#### **QUATERNARY GEOLOGY NOTES**

In 1995, a regional bedrock and surficial geology mapping program was initiated as part of the Nechako Plateau National Mapping Program to stimulate further exploration and define new mineralization targets in the Babine Lake area (Huntley et al., 1996; MacIntyre et al., 1996; Stumpf et al., 1996a; b). This 1:50 000 scale surficial geology map summarizes the Quaternary geology of the Old Fort Mountain area (93M/01) and will be followed by publications on regional drift geochemistry and bedrock mapping.

Preliminary mapping was completed using the existing terrain classification map (Wittneben, 1981) and airphotos (suites BC 86048 and BC 87062), then verified during fieldwork. Surficial geology units and landforms are coded and symbolized using mapping standards similar to those detailed in Howes and Kenk (1988). Drift sampling focused on the collection of basal till samples (lodgement and basal melt-out till) since they are first derivative products of erosion and deposition with relatively simple transport histories. As such, mineralized debris dispersed within basal tills can be more readily traced to origin than in most other deposits. A total of 293 samples (1 to 3 kg per sample) were collected from C-horizon profiles in roadcuts, hand-dug pits, trenches, stream cutbanks, borrow pits, and forest blowdowns. Fieldwork was assisted by Erin O'Brien and Jennifer Hobday.

PHYSIOGRAPHIC SETTING The glaciated Babine and Hautête drainage basins lie close to the northern edge of the Nechako Plateau. Three physiographic elements are common to these basins. Broad valleys are occupied by underfit streams and lakes. Morrison Lake drains southeast into Babine Lake, which in turn drains northward into the Skeena River. Hautête Creek lies within the Fraser River catchment and drains southeast, through Hautête and Natowite lakes into Takla Lake. In the central and northeastern parts of the map area, valleys are bordered by montane uplands with several peaks over 1200 metres, including Old Fort Mountain (1570 m; 5146 ft), Hearne Hill (1370 m; 4500 ft) and Wedge Mountain (1250 m; 4100 ft). Elsewhere, valleys are flanked by undulating to rolling plateaus with glacially eroded hills standing 100 to 150 metres above surrounding lowlands.

**OUATERNARY STRATIGRAPHY** Six surficial sediment types occur in the study area: basal and supraglacial tills, glacigenic debris flows, glaciofluvial, glaciolacustrine, colluvial, fluvial and organic deposits. The relative abundance and areal distribution of these sediments is physiographically constrained. The greatest range of sediment types occur in valleys. Plateau areas are predominantly mantled by tills and glaciofluvial sediments. In upland areas, colluvial deposits dominate on steeper slopes; tills and glaciofluvial sediments are confined to more gentle slopes and

Pre-Late Wisconsinan Deposits Pre-late Wisconsinan fluvial and lake deposits are exposed on the Newman Peninsula in the vicinity of the Bell mine open pit. Mammoth skeletal remains and plant material from these sediments provide an Olympia nonglacial interval age of ca. 34 ka (Harrington et al., 1974). These deposits rest unconformably on glacially eroded bedrock, suggesting at least one pre-Fraser glaciation affected the area.

Late Wisconsinan Glacial Deposits Late Wisconsinan, Fraser Glaciation deposits include: dense, clay and silt-rich massive diamictons, interpreted as basal tills (e.g., log 3048); less compact, massive diamictons with predominantly sandy matrices interpreted as washed basal and supraglacial tills (e.g., logs 3039, 3070, 3197, 3255); and stratified matrixsupported diamictons interpreted as glacigenic debris flows. Till thicknesses range from less than 1 metre in montane uplands, to greater than 5 metres in valleys. In upland areas, bedrock is covered by vencers (Mv) or patchy morainal blankets (Mb, Mm). These deposits are locally overlain by glaciofluvial sediments and postglacial colluvium (e.g., logs 3039, 3287, 3298). Basal tills over the plateau form featureless blankets (Mb) or fluted and drumlinized moraines (Mm). These deposits are locally capped by supraglacial tills and glaciofluvial sediments. A lateral moraine is preserved in the northeast corner of the map area. Moraines in the Morrison, Babine and Hautête valleys comprise undulating (Mu) and hummocky (Mh) blankets of basal and supraglacial tills flanking outwash plains. Morrison and Babine lakes are separated by an undulating moraine with a maximum surface elevation of 780 metres (2560 ft). Linear diamicton-filled ridges are locally found along valley floors. These features lie perpendicular to inferred iceflow and are interpreted as crevasse fills.

Late Wisconsinan Deglacial Deposits

Deglacial sequences include glaciofluvial and glaciolacustrine sediments. Interbedded clast-supported gravel, sand and subordinate stratified, matrix-supported diamictons are interpreted as ice-proximal glaciofluvial and debris flow sequences (e.g., logs DHH 001, DHH 003). Planar cross-bedding, trough cross-bedding and ripplebedding frequently indicate paleoflows counter to contemporary drainage directions. In montane uplands, glaciofluvial sediments (F<sup>G</sup>b) blanketing basal tills are found mainly in southeast-trending bedrock-walled channels. In valleys and plateaus, thick (greater than 5 m) glaciofluvial sequences (F<sup>G</sup>p, F<sup>G</sup>x) form kames, eskers and outwash plains that onlap and overlie morainal sediments. Extensive tracts of moraine are incised by relict meltwater channels that drained toward Babine and Natowite lakes. Fan-shaped deposits of glaciofluvial gravels and sands (FGf) are interpreted as fan deltas that formed around glacial ancestors of Babine and Natowite lakes. Rhythmically-bedded and deformed silts and sands, locally overlie morainal and glaciofluvial sediments up to an elevation of 885 metres (2900 ft) in the Hautête Creek valley. Around the margins of Babine and Natowite lakes, massive and laminated fine sand, silt and clay beds (e.g., log 3256) are draped over washed tills and crevasse fills up to elevations of 760 metres (2500 ft) and 790 metres (2600 ft), respectively. These thin-bedded sediments are interpreted as glaciolacustrine in origin (LGv), and together with fan delta deposits (e.g., log DHH 004) indicate glacial lakes were ponded up to about 50 metres above present lake levels.

Holocene sediments include a variety of colluvial, fluvial and organic sediments. Bedrock and glacial deposits on steep slopes are commonly mantled and, in places, truncated by massive and stratified, clastsupported diamictons, and massive deposits of bouldery rubble. These sequences are derived from subaerial weathering and gravity-induced mass movement, and include veneers and blankets of hill-slope colluvium (Cv, Cb), and talus fans (Ca). Throughout the area, streams have incised gullies and channels into older deposits or bedrock. Along active stream beds, sands and gravels are stored in migrating point, and in-channel bars. More stable deposits are found in broad, relict floodplains, now drained by underfit streams (Fp). Organic deposits (0) are confined to hummocky depressions, and overlie till and glaciofluvial sediments. Around lake margins, organic deposits form floating vegetation mats that encroach upon open water.

QUATERNARY HISTORY The contemporary landscape of the Old Fort map area is the product of multiple glacial and fluvial cycles operating throughout the Pleistocene. Although Olympia nonglacial interval fluvial and lacustrine sediments are locally preserved (Harrington et al., 1974), most sediments and landforms are inferred to date from the Late

Wisconsinan Fraser Glaciation and Holocene. Early during the Fraser Glaciation, ice accumulation occurred in the southern Skeena Mountains northwest of the map area. Valley glaciers from these sources subsequently flowed into the Babine and Hautête valleys. Glacial troughs, crag-and-tails, roches moutonnées, drumlins and flutes probably record the dominant regional iceflow direction and indicate glaciers followed the prominent regional southeasterly structural grain. Abundant smallscale grooves, rat-tails and striae are preserved on larger streamlined landforms. In most areas, these features indicate iceflow directions consistent with larger landforms. However, in the northwest, cross-cutting striae imply early iceflow from the Takla Lake valley (i) was superceded by later flow along MacDougall Creek (ii); and on the Newman Peninsula, early iceflow along the Babine valley (i) was subsequently deflected toward the southwest (ii). Widespread deposition of basal tills occurred during the Fraser Glaciation. No upper limit to glaciation was observed, which suggests that by the glacial maximum, ice had inundated the entire area. The distribution and composition of deglacial deposits and landforms implies that ice retreat was dominated by downwasting of stagnant ice in valleys. Numerous eskers, meltwater channels and glaciofluvial deltas were formed during deglaciation. Eskers occur locally along valley floors in the Babine and Hautête basins, and indicate that drainage was partly maintained through subglacial conduits. Downwasting ice controlled subaerial

meltwater drainage patterns. In montane uplands, early meltwater flow was focused in bedrock channels formed on hill crests. These relict landforms are graded between ca. 1220 metres (4000 ft) and 1160 metres (3800 ft), and drained southeast. Hydrologic continuity between hill crests was probably maintained by supraglacial channels formed on ice below 1220 metres (4000 ft). In the central part of the map sheet, meltwater drained westward from the Hautête valley into the Babine basin, forming a glaciofluvial complex along the eastern flank of Babine and Morrison valleys. This drainage route was abandoned once ice in the Hautête valley fell below 975 metres (3200 ft). Below this elevation, glaciofluvial landforms in the Hautête valley have profiles graded to ca. 790 metres (2600 ft). This elevation was probably a stable minimum water level of an ancestral Natowite Lake. In the western part of the map sheet, meltwater channels drained east and southeast to glaciofluvial deltas formed around the margins of Babine Lake at about 760 metres (2500 ft). The 760-metre elevation defines a minimum water level for a deglacial lake partly impounded by morainal sediments between Morrison and Babine lakes.

Harrington, C.R., Tipper, H.W. and Mott, J.R. (1974): Mammoth from Babine Lake, British Columbia;

Canadian Journal of Earth Sciences, Volume 11, pages 285-303. Howes, D.E. and Kenk, E. (1988): Terrain Classification System for British Columbia (Revised Edition); B.C. Ministry of Environment, Lands and Parks, Surveys and Resource Mapping Branch, MOE Manual 10, 90 Huntley, D.H., Stumpf, A.J., Levson, V.M., and Broster, B.E. (1996): Quaternary Geology and Regional Till Geochemical Sampling, Central Babine Lake Area (93L/16 and 93M/01), British Columbia; in Geological Fieldwork 1995, Grant B. and Newell, J.M., Editors, B.C. Ministry of Energy, Mines and Petroleum

Resources, Paper 1996-1. Stumpf, A.J., Huntley, D.H., Broster, B.E. and Levson, V.E. (1996a): Detailed Drift Exploration Studies in the Babine Porphyry Belt (93L/16 and 93M/01), British Columbia; in Geological Fieldwork 1995, Grant B. and Newell, J.M., Editors, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1996-1.
Stumpf, A.J., Huntley, D.H., Levson, V.M. and O'Brien, E.K. (1996b): Surficial Geology and Quaternary Stratigraphy of the Fulton Lake Area; B.C. Ministry of Energy, Mines and Petroleum Resources, Open File

MacIntyre, D.G., Webster, I.C.L. and Bellefontaine, K.A. (1996): Babine Porphyry Belt Project Bedrock Geology of the Fulton Lake Map Area (NTS 93L/16); in Geological Fieldwork 1995, Grant B. and Newell, J.M., Editors, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1996-1. Wittneben, U. (1981): Terrain Classification, Old Fort Mountain Map Area (93M/01). B.C. Ministry of Environment, Lands and Parks, Surveys and Resource Mapping Branch...

### LEGEND FOR STRATIGRAPHIC SECTIONS

Morainal Sediments Massive boulders Massive cobbles Massive gravels Cross-trough bedded gravels Massive sand Planar bedded sand Cross-trough bedded sand Ripple bedded sand Sand and silt; deformed

Dmm¹ Massive matrix-supported diamicton (basal till)
Dmm² Massive matrix-supported diamicton (supraglacial till)

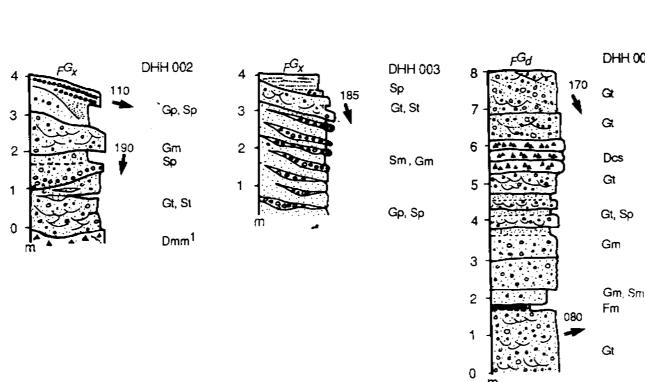
Dms Stratified matrix-supported diamicton Bedrock; includes weathered bedrock

Giaciolacustrine Sediments Fm Massive silt and clay FI Laminated silt and clay Colluviai Sediments

140º Paleocurrent direction (d) dropstones

PG<sub>V</sub> Surficial geology unit (see map legend)

Dcm Massive clast-supported diamicton Dcs Stratified clast-supported diamicton



LANDFORM SYMBOLS

Glacial flutes Striae, glacial grooves (i, ii indicates crosscutting relationship) Mineralized erratics Lateral moraine

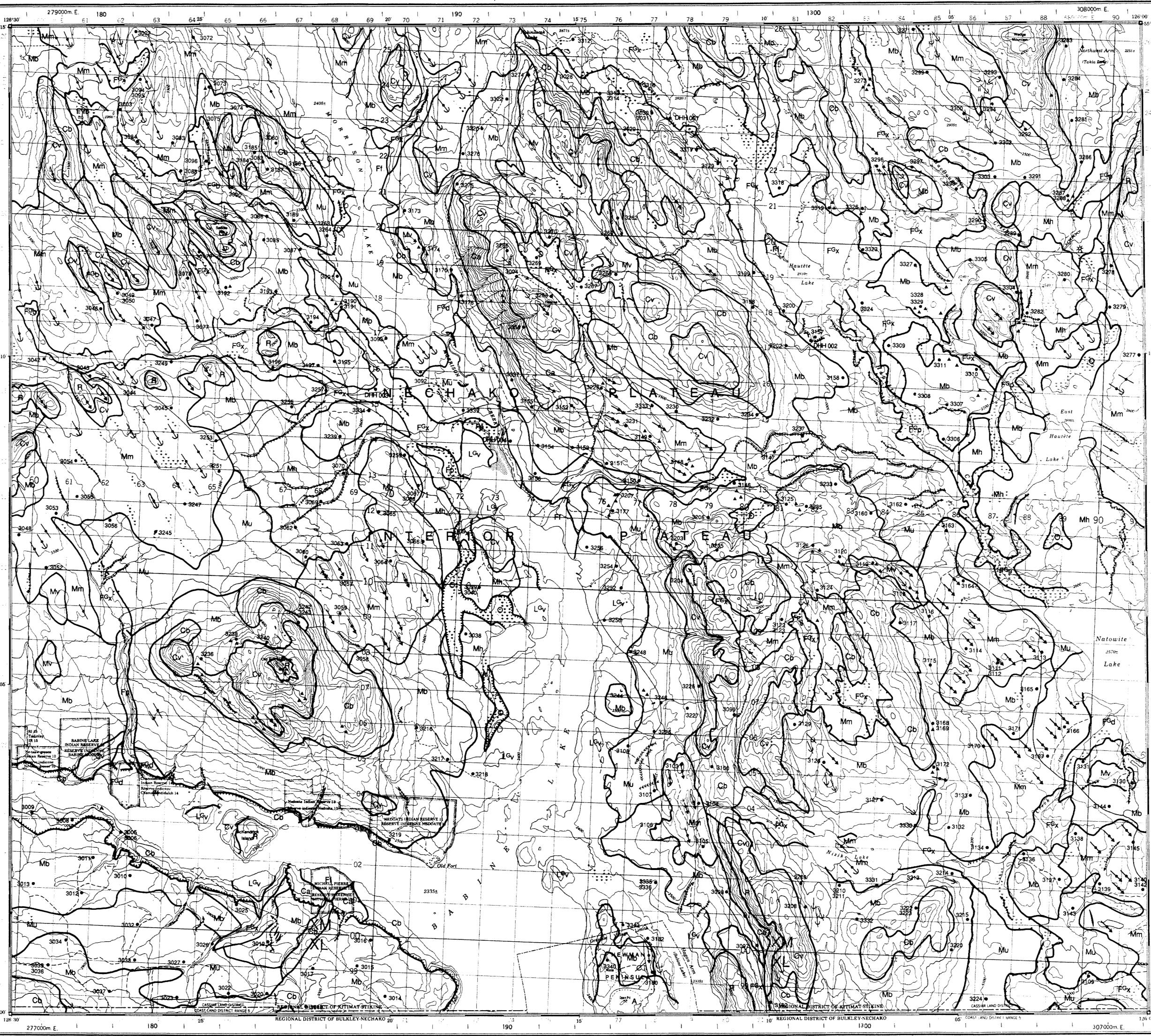
Crevasse fill deposit

☼ Conical kame Тептасе •1364 Till sample site

• DHH001 Stratigraphic section

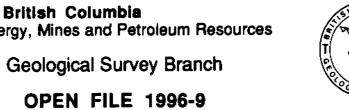
Meltwater channel (minor) Esker (flow direction known; unknown)

Spillway or meltwater channel (major)





Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources



### SURFICIAL GEOLOGY AND QUATERNARY STRATIGRAPHY OF THE OLD FORT MOUNTAIN AREA

NTS 93M/01

Metres 1000 1000 2000

#### **LEGEND**

#### QUATERNARY

HOLOCENE A ANTHROPOGENIC DEPOSITS: culturally disturbed and modified terrain.

occasional stream flooding and reworking.

- ORGANIC DEPOSITS: peat and other vegetative materials at least 50 cm thick and often few metres thick; formed by the accumulation of organic matter in depressions or level areas
- including bogs, fens and swamps. FLUVIAL DEPOSITS: gravel to silt-size sediments deposited by rivers, streams and creeks; commonly well-sorted and stratified; clasts well-rounded.
- Fp Floodplain sediments: cobble to pebble gravel, including minor sand and silt; generally several metres thick; includes local organic and lacustrine deposits in abandoned channels, depressions and backswamp areas; floodplain area subject to
- Ff Fluvial fan sediments: cobble to pebble gravel, including sand and silt; generally greater than 1 m thick; well-sorted to massive; includes areas subject to debris flows, flooding and stream avulsion.
- COLLUVIAL DEPOSITS: massive and stratified, clast and matrix-supported diamicton or rubble resulting from mechanical or chemical weathering of bedrock and other surficial materials, and the downslope movement of materials; reworked and transported by gravitational
- processes including creep, sliding, debris flow, avalanching, topple and rockfall. Cb Colluvial blanket: diamicton or rubble masking minor topographic irregularities in the underlying unit; greater than 1 m thick.
- Ca Colluvial apron and failure sediments: rubble or diamicton in complex fans, aprons, talus cones; generally resulting from slope failures and localized mass movements including debris flows and rockfalls; generally several metres thick.
- Cy Colluvial veneer: diamicton or rubble with surface expression derived from topographic irregularities in the underlying unit; less than 1 m thick and locally

# LATE WISCONSINAN

- LG GLACIOLACUSTRINE DEPOSITS: well-stratified sand, silt and clay, including minor gravel and diamicton deposited in lakes adjacent to glacial ice; slump structures, irregular
- topography and kettles, indicative of collapse from melting of buried ice, may be locally present. LG<sub>V</sub> Glaciolacustrine veneer: sand, silt and clay with surface expression derived from topographic irregularities in the underlying unit; less than 1 m thick.
- FG GLACIOFLUVIAL DEPOSITS: cobble to pebble gravel, including minor sand, silt and diamicton; deposited by rivers and streams flowing from or in contact with glacial ice, including spillways, sandurs, raised deltas and kames; sorting good to poor, massive to well-stratified;
- evidence for ice collapse including slumping, kettles and irregular topography. FGb Glaciofluvial blanket: cobble to pebble gravel, including minor sand, silt and diamicton; masking minor topographic irregularities in the underlying unit; generally
- FGp Glaciofluvial plain: cobble to pebble gravel, including minor sand, silt and diamicton; generally several metres thick; topography level or nearly level.
- FGd Glaciofluvial delta: cobble to pebble gravel, including minor sand, silt and diamicton; generally several metres thick; fan-shaped planform.
- FGx Glaciofluvial complex: cobble to pebble gravel, including minor sand, silt and diamicton; generally several metres thick; includes areas consisting of up to 50 percent FGb, FGp, LGv, Mb, Mu and Mh.
- MORAINAL DEPOSITS: glacial diamicton, primarily till; generally consists of pebbles, cobbles and boulders in a clay, silt and, or sand-rich matrix; massive to stratified; deposited either directly by glacial ice, meltout or sediment gravity flow processes associated with ice.
- Mb Morainal blanket: predominantly basal till masking minor topographic irregularities in the underlying unit; greater than 1 m thick.
- Mm Rolling moraine: predominantly basal till with elongate or linear topographic surface expression; commonly drumlinized, fluted or draping glacially-sculpted bedrock; generally several metres thick.
- Mu Undulating moraine: basal and supraglacial tills with gently sloping topographic surfaces and hollows; generally several metres thick.
- Mh Hummocky moraine: predominantly supraglacial till and reworked basal tills with hummocky topographic surface expression; commonly with kettle lakes, closed depressions, ridges and knobs; generally several metres thick.
- My Morainal veneer: basal and supraglacial tills with surface expression derived from topographic irregularities in the underlying unit; less than 1 m thick and locally

# PRE-QUATERNARY

BEDROCK: includes areas of thin colluvial and morainal cover; subject to mass wasting processes including rockfalls, topples and avalanches.