Glaciation and moving water have determined many of the soil landscapes in the Peel watershed valleys. [FM]

soil landscapes & the extent of glaciation

By Karen McKenna

The soil types and patterns displayed in a soil pit tell researchers a lot about the glacial history of a region. [KMc]

The Peel River Watershed is a diverse and complex landscape resulting in a complex pattern of soils and vegetation. The watershed is at the interface between two major Pleistocene glaciations and the unglaciated portion of northern Yukon. The glacial history affects the topography, the landforms, the deposits and hence the soils and the pattern in which they are distributed

The northeast is within the extent of the continental Laurentide glaciation. The soils are derived mainly from Pleistocene glacial deposits and more recent fluvial and organic deposits. The rolling glacially smoothed landscape of the Peel Plateau and Plain is dotted with wetlands.

The southern part was glaciated by the Cordilleran ice sheet, which occupied most of the Yukon and flowed north and west through the valleys reaching its northernmost extent at the edge of the mountains. In the Mackenzie and Southern Ogilvie Mountains, the soils in the valleys are derived from glacial deposits; the soils on higher slopes are colluvial in origin. Three periods of glaciation are represented by three ages of deposits in the southwestern part of the area (Duk-Rodkin 1999).

The northwest of the watershed, in contrast, was unglaciated; it is part of Beringia. Here, the Eagle Plains, Richardson Mountains and Northern Ogilvies are characterized by old, smoothed mountain slopes topped by tors reflecting the resistance of the rocks which constitute it, descending to gently rolling pediment surfaces at lower elevations. Most soils are residual soils derived from the underlying bedrock.

The northern boreal or taiga forests which dominate the Peel watershed are underlain by shallow soils with limited soil development. The soils are characterized by the continuous occurrence of permafrost (Hegginbottom 1995). The depth of the active layer varies with site position, aspect, and the amount of organic accumulation on the ground surface. In the higher mountains the active layer may be fairly deep, under peaty soils the active layer may be only 30cm. The ice content of the soils is dependent on site position, aspect, slope and microtopography, all influencing the amount of water available for the growth of ground ice. Only recent alluvial soils adjacent to the large rivers are not frozen.

Wetland complexes are common on the uplands of the Peel Plateau and are even more extensive on the Fort McPherson Plain.

The MacKenzie and Southern Ogilvie Mountains

The soils of these high mountains are closely linked to the underlying bedrock and its weathering characteristics. The Wernecke and Southern Ogilvie Mountains are composed

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The highest or broadest level of classification of soils is the Order. Orders are classified based on the factors that were most involved in soil formation. There are three main orders in the Peel River watershed:

Brunisolic Order: Brunisolic soils tend to be soils that have formed under forests and are often brownish in colour. They can be calcareous near the surface and slightly weathered, or strongly acidic and very weathered. Most brunisolic soils are well to imperfectly drained. In the case of those brunisolic soils that do not have good drainage, there is no presence of strongly gleyed colours. Brunisolic soils can be found across a wide range of environments and are common in the boreal forest.

Regosolic Order: Regosolic soils are poorly developed soils with little or no horizon (layers of soil).

Cryosolic Order: Cryosolic soils are found in areas of permafrost. Permanently frozen subsoils do not allow water to drain through the soil, resulting in saturated soils. Frost action subsequently results in the mixing and disruption of soils horizons.

mainly of sedimentary rocks: carbonates, shales, and sandstones (Smith et. al. unpub). Carbonate rocks will usually break down into a calcareous substrate and often support an assemblage of high ph-tolerant flowering plants. Sandstone-derived soils will be sandy maintaining a lot of characteristics of the sandstone itself. Sandy soils are often well drained and alpine plants are often sparsely distributed. Shale breaks down into finer textured soils that provide more moisture for plant growth and are therefore commonly more continuously vegetated. The finer textured soils are often more susceptible to solifluction and soil creep.

High mountain slopes are usually free of ice near the surface, especially on south aspects. Very little permafrost was found within soil profiles to a depth of 50-80 cm (Loewen et. al. field notes). The bare rocky slopes conduct heat and therefore thaw to some depth in the summer. Patterned ground, sorted circles, stripes and steps as well as mud boils, are indicators of cryoturbation, movement of soil particles within the soil due to frost action. These soils are classified as Turbic Cryosols.

Depressions and lower slopes of the mountains support open spruce forests. Permafrost was often not encountered in pits 80 cm. deep (Loewen et. al. unpub). Where thicker organic horizons accumulate, the surface dries out and insulates the cold soils from summertime heat, preventing the frost from melting resulting in Cryosolic soils with permafrost within a meter of the soil surface. Occasional fen peatlands are found.

Soils are not classified as Cryosols (the name given to frozen soils in the Canadian System of Soil Classification) when permafrost is not found within 2 metres of the surface on higher slopes or within one metre on lower slopes.

The valley bottoms are a complex of rolling glacial deposits dissected by old channels and streams, and wetlands. The wetlands appear to have little peat development. This could be due to the predominance of carbonate rocks, often associated with less peat development because the rates of decomposition of organic material are greater at higher ph levels.

The Peel Plateau and Fort McPherson Plain

Most of the Peel Plateau and Fort McPherson Plain ranges in elevation from 300m to 700m asl. The open stunted black spruce forests, and shrublands at higher elevations, are underlain by near surface permafrost. Earth hummocks half a meter in diameter and half a meter high can make walking a challenge over much of the area. The soils are classified as Turbic Cryosols.

Wetland complexes such as at Turner, Chappie, and Lusk Lakes and the lower Snake River wetlands are characteristic of the Peel Plateau.

These surface features, also known as thermokarst, are created when melting permafrost in the soil causes the ground above to slump. [KMc]

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Soils can be further classified into a hierarchy of 4 more levels: Great Group, Subgroup, Family and Series. Map 7 does not classify all these different levels, however as the descriptions above indicate, some of the lower levels of classification have been identified in the Peel River watershed. They are as follows:

Static Cryosol soils: Mineral soil without marked cryoturbation and with permafrost within 1 metre of the soil surface. This is a Great Group.

Orthic Static Cryosol soil: The Subgroup "Orthic" refers to the fact that this soil type defines the Great Group of Static Cryosol.

Turbic Cryosol soils: Mineral soil with marked cryoturbation, usually patterned ground, and permafrost within 2 metres of the soil surface. This is a Great Group.

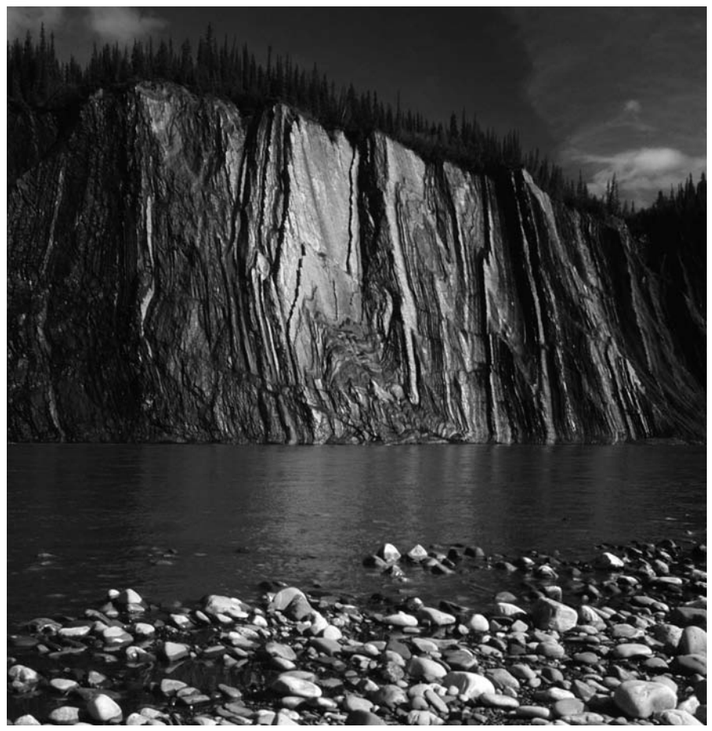
Orthic Turbic Cryosol soil: As above, the Subgroup "Orthic" refers to the defining concept of the Great Group.

Gleysolic Turbic Cryosol soil: The Subgroup "Gleysolic" refers to a variation from the defining concept of the Great Group, where a reduction in iron and other mottling of the soil is common.

Organic Cryosol soils: Organic soil material with permafrost within 1 metre of the soil surface.

Fibric Organic Cryosol soil: Organic cryosol soil where the plants materials and their structures are still easily recognizable (as opposed to having decomposed to the point where individual plant matter is not recognizable)

[The spectacular canyons of the Peel River were created when glaciers blocked the river from its original route. [JP]]



Mineral and organic soils surround the open water ponds. Open water adjacent to mineral soil may be bounded by narrow bands of sedge dominated marshes or fens. Sedge dominated floating fens surround the open water in the areas of peat plateau bogs. Typically the shallow ponds and lakes are surrounded by peat plateau bogs composed of two to three meters of peat (Zoltai et al 1988). The organic soils, derived from acidic, poorly decomposed Sphagnum moss and frozen within about 35 cm of the surface are classified as Fibric Organic Cryosols. Collapse scar fens, circular depressions within the peat plateaus are common. Ribbed fens and organic soil swamps highlight channels of greater water flow.

Slope failures such as active layer detachment slides, also called skin flows, occur on moderate slopes in the glacial deposits of the Peel Plateau. These slides occur when a semi frozen or thawed part of the active layer slides on the lubricated surface of the underlying frozen layer. These slides may be initiated by a high rainfall event.

Retrogressive thaw slides occur in permafrost areas when some sort of natural disturbance such as fire, detachment slide, coastal or fluvial erosion, or man-made disturbance initiates thawing of the permafrost. Once the frozen ground is exposed, thawing and slides or flows will continue until the area is stabilized by melting of all the available ground ice or by overhanging topsoil covering the exposed face. These slope failures also occur in the mountains and the unglaciated terrain (Mougeot unpub).

The Eagle Plains, Northern Ogilvie and Richardson Mountains

The Eagle Plains, Northern Ogilvie and Richardson Mountains are all largely unglaciated. The soils are mainly residual and colluvial soils, derived from the underlying or upslope bedrock. Soil textures are a function of the bedrock type. Sandier soils tend to be better drained, with a deeper active layer. Permafrost is continuous but in favourable locations may not be found within the top meter of soil. The permafrost may be up to 300 to 700 meters in depth (Smith et al draft).

At high elevations, on higher ridges and mountain slopes, where the vegetation thins out, evidence of frost heaving and sorted patterns are evident in gravelly soils. In finer textured soils at higher elevations, mud boils or non sorted circles are common. Stripes and steps may be found on steeper slopes. As in the Mackenzie and Southern Ogilvie Mountains, the distribution of bedrock types influences the pattern of texture, pH of the soil and also the vegetation (Parks and Protected Areas, unpub).

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Peel River Watershed

Map 7: Soil Landscapes & the Extent of Glaciation

Soils

- Turbic Cryosol Soils
- Static Cryosol Soils
- Regosolic Soils
- Brunisolic Soils
- Undifferentiated Bedrock/ Carbonate Bedrock

Extent of Glaciation

- Glaciated by Laurentide Ice Sheet
- Glaciated by Cordilleran Ice Sheet

Peel River Watershed boundary

EAGLE PLAIN

Eagle Plains

RICHARDSON MOUNTAINS

Dempster Highway

Canyon Ck.

Ogilvie River

Not Glaciated

Blackstone River

Hart River

OGILVIE MOUNTAINS

West Hart River

Rae Creek

Klondike River

Trail River

PEEL RIVER

Lusk Lake

Caribou River

Turner Lake

PEEL PLATEAU

Noisy Creek

Chappie Lake

Hungry Cr.

Little Wind River

Wind River

Bear River

WERNECKE MOUNTAINS

Nash Creek

Beaver River

Rackla River

Nadaleen River

FT. MCPHERSON PLAIN

Laurentide Ice Sheet

Arctic Red River

N.W.T.

Yukon

Canswick River

Snake River

Corn Creek

Goz Creek

Mt. MacDonald

Orthogonal River

Cordilleran Ice Sheet

Data sources:

Soil Landscapes of Canada, version 2.2, National Soil Database, Agriculture and Agri-Food Canada, 1996.

Duk-Rodkin, A. Glacial Limits map of Yukon Territory in Gordey, S.P. and Makepeace, A.J. 1999: Yukon digital geology; Geological Survey of Canada, Open File D3826, and Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 1999-I(D)

Base data: National Topographic Data Base (NTDB) at 1:250,000 (NAD 83).

Projection: Albers Equal-Area Conic

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Canadian Parks and Wilderness Society

0 5 10 20 30 40 50 Kilometers

138°W 136°W 134°W 132°W 130°W

64°N 65°N N.99