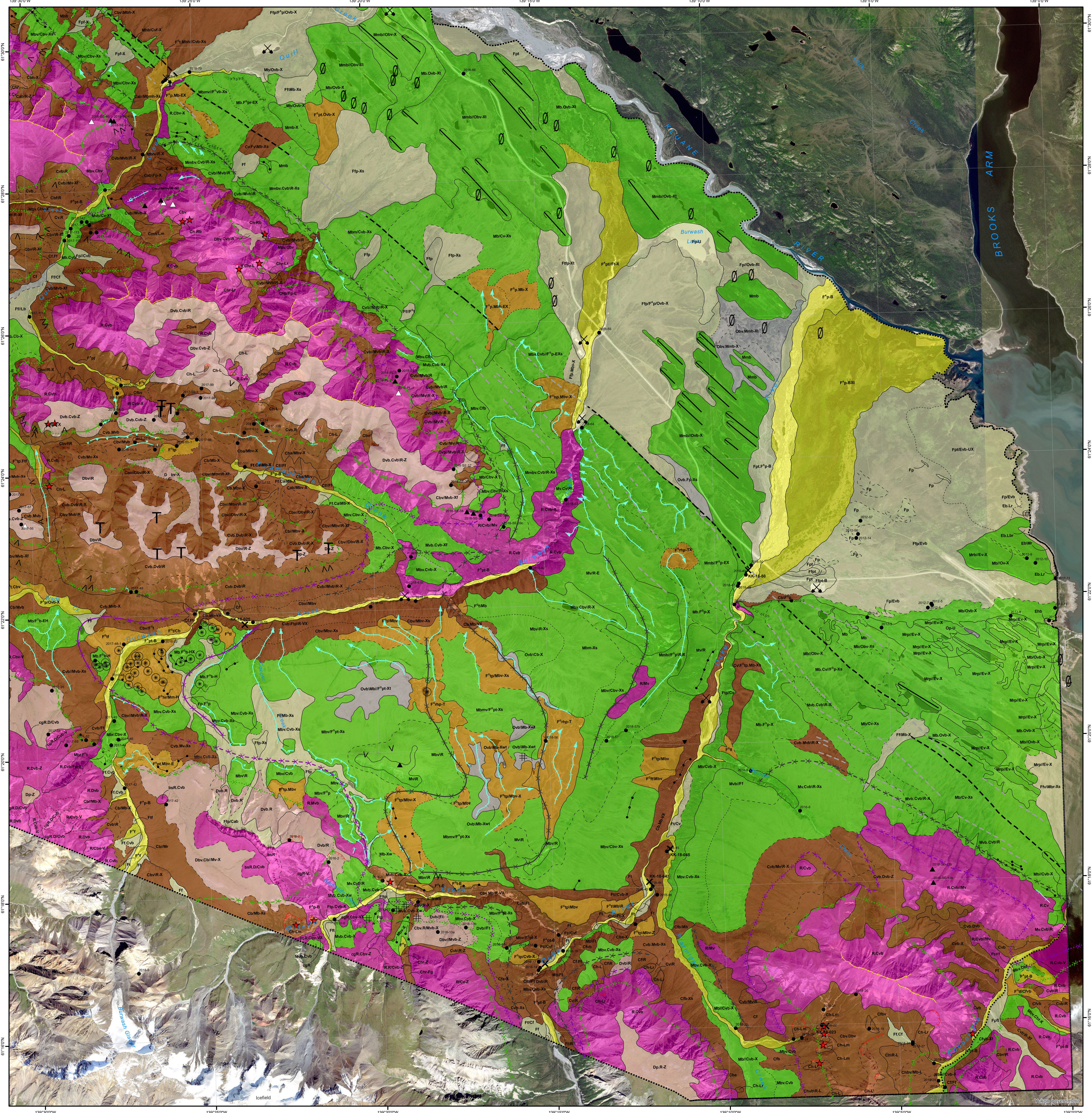
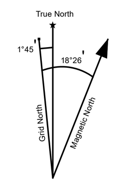


SURFICIAL GEOLOGY

DUKE RIVER, YUKON

PARTS OF NTS 115G/6

SCALE 1:50 000

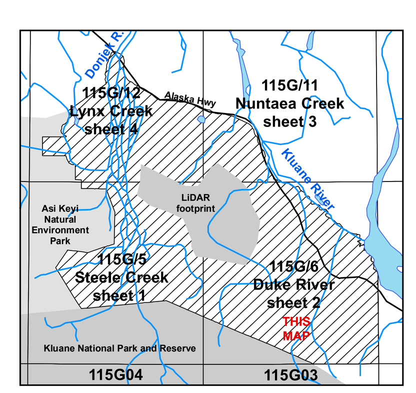


Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION APRIL 2020
FOR CENTRE OF MAP

0 0.5 1 2
kilometres

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

ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 7
CONTOUR INTERVAL 25 FEET
Elevations in feet above Mean Sea Level



LEGEND

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. 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 ("-").

TERRAIN CLASSIFICATION SYSTEM

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) *not displayed on this map

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

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

METHODS

Surficial geological field mapping was completed for the study area at a scale of 1:50 000 from 2016-2018. Remote predictive mapping was completed using 1:50 000-scale digital monochrome aerial photographs flown between 1987 and 1989 with PurView/ArcGIS softcopy viewing software. Lidar data provided by Nickel Creek Platinum for part of the map area was used, where available, to generate a one-metre hillshade for detailed mapping. 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, and 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 exist in that unit.

HOLOCENE

A — **Anthropogenic (A)**: Surficial materials modified by human activities such that their original physical properties have been significantly altered. Applied to areas within the map containing significant quantities of quarried rock on the surface (*i.e.*, sewage lagoon, building pads, mine tailings).

O — **Organic (O)**: Material derived from decomposition of organic matter consisting of peat with fibric to mesic decomposition. Organic materials in the map area are commonly found in low-lying areas where wet ground conditions have facilitated a thick accumulation of vegetative matter. In the map area, organic deposits form blankets (greater than 1 m thick) and veneers (less than 1 m thick) over inorganic materials that commonly have poor drainage capacity due to a high percentage of silt and clay. In particular, the troughs found in ridged and rolling moraine deposits in the map area are prone to the accumulation of organic material because of the combination of poor drainage and impermeable surface materials. Ice-rich permafrost conditions are common in these deposits.

L — **Lacustrine (L)**: Modern lacustrine sediments in the map area consist of sediments that have accumulated at the margins of lakes through the action of waves. Lacustrine materials in the map area are limited to deposits along the margin of Kluane Lake. Lakeshore lacustrine deposits are commonly affected by eolian processes and can be interbedded with eolian sand and silt deposits. Lacustrine beach deposits are rarely affected by permafrost.

V — **Volcanic (V)**: Volcanic sediments consisting primarily of ash (less than 2 mm diameter) produced by repeated eruptions of Mt. Bona-Churchill (known locally as the White River Ash). Primary ash fall deposits can display fining-up stratification from coarse pumice-sand to fine silt, but are often reworked into massive or laminated deposits and interbedded with organic, eolian and colluvial materials. Coarse ash deposits have a characteristic "salt and pepper" colour and texture, while finer deposits are white to grey in colour. Thin (less than 2 cm) ash deposits are present over much of the map area and are not indicated in material labels. Rare thick deposits (30 cm to 2 m) of ash created by eolian or colluvial processes may be identified in material labels.

E — **Eolian - Inactive (E)**: Sediment transported and deposited by wind. Much of the map area is covered with a veneer of wind-deposited silt and fine sand that may not be indicated in material labels. Thick eolian deposits are preserved on the northwest banks of the Donjek River, in some narrow tributary valleys to the Donjek River, and along the northwest shore of Kluane Lake. Inactive, silt-rich eolian deposits are commonly affected by permafrost and may be ice-rich.

E^A — **Eolian - Active (E^A)**: Active eolian deposition is ongoing in the study area and driven by strong northwest and southeast winds entraining silt and sand particles from escarpments of unconsolidated materials, exposed fluvial braidplains, and shorelines exposed by lowering water levels on Kluane Lake. Limited active eolian deposition is also associated with the reactivation of older dune deposits.

F — **Fluvial – Inactive (F)**: Sediments transported and deposited by modern streams and rivers, found in floodplains, fans and terraces. Fluvial sediments in the map area are predominantly those comprising high-energy braided floodplains and fans of streams draining the Kluane and Icefield Ranges. Fluvial deposits typically consist of well-sorted stratified sand and gravel comprising subangular to rounded clasts. Fine-grained lenses and beds in fluvial deposits may contain ice, although it may be discontinuous over relatively small areas. Fluvial fans, fan-shaped landforms or complexes of fluvial and colluvial fan-shape landforms consist of silt, sand and gravel derived from colluvial material. Inactive floodplain and terrace deposits may be subject to flooding accompanied by sudden stream migration and inundation.

F^A — **Fluvial - Active (F^A)**: Active fluvial sediments in the map area are predominantly those associated with floodplains and channels of streams draining the Kluane Ranges and the drainages of the Duke and Donjek rivers. Active fluvial channels migrate widely over alluvial fans in the southern part of the map area, reactivating previously abandoned channels and incising new channels. Permafrost is uncommon in active fluvial deposits.

HOLOCENE AND PLEISTOCENE

C — **Colluvium (C)**: Material transported and deposited by down-slope, gravity-driven processes such as creep, solifluction, landslides and snow avalanches. It commonly has a stratified structure with a highly variable texture and composition controlled by the parent material, transport mechanism and travel distance. In the high mountains of the Kluane Range, colluvial deposits are composed primarily of bedrock derivatives, with increasing contributions from glaciogenic materials toward valley bottoms. Metasedimentary and metavolcanic rocks in the map area are represented by grey to green silty matrix colluvial diamict deposits with angular fragments of rock ranging in size from pebble to boulder. These deposits range from thin veneers (less than 1 m) on slope flanks, to thick rolling blankets of 2–5 m in valley bottoms, and along slope toes. Colluvial aprons found along the base of slopes and stream-cut escarpments commonly contain ice-rich permafrost and are primarily composed of 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 (indicated by –Xf process modifier). 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).
sgC: Colluvial deposits generated from the Amphitheatre Formation pebble-cobble conglomerate in the southwestern part of the map area resemble fluvial or glaciofluvial materials, however, these are usually very close to source rocks on the gentle slopes of subdued Amphitheatre Formation erosional surfaces. Amphitheatre Formation colluvial deposits are recognizable by a high proportion of fractured quartz pebbles and cobbles. Colluvial derivatives of Amphitheatre Formation rocks have increased silt compared to the original bedrock source, and may incorporate other bedrock units and Quaternary materials.

PLEISTOCENE AND OLDER

F^G — **Glaciofluvial (FG)**: Glaciofluvial deposits include materials that have been deposited by glacial meltwater either directly in front of, or in contact with, glacier ice. Glaciofluvial materials are abundant in the Arch Creek valley, the Maple and Wade creek valley, and upper Burwash Creek. They typically form kettled and hummocky plain surfaces, but are also present as ridged and undulating landforms when deposited along a glacier margin, and smooth plains when deposited in deltas and terraces. Glaciofluvial deposits may be affected by permafrost but in most cases are ice-poor.

L^G — **Glaciolacustrine (LG)**: Material deposited in a lake that formed on, in, under, or beside a glacier. Glaciolacustrine sediments generally consist of fine-grained, laminated sand, silt and clay. Glaciolacustrine materials in the map area are most extensive in the low divide occupied by Maple Creek, between Quill and Wade creeks, where they underlie glaciofluvial and morainal deposits. Ice-rich permafrost and thermokarst erosion is widespread in these deposits as their poor drainage and high moisture content can result in massive ice lenses.

M — **Moraine (M)**: Moraine deposits include materials that have been deposited directly by a glacier or ice sheet without modification by any other agent of transportation. Moraine deposits are typically highly variable and depend upon both 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 lacking stratification and containing a heterogeneous mixture of particle sizes, usually in a matrix of sand, silt and clay. Sources of moraine in the map area include small alpine cirque glaciers, first order valley glaciers (*i.e.*, Burwash Glacier), and high-order valley glaciers such as the Donjek Glacier, and the ice stream that occupied the Shakwak Trench during repeated glaciations. Larger glaciers carrying material further from source typically produce finer grained moraine matrix with more lithological and geochemical variability. Moraine deposits are commonly affected by permafrost and some moraine deposits may be ice-rich.

NEOGENE AND OLDER

D — **Weathered Bedrock (D)**: *In situ* weathered and decomposed bedrock is found on low-angle unglaciated upland surfaces in the map area and is commonly associated with cryoplantion terraces. Metasedimentary and metavolcanic units in the map area produce silt in a matrix of angular rock fragments created through frost shattering, colluviation, and chemical weathering processes. Weathered bedrock typically contains a component of loess-derived silt and is subject to sorting and mixing from cryoturbation and other periglacial processes. Permafrost is present in both bedrock and weathered bedrock in the map area.
sgD: Weathered bedrock derived from the weakly-lithified Amphitheatre Formation conglomerate is common in the southern parts of the map area, particularly above glacial limits where thick (greater than 1 m) blankets of weathered bedrock overlie intact bedrock. These deposits comprise a sandy-matrix quartz-rich cobble gravel.

R — **Bedrock (R)**: 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 and Van Zeyl, 2005; Israel *et al.*, 2006).
bsR: Wrangell Lava: rusty red, brown, phyric and non-phyric basalt and andesite flows, interbedded with felsic tuff, volcanic sandstone and conglomerate.
cgR: Amphitheatre Formation yellow-buff to grey-buff sandstone, pebbly sandstone, polymictic conglomerate, siltstone and mudstone; minor brown-grey carbonaceous shale and coal.

SYMBOLS

GEOLOGICAL BOUNDARIES:
- defined
- approximate
- assumed
- map boundary

GEOLOGICAL FEATURES:
- arete or cirque
- landslide headwall scarp
- escarpment, undefined
- escarpment, kame
- esker, direction known
- esker, direction unknown
- fault, defined and approximate
- lineament
- meltwater channel, minor, direction known
- meltwater channel, minor, direction unknown
- meltwater channel, major
- moraine ridge
- filled channel or buried valley
- ravine or canyon, bedrock in part
- sand dunes
- strandlines
- streamlined landforms

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

TOPOGRAPHIC FEATURES:
- contours
- streams
- roads and trails

GROUND OBSERVATION SITES:
- field station
- stratigraphic section
- erratic, unspecified age
- no erratics found

GLACIAL FEATURES:
- pits or kettles
- streamlined landform, striation

PERMAFROST AND PERIGLACIAL FEATURES:
- observation of frozen ground
- thermokarst depression
- patterned ground
- cryoplanation terrace
- tor

OTHER SURFACE FEATURES:
- sand dunes, inactive
- landslide, direction of movement
- landslide, thaw detachment
- landslide, unclassified
- quarry or mine

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
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.*, 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: contains well-preserved fibre (40% or more) that can be identified as to botanical origin upon rubbing

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 are assumed to be active unless the qualifier "I" (inactive) 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 subparallel long, narrow ravines.
HYDROLOGIC 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.
U – inundation: terrain seasonally under standing water which results from high watertable.
MASS MOVEMENT PROCESSES
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: (g) rock creep – slow movement of angular debris under periglacial conditions (e.g., rock glaciers).
R – rapid mass movement: rapid downslope movement by falling, rolling, sliding or flowing of dry, moist or saturated debris derived from surficial materials and/or bedrock.
Subclasses: (b) rockfall – decent of masses of bedrock by falling, bouncing and rolling.
L – undifferentiated landslide: rapid or slow downslope movement of masses of cohesive or non-cohesive surficial materials and/or bedrock.
Subclasses: (r) rockslide - descent of large masses of disintegrating bedrock by sliding; (s) debris slide - sliding of disintegrating mass of surficial material; (m) slump - internally cohesive mass of bedrock sliding along a slip plane that is concave upward or planar.
PERIGLACIAL PROCESSES
X - permafrost: processes controlled by the presence of permafrost, and permafrost aggradation or degradation.
Subclasses: (f) thaw flow slides – slope failures caused by the thawing of permafrost; (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.
S – solifluction: slow gravitational downslope movement of saturated non-frozen overburden across a frozen or otherwise impermeable substrate.
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 metlwater 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.
T - ice contact: sediments deposited in contact with glacier ice.

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, and is 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 (greater than 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.
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 greater than 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 and landslide debris.
l - delta: landform created at the mouth of a river or stream where it flows into a body of water. Deltas have 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 greater than 1 m; in plan, an assemblage of parallel or sub-parallel 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 subparallel 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 to 1m in thick; commonly applied to eolian/loess veneers and colluvial veneers.

ACKNOWLEDGEMENTS

This map was completed within the Traditional Territories of the Kluane First Nation and the White River First Nation. Kluane First Nation is acknowledged for its ongoing support of YGS mapping efforts and for facilitating environmental research within its Traditional Territory and Settlement Land. Kluane First Nation members and government staff were generous with their knowledge of the map area, providing insight and information that was uniquely important. Pauly Sias, Kate Ballegooyen, Geordan Clarke, Luke Johnson and Mary Jane Johnson are thanked in particular for their generosity of time and willingness to share knowledge. This map also benefitted from a number of scientific field collaborations that greatly improved the final product. In particular, discussions with Jeff Bond, Brent Ward, Steve Israel, Derek Cronmiller, Panya Lipovsky, Rosie Cobbett and Sydney van Loon clarified and improved geological interpretations. Field assistance by Alex Brubacher and Amaya Cherian-Hall is appreciated.

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RECOMMENDED CITATION

Kennedy, K.E. and Ellis, S.E., 2020. Surficial geology, Duke River, Yukon. In: Surficial geology of the northern Kluane Ranges (parts of NTS 115G/5, 6, 11, 12). Yukon Geological Survey, Open File Map 2020-5, 4 sheets, scale 1:50 000.

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. E-mail: geology@gov.yk.ca.

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Open File 2020-5
Sheet 2 of 4

Surficial Geology, Duke River, Yukon
Parts of NTS 115G/6
1:50 000 scale

by

K.E. Kennedy and S.E. Ellis

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Yukon