QUATERNARY GEOLOGY OF THE MARILLA MAP SHEET (NTS 93 F/12)

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INTRODUCTION

This paper summarizes surficial geology, Quaternary stratigraphy and ice flow history studies conducted in the Marilla map area (NTS 93 F/12) in central British Columbia as part of the Nechako National Mapping Project (NATMAP) (Figure 1). Regional scale (1:50 000) till sampling was also undertaken and is summarized by Levson *et al*. (1999). This work expands preliminary surficial geology mapping and till sampling from the previous summer (Levson *et al*., 1998).

Mapping objectives were to produce a 1:50 000 scale surficial geology map and understand the distribution of Quaternary deposits and ice flow patterns for the Marilla area. Objectives of stratigraphic and sedimentologic studies were to interpret the glacial history of the area. Data from these studies will help locate suitable areas for future drift prospecting work and help aid in the interpretation of till geochemical data.

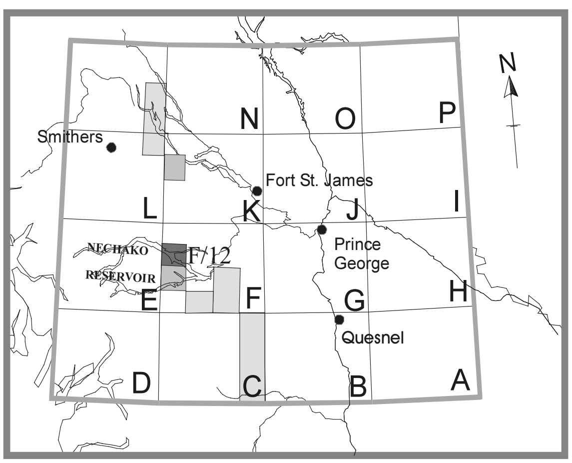

Figure 1. Location of study area in central British Columbia. Area straddles the Ootsa Lake reach of the Nechako Reservoir.

RELATED STUDIES

Mapping of Quaternary deposits in the Interior Plateau was pioneered by Tipper (1971). Terrain mapping at a scale of 1:50 000 was completed by Howes (1977) for several NTS map sheets, south and east of the Marilla area. More recent surficial mapping within the Interior Plateau is a component of the Nechako NATMAP project. Several 1:100 000 surficial geology maps produced by Plouffe (1994, 1996) cover central parts of the Nechako Plateau. A summary of 1:50 000 scale Quaternary geology mapping projects in the Nechako Plateau is provided by Levson and Giles (1997). In conjunction with this fieldwork, NTS map sheet 93 F/5 was mapped by Levson *et al*. (1999).

FIELD PROCEDURES

Air photo interpretation, field checking and stratigraphic and sedimentologic investigations were used to complete surficial geology mapping. Over 180 field check stations were compiled for the map sheet. At each field station the mappable surficial material was recorded and described (sediment texture, areal extent of map unit, and surface topography). Mapping followed guidelines of the Terrain Classification System for British Columbia (Howes and Kenk, 1997). Stratigraphic and sedimentologic studies were carried out on large Quaternary exposures within the area. The regional ice-flow history was determined from the study of striae, crag-and-tail features, and flutings.

Road access within the map area is quite extensive, consisting mostly of logging roads and some well maintained secondary roads. A forest company barge was needed to access

Photo 1. Aerial view of Cheslatta Lake showing general landscape characteristics of the study area. Cheslatta River can be seen entering Cheslatta Lake from the left of the picture.

roads south of Ootsa Lake. Places that could not be reached by truck were accessed using an all terrain vehicle and motor boat.

PHYSIOGRAPHY AND LANDFORMS

The Marilla map area occurs within the Nechako Plateau physiographic region (Holland, 1976). A general physiographic description of the study area is provided by Levson *et al*. (1999; see their Figure 2). Low relief and large surfaces of flat or gently rolling topography are diagnostic features of the plateau, which has elevations up to about 1500 m (Photo 1). The plateau is flanked by the Hazelton and Coast mountains to the west and the Skeena and Omineca ranges to the north. The Quanchus Range (Mt. Wells, Tweedsmuir Peak and Michel Peak) lie immediately west of the map area in Tweedsmuir park, while the Fawnie and Nechako ranges are to the southeast. The majority of the ground surface is covered by glacial drift with very little exposed bedrock.

The dominant landforms within the map area are flutings and drumlinoid ridges. Up-ice (stoss ends) of these features are commonly bedrock knobs, while down-ice (lee) portions appear as ridges of glacial diamicton. Well defined depressions with flat bottoms are consistently seen at the stoss ends and around the sides of these streamlined landforms. These depressions are commonly bog filled. Occasionally crescent-shaped lakes occur at the stoss end of drumlins and flutes (Photo 2). These depressions resemble crescentic scours and lateral furrows as described by Shaw and Sharpe (1987). Therefore, it is quite likely that drumlins and flutes within the map area are remnant ridges formed by subglacial meltwater erosion. Esker complexes, glaciofluvial deposits and meltwater channels can also be found within the map area and rare glaciolacustrine deposits are found at elevations below 950 m.

QUATERNARY STRATIGRAPHY

Stratigraphic information was collected from large, well exposed Quaternary sections along Ootsa Lake on the Nechako Reservoir and Cheslatta River. Some sections on the Cheslatta River occur in the southern part of the Takysie Lake map sheet (NTS 93 F/13). A summary of the Quaternary stratigraphy from these areas is provided below. Stratigraphy from other parts of

Photo 2. Crescentic-shaped lake at the stoss (up-ice) end of a bedrock ridge. Ice-flow direction is from right to left. Ootsa Lake is in the background and Marilla is located at the end of the road on the far right.

the reservoir have been described by Levson and Giles (1997) and Levson *et al*. (1998).

Surficial sediments encountered within the map sheet are mainly a product of the last or Late Wisconsinan glaciation (Tipper, 1971; Levson *et al*., 1998). Pre-Late Wisconsinan sites are rare on the Nechako Plateau but a few sites have been described by Harington *et al*. (1974), Levson and Giles (1997), Plouffe and Jetté (1997) and Levson *et al*. (1998). The closest of these sites to the study area can be found off Euchu Reach on Chelaslie Arm. Radiocarbon dates from organics in sediments under till at these sites, generally range from about 27,000 to >45,000 years BP and correspond to the Olympia Nonglacial interval. Hence, these dates support a Late Wisconsinan age (Fraser Glaciation) for the glacial drift overlying these older organic-rich deposits.

The most common stratigraphic unit in the map area is a massive diamicton unit. This unit is poorly sorted, and well jointed, with striated and faceted clasts, strong fissility and high density. It has clear to sharp lower contacts. This diamiction is consistently found in stratigraphic sections throughout the map area and is interpreted as till. Till is defined as a poorly sorted sediment deposited directly from glacier ice with little or no reworking by water or gravity (Dreimanis, 1989). The till is stratigraphically underlain by well to crudely stratified sands and gravels interpreted as advance-phase glaciofluvial deposits. Commonly these sediments are moderately well to well sorted, pebble and cobble gravels and sands. Clasts are typically rounded to well rounded. These sediments also have a moderate to high density and often contain faults and soft sediment deformation features. Locally, similar sands and gravels overlie till and are interpreted as being glaciofluvial and fluvial in origin. Overall, the density of these glaciofluvial and fluvial deposits is low. Local veneers of poorly sorted sand and gravel, formed from washing of the till surface are present within the map area. Surprisingly, glaciofluvial sand and gravel deposits useful for road building purposes are rare in much of the area.

Other sediments commonly found in Quaternary sections in the region are diamictons that originated as glacigenic debris flows. These diamictons possess a low to moderate density and are commonly interbedded with and contain

Photo 3. Interstadial site on Ootsa Lake. The basal unit is till which is overlain by organic-bearing, blue-grey, fine sands (at the level of the sledge hammer), advance-phase glaciofluvial sediments, and till. Crystal Huscroft for scale.

lenses of silt, sand and gravel. Texturally, debris flow diamictons are usually more sandy than basally derived diamictons and have clear to sharp lower contacts. Debris flow units occur in both advance and retreat phase glacial events. They can also be deposited subaerially in glaciofluvial environments or as subaqueous flows in glaciolacustrine environments.

The most complete stratigraphic section in the map area occurs at a newly discovered interstadial site found during this summer's fieldwork along the Nechako Reservoir (Photo 3). The basal unit of this section is a massive, dense, diamicton, containing striated clasts and interpreted as till. Directly overlying it is a blue-grey, very fine sand with silt and clay laminations. Thin lenses and small fragments of organic detritus are present within this unit. This package is interpreted as being lacustrine and is overlain by advance-phase glaciofluvial sediments. A massive, dense, matrix-supported diamicton (interpreted as till) sharply overlies the entire sequence. Rare sand lenses were present near the top of the unit.

LANDSLIDE STUDIES

A number of rotational landslides present along the Cheslatta River were investigated during stratigraphic studies in the region. These slides probably result in increased siltation in the river and locally may pose a safety hazard. Rotational landslides form along concave slip surfaces with displaced material experiencing little internal deformation (Cruden and Varnes, 1996). Understanding the processes that trigger slides along the river has been aided by stratigraphic work.

Longitudinal profiles, determining the surface topography, and detailed field observations were made at two landslides along the river. Evidence of back-tilted slump blocks (trees on slump blocks leaning back towards the main scarp) and sag ponds helped classify these slides. Both slides have an amphitheatre shape with steep, curved head scarps, and mudflows at their bases. The largest slide was approximately 230 m wide with a 3 m high head scarp and had three separate slump blocks. This slide was found on the south side of Cheslatta River close to where it enters Cheslatta Lake (Photo 4). The

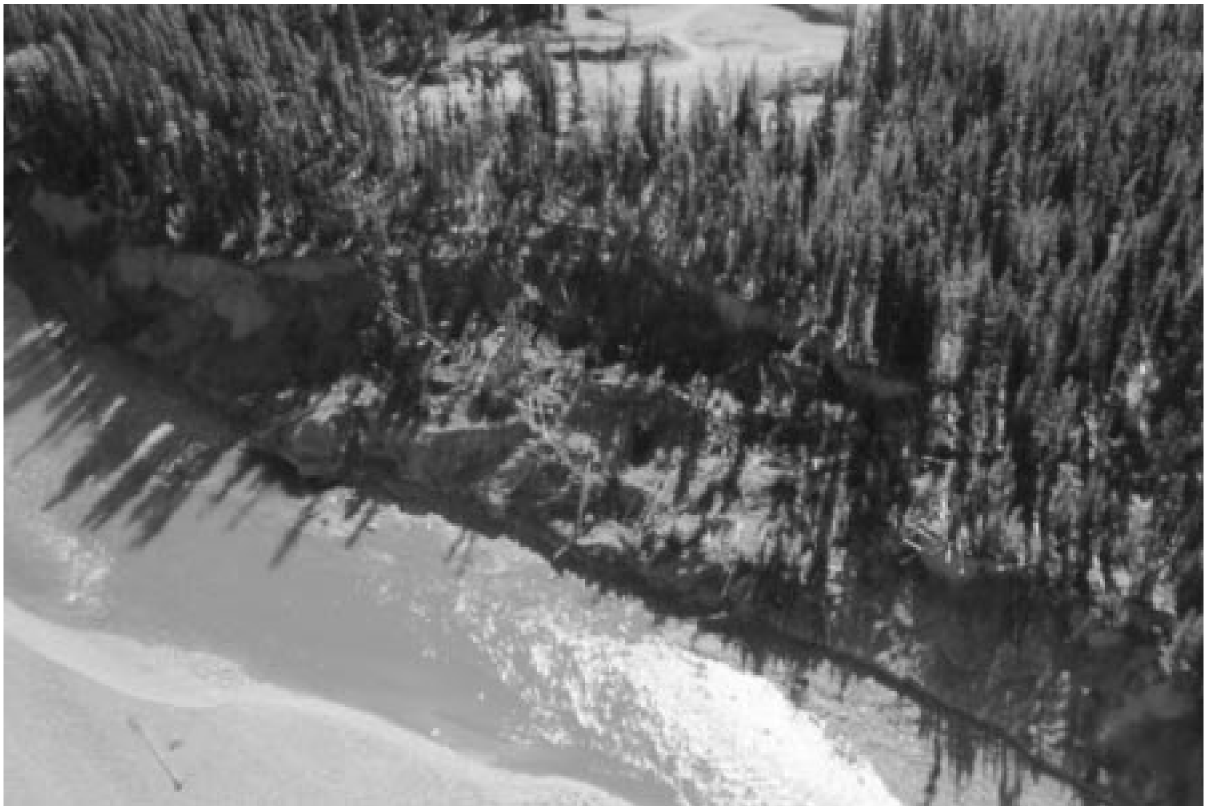

Photo 4. Rotational landslide on the south side of Cheslatta River close to Cheslatta Lake. Note presence of numerous uprooted trees and erosive, turbulent river water flowing along toe of slide.

second slide, was 34 m wide with a 6 m high head scarp and had one slump block. It was found close to the head waters of Cheslatta River. The two factors thought to be responsible for triggering both landslides were the presence of a deep, basal, interbedded very fine sand, silt and clay unit and the removal of material from the toe of each slide by river undercutting.

The presence of basal, interbedded very fine sands, silts and clays is significant because they provide a potential slip surface for the slide to initiate along. At both sites this unit was semi-continuous, highly sheared and brecciated. Bedding plane and slickenside measurements within this unit locally dip toward the main body of the slide (Photo 5). Erosion at high water level (Photo 6) within the Cheslatta River was responsible for undercutting at the toe of each slide (Photo 7). When material was eroded from the toe of each slide, slopes steepened, became unstable, and failed. Eroded material is replaced by material from above, perpetuating the landslide processes.

ICE-FLOW HISTORY

Glacial ice flowing off the Coast Mountains moved in an east and northeast direction onto the Nechako Plateau (Tipper, 1971). Ice flow direction within the map area is dominantly northeast and is reflected by the orientation of large scale landforms (crag-and-tail features, drumlins and glacial flutings) and by striae measurements from exposed bedrock. These data show a dominant regional ice-flow direction between 68° and 75°. Some striae measurements at low elevations along Ootsa Lake provided evidence of valley-parallel (topographically controlled) ice-flow. Measured striae at these sites ranged from 125° to 150°. A roche-moutonnée showing signs of anomalous westerly ice-flow was found at one site in the northwest corner of the map sheet. Striae oriented at 300° were found on east facing surfaces of this form. Westerly ice flow, interpreted as a late glacial event has been observed in surrounding areas but evidence for this event is not widespread in this map sheet (Levson *et al*., 1999).

Photo 5. Brecciated and sheared, interbedded very fine sands, silts and clays at base of a landslide along Cheslatta River. Beds dip into the slope at 37° to 54°. 20 cm knife for scale.

Photo 6. Evidence of high water level along Cheslatta River (dark line close to base of section) roughly 3 meters above river level. Stephen Mate for scale.

Photo 7. Evidence of undercutting along banks of the Cheslatta River. This deep scour occurs at maximum water level just above the till-bedrock interface. Stephen Mate for scale.

SUMMARY

Quaternary geology studies within the Marilla map area reveal extensive areas of rolling ground moraine with a thick till cover. This material was deposited during the Late Wisconsinan. Numerous bog and swamp deposits are present throughout the area. They commonly form in crescent-shaped erosional depressions that wrap around fluted landforms and are interpreted as large subglacial meltwater erosion features

The regional ice flow direction in the map area is approximately 68° to 75°. Mineral dispersal is expected to reflect this trend. However, mineral dispersal patterns in the northwest corner of the map sheet, where evidence of westerly ice-flow indicators are found, may be more complicated. More detailed work will be needed in this part of the map area to gain a better understanding of the ice-flow history and effects on dispersal.

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REFERENCES

Cruden, D.M. and Varnes, D.J. (1996): Landslide types and processes; *in* Landslides: Investigation and Mitigation, A.K. Turner, and R.L Schuster, Editors, *National Academy Press*, Washington D.C., pages 36-75.

Dreimanis, A. (1989): Tills: Their genetic terminology and classification; *in* Genetic Classification of Glacigenic Deposits, R.P. Goldthwait, and C.L. Matsch, Editors, *A.A. Balkema*, Rotterdam, pages 17-83.

Harington, C.R., Tipper, H.W. and Mott, R.J. (1974): Mammoth from Babine Lake British Columbia; *Canadian Journal of Earth Sciences*, Volume 11, pages 285 – 303.

Holland, S.S. (1976): Landforms of British Columbia, a physiographic outline; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 48, 138 pages.

Howes, D.E. (1977): Terrain inventory and Late Pleistocene history of the southern part of the Nechako Plateau; *B.C. Ministry of Lands and Parks*, RAB Bulletin 1, 29 pages.

Howes, D.E., and Kenk, E. (Editors)(1997): Terrain classification system for British Columbia Ministry of Environment, *British Columbia Ministry of Environment*, Manual 10, version 2, 102 pages.

Levson, V.M. and Giles, T.R. (1997): Quaternary geology and till geochemistry studies in the Nechako and Fraser Plateaus, central British Columbia; *in* Interior Plateau Geoscience Project: Summary of Geological, Geochemical and Geophysical Studies, L.J. Diakow and J.M. Newell, Editors, *Geological Survey of Canada* Open File 3448 and *B.C. Ministry of Employment and Investment*, Paper 1997-2, pages 121-145.

Levson, V.M., Stumpf, A.J., and Stuart, A.J. (1998): Quaternary geology and ice-flow studies in the Smithers and Hazelton map areas (93 L and M): Implications for Exploration; *in* Geological Fieldwork 1997, *B.C. Ministry of Employment and Investment*, Paper 1998-1, pages 5-1 to 5-8.

Levson, V.M., Mate, D.J., and Stuart, A.J. (1999): Quaternary geology and drift prospecting studies in the north central Nechako Plateau (93 F and K): *in* Geological Fieldwork 1998, *B.C. Ministry of Energy and Mines*, Paper 1999-1, this volume.

Plouffe, A. (1994): Surficial geology, Chuchi Lake (93N/SE) and Tezzeron Lake (93K/NE), British Columbia; *Geological Survey of Canada*, Open Files 2842 and 2846 (1:100 000 maps).

Plouffe, A. (1996): Surficial geology, Tsayta Lake (93N/SW), Fraser Lake (93K/SE), Cunningham Lake (93K/NW), Burns Lake (93K/SW), Manson Creek (93N/NE) and Old Hogem (93N/NW); *Geological Survey of Canada*, Open Files 3071, 3182, 3183, 3184, 3312, and 3313 (1:100 000 maps).

Plouffe, A. and Jetté, H. (1997): Middle Wisconsinan sediments and paleoecology of central British Columbia: sites at Necoslie and Nautley Rivers; *Canadian Journal of Earth Sciences*, Volume 34, pages 200-208.

Shaw, J., and Sharpe, D.R. (1987): Drumlin formation by subglacial meltwater erosion; *Canadian Journal of Earth Sciences*, Volume 28, pages 2316-2322.

Tipper, H.W. (1971): Glacial geomorphology and Pleistocene history of central British Columbia; *Geological Survey of Canada*, Bulletin 196, 89 pages.