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CANADIAN GEOSCIENCE MAP 126

SURFICIAL GEOLOGY

TIGHTFIT LAKE

British Columbia

Map Information Document

Preliminary

Canadian Geoscience Maps

2013

Canada

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Cover Illustration

Drumlin ridge on the Etsho Plateau in northeast British Columbia, view west in the direction of iceflow.Photograph by D.H. Huntley. 2013-104

Abstract

Canadian Geoscience Map 126 depicts the surficial geology over some 790 km^2 covered by the Tightfit Lake map sheet (NTS 94-O/10) in northeastern British Columbia. The map area lies at the western limit of the Etsho Plateau and northwest limit of the Fort Nelson Lowland. This boundary is a major drainage divide: Klenteh Creek and other tributaries to Kiwigana and Fort Nelson rivers drain the south-facing escarpment of the Etsho Plateau and Fort Nelson Lowland; to the north, the plateau and Tightfit Lake drain north into the Petitot River valley. Bedrock is mantled by unconsolidated earth materials that dates 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. 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.

RÉSUME

La Carte géoscientifique du Canada 126 illustre la géologie des matériaux superficiels d'un territoire d'environ 790 km^2 couvert par le feuillet cartographique de Tightfit Lake (SNRC 94-O/10), dans le nord-est de la Colombie-Britannique. La région cartographique se situe à la bordure occidentale du plateau d'Etsho et à la bordure nord-ouest des basses terres de Fort Nelson. Cette limite correspond à une importante ligne de partage des eaux : le ruisseau Klenteh et d'autres affluents des rivières Kiwigana et Fort Nelson drainent l'escarpement à regard sud du plateau d'Etsho et les basses terres de Fort Nelson; au nord, le plateau et le lac Tightfit se drainent vers le nord dans la vallée de la rivière Petitot. 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 et éoliens, qui recèlent un potentiel en minéraux, en agrégats et en eau souterraine, sont figurés par les couleurs orange et chamois. 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.

ABOUT THE MAP

General Information

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

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, 20º26'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.

Map Viewing Files

The published map is distributed as a Portable Document File (PDF), and may contain a subset of the overall geological data for legibility reasons at the publication scale.

ABOUT THE GEOLOGY

Descriptive Notes

INTRODUCTION

This Surficial Geology Map of NTS 94-O/10 (Canadian Geoscience Map 126) 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 126 will help to reduce the economic costs and risks associated with the sustainable development of energy and mineral resources in NTS 94-O/10. 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 126 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/10 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). 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/10 is largely a product of underlying bedrock and geological structures, with ornamentation by the Late Wisconsinan Laurentide Ice Sheet. Conglomerate, sandstone and carbonaceous shale of the Upper Cretaceous Dunvegan Formation underlie the southeast part of the map area, where the Etsho Plateau reaches its highest elevation. Elsewhere, exposures in borrow pits, and creek and river sections indicate that undifferentiated clastic bedrock (Lower Cretaceous Fort St. John Group) underlies the map area (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 across the map area. Laurentide tills have low clast contents (<20%) of proximally derived Cretaceous siliciclastic sedimentary rocks and distal exotic igneous and metamorphic clasts from the Canadian Shield exposed hundreds of kilometres to the northeast. Drumlins up to several kilometres in length, together with eskers and subglacial meltwater channels confined to the escarpment crest of the Etsho Plateau, imply tills were deposited beneath active, rapidly flowing warm-based glacial ice (Huntley and Hickin, 2010; Huntley et al., 2011b). Small lake basins were excavated by erosion and ice-thrusting as Laurentide ice and subglacial meltwater scoured and deformed older glacial deposits and weak bedrock. Multiple generations of ice flow are preserved in streamlined landforms across the map area (unit Ts). Southwest oriented drumlins are interpreted as a late glacial maximum ice flow direction across the map area. The distribution of younger drumlins suggests converging ice lobes flowed west-northwest from the Fort Nelson Lowland and west to southwest over the Etsho Plateau.

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 the regional drainage system. The mapped distribution of major moraine ridges (unit Tm) implies that ice in the Fort Nelson Lowland retreated to the southeast. Ice over the Etsho Plateau retreated to the northeast into the Petitot River valley (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) 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 of hummocky till and glaciofluvial gravelly sand, and likely exploited pre-existing crevasse patterns beneath the retreating ice sheet or stagnant ice bodies (Huntley et al., 2011a; b).

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. 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. Colluviated deposits (unit Cv) are restricted to slopes where underlain by shale and fine-grained glacial deposits. 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 126 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 126 was provided by Janet Campbell (GSC-Ottawa).

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Author Contact

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Coordinate System

Projection: Universal Transverse Mercator
Units: metres
Zone: 10N
Horizontal Datum: NAD83
Vertical Datum: mean sea level

Bounding Coordinates

Western longitude: 123°00’00” W
Eastern longitude: 122°30’00” W
Northern latitude: 59°45’00” N
Southern latitude: 59°30’00” N

Data Model Information

The Geological Survey of Canada (GSC) through the Geomapping for Energy and Minerals Program (GEM) has undertaken the Geological Map Flow to develop protocols for the collection, management (compilation, interpretation), and dissemination of surficial and bedrock geology data and map information. To this end, a data model has been created.

The Surficial Data Model (SDM) was designed using ESRI geodatabase architecture. The XML workspace document provided can be imported into a geodatabase, and the geodatabase will then be populated with the feature datasets, feature classes, tables, relationship classes, subtypes and domains.

Shapefile and table (.dbf) versions of the data are included within the data. Column names have been simplified and the text values have been maintained within the shapefile attributes. The direction columns are numerical, to display rotation for points, and the symbol fields will hold the correct values to be matched to the appropriate style file.

For a more in depth description of the data model please refer to the official publication:

Science language for an integrated Geological Survey of Canada data model for surficial geology maps, version 1.2; Deblonde, C; Plouffe, A; Boisvert, É; Buller, G; Davenport, P; Everett, D; Huntley, E; Inglis, E; Kerr, D; Moore, A; Paradis, S J; Parent,

M; Smith, I R; St. Onge, D; Weatherston, A. Geological Survey of Canada, Open File 7003, (ed. 1.2), 2012, ; 238 pages (1 sheet), doi:10.4095/290144

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5. The Licensee's liability to indemnify Canada under this Agreement shall not affect or prejudice Canada from exercising any other rights under law.

5.0 TERM

1. This Agreement is effective as of the date and time of acceptance (Eastern Time) and shall remain in effect for a period of one (1) year, subject to subsection 5.2 and section 6.0 below.

2. At the end of the first term, this Agreement shall automatically be extended for successive one (1) year terms, subject to section 6.0 below.

6.0 TERMINATION

1. Notwithstanding section 5.0, this Agreement shall terminate:

    i automatically and without notice, if the Licensee commits or permits a breach of any of its covenants or obligations under this Agreement;

    ii upon written notice of termination by the Licensee at any time, and such termination shall take effect thirty (30) days after the receipt by Canada of such notice; or

    iii upon mutual agreement of the parties.

2. Upon the termination for whatever reason of this Agreement, the Licensee's obligations under section 4.0 shall survive; and the Licensee's rights under section 2.0 shall immediately cease.

3. Upon the termination for whatever reason of this Agreement, the Licensee shall delete or destroy all Data acquired under this Agreement immediately or within a reasonable timeframe where the Data is required to complete orders of Derivative Products made before the termination date of this Agreement.

7.0 GENERAL

1. **Applicable Law**
   This Agreement shall be construed and enforced in accordance with, and the rights of the parties shall be governed by, the laws of Ontario and Canada as applicable. The parties hereto attorn to the jurisdiction of the Superior Court of the Province of Ontario.

2. **Entire Agreement**
   This Agreement constitutes the entire agreement between the parties with respect to its subject matter. This Agreement may only be amended in writing, signed by both parties, which expressly states the intention to amend this Agreement.

3. **Dispute Resolution**
   If a dispute arises concerning this Agreement, the parties shall attempt to resolve the matter by negotiation.

ACCORD DE LICENCE

ACCORD DE LICENCE D'UTILISATION SANS RESTRICTION DE DONNÉES NUMÉRIQUES DE GÉOGRATIS

CE DOCUMENT constitue une entente légale entre vous (ci-après le " Détenteur de licence ") et SA MAJESTÉ LA REINE DU CHEF DU CANADA (ci-après le " Canada "), représentée par le Ministre des Ressources naturelles du Canada. **EN ATTEIGNANT, TÉLÉCHARGEANT, IMPRIMANT OU UTILISANT LES DONNÉES, L'INFORMATION OU LE MATÉRIEL FOURNIS OU ACCESSIBLES SELON CETTE ENTENTE, VOUS VOUS ENGAGEZ À RESPECTER LES MODALITÉS DE CET ACCORD.** SI VOUS ÊTES EN DÉSACCORD AVEC CES MODALITÉS, VOUS DEVEZ IMMÉDIATEMENT ÉLIMINER TOUTE COPIE DE CES DONNÉES, INFORMATION, MATÉRIEL ET PRODUITS DÉRIVÉS.

I. **ATTENDU QUE** le Canada détient les droits de propriété sur les données (les " Données ") accessibles aux termes des modalités de cet Accord;

II. **ATTENDU QUE** le Détenteur de licence désire obtenir certains droits sur les Données, sous réserve des modalités énoncées ci-après;

III. **ATTENDU QUE** le Canada déclare avoir la pleine autorité pour accorder les droits demandés par le Détenteur de licence, sous réserve des modalités énoncées ci-après;

IV. **ET ATTENDU QUE** les parties veulent en venir à une entente d'utilisation à partir de ce qui suit.

V. **À CES CAUSES**, en considérant les conventions contenues dans cet Accord, les parties conviennent de ce qui suit :

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1. Données du Canada signifie toute Donnée dont le Canada détient le droit de propriété.

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3. Produits dérivés signifie tout produit, système, sous-système, appareil, composant, matériel ou logiciel qui comprend ou utilise toute partie des Données.

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2. Le Canada ne peut être tenu responsable par le Détenteur de licence en ce qui a trait à toute réclamation, revendication ou action en justice, quelle qu'en soit la cause, concernant toute perte ou tout préjudice ou dommage ou frais, direct ou indirect, qui pourrait résulter de la possession ou de l'utilisation des Données par le Détenteur de licence.

3. Le Détenteur de licence tiendra le Canada et ses représentants, employés, agents et exécutants, indemnes et à couvert à l'égard de toute réclamation, revendication ou action en justice, quelle qu'en soit la cause, alléguant toute perte, tout frais, toute dépense, tout dommage ou toute blessure (y compris toute blessure mortelle) qui pourrait résulter de la possession ou de l'utilisation des Données par le Détenteur de licence.

4. Le Détenteur de licence devra accorder des licences d'utilisation à toute personne ou partie qui obtient les Données ou des Produits dérivés au moyen d'un accord de licence, et cet accord devra imposer à ces personnes ou parties les mêmes modalités que celles qui sont énoncées dans la section 4.0 de cet Accord.

5. L'obligation du Détenteur de licence d'indemniser le Canada selon cet Accord ne peut affecter ni empêcher le Canada d'exercer tout autre droit selon la loi.

5.0 DURÉE

1. Cet Accord entre en vigueur à partir de la date et de l'heure d'acceptation des modalités de l'Accord (Heure de l'Est) et restera en vigueur pour une période d'un (1) an, en vertu de la sous-section 5.2 et de la section 6.0 qui suivent.

2. À la fin du premier terme, cet Accord sera automatiquement renouvelé pour des termes successifs d'un (1) an, en vertu de la section 6.0 qui suit.

6.0 RÉSILIATION

1. 6.1 Nonobstant la section 5.0, cet Accord peut être résilié :

   i. automatiquement et sans préavis, si le Détenteur de licence manque à ses engagements ou obligations selon cet Accord;

   ii. par un préavis écrit de résiliation émis par le Détenteur de licence, en tout temps, et cette résiliation prendra effet trente (30) jours suivant la réception d'un tel préavis par le Canada; ou

   iii. par consentement mutuel des parties.

2. Lors de la résiliation de cet Accord, pour quelque raison que ce soit, les obligations qui incombent au Détenteur de licence en vertu de la section 4.0 continueront de s'appliquer et les droits du Détenteur de licence en vertu de la section 2.0 cesseront immédiatement.

3. Lors de la résiliation de cet Accord, pour quelque raison que ce soit, le Détenteur de licence devra immédiatement effacer ou détruire toutes les Données obtenues en vertu de cet Accord, ou à l'intérieur d'un délai raisonnable lorsque les Données sont nécessaires pour terminer la livraison de Produits dérivés commandés avant la résiliation de cet Accord.

7.0 GÉNÉRAL

1. **Lois d'application**
   Le présent Accord est régi et interprété en vertu des lois en vigueur dans la province de l'Ontario. Les parties acceptent de tomber sous la juridiction de la Cour supérieure de la Province de l'Ontario.

2. **Totalité de l'Accord**
   Le présent Accord constitue l'intégralité de l'entente conclue entre les parties relativement à l'objet du présent Accord. Toute modification à cet Accord ne peut être que par écrit, doit porter la signature de chaque partie et exprimer clairement l'intention de modifier cet Accord.

3. **Solution des litiges**
   Si un litige survient à propos de cet Accord, les parties tenteront de le résoudre par des négociations de bonne foi.