Preliminary Preliminary Preliminary CANADIAN GEOSCIENCE MAP 121 Preliminary Preliminary Preliminary Preliminary Preliminary

DESCRIPTIVE NOTES

INTRODUCTION

This Surficial Geology Map of NTS 94-O/13 (Canadian Geoscience Map 121) is the product of collaboration between the Geological Survey of Canada and the British Columbia Ministry of Energy, Mines and Natural Gas as part of the Geo-mapping for Energy and Minerals Program (GEM-Energy Yukon Basins Project. The accompanying geodatabase includes field observation points and field photos, landform features as lines, and surficial geology unit polygons. The map and geodatabase are essential baseline geoscience information for a range of potential end-users including resource explorationists, geotechnical engineers, land-use managers, terrestrial ecologists, archaeologists, geoscientists and communities in northern British Columbia. By providing new insight into the distribution and origins of surficial earth materials, CGM 121 will help to reduce the economic costs and risks associated with the sustainable development of energy and mineral resources in NTS 94-O/13. Environmental impact assessments for new access roads, work camps, 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 geological hazards (e.g., landslides, permafrost, flooding), CGM 121 will also help to protect natural resources, infrastructure and communities vulnerable to climate change in Canada's north.

APPROACH TO SURFICIAL GEOLOGY MAPPING

Terrain mapping and field-based benchmarking studies have led to a better understanding of the regional distribution of surficial deposits, permafrost, landslides and other geomorphic processes in the NTS 94-O/13 map area (Huntley and Hickin, 2010; Huntley et al., 2011a-b). Surficial earth materials and landforms were interpreted using a combination of stereo-pair air photos (BCB97010, 15BCB97015, 15BCB97029, 15BCB97075 and 15BCB97088 series), LANDSAT 7 satellite imagery (http://glovis.usgs.gov/ [URL 2011]) and Shuttle Radar Topography Mission digital elevation models (http://dds.cr.usgs.gov/srtm/ [URL 2011]). The base map was generated from CANVEC shape files (http://geogratis.cgdi.gc.ca/geogratis/ [URL 2011]). Surficial geology polygons and landform line 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; Bednarski, 2003a-d; Clement et al., 2004; Bednarski, 2005a-b; Trommelen and Levson, 2008; Demchuk, 2010). The geodatabase accompanying this map conforms to the Science Language for the Data Management component of the GEM Geological Map Flow process (cf. Huntley and Sidwell, 2010; Huntley et al., 2011a; Deblonde 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 predictive 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 stations and remote observations from helicopters. The distribution of glacial and non-glacial landforms is depicted on the surficial geology map. Map units in the Legend are presented chronostratigraphically and include organic deposits, alluvial, colluvial, eolian, glaciolacustrine and glaciofluvial sediments, tills and areas of bedrock.

INFERRED GEOLOGICAL HISTORY

The distinctive landscape of NTS 94-O/13 is largely a product of underlying bedrock and geological structures, with ornamentation by the Late Wisconsinan Laurentide Ice Sheet. In the northeast, the plateau is underlain by conglomerate, sandstone, carbonaceous shale and coal (Upper Cretaceous Wapiti Formation). Over much map area, shale, siltstone and sandstone (Upper Cretaceous Kotaneelee Formation) lie beneath surficial units. Undifferentiated clastic bedrock (Lower Cretaceous Fort St. John Group) is exposed along hill crests in the northwest (Stott and Taylor, 1968).

Topography and drainage patterns were greatly modified during the phase of maximum ice cover (>18 ^{14}C ka BP or >21.4 calendar ka BP). Unconsolidated sediment thicknesses in excess of 2-5 m are observed in major valleys and it is suspected that similar drift thicknesses blanket bedrock (R) across the map area. Silt- and clay-rich Laurentide tills have low clast contents (<20%) of proximally derived Cretaceous siliciclastic sedimentary rocks and distal igneous and metamorphic clasts from the Canadian Shield, hundreds of kilometres to the northeast. Drumlin ridges up to several hundred metres in length suggest clay-rich tills (unit Ts) were deposited beneath active, rapidly flowing warm-based glacial ice (Huntley and Hickin, 2010; Huntley et al., 2011b). Drumlinized till (unit Ts) is most pronounced south of the Petitot River and west of the Maxhamish Escarpment where ice flowed up-hill, and thick accumulations of till were deposited over soft bedrock and unconsolidated advance-phase sediments. Many lake basins were excavated by erosion and ice-thrusting as Laurentide ice and subglacial meltwater scoured and deformed older glacial deposits and weak bedrock.

Deglaciation began sometime after 18 ^{14}C ka BP (or >21.4 calendar ka BP) and ended before 10 ^{14}C ka BP (ca. 12 calendar ka BP), with the retreating active Laurentide Ice Sheet, stagnant ice masses in lowlands, glaciofluvial outwash and landslide debris blocking and reordering regional drainage. The mapped distribution of moraine ridges (unit Tm) implies that ice margins receded to the east across the map sheet (Huntley and Hickin, 2010). Some large end moraines are deformed and streamlined suggesting that receding lobes remained active during retreat and occasionally rapidly advanced. Minor moraine ridges drape drumlins in cross-cutting patterns and are interpreted as crevasse fillings and squeeze moraines deposited shortly after drumlinization ended, or as ice retreated from the map area (Huntley et al., 2011b). Hummocky till (unit Th) found with short segments of subareal-subglacial meltwater channels and eskers indicate that bodies of stagnant glacier ice remained in lowland areas west of the Maxhamish Escarpment (Huntley et al., 2011a-b). As ice retreated from the map area, proglacial lakes formed on the Liard Plateau and were linked by spillways that drained meltwater northward into the Mackenzie River basin. In the map area, glaciolacustrine deposits (unit GLb), glaciofluvial terraces (unit GFt), and meltwater channels incised into till and bedrock indicate that glacial lake levels fell stepwise through deglaciation, with stable elevations at approximately 420 m, 380 m and <300 m. Fine-grained glacial earth materials have been re-worked by eolian activity and discontinuous loess covers glacial lake and till deposits in some places.

Post-glaciation (10 ^{14}C ka BP, or ca. 12 calendar ka BP to present), changes in regional base-level led to episodes of channel incision and aggradation, resulting in the formation of erosional alluvial terraces along most stream and river valleys. In the early Holocene, pulses of fluvial terrace building followed initial valley incision by the Liard and other major rivers. Most streams and rivers have alluvial fans (unit Af) and terraces (unit At) <5 m above active floodplains (unit Ap) consisting of gravel overlain by silt and sand. Poorly drained clay-rich till on the plateaux and glaciolacustrine sediments in lowland areas are covered by extensive postglacial peat deposits (unit Owb), fens (unit Owf) and undifferentiated wetlands (unit O). Discontinuous permafrost is sporadically encountered in glaciolacustrine and some peat deposits. Charcoal, observed in dug pits on alluvial terraces, suggest forest fires may have contributed to periods of landslide activity on slopes and local fluvial aggradation. Landslides and colluviated deposits (unit Cv) are common where bedrock outcrops form escarpments, and where shale or fine-grained glacial deposits are exposed along steep cutbanks. 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 (Huntley and Hickin, 2010; Huntley and Hickin, 2011a-b).

ACKNOWLEDGMENTS

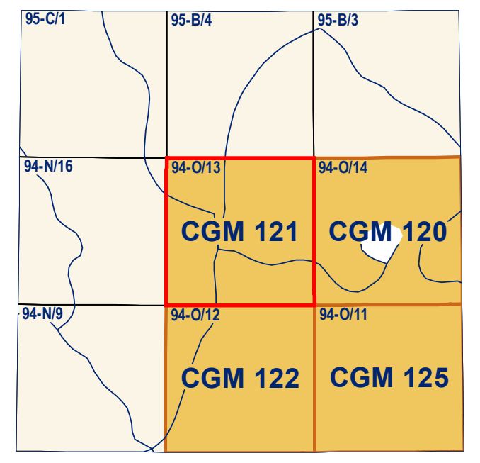
Canadian Geoscience Map 121 is an output of the Geo-Mapping for Energy and Minerals Yukon Basins Project managed by Carl Ozyer and Larry Lane (GSC-Calgary). The assistance of Robert Cocking, Sean Eagles, Vic Dohar, Mike Sigouin, Scott Tweedy and Martin Legault (NRCAN Scientific Publishing Services) was greatly appreciated throughout the map-making process. A critical review of CGM 121 was provided by Ron DiLabio (GSC-Ottawa).

Abstract

Canadian Geoscience Map 121 depicts the surficial geology over some 790 km^2 covered by the Sandy Creek map sheet (NTS 94-O/13) 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-glacial Holocene (ca. 10 ka to present). Deposits of till, green on the map, are generally suitable for placement of infrastructure. Glaciofluvial deposits with mineral, aggregate, and groundwater potential are coloured orange. 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 121 illustre la géologie des matériaux superficiels d'un territoire d'environ 790 km^2 couvert par le feuillet cartographique de Sandy Creek (SNRC 94-O/13), dans le nord-est de la Colombie-Britannique. La région cartographique se situe à la limite occidentale du plateau de 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 (d'env. 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 fluvioglaciaires, qui recèlent un potentiel en minéraux, en agrégats et en eau souterraine, sont figurés par la couleur orange. Les versants dérangés par des glissements de terrain, des coulés 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.



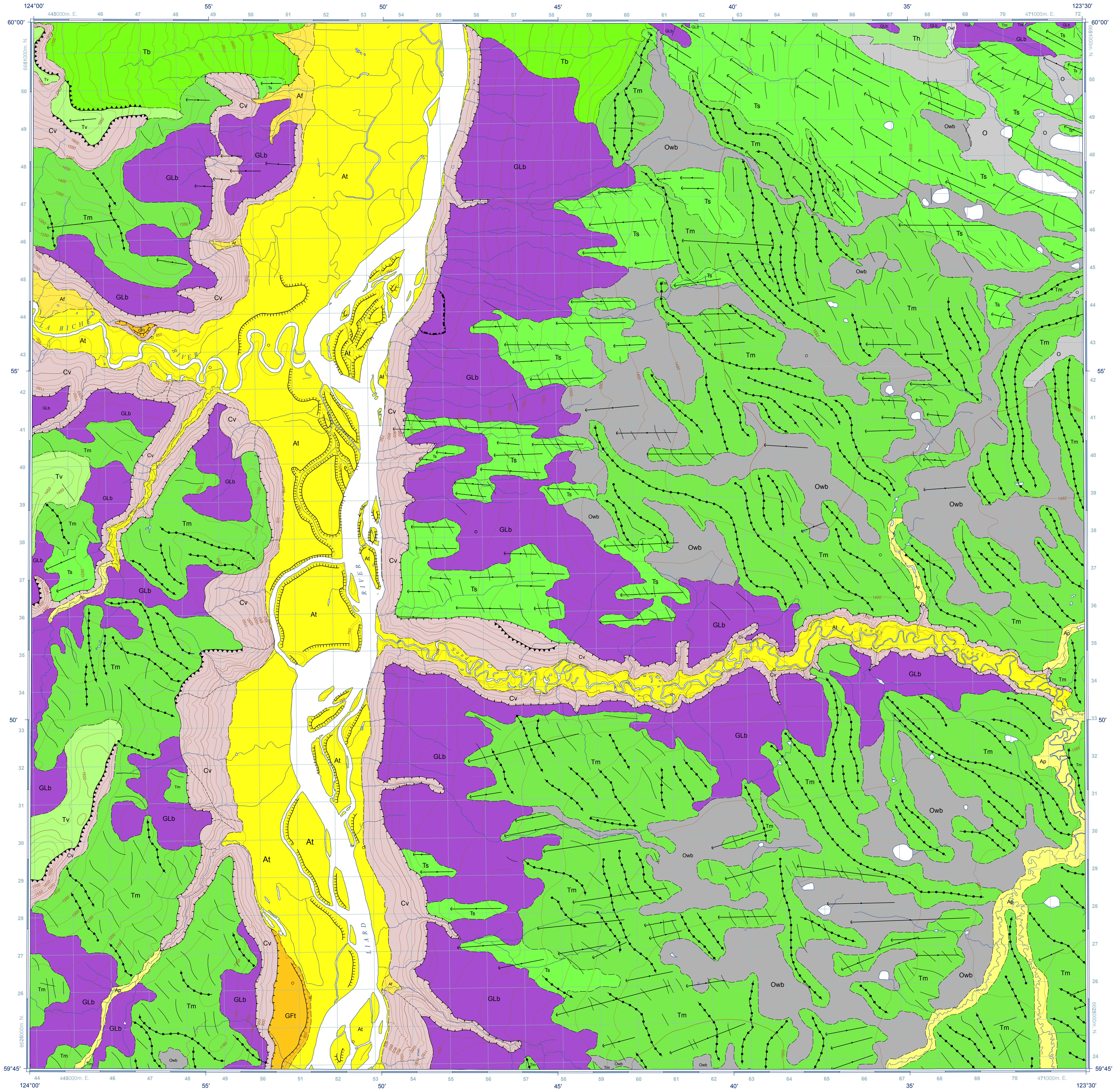
National Topographic System reference and index to adjoining published Geological Survey of Canada maps

Cover illustration
View northwest of moraine ridges, drumlins, meltwater channels and organic deposits over the Liard Plateau, northeast British Columbia.
Photograph by D.H. Huntley. 2013-099

Catalogue No. M183-1/121-2013E-PDF
ISBN 978-1-100-21792-5
doi:10.4095/292398

Natural Resources Canada | Ressources naturelles du Canada

CANADIAN GEOSCIENCE MAP 121
SURFICIAL GEOLOGY
SANDY CREEK
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 till, 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.
Owf	**Fens**: fibric organic matter; massive to stratified; generally greater than 2 m thick; confined to topographic depressions, level areas and meltwater channels; underlain by poorly drained till, glaciolacustrine and other unconsolidated sediments; formed by decomposition of plant material in wetland areas; fens are prone to flooding following drainage damming by beaver activity.
O	**Undifferentiated peat bogs and fens**: humic to fibric organic matter; massive to stratified accumulations; generally greater than 2 m thick; confined to topographic depressions, level areas or channels; underlain by poorly drained till, glaciolacustrine and other unconsolidated sediments; formed by decomposition of plant material in wetland areas; may contain sporadically discontinuous permafrost and thermokarst depressions; potentially unstable if disturbed or removed during development.

Alluvial deposits

Af	**Alluvial fan sediments**: boulders, gravel, sand and silt; generally massive to planar stratified; well to rapidly drained; greater than 2 m thick; fan morphology with slopes up to 15o; may contain interbedded debris flows and buried organic material; transported and deposited by modern rivers, streams and creeks; subject to periodic flooding; potential source of aggregate.
At	**Alluvial terraced 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.

Late Pleistocene to Holocene earth materials and landforms

Colluvial deposits

Cv	**Colluvial veneer**: clast-supported diamictons and rubble; massive to stratified, poorly-sorted; well to rapidly drained; deposits less than 2 m thick; landslide headscarps 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 diamicton; massive or rhythmically interbedded; slump structures and dropstones 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.

Glaciofluvial deposits

GFt	**Outwash terraces**: boulders, cobbles, pebble-gravel, sand, silt and matrix-supported diamicton; generally massive to stratified, some slump structures; moderately to well-drained; greater than 2 m thick; terrace scarps 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.

Till deposits

Tb	**Till blanket**: sand, silt and clay-rich diamictons; 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; greater than 2 m thick mantling bedrock and older glacial deposits; transported and deposited by the Laurentide Ice Sheet directly through lodgement, basal meltout, glacigenic deformation of sediment beneath active, warm-based ice and in situ melting from stagnant cold-based ice; stable terrain, generally suitable for infrastructure placement.
Th	**Hummocky till**: sand and silt-rich diamictons; massive to stratified, matrix- and clast-supported; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately to well-drained; greater than 2 m thick; drapes till and other glacial deposits; deposited by in situ melting from stagnant cold-based ice and modified by meltwater; evidence for ice collapse includes slump structures, kettle lakes and irregular topography; potential source of aggregate when material is gravel rich; generally suitable for infrastructure placement.
Tm	**Moraine ridges**: sand, silt and clay-rich diamictons; massive, matrix-supported; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately to 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; ridges drape bedrock and older glacial deposits; minor moraines include crevasse-fill ridges and small recessional push moraines; major ridges features are large recessional end moraines and ice-thrust ridges; generally suitable for infrastructure placement.
Ts	**Streamlined till**: silt and clay-rich diamictons; 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 km in length; generally less than 50 m wide and 20 m high; formed beneath the Laurentide Ice Sheet directly through lodgement, basal meltout, glacigenic deformation of sediment beneath rapidly-flowing warm-based ice; generally suitable for infrastructure placement.
Tv	**Till veneer**: sand, silt and clay-rich diamictons; 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, glacigenic deformation beneath active, warm-based ice and in situ melting from stagnant cold-based ice; generally suitable for infrastructure placement.

— — — — —	Geological boundary (Confidence: approximate)
▼▼▼▼▼▼▼	Bedrock scarp
●—●—●—●—●	Major moraine ridge (end, interlobate, or unspecified)
———	Other moraine ridge (DeGeer, minor lateral, recessional, rogen, washboard, other transverse or unspecified)
——•——→	Drumlin ridge
- - - - - - - -	Landslide escarpment (Status: inactive or unspecified)
┬—┬—┬—┬	Major meltwater channel scarp
▿┬▿┬▿┬▿	Terrace scarp (environment: glaciofluvial)
┬┬┬┬┬┬┬┬┬┬	Terrace scarp (environment: fluvial)
▼▬▼▬▼▬▼	Terrace scarp (environment: glaciolacustrine)
○	Station location (ground observation or stratigraphic section)

REFERENCES

Bednarski, J.M., 2003a. Betalamea Lake, Northwest Territories – Yukon Territory – British Columbia (NTS 95B/4); Geological Survey of Canada, Open File 4502, scale 1:50 000.

Bednarski, J.M., 2003b. Surficial geology of Fort Liard, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1760, scale 1:50 000.

Bednarski, J.M., 2003c. Surficial geology of Lake Bovie, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1761, scale 1:50 000.

Bednarski, J.M., 2003d. Surficial geology of Celibeta Lake, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1754, scale 1:50,000.

Bednarski, J.M., 2005a. Surficial Geology of Etsine Creek, British Columbia, Geological Survey of Canada, Open File 4825, scale 1:50 000.

Bednarski, J.M., 2005b. Surficial Geology of Gote Creek, British Columbia, Geological Survey of Canada, Open File 4846, scale 1:50 000.

Clement, C., Kowall, R. Huntley, D. and Dalziel, R., 2004. Ecosystem units of the Sahtaneh area; Slocan Forest Products (Fort Nelson) Report, 39 pages and appendices.

Deblonde, C., Plouffe, A., Boisvert, E., Buller, G., Davenport, P., Everett, D., Huntley, D., Inglis, E., Kerr, D., Moore, A., Paradis, S.J., Parent, M., Smith, R., St-Onge, D., and Weatherston, A., 2012. Science Language for an Integrated Geological Survey of Canada Data Model for Surficial Maps Version 1.1 Results of Geological Survey of Canada Surficial Legend Review Committee; Geological Survey of Canada, Open File 7003; 237 pages.

Demchuk, T., 2010. Surficial geology of the Komie Creek area (NTS 094P/05). British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2010-08; Geological Survey of Canada Open File 6568, scale 1:50 000.

Huntley, D.H. and Hickin, A.S., 2010. Surficial deposits, landforms, glacial history and potential for granular aggregate and frac sand: Maxhamish Lake Map Area (NTS 94-O), British Columbia. Geological Survey of Canada, Open File 6430, 17 pages.

Huntley, D., Hickin, A. and Chow, W., 2011a. Surficial geology, geomorphology, granular resource evaluation and geohazard assessment for the Maxhamish Lake map area (NTS 94-O), northeastern British Columbia; Geological Survey of Canada, Open File 6883, 20 pages.

Huntley, D.H., Hickin, A.S. and Ferri, F., 2011b. Provisional surficial geology, glacial history and paleogeographic reconstructions of the Toad River (NTS 94-N) and Maxhamish Lake map areas (NTS 94-O), British Columbia. Geoscience Reports 2011, BC Ministry of Energy, pages 37-55.

Huntley, D.H. and Sidwell, C.F., 2010. Application of the GEM surficial geology data model to resource evaluation and geohazard assessment for the Maxhamish Lake map area (NTS 94-O), British Columbia. Geological Survey of Canada, Open File 6553, 22 pages.

Stott, D.F. and Taylor, G.C., 1968. Geology of Maxhamish Lake. Geological Survey of Canada, Map 2-1968, scale 1:250,000.

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

Recommended citation
Huntley, D.H., Hickin, A.S., Chow, W., and Mirmohammadi, M., 2013. Surficial geology, Sandy Creek, British Columbia; Geological Survey of Canada, Canadian Geoscience Map 121 (preliminary), scale 1:50 000. doi:10.4095/292398

Preliminary Preliminary CANADIAN GEOSCIENCE MAP 121 Preliminary Preliminary Preliminary Preliminary

ess.nrcan.gc.ca

Canadian Geoscience Maps

Authors: D.H. Huntley, A.S. Hickin, W. Chow, and M. Mirmohammadi

Geology by D.H. Huntley and A.S. Hickin (2009–2010)

Geological compilation by D.H. Huntley (2009–2011)

Geomatics by D.H. Huntley, W. Chow, and M. Mirmohammadi

Cartography by W. Chow

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

SURFICIAL GEOLOGY
SANDY CREEK
British Columbia
1:50 000

1 0 1 2 3 4 km

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°45'E, decreasing 22' annually.

The Geological Survey of Canada welcomes corrections or additional information from users.

This publication is available for free download through GEOSCAN (http://geoscan.ess.nrcan.gc.ca/).

Preliminary publications in this series have not been scientifically edited.

CANADIAN GEOSCIENCE MAP 121
SURFICIAL GEOLOGY
SANDY CREEK
British Columbia

Canada