- frequently, end moraines are wave-modified

Drainage/Erosion

- disordered drainage, with local ponds and poorly developed drainage networks
- water may remain trapped in granular lenses
- soil erosion potential is often high, depending on soil texture and degree of slope

Frost-heave Hazard

- frost-heave hazard is generally low

Eskers

General Description (Fig. 24, 25, 26)

Meltwater flowing through cracks and tunnels within and at the base of glacial ice formed sub-glacial channels along which coarse-textured materials were transported and deposited. With the retreat of the glaciers, the channel beds were exposed as narrow, sinuous, often steep-sided ridges called *eskers*. Esker deposits are usually oriented parallel to the direction of ice flow. Eskers may be continuous over long distances or segmented as a result of partial destruction during glacial recession. *Esker complexes* formed where subglacial drainage developed into interconnecting networks. *Esker fans* or *deltas* are found, often in association with end moraines, where subglacial drainage emerged from ice fronts or entered proglacial lakes. Eskers may be "beaded", with numerous bulges reflecting points where the originating subglacial channels widened into pools or branched streams.

Occurrence

Eskers are common landform features in northwestern Ontario, often occurring in proximity to end moraines. They tend to occur in complexes with glacial outwash and kame deposits. Major aggregations of eskers occur in the Geraldton–Nakina general area, in the Graham–Savant Lake–Sioux Lookout area and throughout the northern portions of northwestern Ontario near the southern limit of the Hudson Bay Lowland.

Planning Considerations

Eskers are typically composed of coarse, sandy materials, usually with significant amounts of gravel and cobbles. Sorting and stratification are often complex, resulting in considerable compositional variability. Depending upon the degree of variability, eskers may be suitable sources of sand and gravel for some construction purposes. Esker deltas are usually better sorted, cleaner and less variable in composition than eskers, and are good potential sources of aggregate. With generally low compressibility and high load-bearing strength, the crests or flanks of some larger, wider eskers may serve as good locations for transportation routes, especially in wet, lowlying terrain. In northern areas, eskers provide travel routes for humans and animals alike, and are preferred denning grounds for foxes, wolves, bears and other mammals, especially in areas that are affected by late seasonal frost or permafrost. Eskers should be avoided as waste disposal sites.

Consisting of raised deposits of coarse materials, eskers possess excellent internal drainage, and typically reflect a moderately dry to moderately fresh soil moisture regime. In the commercial forests of northwestern Ontario, stands dominated by red pine (V13, V27) and jack pine (V18, V28, V29, V30, V32) are commonly found along these sand and gravel ridges. Understory vegetation may be sparse, often with a ground cover of lichens and mosses. Narrow, steep-sided eskers may occasionally present terrain obstacles for logging operations.

Topography

- visible from the air as sinuous, low ridges, occurring alone or in complexes; sometimes widening into fan or delta shapes
- discontinuous to continuous features
- esker features often blend into deltas, kames, or glacial outwash

Air Photo Tone/Pattern

- distinctive long, sinuous form
- sometimes support vegetation cover that contrasts (different species, degree of crown closure, tree height, etc.) with the surrounding landscape

Common NWO FEC Vegetation Types

- V10, V11, V13, V16, V18, V27–V30, V32

Common NWO FEC Soil Types

- S1, S2, S3

Material

- typically water-sorted sands and gravels
- strata are typically tilted and, in profile, are often faulted
- abrupt variations in soil materials may occur

Drainage/Erosion

- excellent internal drainage
- eskers are often flanked by swamps or kettle-hole features
- erosion potential is generally low

Frost-heave Hazard

- frost-heave hazard is generally low

Kames and Crevasse Fillings

General Description (Fig. 27, 28, 29)

Wasting of glacial ice released large quantities of meltwater that drained away through any available channels. Water flowed into crevasses and shafts in the ice, ponded in depressions on the ice surface and poured off the edges of ice sheets. Wherever this meltwater flowed, it transported glacial debris, depositing it on, within and around the margins of the glaciers. As the glaciers retreated, these deposits remained on the landscape in the form of steep-sided, conical hills (*kames*) or short, irregular ridges (*crevasse fillings*), typically composed of complex strata of sands and gravels. Clusters of these features are recognized as *kame fields* and, when associated with morainal features, *kame moraines*. *Kame terraces* developed where material was deposited between a glacier and adjacent bedrock, typically along a valley wall. *Kame deltas*, like esker deltas, are found where deposition occurred directly into proglacial lakes.

Occurrence

Kame deposits are common elements of the landscape in northwestern Ontario, occurring both as scattered individual landforms and, in association with eskers, moraines and outwash, as components of extensive landform complexes. In association with outwash deposits, kame features are especially evident in the Graham and Longlac general areas. They occur as distinctive, hummocky kame moraines when found in conjunction with several of the prominent end moraines in northwestern Ontario; this condition is notable along major portions of the Steep Rock, Eagle–Finlayson, Hartman, Lac Seul, Nipigon, Onaman and Agutua moraines (see Fig. 3).

Planning Considerations

Like eskers, kames are typically composed of coarse sandy and gravelly materials, but with a high degree of compositional variability. Depending upon the extent of this variability, kames may be suitable sources of aggregate for some construction purposes. Although kames may provide good building sites for small-scale construction, the small size of discrete deposits and the uneven terrain associated with large kame complexes often make them unsuitable for extensive engineering projects such as transportation corridors. Kame deposits should be avoided as waste disposal sites.

Consisting of raised deposits of coarse materials, kames possess excellent internal drainage, and typically exhibit a moderately dry to moderately fresh soil moisture regime. In irregular terrain, especially kame and kettle topography, there may be ponds and wetlands interspersed among kames. Larger individual kames may occasionally contain kettles on their surfaces, creating small, moist depressions. In the commercial forests of northwestern Ontario, stands dominated by jack pine and black spruce (V10, V11, V17-V20, V28-V33) commonly occur on kame deposits. Vegetation on depressional landscape positions around kames often reflects predominantly moist or wet soil conditions (e.g., V23, V34–V38 or non-treed wetlands). Steep-sided kames and irregular topography may present terrain obstacles for harvesting or silvicultural operations.

Topography

- individual kames are conical to irregularly shaped
- kame terraces in northwestern Ontario are frequently associated with bedrock knobs and modern river valleys
- kame moraines typically occur as groups of hills and knobs with intervening depressions
- crevasse fillings are short, ridge-like features

Air Photo Tone/Pattern

- kames often exhibit a "knob-and-kettle" pattern, but they may be highly variable in general appearance

Common NWO FEC Vegetation Types

- V4, V8, V10–V13, V16–V20, V25, V27–V33

Common NWO FEC Soil Types

- S1, S2, S3, S7, S8, S11

Material

- stratified but poorly-sorted sands and gravels
- strata are often tilted and faulted
- abrupt variations in materials and stratification are common

Drainage/Erosion

- excellent internal drainage
- erosion potential is generally low

Frost-heave Hazard

- frost-heave hazard is generally low

Outwash Deposits

General Description (Fig. 30, 31, 32)

Meltwater that drained away from ice margins often carried sediments long distances from the receding glaciers. These materials, which were laid down beyond the ice fronts, are referred to as *outwash deposits*. Outwash can be of two forms, depending upon the relief of the terrain over which the meltwater flowed: when confined within bedrock valleys, *valley trains* were formed; on terrain of low relief, meltwater rivers were typically wide and shallow, forming broad, sheetlike, gently sloping *outwash plains*. Materials deposited into standing or slow-moving water created *outwash deltas* and *fans*. Since they were laid down by flowing water, outwash deposits are typically composed of well-sorted, stratified sands and gravels. Outwash landforms, especially outwash plains, often present a smooth, flat relief. However, modified or broken topography is common as result of terracing, pitting by *kettle holes*, or dissection by remnant *channel scars*.

Occurrence

Outwash deposits are widespread throughout northwestern Ontario, ranging in size from small, local pockets to extensive outwash plains. Large areas of outwash deposits are often associated with the positions of major end moraines, where extensive complexes of glaciofluvial landforms (moraines, outwash, eskers and kames) are commonly observed. Sizeable outwash deposits occur in the Graham–Brightsand River–Raith and Beardmore–Nakina areas, between Dog Lake and Thunder Bay, north of Ignace, east of Longlac and northwest of Atikokan.

Planning Considerations

Outwash deposits usually consist of clean, well-sorted, coarse-textured sands, with or without a significant gravel component; stone and boulder contents are generally low. Consequently, these landforms have good potential for aggregate extraction. The granular materials of outwash deposits, with their high bearing capacity, stable slopes, low erodibility and low frost-heave hazard, provide suitable sites for most types of engineering projects. Outwash plains, in particular, offer excellent locations for the development of transportation corridors and airfields. Where deposits are deep, especially near lakes and rivers, they have good potential for the development of groundwater resources. Because of their high permeability, outwash deposits are not suitable as waste disposal sites.

Outwash materials possess good internal drainage and commonly reflect a moderately dry to moderately fresh soil moisture regime. In northwestern Ontario, extensive tracts of even-aged forest dominated by jack pine and black spruce (V11, V18, V27, V28, V32) are common on outwash landforms. Because of the typically low relief, undulating and pitted outwash plains often have high water tables throughout portions of their area. Vegetation on the depressional sites reflects the moist soil conditions (V23, V34–V38 or non-treed wetlands), with organic soils sometimes developing on top of outwash materials. Outwash terrain usually offers few limitations to logging operations; in larger areas of outwash, post-cut wind erosion of surface soils may occasionally be a problem.

Topography

- usually level or gently sloping
- the landscape is sometimes pitted or covered with kettle holes
- fossil channel scars may occasionally be apparent

Air Photo Tone/Pattern

- tones are generally light, sometimes with dark areas associated with water infiltration, depressions, basins or kettle holes
- channel scars appear wormlike or sometimes with a mottled pattern

Common NWO FEC Vegetation Types

- V4, V8, V10–V13, V16–V20, V25, V27–V33

Common NWO FEC Soil Types

- S1, S2, S3, S7, S8, S11

Material

- clean, stratified sands and/or gravels
- horizontal strata, often very well-defined

Drainage/Erosion

- good internal drainage, high soil infiltration
- often no streams or well-defined drainageways
- channel scars may be filled with organic soil deposits
- erosion potential is variable, but generally low

Frost-heave Hazard

- frost-heave hazard is generally low
- susceptibility to frost heaving is higher where the water table is close to the surface, and may vary with water table changes

Glaciolacustrine and Glaciomarine Deposits

General Description (Fig. 33, 34, 35)

Throughout the deglaciation process, huge quantities of water were released from the melting ice sheets, resulting in the formation of large *proglacial lakes*. Large portions of northwestern Ontario were inundated, at one time or another, by glacial lakes. In particular, glacial Lake Agassiz, during its various phases, covered virtually all of northwestern Ontario to the west and north of the continental divide (see Fig. 2). *Glaciolacustrine deposits* characteristically form broad, flat, poorly drained plains. They are typically fine-textured, consisting of deep-water silt and clay sediments. These deposits are often *varved*, reflecting seasonal variations in the proportions of clay and silt washed into the lakes. Near former shorelines and at points where rivers discharged into glacial lakes, glaciolacustrine materials tend to consist largely of fine and medium sands. Former lake shorelines are often reflected on the contemporary landscape as raised *beach ridges*, consisting of wave-washed sands, gravels and cobbles. Within approximately 300 km of the Hudson Bay–James Bay coast, these landforms are of *glaciomarine* origin. In particular, a series of well-developed beach ridges clearly marks the successive levels of the Tyrrell Sea as it receded during isostatic rebound of the land surface.

Occurrence

Since most of northwestern Ontario was at some point inundated by one of the major glacial lakes, a significant proportion of the landscape is covered by glaciolacustrine deposits. Fine-textured *lacustrine plains* form extensive "clay belts" in the Dryden and Thunder Bay areas and in the vicinity of Fort Frances–Rainy River. Glaciolacustrine materials are common around the periphery of Lake Nipigon, in the Longlac–Geraldton area and in many of the larger river valleys along the north shore of Lake Superior, especially in the Pic River, Little Pic River and Black River valleys near Marathon. Extensive lacustrine deposits occur north of Pickle Lake and around Sandy Lake near the Ontario-Manitoba border. Glaciomarine silts and clays underlie most of the extensive peatlands of the Hudson Bay Lowland, in many places broken only by sandy or gravelly raised beach ridges.

Planning Considerations

Glaciolacustrine and glaciomarine clay and silt deposits have a high water-retention capability, low permeability and poor internal drainage. Lowlying lacustrine plains often have high water tables and can be prone to flooding during spring runoff. These soils have low bearing strength, high compressibility and low shear strength, making the operation of heavy equipment difficult under wet conditions. Erodibility and susceptibility to frost heaving can be high, creating difficulties for the construction of roadbeds and building foundations. These deposits are of little value for aggregate extraction. As a result of their low permeability, deep deposits may offer suitable waste disposal sites if water tables remain well below the ground surface.

Unless silt content is high, lacustrine sand plains are similar to outwash plains in their engineering and ecological characteristics. Raised beach ridges may be useful as aggregate resources, depending on their size and material composition. In the Hudson Bay Lowland, major inland beach ridges can provide important travel corridors in areas that are otherwise dominated by organic terrain.

Fine-textured lacustrine soils typically possess fair to poor internal drainage, and fresh to very moist moisture regimes. Deep silty or clayey lacustrine deposits usually have better nutrient regimes for vegetation growth than do coarse-textured soils and, except when water-saturated, are among the most productive soils in northwestern Ontario. Natural forest stands on these soils are productive and biologically diverse. Balsam poplar (V1) and black ash (V2) stands occur primarily on glaciolacustrine deposits, as do some of the more productive hardwood (V7, V9) and balsam fir/white spruce (V14, V15, V24) stands. Lowlying glaciolacustrine plains with permanently high water tables are often overlain by organic soils; vegetation on these sites reflects the moist soil conditions (V23, V34–V38 or non-treed wetlands). Forestry practices on lacustrine soils are often influenced by site conditions. The potential for site degradation due to rutting and compaction by heavy equipment is high. Erosion can be a problem when there is a high silt content in the soil. Regeneration may be difficult due to high levels of competition and extensive frost heaving of young seedlings.

Topography

- smooth and level or gently undulating
- often overlain by organic deposits (e.g., Hudson Bay Lowland)
- wind erosion may occur on sand plains creating blowout areas and sand dunes
- raised beaches and minor ridges may be present

Air Photo Tone/Pattern

- typically a uniform, flat plain
- long, often curvilinear, shapes and orientations are diagnostic for raised beaches and dunes
- irregular areas with sharp white tones occur if blowouts or dunes are exposed and unvegetated

Common NWO FEC Vegetation Types

- V1, V2, V7, V9, V14, V15, V24

Common NWO FEC Soil Types

- S4–S7, S9–S11

Material

- well-stratified silts, with either clays or sands
- beach ridges are usually composed of sorted and stratified sands, gravels and cobbles
- silt/clay plains are often varved
- in northwestern Ontario, these deposits are typically freshwater (e.g., Lake Agassiz), but there are also marine deposits in the Hudson Bay Lowland (Tyrrell Sea)

Drainage/Erosion

- silt/clay plains have poor internal drainage and infiltration, high surface runoff, a high (often perched) water table, and gullies
- sand plains have good internal drainage and infiltration, random streams and abrupt gullies
- erosion potential varies from low to high, depending upon soil texture (especially silt content) and slope

Frost-heave Hazard

- frost-heave hazard is high on silt/clay plains because of the high silt percentage and the poor drainage
- frost-heave hazard is generally low on sand plains and beach ridges

Alluvial Deposits

General Description (Fig. 36, 37, 38)

Alluvium is material that has been deposited by modern (i.e., post-glacial) rivers and streams. Alluvial deposits vary in both form and material composition, depending on the characteristics of the local stream environment. Faster currents are capable of transporting larger particles than slower currents. Sediment carried by a stream is eroded from the riverbanks and underlying materials of the streambed, so its composition depends upon the nature of these parent materials. In general, alluvial deposits consist of silts, sands and gravels, although, where groundwater tables remain high, organic deposits may develop over lowlying alluvium. Streambeds eroded in till are often strewn with stones and boulders; streams cutting through glaciolacustrine deposits carry fine-textured materials, predominantly silts and clays. In northwestern Ontario, most rivers are bounded by *alluvial plains*, constituting the historical flood plains of the rivers. Alluvial plains are often scarred by old channel remnants and *oxbows*. Along the sides of a river valley, *alluvial terraces* represent previous levels of the alluvial plain. *Alluvial fans* form where fast-flowing streams spread out onto level plains or flow into slower-moving streams.

Occurrence

Alluvial deposits are found in association with most rivers and streams in northwestern Ontario. The majority are small in areal extent; however, notable alluvial plains are associated with the English–Wabigoon river system north and east of Kenora, the Seine River northeast of Atikokan, the Black and White rivers east of Marathon, the Pagwachuan River east of Longlac, the Black Sturgeon River west of Nipigon and the Dog and Kaministikwia rivers north of Thunder Bay.

Planning Considerations

Alluvial deposits consist mainly of silts and fine or very fine sands. Because water tables are often near the ground surface, organic and mineral soil wetlands often develop in depressional positions. Alluvial plains are often subject to repeated flooding, especially during spring runoff and periods of excessive rainfall. Because of the prevailing high water tables and risks of flooding, alluvial plains are generally unsuitable for the construction of buildings, roadbeds and waste disposal facilities. The movement of heavy equipment over alluvial deposits may result in soil compaction, rutting, slumping and erosion as well as water ponding and redirection.

Alluvial soils are often poorly drained, with moist or wet moisture regimes. Elevated sites such as terraces or levees may have fresh moisture regimes. In northwestern Ontario, rich, fine-textured alluvial soils tend to support diverse and productive forest stands. Balsam poplar (V1), black ash (V2) and cedar (V21, V22) stands are commonly situated on alluvial plains. Trembling aspen, white birch, balsam fir, black spruce and white spruce often occur in various overstory combinations (V6, V8, V25) on alluvial deposits. In the Hudson Bay Lowland, river levees offer the best, sometimes the only, sites for the development of upland forests, which support stands of white spruce, white birch, balsam fir and balsam poplar. Forestry activities, particularly the use of heavy logging equipment, may lead to soil degradation due to rutting and compaction. Erosion can be a problem when silt content of the soil is high. High levels of vegetation competition and frost heaving of young seedlings may contribute to poor regeneration on some alluvial soils.

Topography

- typically associated with clearly visible streams or rivers
- often develop as long, linear features with level to gently undulating terrain
- oxbows and scars of abandoned channels are often evident; the patterns that develop are usually related to the parent material texture and the energy level of the flowing water
- terraces may be evident along valley walls
- wetlands may develop in lowlying areas

Air Photo Tone/Pattern

- configuration of stream features is usually evident, particularly from air photos
- differential vegetation patterns are observed, often including unvegetated or wetland zones adjacent to streams

Common NWO FEC Vegetation Types

- V1, V2, V3, V5, V6, V8, V21, V25
- nutrient-rich soils often support forest with better growth

Common NWO FEC Soil Types

- S1, S2, S4, S7, S8, S9, S11, SS7
- mineral-soil wetlands and organic-soil peatlands may develop in some areas where water is impounded and/or high water tables persist

Material

- well-stratified silts, sands and gravels
- cobbles and boulders are deposited where underlying material is till, and where water moves with sufficient energy to transport larger materials downstream
- channel segments may become filled with silt and organic material

Drainage/Erosion

- often subject to flooding, especially during periods of spring runoff and excessive rainfall
- typically associated with a high water table
- active erosion of stream banks often continues over long periods of time, continually redirecting stream channels

Frost-heave Hazard

- frost-heave hazard is usually high because of poor drainage and the high silt content of the soils

Colluvial Deposits

General Description (Fig. 39, 40, 41)

Colluvium is any heterogeneous, unsorted mixture of materials that has reached its present position as a result of direct, gravity-induced movement. Colluvial deposits are often associated with steep slopes. In northwestern Ontario, the most evident form of colluvial deposit is the accumulation of fragmental *talus* debris at cliff bases. A mixture of finer till and sedimentary materials, washed down from upper slope positions after glacial recession, is often found in association with talus slopes. Downslope *creep* of all these unconsolidated materials may continue intermittently. Another common form of colluvial deposit occurs where water erosion undercuts riverbanks and valley walls, resulting in slope instability and *slumping*.

Occurrence

Colluvial deposits occur locally in northwestern Ontario wherever slopes are steep enough to generate gravity-induced downward movement of soil materials. Striking examples of talus deposits occur at the bases of the near-vertical cliffs that surround mesas and buttes in the Thunder Bay–Nipigon–Beardmore area. Riverbank collapse features are common throughout northwestern Ontario along rivers flowing through deep, fine-textured, alluvial and glaciolacustrine materials.

Planning Considerations

In northwestern Ontario, colluvial landforms are likely to be too steep or unstable for engineering activities; slopes that have failed once are often prone to fail again. Talus may be useful as rock ballast, but removal of the materials could be dangerous because of the slope's instability. Finer materials associated with talus may have value as aggregate, depending on the compositional variability.

Vegetation conditions on colluvial deposits vary with the degree of slope, the physical stability of each site and the type of soil materials. Cliff faces and actively eroding riverbanks may support little vegetation. Abandoned spillways and stream channels, as well as stabilized talus slopes and soil-creep deposits, support a range of forested and non-forested vegetation. White birch is a common component of forest stands on stony, well-drained colluvial deposits along the northern shore of Lake Superior. The microclimates of talus deposits may vary, depending upon the aspect; north- and west-facing slopes are generally colder and more humid; hence, they support different plant associations than south- or east-facing slopes. Colluvial deposits are often too steep or unstable for mechanized timber harvesting.

Topography

- typically associated with moderate to steep slopes, cliffs or riverbanks
- talus material deposited by rock falls from cliff faces is the most commonly encountered colluvial deposit in northwestern Ontario

Air Photo Tone/Pattern

- often appear as light tones on air photos, but this is affected by shadow effects and material composition
- distinctive shapes and forms: kidney-shaped scars, fans or irregularly shaped mounds of debris
- often not vegetated in areas where deposition has recently occurred
- usually restricted in size and well defined in shape

Common NWO FEC Vegetation Types

- V4, V8, V16, V19, V20
- these deposits are often unforested

Common NWO FEC Soil Types

- S3, S6, SS4
- these deposits may often be defined as "non-soils"

Material

- unsorted and unstratified, angular, fragmented rocks and coarse materials of varying sizes (in talus deposits)
- silts, clays or fine to medium sands (in river valley deposits)
- often unconsolidated and unstable slopes

Drainage/Erosion

- very low water-retention capability for talus
- often seepage and springs present in fine-textured deposits
- may be subject to continuing or periodic downslope creep
- soils may be susceptible to erosion by running water, particularly if partly forested or unvegetated

Frost-heave Hazard

- frost-heave hazard is nil in talus materials
- frost-heave hazard may be high in river valley deposits

Aeolian Deposits

General Description (Fig. 42, 43, 44)

Aeolian deposits consist of sediments that have been transported and deposited by wind. *Sand dunes* are mounds or ridges of wind-blown sand, typically composed of sorted, fine and medium sands, often with little structural cohesion. Before deglaciation in northwestern Ontario, sandy glaciofluvial and glaciolacustrine deposits were exposed by receding post-glacial water levels. Before stabilization by the establishment of vegetation, these soils were reworked by wind action, resulting in the formation of "active" dunes. The depth of dune sand ranges up to 20 m in some areas of northwestern Ontario. Currently, most dune systems in northwestern Ontario are vegetated and inactive, although active dunes occur along the coastline of Lake Superior. Many of these landforms have distinct shapes, commonly being parabolic or crescent-shaped. In lowlying areas with high water tables, dunes are often found in association with organic terrain. *Loess deposits* are aeolian landforms that develop from fine-textured materials, mainly silts.

Occurrence

Inactive sand dunes occur locally throughout northwestern Ontario, usually in conjunction with fine-textured, sandy glacial drift (i.e., outwash and sandy glaciolacustrine materials). Extensive dune systems are found south and east of Graham, and north and west of the Ogoki Reservoir. Well-developed, active dunes occur along the shore of Lake Superior near the mouth of the Pic River. Wind-blown loess deposits are less common in northwestern Ontario, but may occasionally be encountered.

Planning Considerations

Dune deposits typically consist of fine and medium sands, occasionally with a silt fraction present. Although easily excavated, dune sands are usually too fine to be useful as aggregate unless they are stabilized in mixture with other materials. Bearing strength of dune sands may be low, providing unsuitable sites for major construction projects. In lowlying areas with high water tables and/or organic soils, loosely packed dune sands may be subject to liquefaction.

Sand dune deposits possess good internal drainage, and typically reflect a dry to moderately fresh soil moisture regime. Jack pine-dominated stands, typically with a shrub-poor understory and lichen-rich ground cover (V30), are common on sand dunes in northwestern Ontario. In lowlying areas, dunes may occur in association with wet, organic terrain, giving rise to a local mosaic of upland and lowland soil and vegetation conditions. Dune soils are sensitive to disturbance, and may be vulnerable to wind erosion after road construction or logging operations.

Topography

- distinct formations and shapes, including parabolic, barchan, transverse and blow-out dunes
- sand dunes typically occur in oriented clusters, sometimes with different shapes in close proximity
- surrounding topography is often level or depressed

Air Photo Tone/Pattern

- the shapes and orientation of dunes are diagnostic
- sharp, white tones often appear on air photos where exposed dune surfaces occur

Common NWO FEC Vegetation Types

- V30, V32

Common NWO FEC Soil Types

- S1, S2

Material

- fine and/or medium sands (in sand dunes)
- silt, with some clay and very fine sand (in loess deposits)
- usually well sorted and weakly stratified
- strata are typically tilted and faulted, with abrupt variations

Drainage/Erosion

- good internal drainage
- susceptible to wind erosion, especially where there is little surface cover by stabilizing vegetation

Frost-heave Hazard

- frost-heave hazard is generally low

Organic Terrain

General Description (Fig. 45, 46, 47)

Surficial deposits of *organic soil*, or peat, occur in areas with poor drainage or perpetually high water tables. Treed fens, bogs and swamps, all with high water tables that persist for part or all of the growing season, represent the majority of northwestern Ontario's forested peatlands. Peat is an accumulation, under predominantly waterlogged or anaerobic conditions, of partly decomposed organic material; in northwestern Ontario, peat is composed mainly of *Sphagnum* spp. and other mosses, woody debris and/or sedges. Peatlands are generally considered to exist where the thickness of organic soil overlying bedrock or mineral soil is greater than 40 cm. On the Precambrian Shield portions of northwestern Ontario, organic deposits cover less than 10% of the land surface, typically occurring in topographic depressions and on lowlying, poorly drained glaciolacustrine or glaciofluvial plains. Peatlands on the Shield range in size from a few hectares to several square kilometres. Surficial features in the Hudson Bay Lowland are characterized by a virtually continuous organic terrain overlying glaciolacustrine and glaciomarine materials; the area represents one of the largest peatland deposits in the world. Peat thicknesses throughout northwestern Ontario are relatively shallow, rarely exceeding 3 to 5 m in depth.

Occurrence

Small, and generally confined, organic deposits are common in landscape depressions on the Precambrian Shield in northwestern Ontario. Extensive peatlands are found infrequently in this physiographic area because of the rugged, rolling topography of the Shield. Organic deposits of notable size occur in the Ignace–Upsala, Fort Frances–Rainy River and Geraldton–Longlac areas, as well as along the northern edge of the Shield near Sandy Lake, north of Pickle Lake and near the Ogoki Reservoir. Shallow, unconfined organic deposits extend over most of the Hudson Bay Lowland; because they consist of a variety of peatland types, the Hudson Bay Lowland organic deposits are often referred to as *peatland complexes*.

Planning Considerations

Organic soils present numerous difficulties for engineering activities. They are highly compressible and typically waterlogged for at least part of the year. They have low bearing capacities and, consequently, do not readily support heavy equipment. Deep organic deposits provide poor foundations for either buildings or roadbeds. Access for forestry operations is often restricted to winter months when organic soils are frozen.

Organic soils are typically poorly drained, with moderately wet to very wet moisture regimes. Vegetation conditions range from closed forest to non-treed bog or fen communities. Commercial forest types found on organic terrain are typically dominated by black spruce (V34–V37), although cedar (V21, V22), tamarack (V23) and black ash (V2) stands also occur. To minimize site degradation, winter scheduling is often necessary for mechanized harvesting and site preparation. Drainage of some peatlands to enhance forest site productivity may be feasible. Some of the larger and deeper organic deposits in northwestern Ontario may be suitable for commercial peat extraction.

Topography

- flat and lowlying
- confined to small pockets and depressions in bedrock terrain
- treed to open, sometimes with surface patterns, including hummocks, water tracks or ribbed features

Air Photo Tone/Pattern

- smooth, often with diagnostic pale tones or light colors
- characteristic flow patterns (ribs, tracks, open-water pools, etc.) or microrelief (mounds and/or raised features, etc.)
- unique patterns, sizes and shapes, depending upon surrounding relief

Common NWO FEC Vegetation Types

- V22, V23, V34–V38
- organic soils are often associated with low nutrient status and growth potential

Common NWO FEC Soil Types

- S11, S12F, S12S, SS9

Material

- organic material in varying states of decomposition
- composed of mostly *Sphagnum* spp. and other mosses, woody materials and sedges
- variable rates of decomposition and accumulation, sometimes over short distances

Drainage/Erosion

- stagnant (in confined pockets) to slow drainage (in unconfined peatlands); persistent frost in the soil may further impede water movement early in the growing season
- the water table is typically at or very near the ground surface, at least for part of the year
- erosion potential is usually low

Frost-heave Hazard

- peatlands in northwestern Ontario may remain frozen until late spring or early summer, leading to slow seasonal growth patterns for vegetation
- permafrost pockets exist in the Hudson Bay Lowland
- frost-heave hazard varies from low to high

Ground Moraine (Subglacial) Till

Figure 9. Striations and ridge patterns of this extensive ground moraine are oriented parallel to the direction of ice flow (E. Sado).

Figure 10. A typical exposed soil profile from a ground moraine, showing unsorted, coarse-textured materials with many large boulders and stones (G. Wickware).

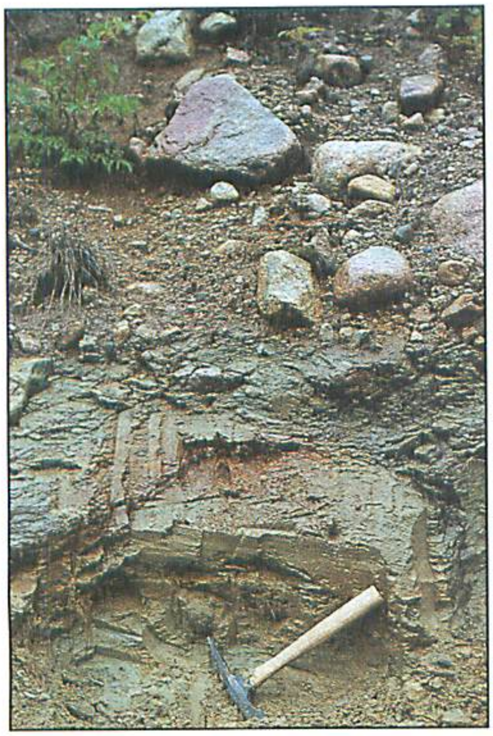


Figure 11. Dense, compacted ground moraine soils are frequently encountered in northwestern Ontario (G. Wickware).

Drumlins

Figure 12. Vertical air photo (original scale 1:60,000) of a well-developed drumlin field; on this photograph, the direction of ice flow was from the upper right corner toward the lower left (E. Sado).

Figure 13. A partially submerged drumlin forms an island in a small lake (G. Wickware).

Figure 14. Profile view of a drumlin in southern Ontario (Geological Survey of Canada: file photo).

Ablation (Supraglacial) Till

Figure 15. Debris-laden ice near the snout of an actively melting and wasting glacier (G. Wickware).

Figure 16. A bouldery ablation till exposed by logging operations in northwestern Ontario (G. Wickware).

Figure 17. Profile of an ablation till soil in northwestern Ontario showing coarse, unsorted, uncompacted fragmental material (G. Wickware).

Shallow Drift Overlying Bedrock

Figure 18. Bedrock-controlled terrain with a discontinuous mantle of shallow drift is a common landform feature throughout much of northwestern Ontario (M. Siltanen).

Figure 19. Shallow soils or exposed bedrock are typical on crest positions, with deeper drift deposits on lower slopes and in depressions (G. Wickware).

Figure 20. The depth of shallow soils typically varies over short distances as a result of undulations in the bedrock (G. Wickware).

End Moraines

Figure 21. An end moraine deposited by a valley glacier; in the background, the glacier is actively retreating and melting (C. Rubec).

Figure 22. Ground view of a portion of the Mackenzie Moraine, near Thunder Bay, Ontario (B. Towill).

Figure 23. This soil profile from an end moraine exhibits a compacted, complex structure and diverse material composition (G. Wickware).

Eskers

Figure 24. An ice tunnel formed by a sub-glacial stream provides a channel for the flow of water and glacial debris; the channel eventually fills in and, as the glacier retreats, an esker is left on the landscape (G. Wickware).

Figure 25. Ground view, looking longitudinally along the crest of a small esker (E. Sado).

Figure 26. Cross-sectional view of an esker, showing coarse-textured materials (G. Wickware).

Kames and Crevasse Fillings

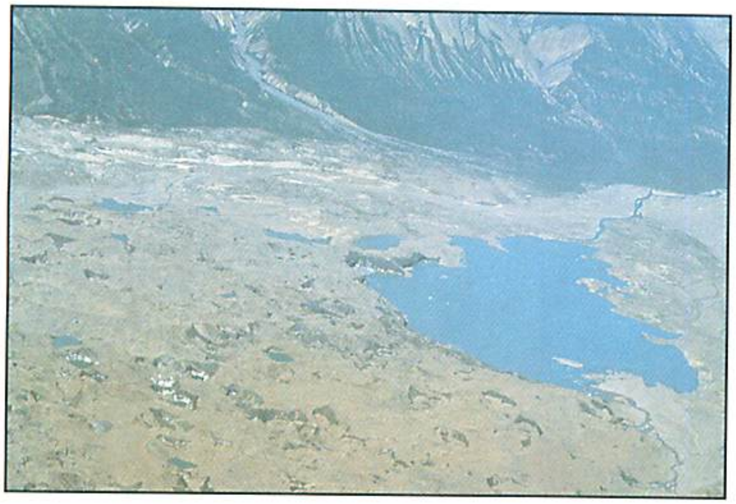


Figure 27. Aerial view of a glacier showing the surface depressions and collapse features into which water flows as the ice surface melts (E. Sado).

Figure 28. Ground view of a kame field (G. Wickware).

Figure 29. Soil profile of a kame deposit in northwestern Ontario, showing complex strata and poorly sorted materials (G. Wickware).

Outwash Deposits

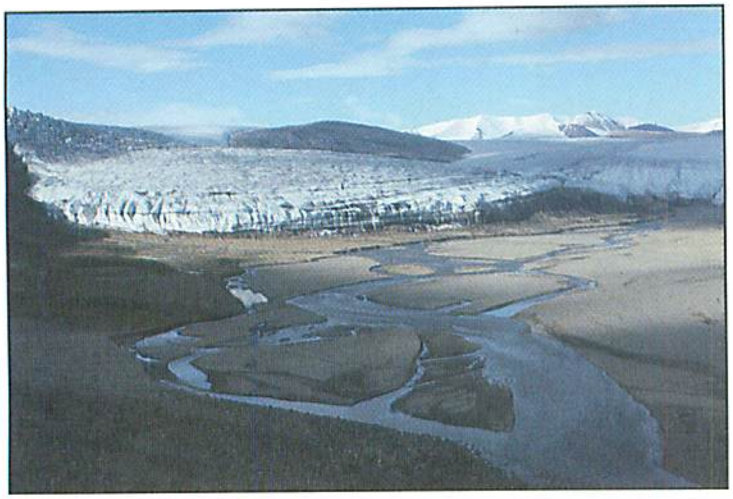


Figure 30. Meltwaters flow away from an ice front, depositing outwash materials (G. Wickware).

Figure 31. Stratified sands and gravels in an outwash deposit (G. Wickware).

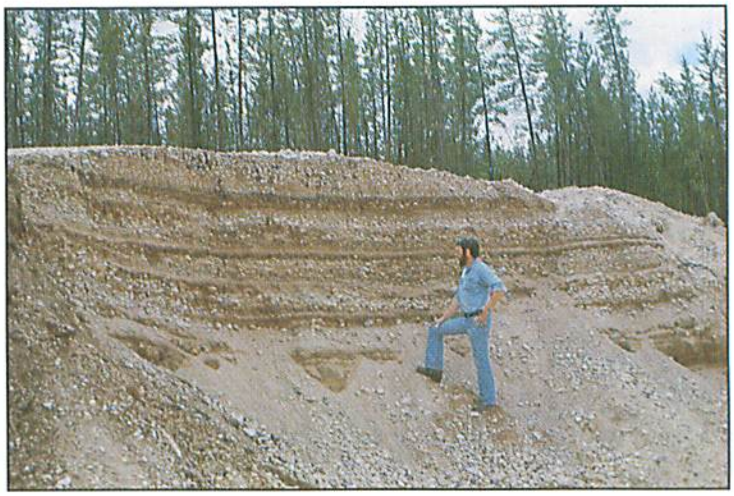


Figure 32. Closeup view of well-sorted and stratified outwash materials (R. Sims).

Glaciolacustrine and Glaciomarine Deposits

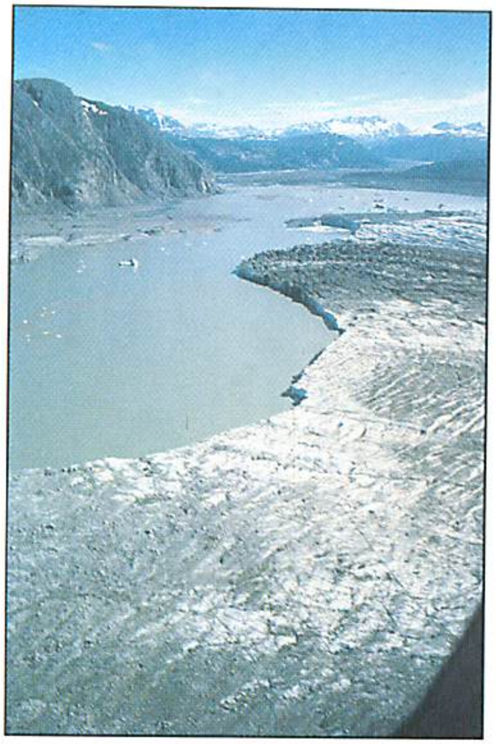


Figure 33. Aerial view of a glacier (foreground and right), showing a large proglacial lake extending in front of the ice margin (E. Sado).

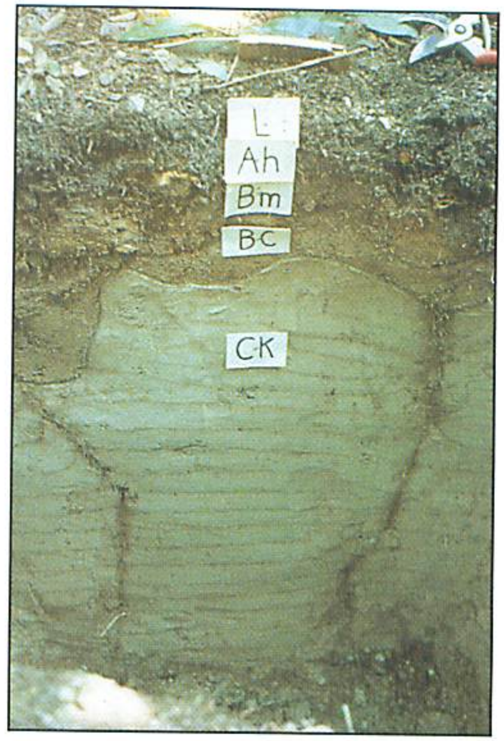


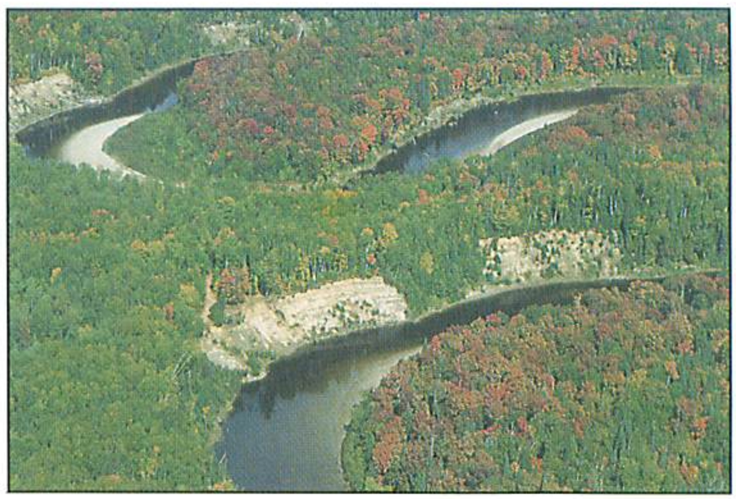
Figure 34. A soil profile in silt-loamy lacustrine materials; well-developed varves in the Ck horizon were formed by annual depositions of sediment onto a glacial lakebed (B. Towill).

Figure 35. The exposed face of a lacustrine clay deposit (G. Wickware).

Alluvial Deposits

Figure 36. Aerial view of river meanders and old (abandoned) channel scars along the Gravel River, near the north shore of Lake Superior (P. Kor).

Figure 37. Aerial view of riverbank erosion along a river meander (K. Baldwin).



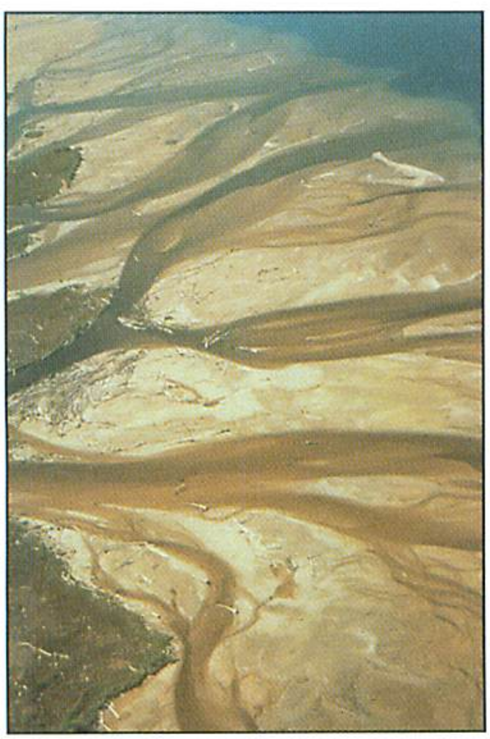


Figure 38. Formation of an alluvial delta at the mouth of the Gravel River (G. Wick-ware).

Colluvial Deposits

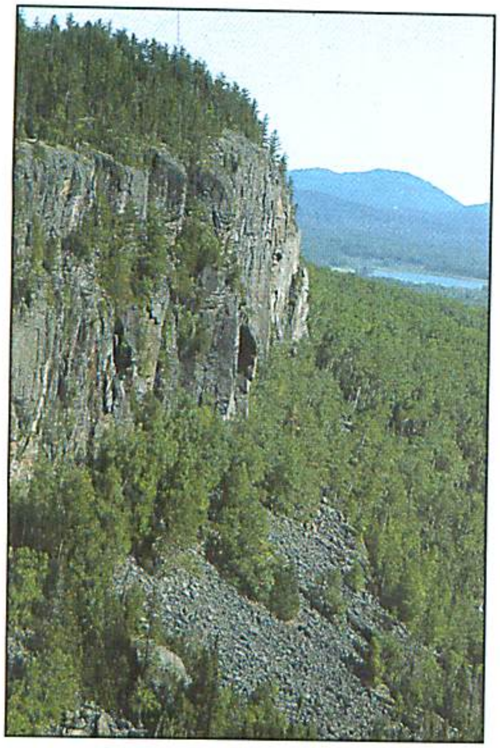


Figure 39. Accumulation of loose talus at the base of a cliff at Ouimet Canyon, Ontario (R. Sims).

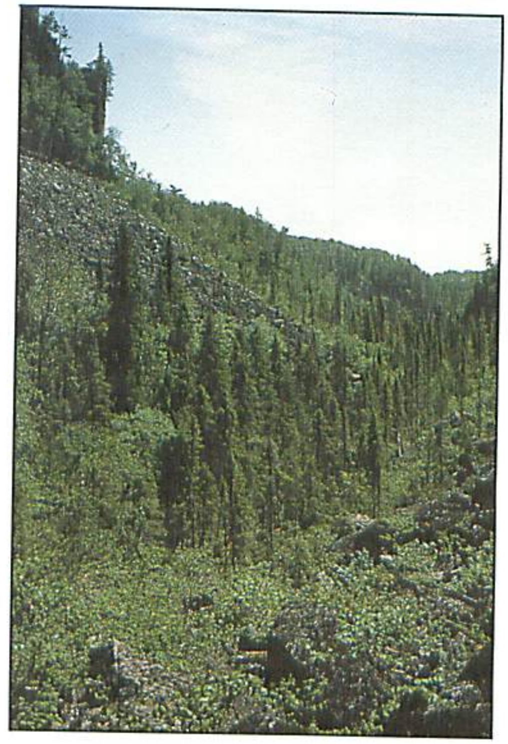


Figure 40. Unconsolidated talus debris at the base of steep bedrock slopes (B. Towill).

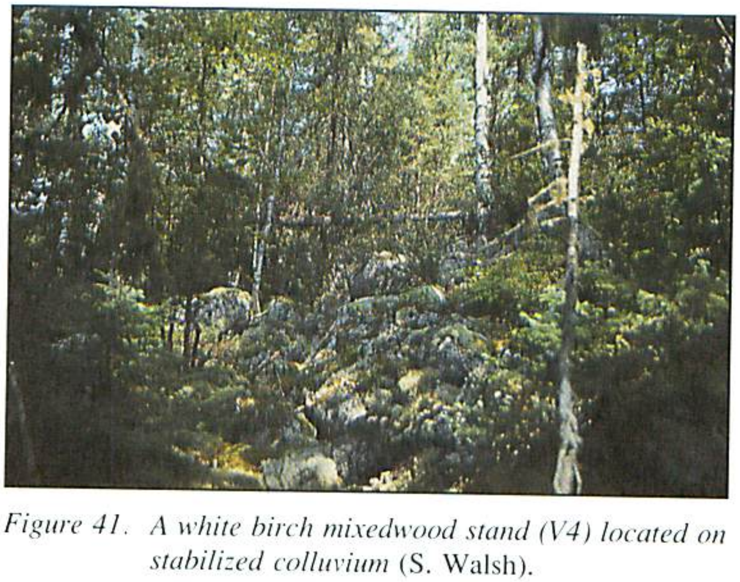


Figure 41. A white birch mixedwood stand (V4) located on stabilized colluvium (S. Walsh).

Aeolian Deposits

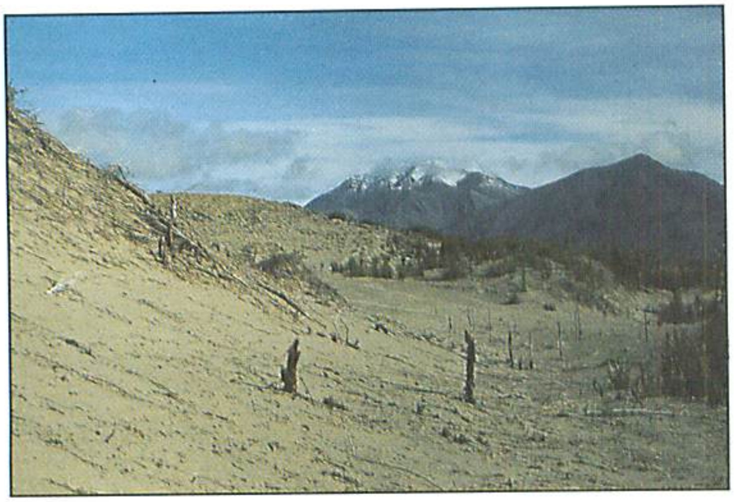


Figure 42. Active dunes in western North America (G. Wickware).

Figure 43. Dune sands exposed during logging operations in northwestern Ontario (B. Towill).

Figure 44. Soil profile from a dune in northwestern Ontario, showing wind-sorted, weakly stratified, medium and fine sands (G. Wickware).

Organic Terrain

Figure 45. Aerial view of unconfined organic terrain in the Hudson Bay Lowland (R. Sims).

Figure 46. A black spruce–tamarack (V38) peatland community (M. Siltanen).

Figure 47. Profile of organic soil, showing fibric peat and a high water table; the range pole in the photo is marked in 10-cm segments (K. Baldwin).

GLOSSARY OF SELECTED TERMS

ablation – the processes by which a glacier decays; the **zone of ablation** is that part of a glacier where melting exceeds accumulation of snow and ice (see Fig. 6)

aeolian – pertaining to the erosive and transporting action of the wind, or to sediments that have been transported and deposited by wind action

barchan dune – a type of crescent-shaped sand dune with the convex side facing the direction of the prevailing, sand-moving winds

channel (or meander) scar – landscape feature that marks the former course of a stream

colluvium – heterogeneous mixture of materials that has reached its present position as a result of direct, gravity-induced movement; usually associated with steep slopes (see Fig. 39, 40)

creep – the imperceptibly slow downward movement of unconsolidated, slope-forming soil or rock

fluting – smooth channels or furrows worn in the surfaces of rocks or impressed into the surface expression of ground moraine deposits by glacial action (see Fig. 9)

fluvial – pertaining to rivers and streams, or to features produced by the actions of rivers and streams

glacial drift – all material transported and deposited by glacial ice and glacial meltwater

glaciofluvial – pertaining to rivers and streams flowing from, on or under melting glacial ice, or to sediments deposited by such rivers and streams

ice-contact deposits – glaciofluvial sediments that were deposited in contact with melting glacial ice (e.g., eskers and kames)

kettle – a steep-sided, bowl-shaped depression in glacial drift caused by the melting of a mass of buried ice

knob-and-kettle landscape – terrain with irregular topography resulting from the interspersion of hummocks and kettles (holes); this type of topography is often observed where kame fields occur

lacustrine – pertaining to lakes, or to sediments that have either settled from suspension in standing bodies of fresh water or have accumulated at their margins through wave action

organic soil – soil materials that have developed predominantly from organic deposition (i.e., containing >17% organic carbon or approximately 30% organic matter by weight) (see Fig. 47)

oxbow – a crescent-shaped lake or slough, formed in an abandoned stream bend, that has become separated from the main stream by a change in its course

parabolic dune – a type of sand dune with a parabolic shape and the concave side facing the direction of the prevailing, sand-moving winds

proglacial – pertaining to features of glacial origin that occur beyond the limits of the glacier itself (e.g., **proglacial lake**, see Fig. 33)

roche moutonée – a rounded, asymmetric rock outcrop which has been reshaped by glacial action; the rock surface is typically smoothed and striated, with a gently sloping upstream side and a steep, roughened, irregular downstream side

rock drumlin – a drumlin-shaped hill consisting of a thin veneer of till overlying a bedrock core

talus – sloping accumulation of fragmental rock (colluvial material) lying at the base of a cliff or steep slope (see Fig. 39, 40)

till – heterogeneous mixture of materials, typically unsorted and unstratified, which has been transported and deposited directly by glacial ice

transverse dune – a sand dune ridge oriented transverse to the direction of the prevailing, sand-moving winds

varve – a distinct band representing an annual deposit of sedimentary materials; typically, a varve consists of two layers, a thicker, lighter-colored layer of silt and very fine sand laid down in the spring and summer, and a thinner, darker-colored layer of clay laid down in the fall and winter (see Fig. 35)

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