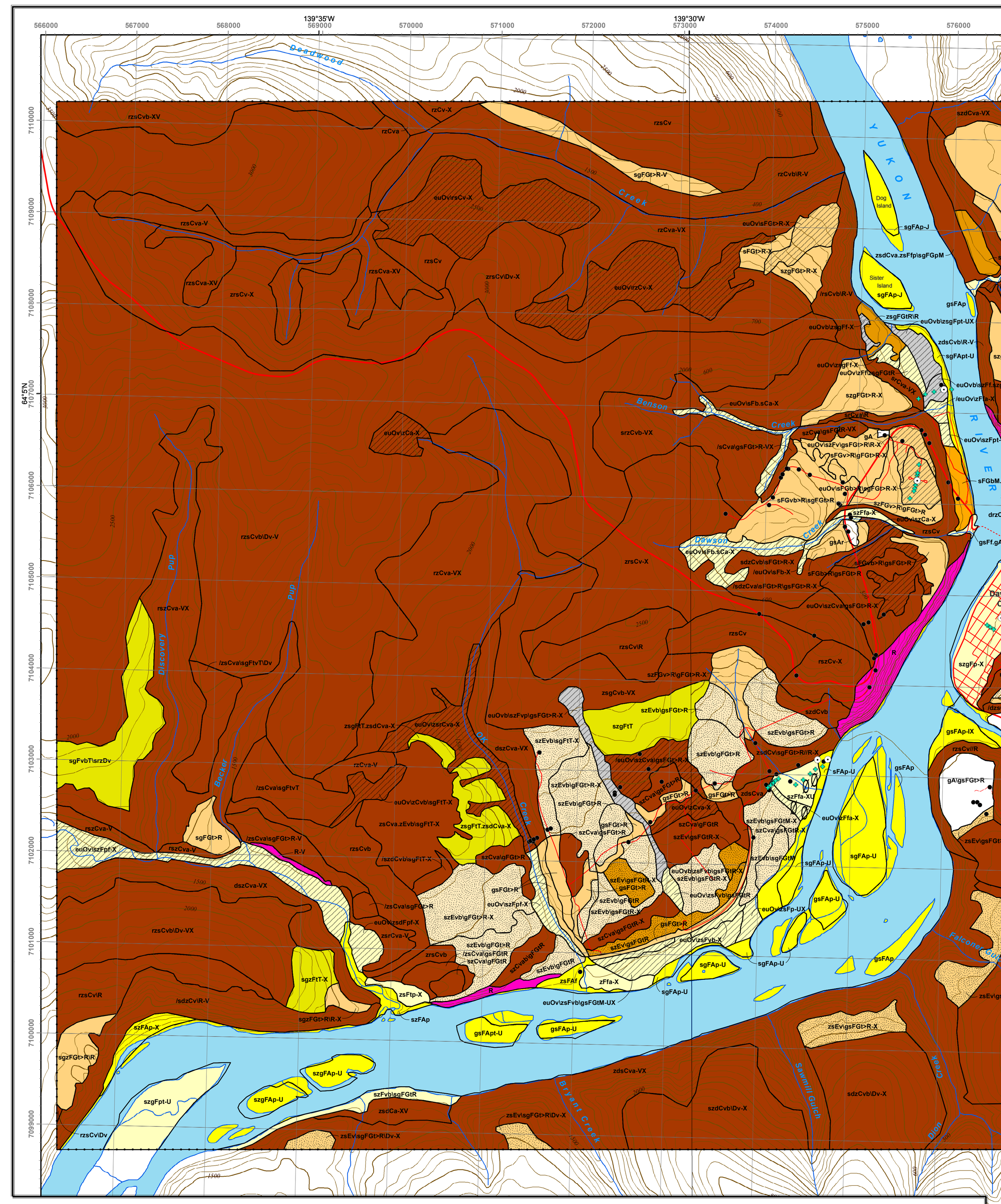
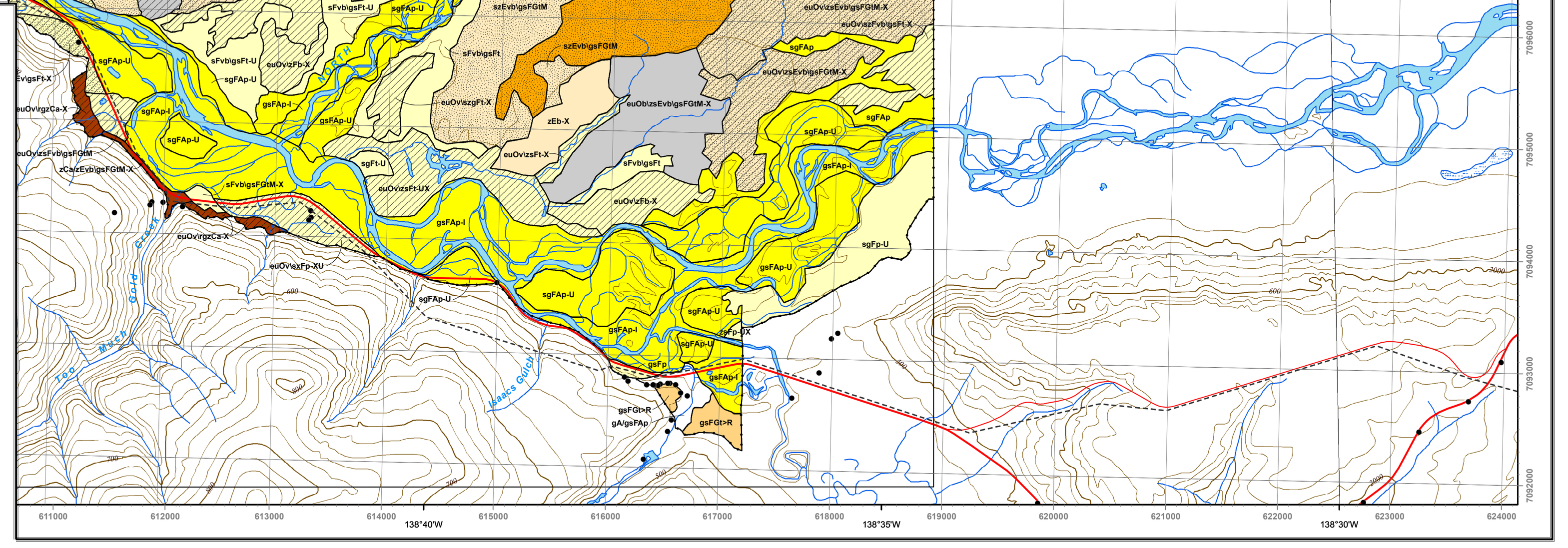




LEGEND

GROUND OBSERVATION SITES:

- field station
- stratigraphic section (labelled with site number)
- permafrost borehole
- electrical resistivity tomography (ERT) profile station

GEOLOGICAL FEATURES:

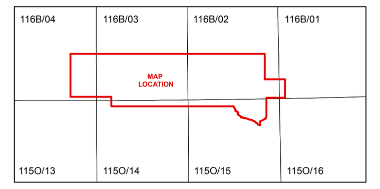
- collapsed open system pingo
- thermokarst pond
- geological boundary
- limit of mapping
- landslide escarpment
- direction of landslide movement

GLACIAL LIMITS:

- Reid (R), defined (after Duk-Rodkin, 1996)
- Pre-Reid (>R), assumed

TOPOGRAPHIC FEATURES:

- roads
- trails
- transmission line
- contours
- streams
- waterbodies
- wetlands



SURFICIAL MATERIALS

Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, and human and volcanic activity. In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. Note that a single polygon will be coloured only by the dominant surficial material, but other materials may exist in that unit.

A — **Anthropogenic:** Surficial materials modified by human activities such that their original physical properties have been significantly altered. Generally applied to mine and dredge tailings within the map area.

O, Ov — **Organic:** Material derived from the accumulation of plant matter, generally consisting of peat with fibric to mesic decomposition. Organic materials cap most surficial materials in the map area and are usually associated with near-surface permafrost. Organic blankets (Ob) greater than 1 m thick are commonly found on abandoned floodplains in old meander scars, in pockets on cool north-facing slopes, and on some cool poorly-drained glaciofluvial terraces. Organic veneers (Ov) 20 to 100 cm thick are widespread throughout the map area, however associated polygons are coloured according to the underlying material and organic veneers are represented by a cross hatched pattern.

E, Ev — **Eolian:** Sediment transported and deposited by wind. The dominant eolian sediment in the map area is loess, which is predominantly silty in texture, with a small fraction of fine sand. Loess veneers (Ev) and blankets (Eb) were deposited over the landscape during the last (McConnell) glaciation (Fraser and Burn, 1997). Ice-rich permafrost is commonly found in gently-sloping eolian blankets. On drier, stable upland sites, loess can be fairly intact, whereas in soils affected by colluvial (slope) processes, permafrost and cryoturbation, loess is reworked into the soil profile and mixed with underlying sediments. In these cases, the presence of loess is indicated by the "z" textural symbol. Resedimented loess is a major component of colluvial aprons and fluvial fans in the map area. Where loess has been reworked extensively and shows flow lines, it has been mapped as a silty fluvial veneer (e.g. zFv\sgFGt). On the broad glaciofluvial terraces north of the mouth of the North Klondike River, reworked loess is finer in texture and contains some clay which may be derived from upland till deposits; the texture of this loess is frequently mapped as mud (m). Where the surface cover consists of an eolian veneer (Ev), it is represented by a dotted pattern and the associated polygon is coloured according to the underlying material.

C — **Colluvium:** Material transported and deposited by down-slope, gravity-driven processes such as creep, solifluction, landslides, and snow avalanches. Colluvium is the dominant surficial material in the uplands north and south of the Klondike River and west of the Yukon River as most of these areas escaped Pleistocene glaciation. It commonly has a stratified structure with a highly variable texture and composition controlled by the parent material, transport mechanism, and travel distance. Colluvium on uplands and slopes is generally derived from weathered bedrock and loess, resulting in a silt-rich diamicton containing angular, local bedrock clasts. On steeper slopes, colluvium is generally coarser grained, as it has been deposited by rapid mass wasting processes such as rock fall, debris flows, and avalanches. Slower processes such as sheetwash, solifluction, and creep occur on gentler slopes, which in conjunction with greater accumulations of loess and the presence of near-surface permafrost, result in finer grained colluvium. Colluvial aprons found on lower slopes and the uphill sides of terraces are commonly ice-rich and are primarily composed of resedimented loess and peat (muck). North of the Klondike River, Pre-Reid morainal deposits have been extensively modified by slope movement (colluviation) and solifluction and are mapped as complexes of colluvial and morainal deposits.

F, FA — **Holocene Fluvial:** Sediments transported and deposited by modern streams and rivers, found in floodplains, fans, and terraces. Fluvial materials may be subject to occasional flooding, sudden stream migration, and/or inundation. Fluvial deposits typically consist of well-sorted stratified sand and gravel comprising subangular to rounded clasts. Thicknesses up to 10 m are common. Low order streams in unglaciated areas are confined to very narrow V-shaped valleys and their fluvial deposits are generally not mapped due to scale limitations. Fluvial fans (Ff), or complexes of coalescing fan-shaped landforms (Fa) are found at the mouths of tributary streams. Where smaller creeks enter the Klondike River valley, fluvial deposits usually consist of large amounts of resedimented silt and sand primarily derived from loess with minor gravels derived from colluvial or glaciofluvial materials. These fans, though still active, likely formed relatively quickly after the McConnell glaciation. They may be ice-rich and contain ice wedges, especially where they are north-facing. Active fluvial (FA) materials primarily consist of sand and gravel and are subject to regular flooding.

$F^{>R}$ — **Pre-Reid Fluvial:** Intermediate level sandy gravel terraces are located near the mouths of Wood Gulch and Foster Gulch.

F^{T} — **Tertiary Fluvial:** sandy pebble and cobble gravel deposited by streams having a fluvial source but graded to the margins of pre-Reid glaciers or glacial drainage; thickness up to 40 m. The highest terraces along the south side of the Klondike River valley west of Hunker Creek consist of Tertiary gravels known as the White Channel gravels which are capped by Pre-Reid Klondike gravels.

Glaciofluvial: Sediments transported and deposited by glacial meltwater above, in, below, or adjacent to a glacier. Glaciofluvial materials are deposited in terraces and plains within the map area. Sediments consist of moderately to well-sorted, rounded, stratified sand and gravel, although the nature and texture may vary locally depending on transport distance. Near-surface ground ice is generally absent in glaciofluvial deposits, especially near the edges of terraces where there is less than 20 cm of silty loess and organic material cover.

FG^{M} — McConnell (late Wisconsin/late Pleistocene) glaciofluvial deposits are expressed as the lowest terraces above the recent (Holocene) fluvial sediments. They are found along the Klondike and Yukon rivers and are commonly covered by a veneer of organic deposits.

FG^{R} — Reid (Illinoian) glaciofluvial terraces are higher than the McConnell terraces, and are commonly covered by organic veneers or blankets.

$FG^{>R}$ — Pre-Reid (early Pleistocene) glaciofluvial terraces are the highest of the glaciofluvial terraces, and two levels are mapped along the Yukon River. Pre-Reid glaciofluvial terraces are best expressed near the mouth of the North Klondike River. Exposures of sand found above the Yukon River along the Top of the World Highway in West Dawson are also interpreted as Pre-Reid glaciofluvial deposits.

Morainal: Morainal (till) materials are diamicts deposited by either: primary glacial processes such as lodgement, deformation, and melt-out (ablation); 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 are relatively coarse grained and tend to have a hummocky or rolling surface expression; lodgement tills typically have a finer grained matrix with fewer clasts and a smoother surface expression. Tills are generally colluviated when found on slopes. Permafrost is widespread within morainal deposits. Morainal sediments are only found in the glaciated portion of the map area, north of the Klondike River and east of Rock Creek. Most of these morainal deposits are Pre-Reid in age and are modified by intense periglacial and colluvial processes.

McConnell (late Wisconsin/late Pleistocene): Small McConnell alpine glaciers and icecaps were limited to higher elevations in the Southern Ogilvie Mountains, to the northeast of the map area.

M^{R} — Reid (Illinoian): The local Reid glaciation was centered in the high elevations of the Ogilvie Mountains. Large Reid valley glaciers extended down the Chandindu River valley to the north of the map area and down the North Klondike River to approximately km 8 of the Dempster highway.

$M^{>R}$ — Pre-Reid (early Pleistocene) glaciers moved in to the map area from the Cordilleran ice sheet to the east and the Ogilvie Mountains to the north. The Pre-Reid glacial limit lies just west of the Rock Creek subdivision. Thick Pre-Reid till is found in the uplands north and east of Rock Creek. Slope failures and near-surface permafrost are extensive in these deposits, and very little undisturbed *in situ* material remains. This area is therefore mapped as a complex of till and colluvium.

R — **Bedrock:** Bedrock in the map area primarily consists of Yukon-Tanana terrane Paleozoic schist, quartzite, and gneiss older than 245 million years, as well as some Slide Mountain terrane greenstone, amphibolite, and serpentinized ultramafic rocks. Bedrock is exposed on steep cliffs and slopes along the Klondike and the Yukon river valleys, having been exposed by large landslides, glacial, or glaciofluvial erosion.

D — **Weathered bedrock:** bedrock decomposed or disintegrated *in situ* by processes of chemical and/or mechanical weathering such as freeze-thaw. Weathered bedrock is common on unglaciated uplands, especially along ridge tops. A silty component may be present due to incorporation of loess by cryoturbation.

TERRAIN CLASSIFICATION SYSTEM

This surficial geology map was classified using the Terrain Classification System for British Columbia (Howes and Kenk, 1997), with minor modification to meet standards set by the Yukon Geological Survey. For example, we have added some permafrost process subclasses to accomodate the wider variety of permafrost features found in Yukon. We have also added an age classification to distinguish materials deposited during different Pleistocene glaciations.

A sample map unit label is shown below to illustrate the terrain classification system. Surficial materials form the core of the polygon map unit labels and are symbolized with a single upper case letter. Lower case textures are written to the left of the surficial material, and lower case surface expressions are written to the right. An upper case activity qualifier (A = active; I = inactive) may be shown immediately following the surficial material designator. The glacial qualifier "G" may alternatively be written immediately following the surficial material to indicate glacially modified materials. Age is indicated by a capital letter that follows the surface expression but precedes the process modifiers. Geomorphological processes (capital letters) and subclasses (lower case letters) always follow a dash symbol ("-").

sgFGptM-Xs

- GEOMORPHOLOGICAL PROCESS(ES) (-X = permafrost) SUBCLASS(ES) (s = sheetwash)
- AGE (M = McConnell)
- SURFACE EXPRESSION (pt = plain, terrace)
- QUALIFIER (G = glacial; A = active; or I = inactive)
- SURFICIAL MATERIAL (F = fluvial)
- TEXTURE (sg = sand, gravel)

COMPOSITE SYMBOL DELIMITERS:

Due to scale limitations, up to 4 terrain units may be included in a single map unit label (*e.g.*, sgFGptM.dsmMbM/xsCv\zcLGpM-XsV). Each component is separated by a delimiter that indicates relative proportions between the components (".", "/", "//") or a stratigraphic relationship "\").

"." - terrain units on either side of the symbol are of approximately equal proportion
"/" - terrain unit(s) before the symbol is more extensive than the one(s) following
"//" - terrain unit(s) before the symbol is considerably more extensive than the one(s) following
"\" - terrain unit(s) before the "\" symbol stratigraphically overlies the one(s) following

1st terrain unit (>50% of map unit) / 2nd terrain unit (30-49% of map unit) // 3rd terrain unit (10-29% of map unit) \ Underlying terrain unit

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. Texture is indicated by up to three lower case letters, placed immediately before the surficial material designator, listed in order of decreasing abundance.

Specific clastic textures
a - blocks: angular particles >256 mm in size
b - boulders: rounded particles >256 mm in size
k - cobbles: rounded particles >64-256 mm in size
p - pebbles: rounded particles >2-64 mm in size
s - sand: particles between >0.0625-2 mm in size
z - silt: particles 2 μm-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
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 less than 10% of the volume of the material

SURFICIAL MATERIAL AGE

GLACIATION	TIME PERIOD	APPROXIMATE GLACIAL MAXIMUM	MARINE ISOTOPE STAGE
M - McConnell	late Wisconsin	15 000 years ago	2
R - Reid	Illinoian	130 000 years ago	6
>R - Pre-Reid	early to Middle Pleistocene	2.6 million to 200 000 years ago	8-102

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 or 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 on 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

d - depressions: circular or irregular area (hollow) of lower elevation than the surrounding terrain and delimited by an abrupt break in slope; depression side slopes are steeper than surrounding terrain; depressions are two or more metres deep; typically applied to kettle holes, karst, or piping depressions

f - fan: sector of a cone with a slope gradient less than 15° (26%) from apex to toe; longtitudinal 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 body of water; 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

u - undulating topography: non-linear rises and hollows with slopes generally less than 15° (26%)

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

w - mantle of variable thickness: a layer or discontinuous layer of variable thickness, typically 0 to 3 m, that fills or partly fills depressions in an irregular substrate; generally too thin to mask irregularities in the underlying material

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. All processes, except for deglacial processes, are assumed to be active unless the qualifier "I" (inactive) is used. All deglacial processes are assumed to be inactive unless the qualifier "A" (active) is used. Up to three upper case letters may be used to indicate processes. These are listed in order of decreasing importance and placed after the surface expression symbol, following a dash (-) symbol.

Subclasses are used to provide more specific information about a general geomorophological process, and are represented by lower case letters placed after the related process designator. Up to two subclasses can be associated with 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

J - anastamosing channel: a channel zone where channels diverge and converge around many islands. The islands are vegetated and have surfaces that are far above mean maximum discharge levels

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 at 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: (") initiation zone; (b) rockfall; (d) debris flow; (g) creep; (m) slump in bedrock; (r) rockslide; (s) debris slide; (u) slump in surficial material

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; (f) thaw flow slides; (l) segregated ice; (n) pingo; (t) thermokarst subsidence; (r) patterned ground; (s) sheetwash; (w) ice-wedge polygons

HYDROLOGIC PROCESSES

U - inundation: terrain seasonally under standing water for greater than one month per year and resulting from a high watertable

BACKGROUND

This map was produced as a base layer for community landscape hazard assessment and climate change adaptation planning. An accompanying report providing additional detail on local surficial geology, stratigraphy, glacial history, and landscape hazards will be available from Yukon College's Northern Climate ExChange in April 2015. Surficial geology and soils in the study area have previously been mapped in whole or in part at various scales by several authors, including: Duk-Rodkin, 1996; Froese and Jackson, 2005; Froese 2005, Ricker, 1967; Thomas and Rampton, 1982, Rostad et al., 1977; and Westland Resource Group, 1987. This map synthesizes all of these data sources to portray surficial geology for the region at 1:25,000 scale.

METHODS

Surficial geology mapping was based on the conversion of the Klondike River valley soil survey map series (Westland Resource Group, 1987) in conjunction with digital air photo interpretation using PurView/ArcGIS softcopy software. The study area boundary was extended beyond the original Westland Resource Group soil map area to include the uplands north and south of the Klondike Valley and west of the Yukon River. Field checking was performed during August and September, 2013. Surficial geology linework is based on 1:25,000 scale aerial photography from 1995 and therefore may not exactly match background physiographic and hydrologic features displayed from 1:50 000-scale topographic base maps. Quickbird (2006) and GeoEye (2009) satellite imagery was also used to update areas disturbed by mining.

ACKNOWLEDGEMENTS

This map was produced as part of a community hazards mapping program coordinated by Bronwyn Benkert from the Northern Climate ExChange, Yukon Research Centre, Yukon College. Surficial geology mapping for the Klondike Valley was undertaken by Karen McKenna (CryoGeographic Consulting) with the assistance of Sydney van Loon. Kristen Kennedy arranged pre-field logistics. Site specific permafrost investigations were conducted by Sarah Laxton, Louis-Philippe Roy, Alexandre Bevington, Antoni Lewkowicz (University of Ottawa), Daniel Fortier (University of Montreal), and Isabelle de Grandpre. Digital cartography and drafting were completed by Panya Lipovsky. Funding for this project was provided by Canadian Northern Economic Development Agency's (CanNor) Strategic Investments in Northern Economic Development (SINED) program. Tr'ondëk Hwëch'in First Nation is gratefully acknowledged for access to their traditional territory.

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RECOMMENDED CITATION

McKenna, K.M. and Lipovsky, P.S., 2014. Surficial geology, Dawson region, Yukon; parts of NTS 115O/14 &15 and 116B/1, 2, 3 & 4. Yukon Geological Survey, Energy, Mines and Resources, Government of Yukon, Open File 2014-12, 1:25 000 scale.

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

Paper copies of this map may be obtained from Yukon Geological Survey, Room 102 - 300 Main St., Whitehorse, Yukon, Y1A 2B5.
Phone: 867-667-3201, E-mail: geology@gov.yk.ca.

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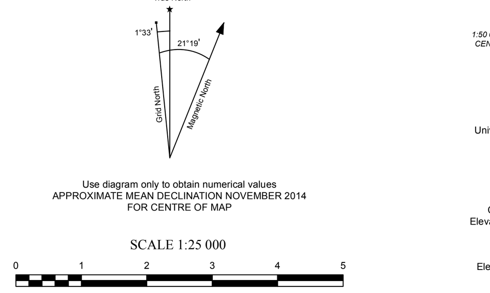

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ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 7

East of 139° 30'
CONTOUR INTERVAL 20 METRES
Elevations in metres above Mean Sea Level

West of 139° 30'
CONTOUR INTERVAL 500 FEET
Elevations in feet above Mean Sea Level

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2014-12

Surficial Geology, Dawson Region, Yukon
Parts of NTS 115O/14 &15 and 116B/1, 2, 3 & 4
1:25 000 scale

by

Karen M. McKenna and Panya S. Lipovsky