## **QUATERNARY GEOLOGY NOTES**

## SURFICIAL GEOLOGY

Steep mountainous areas are characterized by bedrock exposures (A) and a thin colluvial veneer (Cv). More gentle slopes at high elevations may have a thin blanket (Cb) of glacially derived diamicton, resedimented by slope processes after initial deposition. Many high-elevation areas are subject to rapid mass movements (rock falls and debris flows) and snow avalanches. Noteworthy is a large landslide composed mainly of basalt and scoria debris that extends from the east side of Ruby Mountain across the Ruby Creek valley. Landslide debris typically consists of angular bedrock material ranging in size from sand to large boulders and some surficial sediments. Periglacial features such as solifluction lobes, stone stripes, nivation hollows and cryoturbated soils are common, especially in the northwest part of the map area and to a lesser extent along the high mountains in the south. Talus deposits are common below most bedrock cliffs and rock glaciers occur in some high cirques.

Lower slopes and valley bottoms are typically covered by morainal deposits (Mb, Mv) consisting of unsorted, massive diamicton. These tills are generally matrix-supported, with clasts up to large boulder size occurring in a mixture of sand, silt and clay. They are typically compact, impermeable and poorly drained. On slopes, tills are often overlain by 1 or 2 metres of poorly consolidated, sandy diamicton produced by colluvial processes. They are comprised of glacial debris mixed with angular local materials and are commonly interbedded with thin lenses of sorted gravel, sand and silt.

Glaciofluvial sands and gravels ( $F^{G}$ ) are most concentrated along the valley bottoms of Spruce, Pine, Otter and Fourth of July creeks. Glaciofluvial deposits consist mainly of moderately to well-sorted, wellstratified, non-cohesive gravels and sands. They typically have a high porosity and permeability and are well drained. Clasts are well rounded and generally in the pebble to cobble size range. Well-developed glaciofluvial terraces occur in the lower Spruce Creek and Pine Creek valleys and merge with raised glaciofluvial delta complexes east and northeast of Atlin. A large kettled delta complex also occurs in the Fourth of July Creek valley at the northern edge of the map area. An ice-contact kame complex occurs at the mouth of Otter Creek and there are esker complexes in the lower and uppermost reaches of Spruce Creek. Glaciolacustrine sediments (LG) are uncommon surficial deposits in the map area but occur along the shore of Atlin Lake and along Fourth of July Creek. They form a thin discontinuous veneer over morainal materials and bedrock and are typically comprised of cohesive, impermeable, laminated to massive, sitts and

clays. Sandy to pebbly, raised, beach deposits occur along Atlin Lake (Lacelle, 1985). Fluvial deposits are confined mainly to alluvial fans (Ff) at the mouths of creeks entering the Surprise Lake valley, the Pine Creek fan-delta at Atlin Lake and narrow floodplains of streams throughout the area. They are similar to glaciofluvial deposits but tend to be finer grained and often are water saturated. Bog and marsh deposits (O) occur mainly in valley bottoms, particularly along Atlin Lake.

More detailed descriptions of map units in the Atlin area can be found in a report on terrain capability for residential settlements (Lacelle, 1985).

## QUATERNARY HISTORY AND CHRONOLOGY

Glaciation of the Atlin area was preceded by an extensive period of preglacial fluvial valley incision during which many of the placer deposits in the area accumulated. During the last glaciation ice initially moved into the Atlin region down major valleys from accumulation areas in the Coast Range, ice apparently occupied the Atlin Lake valley before smaller tributary valleys, resulting in damming of streams such as McKee Creek, just south of the map area, and Spruce Creek, ice damming in the Boulder and Otter Creek valleys may also have been caused by a glacier flowing up the Pine Creek valley. Prograding glaciofluvial delta complexes formed in all these ice-dammed lakes. During full glacial times the region was almost entirely ice covered by a northeasterly flowing regional ice sheet resulting in a ubiquitous surficial cover of glacigenic sediments. Well-developed moraines are rare, but recessional moraines occur locally, as in the upper Ruby

During deglaciation ice-contact kame and esker complexes formed in a number of areas and a glacial lake developed in the Atlin Lake valley. Outwash from Pine and Spruce creeks deposited glaciofluvial deltas northeast and east of Atlin. As the lake level dropped, deltas and correlative beaches and outwash terraces were constructed at successively lower levels. The highest lake level in the area, determined by the distribution of glaciolacustrine sediments and by maximum delta elevations, was at about 780 metres above sea level. A glacial lake also formed in the McDonald Lakes area as a result of damming by Atlin valley ice retreating down the Fourth of July Creek valley (Taliman, 1975). The elevation of large pitted deltas along Fourth of July Creek northeast of McDonald Lakes indicates that the maximum glacial lake level there was higher than 1000 metres above sea level.

During and following deglaciation, previously deposited glacigenic sediments were extensively reworked by colluvial processes under paraglacial conditions. Resedimented glacigenic deposits are common at the base of steep slopes. Similarly, paraglacial alluvial-fan sedimentation was probably very active the surface on the Boulder Creek fan, yielded a radiocarbon date of 2270 ± 90 years B.P. (AECV-1500C) indicating that fan sedimentation has been slow for at least the last two millennia. At high elevations, periglacial processes have played a large role in the evolution of geomorphic features throughout much of the Holocene (Tallman, 1975). Rock glaciers, solifluction lobes and stone stripes are common highelevation features. At least one major postglacial landslide has occurred in the area. Fluvial terrace, floodplain and active channel deposits have also formed along valley bottoms during the Holocene.

### PLACER POTENTIAL Potential buried-channel deposits

Spruce Creek has produced more placer gold than any other stream in British Columbia and buried lluvial channel deposits in the valley continue to support mining operations. Most activity has been concentrated along the lower end of the creek. A paleochannel on lower Spruce, locally oblique to, and mainly south and west of, the modern valley has been extensively drilled in an attempt to delineate the buried-channel geometry and numerous underground workings have been developed in the past to exploit the gravels. In addition, much of the valley upstream of the Nolan underground mine, near the confluence of Spruce and Dominion creeks, has good potential. Depth of ice erosion and thick glacial and glaciofluvial overburden are the main factors limiting the location and exploitation of these deposits.

Pine Creek is the second largest placer producing stream in British Columbia and it is probable that any undiscovered paleochannels of Pine Creek, downstream of Surprise Lake, would also be highly auriferous. Although thick glacial and glaciofluvial overburden inhibits exploration, there may be potential for expansion of mining operations upstream and downstream of previously mined areas and possibly also closer to the valley sides. The Pine Creek valley is wide and has good potential for discovery of new buried deposits, particularly to the north and east of previously mined areas. On the north side of the valley, broad, linear topographic lows are recognizable on airphotos and may represent surface expressions of former old-bearing paleochannels. The most prominent linear depression, paralleling Pine Creek, is in part occupied by Moose and Elk lakes. Similarly, the area between the Birch Creek confluence and Surprise Lake has not been mined and, given the historical productivity of upstream tributaries such as Otter, Boulder and Ruby creeks, it seems probable that paleochannels in that area would also be gold bearing. Data on the depth of ice erosion and consequent placer preservation potential in these areas has not been published. Confined channel gravels below Pleistocene basalts and rock avalanche deposits in the Ruby viountain area have good placer potential. Unexploited paleochannel deposits, on this creek and on others such as Boulder, Birch and McKee creeks, will mostly be small channel remnants on the valley sides, but

The broad alluvial flat on Wright Creek, downstream from the point where it bends from a northwest o a northerly trend, has good potential for deeply buried fluvial channel deposits. The valley is narrow and obliquely oriented to the regional ice-flow direction and therefore may have escaped deep glacial erosion. Lower Wright Creek was the site of an underground operation that temporarily exploited a rich gold-bearing gravel at approximately 30 metres depth. There is potential for upvalley extension of the buried channel deposits currently being mined on Otter Creek and for buried paleochannel remnants along the valley side in previously mined areas. In addition, there is buried placer potential on lower Otter Creek in low lying areas south of Surprise Lake and west of Wright Creek. One prominent linear depression in this area is shown on

there is local potential for more extensive deposits in areas where the valleys widen.

There is potential for buried alluvial-fan channel deposits at the mouths of most of the historically productive creeks in the area, particularly Otter, Birch, Boulder, McKee and Ruby creeks. The most productive parts of the channels would occur on bedrock near the paleofan apex. The continuity of the channels in the lower parts of the fans may have been disrupted by glacial erosion and the depth of burial there would also be greater than near the fan apex.

# Although postglacial placers are less productive than buried channel deposits, they may have

otential for efficient mining operations with good recovery systems. Holocene fluvial and alluvial placer deposits have not been heavily exploited to date in the region, mainly because they are relatively low-grade and contain finer gold than buried-channel gravels. Large-volume surface placers include alluvial-fan deposits at the mouths of Boulder, Ruby and Birch creeks and to a lesser extent fan deposits on lower Otter and Wright creeks. The most productive parts of the alluvial fan deposits are coarse-gravel facies near the

Holocene fluvial deposits have been mined on many creeks in the area particularly in deeply incised valleys, such as Birch, Boulder, Otter, Ruby, lower Spruce, Snake and upper Wright creeks, where gold has been reconcentrated from older gravel units. Near-surface fluvial placers in the upper parts of these streams may locally be productive but these deposits are generally thin. Low terraces along Spruce and Pine creeks contain some fine gold and locally are mineable. These gravelly deposits are extensive but generally occur below the water table. Higher fluvial, and possibly also glaciofluvial, terrace deposits such as are recognized

In identifying potentially productive placer settings from geomorphic and stratigraphic points of view, t is also necessary to consider the potential for bedrock in the area to yield gold to the placer environment. Ash and Arksey (1990a) have suggested a probable connection between altered ultramatic rocks (listwanites) and lode and placer gold production in the Atlin area. Thus, areas with the best placer potential probably occur downstream from known ultramatic outcrops or in regions where it can be geologically inferred that ultramatic rocks previously occurred and have since been eroded. The extent of ultramatic rocks can be determined from bedrock geology maps by Aitken (1959), Lefebure and Gunning (1989), Bloodgood et al. (1989) and Ash and Arksey (1990b).

on upper Spruce Creek and along Wilson Creek, just south of the map area, also have potential.

East Lansing, 178 pages.

Aitken, J.D. (1959): Atlin Map Area, British Columbia; Geological Survey of Canada, Memoir 307, 89 pages

British Columbia (104N/12); B. C. Ministry of Energy, Mines and Petroleum Resources, Open File 1990-Ash, C.H. and Arksey, R.L. (1990b): The Atlin Ultramatic Allochthon: Ophiolitic Basement within the Cache Creek Terrane: Tectonic and Metallogenic Significance (104N/12); in Geological Fieldwork 1989, B. C.

Ash, C.H. and Arksey, R.L. (1990a): Tectonic Setting of Listwanite - Lode Gold Deposits in Northwestern

Ministry of Energy, Mines and Petroleum Resources, Paper 1990-1, pages 365-374. Black, J.M. (1953): Report on the Atlin Placer Camp; B. C. Ministry of Energy, Mines and Petroleum Resources, Miscellaneous File Copy Report, Victoria, 71 pages, Out of Print, Bloodgood, M.A., Rees C.J. and Lefebure D.V. (1989): Geology of the Atlin Area (104N / 11W, 12E); B. C. Ministry of Energy, Mines and Petroleum Resources, Open File 89-15, two 1:50 000 sheets.

Lacelle, L.E.H. (1985): Terrain Capability for Residential Settlements: Atlin, British Columbia; B.C. Ministry of

Environment, Working Report, 43 pages. Lefebure, D.V. and Gunning, M.H. (1989): Geological Compilation Map of the Atlin Area (104N / 11W, 12E); B. C. Ministry of Energy, Mines and Petroleum Resources, Open File 89-24, two 1:20 000 sheets. Proudlock, P.J. and Proudlock, W.M. (1976): Stratigraphy of the Placers in the Atlin Placer Mining Camp, British Columbia; B. C. Ministry of Energy, Mines and Petroleum Resources, Miscellaneous File Copy

Report, Victoria, 69 pages, Out of Print. Fallman, A.M. (1975): The Glacial and Periglacial Geology of the Fourth of July Creek Valley, Atlin Region, Cassiar District, Northwestern British Columbia; unpublished Ph.D. thesis, Michigan State University,

ATLIN LAKE BASE MAP PRODUCED BY THE SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES, CITTAWA. UPDATED FROM AERIAL PHOTOGRAPHS TAKEN IN 1979. CULTURE CHECK 1991 AND 1983. PUBLISHED IN 1984 AND 1985. CARTE DE BASE ETABLIE PAR LA DIRECTION DES LEVES ET DE LA CARTOGRAPHIE, MINISTERE DE L'ENERGIE, DES MINES ET DES RESISOURCES, OTTAWAL MISE A JOUR À L'AIDE DE PHOTOGRAPHIES AERIENNES PRIBES EN 1878, VERIFICATION DES OUVRAGES EI 1981 ET 1883, PUBLISE EN 1884 ET 1986,



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

SURFICIAL MATERIALS



Geological Survey Branch

**OPEN FILE 1992-7** 

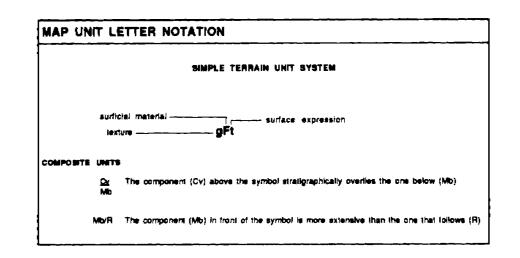
# SURFICIAL GEOLOGY AND PLACER GOLD SETTINGS OF THE ATLIN - SURPRISE LAKE AREA

NTS 104N/11W, 104N/12E

Geology by Victor M. Levson and Daniel E. Kerr

Metres 1000 0 1000 2000 3000 4000 Métres

For an overview of the surficial geology and placer gold deposits of the Atlin area please refer to the paper entitled "Quaternary Geology of the Atlin Area (104N/11W, 104N/12E)" by Victor M. Levson in Geological Fieldwork 1991, B. C. Ministry of Energy, Mines and Petroleum Resources, Paper 1992-1. Geology based on air photo interpretation followed by ground-truthing limited to road accessible areas. Fieldwork completed in 1991 and assisted by Heather Blyth.



TEXTURES	
c	clay
\$	ellt
8	eand
g	Bishe)
ь	boulder

d diamicton

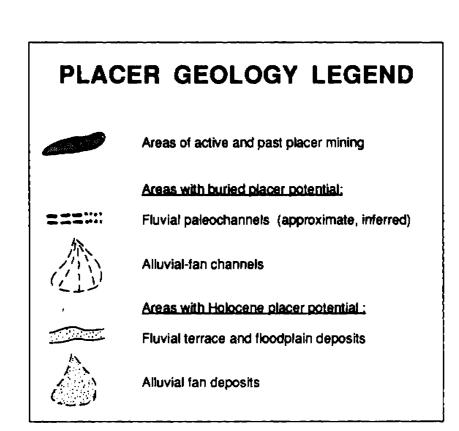
SURFACE EXPRESSION

terraced

y veneer (< 1 metre)

		billion and a super and the distribution of the superior of th	
٨	anthropogenic	Man-made or man-modified materials.	
С	colluvial	Diamicton with variable structure and texture; includes takes, availanche, landslide, debris flow and other mass wastage products and weathered bedrock	
E	solian	Fine sand and allt transported by wind; includes dune and loses deposits.	
F	Huvist	Gravel, sand or sitt deposited by streams and rivers; includes floodplain, river terrace, delta and alluvial fan sediments.	
ß	glaciofluvial	Fluvial sediment deposited in association with glacier los; generally consists of gravel and sand; includes kettled outwash, kame terraces and eskers.	
I	lce	Permanent snow and los; glaciers and lostisids.	
L	lacustrine	Sediment deposited in lakes or around lake shorelines; generally consists of sand, silt and clay; includes beach and facustrine terrace deposits.	
<u>L</u> G	glaciolacustrine	Lacustrine sediment deposited in association with glacier ice; similar to lacustrine deposits but displays features such as slump structures, ice-rafted stones and kettles.	
М	morainai	Diamicton (tilk) deposited directly by glaciers; generally consists of well- compacted material with variable structure and texture; includes moraine, till plain and drumlin leatures.	
0	organic	Material resulting from the accumulation and decay of vegetative matter; generally consists of peat; includes bogs, swamps and marshes.	
A	bedrock	Outcrope and rock covered by less than 10 cm of unconsolidated material.	
U	undifferentiated	Material of variable texture and origin.	
٧	volcanic	Unconsolidated pyroclastic sediments including volcanic ash, lapilli and coarser ejecta.	
₩	marine	Sediment deposited in marine waters or along coastlines; generally consists of clay, silt, sand or gravel; includes beaches and deeper water deposits.	
<b>γ</b> G	glaciomar!ne	Sediment deposited in a marine environment in close proximity to glacier ice; generally poorly sorted and stratified or massive; includes glaciomarine deltas and deeper water deposits.	

ON-SITE SYMBOLS	
ON-SITE SYMBOLS	
Orumlin, crag and tail	مهر
Strise, grooves (ice flow direction known; unknown)	XX
Flutings	
Moraine ridge (major, minor)	الالا معملا
Ester (flow direction known; unknown)	ראנו <sub>ע</sub> ן ולקרקר
Mehwater channel (major, minor)	THE WAR
Escarpment	<del>नगम</del>
Cirques	Season S
Glacier flow	>
Strandline	~
Landslide (headwall scar)	m



## LOCATION OF GROUND INVESTIGATION SITES

