SURFICIAL GEOLOGY IN THE CHILANKO FORKS AND CHEZACUT AREAS (93C/1, 8)

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KEYWORDS: Surficial geology, drift exploration, till, glaciofluvial outwash, glaciolacustrine, applied geochemistry, mineral dispersion.

INTRODUCTION

This report describes the preliminary results of surficial geological mapping during the 1992 field season in the Chilanko Forks (93C/1) and Chezacut (93C/8) map areas (Figure 4-10-1). As part of the Canada - British Columbia Mineral Development Agreement, the British Columbia Geological Survey Branch proposed to map the surficial geology of these areas to derive drift exploration potential maps. The two map sheets to the north, Clusko River (93C/9) and Toil Mountain (93C/16) were also mapped as part of this program (Proudfoot, 1993, this volume). The project's main goals are:

- To produce 1:50 000 surficial geology maps of NTS sheets 93C/1 and 93C/8.
- To define the regional Quaternary stratigraphy and glacial history.
- To derive surficial drift exploration potential maps.

This project illustrates the use of baseline surficial geology data, combined with a drift sampling program, for mineral exploration on a low-relief plateau with thick till cover. The Chilanko Forks and Chezacut map areas were selected because mineral exploration in the region is hampered by the thick and variable cover of surficial sediment, which masks the geological, geochemical and geophysical signatures of mineral occurrences. Furthermore, the surficial geology has not yet been mapped and little is known of the Quaternary geological history. Derivative drift exploration potential maps, which will aid in detailed planning of regional geochemical and drift exploration surveys, will be one of the products resulting from this investigation. A lack of mineral exploration has led to a low demand for geological data in the region and few mapping projects have been completed. Now, with increasing pressure on the mining and exploration industry in British Columbia as the inventory of easily explorable lands decreases, new methods are being tested in areas previously avoided.

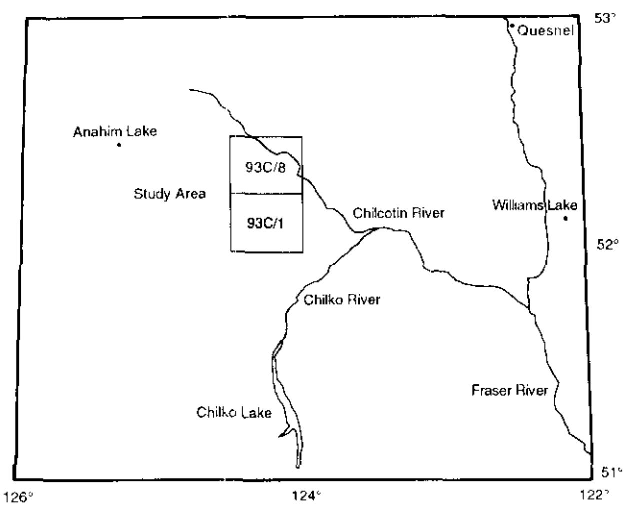

Figure 4-10-1. Location map of the Chilanko Forks (93C/1) and Chezacut (93C/8) map sheets.

The study region lies within the Fraser Plateau, in the west-central part of the Interior Plateau (Holland, 1976). In the study area, the plateau is approximately 1100 to 1400 metres above sea level and is deeply dissected by the Taila Lake, Chilanko River and Chilcotin River valleys. The plateau has flat to gently rolling topography broken by occasional mountains or ridges (Plate 4-10-1). Elevations range from a high of 1615 metres on Arc Mountain in the northwest of the Chezacut map sheet to a low of 900 metres in the Chilanko River valley in the southeast of the Chilanko Forks sheet. The topography becomes generally more diverse towards the north of the study area.

METHODS

Preliminary interpretation of the surficial geology of the study area was completed prior to fieldwork using 1:60 000-scale air photographs. Access in the region was by public and logging roads. All-terrain vehicles were used for traverses along logging roads and trails. A helicopter was used to reach isolated areas and complete sample coverage. Sample and map-unit verification sites consisted of borrow pits, roadcuts, streamcuts, uprooted trees, hand-dug pits and bedrock exposures. Site locations were plotted on 1:50 000 base maps with the aid of air photographs. Ice-flow directions were obtained from striation measurements on exposed bedrock and fluting or drumlin orientations on air photographs. At each exposure the nature of the deposit was determined and a brief description of the sediment was made. Descriptions include primary and secondary structures, matrix texture, pebble content, size and shape, and exposure of the site. Detailed stratigraphic and sedimentological information was collected at a few larger, well exposed sections.

Samples of till were collected for geochemical and grain-size analysis where a good exposure was available, and as needed to verify airphoto mapping. Till samples were

Plate 4-10-1. Aerial view of topography in the northwest of 93C/8, looking northeast. In the foreground is Palmer Creek and the highest feature in the background is Arc Mountain.

recovered from sufficient depths to avoid subaerial or root contamination. Till samples will be analyzed by instrumental neutron activation analysis (INAA) and inductively coupled plasma analysis (ICP) for 32 elements. A total of 151 till or colluviated till samples were collected in the study area at a density of one sample per 12.6 square kilometres. Approximately 100 pebbles were collected for lithologic analysis and provenance studies from most till sample sites as well as from a number of glaciofluvial outwash exposures. Bedrock samples were taken to document exposures for future bedrock geology mapping surveys and to help establish a representative lithologic reference collection. In total, 146 pebble and 26 bedrock and exotic boulder samples were obtained. Sample and map-unit verification sites are shown in Figure 4-10-2. Table 4-10-1 shows information pertaining to each terrain unit: sites, samples, verifications, minimum and maximum thicknesses, and typical stratigraphic setting.

TABLE 4-10-1
SUMMARY OF SELECTED SURFICIAL GEOLOGY DATA PERTAINING TO MAJOR TERRAIN UNITS

Terrain Units	Total Stops	Sampled	Verified	Thickness Minimum	Thickness Maximum	Stratigraphic Position
Moraine blanket or veneer Mbv	188	126	62	50 cm	15 m	Surface, over R Basal, under FG and C
Hummocky moraine Mh	37	20	17	50 cm	5 m	Surface, over R Basal, under FG and C
Glaciofluvial outwash FG	91	11	80	50 cm	30 m	Surface, over Mbv and Mh Basal, under Mbv and C
Esker FG (ridge)	7	1	6	2 m	25 m	Surface, over Mbv, Mh and FG
Eolian E	4	0	4	1 m	5 m	Surface, over FG and LG
Glaciolacustrine LG	26	0	26	20 cm	5 m	Surface, over Mbv and FG
Colluvium C	35	5	30	20 cm	3 m	Surface, over R, Mbv, Mh and FG
Bedrock R	33	21	12	n/a	n/a	Basal, under Mbv, Mh and C
Erratics / exotics	14	6	8	n/a	n/a	Surface, in Mbv, Mh, FG and C

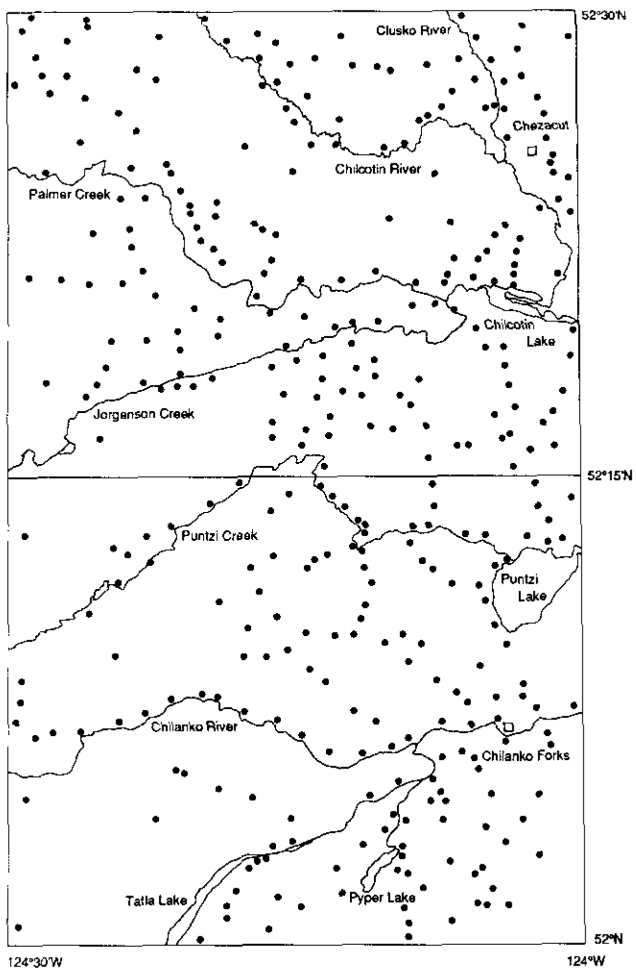

Figure 4-10-2. Location map of sample and verification sites in the the study area.

BEDROCK GEOLOGY

A series of bedrock geology maps of the Interior Plateau, including the Anahim Lake sheet, have been published by the Geological Survey of Canada. Extrusive igneous rocks, rhyolitic to basaltic in composition, dominate the Fraser Plateau and are exposed as knobs and ridges throughout the study area (Tipper, 1969). The oldest rocks in the area are part of the mid-Jurassic Hazelton Group: exposed mostly in the south and central parts of the Chilanko Forks sheet, they consist of andesitic to basaltic tuffs or breccias and derived metamorphic and sedimentary rocks. These have been intruded by Jurassic or younger granodiorites and granites of the Coast Plutonic Suite and their metamorphic equivalents (quartz biotite and granite gneisses). Cretaceous to Tertiary Ootsa Lake Group extrusives are found in the west-central parts of the Chilanko Forks sheet and in the eastern half of the Chezacut map sheet. These are dominantly feldspar-porphyritic andesitic basalts, amygdaloidal basalts or rhyolitic and andesitic tuffs. The study area has only 5 per cent bedrock outcrops, most of which are on mountain tops. There is only one mineral occurrence in the study area listed in MINFILE and only five assessment reports have been filed. Exploration to both the north and south of the study area has been successful in locating mineral occurrences in similar geological settings.

GLACIAL HISTORY

There is a lack of knowledge of the surficial sedimentary cover in the east half of the Anahim Lake (93C) sheet with the exception of a 1:250 000 generalized surficial geology map (Tipper, 1971a). This map provides a regional understanding of glacial geomorphology, but does not provide information on the surficial sediments. The Chilanko Forks and Chezacut map areas were covered by Late Wisconsinan Cordilleran ice of the Fraser glaciation (Tipper, 1971b). Ice originated in the Coast Mountains before flowing north, northeast and east onto the Interior Plateau. Coast Mountain ice extended as far east as the Fraser River before coalescing with Cariboo Mountain ice flowing to the west and northwest. The two ice masses then turned northwards and extended as far as the Parsnip River area (Tipper, 1971b). During deglaciation in the Anahim Lake region, ice flow was increasingly controlled by topography as ice masses became isolated and stagnated.

A late glacial readvance covered much of the Anahim Lake area and is postulated to have reached the northwestern edge of the Chezacut map area (Tipper, 1971a). This ice mass, named the Anahim Lake advance, originated to the west in the Coast Mountains and flowed onto the plateau through the Tusulko River valley before spreading out to the north, east and southeast. It is the eastward limit of this ice, identified on the basis of differential ice-flow directions and pitted or kettled terrain (Tipper 1971b), that is believed to have reached the study area. A second late glacial readvance may also have entered the Chilanko Forks map area from the south through the Tatla Lake valley (Tipper, 1971a). This Kleena-Kleene advance originated from the south in the Mount Waddington area (92N). The margins of the ice were topographically controlled as it flowed north and northeast along the Tatla Lake, Tatlayoko Lake, Kleena-Kleene and Chilko valleys. Tipper (1971a) places the limit of this advance at an elevation of 1065 to 1220 metres on the slopes to the northwest and southeast of Tatla Lake Creek.

Fluted bedrock and drumlins developed in till are preserved in the Chilanko Forks map area on the west-central and southeast uplands. These large-scale directional features indicate a flow toward the northeast between 050° and 065°. Glacial striations measured in the southeast of the area trend between 059° and 082°. They may reflect lower elevation, topographically influenced, ice flow during waning stages of glaciation. Large boulders of exotic lithologies were found throughout the study region, the largest of which was a quartz-biotite gneiss of the Coast intrusive suite measuring approximately 10 by 6 by 3 metres. Rounded erratics, found up to elevations of 1400 metres in the south-central parts of the Chilanko Forks sheet, indicate ice completely covered the region during the Fraser glaciation. Hummocky terrain was identified in the northwestern part of the Chezacut sheet, but whether this is Fraser glaciation or late glacial sediment is uncertain. Geochemical signatures or pebble lithologic analysis may provide evidence of a late glacial readvance but at present only the Late Wisconsinan Fraser glaciation has been defined.

SURFICIAL SEDIMENTS

TILL DEPOSITS

Surficial geological mapping shows that till is the dominant deposit on the uplands of the Fraser Plateau. It forms a blanket of variable thickness across much of the area and is expressed as hummocky or kettled, fluted or relatively flat terrain. Surface exposures of till are up to 10 metres thick but are more commonly 1 to 2 metres or less. Tills on steep slopes have commonly been reworked into colluvial deposits. Till is rarely found in valley bottoms because most of the valleys are either late-glacial meltwater channels which have cut down into the surficial cover, or have been partially infilled by glaciofluvial outwash sediments.

Till deposits in the area generally have a silty to fine sandy matrix with minor clay and little medium or coarse sand. Clasts range in size from small pebbles to large boulders, although medium to large pebbles dominate. Subangular to subrounded clasts are most common but some exposures, notably those close to bedrock, are dominated by angular blocks; rounded clasts are quite rare. Some tills are comprised of up to 50 per cent clasts, but most exposures have between 10 and 30 per cent. Striated clasts are frequently found in the tills and may represent up to 10 per cent of the population.

Poorly to moderately compacted, massive, silty sand till with lenses and beds of silt, sand and pebbles is the most common till deposit. This till is interpreted to have had an englacial or supraglacial origin forming hummocky or flat moraine during retreat and stagnation of the glacier. Compact, platy structured clay, silt and sand till forms thick, prominent cliff-like exposures (Plate 4-10-2). These tills are massive with thin lenses and stringers of silt or sand and a

Plate 4-10-2. A cliff-like deposit of compact, platy till overlain by a glaciolacustrine sequence and colluvium. This section is located in the north of 93C/8 along the Chilcotin River. The exposure is approximately 8 metres thick.

clear, erosive basal contact. They are interpreted to be a blanket or veneer of basal meltout or lodgement till deposited at the base of the advancing ice.

Sand and Gravel Deposits

Sand and gravel was observed beneath the till in the study area. These sediments are over 5 metres thick on the upland between Tatla Lake Creek and Pyper Lake and are overlain by 1 to 2 metres of till. They are dominated by well-stratified, subangular to rounded, sandy, small-pebble to cobble gravels with thin lenses and beds of stratified sand and silt. They are interpreted as glaciofluvial sediments deposited during the advance phase of the Fraser glaciation.

Glaciofluvial outwash is found along most valleys; it varies from well-sorted fine sand to coarse-cobble gravel. There are two types of glaciofluvial outwash deposits: meltwater channel, and esker or esker complex sediments. Meltwater channels, associated with ice-margin areas, carried water away from the advancing or retreating glacier. Steep-sided valleys with terraces on the sides and coarse cobble or boulder lags in the base are typical. Terrace deposits attain thicknesses of 20 metres in the Chilcotin River valley (Plate 4-10-3) but more often are 1 to 5 metres thick. Well-sorted sand deposits are fairly common in the base of the larger meltwater channels of the Chilcotin and Chilanko valleys.

Sand and gravel ridges that branch and rejoin in braided patterns are interpreted as esker complexes. Deep depressions between the ridges are interpreted as kettles. The esker complex in the Chilanko River valley is 8 kilometres long and 1 kilometre wide and has ridges up to 30 metres high (Plate 4-10-4). More typically, they are 50 to 400 metres wide, 500 to 1500 metres long and ridges are 5 to 15 metres high. Esker complexes in the Chilanko River, Tatla Lake Creek and Puntzi Creek valleys are evidence of topographically controlled subglacial or englacial meltwater flow. Several single esker ridges with orientations oblique to regional ice flow were noted during mapping. They are located in the lee of mountains and ridges, on flat, open terrain or in valleys oblique to ice flow. These eskers are 10 to 15 metres high, 25 to 50 metres wide and up to 500 metres long. Eskers and esker-complex ridges are usually moderately sorted pebbly sand to cobbly gravel deposits with subrounded to rounded clasts.

Lake Deposits

Parallel-laminated sand, silt and clay deposits in the Clusko River, Chilcotin Lake and Tatla Lake valleys are interpreted as glaciolacustrine deposits. In the Clusko River area they occur as a ubiquitous veneer, 20 centimetres to 1 metre thick, overlying till. These deposits have up to 5 per cent isolated clasts and rare thin diamicton lenses which are interpreted to be dropstones and subaqueous sediment gravity-flows, respectively. In the Chilcotin Lake area, these deposits are finely laminated to thinly bedded fine sand and silt exhibiting climbing ripples or horizontal stratification (Plate 4-10-5).

Colluvial, Organic and Eolian Deposits

A loose cover of weathered and broken bedrock near the mountain tops grades downhill into a thin veneer of colluvial diamicton derived from weathered bedrock and till (Plate 4-10-6). A colluvial veneer is commonly found overlying till on steeper slopes in lower lying areas. Colluvial sediment is differentiated from till by its loose unconsolidated character, the presence of coarse angular blocks of bedrock, and crude stratification. Lenses of well-sorted and stratified sand and gravel are interbedded with the diamicton.

Plate 4-10-3. A thick deposit of glaciofluvial meltwater-channel terrace gravel. This section located in the northern Chilcotin River valley is over 20 metres high.

Plate 4-10-4. A part of the Chilanko Forks esker complex, the ridges here are approximately 10 to 15 metres high and branch and rejoin in a braided pattern. View is looking north across the Chilanko River near the townsite of Chilanko Forks.

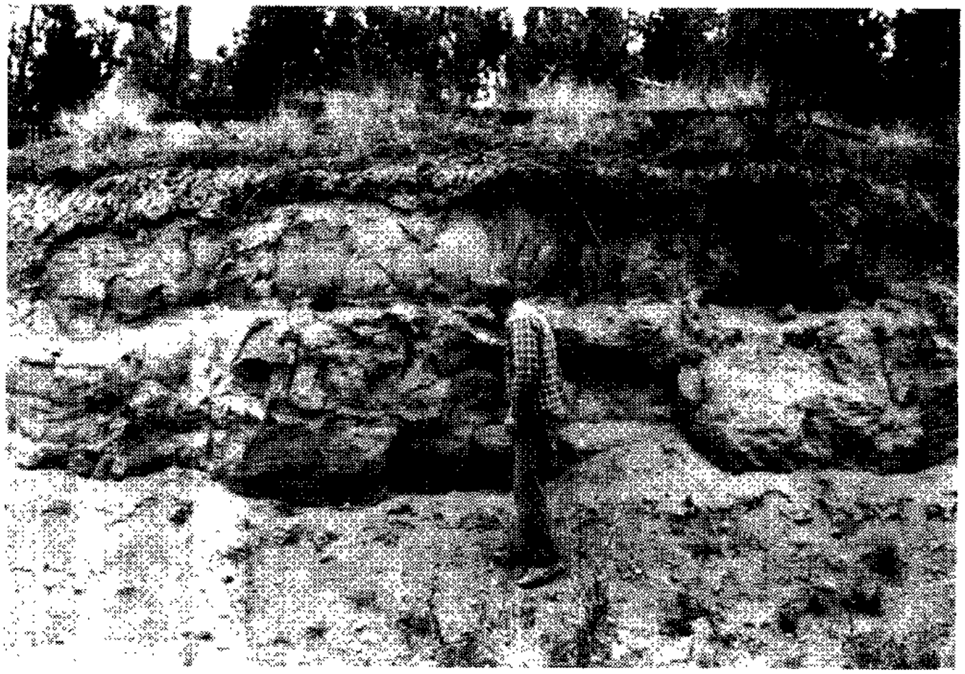

Plate 4-10-5. A thick sequence of glaciolacustrine sand and silt on the north side of Chilcotin Lake. Planar to wavy stratification can be seen in the lower 1.5 metres of the section. The upper metre consists of climbing ripple cross laminations and planar laminations.

Plate 4-10-6. Broken bedrock exposure in a roadcut with a thin layer of till and a capping veneer of colluvial diamicton.

The open, flat terrain in the northwest part of the Chilanko Forks map area and in the western half of Chezacut map area is characterized by marshes and shallow lakes filled with organic sediment. Organic deposits are also common throughout the deep, broad valleys of the Chilcotin and Chilanko rivers, and Puntzi, Pyper and Tatla lakes. The organic deposits consist of decayed marsh vegetation with minor sand, silt and clay. In the bases of some meltwater channels organic deposits occur as a thin veneer of decaying vegetation over cobble and boulder gravel. There was no subsurface organic material recoverable for dating of the sediments and providing a simple chronostratigraphic framework.

Well-sorted, massive to crudely laminated silt and fine sand in the valley bottoms are interpreted as eolian sediments. They are derived from glaciolacustrine deposits in the Puntzi and Pyper Creek valleys and usually occur as low-relief, dune-shaped forms which are not readily visible on air photographs.

CONCLUSIONS AND EXPLORATION IMPLICATIONS

Late Wisconsinan Fraser glaciation ice advanced across the study region from the southwest towards the northeast. Although multiple glacial advances are known to have occurred elsewhere in British Columbia (Clague, 1989), no evidence of any prior glaciation was found in the study area. A sequence of coarse-grained proglacial sand and gravel was deposited in front of the advancing ice. The contact between the outwash and the overlying till is sharp and unconformable, illustrating the erosive nature of the advancing glacier. During glaciation relatively dense till was deposited from the base of the glacier. Bedrock flutings, striations and drumlins attest to the erosive and sculpting capabilities of the ice and indicate a regional northeasterly direction of flow. Later, as the glacier began to stagnate, less compact, silty sandy till was deposited to form hummocky or kettled moraine.

Synchronous with stagnation, large quantities of glacial meltwater formed channels in the Chilanko, Tatla Lake, Pyper, Puntzi and Chilcotin valleys. Confined subglacial and englacial meltwaters created eskers and esker complexes on the valley floors. Unconfined flow in other areas deposited thick sequences of glaciofluvial sand and gravel in the channels. In the Clusko and Chilcotin River valleys, meltwaters appear to have been dammed by stagnant ice masses creating short-lived glacial lakes. Late-glacial re-advances of ice from the Anahim Lake region and Mount Waddington may have reached the edge of the study area (Tipper 1971a). Hummocky morainal sediments may have been deposited along the margin of the late glacial advances but no distinct deposits of either are identified in the study area. Meltwaters from these advances followed existing valleys and deposited more sand and gravel. These deposits have since been incised by modern rivers. The growth and decay of vegetation in valleys and on the open uplands to the west has produced organic deposits. Colluviation has been ongoing slowly since the retreat of ice, forming thin diamicton veneers on the steeper slopes.

Successful mineral exploration in this area will probably require the use of drift prospecting techniques due to limited bedrock exposures. Different genesis and transport histories of the various surficial sediments make some types of sediment more favorable than others for drift exploration (Fortescue and Gleeson, 1984). The thickness of the deposits will affect the ease of sampling and in some cases provides more information on genesis. The best sediments for drift sampling are basal meltout and lodgement tills. These deposits occur relatively close to their source so that boulder tracing and geochemical anomalies in these sediments can be good indicators of nearby mineral occurrences. Using ice-flow directional indicators (striations, flutings, drumlins and till fabrics) these tills can be used to trace dispersal ribbons and isolate mineral sources as demonstrated by DiLabio (1989) and Shilts (1976). Englacially or supraglacially transported debris deposited in hummocky or flat terrain is usually more distally derived and the provenance of the anomaly is less easy to track. Primary colluvial sediments from local bedrock are good indicators of mineral provenance. Colluvium derived from a pre-existing sediment is less desirable as an indicator.

Glaciofluvial outwash sand and gravel deposits tend to have more complex transport histories and they may be less reliable indicators of mineral occurrence. Commonly these sediments are reworked from a variety of sources and determining their provenance may be difficult. These deposits also experience a much more rapid dilution downstream from mineralization due to high rates of sediment transport and deposition. In some cases however, they may contain concentrations of heavy minerals that can be used to detect and trace mineral occurrences. Eolian samples are the least useful sediments for drift exploration sampling.

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