LEGEND

(1) TERRAIN UNIT SYMBOLS

Simple Terrain Units:

e.g. Ft-E (Surficial Material)(Surface Expression)-(Geomophological Process)

Note: Two or three letters may be used to describe any characteristic other than surficial material.

Composite Units: Two or three groups of letters are used to indicate that two or three kinds of terrain are present within a map unit.

e.g. Mv•R indicates that both components are approximately equal in proportion
e.g. Mv/R indicates that "Mv" is more extensive than "R"
e.g. Mv//R indicates that "Mv" is considerably more extensive than "R"

Stratigraphic Units: Groups of letters are arranged one above the other where one or more kinds of surficial material overlie a different material. Veneers are assumed to overlie bedrock, unless otherwise noted in the stratigraphic unit label.

e.g. /Mb over L^Gp indicates discontinuous "Mb" overlies "L^Gp"

(2) SURFICIAL MATERIALS

C	Colluvial	Materials 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. Includes talus and debris flow deposits, as well as reworked till on steep slopes.
F	Fluvial	Materials transported and deposited by streams and rivers; synonymous with alluvial. Includes well-sorted sand, gravel, and overbank silt in post-Fraser Glaciation floodplains, terraces, and fans. Superscript 'A' indicates active channel zone of a modern floodplain.
F^G	Glaciofluvial	Materials that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice. Includes sand and gravel, often stratified, which may show evidence of ice melting (slumped structures). Features include deltas, kame terraces, river terraces, and meltwater channels.
L^G	Glaciolacustrine	Lacustrine materials deposited in or along the margins of glacial (ice-dammed) lakes, including sediments that were released by the melting of floating ice. Includes laminated or bedded to massive fine sand, silt and clay, and may contain ice-rafted stones.
M	Moraine (till)	Material deposited directly by glacier ice without modification by any other agent of transportation. Generally consists of a compact material that is non-stratified and contains a heterogeneous mixture of particle sizes, shapes and lithologies in a sand, silt and clay matrix; includes moraines, till plains and drumlins.
O	Organic	Sediments composed largely of organic materials resulting from the accumulation of vegetative matter. They contain at least 30% organic matter by weight (17% or more organic carbon). Includes swampy areas on plateaus and on floodplains.
R	Bedrock	Bedrock outcrops and rock covered by a thin mantle (up to 10 centimetres thick) of unconsolidated or organic materials.

(3) SURFACE EXPRESSION

b	Blanket	A mantle of unconsolidated materials thick enough to mask minor irregularities of the surface of the underlying unit, but still conforms to the general underlying topography. Greater than 1 metre thick, and possesses no construction forms typical of the materials genesis; outcrops of the underlying unit are rare.
c	Cone	A cone or segment of a cone with a relatively smooth slope gradient from apex to toe greater than 15°, and a longitudinal profile that is either straight, concave or convex.
d	Depression	Circular or irregular area of lower elevation (hollow) than the surrounding terrain and marked by an abrupt break in slope; side slopes within the depression are steeper than the surrounding terrain; depressions are 2 or more metres in depth.
f	Fan	A relatively smooth segment of a cone with a slope gradient from apex to toe, up to, and including 15°, and a longitudinal profile that is either straight, concave, or convex.
h	Hummocky	Steep sided hillocks and hollows of unconsolidated material with multidirectional slopes dominantly between 15 and 35°. Local relief is greater than 1 metre. In plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile.
j	Gentle slope	A planar surface sloping at 3 to 15°.
k	Moderately steep slope	An unidirectional (planar) surface with a slope gradient 27 to 35° (50-70%), and a smooth longitudinal profile that is either straight, or slightly convex; local surface irregularities generally have a relief of less than 1 metre.
m	Rolling	Elongate hillock(s) with slopes dominantly between 3 and 15° (5 to 26%) with local relief greater than 1 metre. In plan, an assemblage of parallel or sub-parallel linear forms with subdued relief.
p	Plain	A level or very gently sloping, unidirectional surface with gradients up to and including 3°; local surface irregularities generally have a relief of less than 1 metre.
r	Ridged	Elongate hillock with slopes dominantly between 15 and 35° (26-70%) if composed of unconsolidated materials; bedrock slopes may be steeper. Local relief is greater than 1 metre. In plan, an assemblage of parallel or sub-parallel linear forms.
s	Steep	A planar surface steeper than about 35°.
t	Terraced	A single or assemblage of step-like forms where each step consists of a scarp face and a horizontal or gently inclined surface above it.
u	Undulating	Gently sloping hillock(s) and hollow(s) with multidirectional slopes generally up to 15° (26%); local relief is greater than 1 metre. In plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile.
v	Veneer	A mantle of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material. It ranges in thickness from 10 centimetres to 1 metre, and possesses no form typical of the material genesis.
w	Mantle of variable thickness	A layer or discontinuous layer of surficial material of variable thickness (typically 0 to 3 metres) that fills or partly fills depressions in an irregular substrate. It is generally too thin to mask prominent irregularities in the underlying material.

(4) GEOMORPHOLOGICAL PROCESSES

B	Braiding channel	A channel zone characterized by many diverging and converging channels separated by unvegetated bars and temporary islands of gravel and sand.
E	Channeled by meltwater	Erosion and channel formation by meltwater alongside, beneath and in front of a glacier.
H	Kettled	Depressions formed in surficial materials due to the melting of buried or partially buried ice.
I	Irregularly sinuous channel	A single, clearly defined main channel displaying irregular turns and bends without repetition of similar features.
M	Meandering channel	Meandering channel; refers to stream channel characterized by regular and repeated bends of similar amplitude and wave length.
S	Solifluction	Slow downslope movement of saturated overburden across a frozen or otherwise impermeable substrate.

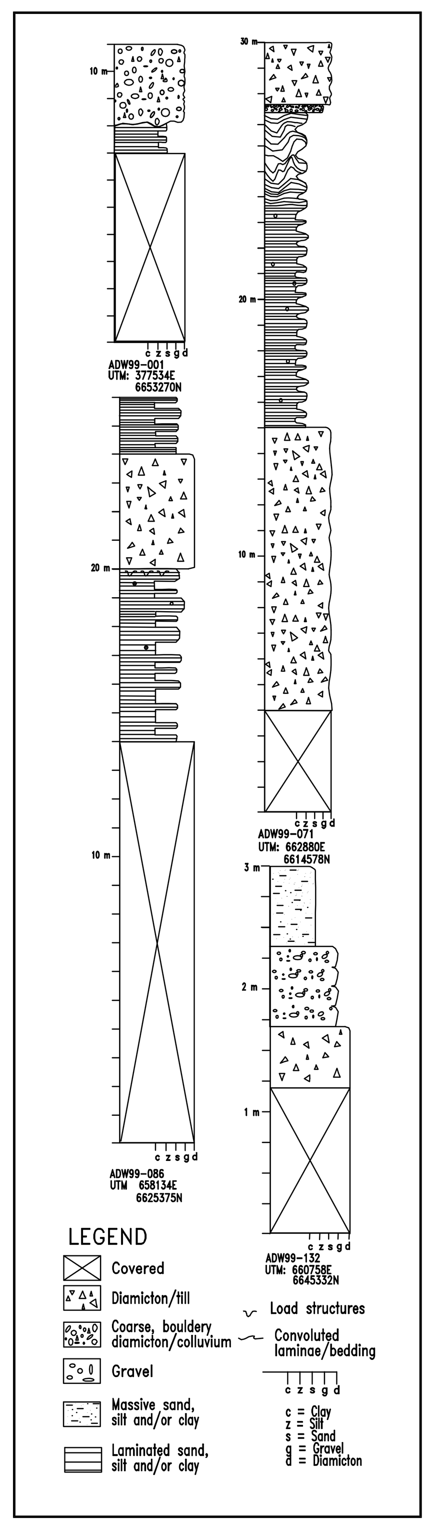
CRITERIA FOR DETERMINING LINES/BOUNDARIES

———	(Solid). Well-defined, sharp boundaries that can be precisely delimited at the scale of mapping.
— — — —	(Dashed). Boundaries that are gradational over a short distance or that can be only approximately located, or where precise boundary locations are masked by forest.
• • • • • • •	(Dotted). Assumed boundaries, and boundaries that are gradational over considerable distances.

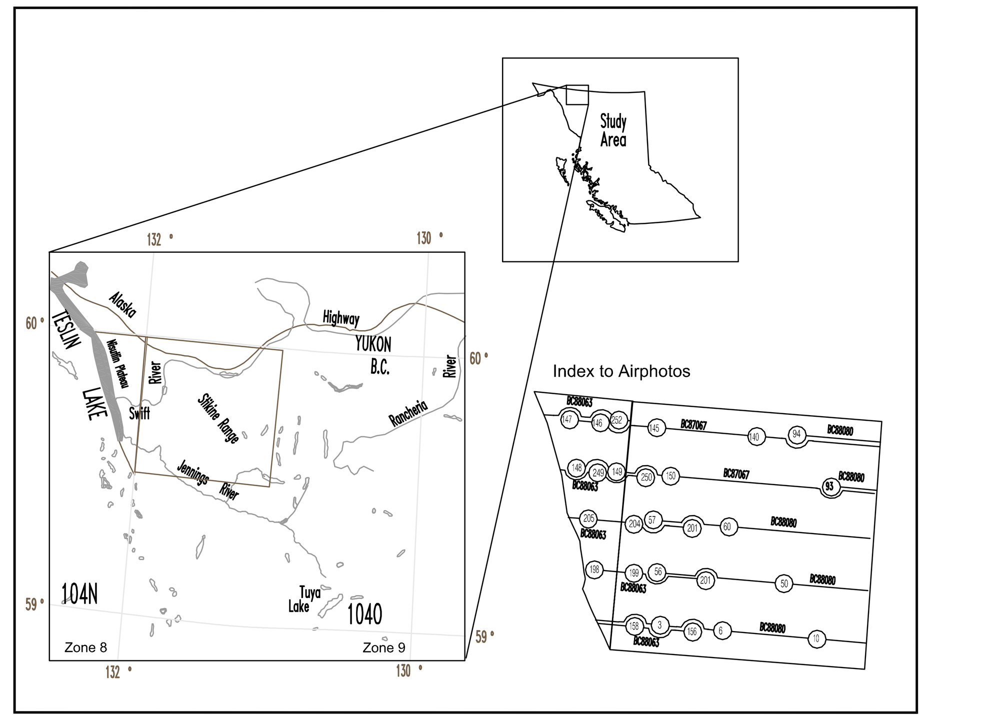
SYMBOLS

- Drumlins (direction known)
- Undifferentiated lineations (direction unknown)
- Striae, glacial grooves (direction known, unknown)
- Craig and tail (direction known)
- Roches moutonnées (direction known)
- Fieldcheck/till sample site
- Stratigraphic section

STRATIGRAPHIC SECTIONS



LOCATION MAP



BASE MAP NOTES

Contours generated from Digital Elevation Model
Contour interval 100 metres
Elevations in metres above Mean Sea Level

For complete reference to symbols, see "Specifications and guidelines for digital baseline mapping at 1:20 000" published by the Ministry of Environment, Lands, and Parks

TRIM base maps obtained from MAPS-BC, Survey and Resource Mapping Branch, British Columbia Ministry of Environment, Lands, and Parks

Universal Transverse Mercator (UTM) Projection, North American Datum - NAD 83

UTM Zone 8 (EAST of 132° 00')
The 1996 MAGNETIC BEARING is approximately 25° 01' EAST of GRID NORTH
Annual change decreasing 18.2'
GRID NORTH is 2° 20' EAST of TRUE NORTH

UTM Zone 9 (WEST of 132° 00')
The 1997 MAGNETIC BEARING is approximately 28° 58' EAST of GRID NORTH
Annual change decreasing 19.4'
GRID NORTH is 2° 10' WEST of TRUE NORTH

BRITISH COLUMBIA
Ministry of Energy and Mines
Energy and Minerals Division

Geological Survey Branch
Open File 2000-5

SURFICIAL GEOLOGY OF THE SWIFT RIVER AREA, BRITISH COLUMBIA

NTS 104N/9, 16 and 104 NW

by A. Dixon-Warren and A. Hickin

SCALE 1:100 000

0 2 4 6 8 10
Kilometres

For an overview of the Quaternary geology and till geochemistry of the Swift River area, please refer to the following report: "Ancient Pacific Margin NATMAP Part IV: Surficial geology and till geochemistry of the Swift River area" by A. Dixon-Warren and A. Hickin; *in* Geological Fieldwork 1996, B.C. Ministry of Energy and Mines, Paper 2000-1. Geology based on air photo interpretation by A. Dixon-Warren, followed by groundtruthing in areas indicated in Dixon-Warren and Hickin (2000).

QUATERNARY GEOLOGY NOTES

QUATERNARY HISTORY OF NORTH WESTERN BRITISH COLUMBIA

The present day landscape of the Swift River map area is the result of multiple glaciations, interglacial events and early-Holocene erosion and sedimentation. There is limited chronological information for the northern Cordilleran Ice sheet, however, evidence suggests past processes were similar to those in the south of the province (Ryder and Maynard, 1991). Although not necessarily present in this map area, glacial and interglacial sediments are preserved in scattered localities across northern British Columbia and a limited number of dates spanning the Pleistocene have been obtained (Miller, 1976; Bobrowsky and Rutter, 1992; Levson and Blyth, 1993; Spooner *et al.*, 1996).

The last glacial advance (Fraser Glaciation) largely obscured any evidence of earlier glacial and non-glacial events. In the early phases of glaciation, ice growth was the result of cirque and valley glacier expansion in the Coast, Cassiar and Skeena Mountains. Alpine glaciers also developed in many parts of the Stikine Plateau. Advancing glaciers from the local mountains dammed river valleys thus forming lakes across the region (Ryder and Maynard, 1991). As the ice overrode these areas and thickened, the extensive ice-sheet rose to an elevation of at least 2100 metres (Gabrielse, 1969). Given the many centres of ice accumulations, ice sheet morphology and flow patterns were complex at the time of coalescence.

Deglaciation occurred partly by frontal retreat of ice tongues and partly by downwasting of stagnant ice. Paleo-ice flow directions altered according to prominant topographic control. Widely distributed small bodies of glaciolacustrine sediments indicate that numerous lakes existed during deglaciation. The large eskers complexes as well as kame and kettles dotting the valley floors, indicate ice stagnation was the dominant deglacial process in certain mountainous areas.

Local ice re-advances or pauses occurred during the late phase of the Fraser Glaciation. Recessional moraines and kame terraces mark ice margins during pauses in ice retreat. Moraines bounding cirques could also be attributed to the growth and decay of alpine glaciers reoccupying cirques after the last ice sheet disappeared (Aitken, 1959).

Since glaciation, previously deposited glaciogenic sediments have been reworked by colluvial processes under paraglacial conditions and re-sedimented at the base of steep slopes Similarly, paraglacial alluvial-fan sedimentation was active during deglaciation and alluvial-fan accumulation has continued until the present. Where Holocene glacial activity occurred, it was restricted to high cirques in alpine areas.

SURFICIAL GEOLOGY

At lower elevations, on gentle slopes and plateaus, the bedrock topography is mantled by variable amounts of morainal deposits. Deposits commonly range from a thin veneer (<1 metre) to thick blankets (≤45 metres). The physical properties of these diamictons suggest they are basal tills derived from lodgement processes (*e.g.* Dreimanis, 1988). In some areas, particularly along or at the base of steep slopes, tills are reworked and colluviated.

Lateral and recessional moraines are common in the study area. Moraines mark the location of ice pauses during local glacier retreat. Here, surficial sediments are commonly dissected by meltwater channels and can be used to establish the sequential positions of the ice edge.

Glaciofluvial, glaciolacustrine and modern fluvial materials dominate valley settings. Deposits of glaciofluvial sand, gravel and silt are evident in upland valleys and as terraces throughout the study area. Such sediments likely represent ice-proximal to ice-distal facies deposited during deglaciation. In the deep, broad valleys in the Cassiar Mountains, esker complexes and kame and kettle topography are abundant. Kettles, identified by their circular shape, formed where abandoned ice blocks were left to slowly ablate, while sedimentation occurred around their periphery.

Along the Swift River valley and Teslin Lake, thick sequences of fine sand, silt and clay form terraces above the modern day floodplain. In select areas, glaciolacustrine rhythmites lie stratigraphically between two till layers (*e.g.* ADW99-071). The glaciolacustrine sediments are the remnants of a lake formed by the damming of the Teslin trench by advancing glaciers. Whether the tills are the result of two advances of the same ice sheet, or of two separate glaciations, is unclear without dating control. Modern fluvial floodplains also dominate valley settings, with large alluvial fans forming along valley margins.

Intense post-glacial erosion within the area has produced widespread colluvial debris. Deposition and accumulation of these sediments result from 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. Deposits commonly occur in veneer or blanket accumulations or as large cones along steep valley walls and slopes.

Organic deposits commonly occur in areas of poor drainage such as marshes and swamps. Deposits are common along floodplains, along old meltwater channels, and between drumlinoid features. In areas of higher elevations, including plateaus, organic material accumulates where bedrock topography traps surface water to form bogs.

ACKNOWLEDGEMENTS

This project was a component of the Ancient Pacific Margin NATMAP program, a joint-venture between the British Columbia Geological Survey Branch and the Geological Survey of Canada. Additional funding provided by the Public Service Internship Program. S. Cook, M. Mihalynuk and H. Pass assisted with fieldwork. G. McArthur edited earlier versions of the Open File. A. Bichler helped with digital map compilation and preparation of figures. V. Levson provided insight on the local surficial geology and airphoto interpretation. P. Bobrowsky supervised the project.

REFERENCES

Aitken, J.K. (1959): Atlin map-area, British Columbia (104N); *Geological Survey of Canada*, Memoir 307, 88 pages.

Bobrowsky, P.T. and Rutter, N. (1992): The Quaternary geologic history of the Canadian Rocky Mountains; *Geographie Physique et Quaternaire*, Volume 46, Number 1, pages 5-50.

Dreimanis, A. (1988): Till: their genetic terminology and classification; *in* Genetic Classification of Glaciogenic Deposits, R.P. Goldthwait and C.L. Matsch, Editors, *Balkema*, pages 17-67.

Gabrielse, H. (1969): Geology of the Jennings River Map Area, British Columbia (104 O); *Geological Survey of Canada*, Paper 8-55.

Levson, V. and Blyth, H. (1993): Applications of Quaternary geology to placer deposit investigations in glaciated areas; a case study, Atlin, British Columbia; *Quaternary International*, Volume 20, pages 93-105.

Miller, M.M. (1976): Quaternary erosional and stratigraphic sequences in the Alaska-Canada Boundary Range; *in* Quaternary stratigraphy of North America, W.C. Mahaney, Editor, Dowden, *Hutchinson and Ross Inc.,* Stroudsburg, Pennsylvania, pages 463-492

Ryder, J. and Maynard, D. (1991): The Cordilleran Ice Sheet in Northern British Columbia; *Geographie Physique et Quaternaire*, Volume 45, pages 355-363.

Spooner, I.S., Osborn, G.D., Barendregt, R., and Irving, E. (1996): A Middle Pleistocene (isotope stage 10) glacial sequence in the Stikine River valley, British Columbia; *Canadian Journal of Earth Sciences*, Volume 33, Number 10, pages 1428-1438.