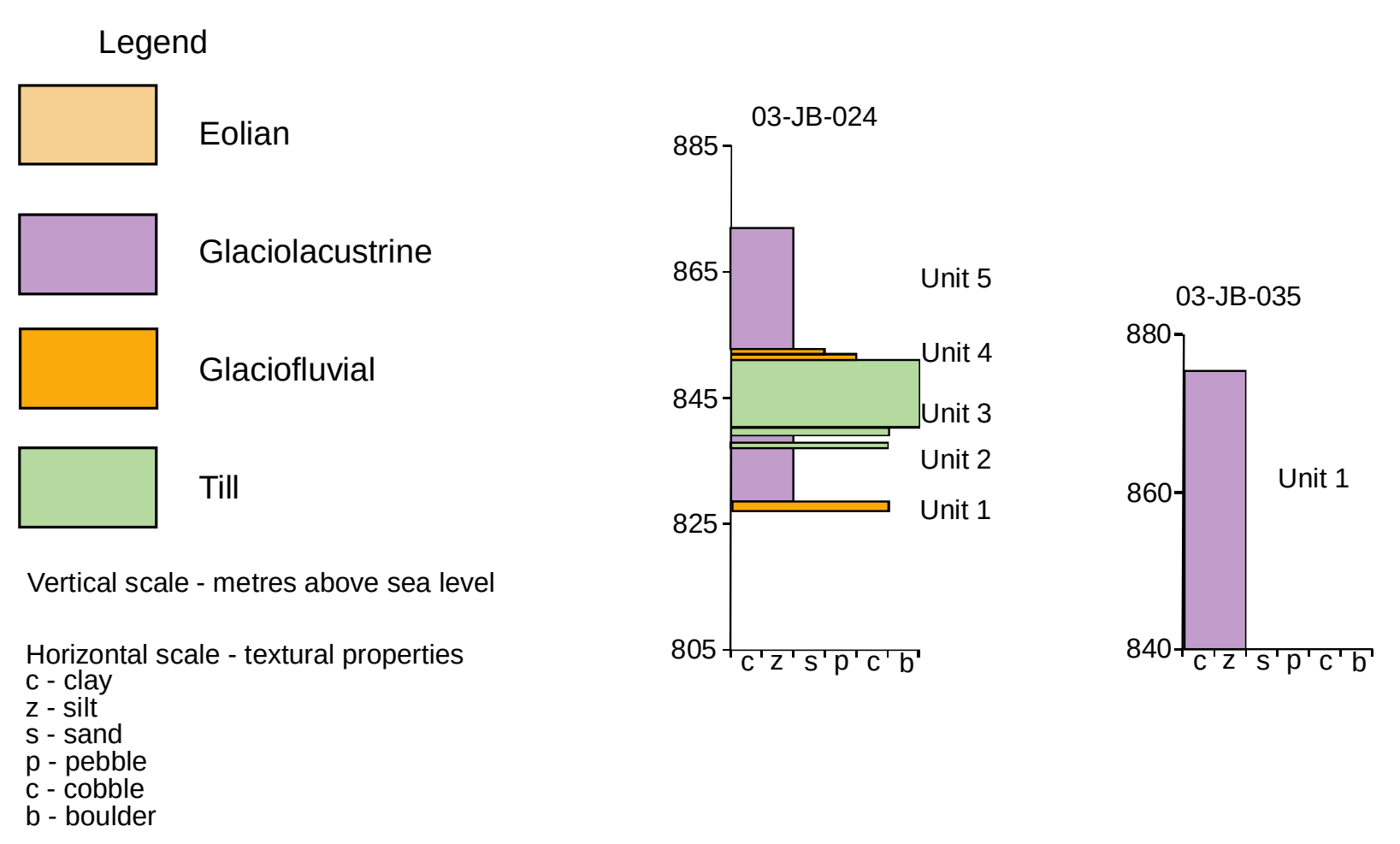
Figure 4. A view to the soutwest up the Wheaton River valley. This photo was taken at an elevation immediately above the highest glacial lake shoreline in the valley (300 m above the valley floor). Glacial lake Wheaton was the deepest glacial lake to form in the vicinity of Whitehorse.

Figure 5. An aerial view to the south over the Wheaton River near Annie Lake (see map 5). The sediment deposit on the south side of the river consists of glacial lake sediment, glaciofluvial gravel and till that was deposited at the margin of the glacier as it retreated out of the Coast Mountains towards Bennett Lake (see map 2) A glacial lake filled the Wheaton River upstream from this location as a result of this ice and sediment dam.

Stratigraphic Sections



Vertical scale - metres above sea level

Horizontal scale - textural properties
c - clay
z - silt
s - sand
p - pebble
c - cobble
b - boulder

Descriptive Notes

Physiography and Drainage
This map area is part of the Boundary Ranges of the Coast Mountain physiographic region. The topography is characterized by increasingly rugged terrain to the south. Deeply-incised narrow valleys cut into the plateau surface. The highest summits in the map area include peaks west of Alligator Lake and south of the Watson River.

The main drainages in the map area include the eastward flowing Watson and Wheaton rivers. Tributaries to the Watson River include Two Horse, Friday and Thompson creeks. Lakes in the map area include Coal, Alligator and Hodnett.

The McConnell Glaciation in the Whitehorse area
During the Late Wisconsinan McConnell Glaciation (~20 000 years ago), the Whitehorse map area (NTS 105D) was glaciated by ice lobes originating in the Coast Mountains and the Cassiar Mountains of southern Yukon. Initial ice accumulations in the map area probably began in the higher regions of the Coast Mountains. It was likely not until localized ice caps had formed that the more distal Cassiar Lobe advanced into the map area from the southeast through Marsh Lake valley (see map 6). The convergence of the two lobes at glacial maximum occurred over the Coast Mountains west of the city of Whitehorse. At the height of the last glaciation, movement of ice over this area was to the northwest and was unobstructed by topography.

The pattern of deglaciation is highlighted by periods of differential retreat and fluctuating ice fronts. As in the adjacent map areas, the Cassiar Lobe re-advanced into this area from the east. This resurgence in the ice lobe and its subsequent retreat back to the east resulted in a significant amount of sediment deposition on the landscape. In particular, systems of pro-glacial lakes developed marginally to the ice front in the Alligator Lake, and the Watson River and Wheaton River valleys as it retreated. Glacial lake shorelines are evident 150 m (500 ft) above the valley bottom in the Watson River valley. In the Wheaton River valley, the glacial lake attained depths of 300 m (1000 ft).

Landforms
Coal Lake
An impressive collection of permafrost mounds (palsas) are visible at the south end of Coal Lake (Figure 1). These mounds develop in areas of discontinuous permafrost and typically form in wetland peaty deposits. They are dynamic landforms that come and go on a decadal scale.

Alligator Lake
The formation of Alligator Lake occurred during the retreat of the Cassiar lobe from the Coast Mountains following the Cassiar re-advance. An extensive standstill during the retreat phase deposited a large accumulation of sediment at the northeast end of Alligator Lake (Figure 2). Landforms of these deposits consist of rolling moraine and a large glaciofluvial delta (see “FGd-H” adjacent to Alligator Lake on map). Because the normal drainage in the Alligator Lake valley was blocked by the retreating ice the water level increased until it established a temporary outlet at the south end of the lake. This outlet channel cut a canyon into the bedrock before it merged with the Watson River valley. Like the Alligator Lake area the Watson River valley was also dammed by the retreating ice. As a result, a large lake inundated the valley. The glacial lake water draining out of Alligator Lake, through the southern channel, flowed into Glacial Lake Watson. An impressive delta is preserved high on the valley side where the outlet channel entered the glacial lake.

Watson River valley
With the development of a glacial lake in the Watson River valley behind the eastward retreating ice front, large accumulations of lake bottom sediment were deposited on the valley floor (Figure 3). These deposits have since been eroded into by the Watson River leaving pronounced terraces lining the edges of the valley bottom. Also remnant from the glacial lake history in this valley are well preserved relict shorelines on the north side of the valley. The outlet for Glacial Lake Watson, which defined the former lake level, was westward over a 1100 m a.s.l (3600 ft) pass into the Rose Lake valley.

Wheaton River valley
Similar to the Watson River valley, the Wheaton River was also dammed and flooded by the retreating Cassiar ice lobe (Figure 4). The upper elevation of shorelines in this valley reaches 1200 m a.s.l. (3950 ft) according to well defined shorelines on the northwest slope of Tally-Ho Mountain. Only two outlets potentially existed that would drain a lake level of such elevation in the Wheaton River valley and both would have contained ice. One is subglacially through the Partridge Creek pass (see map 3) and the second was subglacially under the ice dam near present day Annie Lake (see map 5). With water pressures being higher in the Wheaton River valley proper, versus the much more elevated Partridge Creek pass, it is more likely drainage occurred under the ice dam in the Wheaton River and flowed northward into Glacial Lake Watson. A well defined outlet channel is cut at 1280 m a.s.l. (4200 ft) on the Summit Creek pass/Thompson Creek headwaters which likely defined an older glacial lake level when the Cassiar lobe extended further up the Wheaton River valley. Glacial Lake Wheaton was the deepest of the glacial lakes to form against the retreating Cassiar lobe from the Coast Mountains near Whitehorse. Depths of at least 300 m (1000 ft) would have existed in the portions of this valley west of Annie Lake (497000m E, 6682000m N). Later, during the Chadburn stage of the glacial recession a well defined end moraine was deposited across the Wheaton River valley near Annie Lake. The Wheaton River has since eroded through the moraine leaving a remnant portion of it on the valley side (Figure 5).

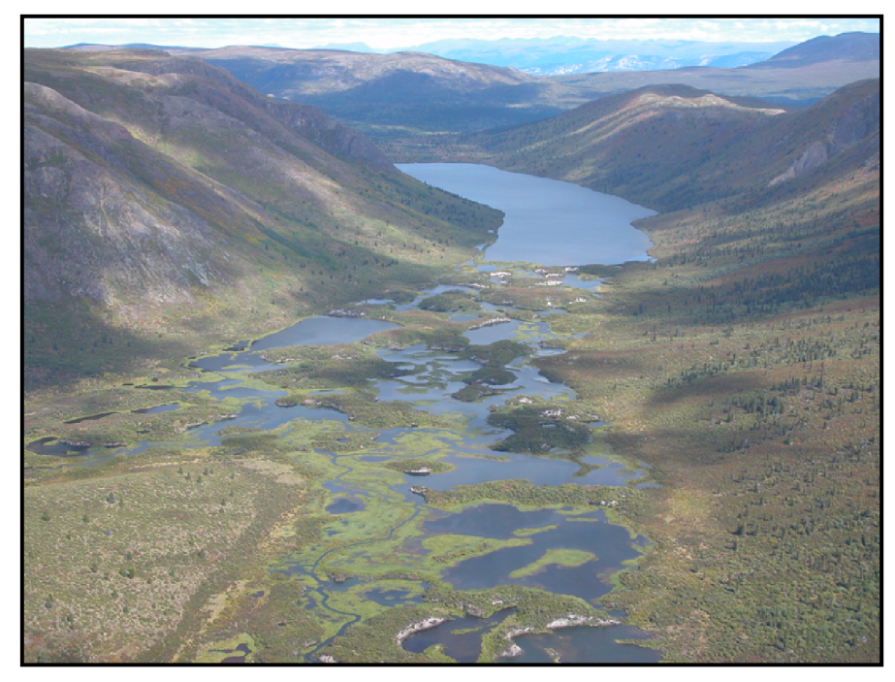
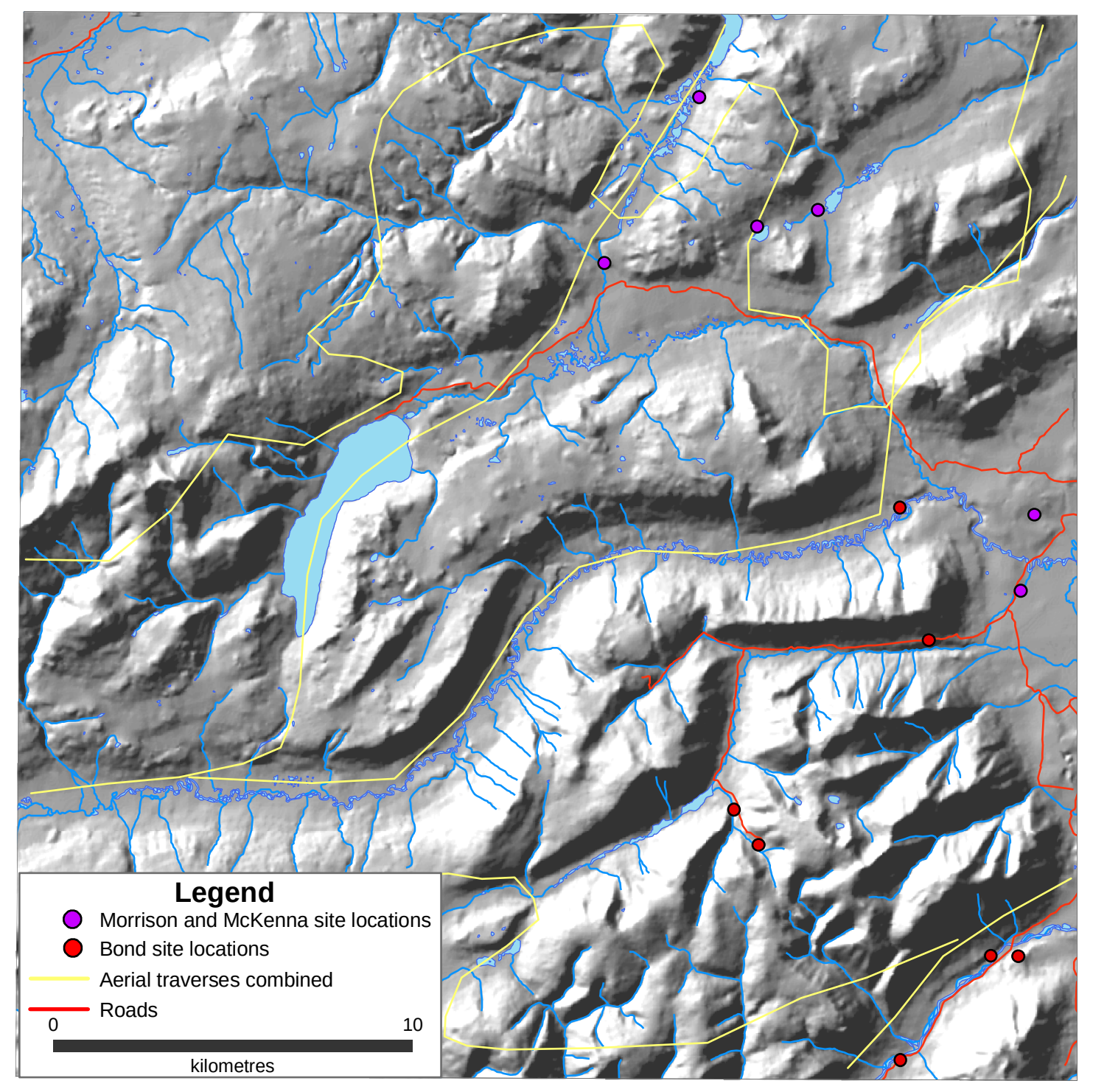


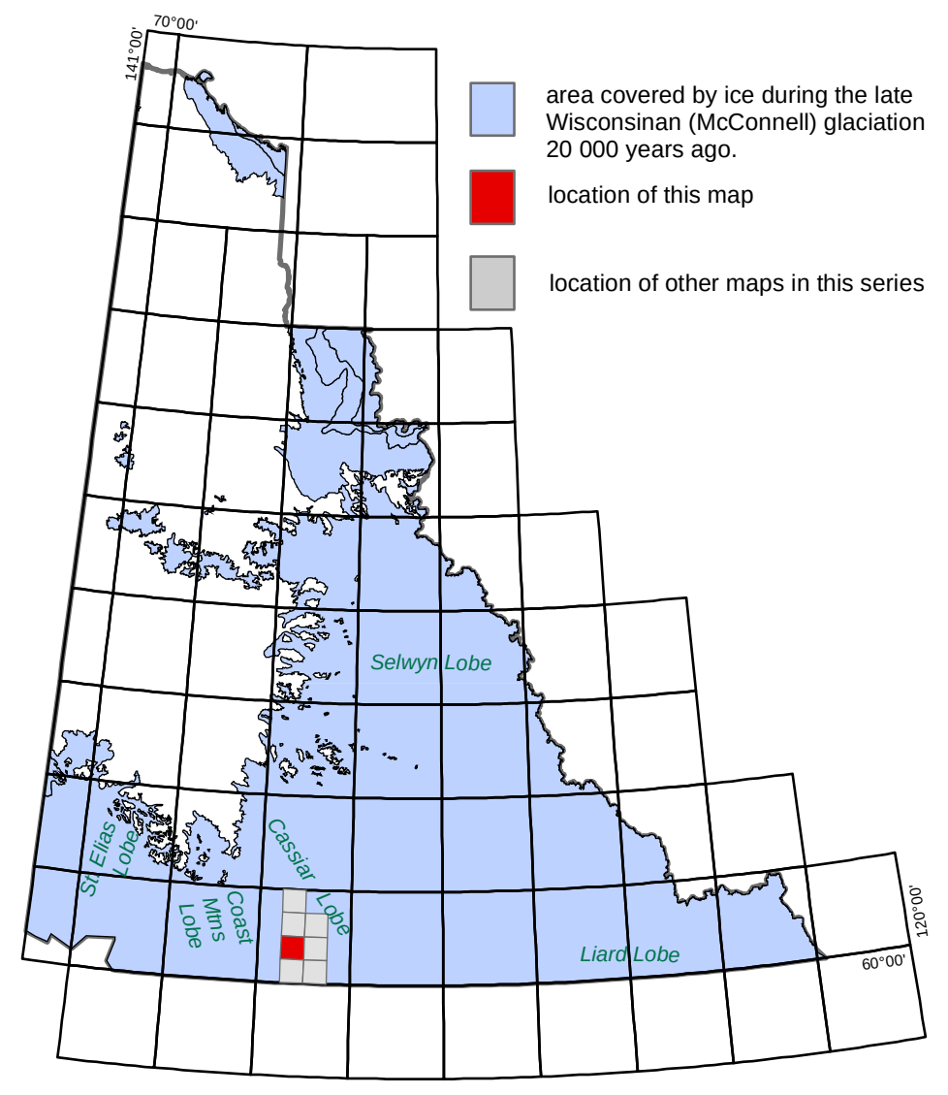
Figure 1. An aerial view to the northeast over Coal Lake. The patchwork of lakes in the foreground are interspersed with palsa mounds. An indication of permafrost at depth.

Figure 2. An aerial view to the northeast of the Glacial Lake Alligator delta This elevated delta was deposited at the terminus of a glacier that extended up Two Horse Creek. The ice front paused in this location for a prolonged period of time. Because the drainage in this valley was blocked by the ice the lake level increased and was forced to find an outlet to the south into the Watson River valley. A former shoreline of Glacial Lake Alligator is visible on the edge of the delta (see arrow).

Figure 3. An aerial view to the east down the Watson River valley. This photo is taken where water from Glacial Lake Alligator spilled into the Watson River valley. A perched glaciofluvial delta (see FGd on map) is visible on the left (see arrow) as well as the meltwater channel that was feeding the delta from Alligator Lake. Benches of glacial lake sediment are also visible in the bottom of the Watson River valley. The Watson River valley has eroded the glacial lake sediment from the middle of the valley.

Aerial Traverses and Site Locations





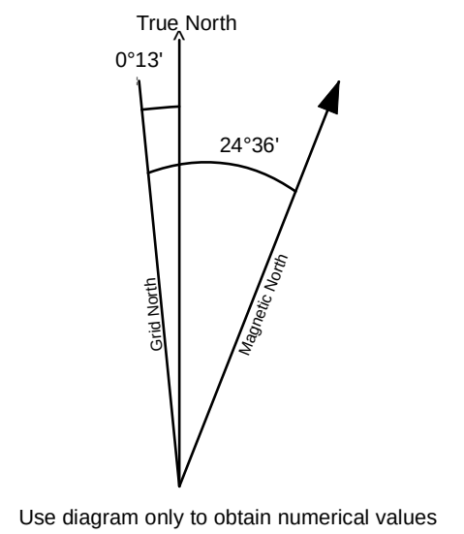
SURFICIAL GEOLOGY
ALLIGATOR LAKE
NTS 105D/6
YUKON

SCALE 1:50 000

CONTOUR INTERVAL 100 FEET
Elevation in feet above Mean Sea Level
North American Datum 1927
Universal Transverse Mercator

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

ONE THOUSAND METRE
Universal Transverse Mercator Grid
Zone 8

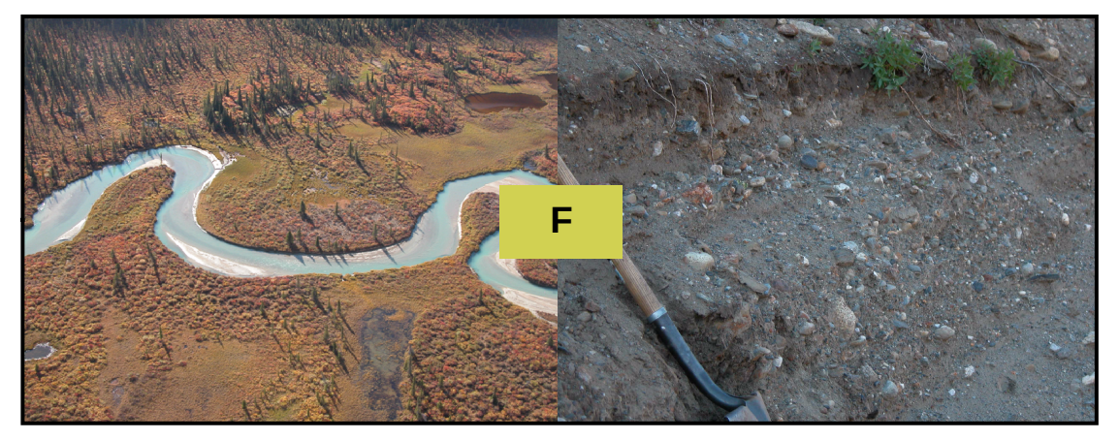


Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 2005
FOR CENTRE OF MAP
Annual change decreasing 11.5'

Legend

QUATERNARY

HOLOCENE



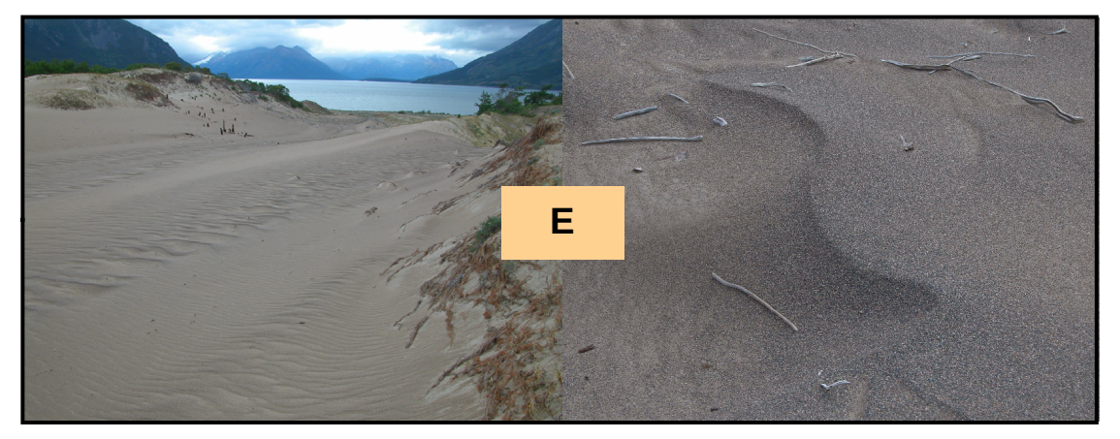
Fluvial Deposits: Sediment transported and deposited by streams and rivers; synonymous with alluvial. General Description: deposits consist of gravel and/or sand and/or silt (and rarely clay). Gravel is typically rounded and contains interstitial sand. Fluvial sediment is commonly moderately to well-sorted and displays stratification, although massive, nonsorted fluvial deposits do occur. Fluvial deposits in the large valley bottoms typically have a sandy texture because of the abundance of reworked glaciolacustrine sediment. Includes floodplains, fluvial terraces and fans, and deltas.

The landform photograph shows the upper Wheaton River floodplain and fluvial sediment. The active components of the floodplain have minimal vegetative cover, whereas older, less active sections of the floodplain are well vegetated.

Organic Deposits: Materials resulting from vegetative growth, decay and accumlation in and around closed basins or on gentle slopes, where the rate of accumulation exceeds that of decay. Two types of organic material are recognized. The first are commonly saturated with water and consist mainly of the accumulated remains of mosses, sedges or other hydrophytic vegetation. The second are rarely saturated with water and consist typically of leaf litter, twigs, branches and mosses (folisols).

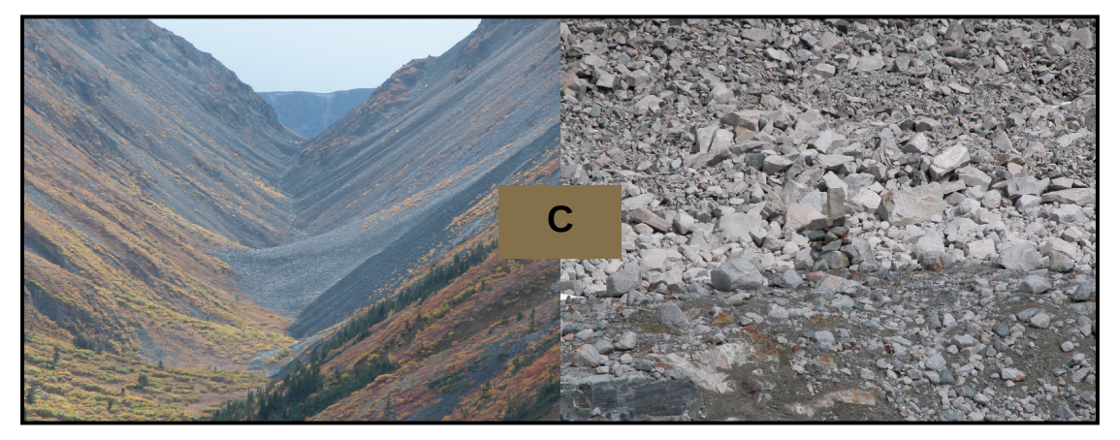
The landform photograph shows an inactive channel of the Yukon River near the mouth of Cowley Creek. Organic deposits have accumulated in the poorly drained abandoned river channel.

PLEISTOCENE AND HOLOCENE (UNDIVIDED)



Eolian Deposits: Sediment transported and deposited by wind action. General Description: consists of medium to fine sand and coarse silt that is well-sorted, noncompacted and may contain internal structures such as crossbedding or ripple laminae, or may be massive. Individual grains may be rounded and exhibit frosting. Eolian landforms may be active (Carcross dunes) or vegetated and inactive (Whitehorse dune field).

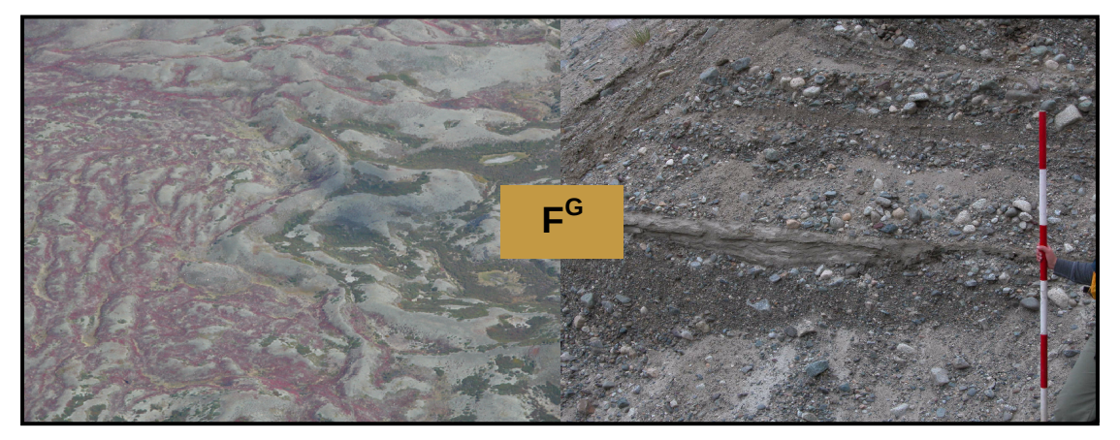
The landform photograph shows active dunes along the shoreline of Bennett Lake near the town of Carcross. Most eolian deposits in the map area are inactive. The Whitehorse dune field was last active between 9000 and 10 000 years ago.



Colluvial Deposits: Sediments that have reached their present position as a result of direct, gravity induced movement involving no agent of transportation such as water or ice, although the moving material may have contained water and/or ice. General Description: consists of massive to moderately well stratified, nonsorted to poorly sorted sediments with a range of particle sizes from clay to boulders and blocks. The character of any particular colluvial deposit depends upon the nature of the material from which it was derived and the specific process whereby it was deposited.

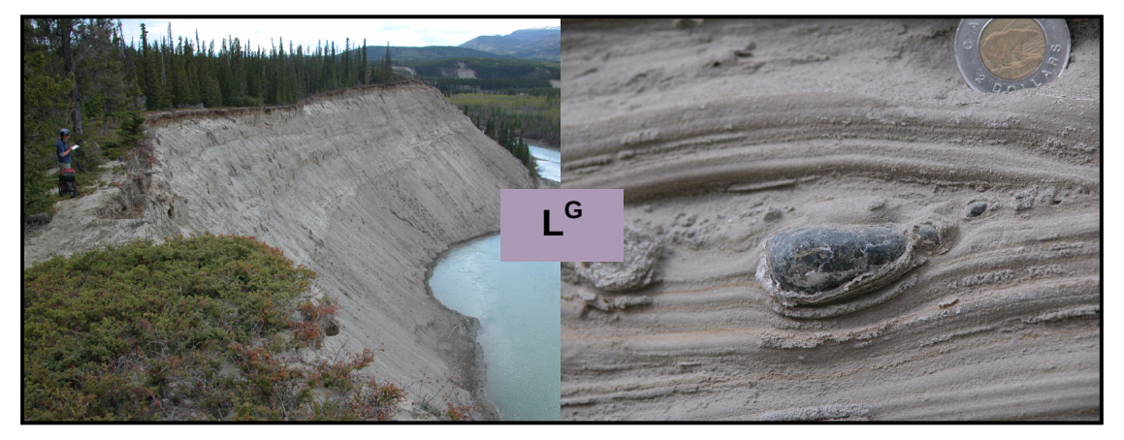
The landform photograph shows active colluviation into a meltwater channel east of Lake Laberge. The colluvial deposit depicted in the textural photograph originated from lateral moraine sediment of the Little Ice Age advance in the Wheaton River valley.

LATE PLEISTOCENE (WISCONSINAN) McCONNELL GLACIATION



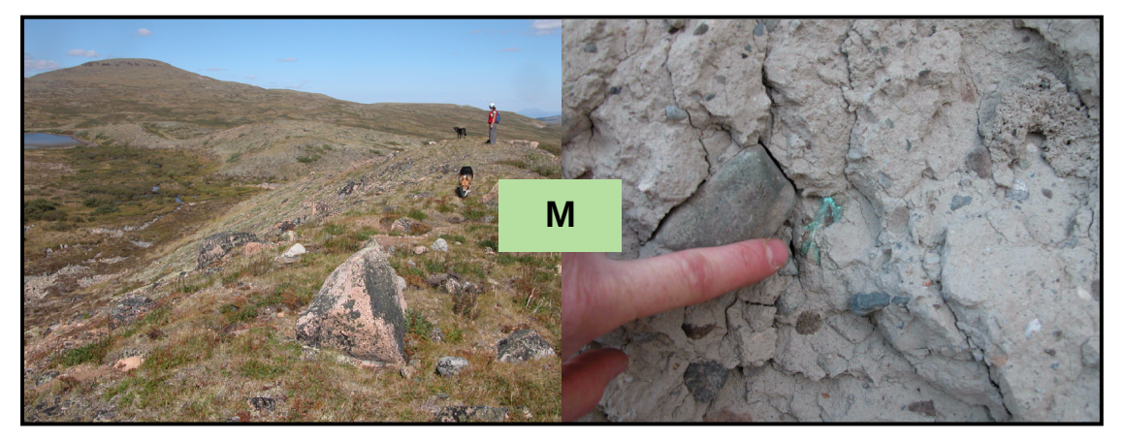
Glaciofluvial Deposits: Fluvial materials that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice. General Description: glaciofluvial sediment typically ranges from nonsorted and nonbedded gravel made up of a wide range of particle sizes, such as that resulting from very rapid aggradation at an ice front, to moderately to well-sorted, stratified gravel; flow tills may occur in some deposits. Slump structures and/or equivalent topographic expression, such as hummocky, kettled or irregular terrain may be present. These features are indicative of collapse of the material due to melting of supporting ice. Includes pitted outwash plains, kames and eskers.

The landform photograph shows an esker located southwest of Whitehorse near Fish Lake. Eskers are sinuous glaciofluvial ridges deposited by streams that were once flowing under a former glacier.



Glaciolacustrine Deposits: Lacustrine sediment deposited in or along the margins of glacially fed lakes; includes sediments that were released by the melting of floating ice. General Description: glaciolacustrine sediments include: 1) lake bed sediments consisting of stratified fine sand, silt and/or clay; they commonly contain ice-rafted stones and lenses of till and/or glaciofluvial material; slump structures and/or their topographic expression, such as hummocky, kettled or irregular terrain, may be present and are remnant of collapse of the material due to melting of supporting ice, and 2) moderately sorted to well sorted, stratified sand and coarser beach sediments transported and deposited by wave action along the margins of glacial lakes.

The landform photograph depicts glaciolacustrine sediment along the Takhini River valley. The pebble in photograph 2 was ice-rafted out into the former lake and subsequentely dropped onto the lake bed when the ice-raft melted.



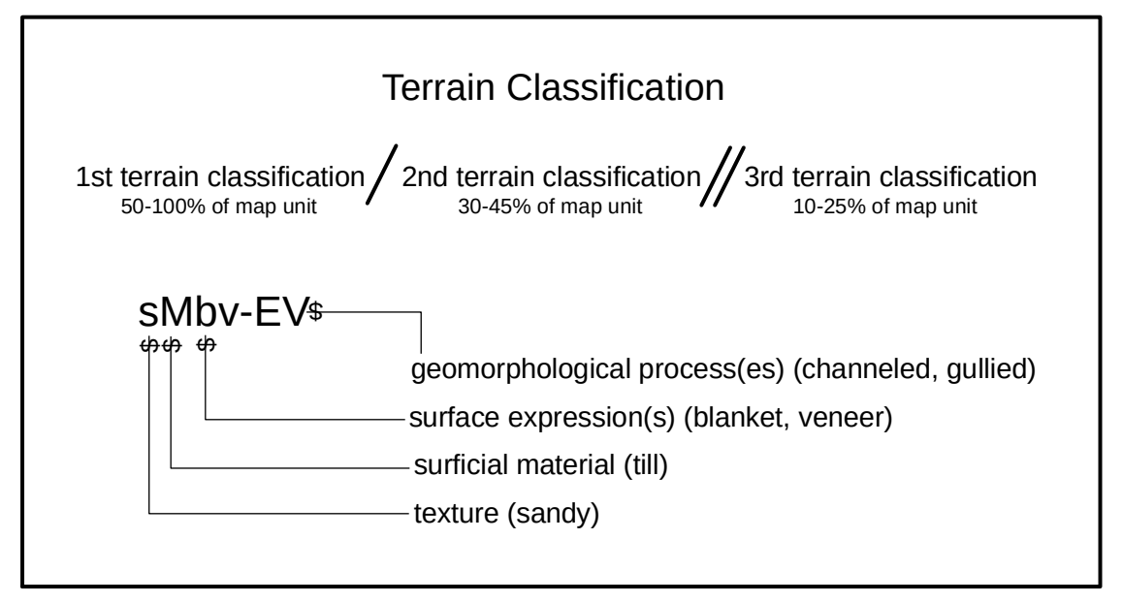
Glacial Deposits (Till): Sediment deposited directly by glacier ice without modification by any other agent of transportation. General Description: till can be transported beneath, beside, on, within and in front of a glacier. The mineraological, textural, structural and topographic characteristics of till deposits are highly variable and depend upon both the source of material incorporated by the glacier and the mode of deposition. In general, till consists of well compacted to noncompacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, commonly in a matrix of sand, silt and clay.

The landform photograph shows a lateral moraine that is composed of coarse, blocky till in the Wolf Creek drainage. The textural photograph displays an exposure of compact lodgement till on the copper haul road in the city of Whitehorse. A malachite-rich pebble is visible near the centre of the photograph.

PRE-QUATERNARY (UNDIVIDED)

Bedrock: Bedrock outcrops and rock covered by a thin mantle of unconsolidated or organic materials. Rocks in the Whitehorse area are part of a Mesozoic sedimentary basin known as the Whitehorse Trough (Wheeler, 1961; Lowey, 2005). These rocks largely consist of volcanic, volcaniclastic, clastic and carbonate rocks of the Lewes River Group (Upper Triassic); volcaniclastic, clastic and coal of the Laberge Group (Lower-Middle Jurassic); and clastics and coal of the Tantalus Formation (Upper-Lower Cretaceous; Wheeler, 1961; Lowey, 2005). Large areas of the sedimentary sequence were subsequently intruded by granitic rocks during the Cretaceous. Tertiary basalt flows occur within the city of Whitehorse, north of Alligator Lake and in the Wheaton River valley. Photograph on the far left shows a glacially sculpted outcrop of Lewes River Group limestone. The photograph on the adjacent left shows striated granite recently deglaciated near the headwaters of the Wheaton River.

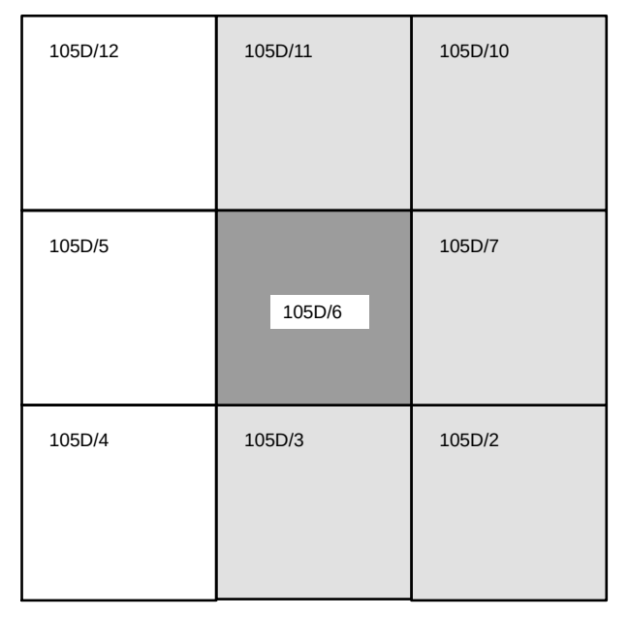
Terrain Classification



1st terrain classification / 2nd terrain classification // 3rd terrain classification
50-100% of map unit / 30-45% of map unit // 10-25% of map unit

sMbv-EV

- geomorphological process(es) (channeled, gullied)
- surface expression(s) (blanket, veneer)
- surficial material (till)
- texture (sandy)



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.

Label	Name	Description
a	apron	Material that has been transported down a slope and deposited in accumulations at the base of the slope.
b	blanket	A layer of unconsolidated material thick enough to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography. A blanket is greater than 1 m thick and possesses no constructional forms typical of the material’s genesis; outcrops of the underlying unit are rare.
d	delta	Flat to gently sloping surface deposited at the mouth of a river in a body of water. Channel scars on the delta surface are commonly visible.
f	fan(s)	A fan is a relatively smooth sector of a cone with a slope gradient from apex to toe up to and including 15° (26%), and a longtitudinal profile that is either straight, or slightly concave or convex. Commonly applies to fluvial fans.
h	hummocky	Steep-sided hillock(s) and hollow(s) with multidirectional slopes dominantly between 15 and 35° (26 to 70%) if composed of unconsolidated materials; bedrock slopes may be steeper. Local relief is 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.
m	rolling	Elongate hillock(s) with slopes dominantly between 3 and 15° (5 to 26%) with local relief greater than 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 gradients 0 to 3° (0 to 5%); local surface irregularities generally have a relief of less than 1 m. Applied to (glacio)fluvial floodplains, organic deposits, lacustrine deposits and till plains.
r	ridge(s)	Elongate hillock(s) with slopes dominantly between 15 and 35° (26 to 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.
s	steep slope	A unidirectional (planar) surface with gradients greater than 35° (70%), and a smooth longitudinal profile that is either straight, or slightly concave or convex; local surface irregularities generally have a relief of less than 1 m; bedrock slopes may be more irregular. Commonly applied to terrace scarps, gully side walls and bedrock cliffs.
t	terrace(s)	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 (tread) 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. It is between about 10 cm and 1m in thickness, and possesses no constructional form typical of the material genesis. Commonly applied to eolian loess and colluvial veneers.
x	complex	A combination of several surface expressions.

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. 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 (-).

Group	Process	Label	Description
Erosional Processes	deflation	D	The removal of sand and silt sized particles from unconsolidated materials by wind.
	thermokarst	K	Characterized by subsidence and caving due to melting or ground ice in permafrost areas.
	gully erosion	V	Running water, mass movement and/or snow avalanching, resulting in the formation of parallel and subparallel long, narrow ravines.
	washing	W	Wave action or, locally, running water (e.g., meltwater), resulting in lag deposits formed by the removal of fines from a mixture of coarse and fine particles.
	bevelled	B	Cut or planed by running water but not underlain by fluvial deposits.
Mass Movement Processes	snow avalanches	A	Rapid downslope movement of snow and ice, as well as incorporated rock, surficial material and vegetation debris, by flowing or sliding.
	failing	F	Downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by creeping, flowing or sliding.
Periglacial Processes	cryoturbation	C	Movement of surficial materials by heaving and/or churning due to frost action (repeated freezing and thawing).
	nivation	N	Erosion of bedrock or surficial materials beneath and along the margin of snow patches by freeze/thaw processes (frost shattering and heave), meltwater action and snow creep.
	solifluction	S	Slow gravitational downslope movement of saturated non-frozen overburden across a frozen or otherwise impermeable substrate.
	permafrost processes	X	Processes controlled by the presence of permafrost, and permafrost aggradation or degradation. Applied to areas with ice-wedge polygons, thermokarst features, palsas and pingos.
Deglacial Processes	channeled by meltwater	E	Erosion and channel formation by meltwater alongside, beneath, or in front of a glacier.
	kettled	H	Depressions in surficial materials resulting from the melting of buried glacier ice.

TEXTURE

Describes the dominant size of particles in mineral sediments and the fiber content of organic materials. Texure is indicated by up to three lower case letters.

Label	Name	Description
a	blocky	Angular particles greater than 256 mm in size.
r	rubbly	Angular particles with a size range of 2-256 mm, but may include interstial sand.
g	gravelly	Two or more size ranges of rounded particles greater than 2 mm, but may include interstial sand.
f	fine	A mixture of silt and clay; may also contain a minor fraction of fine sand.
b	bouldery	Rounded particles greater than 256 mm in size.
k	cobbly	Rounded particles having a diameter of 64-256 mm.
p	pebbly	Rounded particles having a diameter of 2-64 mm.
s	sandy	Particles of which the fine fraction contains more than 70% by weight of fine sand or coarse particles. Particles great than 2 mm occupy less than 35% by volume.
z	silty	Particles of which the fine earth fraction contains less than 15% of fine sand or coarse particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.
c	clayey	Particles where the fine earth fraction contains 35% or more clay (less than 0.002 mm) by weight and particles greater than 2 mm occupy less than 35% by volume.
f	fibric	The least decomposed of all organic materials; there is alarge amount of well preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.
m	mesic	Organic material in an intermediate stage of decomposition; there is an intermediate amount of fiber that can be identifiable as to botanical origin.
h	humic	Highly decomposed organic material; there is a small amount of fiber that can be identified as to botanical origin. Fibers that are present can be easily destroyed by rubbing.
w	woody	Organic material containing more than 50% of woody fibers.

SYMBOLS

- glacially aligned landform; includes: drumlins, crag and tails, roches moutonees, flutings, grooves and striae. These landforms indicate past ice flow direction.
- esker; known direction
- esker; unknown direction
- moraine ridge
- glacial meltwater channel - minor
- glacial meltwater channel - major
- glacial lake strand lines
- cirque
- escarpment
- escarpment - failing
- landslide
- recessional glacial limit
- ● Bond site locations
- roads

GEOLOGICAL BOUNDARIES

- defined
- approximate
- assumed

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Original mapping and drafting completed by S. Morison, K. McKenna and S. Davies (1982). Subsequent mapping and compilation completed by J.D. Bond (2003-2004).

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

Geoscience Map 2005-4
Surficial Geology of Alligator Lake (NTS 105D/6), Yukon (1:50 000 scale)

by
J.D. Bond, S.R. Morison and K. McKenna