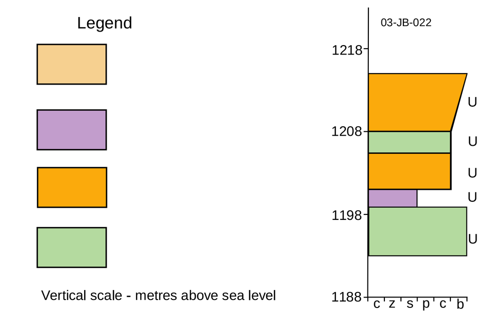
Figure 4. A scoured granitic bedrock surface on the west side of the Ibex River valley. View is to the northeast and Scout Lake valley is in the background. This network of canyons and granite outcrop formed as a result of erosin by the subglacial drainage of water emptying out of Glacial Lake Ibex.

Figure 5. A view to the north of a meltwater channel within the city limits of Whitehorse (arrow indicates direction of flow within the channel). The residential development of Copper Ridge is visible to the east of the channel. This channel was carved by meltwater draining off an ice margin that was positioned immediately south of this photograph. McIntyre Creek meltwater channel is visible in the

Figure 6. An aerial view to the north over the City of Whitehorse downtown and the Yukon River. Glaciolacustrine terraces (clay cliffs) are visible at the left of the photograph and are remnant of sediment deposition into a glacial lake that once covered this part of the valley. Post-glacial incision by the Yukon River into the glacial lake sediments is on-going as the river tries to reach baselevel with Lake

Stratigraphic Sections



Vertical scale - metres above sea level

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

Yukon Geological Survey

Yukon Energy, Mines and Resources

Descriptive Notes

Physiography and Drainage

The physiography of this map area is characterized by a high plateau of the Boundary Ranges of the Coast Mountains (Figure 1). Prominent summits in the map area include Mount McIntyre, Golden Horn Mountain, Mount Granger and Mount Sumanik. The highest summit in the map area is Mount Granger 2087 m a.s.l. The average elevation of the plateau lies between 1100 and 1700 m. The overall topography has a gently rolling character except where deeper valleys have cut into the plateau surface. The margins of these valleys typically have steep and rugged slopes.

All drainages in the map area are part of the Yukon River basin. The Yukon River valley borders the plateau to the northeast. The Ibex River flows northward within a deeply inset valley along the west side of the map area and drains into the Takhini River. Wolf Creek flows directly into the Yukon River. It is fed by Coal Lake and tributaries originating on the eastern flank of Mount Granger. Fish Lake, in the centre of the map, drains northward into Porter Creek. Other lakes in the map area include Bonneville Lakes, Louise, Franklin, Ibex and Coal lakes.

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 area probably began in the higher regions of the Coast Mountains to the south. It was likely not until localized Coast Mountain ice caps had formed that the more distal Cassiar Lobe advanced into the map area from the southeast through Marsh Lake valley (see map 3). 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 McConnell glaciation the movement of ice over this area was to the north-northwest and flowed unobstructed by topography. An erratic found on the summit of Granger suggest the ice sheet overtopped this summit. The presence of ice at this elevation suggests a minimum ice thickness over the city of Whitehorse of 1350 m and was likely closer to 1500 m thick.

The pattern of deglaciation is highlighted by periods of differential retreat and fluctuating ice fronts. During the retreat phase of the glaciation the Cassiar lobe re-advanced into this area from the east. This re-advance flowed westward across the Yukon River valley and into the Coast Mountains.

Landforms

Mount McIntyre/Fish Lake valley

The Cassiar re-advance was not extensive enough to overtop Mount McIntyre however meltwater channels did breach over the mountain through divides into the Fish Lake valley. This occurred near the north end of Fish Lake (see glaciofluvial deltas, FGd) and northeast of Mount Granger near the Coal Lake Road (see meltwater channel symbols). Deeply incised meltwater channels attest to this glacial history. Ice flowing from the east filled the Fish Lake valley during the re-advance and flowed south to where it terminated at the foot of Ibex Mountain in the southwest corner of the map area. A large area of ice stagnation sediment consisting of abundant rolling moraine, eskers and kettled terrain is remnant from this stage (Figure 2). As the ice retreated from this position, a glacial lake was impounded in the Fish Lake valley (Glacial Lake McIntyre; Figure 3). The outlet for this lake was westward into Glacial Lake Ibex in the Ibex River valley. Glacial Lake McIntyre shorelines are visible above Fish Lake at elevations up to 1254 m or approximately 120 m (393 ft) above the modern shoreline.

Ibex River Valley

The Ibex River valley was dammed by a glacier flowing into the drainage from the Takhini River valley via Scout Lake valley. Evidence of this glacier is well preserved in the Scout Lake valley (see map 8) from deeply incised lateral meltwater channels. The glacial lake in the Ibex River valley was approximately 120 m
(393 ft) deep. Drainage of the lake occurred along the margin of the ice dam on the west side of the Ibex River valley near the mouth of Jackson Creek. Much of the glacial sediment that normally blankets a valley side has been removed in this area. In addition, large canyons cut into the granitic bedrock are preserved from this period (Figure 4). The orientation of the canyons towards the valley bottom suggest the water draining from the glacial lake may have initially flowed ice marginally but dropped into subglacial channels oriented toward the valley bottom.

McIntyre Creek

McIntyre Creek drains the northeast slope of Mount McIntyre and becomes confined to a large meltwater channel near the edge of the Yukon River valley bottom (Figure 5). This channel was cut by meltwater draining off a large ice front positioned over the city of Whitehorse area. The erosional energy of the meltwater was sufficient to carve through the glacial sediment and into the local bedrock. In this area, many of the copper deposit showings that later became mines were discovered in meltwater channel exposures near the turn of the 20th century.

Yukon River valley bottom (downtown Whitehorse)

Downtown Whitehorse is situated on a low terrace of the Yukon River that is cut into the surrounding glacial deposits (Figure 6). These glacial deposits consist mostly of fine sediment that was deposited in the bottom of Glacial Lake Laberge when it inundated this area. The Whitehorse airport is situated on top of the glaciolacustrine sediment (locally referred to as the clay cliffs). Capping the glacial lake sediment is a sandy deposit with a variable thickness. This sediment was deposited in the Yukon River delta that formed where the Yukon River entered the glacial lake. This delta has since migrated north as the glacial lake slowly drained. The modern Yukon River delta is visible on map 1 in this series.

East and south of the downtown, the glacial deposits, including the glacial lake sediment bounding the

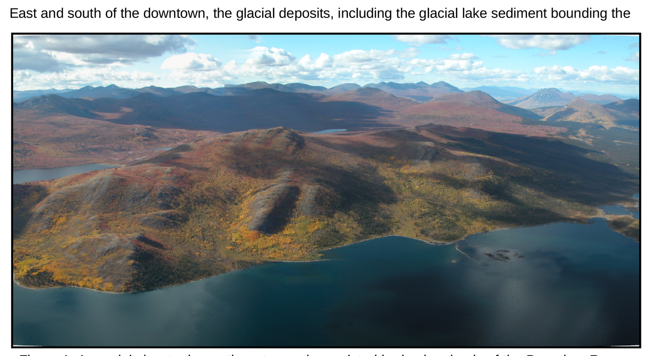
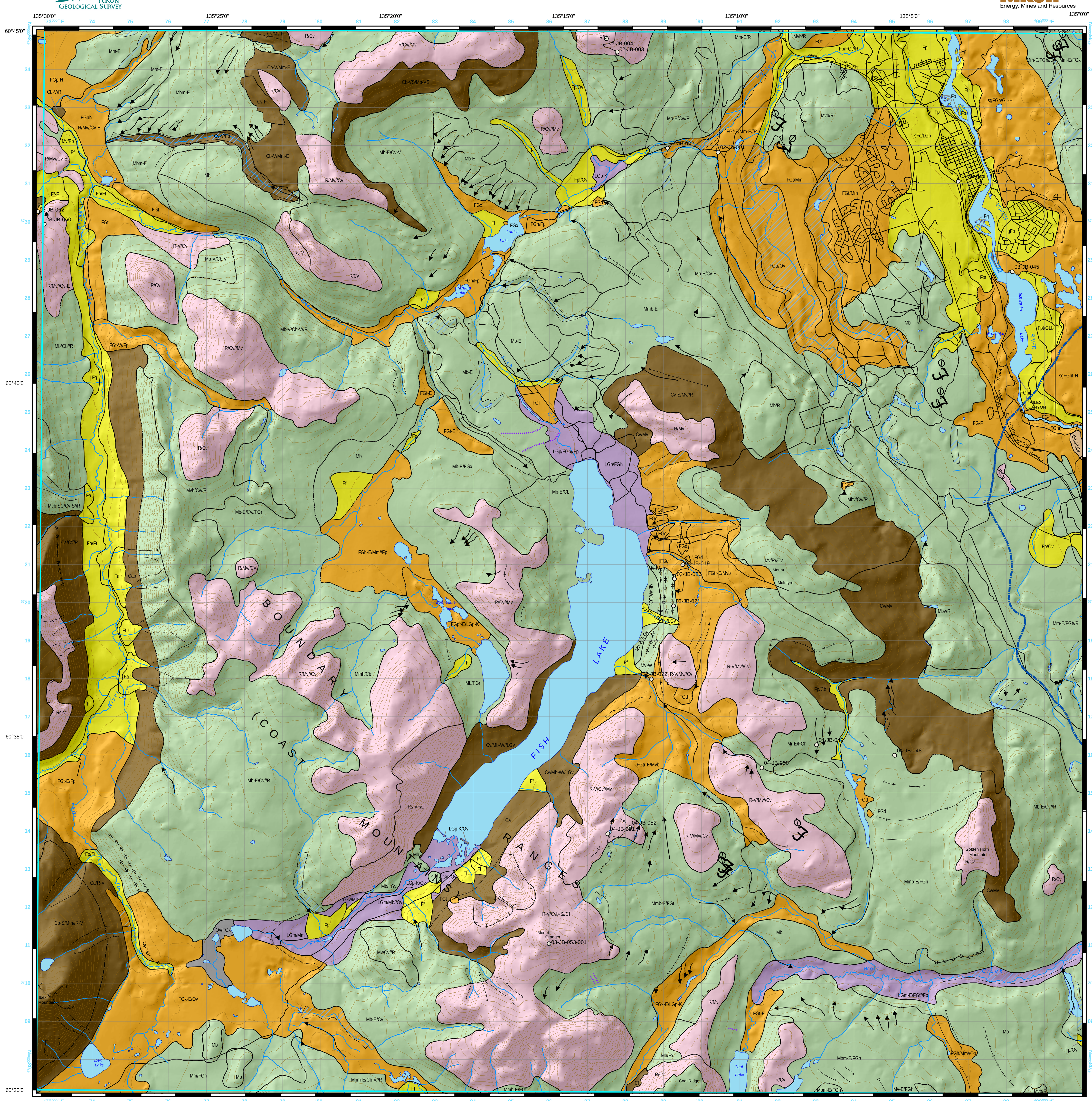


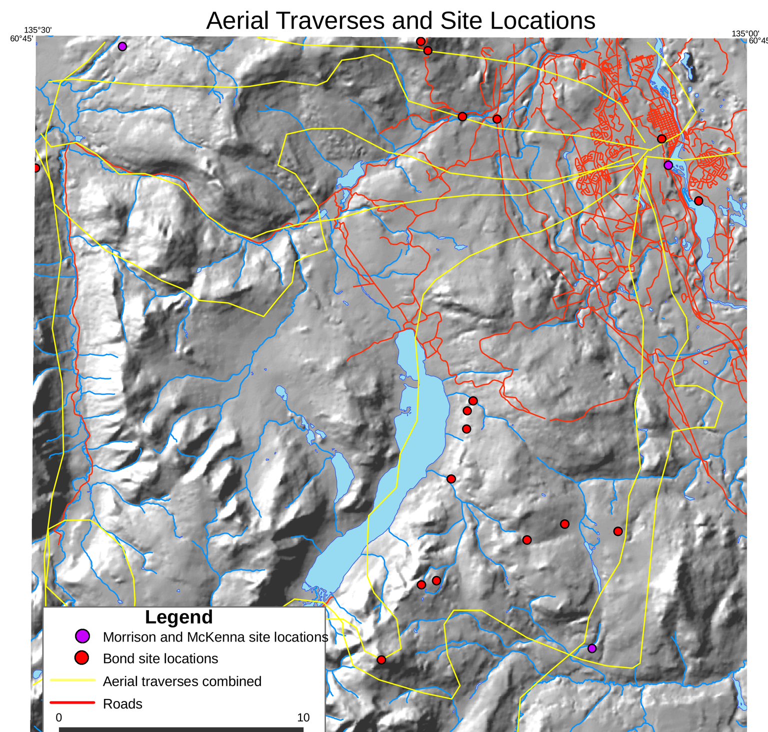
Figure 1. An aerial view to the northwest over the sculpted bedrock uplands of the Boundary Ranges in the Coast Mountains west of Whitehorse. Fish Lake is in the foreground and Bonneville Lakes are visible in the left middle ground.

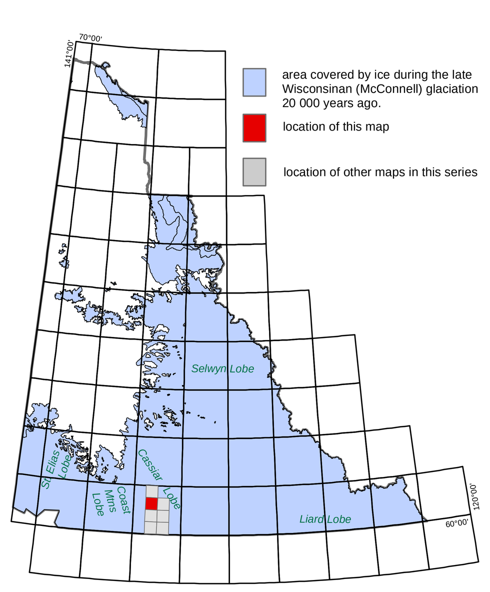
Figure 2. Ablation moraine between Fish Lake and Ibex Mountain. This mass of rolling moraine, kames and eskers was deposited from former ice fronts that converged on this area from the northeast (Fish Lake valley) and the southeast.

Figure 3. A view northwest across Fish Lake towards Mount Sumanik in the distance. The well-drained surface in the foreground is a former shoreline of Glacial Lake McIntyre. The elevation of the shoreline is approximately 120 m above the modern shoreline. Glacial Lake McIntyre developed when ice blocked the northward drainage of the lake basin causing water to overtop a divide with the Ibex River valley to the southwest.



Aerial Traverses and Site Locations





SURFICIAL GEOLOGY
WHITEHORSE

YUKON

SCALE 1:50 000

1 0 1 2 3 4
kilomètres kilometres

CONTOUR INTERVAL 40 METRES
Elevation in metres above Mean Sea Level
North American Datum 1983
Universal Transverse Mercator

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

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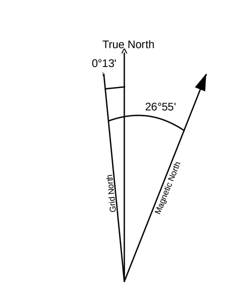
ONE THOUSAND METRE
Universal Transverse Mercator Grid
Zone 8



Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 2000
FOR CENTRE OF MAP
Annual change decreasing 11.3'

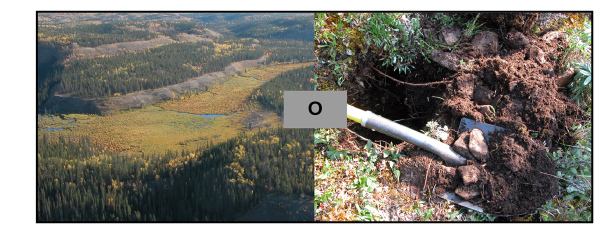
Legend

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.



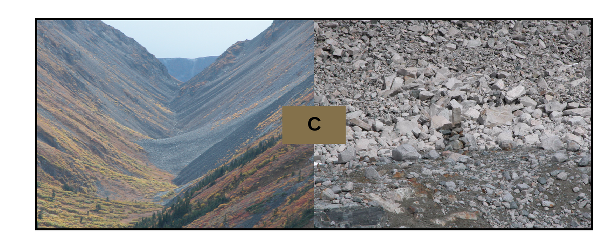
Organic Deposits: Materials resulting from vegetative growth, decay and accumlation in and around closed basins or on gentle slopes, where the rate of accumulation exceeds that of decay. Two types of organic material are recognized. The first are commonly saturated with water and consist mainly of the 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).

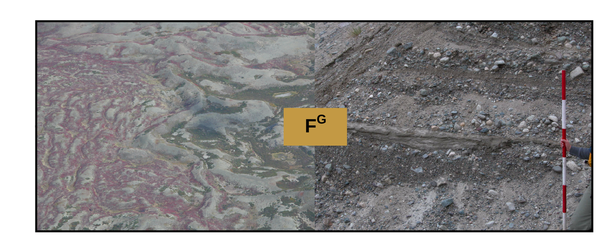
The landform photograph shows active dunes along the shoreline of Bennett Lake near the town of Carcross. Most eolian deposits in the map area are inactive. The Whitehorse dune field was last active between 9000 and 10 000 years ago.



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.

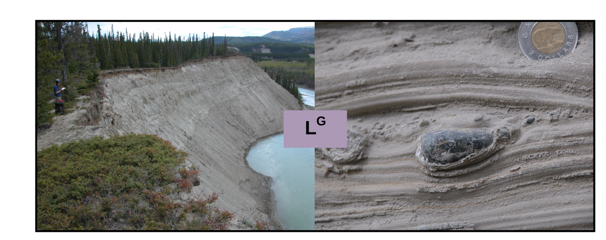
The landform photograph shows active colluviation into a meltwater channel east of Lake Laberge. The colluvial deposit depicted in the textural photograph originated from lateral moraine sediment of the Little Ice Age advance in the Wheaton River valley.

LATE PLEISTOCENE (WISCONSINAN) McCONNELL GLACIATION



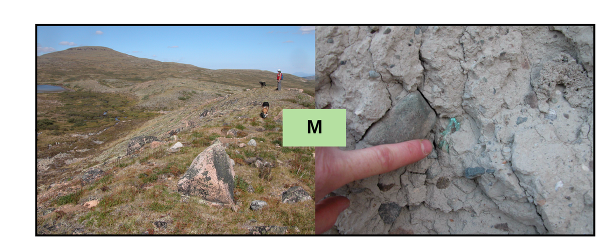
Glaciofluvial Deposits: Fluvial materials that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice. General Description: glaciofluvial sediment typically ranges from nonsorted and nonbedded gravel made up of a wide 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.

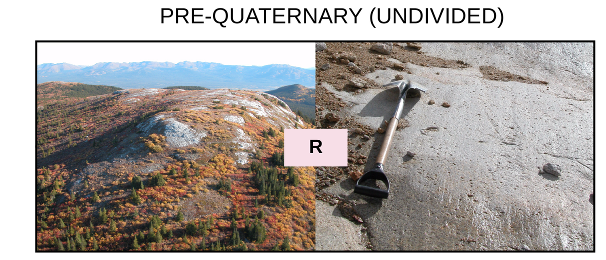
The landform photograph depicts glaciolacustrine sediment along the Takhini River valley. The pebble in photograph 2 was ice-rafted out into the former lake and subsequently dropped onto the lake bed when the ice-raft melted.



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

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

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105D/13	105D/14	105D/15
105D/12	105D/11	105D/10
105D/5	105D/6	105D/7

Yukon Geological Survey
Energy, Mines and Resources
Yukon Territorial Government

Geoscience Map 2005-7
Surficial Geology of Whitehorse (NTS 105D/11),
Yukon (1:50 000 scale)

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