54 5**55**000m. E. Holocene earth materials and landforms REFERENCES Peat bogs: fibric to humic organic matter; massive to stratified accumulations; Bednarski, J.M., 2003a. Betalamea Lake, Northwest Territories - Yukon Territory - British Columbia (NTS generally greater than 2 m thick; confined to topographic depressions or level This Surficial Geology Map of NTS 94-O/9 (Canadian Geoscience Map 123) is the product of collaboration between the Geological Survey of 95B/4); Geological Survey of Canada, Open File 4502, scale 1:50 000. Canada and the British Columbia Ministry of Energy, Mines and Natural Gas as part of the Geo-mapping for Energy and Minerals Program areas; underlain by poorly drained till, glaciolacustrine and other (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 unconsolidated sediments; formed by decomposition of plant material in Bednarski, J.M., 2003b. Surficial geology of Fort Liard, Northwest Territories - British Columbia. Geological wetland areas; bogs with sporadically discontinuous permafrost and 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 Survey of Canada, Open File 1760, scale 1:50 000. thermokarst depressions potentially unstable if organic material is disturbed or Bednarski, J.M., 2003c. Surficial geology of Lake Bovie, Northwest Territories - British Columbia. Geological Survey of Canada, Open File 1761, scale 1:50 000. materials, CGM 123 will help to reduce the economic costs and risks associated with the sustainable development of energy and mineral resources in NTS 94-0/9. Environmental impact assessments for new access roads, work camps, well pads, pipeline and power transmission **Fens**: fibric organic matter; massive to stratified; generally greater than 2 m line corridors, water storage and waste management systems and other infrastructure will benefit from the geoscience information presented Bednarski, J.M., 2003d. Surficial geology of Celibeta Lake, Northwest Territories - British Columbia. Geological here. By identifying areas prone to geological hazards (e.g., landslides, permafrost, flooding), CGM 123 will also help to protect natural 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 Bednarski, J.M., 2005a. Surficial Geology of Etsine Creek, British Columbia, Geological Survey of Canada, Open wetland areas; fens are prone to flooding following drainage damming by Terrain mapping and field-based benchmarking studies have led to a better understanding of the regional distribution of surficial deposits, ermafrost, landslides and other geomorphic processes in the NTS 94-O/9 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://gdovis.usgs.gov/ [URL 2011]). The base map was generated from CANVEC shape files (http://gdogratis.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 ArcGlS) and compared to published maps, reports and symbols digital elevation (or a State and Taxing 10828). Redrapatic 20036 in Taxing and Landson and La Bednarski, J.M., 2005b. Surficial Geology of Gote Creek, British Columbia, Geological Survey of Canada, Open Undifferentiated peat bogs and fens: humic to fibric organic matter; massive to stratified accumulations; generally greater than 2 m thick; confined to Clement, C., Kowall, R. Huntley, D. and Dalziel, R., 2004. Ecosystem units of the Sahtaneh area; Slocan Forest topographic depressions, level areas or channels; underlain by poorly drained Products (Fort Nelson) Report, 39 pages and appendices. till glaciolacustrine and other unconsolidated sediments; formed by 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 decomposition of plant material in wetland areas: may contain sporadically 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 discontinuous permafrost and thermokarst depressions; potentially unstable if of the GEM Geological Map Flow process (cf. Huntley and Sidwell, 2010; Huntley et al., 2011a; Deblonde et al., 2012). Language for an Integrated Geological Survey of Canada Data Modelfor Surficial Maps Version 1.1 Results of Geological Survey of Canada Surficial Legend Review Committee; Geological Survey of Canada, Open File disturbed or removed during development. Field work was undertaken in 2009 and 2010 to ground truth surficial geology polygons interpreted from air photos and satellite imagery, and to the properties of the propergather 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 Alluvial terraced sediments: boulders, gravel, sand and silt; generally Demchuk, T., 2010. Surficial geology of the Komie Creek area (NTS 094P/05). British Columbia Ministry of field stations and remote observations from helicopters. The distribution of glacial and non-glacial landforms is depicted on the surficial massive to planar stratified; well to rapidly drained; greater than 2 m thick; may Energy, Mines and Petroleum Resources, Open File 2010-08; Geological Survey of Canada Open File 6568, geology map. Map units in the Legend are presented chronostratigraphically and include organic deposits, alluvial, colluvial, eolian, contain interbedded debris flows and buried organic material; underlain by outwash, till or bedrock; transported and deposited by modern rivers, streams Huntley, D.H. and Hickin, A.S., 2010. Surficial deposits, landforms, glacial history and potential for granular and creeks; subject to rare flooding; potential source of aggregate; land use aggregate and frac sand: Maxhamish Lake Map Area (NTS 94-O), British Columbia. Geological Survey of activities may adversely affect stream courses and conditions, and impact fish $The \ distinctive \ landscape \ of \ NTS \ 94-O/9 \ is \ largely \ a \ product \ of \ underlying \ bedrock \ and \ geological \ structures, \ with \ omamentation \ by \ the \ Late$ Canada, Open File 6430, 17 pages. and wildlife resources. Wisconsinan Laurentide Ice Sheet. The Etsho Plateau is underlain by conglomerate, sandstone and carbonaceous shale of the Upper retaceous Dunvegan Formation. In the northwest corner of the map sheet, the Stanislas Creek headwaters are underlain by undifferentiated Huntley, D., Hickin, A. and Chow, W., 2011a. Surficial geology, geomorphology, granular resource evaluation and geohazard assessment for the Maxhamish Lake map area (NTS 94-0), northeastern British Columbia; Alluvial floodplain sediments: gravel, sand and silt; massive, trough crossbedded, rippled-bedded, planar stratified; well to rapidly drained; greater Geological Survey of Canada, Open File 6883, 20 pages. Topography and drainage patterns were greatly modified during the phase of maximum ice cover (>18 [™]C ka BP or >21.4 calendar ka BP). than 2 m thick; underlain by till or bedrock; transported and deposited by Unconsolidated sediment thicknesses in excess of 2-5 m are observed in major valleys and it is suspected that similar drift thicknesses blanket bedrock (unit R) across the map area. Silt- and clay-rich Laurentide tills have low clast contents (<20%) of proximally derived Cretaceous Huntley, D.H., Hickin, A.S. and Ferri, F. 2011b. Provisional surficial geology, glacial history and paleogeographic modern rivers, streams and creeks; subject to seasonal flooding; land use reconstructions of the Toad River (NTS 94-N) and Maxhamish Lake map areas (NTS 94-O), British Columbia. activities may adversely affect stream courses and conditions, and impact fish siliciclastic sedimentary rocks and distal igneous and metamorphic clasts from the Canadian Shield, hundreds of kilometres to the northeast. Geoscience Reports 2011, BC Ministry of Energy, pages 37-55 and wildlife resources. Drumlinized ridges up to several hundred metres in length suggest clav-rich tills (unit Ts) were deposited beneath active, rapidly flowing warmbased glacial ice (Huntley and Hickin, 2010; Huntley et al., 2011b). Small lake basins were excavated by erosion and ice-thrusting as Huntlev. D.H. and Sidwell, C.F. 2010. Application of the GEM surficial geology data model to resource evaluation Laurentide ice and subglacial meltwater scoured and deformed older glacial deposits and weak bedrock. Multiple directions and generations of ice flow are preserved in streamlined till across the map area. In the southeast of the map area, ice flow was toward the southwest, whereas and geohazard assessment for the Maxhamish Lake map area (NTS 94-O), British Columbia. Geological Survey of Canada, Open File 6553, 22 pages Colluvial veneer: clast-supported diamictons and rubble; massive to stratified, in the northern half of the map area, ice flow was deflected west by the sloping flank of the Etsho Plateau. Together, this suggests diverging ice poorly-sorted; well to rapidly drained; deposits less than 2 m thick; landslide Stott, D.F. and Taylor, G.C., 1968. Geology of Maxhamish Lake. Geological Survey of Canada, Map 2-1968, headscarps range from 300 m to 10.5 km; formed by the weathering and down-slope movement of earth materials by gravitational processes; bedrock Deglaciation began sometime after 18 ⁴C ka BP (or >21.4 calendar ka BP) and ended before 10 ⁴C ka BP (ca. 12 calendar ka BP), with the and unconsolidated debris on slopes above 10-15° with greater than 5 m relief retreating active Laurentide Ice Sheet, stagnant ice masses in lowlands, glaciofluvial outwash and landslide debris blocking and reordering Trommelen, M. and Levson, V.M., 2008. Quaternary stratigraphy of the Prophet River, northeastern British regional drainage. The mapped distribution of major moraine ridges (unit Tm) implies that ice over the Etsho Plateau retreated to the northeast prone to mass-wasting; rock falls, topples, rock slides and debris flows occur Columbia: Canadian Journal of Earth Sciences, Vol. 45, pages 565-575. into the Petitot River valley (Huntley and Hickin, 2010). Some large end moraines are deformed and streamlined suggesting that receding where shale, sandstone and carbonate strata is exposed close to the surface; lobes remained active during retreat and occasionally rapidly advanced. Minor moraine ridges drape drumlins in cross-cutting patterns and retrogressive rotational debris slides, debris flows and slumps occur in re interpreted as crevasse fillings and squeeze moraines deposited shortly after drumlinization ended, or as ice retreated from the map area glaciolacustrine sediments and outwash containing sporadically discontinuous (Huntley et al., 2011b), Hummocky till (unit Th) is found in proximity to short segments of subareal-subglacial meltwater channels and eskers, indicating that bodies of stagnant glacier ice remained in lowland areas west of the Maxhamish Escarpment. Eskers (unit GFr) are composed permafrost; where ground ice is found slope failure can occur on surfaces less of hummocky till and glaciofluvial gravelly sand, and likely exploited pre-existing crevasse patterns beneath the retreating ice sheet or than 5°; slope instability could present major problems for construction in Post-glaciation (10 ¹⁴C ka BP, or ca. 12 calendar ka BP to present), changes in regional base-level led to episodes of channel incision and Colluvial blanket: clast-supported diamictons and rubble; massive to aggradation, resulting in the formation of erosional alluvial terraces along most stream and river valleys. In the early Holocene, pulses of fluvial stratified, poorly-sorted; well to rapidly drained; deposits greater than 2 m terrace building followed initial valley incision by the Liard and other major rivers. Most streams and rivers have alluvial fans (unit Af) and thick; landslide headscarps range from 300 m to 10.5 km; formed by the terraces (unit At) <5 m above active floodplains (Ap) consisting of gravel overlain by silt and sand. Poorly drained clay-rich till on the plateaux weathering and down-slope movement of earth materials by gravitational and glaciolacustrine sediments in lowland areas are covered by extensive postglacial peat deposits (unit Owb), fens (unit Owf) and processes; bedrock and unconsolidated debris on slopes above 10-15° with 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 greater than 5 m relief prone to mass-wasting; rock falls, topples, rock slides fluvial aggradation. Landslides and colluviated deposits (units Cv, Cb) are common where bedrock outcrops form escarpments, and where and debris flows occur where shale, sandstone and carbonate strata is shale or fine-grained glacial deposits are exposed along steep cutbanks. Stream networks and wetlands draining plateau watersheds are exposed close to the surface; retrogressive rotational debris slides, debris isrupted by beaver activity and, to a lesser extent, by roads and infrastructure where they cross streams, rivers and organic deposits (Huntley 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. Canadian Geoscience Map 123 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 Late Pleistocene earth materials and landforms Glaciolacustrine deposits (NRCAN Scientific Publishing Services) was greatly appreciated throughout the map-making process. A critical review of CGM 123 was provided by Ron DiLabio (GSC-Ottawa). 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, La Carte géoscientifique du Canada 123 illustre la subaqueous gravity flows and thermal melting of ice in proglacial lakes; where géologie des matériaux superficiels d'un territoire sporadically discontinuous permafrost is, or was present, glaciolacustrine d'environ 790 km² couvert par le feuillet cartographique sediments may be subject to thermokarst processes; slopes less than 5° are de Trail Lake (SNRC 94-/-09), dans le nord-est de la potentially unstable and prone to landslides and debris flows. Colombie-Britannique. Ici, le plateau d'Etsho se situe dans le bassin versant de la rivière Petitot et et est Glaciofluvial deposits drainé par le ruisseau Gote vers l'est ainsi que par les Kames and hummocky outwash: boulders, cobbles, pebble-gravel, sand, silt ruisseaux Dilly et Yesshadle vers le nord. Au nord du and diamicton; generally massive to stratified, some slump structures; plateau, le ruisseau Stanislas draine le territoire vers le moderately to well-drained; greater than 2 m thick; irregular hummocks and nord-est pour aboutir dans la rivière Petitot. Le socle kettled topography; in contact with, and overlying till units, outwash and rocheux est couvert de matériaux terrestres non glaciolacustrine sediments; deposited by rivers and streams flowing from, or in consolidés remontant au Pléistocène supérieur contact with glacial ice; potential source of groundwater and granular (Glaciation du Wisconsinien supérieur, de > 25 ka à aggregate when material is gravel rich. env. 10 ka) ainsi que de matériaux non glaciaires de l'Holocène (d'env. 10 ka jusqu'à nos jours). Les dépôts Esker ridges: boulders, cobbles, pebble-gravel, sand, silt and de till, de couleur verte sur la carte, sont généralement matrix-supported diamicton; generally massive to stratified, some slump propices à l'établissement de l'infrastructure. Les structures; moderately to well-drained; greater than 2 m thick; range from 100 m to 8.8 km in length; in contact with, and overlying till units, outwash and potentiel en minéraux, en agrégats et en eau glaciolacustrine sediments; deposited by subglacial meltwater in contact with souterraine, sont figurés par les couleurs orange et glacial ice; potential source of groundwater and granular aggregate when chamois. Les versants dérangés par des glissements material is gravel rich. de terrain, des coulés de débris et des chutes de blocs Outwash terraces: boulders, cobbles, pebble-gravel, sand, silt and sont représentés en brun et en rose. Les dépôts matrix-supported diamicton; generally massive to stratified, some slump glaciolacustres et organiques, qui renferment structures; moderately to well-drained; greater than 2 m thick; terrace scarps sporadiquement du pergélisol discontinu, sont range from 100 m to 8 km in length; in contact with, and overlying other till représentés en violet et en gris. Les dépôts alluviaux units, outwash and glaciolacustrine sediments; deposited by meltwater sujets aux inondations, à l'érosion et à la sédimentation confined to proglacial channels and spillways; potential source of groundwater apparaissent en jaune sur la carte. and granular aggregate when material is gravel rich. 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. Hummocky till: sand and silt-rich diamictons; massive to stratified, matrixand 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. National Topographic System reference and index to adjoining 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 Catalogue No. M183-1/123-2013E-PDF 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 © Her Majesty the Queen in Right of Canada 2013 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. ---- Geological boundary (Confidence: approximate) ● ● ● ● ● Major moraine ridge (unspecified) Other moraine ridge (unspecified) <>>>>>> Esker ridge (sense: unknown or unspecified) Drumlin ridge Major meltwater channel scarp Minor meltwater channel central axis (unspecified; sense: known) Station location (ground observation or stratigraphic section) Recommended citation Huntley, D.H., Hickin, A.S., Chow, W., and Mirmohammadi, M., 2013. Surficial geology, Trail Lake, British Columbia; Geological Survey of Canada, Canadian Geoscience Map 123 (preliminary), scale 1:50 000. doi:10.4095/292400 5**56**000m. **Preliminary CANADIAN GEOSCIENCE MAP 123 Preliminary Preliminary Preliminary Preliminary Preliminary SURFICIAL GEOLOGY** Authors: D.H. Huntley, A.S. Hickin, W. Chow, and Geomatics by D.H. Huntley, W. Chow, and Map projection Universal Transverse Mercator, The Geological Survey of Canada welcomes Canadian M. Mirmohammadi M. Mirmohammadi zone 10. North American Datum 1983 corrections or additional information from users. TRAIL LAKE **Geoscience Maps** Base map at the scale of 1:50 000 from Natural Geology by D.H. Huntley and A.S. Hickin (2009–2010) Cartography by W. Chow This publication is available for free download through Resources Canada, with modifications. GEOSCAN (http://geoscan.ess.nrcan.gc.ca/). **British Columbia** Geological compilation by D.H. Huntley (2009–2011) Initiative of the Geological Survey of Canada, Elevations in feet above mean sea level conducted under the auspices of the Yukon Basin

Magnetic declination 2013, 20°19'E

decreasing 22' annually.

CANADIAN GEOSCIENCE MAP 123

Project as part of Natural Resources Canada's Geo-

mapping for Energy and Minerals (GEM) program

Canadä

DESCRIPTIVE NOTES

resources, infrastructure and communities vulnerable to climate change in Canada's north.

APPROACH TO SURFICIAL GEOLOGY MAPPING

glaciolacustrine and glaciofluvial sediments, tills and areas of bedrock.

clastic bedrock (Lower Cretaceous Fort St. John Group, Stott and Taylor, 1968).

INFERRED GEOLOGICAL HISTORY

flow prior to the onset of deglaciation.

stagnant ice bodies (Huntley et al., 2011a; b).

and Hickin, 2010; Huntley and Hickin, 2011a-b).

Canadian Geoscience Map 123 depicts the surficial

geology over some 790 km² covered by the Trail Lake

map sheet (NTS 94-O/09), in northeastern British

Columbia. Here, the Etsho Plateau lies within the Petitot

River watershed and is drained by east-flowing Gote

Creek, and northward by Dilly and Yesshadle creeks. To

the north of the plateau, the Stanislas Creek drains

northeast into the Petitot River. 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 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.

discontinuous permafrost are coloured purple and grey.

Alluvial deposits prone to flooding, erosion, and

CGM 119 | CGM 118

CGM 126 | CGM 123

CGM 127 | CGM 124

Natural Resources Ressources naturelles

CANADIAN GEOSCIENCE MAP 123

du Canada

published Geological Survey of Canada maps

doi:10.4095/292400

sedimentation appear yellow on the map.

Cover illustration

Columbia, view west.

Canada

SURFICIAL GEOLOGY

TRAIL LAKE

British Columbia

1:50 000

Rotational landslide triggered by the Kiwigana Rive

ncising the Etsho Plateau in northeast British

Photograph by D.H. Huntley. 2013-101

INTRODUCTION

CANADIAN GEOSCIENCE MAP 123 SURFICIAL GEOLOGY TRAIL LAKE British Columbia

reliminary publications li

this series have not been

scientifically edited.

Preliminary