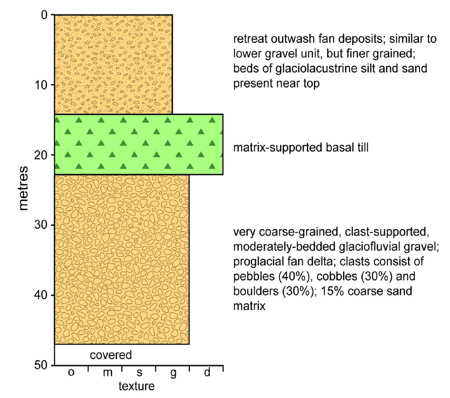
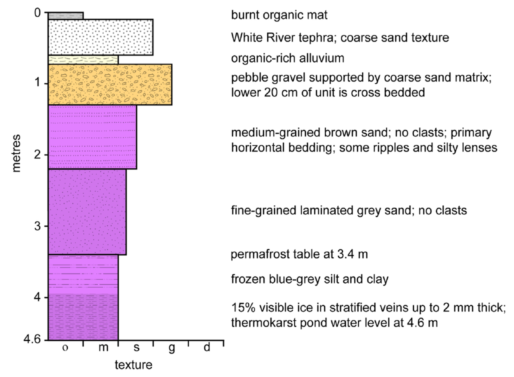
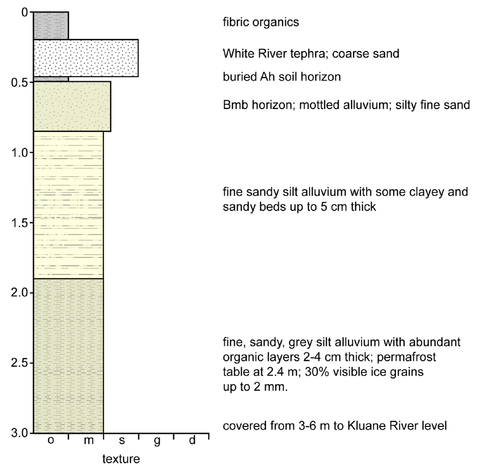
07JB013 - CUTBANK EXPOSURE OF MCCONNELL LATERAL MORAINE



07PL010 - COLLAPSING BANK OF THERMOKARST POND



07PL041 - KLUANE RIVER CUTBANK



MARGINAL NOTES

INTRODUCTION

The Toshingermann Lakes map area straddles the northwestern extent of the Ruby and Nisling Ranges. Broad treeless uplands dominate the landscape and summits reach more than 1800 m a.s.l. Upland surfaces are covered with weathered bedrock colluvium and sporadically distributed till deposits from former alpine glaciers and ice sheets. Upland surficial deposits are affected by active periglacial processes such as cryoturbation, nivation and solifluction. Cryoplanation terraces were documented on unglaciated upland surfaces in the Nisling Range (Fig. 1). The valleys occupied by the Kluane River and Toshingermann and Tincup lakes are steep sided and narrow. Many of these slopes are over-steepened and susceptible to rockslides, such as is documented at the south end of Tincup Lake and near Dog Pack Lake just south of the map area. The valleys within the Nisling Range have a more mature or broad appearance. The Grace Lake valley that cuts across the northern part of the map area, may represent the paleo-drainage course of the Donjek River. The valleys are generally poorly drained due to the thick deposits of glacial sediment and widespread permafrost.

GLACIAL HISTORY

At least three ice sheets originating from the St. Elias Mountains have advanced into the Ruby and Nisling ranges during the Quaternary period. The oldest advance predates marine isotope stage (MIS) 4 (50ka BP to 80ka BP) and may correlate with the MIS 6 (130ka BP to 230ka BP) Reid glaciation documented for the Selwyn Lobe (Ward et al., 2008). Mapping the Reid glacial limit in the Toshingermann Lakes map area was not possible since the younger Gladstone glaciation reached a similar extent (up to 1200 - 1400 m) and therefore masks the older features. The early Wisconsin Gladstone glaciation reached its maximum extent and had begun to recede by 50,000 years ago (Ward et al., 2007). Deposits from this glaciation are preserved above and beyond the late Wisconsin McConnell limit, which reached up to 1180 m. Evidence of the Gladstone glaciation consist of morainal deposits and ice proximal features such as meltwater channels.

Most of the glacial deposits in the map area are attributed to the late Wisconsinan McConnell glaciation. According to cosmogenic dates on erratics from the glacial limit immediately to the southeast of the map area, the McConnell glaciation was positioned at its maximum extent between 13,740 ± 500 years B.P. and 14,620 ± 800 years B.P. The style of glaciation in the map area could be characterized as a network of coalescing valley glaciers. The thickest ice penetrated the map area from the west via the Donjek and Kluane river valleys. This "Donjek glacier" followed the Grace Lake valley to the northeast and advanced southeastward up Tincup Creek valley. Here the Donjek glacier converged with a westward-flowing glacier occupying upper Onion Creek valley. Abundant ablation moraine and flights of moraine ridges in the Onion and Grace lake valleys suggest the McConnell glaciers in the map area were active during deglaciation (Fig. 2). Thick glaciolacustrine deposits in the Tincup Creek and Grace Lake valleys indicate that glacial lakes occupied the valleys as the ice receded (Fig. 3). Small McConnell and Gladstone alpine glaciers formed on the upland separating Toshingermann and Tincup lakes and in one cirque to the east of Tincup Lake. These glaciers likely did not coalesce with the large valley glaciers originating from the St. Elias Mountains.

PERMAFROST

Most of the map area is underlain by permafrost. The nature of the ice within the sediments is generally a function of drainage. Thermokarst ponds are present within glaciolacustrine sediments in the Grace Lake and Onion Creek valleys, which indicates that massive ice bodies are present (Fig. 3). Well-drained glaciofluvial deposits have a thicker active layer, but likely still contain ground ice at depth. The large glaciofluvial plain north of Tincup Lake supports stunted vegetation and appears to have a high water table. This may be attributed to a shallow permafrost table and/or poorly drained glaciolacustrine sediments at depth.

WHITE RIVER TEPHRA

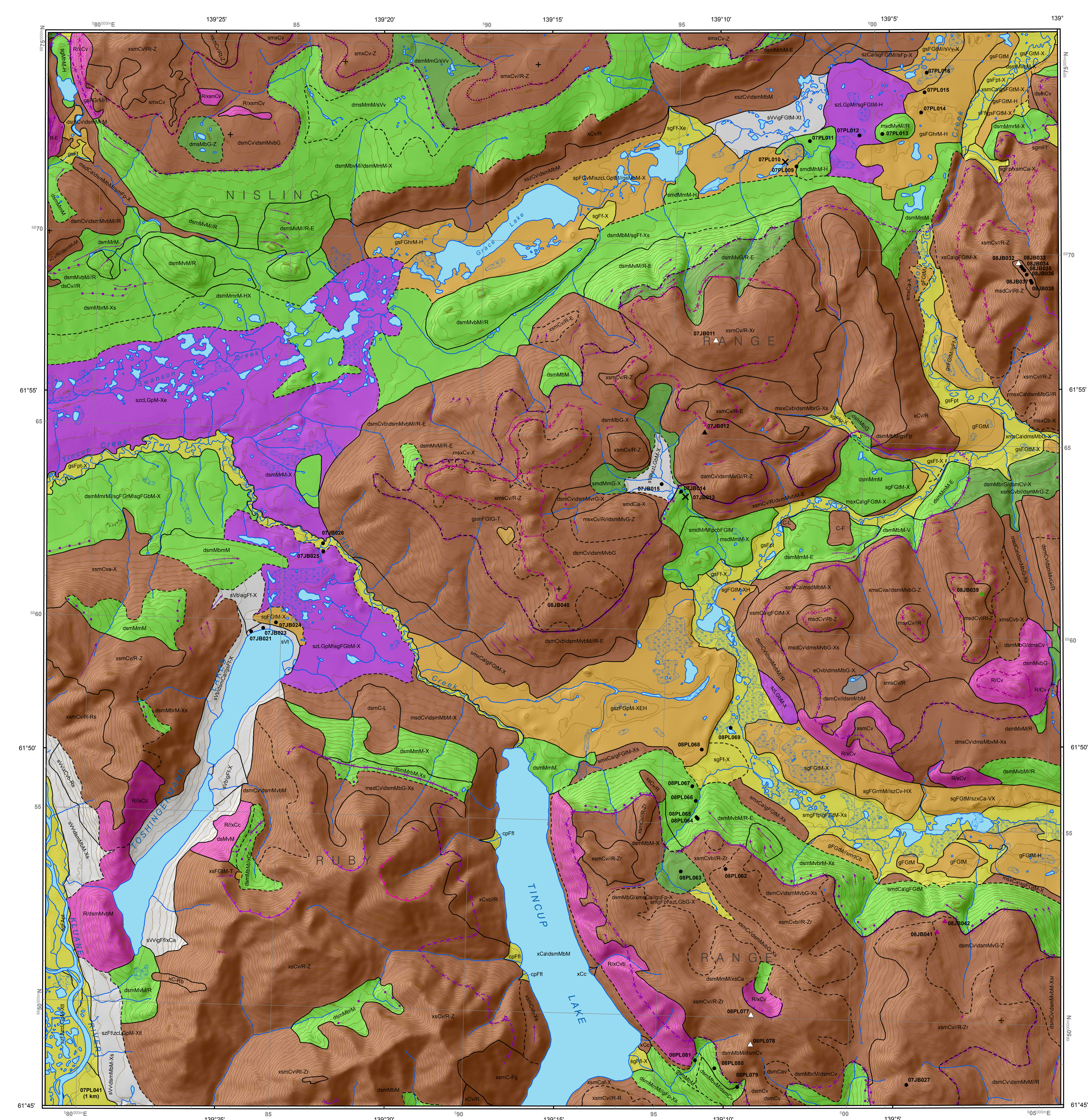
Significant thicknesses of White River tephra can be found in the Toshingermann Lakes map area (Fig. 4). The thickest deposits occur near Toshingermann Lakes and into the Grace Lake valley. The primary tephra accumulation, which has a medium sand-sized texture, is estimated to be 10-20 cm thick on average throughout the map area. Much greater thicknesses accumulated in valley bottoms when the tephra was eroded and resedimented off the hill tops. Thicknesses exceeding 200 cm are common on fluvial fans and deltas (Fig. 4). At Toshingermann Lakes, the outlet of the northern lake became plugged with ash accumulating on a fluvial fan. As a result, the level of the northern lake rose by over 2 m until it was able to overtop the fan. Since that time,

Figure 1. A view to the south of cryoplanation terraces in the northeast part of the map area. A muddy colluvial diamicton veneers the upland and bedrock outcrops in the scarps. These landforms develop over hundreds of thousands of years through periglacial weathering and sediment creep. The terrace scarps are 6 to 8 m in height (08JB035)

Figure 2. A view to the northwest over upper Onion Creek valley. This is a typical valley containing mixed glaciofluvial, morainal and fluvial deposits.

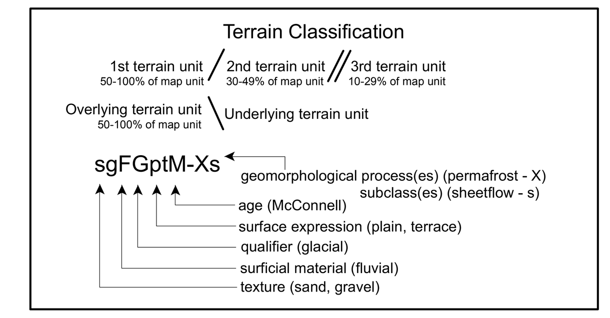
Figure 4. Ice-rich glaciolacustrine sediments exposed in a thermokarst pond in Grace Lake valley (07PL010).

Figure 3. White River tephra accumulation at the north end of Toshingermann Lakes (07JB021). The grey band separates primary tephra accumulations (below band) from secondary resedimented tephra accumulations.



SURFICIAL GEOLOGY MAP

This surficial geology map was classified using the Terrain Classification System for British Columbia (Howes and Kenk, 1997), with modification to meet standards set by the Yukon Geological Survey. For example, we have added permafrost process subclasses to further account for the breadth of permafrost features on the landscape. In addition, we have added an age classification to the glacial deposits to distinguish different Pleistocene glaciations. Linework for the map was produced from interpretations of 1:40 000-scale aerial photos (1987). Subsequent field checking of the map area was completed in the summers of 2007 and 2008.



SURFICIAL MATERIAL

Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity. In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. On the map, surficial materials form the core of the polygon label. They are symbolized with a single upper case letter, with texture written to the left, and surface expression or glacial qualifier to the right. The glacial qualifier "G" was used to describe glacially modified materials. If actual activity state is different than the assumed activity state (indicated in brackets next to the surficial material name below), a qualifier A (active) or I (inactive) must be used as a superscript following the surficial material designator. Note that a single polygon will be coloured only by the dominant surficial material, but other materials may exist in that polygon.

O — HOLOCENE
Organic: Organic deposits are accumulations of vegetative matter thicker than 1 m. They are commonly found in floodplains, areas of near-surface permafrost such as north-facing slopes, and locations where there is poor drainage. Thin veneers of organic material are widespread and often unmapped.

V — Volcanic: Volcanic tephra deposits found in the map area are from the 1140-year-old White River eruption. Primary tephra deposition across the map area was between 10 cm and 20cm and consisted of a grain size of medium-sand. Local redistribution of the tephra into lake basins, onto fluvial fans or into cirque basins can result in accumulations exceeding 20cm.

E — Eolian: Material that was transported and directly deposited by wind. The dominant eolian sediment in the map area is loess. A thin veneer of loess (10-20 cm) was deposited over the landscape during the last glaciation. On stable sites, the loess is intact, whereas at cryoturbated or colluviated areas, the loess is reworked into the soil profile. Since loess deposits represent only a thin veneer, they were not mapped; however, loess it is a widespread material in the map area.

C — Colluvium: Material that was transported and directly deposited by down-slope, gravity-driven processes such as creep, landslides and snow avalanches. Due to the active periglacial processes that have occurred in the map area, colluvium is widespread across the upland surfaces. The texture and composition of colluvium vary more than any other material in the map area, depending on the parent material, and the mechanism and distance transported. For example, materials derived from till will likely resemble the in situ till. Alternatively, colluvium can contain slope-parallel resedimentation structures. Comparatively, colluvium derived from physically weathered bedrock will be an angular, poorly sorted diamict and will likely contain less matrix. Some materials formed by rapid processes, such as rock falls, debris flows and avalanches, are deposited within tens of seconds and are typically found on steep to moderate slopes. Conversely, slower processes occur on gentle slopes and are commonly associated with permafrost, solifluction and creep. Colluvium in the map area is commonly derived from weathered bedrock and till, resulting in a silt-rich diamicton with angular, local bedrock and sub-rounded erratic clasts. Beyond the glacial limits and in alpine settings, colluvium is dominantly derived from weathered bedrock fragments and loess.

F — Fluvial: Fluvial materials are transported and deposited by modern streams and rivers. They typically consist of stratified sand and gravel that is well sorted and contains sub-angular to rounded clasts. These deposits occur in floodplain, terrace and fan surface expressions within the map area. Due to scale limitations, fluvial deposits in most of the smaller valleys are not mapped.

L — Lacustrine: Sediment that has been deposited into a modern lake. Includes biologically produced material such as marl and gyttja. Lacustrine deposits are only mapped where a lake has drained exposing the lake bottom material.

Glaciofluvial: Glaciofluvial materials have been deposited directly by glacial meltwater. These deposits can form above, in, below, or adjacent to a glacier. They are deposited in meltwater channels, eskers, plains, terraces, kames and deltas. Glaciofluvial deposits consist of moderately to well-sorted, rounded, stratified sand and gravel, but can vary locally depending on transport distance. Near surface ground ice is generally absent in glaciofluvial deposits unless there is a poorly drained underlying unit present.

FG — LATE WISCONSIN - MCCONNELL (M)
Large glaciofluvial plains and terraces are found north of Tin Cup Lake.

FG — EARLY WISCONSIN - GLADSTONE (G)
Isolated pockets of Gladstone glaciofluvial deposits are found above the McConnell limit in the map area.

FG — ILLINOIAN - REID (R)
Isolated pockets of Reid glaciofluvial deposits may be found above the Gladstone limit in the map area.

Morainal: Morainal materials are diamicts deposited by either primary glacial processes such as lodgement, deformation and melt-out, or secondary glacial processes caused by gravity and water. Therefore, this term applies to all types of till including flow tills, which are not directly deposited by glacial ice. Ablation tills tend to have a hummocky or rolling surface morphology with a sandy matrix comprising 30-40% of the material. Lodgement tills have a more uniform surface morphology with a silty sand matrix comprising 40-60% of the material, with uneven topography of the map area, tills are often colluviated. Permafrost is generally widespread within morainal deposits.

M — LATE WISCONSIN - MCCONNELL (M)
Both ablation and lodgement tills were observed and are common on the valley flanks throughout the map area.

M — EARLY WISCONSIN - GLADSTONE (G)
Both ablation and lodgement tills were observed and occur in isolated deposits immediately above, or beyond the McConnell limit.

M — ILLINOIAN - REID (R)
No Reid morainal deposits were mapped; however, isolated deposits may be found above the Gladstone limit

Glaciolacustrine: Glaciolacustrine materials were deposited in a lake that formed on, in, under or beside a glacier. Glaciolacustrine sediments consist of stratified sand, silt and clay. Ice-rich permafrost and thermokarst erosion is widespread in these deposits. Their poor drainage and high ice-moisture content result in massive ice lenses.

LG — LATE WISCONSIN - MCCONNELL (M)
McConnell glaciolacustrine deposits are common in Tin Cup Creek, Grace Lake and the Kluane River.

LG — EARLY WISCONSIN - GLADSTONE (G)
Glaciolacustrine sediment of this age are rare and restricted to small tributary valleys above the McConnell limit. As a result, all of these deposits are now buried under colluvium or fluvial deposits.

LG — ILLINOIAN - REID (R)
Glaciolacustrine sediments of this age have not been documented in the map area.

R — PRE-QUATERNARY
Bedrock: Rocks in the Kluane Lake area are composed of three metamorphic assemblages, mid- and Late Cretaceous to Eocene granitoids and Upper Cretaceous to Eocene volcanic rocks. Late Cretaceous to Eocene Ruby Range batholith, the largest pluton in the area. Metamorphic rocks to the northwest belong to Yukon-Tanana terrane and the structurally overlie Windy-McKinley terrane. Yukon-Tanana terrane consists of two assemblages: quartzose psammite, pelite, marble and amphibolite of the Proterozoic to Lower Paleozoic Snowcap assemblage, and carbonaceous phyllite and quartzite and lesser felsic and mafic metavolcanic rocks of the mid-Paleozoic to Late Permian Finlayson assemblage. Foliated granitic rocks occur in both assemblages. Windy-McKinley terrane also comprises two assemblages: the schist-gabbro subdivision and the Harzburgite Peak-Eikland Mountain ophiolite. The former assemblage is lithologically and stratigraphically similar to Yukon-Tanana terrane, differing only in the presence of voluminous bodies of Triassic metagabbro. The Harzburgite Peak-Eikland Mountain ophiolite in Kluane Lake area consists primarily of harzburgite, with lesser amounts of gabbro, dunite and plagiogranite. The third metamorphic assemblage, the Kluane schist, is southwest of the Ruby Range batholith. Kluane schist consists primarily of highly deformed, variably carbonaceous, porphyroblastic biotite schist and rare bodies of gabbro and harzburgite (Murphy et al., 2009).

SYMBOLS

GEOLOGICAL BOUNDARIES:
- defined
- approximate
- assumed

AGE OF GLACIAL FEATURES:
- McConnell (M) - late Wisconsin
- Gladstone (G) - early Wisconsin
- Reid (R) - Illinoian
- unspecified age

GLACIAL FEATURES:
- moraine ridge
- meltwater channel
- cirque
- esker

GLACIAL LIMITS:
- defined
- approximate
- assumed

GROUND OBSERVATION SITES:
(labelled with site number, e.g. 08JB004)
- field station
- stratigraphic section
- radiocarbon sample
- cosmogenic sample
- heavy mineral sample
- erratic, unspecified age
- erratic, Gladstone
- erratic, Reid
- no erratics found

OTHER SURFACE FEATURES:
- open system pingo
- tor
- drumlin (coloured by glacial age)

TOPOGRAPHIC FEATURES:
- contours
- streams
- trails
- wetlands

TEXTURE

Texture refers to the size, shape and sorting of particles in clastic sediments, and the proportion and degree of decomposition of plant fibre in organic sediments.

Specific clastic textures
- a - blocks: angular particles >256 mm in size
- b - boulders: rounded particles >256 mm in size
- k - cobbles: rounded particles between 64 and 256 mm in size
- p - pebbles: rounded particles between 2 and 64 mm in size
- s - sand: particles between 0.0625 and 2 mm in size
- z - silt: particles between 2 μm and 0.0625 mm in size
- c - clay: particles <2 μm in size

Common clastic textural groupings
- d - mixed fragments: a mixture of rounded and angular particles >2 mm in size
- x - angular fragments: a mixture of angular fragments >2 mm in size (i.e., a mixture of blocks and rubble)
- g - gravel: a mixture of two or more size ranges of rounded particles >2 mm in size (e.g., a mixture of boulders, cobbles and pebbles); may include interstitial sand
- r - rubble: angular particles between 2 and 256 mm; may include interstitial sand
- m - mud: a mixture of silt and clay; may also contain a minor fraction of fine sand
- y - shells: a sediment consisting dominantly of shells and/or shell fragments

Organic terms
- o - organic: general organic materials
- e - fibric: the least decomposed of all organic materials; it contains amounts of well-preserved fibre (40% or more) that can be identified as to botanical origin upon rubbing
- u - mesic: organic material at a stage of decomposition intermediate between fibric and humic
- h - humic - organic material at an advanced stage of decomposition; it has the lowest amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity of the organic materials; fibres that remain after rubbing constitute

SURFACE EXPRESSION

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial material at the land surface. This three-dimensional shape of the material is equivalent to 'landform' used in a non-genetic sense (e.g., ridges, plain). Surface expression symbols also describe the manner in which unconsolidated surficial materials relate to the underlying substrate (e.g., veneer). Surface expression is indicated by up to three lower case letters, placed immediately following the surficial material designator, listed in order of decreasing extent.

a - apron: a wedge-like slope-toe complex of laterally coalescent colluvial fans and blankets. Longitudinal slopes are generally less than 15° (26%) from apex to toe with flat or gently convex/concave profiles

b - blanket: a layer of unconsolidated material thick enough (>1 m) to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography; outcrops of the underlying unit are rare

c - cone: a cone or sector of a cone, mostly steeper than 15° (26%); longitudinal profile is smooth and straight, or slightly concave/convex; typically applied to talus cones

f - fan: sector of a cone with a slope gradient less than 15° (26%) from apex to toe; longitudinal profile is smooth and straight, or slightly concave/convex

h - hummock: steep sided hillock(s) and hollow(s) with multidirectional slopes dominantly between 15-35° (26-70%) if composed of unconsolidated materials, whereas bedrock slopes may be steeper; local relief >1 m; in plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile; commonly applied to knob-and-kettle glaciofluvial terrain

l - delta: landform created at the mouth of a river or stream where it flows into a lake or sea; gently sloping surfaces between 0-3° (0-5%), and moderate to steeply sloping fronts between 16-35° (27-70%); glaciofluvial deltas in the map area are typically coarse-grained with steep sides and gently inclined kettled or channeled surfaces

m - rolling: elongate hillock(s); slopes dominantly between 3-15° (5-26%); local relief >1 m; in plan, an assemblage of parallel or sub-parallel linear forms with subdued relief (commonly applied to bedrock ridges and fluted or streamlined till plains)

p - plain: a level or very gently sloping, unidirectional (planar) surface with slopes 0-3° (0-5%); relief of local surface irregularities generally <1 m; applied to (glacio)fluvial floodplains, organic deposits, lacustrine deposits and till plains

r - ridge: elongate hillock(s) with slopes dominantly 15-35° (26-70%) if composed of unconsolidated materials; bedrock slopes may be steeper; local relief is >1 m; in plan, an assemblage of parallel or sub-parallel linear forms; commonly applied to drumlinized till plains, eskers, morainal ridges, crevasse fillings and ridged bedrock

t - terrace: a single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or gently inclined surface above it; applied to fluvial and lacustrine terraces and stepped bedrock topography

v - veneer: a layer of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material; 10 cm - 1m thick; commonly applied to eolian/loess veneers and colluvial veneers

GEOMORPHOLOGICAL PROCESSES

Geomorphological processes are natural mechanisms of weathering, erosion and deposition that result in the modification of the surficial materials and landforms at the earth's surface. Unless a qualifier (A (active) or I (inactive)) is used, all processes are assumed to be active, except for deglacial processes. Process is indicated by up to three upper case letters, listed in order of decreasing importance, placed after the surface expression symbol, and separated from the surface expression by a dash (-).

Subclasses can be used to provide more specific information about a general geomorophological process, and are represented by lower case letter(s) placed after the related process designator. Up to three subclasses can be attached to each process. Process subclasses used on this map are defined with the related process below.

EROSIONAL PROCESSES

V - gully erosion: running water, mass movement and/or snow avalanching, resulting in the formation of parallel and sub-parallel long, narrow ravines

FLUVIAL PROCESSES

I - irregularly sinuous channel: a clearly defined main channel displaying irregular turns and bends without repetition of similar features; backchannels may be common, and minor side channels and a few bars and islands may be present, but regular and irregular meanders are absent

M - meandering channel: a clearly defined channel characterized by a regular and repeated pattern of bends with relatively uniform amplitude and wave length

MASS MOVEMENT PROCESSES

F - slow mass movements: slow downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by creeping, flowing or sliding

L - mass movement with an unspecified rate

R - rapid mass movements: rapid downslope movement by falling, rolling, sliding or flowing of dry, moist or saturated debris derived from surficial material and/or bedrock

Subclasses: (b) rockfall; (g) rock creep

PERIGLACIAL PROCESSES

C - cryoturbation: movement of surficial materials by heaving and/or churning due to frost action (repeated freezing and thawing)

S - solifluction: slow gravitational downslope movement of saturated non-frozen overburden across a frozen or otherwise impermeable substrate

X - permafrost processes: processes controlled by the presence of permafrost, and permafrost aggradation or degradation

Z - general periglacial processes: solifluction, cryoturbation and nivation, possibly occuring in a single polygon

Subclasses: (e) thermokarst erosion; (l) segregated ice; (n) pingo; (t) thermokarst subsidence; (r) patterned ground; (s) sheetwash

DEGLACIAL PROCESSES

E - channeled by meltwater: erosion and channel formation by meltwater alongside, beneath, or in front of a glacier

H - kettled: depressions in surficial materials resulting from the melting of buried glacier ice

T - ice contact: landforms that developed in contact with glacier ice such as kames

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RECOMMENDED CITATION

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Any revisions or additional geological information known to the user would be welcomed by the Yukon Geological Survey.

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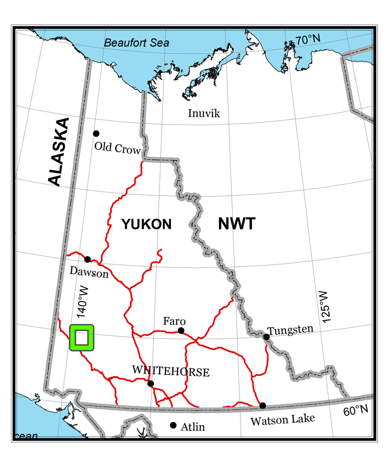
A digital PDF (Portable Document Format) file of this map may be downloaded free of charge from the Yukon Geological Survey website: http://www.geology.gov.yk.ca.



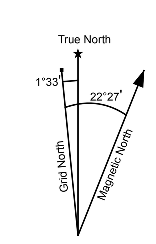
1:50 000-scale topographic base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION, NATURAL RESOURCES CANADA

FIVE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 7

CONTOUR INTERVAL 100 FEET
Elevations in feet above Mean Sea Level

SURFICIAL GEOLOGY
TOSHINGERMANN LAKES
YUKON 115G/14

SCALE 1:50 000
0 1 2 3 4 5
kilometres



Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION NOVEMBER 2009
FOR CENTRE OF MAP

115J/04 MACKINNON CREEK	115J/03	115J/02 ONION CREEK
115G/13 TOM MURRAY CREEK	115G/14 TOSHINGERMANN LAKES open file 2009-45 MAP LOCATION	115G/15 KIYERA LAKE open file 2009-46
115G/12 LYNX CREEK	115G/11 NUNTAKA CREEK	115G/10 SERPENTHEAD LAKE

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2009-45

Surficial Geology of Toshingermann Lakes (NTS 115G/14) Yukon (1:50 000 scale)

by

Jeffrey D. Bond and Panya S. Lipovsky