MARGINAL NOTES

INTRODUCTION

The map area includes steep mountainous terrain of the central Kluane Ranges as well as gently sloped rolling terrain of the Shakwak trench. The distribution of surficial materials is primarily controlled by slope steepness and glacial history. In mountainous terrain, bedrock is commonly exposed in canyons, and along ridges, summits, and upper slopes. Upper and middle slopes are typically steep. High slope angles result in rapid and slow downslope movement of weathered bedrock by gravitational processes forming a discontinuous colluvial veneer (<1 m thick) or blanket (>1m thick) between areas of exposed bedrock. Glacial deposits are generally poorly preserved in steep terrain. Lower slope positions and valley bottoms have thick and more varied deposits of surficial materials. Valley bottom materials are commonly characterized by large fluvial fans with areas of moraine and glaciofluvial sediment. Additional details on the distribution of surficial sediments, stratigraphy, and glacial history of the map area can be found in Ackerson et al., 2021.

GEOMORPHIC PROCESSES

Steep slopes and weak bedrock result in widespread slope failures in the map area. Rockfall deposits accumulate as veneers and blankets over upper and mid-elevation slopes and as aprons at the toe of slopes. Rockslides deposit hummocky to ridged deposits on lower slopes. Debris slides and debris flows commonly initiate at mid to upper slope positions and form deposits at lower-slope positions, typically on fans and cones. Abundant colluvium, till, and weathered bedrock are easily remobilized into debris slides and flows. Where permafrost is present active layer detachment slides are common. Rotational failures are common in sedimentary and volcanic bedrock in the SW and NW map area.

PERMAFROST

Permafrost is widespread but discontinuous in the central Kluane Ranges. It is most common on slopes with northeastern and northern aspects and on lower slopes or in valley bottoms. The distribution of permafrost varies widely as does its character (depth, thickness and ice content) based on topography, texture of surficial materials and surface cover. Permafrost was found in a variety of different material types such as fluvial, coarse and fine-grained colluvium, fibric organics and tephra. Permafrost was identified in the mapping based on indicators such as sheetwash, active layer detachment scars (including revegetated scars), tilted trees (drunken forest), thermokarst ponds or in polygons containing field stations where permafrost was encountered during manual excavations. As such permafrost is likely under-represented and may be much more extensive than is indicated by this mapping. Permafrost is commonly 40–50 cm deep, or as shallow as 15–20 cm where insulating vegetative cover exceeds 10 cm thick. Active layer detachment slides are common and are the result of saturated conditions at the bottom of the active layer.

GLACIAL HISTORY

Yukon was repeatedly glaciated by the northern part of the Cordilleran Ice Sheet (CIS) during the Quaternary. The map area was affected by the St. Elias Lobe of the CIS as well as by local ice. Stratigraphic studies have recognized five glacial advances in this region but there were likely additional unrecognized earlier advances (Turner, 2014; Turner et al., 2016; Cronmiller, 2019; Kennedy and Ellis, 2020).

Glacial features and sediments in the map area have been attributed to the MIS 2 (McConnell Glaciation) advance of the CIS as well as local glaciers in cirques and valleys of the central Kluane Ranges. Morainal deposits observed in Shakwak trench record glaciers from the St. Elias Mountains and Ruby Range (up to the mouth of Gladstone Creek and possibly beyond) coalescing and flowing NW up the trench. Outwash gravel overlying MIS 2 moraine is interpreted to represent a retreating or stagnant ice front during deglaciation. It is likely that ice advancing out of the Kluane Ranges to the northwest of Kluane Lake blocked north-flowing drainage in Shakwak trench resulting in a higher than present lake level (Turner et al., 2016). We see a record of this at the Lewis Creek north (CA203201) and Lewis Creek south (CA203202) sections (Fig. 2).

Till deposits preserved in the four Shakwak trench sections are interpreted to record glaciers from the St. Elias Mountains and possibly Ruby Range coalescing in, and flowing NW up, the trench. Outwash gravel at the Dutch Harbour (CA201901 and CA201902) and Goose Bay sites (CA201903) represent a retreating or stagnant ice front (Fig. 3). These sites are located within proximal channels, further supporting the interpretation of deglaciation. Glaciolacustrine sediments at the Dutch Harbour (CA201901 and CA201902) and Goose Bay sites (CA201903) are interpreted to be the result of sediment deposited into a glacial lake occupying Shakwak trench during deglaciation. The colours in the stratigraphic sections correspond to those of the surficial materials on the map.

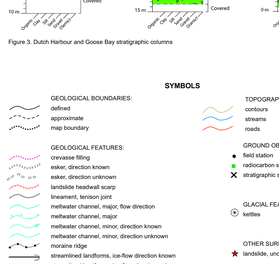

Figure 1. Shakwak trench composite stratigraphic column

Figure 2. Lewis Creek stratigraphic columns

Figure 3. Dutch Harbour and Goose Bay stratigraphic columns

Paleosol
Clayey Silt
Silt
Sand with Fines
Bedded/Laminated Sand
Pebble Gravel
Gravel
Coarse Gravel
Diamict

Stratigraphic column legend

SYMBOLS

GEOLOGICAL BOUNDARIES:
- defined
- approximate
- map boundary

GEOLOGICAL FEATURES:
- crevasse filling
- esker, direction known
- esker, direction unknown
- landslide headwall scarp
- lineament, tension joint
- meltwater channel, major, flow direction
- meltwater channel, major
- meltwater channel, minor, direction known
- meltwater channel, minor, direction unknown
- moraine ridge
- streamlined landforms, ice-flow direction known
- streamlined landforms, ice-flow direction unknown

GLACIAL LIMITS:
- Penultimate Glaciation (early Wisconsin), assumed
- Last Glacial Maximum (late Wisconsin), assumed
- Recessional glacial limits, undefined, assumed

TOPOGRAPHIC FEATURES:
- contours
- streams
- roads

GROUND OBSERVATION SITES:
- field station
- radiocarbon sample (associated with stratigraphic section)
- stratigraphic section (labelled with station ID, e.g. CA203202)

GLACIAL FEATURES:
- kettles

OTHER SURFACE FEATURES:
- landslide, unclassified

SURFICIAL GEOLOGY

CENTRAL KLUANE RANGES, YUKON

PARTS OF NTS 115B/15, 16 and 115G/1, 2, 3, 6, 7

SCALE 1:50 000

0 0.5 1 2

kilometres

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

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

CONTOUR INTERVAL 40 METRE
Elevations in feet above Mean Sea Level

LEGEND

This surficial geology map was created using Yukon Geological Survey criteria which is a modified version of Terrain Classification System for British Columbia (Howes and Kenk, 1997). For example some permafrost subclasses have been added by the Yukon Geological Survey to accommodate the wider variety of permafrost features present in Yukon. Age classification has been included to distinguish materials deposited during different Pleistocene glaciations.

A sample map unit label below illustrates 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. The abundance of a texture or surface expression decreases from left to 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 ("-").

TERRAIN CLASSIFICATION SYSTEM



COMPOSITE SYMBOL DELIMITERS:

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

"." - 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

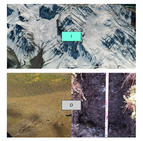
METHODS

Surficial geological field mapping was completed at a scale of 1:50 000 in 2020. Remote predictive mapping was completed using 1:50 000-scale digital monoscopic aerial photographs flown between 1967 and 1989 with Summit Evolution/ArcGIS viewing software. Field checking of units was completed by documenting anthropogenic and natural exposures of surficial materials and by digging soil pits (up to ~1 m deep) in a broad range of surface sediments and landforms.

SURFICIAL MATERIALS

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 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 be present. The photos found in the legend represent examples of surficial materials encountered in the mapping area.

Holocene



Ice (I): Modern accumulations of snow and ice with glacial movement. Active glacial ice is rare and confined to high elevation cirques of the central Kluane Ranges.

Organic (O): Accumulations of plant material consisting of peat with fibric to mesic decomposition. Organic blankets (>1 m thick) and veneers (<1 m thick), are commonly found in low-lying areas and depressions in sloping terrain. They commonly overlie poorly drained materials that have a high percentage of silt and clay and/or permafrost resulting in wet ground conditions that facilitate vegetative accumulation. These deposits are primarily found in the troughs of ridged and rolling till deposits, the upslope trough of ridges on sloped ground and the low lying areas between adjacent fans prograding onto the Slims River flood plain.

Eolian (E): Sediments transported and deposited by wind. Although windblown silt and fine sand (loess) are the most widespread sediments throughout the map area, they are generally thin and may not be indicated in material labels. Loess has been deposited throughout the Holocene, but is primarily associated with periods of deglaciation. Modern loess deposits are typically confined to the southern part of the map area and originate primarily from the Slims River valley and delta.

Lacustrine (L): Lacustrine sediments in the map area are sediments that have accumulated at the margin of Kluane Lake (beaches) mainly through wave action. They are moderate to weakly stratified sand, pebble gravel with a sandy matrix, and openwork pebble gravel. Berms of lacustrine beach sediment up to 2 m high can be found several hundred metres inland from the shore. Lakeshore lacustrine deposits are commonly affected by eolian processes and can be interbedded with eolian sand and silt deposits. Lacustrine beach deposits are well drained and are rarely affected by permafrost. Beaches above the modern lake level are mapped as inactive (L) lacustrine while beach materials near the modern shoreline of Kluane Lake are mapped as active (LA) lacustrine.

Fluvial – Inactive (F): Sediments transported and deposited by streams and rivers. Inactive fluvial sediments in the map area are found in plains, fans, and terraces above and adjacent to active floodplains and were predominantly formed by high-energy streams draining the Kluane Ranges. These deposits are dominantly well to moderately sorted stratified sand and gravel. Clasts are subangular to round and range in size from pebble to boulder. Fine-grained lenses and beds in fluvial deposits may contain silt, although it may be discontinuous over relatively small areas. Fluvial fans are fan-shaped landforms formed when a stream leaves a confined valley and consist of silt, sand and gravel derived from colluvial material. Inactive fan, floodplain and terrace deposits may be subject to flooding accompanied by sudden stream migration and inundation.

Fluvial – Active (FA): Sediments transported and deposited by streams and rivers. Active fluvial sediments are predominantly those associated with floodplains and channels of streams draining the Kluane Ranges and the drainages of the Duke River and Slims River. These deposits are dominantly well to moderately sorted, stratified sand and gravel. Clasts are subangular to round and range in size from pebble to boulder. Steep, confined channels are characterized by larger boulder fractions. Broad floodplains are characterized by gravel dominated by pebbles and cobbles with few boulders. Active fluvial channels migrate widely over alluvial fans in the map area, reactivating previously abandoned channels and incising new channels. Permafrost is uncommon in active fluvial deposits.

Holocene and Pleistocene



Colluvium (C): Material transported by gravity-driven processes including rapid processes such as rock fall, slumps, slides, debris flows and rock avalanches, and slow processes such as solifluction and creep. Colluvium commonly is moderately stratified with a highly variable texture and composition controlled by the parent material, transport mechanism and travel distance. At higher elevations in the central Kluane Range colluvial deposits are primarily derived from bedrock, with increasing contributions from glaciogenic materials toward valley bottoms. Colluvial veneers and blankets form thin veneers (<1 m thick) on steep slopes, to blankets (>1 m thick) on gentler slopes and lower slope positions.

Bedrock-derived colluvial materials are commonly sourced from metasedimentary and metavolcanic rocks in the map area. These deposits are grey to green silty matrix colluvial diamicts with angular fragments of rock ranging in size from pebble to boulder. Less commonly, colluvium is derived from Cenozoic basalt (rocks of the Wrangell Formation) and has a higher content of fines (silt and clay) and a reddish colour. Colluvial deposits generated from the Amphitheatre Formation pebble-cobble conglomerate in the southwestern and northwestern part of the map area resemble fluvial or glaciofluvial materials. Amphitheatre Formation colluvial deposits are recognizable by a high proportion of fractured quartz pebbles and cobbles.

Colluvium derived from glaciogenic sediment in the broad Shakwak trench, and the Duke and Slims valleys, is typically a light to dark grey sandy silt matrix diamict with subangular to subrounded clasts. In the narrow valleys of the central Kluane Range glacial deposits are often locally derived and secondary colluvial deposits reflect this source. Colluvial aprons found along the base of slopes and stream-cut escarpments commonly contain ice-rich permafrost and are primarily composed of diamict from resedimented slope materials. Permafrost processes play a significant role in the generation of colluvial deposits, particularly on north and east-facing aspects. Shallow permafrost in these environments facilitates downslope movement through active layer detachments and soil creep. A small number of rock glaciers occur in the map area where angular bedrock-derived blocks and boulders are frozen and moving downslope through combined gravity and ice processes (indicated by –Fg process modifier). There is both active (C) and inactive (Ci) colluvium in the map area. Inactive colluvium comprises deeply incised colluvial fans and cones in Shakwak trench and Duke River valley.

Pleistocene and older



Glaciofluvial (FG): Materials deposited by glacial meltwater either directly in front of, or in close contact with glacial ice. Glaciofluvial materials commonly comprise well to moderately sorted, stratified silty-sandy gravel. They typically form kettled and hummocky plain surfaces, and are also present as ridged and undulating landforms when deposited along a glacier margin or sub-glacially (eskers), and as smooth plains when deposited as terraces. In the canyons and valleys of the central Kluane Range, glaciofluvial materials are typically poorly preserved and exist only in isolated pockets. In Shakwak Trench glaciofluvial deposits are present along the western and southern margins of Kluane Lake. Glaciofluvial deposits may be affected by permafrost but in most cases do not have segregated ice lenses.

Glaciolacustrine (LG): Materials deposited in or along the margins of glacial lakes and include ice rafted debris. Glaciolacustrine sediments consist of fine-grained, laminated sand, silt, and clay. Isolated clasts (drop stones) are common in these deposits. Glaciolacustrine deposits are most extensive in the southeastern part of the map area where they underlie glaciofluvial sediments in Shakwak trench. Ice-rich permafrost is widespread in these deposits due to their poor drainage and high moisture content.

Moraine (M): Material directly deposited by glacier ice without significant modification. Moraine deposits are typically highly variable and depend on the source of material incorporated by the glacier and the mode of deposition. Moraine deposits in the map area are characterized by poorly sorted, weakly to strongly compacted material containing a heterogeneous mixture of particle sizes. The matrix is usually sand and silt, but clay can be present. Moraine in the map area commonly lacks stratification, however, weak stratification is noted in deposits near the southwestern margins of Kluane Lake. Moraine is preserved on gently sloping surfaces and benches on mid to lower slopes of the central Kluane Range and the valley bottom of Shakwak trench and Duke River valley. Sources of moraine in the map area include small alpine cirque glaciers, first order valley glaciers, and high-order valley glaciers such as the ice stream that occupied the Shakwak trench during repeated glaciations. Larger glaciers carrying material farther from source typically produce finer grained matrix with more lithological and geochemical variability. Moraine deposits are commonly affected by permafrost, and some may be ice-rich.

Neogene and older



Weathered Bedrock (D): In situ weathered and decomposed bedrock is found on low-angle older upland surfaces and is commonly associated with periglacial processes. Texture varies with respect to the initial lithologic characteristics and degree of mixing with loess and/or glaciogenic deposits by periglacial processes such as cryoturbation and frost heave. Metasedimentary and metavolcanic units in the map area produce angular rock fragments in a matrix of silt through frost shattering and chemical weathering processes. Permafrost is present in weathered bedrock in the map area.

Bedrock (R): Bedrock in the map area comprises Late Paleozoic to mid-Mesozoic volcanic and sedimentary rocks belonging to the Wrangellia terrane. Intruded by younger mafic and ultramafic sills, dikes and granitic rocks and overlain by Tertiary terrestrial sedimentary and volcanic deposits (Israel et al., 2005; Israel et al., 2006). Permafrost is present in bedrock in the map area.

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. Textures are not displayed on this map, but are contained within the associated digital release.

Specific clastic textures
a - blocks: angular particles >256 mm in size
b - boulders: rounded particles >256 mm in size
p - pebbles: rounded particles >2-64 mm in size
s - sand: particles >0.0625-2 mm in size
z - silt: particles 2 µm-0.0625 mm 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

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.

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 way 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: sector of a cone with a slope gradient greater than 15° (26%) from apex to toe; longitudinal profile is smooth and straight, or slightly concave/convex.
f - fan: sector of a cone with a slope gradient less than or equal to 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 local relief greater than 1 m and multidirectional slopes dominantly from 15-35° (26-70%) if composed of unconsolidated materials. Bedrock sloped hummocks may be steeper. 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 and sandhills.
i - delta: landform created at the mouth of a river or stream where it flows into a body of water. Deltas have gently sloping surfaces from 0-3° (0-5%), and moderate to steeply sloping fronts from 15-35° (27-70%). Glaciofluvial deltas in the map area are typically coarse grained with steep sides and gently inclined kettled or channelled surfaces.
m - rolling: elongate hillock(s), slopes dominantly from 3-15° (5-26%); local relief >1 m; in plan, an assemblage of parallel or subparallel linear forms with subdued relief.
p - plain: a level or very gently sloping, unidirectional (planar) surface with slopes 0-3° (0-5%); relief of local surface irregularities generally less than 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 greater than 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: gently sloping hillock(s) and hollow(s) with multidirectional slopes generally up to 15° (26%); local relief is >1 m; in plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile.
v - veneer: a layer of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material; 10 cm to 1m in 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.
x - thin veneer: a very thin layer of unconsolidated material, 2 to 20 cm thick.

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 geomorphological 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 subparallel long, narrow ravines.

FLUVIAL PROCESSES

B - braiding channel: active channel zone is characterized by many diverging and converging channels separated by unvegetated bars. Many channels are dry at moderate and low flows, but during major floods, the entire channel zone may be occupied by flowing water.

MASS MOVEMENT PROCESSES

The map symbol (*****) following a mass movement process indicates an initiation zone or zone of instability, such as headscarps of debris slides or earthflows and source areas for rockfall and debris flows.

F - slow mass movement: slow downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by creeping, flowing or sliding.
Subclasses: (e) earthflow - slow viscous flow of material containing a high proportion of silt and clay; (g) rock creep - slow movement of angular debris under periglacial conditions (e.g., rock glaciers); (k) tension cracks - open fissures, commonly near the crest of slope; (m) slump (in bedrock) - internally cohesive mass of bedrock sliding along a slip plane that is concave upward or planar; (r) rockslide - descent of large masses of disintegrating bedrock by sliding; (s) debris slide - sliding of disintegrating mass of surficial material; (u) slump (in surficial material) - internally cohesive mass of bedrock sliding along a slip plane that is concave upward or planar.

L - Undifferentiated landslide: rapid or slow downslope movement of masses of cohesive or non-cohesive surficial materials and/or bedrock.
Subclasses: (m) slump (in bedrock) - internally cohesive mass of bedrock sliding along a slip plane that is concave upward or planar.

PERIGLACIAL PROCESSES

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

X - permafrost: processes controlled by the presence of permafrost, and permafrost aggradation or degradation.
Subclasses: (s) sheetflow - transport of fine sediment (sand, silt and clay) through unconcentrated overland flow and percolation; (t) thermokarst subsidence - ground-surface depressions created by the thawing of ice-rich permafrost and associated soil subsidence; (w) ice wedge polygons - intersecting narrow cracks that contain ice-wedges comprise polygonal patterns on ground underlain by permafrost.

Z - general periglacial processes: solifluction, cryoturbation and nivation occurring together within a single terrain unit.

DEGLACIAL PROCESSES

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

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

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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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Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

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Sheet 1 of 2

Surficial Geology, Central Kluane Ranges, Yukon
Parts of NTS 115B/15, 16 and 115G/1, 2, 3, 6, 7
1:50 000 scale

by
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MARGINAL NOTES

INTRODUCTION

The map area includes steep mountainous terrain of the central Kluane Ranges as well as gently sloped rolling terrain of the Shakwak trench. The distribution of surficial materials is primarily controlled by slope steepness and glacial history. In mountainous terrain, bedrock is commonly exposed in canyons, and along ridges, summits, and upper slopes. Upper and middle slopes are typically steep. High slope angles result in rapid and slow downslope movement of weathered bedrock by gravitational processes forming a discontinuous colluvial veneer (<1 m thick) or blanket (>1m thick) between areas of exposed bedrock. Glacial deposits are generally poorly preserved in steep terrain. Lower slope positions and valley bottoms have thick and more varied deposits of surficial materials. Valley bottom materials are commonly characterized by large fluvial fans with areas of moraine and glaciofluvial sediment. Additional details on the distribution of surficial sediments, stratigraphy, and glacial history of the map area can be found in Ackerson et al., 2021.

GEOMORPHIC PROCESSES

Steep slopes and weak bedrock result in widespread slope failures in the map area. Rockfall deposits accumulate as veneers and blankets over upper and mid-elevation slopes and as aprons at the toe of slopes. Rockslides deposit hummocky to ridged deposits on lower slopes. Debris slides and debris flows commonly initiate at mid to upper slope positions and form deposits at lower slope positions, typically on fans and cones. Abundant colluvium, till, and weathered bedrock are easily remobilized into debris slides and flows. Where permafrost is present active layer detachment slides are common. Rotational failures are common in sedimentary and volcanic bedrock in the SW and NW map area.

PERMAFROST

Permafrost is widespread but discontinuous in the central Kluane Ranges. It is most common on slopes with northeastern and northern aspects and on lower slopes or in valley bottoms. The distribution of permafrost varies widely as does its character (depth, thickness and ice content) based on topography, texture of surficial materials and surface cover. Permafrost was found in a variety of different material types such as fluvial, coarse and fine-grained colluvium, fibric organics and tephra. Permafrost was identified in the mapping based on indicators such as sheetwash, active layer detachment scars (including revegetated scars), tilted trees (drunken forest), hummocked ponds or in polygons containing field stations where permafrost was encountered during manual excavations. As such permafrost is likely under-represented and may be much more extensive than is indicated by this mapping. Permafrost is commonly 40–50 cm deep, or as shallow as 10–20 cm where insulating vegetative cover exceeds 10 cm thick. Active layer detachment slides are common and are the result of saturated conditions at the bottom of the active layer.

GLACIAL HISTORY

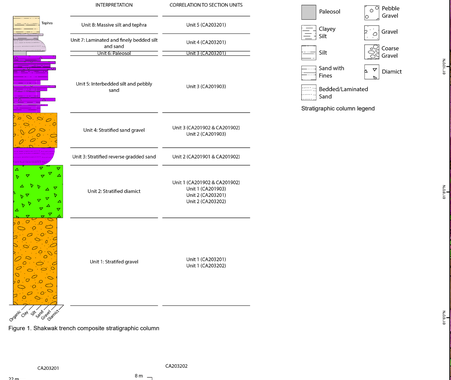
Yukon was repeatedly glaciated by the northern part of the Cordilleran Ice Sheet (CIS) during the Quaternary. The map area was affected by the St. Elias Lobe of the CIS as well as by local ice. Stratigraphic studies have recognized five glacial advances in this region but there were likely additional unrecognized earlier advances (Turner, 2014; Turner et al., 2016; Cronmiller, 2019; Kennedy and Ellis, 2020).

Glacial features and sediments in the map area have been attributed to the MIS 2 (McConnell Glaciation) advance of the CIS as well as local glaciers in cirques and valleys of the central Kluane Ranges. Morainal deposits observed in Shakwak trench record glaciations from the St. Elias Mountains and Ruby Range (up to the mouth of Gladstone Creek and possibly beyond) coalescing and flowing NW up the trench. Outwash gravel overlying MIS 2 moraine is interpreted to represent a retreating or stagnant ice front during deglaciation. It is likely that ice advancing out of the Kluane Ranges to the northwest of Kluane Lake blocked north-flowing drainage in Shakwak trench resulting in a higher than present lake level (Turner et al., 2016). We see a record of this at the Lewis Creek north (CA203201) and Lewis Creek south (CA203202) sections (Fig. 2).

Till deposits preserved in the four Shakwak trench sections are interpreted to record glaciers from the St. Elias Mountains and possibly Ruby Range coalescing in, and flowing NW up, the trench. Outwash gravel at the Dutch Harbour (CA201901 and CA201902) and Goose Bay sites (CA201903) represent a retreating or stagnant ice front (Fig. 3). These sites are located along ice marginal meltwater channels, further supporting the interpretation of deglaciation. Glaciolacustrine sediments at the Dutch Harbour (CA201902) and Goose Bay sites (CA201903) are interpreted to be the result of sediment deposited into a glacial lake occupying Shakwak trench during deglaciation. The colours in the stratigraphic sections correspond to those of the surficial materials on the map.

STRATIGRAPHIC SECTIONS

A composite stratigraphic column (Fig. 1) was developed to help reconstruct the stratigraphy of Shakwak trench. It is likely that ice advancing out of the Kluane Ranges to the northwest of Kluane Lake blocked north-flowing drainage in Shakwak trench and resulted in a higher than present lake level (Turner et al., 2016). We see a record of this at the Lewis Creek north (CA203201) and Lewis Creek south (CA203202) sections (Fig. 2).



INTERPRETATION	CORRELATION TO SECTION UNITS
Unit 8: Massive silt and tephra	Unit 5 (CA203201)
Unit 7: Laminated and finely bedded silt and sand	Unit 4 (CA203201)
Unit 6: Paleosol	Unit 3 (CA203201)
Unit 5: Interbedded silt and pebbly sand	Unit 3 (CA201903)
Unit 4: Stratified sand gravel	Unit 3 (CA201902 & CA201902) Unit 2 (CA201903)
Unit 3: Stratified reverse-graded sand	Unit 2 (CA201901 & CA201902)
Unit 2: Stratified diamict	Unit 1 (CA201902 & CA201902) Unit 1 (CA201903) Unit 2 (CA203201) Unit 2 (CA203202)
Unit 1: Stratified gravel	Unit 1 (CA203201) Unit 1 (CA203202)

Paleosol
Clayey Silt
Silt
Sand with Fines
Bedded/Laminated Sand
Pebble Gravel
Gravel
Coarse Gravel
Diamict
Stratigraphic column legend

Figure 1. Shakwak trench composite stratigraphic column

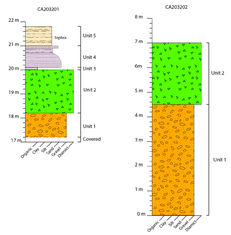


Figure 2. Lewis Creek stratigraphic columns

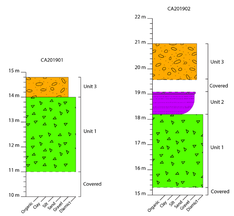


Figure 3. Dutch Harbour and Goose Bay stratigraphic columns

SYMBOLS

GEOLOGICAL BOUNDARIES:
- defined
- approximate
- map boundary

GEOLOGICAL FEATURES:
- crevasse filling
- esker, direction known
- esker, direction unknown
- landslide headwall scarp
- lineament, tenison joint
- meltwater channel, major, flow direction
- meltwater channel, major
- meltwater channel, minor, direction known
- meltwater channel, minor, direction unknown
- moraine ridge
- streamlined landforms, ice-flow direction known
- streamlined landforms, ice-flow direction unknown

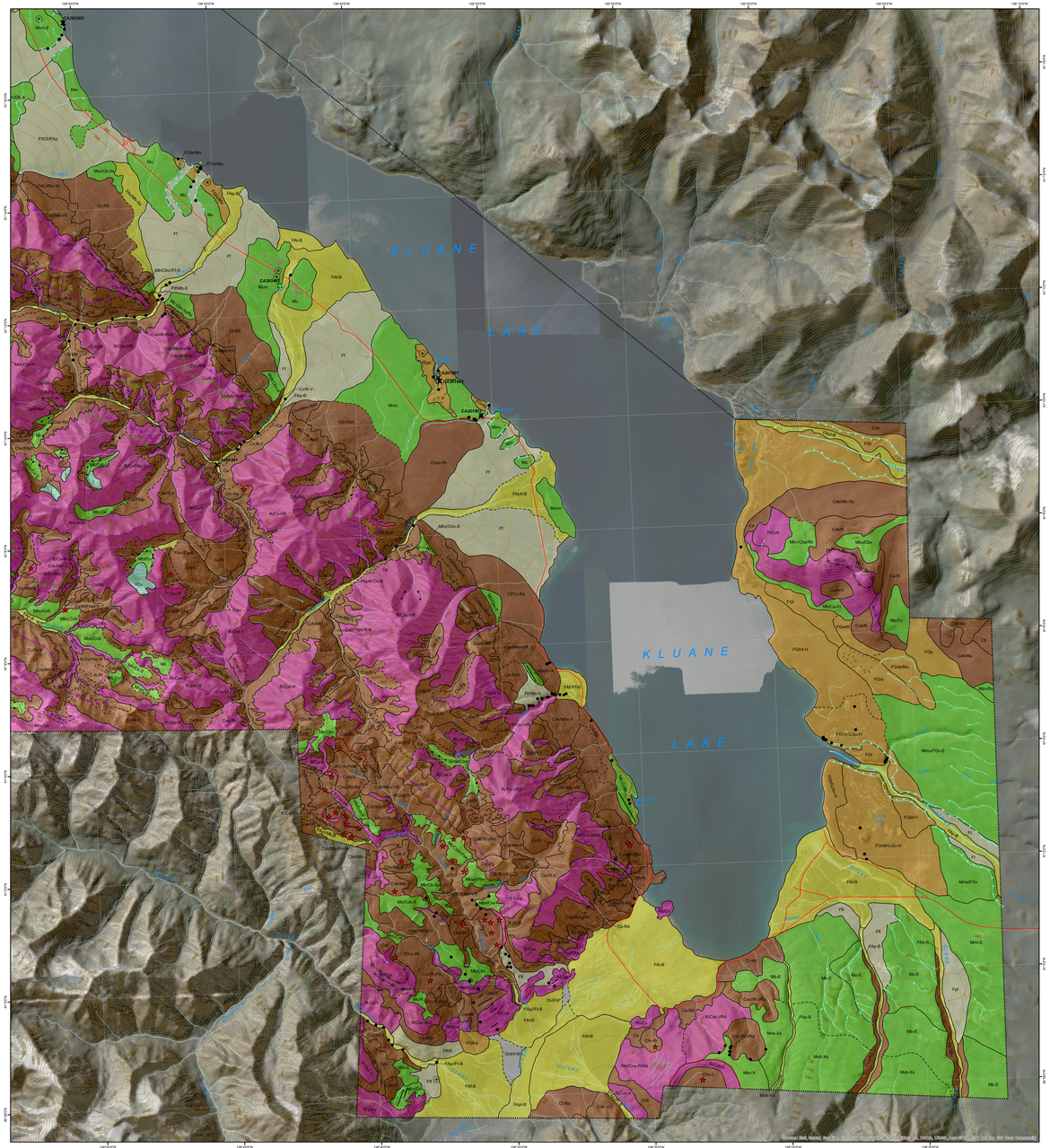
GLACIAL LIMITS:
- Penultimate Glaciation (early Wisconsin), assumed
- Last Glacial Maximum (late Wisconsin), assumed
- Recessional glacial limits, undefined, assumed

TOPOGRAPHIC FEATURES:
- contours
- streams
- roads

GROUND OBSERVATION SITES:
- field station
- radiocarbon sample (associated with stratigraphic section)
- stratigraphic section (labelled with station ID, e.g. CA203202)

GLACIAL FEATURES:
- kettles

OTHER SURFACE FEATURES:
- landslide, unclassified


KLUANE
LAKE
CA203202
CA203201
Mmu
Mu
Mm
Mmu/FGr-E
FGr-E
FGr
FGr/Mmu-E
FGr/Mmu
FGr/Mmu-H
FGr/Mmu-Gr-H
FGr/Gr-H
FGr/Gr
FGr/Mmu-Gr
FGr/Mmu-Gr-E
FGr/Gr-E
FGr/Mmu-E
Mmu-E
Mu-E
Mm-E
Mu/FGr
Mu/Gr
Mu/Mmu
Mu/Mmu-E
Mu/Mmu-Gr
Mu/Mmu-Gr-E
Mu/Gr-E
Mu/Gr
Mu/Mmu-H
Mu/Mmu-Gr-H
Mu/Gr-H
Mu/Mmu-Xs
Mu/Gr-Xs
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Mu-Mmu-Xs
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Mu-Xs