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GEOLOGICAL SURVEY OF CANADA | COMMISSION GÉOLOGIQUE DU CANADA

BRITISH COLUMBIA

DESCRIPTIVE NOTES
Surficial Geology of the Adsett Creek map area (NTS 094J/SE)

Introduction
The Adsett Creek map area (NTS 094J/SE) is situated in northeastern British Columbia, south of Fort Nelson. Most of the study area is located within the Fort Nelson Lowland physiographic region (Holland 1976), a generally flat, low-lying area 450-600 m above sea level (asl). Flat-topped mesas in the southern map area are located within the Alberta Plateau physiographic region (Holland 1976), rising 60-90 m above the lowland to an elevation 910 m asl. The Prophet River flows north through the study area, and eventually joins the Muskwa River. The area is blanketed by Boreal forest (white and black spruce, aspen, lodgepole pine) and underlain by soils with high clay content that result in abundant poorly drained bog and fen areas. The main economic activities in the map area include oil and gas exploitation and forestry.

Methods
The surficial geology of the Adsett Creek map area was interpreted from 1:60 000 scale airphotos (British Columbia Integrated Land Management Bureau, 1986). Prior to the field season, preliminary surficial geology interpretations were made, and then subsequently ground truthed in the field. Aspects of the regional surficial geology were also interpreted from shuttle radar topography mission (SRTM) imagery (3-arc second, 90 meter resolution) and to a lesser extent light ranging and detecting (LIDAR) imagery. Field data were obtained by truck, all terrain vehicle, helicopter and jet boat in the summers of 2004 and 2005. Twenty-two samples of diamict were submitted for trace element geochemistry to provide a preliminary characterization of tills in the area (Trommelen,2006).
Additional stratigraphic investigation of the Prophet River valley occurred in early fall of 2005. Thirteen key sections observed along the Prophet River valley expose dense clay, silt, sand, gravel, stratified diamict and massive diamict. Based on lithology, texture, sedimentary structures, stratigraphic position, radiocarbon dating and paleolimnology, these sections have been separated into six units. A schematic cross-section for the Prophet River valley is found in Figure 1, and details are forthcoming (Trommelen and Levson submitted 2007).

Bedrock Geology
The bedrock in the map area consists of horizontally bedded Fort St. John Group shales and sandstones (Buckinghorse Formation, Sikanni Formation, and Sully Formation; (Thompson 1977). Outcrops are rare in the map area, except along steep river cuts where there is little or no Quaternary cover. Exposed along the mesa scarps, the Dunvegan Formation sandstone and conglomerate overly the Fort St. John Group rocks (Taylor and Stott 1968, Thompson 1977).

Surficial Geology
Till is the most extensive surficial material in the Adsett Creek map area and consists of a clayey-silt diamicton with a clast content varying from 5-15%. Clast lithologies in till consist of locally derived sandstone, ironstone, chert and shale, intermixed with Canadian Shield and Proterozoic to Paleozoic sedimentary bedrock transported by the Laurentide Ice Sheet from the northeast. Occasional phyllite, limestone, granitic and gneissic clasts may have been transported to the study area from the west, by the Cordilleran Ice Sheet, in the Late Wisconsinan or earlier (Trommelen 2006).
Glacial lake sediments occur throughout the western map area, between elevations of 600-525 m asl. Where encountered, they consist of massive, well-sorted fine sand, silt and clay. A delta was found at 560 m a.s.l. (upper elevation), sourced by a meltwater channel trending southwest off the uplands that is now occupied by Adsett Creek. These sediments were deposited in glacial Lake Prophet, which formed as a result of the damming of the northward and eastward drainage by ice. Some regions along the plateau level of the modern Prophet River exhibit extensive mounds or small hills (Figure 2). These features are also found along the Fort Nelson River (NTS 094I/SW) (Trommelen and Smith 2007). Identified on aerial photograph and LIDAR hillshade images, ground checking indicates that they consist of clay, with one to two metres of relief and diameters of 100-600 m. Across the regions covered by hummocks, topography is very flat, with1-3 m of elevation gain over 10 km. It is possible that these are periglacial features (Boothon and Caban 1995; Trommelen and Smith 2007), formed after rapid drainage of the small ice-dammed lakes. However, further sedimentology and geomorphic work is required to confidently determine the origin of these features.
Glaciofluvial sediments are rare in the map area, though a southeast-trending esker, approximately 10 km long and 1-5 m high, was found just southwest of Klua Creek.
Colluvial sediments, sourced from clay-rich till, glaciolacustrine clay, interglacial sediments and shale bedrock, are present along all river valleys and most stream cuts. Cutbanks along the Prophet and Fort Nelson rivers, incised into thick (5 - >50 m) fine-grained sediments, are extremely unstable. These slopes are perceptible to both slow and fast mass movements, including slides, slumps, flows and creep. Colluvial debris along the Prophet River bottom has changed the thalweg location in many areas, indicating repeated blockage of the river during the Holocene.
Permeability of these surficial sediments is low, and combined with low topographic gradients, has lead to widespread development of organic bog and fen vegetation.

Glacial History
The Laurentide Ice Sheet (LIS) inundated northeast British Columbia up to the Rocky Mountain front during the Late Wisconsinan glaciation. The map area is interpreted to be near the western limit of the LIS and just within of the eastern limit of the Cordillera Ice Sheet. Coalescence between the two ice sheets is likely - however, the limit of Cordilleran ice in Columbia Mountains for the Late Wisconsinan is not well established in northern British Columbia. West of the Fort Nelson Lowland, the limit of the LIS, in the Mackenzie Basin, can be found at least 10 km up-valley into the Rocky Mountain front (Testa, Chisca and Tsoholi River valleys, NTS 094A). Additionally, a outlwrk on the Tuchodi River exposes Cordilleran/Montane outwash overlain by glaciolacustrine sediment. This indicates outwash was draining east from the Cordilleran/Montane glaciers prior to advance of the LIS which blocked drainage along the mountain front.
West to west-southwest ice-flow direction in the Adsett Creek map area is recorded by flutings and low-lying streamlined bedrock hills. A subsequent set of cog and tail features trend 190°-200°, likely formed by local ice flow into the Prophet River valley during deglaciation. Chronological constraint on the advance of the LIS is provided by a radiocarbon date of 24 400 ± 150 C14 yr BP on wood recovered from gravel underlying Late Wisconsinan till just north of the map area (Levson et al. 2005). Retreat of ice from the area occurred between 11 500 -11 000 14C years BP (Mathews 1978, Mathews 1980, Dyke 2004).
A dense set of curvilinear moraines, southwest of Klua Creek, plot the retreat of a southwestward flowing ice lobe in the Fort Nelson Lowland. Several areas of closely-spaced crevasse ridges close to the moraine set record periods of ice stagnation during retreat. This pattern also suggests that retreat may not have been uniform, but lreiloid was punctuated by discrete readvances and/or surges (Christoffersen et al. 2005; Bennet et al. 1996).
Northeast retreat of the LIS temporarily blocked existing drainage patterns, leading to the formation of transient proglacial lakes. Glaciolacustrine sediments situated in the western map area were deposited in glacial Lake Prophet, which formed as a result of this ice damming. Adjacent to the Rocky Mountain Foothills, the lake existed at an upper level of ~750-800 m asl (Bednarski 2000) and likely submerged the Prophet-Muskwa divide (Mathews 1980, Rampton 1987). Once the ice margin retreated northeast of Akue Creek and the lower Prophet River, the glacial lake filling the upper Muskwa and Tetsa river valleys likely drained into this newly-exposed low-lying part of the Adsett Creek map area. Constrained by topography and the retreating ice margin, >10 m of glaciolacustrine sediment was deposited in the Prophet River valley, including the small delta at 560 m asl, before water was able to freely drain northward through a spillway now occupied by the Muskwa River.
Since ice retreated from the Prophet River area, the river has undergone multiple periods of aggradation and incision. At section 8 (Figure 1), a piece of wood provided a radiocarbon date of 6 120±70 BP, indicating the Prophet River underwent six metres of aggradation followed by 18.5 m of incision to the present level since that time.

Quaternary Stratigraphy
The Prophet River valley system existed prior to the Late Wisconsinan Laurentide glaciation, with drainage probably to the northnortheast and headwaters in the Rocky Mountains. Mature subrounded to rounded gravels (Unit A-1 and Unit C) and immature subangular to subrounded gravels (Unit A-2) were deposited along the valley (Figure 1). At several sites, overbank fines from this system are preserved overlying the fluvial gravels (Unit B). All clasts in these units are derived from the Rocky Mountains or local bedrock and the sediment contained organics beyond the limit of radiocarbon dating.
Contemporaneous to deposition of fluvial sediments along the main channel, formation of one or multiple lacustrine environments occurred. Exact relations between units are unknown as all radiocarbon dates were near or at the limit of radiocarbon dating. However it can be assumed that sedimentation likely occurred over a considerable time range. Change to a lacustrine environment could happen by abandoning a river channel (creation of an oxbow lake), blockage due to landslide (sag pond formation) or blockage by an advancing glacier. Horizontally laminated organic-rich black clay and silt was likely deposited in an oxbow-lake or sag pond environment surrounded by a spruce forest, an interpretation substantiated by macrofossil data (Telka 2005). Ponding by a glacier is discounted by the abundance of organics and lack of clasts, derived from the Canadian Shield, within the section.
As the Laurentide Ice Sheet advanced, northward drainage of the Prophet River was blocked and advance-phase glaciolacustrine sediment deposited in the valley. The rhythmically bedded clay and silt sequence (Unit D) varies from 4 to at least 15 m thick, unconformably overlain by Laurentide till (Unit G) or Holocene terrace gravels (Unit F).

Aggregate Potential
The map region is dominated by the presence of clast-poor diamict and massive clays and silts unsuited for aggregate use. A very extensive mantle of organics throughout the study area adds difficulty in identifying aggregate resources. While no gravel pits occur in the study area, a significantly large aggregate deposit occurs just north at Ellen Creek (NTS 094J/09). New aggregate potential also north of the map area includes the glaciofluvial outwash deposit at Klua Creek (NTS 094J/09). Within the map area, possible aggregate sources are limited to the delta at Adsett Creek and glaciofluvial gravels adjacent to meltwater channels or occurring as high glaciofluvial terraces.

Acknowledgements
This map was completed as part of a Master of Science degree at the University of Victoria, supervised by Vic Levson and funded by the British Columbia Ministry of Energy, Mines and Petroleum Resources (EMPR), Oil and Gas Division, Resource Development and Geosciences Branch; as well as a University of Victoria-EMPR partnership grant. Additionally, the project received support from the Shallow Gas and Diamond Opportunities in Northern Alberta and British Columbia project (NR4409) conducted by the Geological Survey of Canada (Natural Resources Canada), Alberta Geological Survey (Alberta Energy and Utilities Board), the Resource Development and Geosciences Branch (EMPR) and the GEM Program (Geological Survey of Canada). Surficial geology maps adjacent to the Adsett Creek map area include 94I/SW (Trommelen and Smith 2007) and 94G (Bednarski 2000). Field assistance by Kirsten Brown, Amber Church, Tania Demchuk and Adrian Hickin was greatly appreciated.

References

Bednarski, J. M. 2000. "Surficial geology, Trutch British Columbia (NTS 094G)." Geological Survey of Canada Open File 3685: 1:250 000 scale map.

Bennet, M. R., Hambrey, M. J., Huddart, D. and Ghienne, J. F. 1996. "The formation of a geometrical ridge network by the surge type glacier Kongsvegen, Svalbard. Journal of Quaternary Science 11 437-449.

Boulton, G. S. and Caban, P. 1995. "Groundwater flow beneath Ice Sheets: Part II - It's impact on glacier tectonic structures and moraine formation." Quaternary Science Reviews 14: 563-587.

Christoffersen, P., Piotrowski, J. and Larsen, N. 2005. "Basal processes beneath an Arctic glacier and their geomorphic imprint after a surge, Elisebreen, Svalbard; Quaternary Research 64 125-137.

Dyke, A. S. 2004. "An outline of North American deglaciation with emphasis on central and northern Canada." In: Quaternary Glaciations - Extent and Chronology, Part II: North America. J. Ehlers and P.L. Gibbard (eds.), Development in Quaternary Science Series, Elsevier B.V.: 373–424.

Holland, S. S. 1976. "Landforms of British Columbia, a physiographic outline." British Columbia Department of Mines and Petroleum Resources Bulletin 48: 138.

Levson, V. M., Ferbey, T., Hickin, A. S., Bednarski, J., Smith, I. R., Demchuk, T. E., Trommelen, M. S., Kerr, B. and Church, A. 2005. "Surficial Geology and aggregate studies in the boreal plains of northeast British Columbia." Summary of Activities 2005, BC Ministry of Energy and Mines.

Mathews, W. H. 1978. "Quaternary stratigraphy and geomorphology of the Charlie Lake (94A) map area, British Columbia." Geological Survey of Canada, Paper 76-20: 25 pages; Map 1640 A, 1:250 000 scale.

Mathews, W. H. 1980. "Retreat of the last ice sheets in northeastern British Columbia and adjacent Alberta." Geological Survey of Canada, Bulletin 331: 22.

Rampton, V. N. 1987. "Late Wisconsin deglaciation and Holocene river evolution near Fort Nelson, northeastern British Columbia." Canadian Journal of Earth Sciences 24: 188-191.

Taylor, G. C. and Stott, D. F. 1968. "Fort Nelson, British Columbia (94J)." Geological Survey of Canada, Paper 68-13: 21.

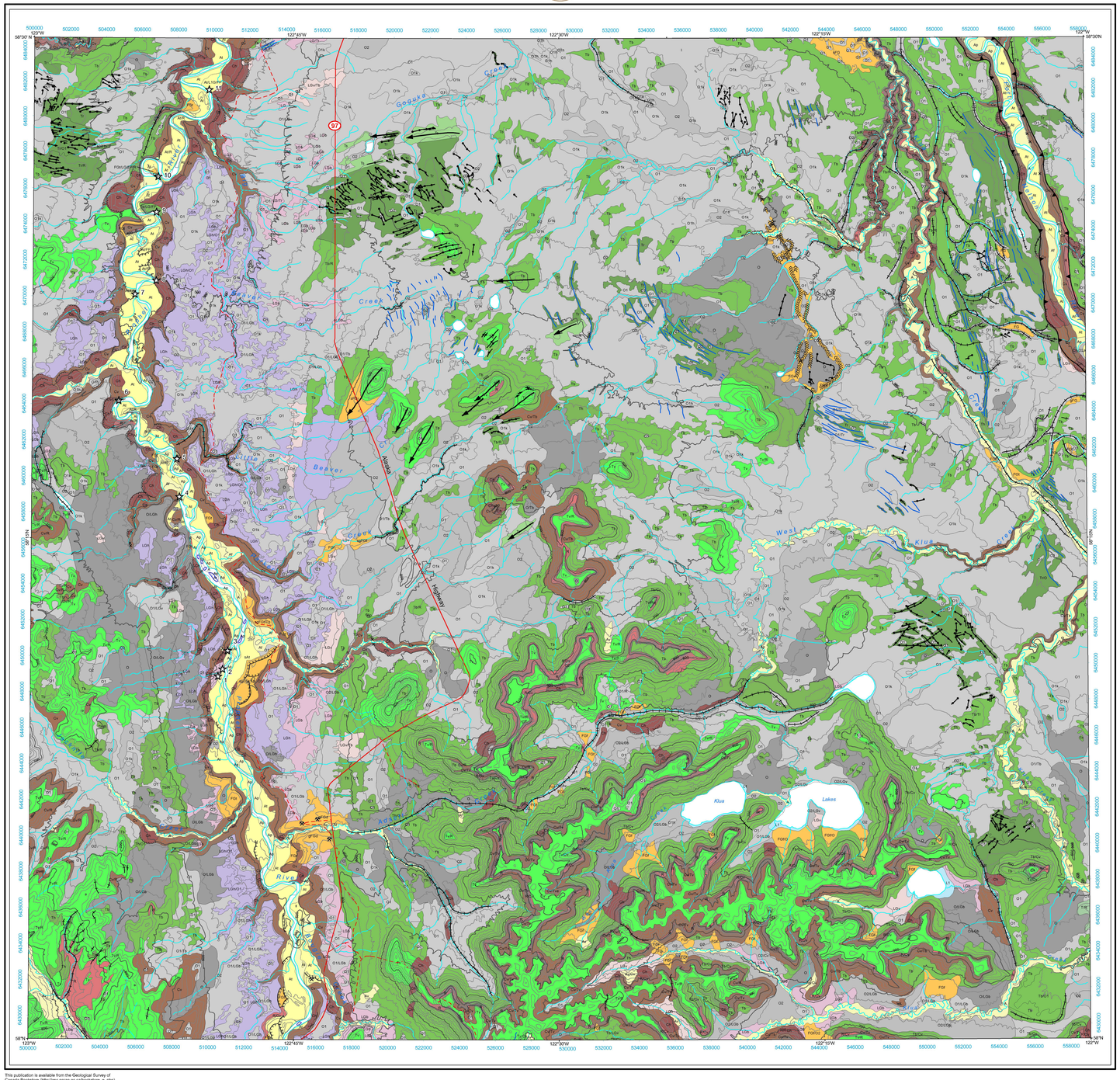
Telka, A.M. 2005. Plant Macrofossil and Arthropod Report.MFRPT: 05-02. Ottawa, Paleotec Services: 20 p.

Thompson, R. I. 1977. "Geology of Beatton River, Fontas River and Petitot River map-areas, northeastern British Columbia." Geological Survey of Canada, Paper 75-11: 8.

Trommelen, M. S. 2006. "Quaternary stratigraphy and glacial history of the Fort Nelson (southeast) and Fontas River (southwest) Map Areas (NTS 094J/SE and 094I/SW), Northeastern British Columbia." University of Victoria Unpublished M.Sc. thesis: 250.

Trommelen, M. and Levson, V. 2008. Quaternary stratigraphy of the Prophet River, northeastern British Columbia. Canadian Journal of Earth Sciences, Volume 45, Number 5, May 2008, pages 565-575.

Trommelen, M. S. and Smith, I.R. 2007. Surficial Geology, Dazo Creek, British Columbia. Geological Survey of Canada, Open File 5527; British Columbia Ministry of Energy, Mines and Petroleum Resources, Map 2007-1; scale 1:100,000.



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doi: 10.4095/288643

LOCATION MAP

Geology by M. Trommelen, University of Victoria, 2004-2005

Geology compilation by M. Trommelen and V. Levson, 2004-2005

Digitizing and digital cartography by M. Fournier, 2010

GSC OPEN FILE 6832
BCGS OPEN FILE 2011-05

SURFICIAL GEOLOGY

Adsett Creek

NTS 94J/SE

Scale 1:100 000

2 1 0 2 4 6 8 Kilometres

Universal Transverse Mercator Projection
North American Datum 1983

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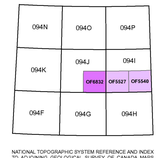

NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

LEGEND

QUATERNARY

SURFICIAL DEPOSITS

POST LAST GLACIATION

NONGLACIAL ENVIRONMENTS

O — ***ORGANIC DEPOSITS:*** undifferentiated bog and fen deposits; peat and muck; 1 to 3 m thick; formed by the accumulation of plant material in various stages of decomposition; generally occurs as flat, wet terrain (swamps and bogs) over poorly drained substrates.

O1 — **Bog peat:** sphagnum or forest peat formed in an ombrotrophic environment; wet terrain; may be treed or treeless.

O1h — **Hummocky bog deposits:** area may be underlain by ground ice or shallow permafrost conditions.

O1k — **Bog deposits:** with thermokarst terrain related to melting of ground ice.

O2 — **Fen peat:** peat derived from sedges and partially decayed shrubs in an eutrophic environment; forms relatively open peatlands with a mineral-rich water table that persists seasonally near the surface; often covered with low shrubs and sometimes a sparse layer of trees.

COLLUVIAL DEPOSITS: mass wasting debris < 1 to > 10 m thick; nonsorted to poorly sorted, massive to stratified debris deposited by direct, gravity-induced movement; composition dependant on source material.

Ch — **Landslide and slump debris:** active and inactive landslides; hummocky topography; diamicton, generally 1 to 10 m thick, but may exceed 10 m near the toe of large landslides.

Cv — **Colluvial veneer:** thin and discontinuous cover of slumped and/or soliflucted material < 2 m thick; overlies bedrock or till.

ALLUVIAL DEPOSITS: sorted gravel, sand, silt and organic detritus deposited by flowing water; commonly stratified.

Ap — **Floodplain deposits:** sorted gravel, sand, silt and organic detritus >1 m thick; forming active floodplains close to river level with meander channels and scroll marks.

Af — **Alluvial fan deposits:** poorly sorted gravel, sand and organic detritus >1 m thick forming fans at the toe of slopes.

At — **Fluvial terraces:** inactive terraces above modern floodplain; >2 m thick; consisting of gravel, sand, and overbank silts and organic detritus.

Av — **Alluvium veneer:** primarily occurs as uniform sheets of slopewash on gentle slopes; < 1 m thick.

A — **Undifferentiated fluvial deposits.**

L1 — ***LACUSTRINE DEPOSITS:*** sand, silt and minor clay deposited in a former lake; generally overlain by organic deposits; exposed by recent fluctuations in lake levels; < 1 m thick.

PRE-GLACIAL ENVIRONMENTS

FP — **Pre-glacial fluvial sediments**: sand, gravel, silt, clay and organic detritus, deposited by rivers flowing east from the Rocky Mountains; > 1 m thick. Once contained coal seams of lithologies, including sandstone, pebble conglomerate, chert and quartzite; devoid of clasts from the Canadian Shield. Unit occurs only in the subsurface.

PRE-QUATERNARY BEDROCK

R — Sedimentary bedrock, Cretaceous Fort St. John Group shales (including the Buckinghorse, Sikanni and Sully Formations) and Dunvegan Formation sandstone and conglomerate exposed in highlands and along meltwater channel and canyon walls.

POSTGLACIAL OR LATE WISCONSINAN

PROGLACIAL AND GLACIAL ENVIRONMENTS

LG — ***GLACIOLACUSTRINE DEPOSITS:*** fine sand, silt and clay, with minor debris-flow diamicton, deposited in glacier-dammed lakes in valleys and along the margin of the retreating Laurentide Ice Sheet, usually overlain by organic deposits in lowlands with flat topography.

LGb — **Glaciolacustrine blanket:** forming blankets > 2 m thick.

LGh — **Glaciolacustrine Hummocks:** well-sorted massive clay with a hummocky geomorphology, 100-600 m in diameter, with 1-2 m of relief.

LGv — **Glaciolacustrine veneer:** thin and discontinuous, < 2 m thick.

GLACIOFLUVIAL DEPOSITS: well to poorly stratified sand and gravel with minor diamicton; deposited behind, at or in front of the ice margin by glacial meltwater; represents a potential aggregate source.

FG — **Undifferentiated proglacial outwash:** cross-stratified gravel and sand deposited in front of the ice margin, often within a meltwater channel.

FGd — **Glaciofluvial delta:** cross-bedded gravel and sand deposited in a raised, relatively flat-topped, glaciofluvial delta at the mouth of the Adsett Creek meltwater channel.

FGt — **Outwash terrace deposits:** inactive terraces high above the modern floodplain; > 2 m thick; deposited during flow of glacial meltwater in meltwater channels and canyons.

FGf — **Glaciofluvial fan deposits:** well to poorly stratified sand and gravel; minor diamicton; forming fans at the mouth of abandoned meltwater channels or at the toe of slopes in the Alberta Plateau uplands > 1 m thick; represents a potential aggregate source. The systems are not currently active, and thus required the presence of glacial meltwater to have formed.

FGi — **Undifferentiated ice-contact stratified drift:** poorly-sorted sand and gravel with minor diamictons: deposited in contact with the retreating glacier; 1 to > 20 m thick.

FGir — **Ice-contact glaciofluvial ridge:** stratified sand and gravel with minor diamicton, deposited in an esker ridge, 1-10 m high.

T — ***TILL:*** nonsorted diamicton deposited directly by the Laurentide Ice Sheet; matrix is generally a silty-clay and contains striated clasts of various lithologies, including many Canadian Shield, carbonate and sandstone erratics; clast content is typically low (< 10%).

Tb — **Till blanket:** > 2 m thick, continuous till cover forming flat to undulating topography that locally obscures underlying units.

Th — **Hummocky moraine:** terrain consisting of approximately equidimensional hills and depressions with moderately high relief (relief > 2 m).

Tr — **Ridged till deposits:** > 2 m thick, continuous till cover; moraines or crevasse fillings (squeeze ridges?) forming a ridged topography.

Ts — **Streamlined and fluted till:** > 1 m thick, till surface marked by streamlined landforms including flutes and bedrock outcrops.

Tv — **Till veneer:** > 2 m thick, discontinuous till cover, underlying bedrock topography is discernible.

NOTE: In areas where the underlying stratigraphic units are known, areas are coloured according to the overlying unit and labeled from the surface down (e.g. O/Tr). In a few cases, the underlying units may come to surface to form a complex pattern but the area is always coloured according to the dominant unit of cover and units are listed in decreasing order of abundance. Where preceded by a modifier, the polygon has been field-checked and assigned a textural modifier indicative of the dominant grain-size: **s**, sand; and **g**, gravel.

BASE MAP FEATURES

- Road - Gravel
- Road - Paved
- Railroad - Single track
- Contour - Index 100 m interval
- Contour - Intermediate 20 m interval

GEOLOGICAL AND GLACIAL FEATURES

- Bedrock outcrop
- Pit - aggregate
- Stratigraphic point
- Geological contact
- Fluting
- Drumlin / Crag and tail
- Escarpment
- Esker
- Meltwater channel (minor)
- Meltwater channel (major)
- Minor moraine
- Major moraine
- Major landslide

A- Pre-Late Wisconsinan (Interglacial?) fluvial gravels (Montane)
A-1- pebble to cobble-sized mixed gravels
A-2- pebble-sized sandstone gravels
B- Pre-Late Wisconsinan floodplain sediments and oxbow lake/seg pond sediments
B-1- diamict with Montane-derived clasts (Glacial?)
C- Pre-Late Wisconsinan (Interglacial?) fluvial gravels (Montane)
D- Late Wisconsinan, Laurentide advance-phase glaciolacustrine sediments
E- Late Wisconsinan Laurentide till
F- Holocene fluvial sediments
R- Cretaceous shale

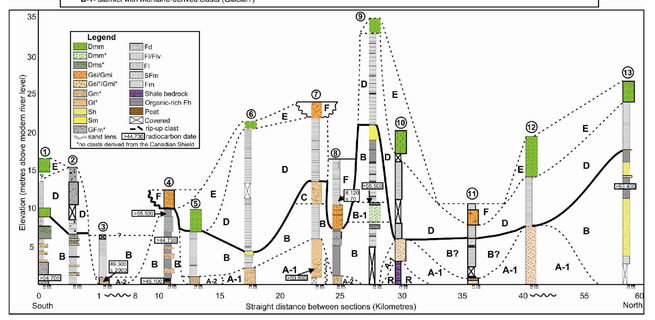

Figure 1. Interpreted cross-section of the stratigraphy exposed along the Prophet River valley in northeastern British Columbia. Six units are recognized using a combination of sedimentology, sedimentary structures, clast lithologies and radiocarbon dates. The dark black line divides Pre-Late Wisconsinan stratigraphy (FP on the map) from overlying Late Wisconsinan glacial stratigraphy (Trommelin and Levson, 2008).

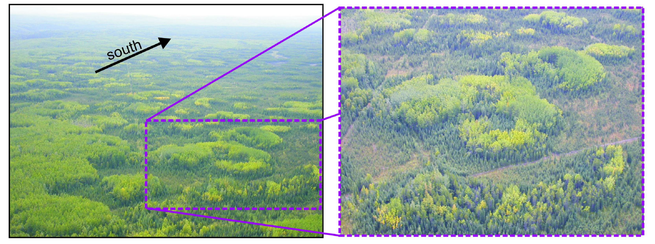

Figure 2. Glaciolacustrine hummocks (LGh) photographed from the air just west of the Prophet River Valley. The hummocks are 100-600 m in diameter, with a relief of 1-2 m. The origin of these features is unknown, but they may represent hydrodynamic blowouts of glacially-pressured fluids in clay at the margin of the Laurentide Ice Sheet.

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6832
GEOLOGICAL SURVEY OF CANADA
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2011

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Recommended citation:
Trommelen, M. and Levson, V., 2011. Surficial geology, Adsett Creek (NTS 94J/SE), British Columbia; British Columbia Ministry of Energy and Mines, BCGS Open File 2011-05; Geological Survey of Canada, Open File 6832, scale 1:100 000. doi: 10.4095/288643.

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