

DESCRIPTIVE NOTES

INTRODUCTION

This Surficial Geology Map of NTS 94-O12 (Canadian Geoscience Map 122) is the product of collaboration between the Geological Survey of Canada and British Columbia Ministry of Energy, Mines and Natural Gas as part of the Geoscience Program for Energy and Minerals Project (GEM-EP) Yukon Basins Project. The accompanying geodatabase includes field observation points and field photos, landform features as lines, and surficial geology polygons. The map and geodatabase are essential for a range of potential end-users including resource explorationists, geotechnical engineers, land-use managers, terrestrial ecologists, archaeologists, geoscientists and environmental impact assessors. By providing new insight into the distribution and origins of surficial earth materials, CGM 122 will help to reduce the economic costs and risks associated with the sustainable development of energy and mineral resources in NTS 94-O12. Environmental impact assessments for new resource roads, well pads, pipeline and power transmission line corridors, water storage and waste management systems and other infrastructure will benefit from the geoscience information presented here. By identifying areas prone to geotechnical hazards (e.g., landslides, permafrost, flooding), CGM 122 will also help to protect natural resources, infrastructure and communities vulnerable to climate change in Canada's north.

APPROACH TO SURFICIAL GEOLOGY MAPPING

Remote sensing and field-based data were used to better understand the regional distribution of surficial deposits, permafrost, landslides and other geomorphic processes in the NTS 94-O12 map area (Hurley and Hicks, 2010; Hurley et al., 2011a-b). Surficial earth materials and landforms were interpreted using a combination of stereo-pair air photos (e.g., BC890710, 1968; B91010, 1968; B91020, 1968; B91030, 1968; B91040, 1968; B91050, 1968; B91060, 1968; B91070, 1968; B91080, 1968; B91090, 1968; B91100, 1968) and satellite imagery (e.g., Landsat 7 satellite imagery from Earth Resources Observation and Science Center, 2011). The base map was generated from CANVEC shape files (http://canvec.gc.ca/geospatial/180_2010). Terrain polygons and vector symbols were digitized using commercially available computer software packages (Global Mapper ArcMap and ArcGIS) and compared to published maps, reports and archived digital data (e.g., Stott and Taylor, 1968; Dobson et al., 2004; Dobson, 2005a-b). The geodatabase accompanying this map conforms to the Science Language for the Data Management component of the GEM Geospatial Map Flow process (cf. Hurley and Sidelov, 2010; Hurley et al., 2011a; Dobson et al., 2012).

Fieldwork was undertaken in 2009 and 2010 to ground truth surficial geology polygons interpreted from air photos and satellite imagery, and to gather characteristics that could not be determined through remote sensing mapping. Earth materials were defined on the basis of facies and landform associations, texture, sorting, colour, sedimentary structures, degree of consolidation, and stratigraphic contact relationships at field locations from holocene to Pleistocene. The distribution of glacial and non-glacial landforms is depicted on the surficial geology map. Map units in the legend are presented choroplethographically and include organic deposits, alluvial, colluvial, eolian, glaciolacustrine and glaciolacustrine sediments, tills and areas of bedrock.

INFERRED GEOLOGICAL HISTORY

The distinctive landscape of NTS 94-O12 is largely a product of underlying bedrock and geological structures, with ornamentation by the Late Wisconsinan Laurentide Ice Sheet. La Jolie Butte is underlain by conglomeratic sandstone, carbonaceous shale and coal (Upper Cretaceous Vapiti Formation). Over much map area, shale, siltstone and sandstone (Upper Cretaceous Kotabekoe Formation) lie beneath surficial units (Stett and Taylor, 1968). Topography and drainage patterns were greatly modified during the phase of maximum ice cover (~18° C ka BP or c. 12,000 years BP). Unconsolidated sediment thickened in recesses and is exposed in valleys and is suspected that under-ice thickness blanket bedrock (unit Ts) across the map area. Silt- and clay-rich Laurentide tills have low clay contents (<20%) of proximal bedrock. Cretaceous silicified sedimentary rocks and diatomaceous and melanocratic shales from the Canadian Shield underlie the north-east. Drumlin ridges up to several hundred metres in length suggest clay-rich tills (unit Ts) were deposited beneath rapidly flowing ice sheets (Stett and Taylor, 2010; Hurley et al., 2011b). The Laurentide Ice Sheet advanced from the east of the La Jolie Butte where west- and south-west moving ice flowed up-hill, and thick accumulations of till were deposited over soft bedrock and unconsolidated advanced glacial sediments. Small lake basins were excavated by erosion and scabotting as Laurentide ice and subglacial meltwater scoured and deformed outcropping deposits and weak bedrock.

Deposition began sometime after 18° C ka BP (or ~21.4 calendar ka BP) and ended before 10° C ka BP (ca. 12,000 years BP) with the retreating active Laurentide Ice Sheet, stagnating ice masses in lowlands, glaciolacustrine outwash and landslide debris blocking and reordering regional drainage. The regional distribution of moraine ridges (unit Tm) implies that the Laurentide Ice Sheet margin retreated to the west (Hurley and Hicks, 2010). Some large and moraines are deformed and streamlined suggesting that receding lobes remained active during retreat and occasionally rapidly advanced. Minor moraine ridges draped diamictic till occur in the plateau and glaciolacustrine sediments and ice-rafted moraines deposited shortly after abandonment ended, or as ice retreated from the map area (Hurley et al., 2011b). Landslide till (unit Ts) together with till and debris flow sediments indicate that lobes of stagnant glacier ice remained in lowland areas west of the Mackenzie Escarpment (Hurley et al., 2011a-b). As ice retreated from the map area, a proglacial lake formed on the Liard Plateau. Proglacial lakes were formed by spillways that drained meltwater northward into the Mackenzie River basin. In the map area, glaciolacustrine deposits (unit GLb), glaciolacustrine terraces (unit GFI), and meltwater channels incised into till and bedrock indicate glacial lake levels that elevated at approximately 420 m, 303 m and ~300 m. Fine-grained glacial earth materials have been re-worked by solon activity and discontinuous lens cover glacial lake and till deposits in some areas.

Postglaciation (10° C ka BP, or ca. 12,000 years BP to present), changes in regional base-level led to episodes of channel incision and aggradation, resulting in the formation of terraced alluvial fans and river valleys. In the early Holocene, judicious faulting, judicious faulting followed initial valley incision by the Liard and other major rivers. Most streams and rivers have alluvial terraces (unit At) ~5 m above active floodplains (unit Ap) consisting of gravel overlain by silt and sand. Poorly drained till on the plateau and glaciolacustrine sediments in lowland areas are covered by extensive proglacial peat deposits (unit Owb). Discontinuous permafrost is sporadically encountered in glaciolacustrine and some peat deposits. Charcoal preserved in deep gullies at alluvial terraces, suggest forest fires may have contributed to periods of landscape activity on slopes and local fluvial aggradation. Landslides and colluvial deposits (units Cv, C2) are common where bedrock outcrops form escarpments, and where glacial debris is exposed along steep outcrops. Stream networks and wetlands draining plateau watersheds are disrupted by beaver activity, and to a lesser extent, by roads and infrastructure where they cross streams, rivers and organic deposits (Hurley and Hicks, 2010; Hurley and Hicks, 2011a-c).

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Abstract

Canadian Geoscience Map 122 depicts the surficial geology over some 700 km² covered by the La Jolie Butte map sheet (NTS 94-O12) in northeastern British Columbia. The map area lies at the western limit of the Liard Plateau and is incised by the Liard River and its tributaries. Bedrock is mantled by unconsolidated earth materials dating to the Late Pleistocene (Late Wisconsinan Glaciation, > 25 ka to ca. 10 ka) and non-consolidated Holocene (< 10 ka to present). Deposits of all green on the map, are generally suitable for placement of infrastructure. Glaciolacustrine and eolian deposits with mineral aggregate, and groundwater potential are coloured orange and buff. Slopes disturbed by landslides, debris flows, and rock falls appear brown and pink. Glaciolacustrine and organic deposits with sporadically discontinuous permafrost are coloured purple and grey. Alluvial deposits prone to flooding, erosion, and sedimentation appear yellow on the map.

Résumé

La Carte géoscientifique du Canada 122 illustre la géologie des matériaux superficiels d'un territoire d'environ 700 km² couvert par le feuillet cartographique de La Jolie Butte (NTS 94-O12) dans le nord-est de la Colombie-Britannique. La région cartographique se situe à la bordure occidentale du plateau du Liard et est entaillée par la rivière Liard et ses affluents. Le socle rocheux est couvert de matériaux terrestres non consolidés remontant au Pléistocène supérieur (Glaciation du Wisconsinien supérieur, de > 25 ka à env. 10 ka) ainsi que de matériaux non glaciaires de l'Holocène (de 10 ka jusqu'à nos jours). Les dépôts de till, de couleur verte sur la carte, sont généralement propices à l'établissement de l'infrastructure. Les dépôts fluvio-glaciaires et éoliens, qui recèdent un potentiel en minéraux, en agrégats et en eau souterraine, sont figurés par les couleurs orange et beige. Les versants dérangés par des glissements de terrain, des coulées de débris et des chutes de blocs sont représentés en brun et en rose. Les dépôts glaciolacustres et organiques, qui renferment sporadiquement du pergélisol discontinu, sont représentés en violet et en gris. Les dépôts alluviaux sujets aux inondations, à l'érosion et à la sédimentation apparaissent en jaune sur la carte.

MAP SHEET	SCHEMATIC	INDEX
CGM 121	CGM 120	
CGM 122	CGM 125	
CGM 109	CGM 128	

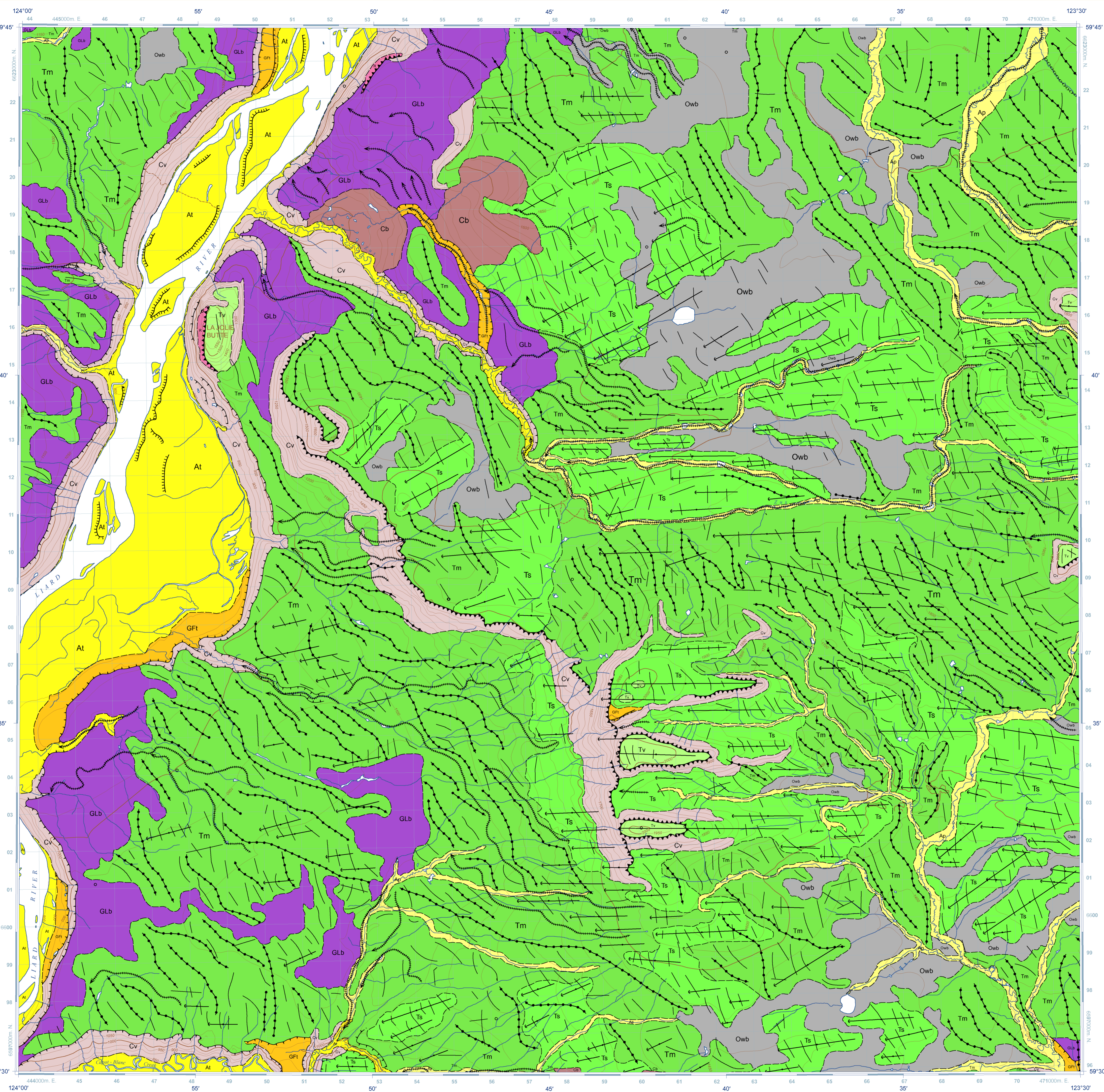
National Topographic System reference and index to adjoining published Geological Survey of Canada maps

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CANADIAN GEOSCIENCE MAP 122
SURFICIAL GEOLOGY
LA JOLIE BUTTE
British Columbia
1:50 000



Holocene earth materials and landforms

Organic Deposits

- Owb** **Peat bogs:** fibric to humic organic matter, massive to stratified accumulations; generally greater than 2 m thick, confined to topographic depressions or level areas, underlain by poorly drained, glaciolacustrine and other unconsolidated sediments; formed by decomposition of plant material in wetland areas; bogs with sporadically discontinuous permafrost and thermokarst depressions potentially unstable if organic material is disturbed or removed.
- Alluvial deposits**
- At** **Well-drained sediments:** boulders, gravel, sand and silt, generally massive to planar stratified, well to rapidly drained, greater than 2 m thick; may contain interbedded debris flows and buried organic material; underlain by outwash, till or bedrock; transported and deposited by modern rivers, streams and creeks; subject to rare flooding; potential source of aggregate; land use activities may adversely affect stream courses and conditions, and impact fish and wildlife resources.
- Ap** **Alluvial floodplain sediments:** gravel, sand and silt, massive, trough cross-bedded, rippled-bedded, planar stratified, well to rapidly drained, greater than 2 m thick; underlain by till or bedrock; transported and deposited by modern rivers, streams and creeks; subject to seasonal flooding; land use activities may adversely affect stream courses and conditions, and impact fish and wildlife resources.
- Colluvial deposits**
- Cv** **Colluvial veneer:** clast-supported diamictics and rubble; massive to stratified, poorly-sorted, well to rapidly drained, deposits less than 2 m thick; landslide headscarp range from 300 m to 10.5 km, formed by the weathering and down-slope movement of earth materials by gravitational processes. Bedrock and unconsolidated debris on slopes above 10-15° with greater than 5 m relief prone to mass-wasting; rock falls, topples, rock slides and debris flows occur where shale, sandstone and carbonate strata is exposed close to the surface; retrogressive rotational debris slides, debris flows and slumps occur in glaciolacustrine sediments and outwash containing sporadically discontinuous permafrost, where ground ice is found; slope failure can occur on surfaces less than 5°; slope instability could present major problems for construction in some areas.
- Cb** **Colluvial blanket:** clast-supported diamictics and rubble; massive to stratified, poorly-sorted, well to rapidly drained, deposits greater than 2 m thick; landslide headscarp range from 300 m to 10.5 km, formed by the weathering and down-slope movement of earth materials by gravitational processes; bedrock and unconsolidated debris on slopes above 10-15° with greater than 5 m relief prone to mass-wasting; rock falls, topples, rock slides and debris flows occur where shale, sandstone and carbonate strata is exposed close to the surface; retrogressive rotational debris slides, debris flows and slumps occur in glaciolacustrine sediments and outwash containing sporadically discontinuous permafrost, where ground ice is found; slope failure can occur on surfaces less than 5°; slope instability could present major problems for construction in some areas.

Late Pleistocene earth materials and landforms

Glaciolacustrine deposits

- GLb** **Glaciolacustrine blanket:** silt and clay with subordinate sand, gravel and diamictic; massive or rhythmically interbedded; slump structures and druspstones locally present; poor to moderately drained; generally greater than 2 m thick; kettle lakes and irregular topography underlain by bedrock, tills and outwash; transported by and deposited from sediment-laden meltwater; subaqueous gravity flows and thermal melting of ice in proglacial lakes; where sporadically discontinuous permafrost is, or was present; glaciolacustrine sediments may be subject to thermokarst processes; slopes less than 5° are potentially unstable and prone to landslides and debris flows.
- GFI** **Glaciolacustrine terraces:** boulders, cobbles, pebble-gravel, sand, silt and matrix-supported diamictic; generally massive to stratified, some slump structures; moderately to well-drained; greater than 2 m thick; terrace scarp range from 100 m to 8 km in length; in contact with, and overlying other till units, outwash and glaciolacustrine sediments, deposited by meltwater confined to proglacial channels and spillways; potential source of groundwater and granular aggregate when material is gravel rich.
- Tm** **Moraine ridges:** sand, silt and clay-rich diamictics, massive, matrix-supported; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately well-drained; greater than 2 m thick; minor moraines less than 1 km long and 5 m high; major moraines up to 12.5 km in length and 10 m high; ridge drupe bedrock and older glacial deposits; minor moraines include crevasse-fan ridges and small recessional fan moraines; major ridges features are large recessional end moraines and ice-trust ridges, generally suitable for infrastructure placement.
- Ts** **Streamlined till:** silt and clay-rich diamictics, massive, matrix-supported and compact; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately well-drained; greater than 2 m thick mantling bedrock and older glacial deposits; drumlins and fluted till ridges typically under 1 km long but can exceed 9 m in length; generally less than 50 m wide and 20 m high; formed beneath the Laurentide Ice Sheet directly through lodgement, basal meltout, glaciogenic deformation of sediment beneath rapidly-flowing warm-based ice; generally suitable for infrastructure placement.
- Tv** **Till veneer:** sand, silt and clay-rich diamictics, massive, matrix-supported and compact; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately to well-drained; less than 2 m thick draping bedrock and older glacial deposits; transported and deposited by the Laurentide Ice Sheet directly through lodgement, basal meltout, glaciogenic deformation of sediment beneath rapidly-flowing warm-based ice and in situ melting from stagnant cold-based ice; generally suitable for infrastructure placement.

Pre-Quaternary earth materials and landforms

Bedrock

- R** **Undifferentiated bedrock:** conglomerate, sandstone, siltstone, shale and limestone; slopes above 10-15° with greater than 5 m relief prone to rock falls, topples rock slides and debris flows; Paleozoic; unconformably overlain by Mesozoic sedimentary rocks; limestone and clastic sedimentary rocks are a potential source of crushed granular aggregate.

Geological boundary (Confidence: approximate)
Bedrock scarp
Major moraine ridge (end, interlobe, or unspecified)
Other moraine ridge (DeGeer, minor lateral, recessional, rogen, washboard, other transverse or unspecified)
Esker ridge (sense: unknown or unspecified)
Drumlin ridge
Major meltwater channel scarp
Minor meltwater channel center axis (marginal, overflow, subglacial or unspecified; sense: known)
Terrace scarp (environment: glaciolacustrine)
Terrace scarp (environment: fluvial)
Station location (ground observation or stratigraphic section)

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Canadian Geoscience Maps

Canada

Preliminary

CANADIAN GEOSCIENCE MAP 122

SURFICIAL GEOLOGY
LA JOLIE BUTTE
British Columbia
1:50 000

Map projection: Universal Transverse Mercator, zone 10, North American Datum 1983
Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications.
Elevations in feet above mean sea level
Magnetic declination 2013, 20°39'E, decreasing 22' annually

The Geological Survey of Canada welcomes corrections or additional information from users.
This publication is available for free download through GEOCAN (http://geocan.ess.nrcan.gc.ca/)

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Initiative of the Geological Survey of Canada, conducted under the auspices of the Yukon Basin Project as part of Natural Resources Canada's Geomapping for Energy and Minerals (GEM) program

Geological compilation by D.H. Hurley (2009-2011)

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Preliminary

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British Columbia

Preliminary publications in this series have not been scientifically edited.

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